

**Final Annual Report on the
Mathematical Sciences Research Institute
2019-20 activities supported by
NSF Grant DMS-1440140
June 1, 2019 to May 31, 2020**

August 2020

Mathematical Sciences Research Institute

Annual Report, 2019-2020

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1. Overview of Activities

This annual report covers MSRI's projects and activities supported by the NSF core grant, DMS-1440140, during the period of June 1st, 2018 to May 31st, 2019.

1.1 New Developments

The year 2019–20 was a lively and productive one. In Fall 2019, we held two programs: *Holomorphic Differentials in Mathematics and Physics* with lead organizer Jayadev Athreya (University of Washington) and *Microlocal Analysis* with lead organizer Andras Vasy (Stanford University). We held two more programs in Spring 2020: *Higher Categories and Categorification* with lead organizer Emily Riehl (Johns Hopkins University) and *Quantum Symmetries* with lead organizer Scott Morrison (Australian National University).

In mid-March, due to the COVID-19 pandemic, MSRI's Spring program activities were moved entirely online. While in-person programs are of course irreplaceable, the MSRI Directorate was very pleased to find that the online format worked quite well under the circumstances. Much credit is due to the Organizers of the programs who worked hard to establish a friendly and productive virtual environment. MSRI is very grateful for their dedication and initiative. The programs enjoyed a high level of engagement online and the workshops had greater attendance than usual. In addition, MSRI hosted several summer 2020 activities online with surprising success, including ADJOINT, MSRI-UP, and one Summer Graduate School. The Summer School was organized by Daniel Tataru and Mihael Ifrim, who reported that it was the best summer school they've experienced in a long time thanks to the profoundly engaged students. Further details about the summer 2020 activities will be included in next year's annual report. For more information on the effect of COVID-19 on the Spring programs, see Section 1.10.

All four programs were very popular, and their workshops well attended. All programs had stellar researchers, including four Clay Senior Scholars: Daniel Freed from the Quantum Symmetries program, Peter Teichner from the Higher Categories program, Gunther Uhlmann from the Microlocal Analysis program, and Anna Wienhard from the Holomorphic Differentials in Mathematics and Physics program.

Professor Freed is an eminent scholar whose work is at the interface between physics and mathematics, with a focus on quantum field theory and its relationship to algebra, topology, and geometry. His work on invertible quantum field theories is at the heart of the program's research area (quantum symmetries). Similarly, his expertise on extended topological field theory played a key role in facilitating interactions with the concurrent program, Higher Categories and Categorification. Furthermore, his experience mentoring graduate students and postdocs made him well suited for mentoring the MSRI Postdocs in residence during the Spring. As Professor Constantin Teleman wrote in his recommendation letter, "what suits [Freed] so well for the role [of Clay Senior Scholar] beyond his contribution to the subject, is his engaging personality and boundless energy in interacting and sharing his thoughts with scholars of all levels, from luminaries in quantum physics to graduate students in search of guidance."

Since 2008, Professor Teichner has been the Director of the Max Planck Institute for Mathematics in Bonn. During that time, he was also a Professor at the University of California, Berkeley from 2004-2017. He has mentored 37 graduate students and postdoctoral fellows, and currently supervises another 15. Professor Teichner is known for his research on 4-manifolds topology. The organizers of the Higher Categories program wrote, “[Teichner] is now one of the few mathematicians to have forged links—largely from mathematical physics—between higher category theory and differential topology, most notably between factorization algebras and knot theory.” He is a prolific author with several of his papers having been published in top journals, such as the *Annals of Mathematics*, *Inventiones*, and *PNAS*.

Professor Uhlmann is internationally renowned for his profound work on inverse problems. His work is motivated by applications to science, medicine, and engineering, such as in geophysical prospection and brain imaging. Professor Uhlmann has received countless honors and prizes for his research including the Solomon Lefschetz Medal (2017), the Bocher Memorial Prize, and the Kleinman Prize (2011), among others. To quote Professor Richard Melrose, Uhlmann’s achievement has been “to take highly theoretical work on microlocal analysis and refine it (not just apply it) to handle inverse problems. [...] In short, the work of Uhlmann over the last few years is a remarkable vindication of the idea that sophisticated mathematics can have wide consequences when applied with knowledge and insight.”

A graduate of Rheinische Friedrich-Wilhelms Universität Bonn, Professor Wienhard is currently the Chair of the Differential Geometry Research group at the Ruprecht-Karls-Universität, Heidelberg. She is also the Leader of the “Groups and Geometry” group at the Heidelberg Institute of Theoretical Studies. From 2008 to 2013 Professor Wienhard was a member of the Young Academy of the German National Academy of Science, in 2013 she became a Fellow of the American Mathematical Society, and in 2017 she joined the Heidelberg Academy of Science. The Holomorphic Differentials in Mathematics and Physics program brought together distinct research communities that are unified by holomorphic differentials. Among those research communities was the study of character varieties and deformations of geometric structures. Professor Wienhard is one of the most prominent geometers of her generation, and her involvement acted as a catalyst in creating necessary interactions to advance this research.

Other luminaries, aside from the organizers listed in the program reports, were Pierre Albin (University of Illinois, Urbana-Champaign), Nalini Anantharaman (Université de Strasbourg), Clark Barwick (University of Edinburgh), David Ben-Zvi (University of Texas, Austin), Vladimir Fock (Université de Strasbourg), Terry Gannon (University of Alberta), David Gepner (Purdue University), Teena Gerhardt (Michigan State University), Colin Guillarmou (Université de Paris XI), Vaughan Jones (Vanderbilt University), François Labourie (Université de Nice), Rafe Mazzeo (Stanford University), Richard Melrose (Massachusetts Institute of Technology), Andrew Neitzke (University of Texas, Austin), Victor Ostrik (University of Oregon), Sorin Popa (University of California, Los Angeles), Emily Riehl (Johns Hopkins University), Ulrike Tillmann (Oxford University), Andras Vasy (Stanford University), Kevin Walker (Microsoft Station Q), Richard Wentworth (University of Maryland), Sarah Witherspoon (Texas A&M University), Steve Zelditch (Northwestern University), Anton Zorich (Institut de Mathématiques de Jussieu).

In all, MSRI awarded twenty (24) researchers the distinguished Chern, Eisenbud and Simons Professorships.

A description of the research areas investigated during the 2019-20 academic year programs, together with a summary of the salient discoveries, can be found in the Appendix as part of the program organizers' reports. Here is a small sample that gives a glimpse into the effervescent research activities that took place throughout the year.

Holomorphic Differentials in Mathematics and Physics. One of the interesting developments of this program was the collaboration between a postdoc, Dami Lee, a workshop speaker, Alexandra Skripchenko, and several members of the program. The classification of triply-periodic surfaces obeying certain particularly regular rules of construction is an open problem. As it turned out, a new surface of this kind was recently discovered by Dami Lee. As she pursued her work in this area Sasha Skripchenko announced the proof (with Dynnikov, Hubert, and Mercat) of an 80-year-old conjecture by Novikov claiming that chaotic electron trajectories appear exceptionally rarely for symmetric Fermi-surfaces of genus 3. Subsequently, Dami, Sasha, and Jayadev Athraya (one of the program organizers) initiated a collaboration on this circle of problems. They are investigating the behavior of hyperplane sections of the genus 3 surfaces that Dami has discovered, and how these relate to Novikov's conjecture.

Microlocal Analysis. The organizers of this program report enthusiastically that the collaborations among the members were exceptional. They mention 30 new collaborations that were created during the semester. A common theme of the semester was the application of microlocal analysis to a wide range of problems from other areas of mathematics. In this direction, ongoing efforts to apply microlocal analysis to the representation theory of noncompact Lie groups were advanced by the development of a new approach to compactification of reductive Lie groups in a paper of Albin, Dimakis, Melrose, and Vogan completed during the semester. This new, 'hd'-compactification, of a Lie group is a manifold with corners to which the group operations have natural extensions and is shown in the paper to be essentially characterized by this property. The machinery of geometric microlocal analysis can then be applied to the compactification together with the left/right invariant vector fields to produce a pseudodifferential calculus. It is expected that this calculus will give new approaches to, and explanations of, objects in representation theory (e.g., through the spectral theory of the Casimir).

Quantum Symmetry. As the organizers mention in their report "The research development during the Quantum Symmetries program was remarkable both in the number of projects initiated prior to the shutdown [due to the COVID 19 pandemic] and the interrupted and potential projects put on hold. [...] The program presented a unique opportunity for established research directions to advance very quickly. Only 3 of 40 respondents reported having neither written papers nor initiated research in new areas or with new collaborators. In all 3 cases the respondents missed a major proportion of their residence in Berkeley."

While the organizers were quick and remarkable in adapting to the mandatory shelter-in-place ordinance, the pandemic still had consequences on the program. Many members reported finishing papers begun elsewhere, often with other members as co-authors, but a significant

number of projects' development was slowed or paused by the crisis of the COVID-19 pandemic. Operator algebras suffered disproportionately from this as Popa, Kawahaigashi, Wenzl and Bischoff were scheduled to arrive after mid-March 2020. Connections to physics were also muted—at least three physics-focused workshop talks did not receive the deserved follow-up after the workshop's rapid transition to an online format. Interdisciplinary and “branching out” research were also notable casualties to the shutdown of in-person activities.

At the same time, the organizers note that “One of the [program's] most unexpected breakthroughs was the rapid development of the online workshop, falling exactly on the week of the mandatory shelter-in-place order in Berkeley. The remarkably smooth transition of seminars to a virtual format was exemplary. The members and participants' devotion to the subject was impressive: attendance at the virtual workshops and seminars was consistently quite high (70+ during the workshops, and 25-35 for the seminars). The virtual talks drew a very broad audience, with many attendees not officially affiliated with the program. This broad reach of the workshops and seminars partially mitigated the significant loss of members that could not attend synchronously due to family responsibilities, time zone inconvenience, connectivity issues and other difficulties.

Another highlight was that the two concurrent workshops [with the program Higher Category and Categorifications] were very well-matched and the talks in both areas drew significant cross-over participation. Many members reported that the virtual talks were particularly helpful in this way, as the breadth of the audience necessitated less technical talks. Topological quantum field theory is a particularly compelling source of cross-over breakthroughs.”

Higher Categories and Categorification. The Higher Categories and Categorification program at MSRI sought to connect “end-users” who offer a vision to use higher categorical technology in mathematical physics, representation theory, differential topology, and homotopy theory, to the “engineers” who are actively developing higher categorical technologies. This program had unique characteristics that we wish to describe here, as some of those might be used for future programs. One of the striking features was the partially-blind review of the postdoctoral applications. All the details, including the rubric and a description of the help provided by MSRI staff to remove identifying material, can be found in their report. As the organizers wrote:

“Of course part of the postdoctoral fellow application included letters of reference and a CV, so we eventually learned the names of each applicant. But in our experience, first impressions of how strong a candidate is are made quickly, and we felt it was much healthier to form those impressions when focused solely on the research of each candidate, without being distracted by biographical details. Since applicants were proposing future research projects, we found them less identifiable than one might think. Even when we realized we knew who was writing, it felt like we were seeing them through new eyes.”

The result was indeed more inclusive than we see in most programs. While the numbers are small (only eight postdocs per program), the *Higher Categories* program offered postdoctoral fellowships to four women (one of whom ultimately attended as a research member), whereas most programs will invite only one or two women postdocs. Additionally, only one of the postdocs was a past Ph.D. student of an organizer. The MSRI's Scientific Advisory Committee

endorsed the selection with enthusiasm and admiration. There was no need to adjust their selection.

Scientifically one of the breakthroughs reported by the organizers is the following:

“After the pandemic forced the semester online, Barwick started a working group on stratified homotopy theory and related problems. Beginning at an elementary level, participants shared the burst of new advances relating stratifications in topology and geometry to higher categorical structures from the past ten years. Over time, the aim and nature of the working group shifted away from exposition to proving new theorems. The working group is now developing a framework in which to prove a stratified form of tannakian duality. This is a fundamental connection between some extremely abstract objects of category theory and higher category theory and much more concrete geometric objects — topological groups, group schemes, and stacks. The original forms of this duality were developed by Grothendieck and his school in the 60s and 70s, and their vision was fully realized by Deligne in 1990. This duality has been critical for the modern understanding of cohomology theories in algebraic geometry.”

I am happy to report that this group is still meeting regularly through MSRI's Zoom and slack licenses.

This year's Hot Topic workshop was on Optimal Transport and Applications to Machine Learning and Statistics. Due to the pandemic, it was moved online and was open to all interested scientists. Consequentially, the workshop had a total of 264 participants making it the largest workshop MSRI has “hosted” in the last 10 years.

Gabriel Peyré gave a fascinating introductory talk that set the tone for the rest of the workshop. As he wrote in his abstract, “Optimal transport (OT) has recently gained lot of interest in machine learning. It is a natural tool to compare in a geometrically faithful way probability distributions. It finds applications in both supervised learning (using geometric loss functions) and unsupervised learning (to perform generative model fitting). OT is however plagued by the curse of dimensionality, since it might require a number of samples which grows exponentially with the dimension.”

Peyré reviewed entropic regularization methods which define geometric loss functions approximating OT with a better sample complexity.

The talks of all of our workshops were recorded and can be seen on our website at <http://www.msri.org/web/msri/online-videos>.

Funding. In 2019-20, of the support for program members (long-term visitors, excluding Postdocs), 55% came from the NSF and 45% from private funds. Of the support for workshop participants (short-term visitors, including summer graduate schools) 67% came from NSF, and 33% from private funds. These numbers demonstrate MSRI's ability to leverage the support that the NSF provides and thereby amplify its benefits; we feel that this is possible because the core NSF support provides such a strong foundation for, and endorsement of, MSRI's scientific quality.

Postdoctoral Program. Thirty-two (32) Postdoctoral Fellows participated in our four scientific programs and in the complementary program. Of those, eighteen (18) were funded by this NSF grant.

Nicolle Sandoval Gonzalez was the Berlekamp Postdoctoral Fellow; Katrina Morgan the Gamelin Fellow; Cris Negron the Huneke Fellow; Dylan Allegretti the McDuff Fellow; David Reutter the Strauch Fellow; Xuwen Zhu the Uhlenbeck Fellow; Alexander Campbell and Hui Zhu the Viterbi Fellows; and Colleen Delaney and Laura Fredrickson the Della Pietra Fellows. For details, please see Section 3.

Collaborative Diversity Initiative. This Diversity Initiative, known as MSIDI, consists of a series of workshops for members of groups that have been historically underrepresented in the mathematical sciences. These workshops are sponsored by a collaborative grant involving NSF-funded US mathematical sciences institutes (AIM, IAS, ICERM, IPAM, MSRI, and SAMSI). MSRI is the institutes administering the grant. During the 2019-20 academic year, one workshop was supported by the Initiative. The Modern Math Workshop was held in October 2019 in Honolulu, Hawaii. It was organized by MSRI and attracted 109 participants. A complete report can be found in the Appendix.

Critical Issues in Mathematics Education. The Critical Issues in Mathematics Education (CIME) series of workshops addresses key problems in education today. They are designed to engage professional mathematicians in discussions with education researchers, teachers, and policy makers to improve mathematics education. This year's topic was on *Today's Mathematics, Social Justice, and Implications for Schools*. Due to the COVID-19 pandemic, the workshop was held online with a modified schedule. There were 139 attendees, which is in line with our 5-year average attendance of 142. It was funded through a grant from Math for America.

Public Understanding of Mathematics. MSRI organizes activities each year that help the public understand the power, beauty, and fun of mathematics:

Mathical Book Prize: (www.mathicalbooks.org) MSRI, in coordination with the Children's Book Council (CBC) and in partnership with the National Council of Teachers of Mathematics (NCTM) and the National Council of Teachers of English (NCTE), continued the Mathical Book Prize for its sixth year. The prize aims to cultivate a love of mathematics in the everyday world in children ages 2-18 through fiction and literary nonfiction stories. A national committee of mathematicians, librarians, educators, and early childhood experts selects each year's winners.

The prize is supported by the Firedoll Foundation and the Patrick J. McGovern Foundation. MSRI continues to partner with the nonprofit First Book to distribute Mathical titles and accompanying educational resources to schools and programs serving children in low-income communities. In 2020, MSRI began additional partnerships with several organizations to share Mathical titles with communities around the U.S. New partners include the Association of Children's Museums (ACM); the Books for Kids Foundation; Development and Research in Early Math Education (DREME); and School Library Journal (SLJ). In partnership with SLJ, 24

libraries in Title I K–12 schools were selected in the inaugural Mathical Book Prize Collection Development Awards to receive grants of \$700 each to purchase titles from the Mathical list.

The 2020 Mathical Prize winners (published in 2019) are: Pre-Kindergarten, *One Fox: A Counting Book Thriller*, by Kate Read (Peachtree Publishing Company), a surprising counting book featuring barnyard intrigue between a fox and hens; Grades K-2, *Pigeon Math*, by Asia Citro (Innovation Press), on the challenges of counting an ever-changing flock of birds; Grades 3-5, *Solving for M*, by Jennifer Swender (Crown Books for Young Readers), about a middle schooler who uses a math journal to come to terms with changes in her family and friendships; and Grades 9-12, *Slay*, by Brittney Morris (Simon Pulse), a dramatic tale of a Black teenager who faces real-world challenges regarding the popular online game she has secretly developed. The committee also selected nine honor books and two Hall of Fame titles.

Films for Public Television: People who do and use mathematics often have fascinating stories and adventures to tell related to their work; and partly because their work itself is often hard for non-mathematicians to comprehend, these stories can have a special interest. As part of MSRI's commitment to telling the story of mathematics, we have produced a number of films about mathematicians; many have been directed by George Csicsery of Zala Films, whose first film about a mathematician, *N is a Number*, has become a classic.

MSRI's newest feature-length documentary film, *Secrets of the Surface: The Mathematical Vision of Maryam Mirzakhani* (www.zalafilms.com/secrets) premiered at the Joint Mathematics Meetings in Denver, CO in January 2020. The film has been screened worldwide as part of the May 12th initiative (may12.womeninmaths.org) of the International Mathematical Union's Committee for Women in Mathematics. Over 20,000 people registered to view the film (1/3 for the English version, 1/3 for the Farsi subtitled version, and the rest for subtitled versions in Spanish, French, Italian, Portuguese, and Turkish). Additional online screenings have been held by various universities worldwide as well as a special Twitter watch party hosted by The Fields Institute for Research in Mathematical Sciences. The film was featured in *Nature* magazine and *The Hindu* newspaper of India, and has been selected for many festivals, including the Iranian Film Festival of Zurich and the Australian Muslim Film Festival. Television broadcast is anticipated for 2020-2021.

Numberphile: (www.youtube.com/numberphile). Since January 2014, MSRI has contributed financial and intellectual support to Brady Haran's Numberphile YouTube channels and, starting this year, an audio podcast as well. In this period the number of subscribers has climbed from about 750,000 to 3.41 million, and the channel has had over 500 million views.

This year Numberphile has uploaded 79 new videos, taking the total number to 579. It has accumulated a further 85 million video viewers, bringing the total to 502 million views as of July 2020. In addition, a further 16 supplemental videos and 15 podcast episodes were uploaded to the "extras channel" called Numberphile2, for a total of 173 bonus videos. Recent podcast episodes have featured a lengthy interview with Sir Roger Penrose and tributes to Ronald Graham and John Conway. Numberphile in all formats remains an unprecedented way to share mathematics with millions of people from all generations.

For a sample of recent additions to the video collection, we recommend “A New Discovery about Dodecahedrons” featuring MSRI program organizer Jayadev Arthreya (University of Washington), “Colouring Numbers” with Fields Medalist Sir Timothy Gowers (University of Cambridge) on Van der Waerden's theorem, “Mathematics and Coronavirus” with author Kit Yates, and “The Girl with the Hyperbolic Helicoid Tattoo” featuring Sabetta Matsumoto (Georgia Tech).

The CME Group-MSRI Prize in Innovative Quantitative Applications:

(www.msri.org/web/msri/activities/cme-prize) recognizes originality and innovation in the use of mathematical, statistical or computational methods for the study of the behavior of markets, and more broadly of economics. The 14th annual Prize was awarded to Susan Athey, The Economics of Technology Professor; Professor of Economics (by courtesy), School of Humanities and Sciences; and Senior Fellow, Stanford Institute for Economic Policy Research, Stanford Business School. Athey’s current research focuses on the economics of digitization, marketplace design, and the intersection of econometrics and machine learning. As one of the first “tech economists,” she served as consulting chief economist for Microsoft Corporation for six years, and now serves on the boards of Expedia, Lending Club, Rover, Turo, and Ripple, as well as non-profit Innovations for Poverty Action. She also serves as a long-term advisor to the British Columbia Ministry of Forests, helping architect and implement their auction-based pricing system. Athey is the founding director of the Golub Capital Social Impact Lab at Stanford GSB, and associate director of the Stanford Institute for Human-Centered Artificial Intelligence. An award ceremony scheduled for April 2020 in Chicago was postponed because of the pandemic.

Congressional Briefings: (www.msri.org/congress) Since December, 2017, MSRI, in cooperation with the American Mathematical Society, has run twice-yearly Congressional Briefings in Washington highlighting the value to the U.S. of Federal funding for basic research. On December 5, 2019, Jill Pipher, Vice President for Research and Elisha Benjamin Andrews Professor of Mathematics at Brown University, presented "No Longer Secure: Cryptography in the Quantum Era".

The briefing planned for Spring 2020 was “Differential Privacy: Defending Large Datasets Against Powerful Attack”, featuring Cynthia Dwork, Gordon McKay Professor of Computer Science at the John A. Paulson School of Engineering and Applied Sciences at Harvard and the Radcliffe Alumnae Professor at the Radcliffe Institute for Advanced Study. This event has been postponed because of the pandemic.

National Math Festival: (www.nationalmathfestival.org) As a lead-in activity to the 2021 National Math Festival, MSRI hosted three online roundtable discussions with 2021 Festival presenters in April and May 2020. These events were offered as informal occasions to connect in real time with Festival presenters via Zoom webinar, featuring math educators, Mathical Book Prize award-winning authors, live performances, and Q&A sessions. Over 600 attendees joined these free events for all ages, from throughout the U.S. and around the globe. The 2021 National Math Festival will be held online due to COVID-19, with sessions beginning December 2020 and continuing through the Festival weekend of April 17-18, 2021.

Private Fundraising: The Private fundraising or MSRI continues to be a robust operation that leverages NSF support to enhance and grow both our scientific and public outreach programming. We continue to welcome new donors through annual fund drive efforts, as well as through targeted communication and networking.

As shown by the Spendable Annual Revenue Chart below, the total percentage of spendable funds from private donors (individuals, private foundations, and corporations) continues to increase. In 2013, approximately one-third of the revenue came from private sources. Today, we receive close to one-half of the revenue from private sources. In addition to what is shown on the chart for FY 19-20, we have over \$800,000 in pledges that we expect to receive which will be counted in the next fiscal year.

MSRI is in the quiet portion of a years-long capital campaign with the intent to further increase the percentage of funding from private sources.

1.2 Summary of Demographic Data for 2019-20 Activities

During the academic year 2019–20, MSRI hosted 229 program members (32 of whom were Postdoctoral Fellows) and 1884 workshop participant visits.

The Postdoctoral program was particularly successful and is described in detail in Section 3. Of the 32 Fellows, 10 (31%) were female, 13 (41%) were U.S. Citizens or Permanent Residents, and 22 (69%) listed a U.S. university as their home institution. Of those 22 US based fellows, 1 (5%) is located in the Northeast, 12 (55%) in the West, 6 (27%) in the Midwest, and the remaining 3 (14%) in the South.

MSRI had a total of 229 long-term members. During the Fall 2019 semester, members spent an average of 71 days (2.4 months) at MSRI per visit, with peak attendance in October. The Fall semester ran for a total of 131 days (4.4 months). During the Spring 2020 semester, members spent an average of 39 days (1.3 months) per visit, with peak attendance in February. The much shorter average visit length in the Spring semester is due to the COVID-19 pandemic, which prompted MSRI to close as of March 10th, 2020. This means that longest possible visit during the Spring semester was 50 days (1.7 months).

While no members were physically present at MSRI following the closure, programmatic activities continued online. Many members chose to stay in Berkeley where they could remain deeply engaged in the program and continue the research momentum built during the time away from their usual responsibilities. Furthermore, many of the members who returned home following the closure were still able to continue engaging in programmatic activities online. Out of 114 distinct members who had planned to visit MSRI during the Spring semester, 93 of them (82%) were impacted in some way by the closure. Of those, 15 members (16%) cancelled their visits altogether, 46 members (49%) returned home earlier than planned, and 32 members (34%) stayed in Berkeley for the length of their planned visit despite not having access to the MSRI building. See Section 1.10 for detailed information on how the pandemic affected the programs.

Of the 229 members who were in residence at MSRI during the 2019-20 academic year, 24% were female, 50% reported being U.S. Citizens or Permanent Residents, and 55% listed a U.S. university as their home institution. Of those institutions, 31% are located in the West, 17.5% in the Northeast, 31% in the Midwest, and 20.6% in the South. Of the members, 20% received their Ph.D. during the year 2015 or later, 29% received one between 2005 and 2014, 36% received their Ph.D. in 2004 or earlier, and the remaining 15% were graduate students. Detailed demographic data can be found in Section 2.

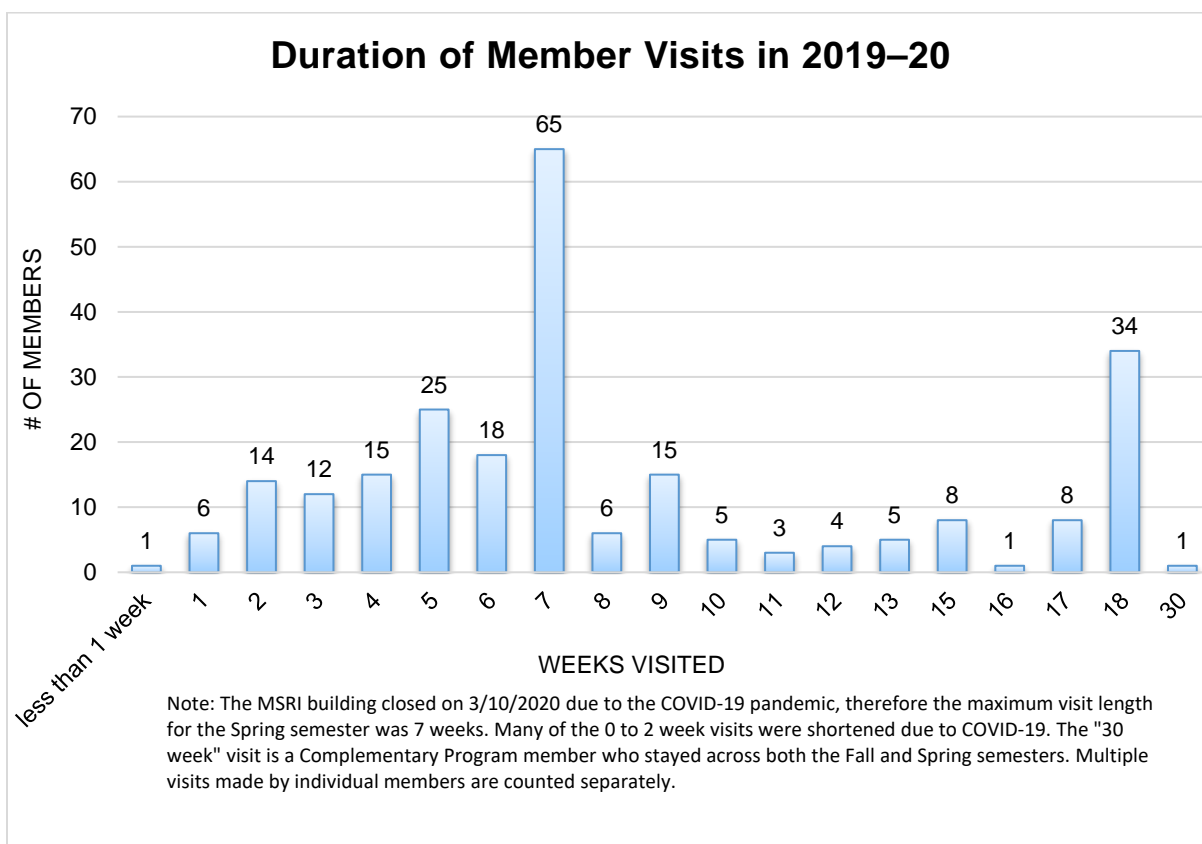
MSRI hosted 17 workshops during the 2019–20 academic year, four of which were held online only. A total of 1884 participants attended the workshops (some individuals attended multiple events and are counted more than once). Registration was encouraged, but not required for the online workshops; therefore demographic information is not available for 214 unregistered participants. Of the 1670 workshop participants for whom information is available, 28% were female and 50% were U.S. Citizens or Permanent Residents, of whom 12% reported being a

member of an under-represented minority. In addition, 66% came from a U.S. institution. Demographic data on workshop participants can be found in Sections 2 and 4.

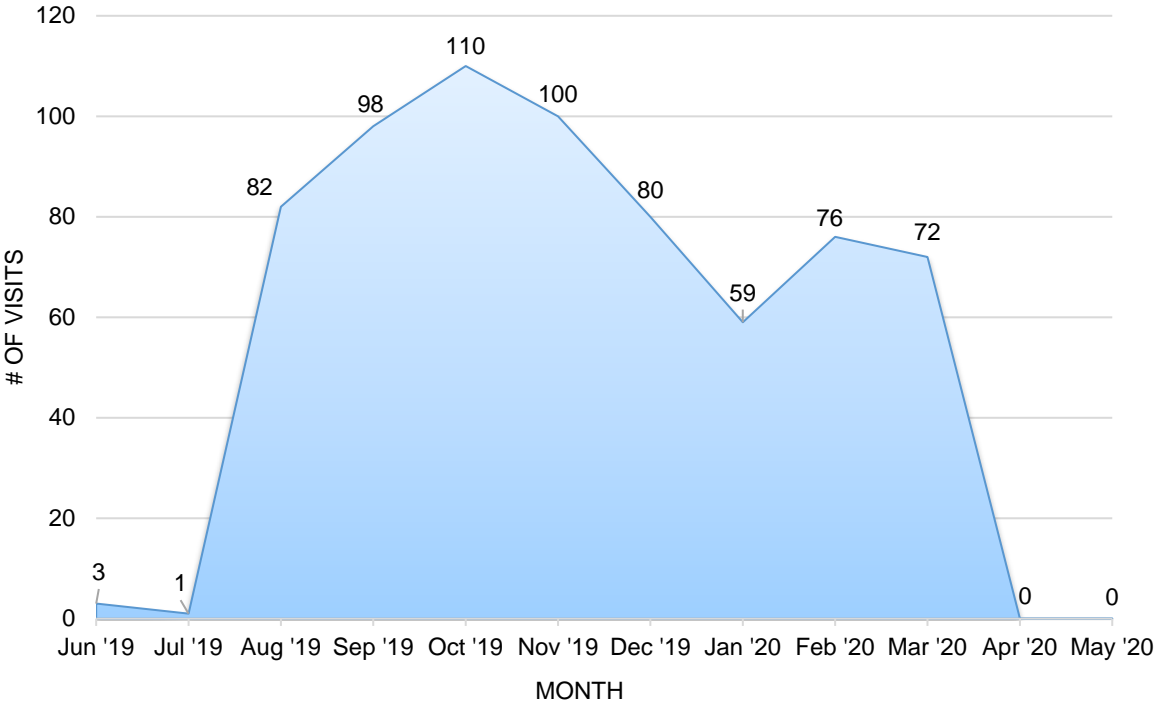
Member Visits Summary*

All program members	Summer 2019	Fall 2019	Spring 2020	2019-20	2004-20
Total Member Days	111	10,326	3,936	14,373	287,955
Total # of Member Visits	3	145	101	249	4,001
Average # of Days per Member Visit	37.00	71.21	38.97	57.72	71.97
Average # of Months per Member Visit	1.23	2.37	1.30	1.92	2.40
All female program members	Summer 2019	Fall 2019	Spring 2020	2019-20	2009-20
Total Member Days	0	2,584	1,007	3,591	50,288
Total # of Member Visits	0	36	26	62	679
Average # of Days per Member Visit	0.00	71.78	38.73	57.92	74.06
Average # of Months per Member Visit	0.00	2.39	1.29	1.93	2.47

*Please note that this table calculates member's visits, which can be multiple.



Member Visits by Month in 2019-20



Note: The MSRI building closed on 3/10/2020 due to the COVID-19 pandemic. Programmatic activities continued online, but no members were physically present at MSRI after the closure.

1.3 Scientific Programs and their Associated Workshops

There were four major, one complementary, and two summer research programs that took place at MSRI during the 2019-20 year, as well as twelve programmatic workshops. Due to the COVID-19 pandemic, two of the programmatic workshops were conducted virtually.

Note: Full descriptions of each activity can be found the Appendix (Section 13) of this Annual Report. In the lists of organizers of each activity below, the name of the lead organizer(s) appears in blue.

Program 1: Holomorphic Differentials in Mathematics and Physics

August 12, 2019 to December 13, 2019

Organizers: [Jayadev Athreya](#) (University of Washington), Steven Bradlow (University of Illinois at Urbana-Champaign), Sergei Gukov (California Institute of Technology), Andrew Neitzke (Yale University), Anna Wienhard (Ruprecht-Karls-Universität Heidelberg), Anton Zorich (Institut de Mathématiques de Jussieu)

Workshop 1: Connections for Women: Holomorphic Differentials in Mathematics and Physics

August 15, 2019 - August 16, 2019

Organizers: Laura Fredrickson (Stanford University), Lotte Hollands (Heriot-Watt University, Riccarton Campus), [Qionglin Li](#) (Chern Institute of Mathematics), Anna Wienhard (Ruprecht-Karls-Universität Heidelberg), Grace Work (Massachusetts Institute of Technology)

Workshop 2: Introductory Workshop: Holomorphic Differentials in Mathematics and Physics

August 19, 2019 - August 23, 2019

Organizers: [Jayadev Athreya](#) (University of Washington), Sergei Gukov (California Institute of Technology), Andrew Neitzke (Yale University), Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)

Workshop 3: Holomorphic Differentials in Mathematics and Physics

November 18, 2019 - November 22, 2019

Organizers: [Jayadev Athreya](#) (University of Washington), Steven Bradlow (University of Illinois at Urbana-Champaign), Sergei Gukov (California Institute of Technology), Andrew Neitzke (Yale University), Laura Schaposnik (University of Illinois at Chicago), Gabriela Weitze-Schmithuesen (Universität des Saarlandes), Anton Zorich (Institut de Mathématiques de Jussieu)

Program 2: Microlocal Analysis

August 12, 2019 to December 13, 2019

Organizers: Pierre Albin (University of Illinois at Urbana-Champaign), Nalini Anantharaman (Université de Strasbourg), Kiril Datchev (Purdue University), Raluca Felea (Rochester Institute of Technology), Colin Guillarmou (Université de Paris XI (Paris-Sud)), [Andras Vasy](#) (Stanford University)

Workshop 1: Connections for Women: Microlocal Analysis

August 29, 2019 – August 30, 2019

Organizers: Tanya Christiansen (University of Missouri), [Raluca Felea](#) (Rochester Institute of Technology)

Workshop 2: Introductory Workshop: Microlocal Analysis

September 03, 2019 - September 06, 2019

Organizers: Pierre Albin (University of Illinois at Urbana-Champaign), [Raluca Felea](#) (Rochester Institute of Technology), Andras Vasy (Stanford University)

Workshop 3: Recent Developments in Microlocal Analysis

October 14, 2019 - October 18, 2019

Organizers: [Pierre Albin](#) (University of Illinois at Urbana-Champaign), Nalini Anantharaman (Université de Strasbourg), Colin Guillarmou (Université de Paris XI (Paris-Sud))

Program 3: Quantum Symmetries

January 21, 2020 to May 29, 2020

Organizers: Vaughan Jones (Vanderbilt University), [Scott Morrison](#) (Australian National University), Victor Ostrik (University of Oregon), Emily Peters (Loyola University), Eric Rowell (Texas A & M University), [Noah Snyder](#) (Indiana University), Chelsea Walton (University of Illinois at Urbana-Champaign)

Workshop 1: Connections for Women: Quantum Symmetries

January 23, 2020 - January 24, 2020

Organizers: Emily Peters (Loyola University), [Chelsea Walton](#) (University of Illinois at Urbana-Champaign)

Workshop 2: Introductory Workshop: Quantum Symmetries

January 27, 2020 - January 31, 2020

Organizers: Vaughan Jones (Vanderbilt University), Victor Ostrik (University of Oregon), Emily Peters (Loyola University), [Noah Snyder](#) (Indiana University)

Workshop 3: Tensor Categories and Topological Quantum Field Theories (ONLINE)

March 16, 2020 - March 20, 2020

Organizers: Scott Morrison (Australian National University), Eric Rowell (Texas A & M University), [Claudia Scheimbauer](#) (TU München), Christopher Schommer-Pries (University of Notre Dame)

Program 4: Higher Categories and Categorification

January 21, 2020 to May 29, 2020

Organizers: David Ayala (Montana State University), Clark Barwick (University of Edinburgh), David Nadler (University of California, Berkeley), [Emily Riehl](#) (Johns Hopkins)

University), Marcy Robertson (University of Melbourne), Peter Teichner (Max-Planck-Institut für Mathematik), Dominic Verity (Macquarie University)

Workshop 1: Connections for Women: Higher Categories and Categorification

February 06, 2020 - February 07, 2020

Organizers: Emily Riehl (Johns Hopkins University), [Marcy Robertson](#) (University of Melbourne)

Workshop 2: Introductory Workshop: Higher Categories and Categorification

February 10, 2020 - February 14, 2020

Organizers: [David Ayala](#) (Montana State University), Emily Riehl (Johns Hopkins University), Christopher Schommer-Pries (University of Notre Dame), Peter Teichner (Max-Planck-Institut für Mathematik)

Workshop 3: (∞, n) -Categories, Factorization Homology, & Algebraic K-Theory (ONLINE)

March 23, 2020 - March 27, 2020

Organizers: [Clark Barwick](#) (University of Edinburgh), David Gepner (University of Melbourne), David Nadler (University of California, Berkeley), Marcy Robertson (University of Melbourne)

Program 5: Complementary Program (2019-20)

August 12, 2019 to May 29, 2020

MSRI had a small Complementary Program comprised of two postdoctoral fellows, Bob Lutz (University of Michigan) and Adrian Zahariuc (University of California, Davis), and the following researchers: Indira Chatterji (Universite Nice Sophia-Antipolis), Brian Collier (University of California, Riverside), Christian Haesemeyer (University of Melbourne), Bernd Ulrich (Purdue University), James Unwin (University of Illinois at Chicago), Anna Wienhard (Ruprecht-Karls-Universität Heidelberg), Sarah Yeakel (University of California, Riverside), and Paul Ziegler (TU München).

Program 6: Summer Research for Women in Mathematics

June 10, 2019 – August 02, 2019

Program 7: 2019 African Diaspora Joint Mathematics Workshops (ADJOINT)

June 10, 2019 – August 02, 2019

1.4 Scientific Activities Directed at Historically Underrepresented Groups in Mathematics

Connections Workshops

During the 2019-20 academic year, MSRI hosted four Connections workshops, one for each scientific program. These workshops have three overarching goals: (1) to give accessible introductions to the main themes of the program and exciting new directions in related research; (2) to provide participants the opportunity to become acquainted with the work of women in the field; and (3) to connect early-career researchers, especially women, gender-expansive individuals, and minorities, to potential senior mentors. A typical workshop consists of introductory lectures, presentations by post-doctoral researchers and graduate students, and a panel discussion addressing the challenges faced by all young researchers, but especially by women, in establishing a career in mathematics. Throughout the workshops, special effort is made to foster mentoring relationships between established and early-career researchers at the lunches, dinners, and coffee breaks. Participants of the Connections Workshop are encouraged to stay for the following week for the Introductory Workshop to the semester's program. The workshop organizers are also encouraged to propose week-end activities for small groups of women with similar research interests to discuss problems and perhaps to begin work on a joint research project (e.g. forming small research or study groups that would work on predetermined problems, read a paper, or learn new techniques). As is the case for all MSRI workshops, registration to attend Connections workshop lectures is open to all interested persons. For more information regarding each workshop, please refer to Section 1.3 above as well as the Appendix (Section 13).

Summer Research in Mathematics

June 10, 2019 – August 2, 2019

During the summer of 2019 MSRI hosted the Summer Research in Mathematics program, which provides space, funding, and the opportunity for in-person collaboration to small groups of mathematicians, especially women and gender-expansive individuals, whose ongoing research may have been disproportionately affected by various obstacles including family obligations, professional isolation, or access to funding. Through this effort, MSRI aims to mitigate the obstacles faced by these groups, improve the odds of research project completion, and deepen their research experience. The ultimate goal of this program is to enhance the mathematical sciences as a whole by positively affecting the research and careers of all of its participants and assisting their efforts to maintain involvement in the research community.

Groups of two to six mathematicians with partial results on an established research project submitted applications to the program. Each member of the group must have a Ph.D. in mathematics or advanced graduate standing. Each group was in residence at MSRI for a minimum of five working days, though the majority stayed for two weeks or more. For more information regarding this program, please refer to Section 6 of this annual report.

Please note: This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix.

2019 African Diaspora Joint Mathematics Workshops (ADJOINT)

June 10, 2019 – August 02, 2019

The main objective of ADJOINT is to provide opportunities for in-person research collaboration to U.S. mathematicians, especially those from the African American mathematics community, who work in small groups with research leaders on various research projects. Through this effort, MSRI aims to establish and promote research communities that will foster and strengthen research productivity and career development among its participants. The ADJOINT workshops are designed to catalyze research collaborations, provide support for conferences to increase the visibility of the researchers, and to develop a sense of community among the mathematicians who attend. This program will enhance the mathematical sciences and its community by positively affecting the research and careers of African-American mathematicians and supporting their efforts to achieve full access and engagement in the broader research community.

The ADJOINT 2019 pilot program hosted a total of 15 researchers divided into three groups, including three respected African American mathematicians acting as Research Leaders. All teams were predominantly comprised of African American mathematicians at various stages in their careers and were in residence at MSRI for up to two weeks. Their research projects were pursued further during the academic year via periodic virtual meetings and visits among collaborators, although some travel plans have been postponed due to the COVID-19 pandemic. MSRI plans to continue hosting ADJOINT in future years. For more information regarding this program, please refer to Section 7 of this annual report.

Please note: ADJOINT was funded by an independent NSF grant, DMS-1915954. The report was filed independently to the NSF, thus there is no report attached in Section 13: Appendix.

Undergraduate Program: MSRI-UP 2019: Combinatorics and Discrete Mathematics

June 15, 2019 – July 28, 2019

Organizers: Federico Ardila (San Francisco State University), Duane Cooper (Morehouse College), Maria Franco (Queensborough Community College (CUNY)), [Rebecca Garcia](#) (Sam Houston State University), Pamela Harris (Williams College), Suzanne Weekes (Worcester Polytechnic Institute)

The MSRI Undergraduate Program (MSRI-UP) is a comprehensive summer program designed for undergraduate students who have completed two years of university-level mathematics courses and would like to conduct research in the mathematical sciences. The main objective of the MSRI-UP is to identify talented students, especially those from underrepresented groups, who are interested in mathematics and make available to them meaningful research opportunities, the necessary skills and knowledge to participate in successful collaborations, and a community of academic peers and mentors who can advise, encourage and support them through a successful graduate program.

Please note: MSRI-UP is funded by an independent NSF grant, DMS-1659138. The report was filed independently to the NSF, thus there is no report attached in Section 13: Appendix.

NSF Mathematics Institutes' Modern Math Workshop at SACNAS

Location: SACNAS in Honolulu, Hawaii

October 30, 2019 – October 31, 2019

Organized by MSRI

The Modern Math Workshop is designed to encourage undergraduates from underrepresented minority groups to pursue careers in the mathematical sciences, and to build research and networking opportunities among undergraduates, graduate students and recent PhDs. The workshop includes two mini-courses aimed at undergraduates, research sessions aimed at graduate students and recent PhDs, a panel addressing professional issues of interest to both, a reception open to all participants, and a Q&A with NSF Math Institute representatives. For more information please see the report in the Appendix (Section 13).

1.5 Summer Graduate Schools (Summer 2019)

SGS 1: Commutative Algebra and Its Interaction with Algebraic Geometry

June 03, 2019 – June 14, 2019

Location: *Center for Mathematics, University of Notre Dame*

Organizers: *Craig Huneke (University of Virginia), Sonja Mapes (University of Notre Dame), Juan Migliore (University of Notre Dame), Claudia Polini (University of Notre Dame), Claudiu Raicu (University of Notre Dame)*

SGS 2: Random and Arithmetic Structures in Topology

June 10, 2019 – June 21, 2019

Organizers: *Alexander Furman (University of Illinois at Chicago), Yizhaq Gelfand (Weizmann Institute of Science)*

SGS 3: Representation Stability

June 24, 2019 – July 05, 2019

Organizers: *Thomas Church (Stanford University), Andrew Snowden (University of Michigan), Jenny Wilson (University of Michigan)*

SGS 4: Geometric Group Theory

July 01, 2019 – July 12, 2019

Location: *Oaxaca, Mexico*

Organizers: *Rita Jiménez Rolland (Instituto de Matemáticas, UNAM-Oaxaca), Pierre Py (Instituto de Matemáticas, UNAM-Ciudad Universitaria)*

SGS 5: Séminaire de Mathématiques Supérieures 2019: Current trends in Symplectic Topology

July 01, 2019 – July 13, 2019

Location: *Montreal, Canada*

Organizers: *Octav Cornea (Université de Montréal), Yakov Eliashberg (Stanford University), Michael Hutchings (University of California, Berkeley), Egor Shelukhin (Université de Montréal)*

SGS 6: Polynomial Method

July 08, 2019 – July 19, 2019

Organizers: *Adam Sheffer (Bernard M. Baruch College, CUNY), Joshua Zahl (University of British Columbia)*

SGS 7: Recent Topics on Well-Posedness & Stability of Incompressible Fluid & Related Topics

July 22, 2019 – August 02, 2019

Organizers: *Yoshikazu Giga (University of Tokyo), Maria Schonbek (University of California, Santa Cruz), Tsuyoshi Yoneda (University of Tokyo)*

SGS 8: H-Principle (INdAM, Cortona, Italy)

July 29, 2019 – August 09, 2019

Location: *Cortona, Italy*

Organizers: Adam Sheffer (Bernard M. Baruch College, CUNY), [Joshua Zahl](#) (University of British Columbia)

SGS 9: Mathematics of Machine Learning

July 29, 2019 – August 09, 2019

Location: *University of Washington, Seattle*

Organizers: Sebastien Bubeck (Microsoft Research), Anna Karlin (University of Washington), Adith Swaminathan (Microsoft Research)

SGS 10: Toric Varieties (National Center for Theoretical Sciences, Taipei)

July 29, 2019 – August 09, 2019

Location: *National Center for Theoretical Sciences, Taipei*

Organizers: David Cox (Amherst College), Henry Schenck (Auburn University)

1.6 Other Scientific Workshops

Workshop 1: Neural Theories of Cognition

Aspen Meadows Resort, Aspen, CO

October 07, 2019 to October 09, 2019

Organizers: David Eisenbud (MSRI), Adrienne Fairhall (University of Washington), John Maunsell (University of Chicago), Bruno Olshausen (University of California, Berkeley)

Please note: This workshop was held off site and is not included in this report's workshop participant summaries. This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix. For more information about this workshop, please visit our website at www.msri.org.

Workshop 2: Berlekamp Memorial Workshop on Combinatorial Games

October 21, 2019 – October 22, 2019

Organizers: Svenja Huntemann (Carleton University), Richard Nowakowski (Dalhousie University), Aaron Siegel (Airbnb)

Please note: This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix. For more information about this workshop, please visit our website at www.msri.org.

Workshop 3: Symposium in Honor of Julia Robinson's 100th Birthday

December 09, 2019

Organizers: Hélène Barcelo (MSRI), Thomas Scanlon (University of California, Berkeley), Carol Wood (Wesleyan University)

Please note: This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix. For more information about this workshop, please visit our website at www.msri.org.

Workshop 4: Hot Topics: Optimal Transport and Applications to Machine Learning and Statistics (ONLINE)

May 04, 2020 – May 08, 2020

Organizers: Luigi Ambrosio (Scuola Normale Superiore), Francis Bach (École Normale Supérieure), [Katy Craig](#) (University of California, Santa Barbara), Carola-Bibiane Schönlieb (University of Cambridge), Stefano Soatto (University of California, Los Angeles)

For more information please see the report in Section 13, Appendix.

1.7 Education & Outreach Activities

Improving the Preparation of Graduate Students to Teach Undergraduate Mathematics

June 10, 2019 – June 12, 2019

*Organizers: Jack Bookman (Duke University), Shandy Hauk (WestEd), **Dave Kung** (St. Mary's College of Maryland), **Natasha Speer** (University of Maine)*

Please note: This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix. For more information about this workshop, please visit our website at www.msri.org.

Critical Issues in Mathematics Education 2020: Today's Mathematics, Social Justice, and Implications for Schools (ONLINE)

Online sessions held weekly from March 12, 2020 through May 29, 2020

*Organizers: Meredith Broussard (New York University), Victor Donnay (Bryn Mawr College), Courtney Ginsberg (Math for America), Luis Leyva (Vanderbilt University), Candice Price (Smith College), Chris Rasmussen (San Diego State University), **Katherine Stevenson** (California State University, Northridge), William Tate (Washington University in St. Louis)*

Please note: This workshop was not funded by any NSF grants, thus there is no report attached in Section 13: Appendix. For more information about this workshop, please visit our website at www.msri.org.

**1.8 Program Consultants List
in 2019–20**

Consultant Name(s)	Consultant Disciplinary Specialty	Consultant Employer	Activity Title
Larry Abbott	Math Biology	Columbia University	Neuroscience meeting
Sébastien Bubeck	Machine Learning	Microsoft	Speaker at November 2019 SAC Meeting
Gunnar Carlsson	Algebraic Topology	Stanford University	Speaker at January 2020 SAC Meeting
Douglas Diamond	Economics	University of Chicago	MSRI-CME Group Prize
Darrell Duffie	Economics	Stanford University	MSRI-CME Group Prize
John Ewing	Math, Education	Math for America	Critical Issues in Math Education workshop
Jack Gould	Economics	University of Chicago	MSRI-CME Group Prize
Sanford Grossman	Econ, Neuroscience	self	Neuroscience meeting
Lars Hansen	Economics	University of Chicago	MSRI-CME Group Prize
Ruth Hass	Combinatorics	University of Hawaii, Manoa	Summer Research for Women in Mathematics
Nicholas Jewell	Biostatistics	University of California, Berkeley and London School of Hygiene & Tropical Medicine	Speaker at March 2020 BoT Meeting
Robert Klein	Mathematics education	Ohio University	Navajo Math Circles and Alliance for Indigenous Math Circles
Albert S. (Pete) Kyle	Finance	University of Maryland	MSRI-CME Group Prize
Jane Long	Education	Stephen F. Austin State University	National Association of Math Circles
William Macallum	Education	University of Arizona	Educational workshops
Howard Masur	Topology, Geometry	University of Chicago	Speaker at November 2019 BoT Meeting
Robert Megginson	Functional analysis	University of Michigan	Critical Issues in Math Education
Leo Melamed	Economics	CME Group	MSRI-CME Group Prize
Paul Milgrom	Economics	Stanford University	MSRI-CME Group Prize
Marni Mishna	Combinatorics	Simon Fraser University	Summer Research for Women in Mathematics
Roger Myerson	Economics	University of Chicago	MSRI-CME Group Prize
Maureen O'Hara	Finance	Cornell University	MSRI-CME Group Prize
Mark Saul	Education	Education Development Center	Great Circles
Myron Scholes	Economics	Stanford University	MSRI-CME Group Prize
Tatiana Shubin	Number theory	San Jose State University	Navajo Math Circles and Alliance for Indigenous Math Circles
Michael Singer	Algebra	North Carolina State University	Advice on Diversity Issues
Jean Tirole	Economics	Toulouse School of Economics	MSRI-CME Group Prize
Robert Wilson	Management	Stanford University	MSRI-CME Group Prize
Educational Advisory Committee (EAC)	See Section 10: Committee Membership		Using Partnerships to Strengthen Elementary Mathematics Teacher Education
Human Resources Advisory Committee (HRAC)	See Section 10: Committee Membership		MSRI-UP, HDMP, MLA, QS, HCC, and CP
Scientific Advisory Committee (SAC) & Board of Trustees (BOT)	See Section 10: Committee Membership		Holomorphic Differentials in Mathematics and Physics (HDMP)
			Microlocal Analysis (MLA)
			Quantum Symmetry (QS)
			Higher Categories and Categorification (HCC)
			Complementary Program (CP)
		Summer Graduate Schools	

1.9 Effect of COVID-19 on Spring Programs

Executive Summary

As of March 10th, 2020 all MSRI activities were moved to an online only format. This meant that the two Spring programs, their associated seminars and working groups, and 4 planned workshops all took place virtually. The organizing committees were invaluable to the successful transition from onsite to online activities. As the next few sections will show, MSRI's Directorate was pleased to see that the programs were quite successful in spite of the difficult conditions, and that those involved with the program were determined to make the best out of the situation. MSRI's observations of the Spring semester have been inspiring and what we have learned will serve to bring about permanent improvements to MSRI programs, even after conditions return to normal.

The online workshops reached record high attendance and a large percentage of exit survey comments indicated that they would not have been able to participate without the online format, even under normal circumstances. The level of overall participant satisfaction was a bit lower than our six-year average, though still 4.4 out of 5 (the highest possible level of satisfaction). The workshop exit surveys asked for suggestions on how to improve the online workshop experience and MSRI is currently working with future organizing committees to implement some of those improvements.

Out of 114 program members who had planned visits to MSRI in the Spring, 93 of them were impacted by the MSRI building closure. Still, a total of 99 members ultimately made visits to MSRI. Additionally, 34% of the impacted members were able to complete their visit as scheduled, despite the closure.

It is notable that many members who returned home early were still able to stay engaged in the program. In fact, a majority of members who attended at least one online seminar or working group did so from their home institution. However, the members who remained in Berkeley attended seminars much more often than those who returned home. It is clear from the data that the level of members' engagement in the program is about twice as high among those who remained in Berkeley compared to those who participated from their home institutions. This was an important factor in MSRI's decision to reopen in a limited and safe capacity for the Fall 2020 semester.

Introduction

Due to the COVID-19 pandemic MSRI made the decision to close its building as of March 10, 2020. No members were physically present at MSRI after the closure, but the following programmatic activities and other planned events continued online:

- Higher Categories and Categorification Program
- Quantum Symmetries Program
- 59 seminars/working groups jointly associated with the two Spring programs
- Topical workshop on Tensor categories and topological quantum field theories

- Topical workshop on (∞, n) -categories, factorization homology, and algebraic K-theory
- Hot Topics workshop on Optimal transport and applications to machine learning and statistics
- 2020 Critical Issues in Mathematics Education Workshop Series: Today's Mathematics, Social Justice, and Implications for Schools

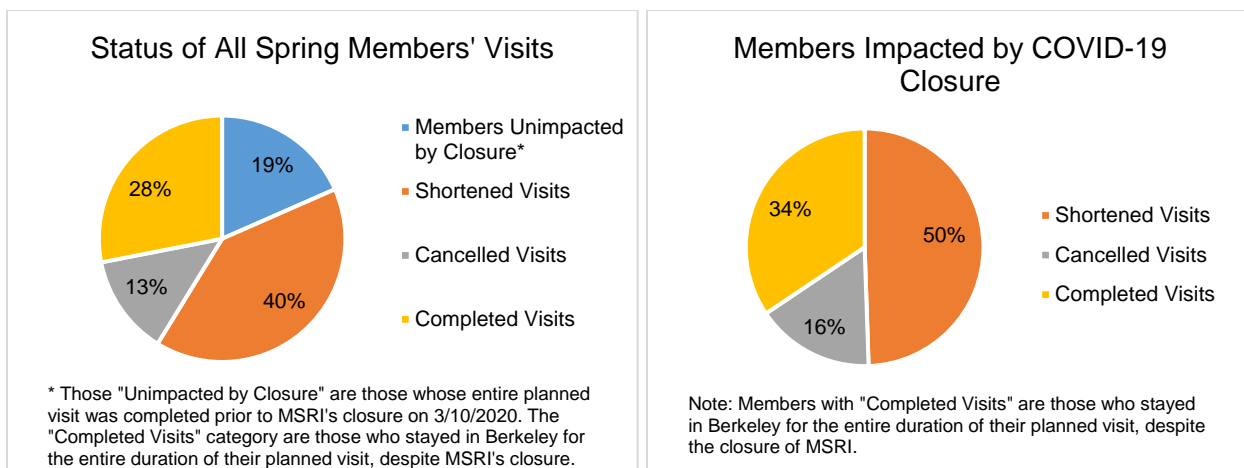
The organizers of both programs were instrumental in the successful transition to an online format. They worked hard to create a virtual environment that was as friendly and productive as possible and MSRI is very grateful for their flexibility and dedication. Immediately following MSRI's closure, the program organizers made the decision to limit the number of virtual seminars to one per day and, over time, working groups were also formed that met at regular intervals with technical support from MSRI's IT staff. Many other collaborations took place without MSRI's intervention.

MSRI obtained licenses for the messaging application, Slack, which enabled real time communication between program members. In addition to purchasing Slack licenses, MSRI also purchased additional Zoom licenses which enabled us to use the platform to host virtual workshops, seminars, working groups, and to enable virtual face-to-face collaboration between program members. Furthermore, MSRI hired an additional IT team member to provide dedicated support for the online activities. This team member facilitated the set-up of virtual Zoom seminars and workshops and was present during these activities to ensure the technology's smooth operation. Additionally, with the consent of the presenters and participants, all scheduled virtual activities were recorded, edited, and posted online for later viewing.

In addition to the heightened IT support required to facilitate the online programs, the rest of MSRI's staff also worked tirelessly to support the members in myriad other ways. The Program staff executed the complex task of rescheduling planned events and scheduling new virtual events. The Housing Advisor worked with both members and landlords to help negotiate favorable terms for those who needed to break their lease and our International Scholar Advisor assisted members with any visa issues that arose with members returning to their home countries. The Finance staff worked flexibly to ensure that all members received the appropriate reimbursements, and the Operations Manager helped address members' concerns and provided resources related to healthcare.

Programs

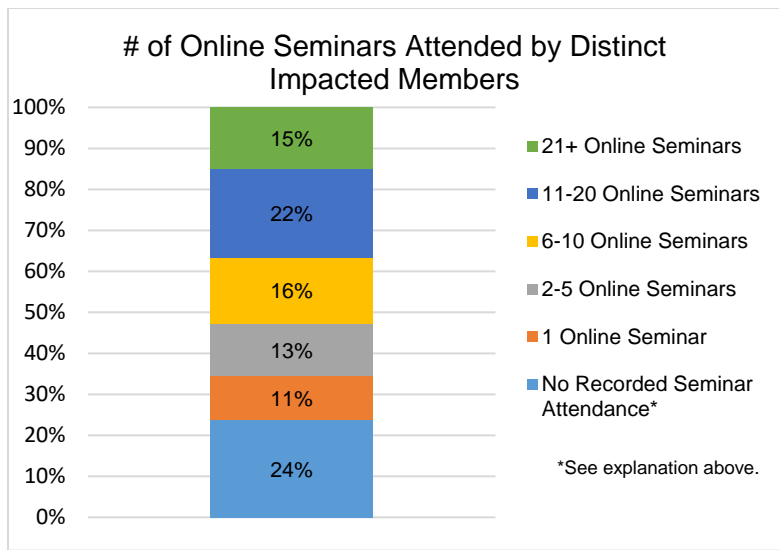
Out of 114 distinct members who had planned to visit MSRI during the Spring 2020 semester, 93 of them (82%) were impacted in some way by the closure. Of those, 15 members (16%) cancelled their visits altogether, 46 members (49%) returned home earlier than planned, and 32 members (34%) stayed in Berkeley for the length of their planned visit despite having no access to the MSRI building. A total of 99 program members ultimately made visits to MSRI during the Spring semester.



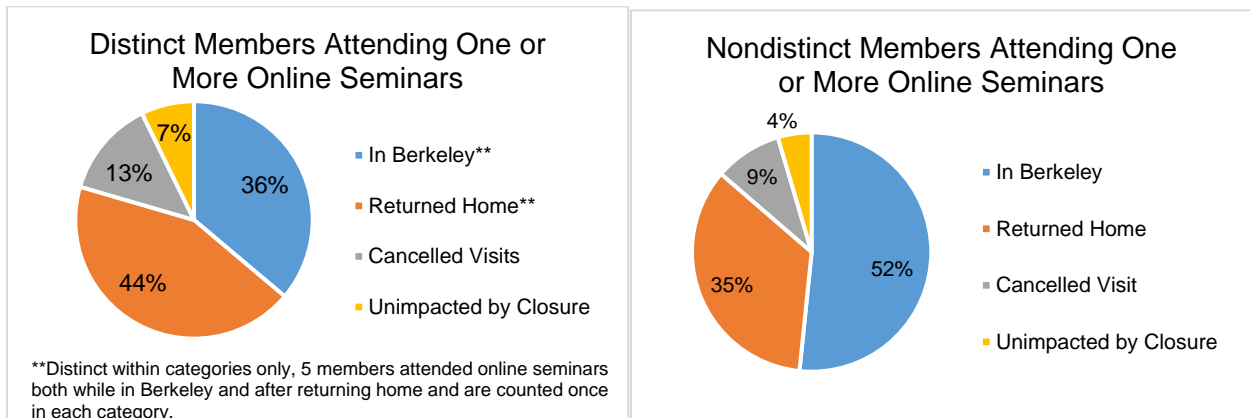
MSRI's Spring programs, **Quantum Symmetries (QS)** and **Higher Categories and Categorification (HCC)**, began on January 21, 2020 and ran for approximately seven weeks prior to the MSRI building closure. During this time, each program hosted a Connections workshop and an Introductory workshop. The QS program also hosted four seminars, the HCC program hosted 18 seminars, and the two programs jointly hosted another 20 seminars. This comes to a combined total of 4 workshops and 42 seminars held prior to the closure; an average of 11 seminars occurred during each of the four non-workshop weeks.

The two Spring programs continued for 12 more weeks following MSRI's closure, with all programmatic activities happening virtually. Each program hosted their "topical" workshop online during this time with an average of 176 participants; much higher than the 5-year average of 132 participants per topical workshop. Additionally, the Spring programs hosted 59 online seminars over 10 non-workshop weeks, for an average of six seminars per week. This does represent a reduction from the pre-closure average but, as mentioned above, the program organizers made the deliberate choice to limit the number of virtual seminars per day. The online seminars were well attended with about 23 participants on average, of whom 73% were MSRI members, 23% were guests unaffiliated with the programs, and 4% did not provide identifying information.

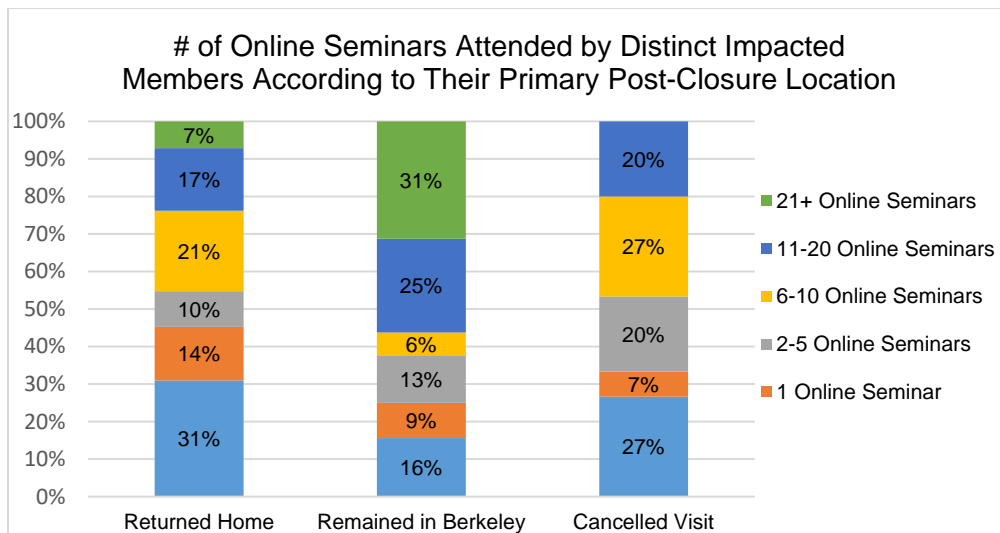
Of the 93 members who were impacted by the closure, at least 71 (76%) of them attended one or more virtual seminars and 49 (53%) of them attended six or more seminars. On average, each member attended 9 virtual seminars following the closure. These numbers are detailed further in the next paragraph. Only 22 (24%) impacted members have no recorded seminar attendance, however it is possible that some of them were among the participants who did not provide identifying information. Of those 22 members, three were members of the Complementary Program (which does not host online seminars), four had cancelled their visits to MSRI, and seven of them were located in time zones that were not compatible with the seminar schedule.



It is notable that many MSRI members who returned home early, cancelled their visits entirely, or had already left MSRI prior to the closure still participated in the virtual seminars. In fact, a 64% majority of (distinct) members who attended one or more online seminars fell into those categories. However, members who remained in Berkeley following the closure still comprised 52% of overall (non-distinct) seminar attendance, indicating that those members attended seminars more often. In fact, members who remained in Berkeley attended twice as many seminars (an average of 14), compared to those members who returned home (an average of 7).



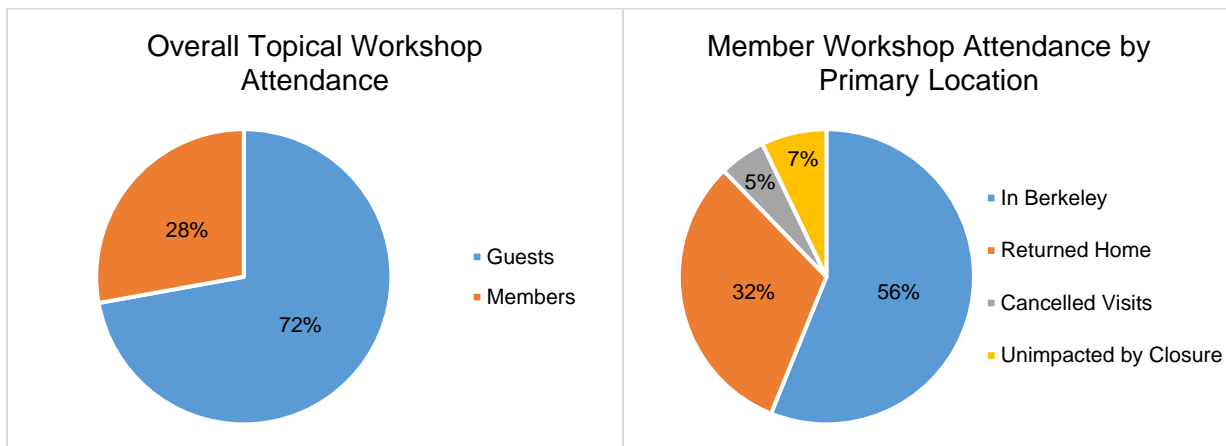
In fact, the primary post-closure location of MSRI's members had a noticeable effect on the frequency of their seminar participation. The percentage of members with no recorded seminar attendance is approximately twice as great among those who were located at their home institutions post-closure than among those who remained in Berkeley. Conversely, the percentage of members who attended more than 10 virtual seminars is twice as great among those who remained in Berkeley than among those located at their home institutions. This shows that, while virtual seminars allow for much greater participation from off-site members than is usually possible, the highest rate of participation remains concentrated among those geographically near MSRI. This is probably due to many factors, such as the demand of daily responsibilities when one is at home or differing time zones.



Workshops

MSRI hosted four online workshops following the building closure. The workshops were conducted via Zoom and were very well attended. All talks were recorded, with permission, and are available to view for free on the MSRI website.

Both Spring programs hosted a “topical” workshop online in the weeks immediately following the MSRI building closure. The workshop schedules were largely similar to what they would have been if held onsite—that is, about 4 talks were held per day over the course of one week. A virtual “tea room” was also set up through Zoom for participants to interact between talks. Over the last five years, MSRI topical workshops have attracted an average of 132 participants; both online topical workshops exceeded this average. A total of 146 distinct participants attended the QS online workshop and 206 distinct participants attended the HCC online workshop, making it MSRI’s best attended topical workshop of the last 10 years. Program members made up about 28% of overall workshop attendance and, of those members, roughly 56% were located in Berkeley at the time of the workshop. Furthermore, 45% of all impacted members attended more than half of the days of at least one workshop, with 43% of those attending both online topical workshops.



MSRI's annual "Hot Topics" workshop was also held virtually with 4 talks per day occurring over the course of one week. Hot Topics workshops in general, which are not connected to an MSRI program, attract an average of 73 participants. Our largest ever Hot Topics workshop prior to this year took place in 2013-14 with 192 participants. This year's workshop had a total of 264 distinct attendees, more than tripling the average and making it our best attended workshop of the last ten years, by far.

MSRI's fourth online workshop was the 2020 Critical Issues in Mathematics Education (CIME) series. These workshops usually take place over the course of five days, but due to the online format the organizers elected instead to host lunch-time talks once a week for ten weeks. This schedule was intended to increase accessibility for participants, many of whom are K12 educators. The 2020 CIME workshop had a total of 139 distinct participants, which is in line with the CIME five-year average of 142 participants each year.

While the online format of the workshops allowed for a much higher attendance and greater accessibility than is usually possible, it came at the cost of participant interaction. This was most acutely felt during the two topical workshops; since they are associated with the scientific programs taking place at MSRI, many people attend not only for the talks but also to interact with the program members. The comments we received through the topical workshop exit surveys reflected this expectation. While many respondents indicated that they would not have been able to attend (even under normal circumstances) if not for the online format, many others noted that they missed the informal interactions that usually take place in between talks and found it harder to focus and stay engaged in the workshop. Overall, the exit survey results were positive, but we did observe a lower than usual level of participant satisfaction. When asked if "The overall experience of the workshop was worthwhile," the online topical workshops received an average score of 4.34 out of 5.00 compared to a six-year average of 4.70.

The online Hot Topic workshop was less impacted by the change in format and, in fact, reached record breaking attendance. Since this type of workshop focuses on new and innovative mathematics and is not associated with the programs, the prospect of interaction with program members is less of a consideration for participants. While many survey respondents still indicated that they missed the informal interaction, a much higher proportion of attendees reported that the online format actually facilitated their participation. In fact, some participants preferred having the workshop online. This has led to the idea of hosting other virtual Hot Topics workshops in the future; a possibility that will be carefully considered by MSRI's Scientific Advisory Committee. In response to the same exit survey question as mentioned above, the Hot Topic workshop received an average score of 4.44 out of 5.00 compared to a six-year average of 4.75. For more details on these workshops, including participant data and exit survey results, see the reports in Section 13: Appendix.

MSRI has solicited suggestions from the attendees for ways to improve the virtual workshop experience. It is clear that in-person meetings are an important part of MSRI's activities and are essential to catalyzing research and advancing the mathematical sciences. However, we have also come to realize that the virtual format is a valuable mechanism towards increasing accessibility and should have a place in our programs. MSRI intends to capitalize on this opportunity in future years. For example, we are exploring ways to enable virtual participation in workshops held at

MSRI by allowing remote participants to live-stream talks and ask questions in real time. Similarly, while an extended visit to MSRI is irreplaceable, we are exploring the possibility of opening program seminars and working groups to online participants as well. Technology such as Jamboard may help facilitate active, remote engagement and we have improved our ability to quickly edit and post videos of talks so they are now available on our website within hours. All of these initiatives have the potential to greatly increase the accessibility of MSRI's programs and therefore expand the impact of our activities.

2. Program and Workshop Data

2.1 Program Member List

(See email attachment)

2.2 Program Members Summary

Programs	Distinct Members ⁺	US Citizens & Perm. Res.	Women	%	Minorities*	%	US Home Inst.	%
Holomorphic Differentials in Mathematics and Physics	68	30	17	25.0%	1	3.3%	35	51.5%
Microlocal Analysis	63	33	13	20.6%	5	15.2%	37	58.7%
Higher Categories and Categorification**	48	23	13	27.1%	2	8.7%	23	47.9%
Quantum Symmetries**	44	27	11	25.0%	3	11.1%	28	63.6%
Complementary Program 2019-20	10	4	3	30.0%	0	0.0%	6	60.0%

Total # of Distinct Members	229	114	55	24.0%	11	9.6%	126	55.0%
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*Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

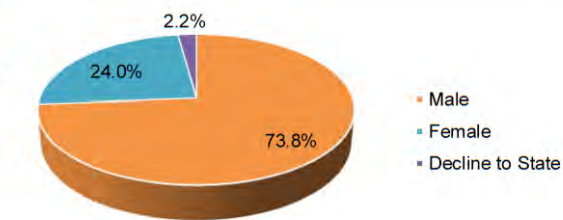
**MSRI closed on 3/10/2020 due to the COVID-19 pandemic. The above numbers include only members who were physically present at MSRI prior to its closure. 15 planned visits to the Spring programs were cancelled due to COVID-19, including 8 from the Higher Categories program and 7 from the Quantum Symmetries program.

+ Counts distinct members within each program and distinct members overall. There were 4 members with dual program memberships; they are counted once in each program but are not double counted in the overall total.

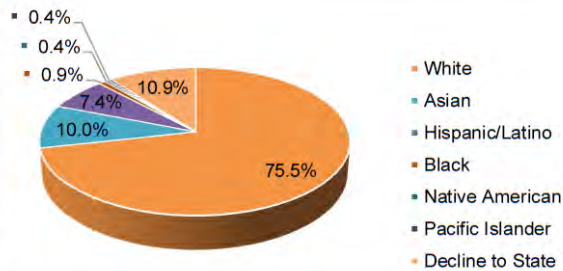
2.3 Program Members Demographic Summary

2019-20 Program Members Demographic Summary

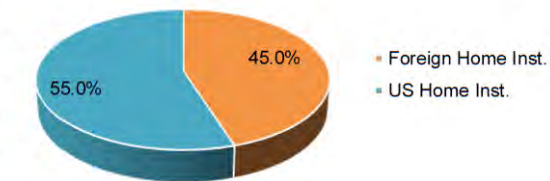
Gender	#	%
# of Distinct Members	229	100.0%
Male	169	73.8%
Female	55	24.0%
Decline to State	5	2.2%



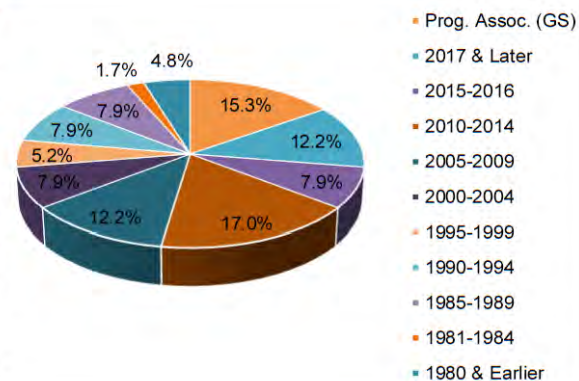
Race/Ethnicity*	#	%
White	173	75.5%
Asian	23	10.0%
Hispanic/Latino	17	7.4%
Black	2	0.9%
Native American	1	0.4%
Pacific Islander	1	0.4%
Decline to State	25	10.9%
Unavailable Info.	0	0.0%
Minorities**	11	9.6%



Citizenships	#	%
Foreign Home Inst.	103	45.0%
US Home Inst.	126	55.0%
US Citizen & Perm. Residents	114	49.8%
Foreign	115	50.2%
US Citizens	100	43.7%
US Permanent Residents	14	6.1%



Year of Ph.D	#	%
Prog. Assoc. (GS)	35	15.3%
2017 & Later	28	12.2%
2015-2016	18	7.9%
2010-2014	39	17.0%
2005-2009	28	12.2%
2000-2004	18	7.9%
1995-1999	12	5.2%
1990-1994	18	7.9%
1985-1989	18	7.9%
1981-1984	4	1.7%
1980 & Earlier	11	4.8%
Total # of Distinct Members	229	100.0%



*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

Programs

Holomorphic Differentials in Mathematics and Physics

Microlocal Analysis

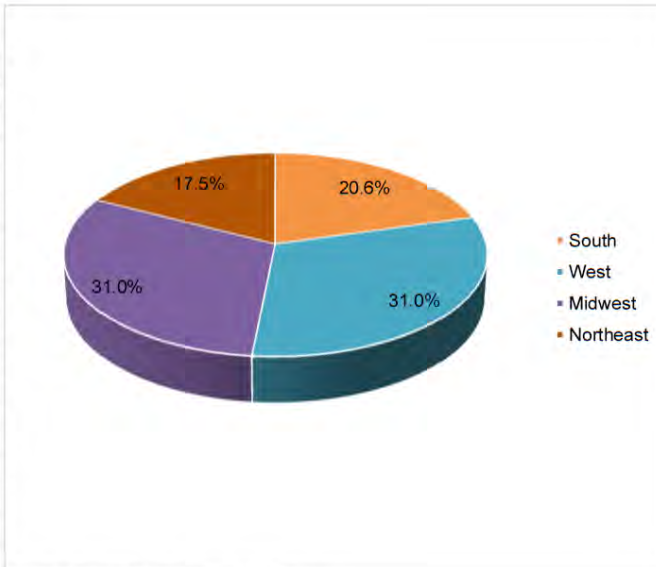
Higher Categories and Categorification

Quantum Symmetries

Complementary Program 2019-20

2019-20 Program Members Classified by State

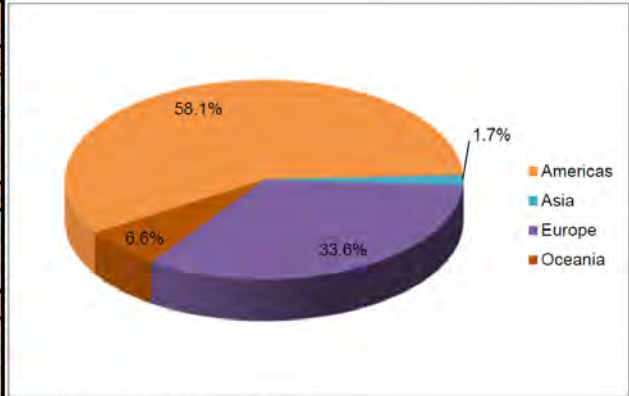
State	#	%	2010 Census Population
South	26	20.6%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	1	0.8%	6.1%
GA	1	0.8%	3.1%
KY	0	0.0%	1.4%
LA	2	1.6%	1.5%
MD	6	4.8%	1.9%
MS	0	0.0%	1.0%
NC	2	1.6%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	3	2.4%	2.1%
TX	11	8.7%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	39	31.0%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	30	23.8%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	1	0.8%	1.6%
NM	0	0.0%	0.9%
NV	1	0.8%	0.7%
OR	1	0.8%	1.2%
UT	0	0.0%	0.9%
WA	6	4.8%	2.2%
WY	0	0.0%	0.2%
Midwest	39	31.0%	21.7%
IA	1	0.8%	4.2%
IL	17	13.5%	2.1%
IN	11	8.7%	1.0%
KS	1	0.8%	0.9%
MI	5	4.0%	3.2%
MN	1	0.8%	1.7%
MO	1	0.8%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	2	1.6%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	22	17.5%	17.9%
CT	5	4.0%	1.2%
MA	7	5.6%	0.4%
ME	0	0.0%	2.1%
NH	1	0.8%	0.4%
NJ	1	0.8%	2.8%
NY	8	6.3%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	126	100.0%	100.0%



*Regions based on US Census classification

2019-20 Program Members Classified by Countries

Africa		0
Americas		133
North America	Canada	5
	United States	126
South America	Argentina	1
	Chile	1
Asia		4
East Asia	China	2
Western Asia	Israel	1
Southern Asia	India	1
Europe		77
Northern Europe	Finland	2
	Norway	1
	Sweden	1
	United Kingdom	15
Southern Europe	Italy	2
	Spain	1
Western Europe	France	24
	Germany	24
	Switzerland	6
Eastern Europe	Czech Republic	1
Oceania		15
Australia and New Zealand	Australia	14
	New Zealand	1
Grand Total		229



*Regions based on United Nations classification

2.4 Workshop Participant List

(See email attachment)

2.5 Workshop Participant Summary*

Scientific Workshops	Total Participants	Available Demographics	US Citizens & Perm. Res.	% [†]	Women	% [†]	Minorities*	% [†]	US Home Inst.	% [†]
12 Onsite Workshops										
Berlekamp Memorial Workshop on Combinatorial Games	30	30	22	73.3%	6	20.0%	1	4.5%	20	66.7%
Symposium in Honor of Julia Robinson's 100th Birthday	41	41	28	68.3%	8	19.5%	2	7.1%	38	92.7%
Connections for Women: Holomorphic Differentials in Math and Physics	59	59	31	52.5%	30	50.8%	3	9.7%	34	57.6%
Introductory Workshop: Holomorphic Differentials in Math and Physics	93	93	41	44.1%	28	30.1%	4	9.8%	56	60.2%
Holomorphic Differentials in Mathematics and Physics	112	112	43	38.4%	26	25.0%	3	7.0%	56	50.0%
Connections for Women: Microlocal Analysis	49	49	16	32.7%	25	51.0%	2	12.5%	30	61.2%
Introductory Workshop: Microlocal Analysis	107	107	42	39.3%	25	23.4%	9	21.4%	69	64.5%
Recent developments in microlocal analysis	115	115	47	40.9%	19	16.5%	6	12.8%	67	58.3%
Connections for Women: Quantum Symmetries	75	75	48	64.0%	41	54.7%	5	10.4%	55	73.3%
Introductory Workshop: Quantum Symmetries	149	149	80	53.7%	42	28.2%	7	8.8%	102	68.5%
Connections for Women: Higher Categories and Categorification	100	100	51	51.0%	44	44.0%	7	13.7%	61	61.0%
Introductory Workshop: Higher Categories and Categorification	169	169	90	53.3%	43	25.4%	8	8.9%	111	65.7%
3 Virtual Workshops**										
Tensor categories and topological quantum field theories	146	109	60	55.0%	18	16.5%	5	8.3%	74	67.9%
(w, n)-categories, factorization homology, and algebraic K-theory	206	123	70	56.9%	27	22.0%	7	10.0%	85	60.1%
Hot Topics: Optimal transport & applications to machine learning & statist	264	237	71	30.0%	40	16.9%	7	9.9%	143	60.3%
All 15 Workshops Total	1,715	1,568	740	47.2%	424	27.0%	76	10.3%	1,001	63.8%
Education & Outreach Workshops										
1 Onsite Workshop										
Improving the Preparation of Graduate Students to Teach Undergraduate Mathematics	30	30	26	86.7%	9	30.0%	3	11.5%	28	93.3%
1 Virtual Workshop**										
Critical Issues in Mathematics Education 2020: Today's Mathematics, Social Justice, and Implications for Schools	139	74	64	86.5%	41	55.4%	18	28.1%	71	95.9%
All 2 Workshops Total	169	104	90	86.5%	50	48.1%	21	23.3%	99	95.2%
All 17 Workshops Total	1,884	1,672	830	49.6%	474	28.3%	97	11.7%	1,100	65.8%

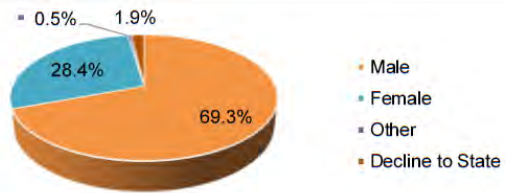
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.
 ** MSRI closed on 3/10/2020 due to the COVID-19 pandemic. Workshops scheduled after this date were held virtually and registration was encouraged, but not required. Therefore while total participant counts are comprehensive, demographic information is only available for registered participants.
 † Percentage among those for whom information is available.

*Note that the overall workshop data in section 2.5 is not distinct as some participants attended multiple workshops, but the statistics of individual workshops found in Section 13, Appendix, were calculated on distinct participant data.

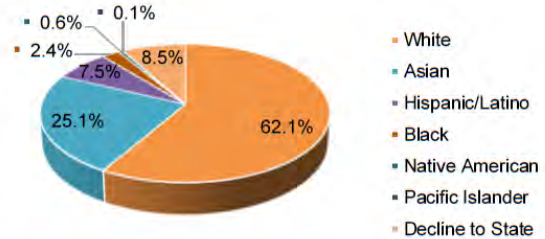
2.6 Workshop Participant Demographic Data

2019–20 Workshop Participants Demographic Summary

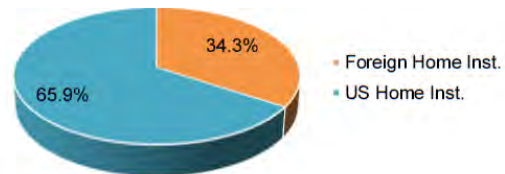
Gender	#	% excl. unavail.*	% overall
# of Participants	1884	100.0%	100.0%
Male	1157	69.3%	61.4%
Female	474	28.4%	25.2%
Other	8	0.5%	0.4%
Decline to State	31	1.9%	1.6%
Unavailable Info.*	214	n/a	11.4%



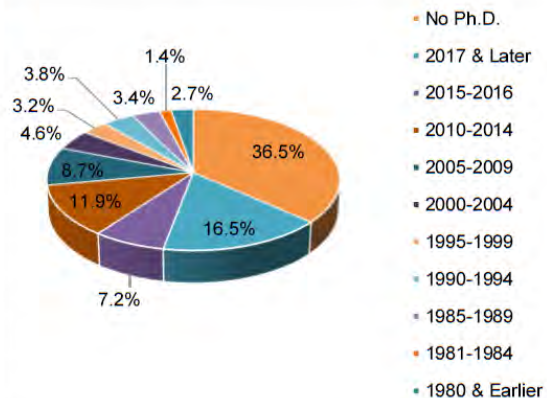
Race/Ethnicity*	#	% excl. unavail.*	% overall
White	1037	62.1%	55.0%
Asian	419	25.1%	22.2%
Hispanic/Latino	126	7.5%	6.7%
Black	40	2.4%	2.1%
Native American	10	0.6%	0.5%
Pacific Islander	1	0.1%	0.1%
Decline to State	142	8.5%	7.5%
Unavailable Info.*	214	n/a	11.4%
Minorities**	97	11.7%	11.7%



Citizenships	#	% excl. unavail.*	% overall
Foreign Home Inst.	572	34.3%	30.4%
US Home Inst.	1100	65.9%	58.4%
Unavailable Info.*	212	n/a	11.3%
US Citizen & Perm. Residents	830	49.7%	44.1%
Foreign Citizens	842	50.4%	44.7%
Unavailable Info.*	212	n/a	11.3%
US Citizen	756	45.3%	40.1%
Perm. Residents	74	4.4%	3.9%



Year of Ph.D.	#	% excl. unavail.*	% overall
No Ph.D.	610	36.5%	32.4%
2017 & Later	276	16.5%	14.6%
2015-2016	121	7.2%	6.4%
2010-2014	199	11.9%	10.6%
2005-2009	146	8.7%	7.7%
2000-2004	77	4.6%	4.1%
1995-1999	53	3.2%	2.8%
1990-1994	64	3.8%	3.4%
1985-1989	57	3.4%	3.0%
1981-1984	24	1.4%	1.3%
1980 & Earlier	45	2.7%	2.4%
Unavailable Info.*	212	n/a	11.3%
Total # Participants	1884	100.0%	100.0%



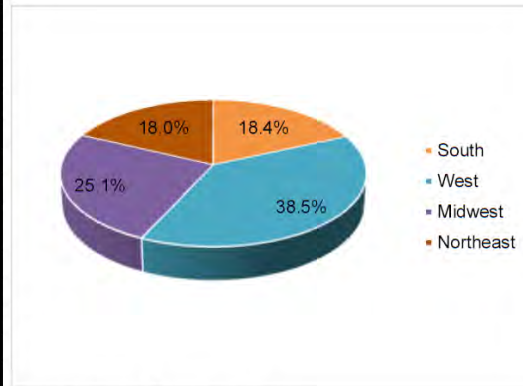
*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

‡ Four workshops were held online due to the COVID-19 pandemic. Registration was encouraged, but not required; therefore while total participant counts are comprehensive, demographic information is only available for registered participants. Percentages are calculated from among those for whom demographic information is available.

2019–20 Workshop Participants Classified by State

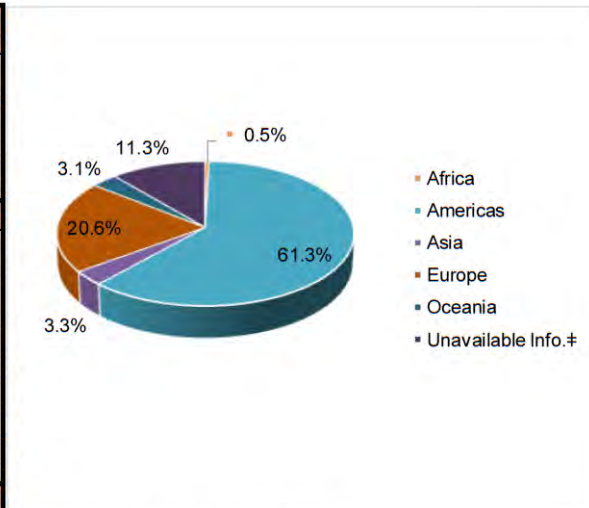
State	#	%	2010 Census
South	202	18.4%	37.1%
AL	3	0.3%	1.5%
AR	2	0.2%	0.9%
DE	0	0.0%	0.3%
DC	2	0.2%	0.2%
FL	10	0.9%	6.1%
GA	9	0.8%	3.1%
KY	0	0.0%	1.4%
LA	19	1.7%	1.5%
MD	34	3.1%	1.9%
MS	0	0.0%	1.0%
NC	32	2.9%	3.1%
OK	4	0.4%	1.2%
SC	2	0.2%	1.5%
TN	11	1.0%	2.1%
TX	67	6.1%	8.1%
VA	7	0.6%	2.6%
WV	0	0.0%	0.6%
West	424	38.5%	23.3%
AK	1	0.1%	0.2%
AZ	2	0.2%	2.1%
CA	347	31.5%	0.4%
CO	3	0.3%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	13	1.2%	1.6%
NM	2	0.2%	0.9%
NV	2	0.2%	0.7%
OR	6	0.5%	1.2%
UT	5	0.5%	0.9%
WA	43	3.9%	2.2%
WY	0	0.0%	0.2%
Midwest	276	25.1%	21.7%
IA	13	1.2%	4.2%
IL	86	7.8%	2.1%
IN	71	6.5%	1.0%
KS	10	0.9%	0.9%
MI	40	3.6%	3.2%
MN	15	1.4%	1.7%
MO	5	0.5%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	27	2.5%	3.7%
SD	0	0.0%	0.3%
WI	9	0.8%	1.8%
Northeast	198	18.0%	17.9%
CT	16	1.5%	1.2%
MA	61	5.5%	0.4%
ME	2	0.2%	2.1%
NH	9	0.8%	0.4%
NJ	17	1.5%	2.8%
NY	55	5.0%	6.3%
PA	35	3.2%	4.1%
RI	2	0.2%	0.3%
VT	1	0.1%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Unavailable	0	0.0%	0.0%
Total	1100	100.0%	100.0%



*Regions based on US Census classification

2019–20 Workshop Participants Classified by Country

Africa		9
Middle Africa	Congo, The Dem	1
Northern Africa	Tunisia	3
Western Africa	Benin	1
	Ghana	2
	Senegal	2
Americas		1154
Caribbean	Jamaica	1
Central America	Mexico	4
North America	Canada	29
	United States	1100
South America	Argentina	7
	Brazil	4
	Chile	6
	Colombia	3
Asia		62
East Asia	China	11
	Hong Kong	2
	Japan	12
	Korea, Republic	14
South-central Asia	Bangladesh	1
	India	8
South-eastern Asia	Iran, Islamic Re	1
	Singapore	1
	Thailand	1
Western Asia	Israel	4
	Saudi Arabia	2
	Turkey	5
Europe		388
Eastern Europe	Czech Republic	4
	Poland	3
	Russian Federa	3
	Serbia	2
Northern Europe	Denmark	7
	Finland	6
	Ireland	2
	Norway	6
Southern Europe	Sweden	8
	United Kingdom	87
	Italy	10
	Portugal	7
Western Europe	Spain	3
	Belgium	3
	France	84
	Germany	113
	Netherlands	5
Switzerland	35	
Oceania		59
Australia & NZ	Australia	57
	New Zealand	2
Unavailable Info.*		212
Grand Total		1884



Regions based on United Nations classifications.

* Four workshops were held online due to the COVID-19 pandemic. Registration was encouraged, but not required, therefore while total participant counts are comprehensive, demographic information is only available for registered participants.

2.7 Program Publication List
(Attachment in Research.gov)

2.8 Program Publication Work-In-Progress List
(Attachment in Research.gov)

3. Postdoctoral Program

3.1 Description of Activities

The postdoctoral program at MSRI is central to MSRI's mission of continued excellence in research in the mathematical sciences. Today, MSRI's programs bring together researchers from all over the world to discuss developments in the most exciting areas of fundamental mathematics. They strongly catalyze research and generate many new collaborations. The programs provide extraordinary opportunities and training for young researchers. MSRI is also recognized for its groundbreaking work on inclusivity and for its public programs. Perhaps the most important way in which MSRI enhances the world's mathematical research is as an incubator. Participants in MSRI's programs form intense new collaborations that lead to fundamental advances in the field, maturing over a period of years or even decades. MSRI's postdocs engage with fellow mathematicians from all over the world to develop their interests and contribute to the Science community.

During the 2019-20 academic year, MSRI selected 32 postdoctoral scholars with research interests in the programs that MSRI offers. Of those postdocs, 18 were funded by the NSF Core Grant, 4 were funded by the NSA, and 10 "named" postdoctoral fellows were privately funded by the Berlekamp, Gamelin, Huneke, and Viterbi Endowments, as well as the Vincent Della-Pietra, Stephen Della-Pietra, McDuff, Uhlenbeck, and Strauch Postdoctoral Fellowship Grants.

Of the 32 Postdoctoral Fellows at MSRI, 10 (31%) were women, 13 (41%) were U.S. Citizens or Permanent Residents, and 22 (69%) came from a US institution. The program organizers were extremely satisfied with the Postdoctoral program and believed that it was by all accounts an enormous success.

Here are additional details on the Postdoctoral Fellows for each program.

HOLOMORPHIC DIFFERENTIALS IN MATHEMATICS AND PHYSICS



Allegretti, Dylan

Name: Dylan Allegretti
Year of Ph.D.: 2016
Dissertation title: The Geometry of Cluster Varieties from Surfaces
Ph.D. advisor: Alexander Goncharov
Mentor while at MSRI: Richard Wentworth

Institution prior to MSRI: University of Sheffield
Mentor: Tom Bridgeland

Institution post MSRI: University of British Columbia
Position: Postdoctoral Fellow
Anticipated length: Two years
Mentor: Sabin Cautis, Jim Bryan, Kai Behrend

Postdoctoral fellow's comments:

My main achievement this semester was the completion of a project started almost three and a half years ago when I was a postdoc with Tom Bridgeland. I have written a paper on the results of this project, and I am beginning to work on a second paper discussing related ideas. The main result of this project is the construction of a map between two interesting spaces: a space of stability conditions and a cluster variety. This construction is important for several reasons. On the one hand, it gives a mathematically rigorous approach to understanding certain physical ideas of Gaiotto, Moore, and Neitzke. On the other hand, it provides solutions to a class of Riemann-Hilbert problems posed by Bridgeland in the context of Donaldson-Thomas theory.

In completing this project, I benefitted from the presence of other like-minded researchers at MSRI. In particular, conversations with Laura Fredrickson, Dmitry Korotkin, Andrew Neitzke, and Richard Wentworth helped to resolve some of the main questions I had while working on this project.

While at MSRI, I gave a number of lectures on my work and my research area. I was a speaker in the introductory workshop and gave a talk there about my work in exact WKB analysis. After the workshop, I helped organize a learning seminar on stability conditions. In that capacity, I contributed three expository talks on the relationship between stability conditions and quadratic differentials and one research talk explaining my work mentioned above. In addition to the lectures given at MSRI, I gave invited lectures and lecture series in Bonn, Los Angeles, Hamburg, and Kyoto.

Finally, my conversations with the other participants have led to at least two projects that I have not been directly involved in. Based on our conversations about exact WKB analysis, Dmitry Korotkin and Marco Bertola have written an article on the symplectic aspects of the monodromy map for second order differential equations on a Riemann surface. My conversations with Richard Wentworth have also led to an ongoing collaboration between him, Brian Collier, and Laura Fredrickson attempting to prove a meromorphic analog of their results on Gaiotto's conjecture.

Overall, my experience at MSRI has been an enjoyable one, and I am hopeful that it will help me eventually find a permanent academic position. So far this seems promising as several senior members and visitors have expressed interest in hiring me at their home institutions.



Collier, Brian

Name: Brian Collier
Year of Ph.D.: 2016
Institution of Ph.D.: The University of Illinois (UIUC)
Dissertation title: Finite order automorphism of Higgs bundles: theory and application
Ph.D. advisor: Steven Bradlow
Mentor while at MSRI: Yair Minsky

Institution prior to MSRI: University of Maryland
Position at that institution: NSF postdoc
Mentor (if applicable): Richard Wentworth

Institution (or company) post MSRI: UC Irvine
Position: Assistant Professor
Anticipated length: Tenure-track

Postdoctoral fellow's comments:

During the semester at MSRI I started working on two projects, one with Richard Wentworth and Laura Fredrickson on conformal limits for parabolic Higgs bundles and another with Wentworth on a universal deformation theory for Higgs bundles. I continued to work on a joint paper with Bradlow, Garcia-Prada, Gothen and Oliveira, and it was very helpful that most of the collaborators were at MSRI for various amounts of time. I also had many interesting and useful conversations with Anna Wienhard which may lead to a future collaboration. The working conditions at MSRI were wonderful and I found the atmosphere at MSRI intellectually stimulating.



Fougeron, Charles

Name: Charles Fougeron

Year of Ph.D.: 2017

Institution of Ph.D.: Université Paris Diderot 7

Dissertation title: Exposants de Lyapunov et variations de structures de Hodge

Ph.D. advisor: Anton Zorich

Mentor while at MSRI: Mike Wolf

Institution prior to MSRI: Max Planck institute, Bonn

Position at that institution: Postdoc

Institution (or company) where you are going after MSRI: Université Paris Diderot 7

Position: Postdoc

Anticipated length: 1.5 year

Mentor (if applicable): Valérie Berthé

Postdoctoral fellow's comments:

I have spent the first half of the semester finishing a project that I had started a year ago on multidimensional continued fractions algorithms. Being at MSRI was very helpful since I was using techniques from thermodynamical formalism, subject which some people in both programs HDMP and MLA were experts in.

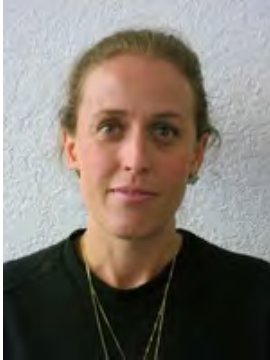
During the end of the semester, I could work on two other projects with my collaborators. One with A. Skripchenko on strong convergence of multidimensional continued fraction algorithms related to Lyapunov exponents of such algorithms. And another one with S. Filip on the some new set of examples of thin groups related to the equality case of the sum of Lyapunov exponents and degree of a flat bundle. Both of them are still work in progress, but being able to meet with my collaborators in person on a sufficiency long period was very useful to make major advances.

Finally I have learned a lot of new mathematics, on one hand with the class of F. Labourie who introduced us to higher Teichmüller theory throughout the semester. And with several weeks of discussion with Frédérique Faure, who was part of the other program, on microlocal analysis. We plan to continue our discussion and work on application of such techniques to pseudo-Anosov maps and Teichmüller dynamics.

In conclusion, I think my stay at MSRI was extremely helpful for my career, on one hand to provide a good environment to make progress efficiently on my current projects, and on the other hand to learn new mathematics, and create new interactions with

mathematicians from different backgrounds.

The mentorship was also a good experience. Our weekly meeting with Mike Wolf were very pleasant and useful. He has helped me in the writing of my article as well as with more general choices of orientation in my future career. His advices will help me to better understand the strings of the committees and will certainly help me to write better applications in the future.



Fredrickson, Laura

Name: Laura Fredrickson
Year of Ph.D.: May 2016
Institution of Ph.D.: University of Texas at Austin
Dissertation title: Asymptotic Limits in the Hitchin moduli space
Ph.D. advisor: Andrew Neitzke
Mentor while at MSRI: François Labourie

Institution prior to MSRI: Stanford University
Position at that institution: Szego Assistant Professor
Mentor (if applicable): Rafe Mazzeo

Institution (or company) post MSRI: Stanford University (through June 2020); then University of Oregon (starting Fall 2020)
Position: Szego Assistant Professor (Stanford); then Assistant Professor (UO)
Anticipated length: tenure-track at UO

Postdoctoral fellow's comments:

It's been a wonderful and productive semester at MSRI. My research lies in the intersection of both programs, so it's been good to talk to with people in my program, as well as people in the microlocal analysis program like Michael Singer, Chris Kottke, Xuwen Zhu, Anda Degeratu and others. I've learned more about these two broad topics and people's various approaches in the conference weeks and in the usual seminars. MSRI has been very productive from a research standpoint. Early in the program, MSRI member Rafe Mazzeo and I worked with our visiting collaborators Jan Swoboda and Hartmut Weiss. We are wrapping up a project on the asymptotic geometry of parabolic Higgs bundles, but also started working on three new projects. In mid-October, Rafe and I worked with our visiting collaborator Max Zimet on a project about ALG metrics. In early November, my collaborator Steven Rayan visited, and we are wrapping up one project, and made good progress starting a second project. Since this summer I've been working on a new larger multi-paper project with MSRI member Andy Neitzke, and we've made good progress here. As of mid-November, we have enough to write one paper, and are making progress on work for a

second paper. In early November, I started a project on the conformal limit for parabolic Higgs bundles with MSRI member Richard Wentworth and MSRI postdoc Brian Collier. I've been talking with MSRI member Laura Schaposnik about a topic which may turn into a project in the future. While I haven't finished many papers at MSRI, I've finished remaining proofs on a number of papers, and started even more projects. I expect to post and publish a number of papers in the next few months.

Last year, I went on the tenure-track job market, and accepted a position of University of Oregon. I deferred my start date to Fall 2020 to attend the Fall 2019 MSRI program and finish out the 2019-2020 academic year at Stanford University, where I've been since September 2016. I wanted this to be a year of starting new projects and some new research directions, and MSRI has been very helpful towards these purposes. I wrote an NSF grant proposal in October, which featured these new research directions. Participating in the MSRI program between accepting and starting a tenure-track job has been optimal, timing-wise. I've had the freedom to pursue research directions which don't have immediate payout, so the community of researchers at MSRI has been even more valuable. Additionally, while many projects have slow starts, because I've been in residence with my collaborators at MSRI and surrounded by so many chalkboards, the early stages of these various projects have been drastically accelerated. Lastly, it's been a beautiful, and inspiring place to work. I am thankful for this opportunity, which has been far far better than I hoped for or expected.



Lee, Dami

Name: Dami Lee
Year of Ph.D.: 2018
Institution of Ph.D.: Indiana University Bloomington
Dissertation Title: Geometric Realizations of Cyclic Branched Covers over Punctures Spheres
Ph.D. advisor: Matthias Weber
Mentor while at MSRI: Alessandra Iozzi

Institution prior to MSRI: University of Washington, Seattle
Position at that institution: Postdoctoral Scholar
Mentor (if applicable): Jayadev Athreya

Institution (or company) post MSRI: University of Washington, Seattle
Position: Postdoctoral Scholar
Anticipated length: until September 2021
Mentor (if applicable): Jayadev Athreya

Postdoctoral fellow's comments:

I was able to begin new projects with Steve Bradlow, John Loftin, and Laura Schaposnik, on building explicit Higgs bundles and real projective structures. I also communicated with David Auricino and Gabriela Schmithusen on regular origami. David Auricino and Gabriela Schmithusen also provided useful feedback on my work with Jayadev Athreya, which I was able to finish at the end of the program.

As a co-organizer of the HDMP weekly seminar, I interacted with many speakers from different subfields. Overall, staying at MSRI was beneficial for my career as I was able to find many new collaborators and begin new projects. I am positive that this experience will help me find a future position.



Longhi, Pietro

Name: Pietro Longhi

Year of Ph.D.: 2015

Institution of Ph.D.: Rutgers University

Dissertation title: The Structure of BPS Spectra

Ph.D. advisor: Gregory W. Moore

Mentor while at MSRI: Martin Möller

Institution prior to MSRI: ETH Zurich

Mentor (if applicable): Matthias Gaberdiel

Institution (or company) post MSRI: ETH Zurich

Position: Postdoc

Anticipated length: until August 2021 (total 3 years, starting one year before MSRI fellowship and on leave during the period at MSRI)

Mentor (if applicable): Matthias Gaberdiel

Postdoctoral fellow's comments:

At MSRI I have engaged in research activities with a group participants of the program, including the assigned mentor (M. Moeller) as well as another faculty member and another postdoc. The project is ongoing at the moment. I have also attended all workshops of the program on holomorphic differentials, and gave talks both in the program seminar as well as in two of the reading groups (one on physics for mathematicians and one on spectral networks, which I co-organized).

While at MSRI I concluded two research projects (arxiv preprint numbers <https://arxiv.org/abs/1910.06193> and <https://arxiv.org/abs/1910.05296>), with one more close to conclusion and soon to appear.

For these projects, I have benefited directly from discussions with experts on saddle counting in the context of quadratic and higher differentials, as well as with experts on stability conditions (some of them visitors for part of the program) and with experts on isomonodromy problems (full-time members of the program).

I feel that this experience at MSRI will help me find a future position, in particular being a physicist with mathematically orientated research directions it should help with applications for math jobs.



Pei, Du

Name: Du Pei

Year of Ph.D.: 2016

Institution of Ph.D.: Caltech

Dissertation title: 3d-3d Correspondence for Seifert Manifolds

Ph.D. advisor: Sergei Gukov

Mentor while at MSRI: Alexander Goncharov

Institution prior to MSRI: Caltech and Aarhus University

Position at that institution: Postdoctoral Fellow

Institution (or company) post MSRI: Harvard University

Position: Postdoctoral Fellow

Anticipated length: 2.5 years

Mentor (if applicable): Shing-Tung Yau

Postdoctoral fellow's comments:

I really enjoyed my stay in MSRI. The scientific environment is superb and the staff is extremely helpful. I especially appreciate the assistance MSRI provided for finding housing and daycare.

During my fellowship, I finished a preprint

<https://arxiv.org/abs/1910.13455>

and have worked on a couple of another projects. One of them is about level-rank duality for general Lie groups in collaboration with Richard Wentworth, a research member who is also here at MSRI this fall.

I really benefited from frequent interaction with other people in MSRI. I get a few new ideas almost daily, and it is hard to list all of them here. The people that I discuss the most includes Andrew Neitzke, Pietro Longhi, Richard Wentworth and Alex Takeda, from whom I learned a lot about closely related research fields that I don't directly work on.

My mentor at MSRI is Alexander Goncharov, who offered me much useful advice concerning my career. Overall, I strongly believe that the fellowship is really helping me achieving my career goals.



Takeda, Alex

Name: Alex Atsushi Takeda

Year of Ph.D.: 2019

Institution of Ph.D.: University of California, Berkeley

Dissertation title: Developments in the mathematics of the A-model: constructing Calabi-Yau structures and stability conditions on target categories

Ph.D. advisor: Prof. Mina Aganagic and Prof. Vivek Shende

Mentor while at MSRI: Prof. Ursula Hamenstädt

Institution prior to MSRI: University of California, Berkeley

Position at that institution: Graduate student

Mentor (if applicable): Mina Aganagic and Prof. Vivek Shende

Institution (or company) post MSRI: Institut des Hautes Études Scientifiques

Position: Postdoctoral researcher

Anticipated length: 2.5 years

Mentor (if applicable): Prof. Maxim Kontsevich

Postdoctoral fellow's comments:

Being a postdoc in the Holomorphic Differentials in Mathematics and Physics at MSRI was wonderful and very beneficial for my career as a young mathematician. MSRI provided me and the other postdocs with a great physical space for interaction and the structure of the program, with its open seminars and talks, was very conducive to learning.

I think my experience was slightly unusual amongst MSRI postdocs, in the sense that my previous research was a bit further from the main topics of the semester; I had only come into contact with the study of Holomorphic Differentials through their relation with stability conditions and Fukaya categories. There seemed to be quite a bit of interest from the other members of the program in learning about stability conditions, and I was very happy that I could share my knowledge and results. Conversely, it was also very good that other people working in different subfields were friendly and always willing to teach me about the foundations of their work.

As for projects and collaborations, I spend some of this semester updating and doing revisions for two papers that I had started before MSRI. A lot of people at MSRI and down at the UC Berkeley math

department helped me with discussions and ideas for that. As for within the program, I also started a new project with some other members, looking at understanding a higher rank version of Strebel differentials. While we have not compiled our studies and results in a paper yet, we will shortly start writing about it. I also had some very productive discussions with another MSRI member (Pranav Pandit), which helped me understand some things about my research in stability conditions, and I also expect that we could write a sequel to my own paper on this topic shortly.

Since I already had a position lined up for the next 2.5 years, I cannot say now whether my stay at MSRI will help me find a future position, but I really do believe that is the case. I met many more senior people in a variety of fields, and had meaningful mathematical conversations with them; that probably will be of great help when I try in the future to advertise and explain my work to the community.

In conclusion, I'm very thankful for this semester at MSRI, and hope that future young researchers are able to experience something like this for the years to come.

MICROLOCAL ANALYSIS



Balehowsky, Tracey

Name: Tracey Balehowsky
Year of Ph.D.: 2017
Institution of Ph.D.: University of Toronto
Dissertation title: Recovering a Riemannian Metric from Knowledge of the Areas of Properly-Embedded, Area-Minimizing Surfaces
Ph.D. advisor: Spyros Alexakis and Adrian Nachman
Mentor while at MSRI: Katya Krupchyk

Institution prior to MSRI: University of Helsinki
Mentor (if applicable): Matti Lassas

Institution (or company) post MSRI: University of Helsinki
Position: Postdoctoral Researcher
Anticipated length: 1 year
Mentor (if applicable): Matti Lassas

Postdoctoral fellow's comments:

During my time at MSRI I have focused on three activities 1. Finishing up some previous collaborative work, 2. Applying for tenure-track positions, and 3. Making new research collaborations.

1. I have completed two preprints of work started before my time at MSRI: "Identification of molecular cluster evaporation rates, enthalpies and entropies by Monte Carlo method" with Anna Shcherbacheva et. al., submitted to Atmospheric Chemistry and Physics, and "The Relativistic Boltzmann Equation and Determination of Lorentzian Metrics" with Antti Kujanpää et. al. . I started these projects while at the University of Helsinki.

2. I prepared and applied to several places for a tenure-track position. My time at MSRI has been very helpful in making connections with other faculty and giving me an opportunity to present my work to a broader (and new) audience. My mentor at MSRI, Katya Krupchyk, has been incredibly supportive and has given me numerous advice on my application materials and on the application process.

3. I have also started some discussions with Katya Krupchyk about a few linearized Calderón inverse problems. We are assessing the viability of some microlocal techniques applied to these problems. I have also been discussing with Ting Zhou a problem which builds on my Boltzmann equation work with Antti Kujanpää et. al.. My participation in the MSRI program was instrumental in providing me the opportunity to spend a considerable amount of time in the

same location as both Katya and Ting.

I think the fellowship at MSRI will help me to find a future position as I have met several people in my field, started some promising projects, and received valuable career advice while at MSRI.



Deleporte, Alix

Name: Alix Deleporte

Year of Ph.D.: 2019

Institution of Ph.D.: IRMA, UMR 7501, CNRS, Université de Strasbourg

Dissertation title: The low-energy spectrum of Toeplitz operators

Ph.D. advisor: Nalini Anantharaman

Mentor while at MSRI: Semyon Dyatlov

Institution prior to MSRI: IRMA, UMR 7501, CNRS, Université de Strasbourg

Mentor (if applicable): Nalini Anantharaman

Institution (or company) post MSRI: Institut für Mathematik, Universität Zürich

Position: Postdoctoral fellow

Anticipated length: 21 months

Mentor (if applicable): Benjamin Schlein

Postdoctoral fellow's comments:

During my stay at MSRI, I have fostered new collaborations as well as made decisive progress on pre-existing research projects. One of my collaborators, Frédéric Faure, was also at MSRI for part of the program and we could make progress on our project on Ansätze with entanglement in spin systems. In addition of him and my mentor Semyon Dyatlov, I have enjoyed mathematical discussions with Clotilde Fermanian and Daniel Tataru who shared their insight with me, providing me with new perspectives for my ongoing project on the Weyl law for the Laplace operator in low regularity.

I benefited from intense discussions with Steven Zelditch and Michael Hitrik that gave birth to two new collaborative projects, respectively on geodesics on the moduli space of Kähler manifolds and on a synthetic approach for the Bergman kernel.

The intense seminar schedule at MSRI has allowed me to keep in touch with recent developments in my field, and to discover new domains of interest (for instance, inverse problems). My curiosity drove me to the introductory conferences of the other program (holomorphic differentials) and I could discover interesting connections between the two fields.

The environment at MSRI was also greatly beneficial in terms of employment prospects. Even though I do not wish to apply for long-terms positions in North America, the density of French researchers in this program was high enough that I could prepare and obtain information and advice on applications for several faculty positions in France.

My experience at MSRI was very beneficial; this research environment is close to optimal for meeting new people and creating or making advances in collaborative works.



Gannot, Oran

Name: Oran Gannot

Year of Ph.D.: 2016

Institution of Ph.D.: UC Berkeley

Dissertation title: Quasinormal modes of anti-de Sitter black holes

Ph.D. advisor: Maciej Zworski

Mentor while at MSRI: Michael Hitrik & Maarten de Hoop

Institution prior to MSRI: Northwestern University

Mentor (if applicable): Jared Wunsch

Institution (or company) post MSRI: TBD

Position: N/A

Anticipated length: N/A

Mentor (if applicable): N/A

Postdoctoral fellow's comments:

The MLA program provided me with an excellent opportunity to discuss new ideas with researchers from all over the world, including collaborators I do not often meet face-to-face. I was able to continue thinking about projects I began during my previous postdoc. Many of the people I met at MSRI (including one of my mentors) were eager to assist me in securing postdoc positions at their universities.



Name: Katrina Morgan

Year of Ph.D.: 2019

Institution of Ph.D.: University of North Carolina at Chapel Hill

Dissertation title: Wave decay in the asymptotically flat stationary setting

Ph.D. advisor: Jason Metcalfe

Mentor while at MSRI: Gunther Uhlmann

Institution prior to MSRI: University of North Carolina, Chapel Hill

Position at that institution: Graduate Student

Morgan, Katrina

Mentor (if applicable): Jason Metcalfe

Institution (or company) where you are going after MSRI:

Northwestern University

Position: NSF RTG Postdoctoral Fellow

Anticipated length: 3 years

Mentor (if applicable): Jared Wunsch

Postdoctoral fellow's comments:

My time as a Postdoctoral Fellow with the Microlocal Analysis Program at MSRI has been productive and beneficial for my career. This was my first position after earning my Ph.D., and the connections I made here have been incredibly helpful as I begin my career as an independent researcher. During the semester I began working with two collaborators: Professor Gunther Uhlmann and Professor Sung-Jin Oh. Uhlmann is a well-established senior mathematician at University of Washington. Oh is a tenure-track professor who recently began a position at UC Berkeley. I also worked on writing my single author paper The effect of metric behavior at spatial infinity on pointwise wave decay. This paper is a continuation of my research in progress before coming to MSRI.

The lectures, workshops, and conversations at MSRI helped me to learn new tools and develop new ideas for my research. For example, I learned about the role of Lagrangian distributions in solving inverse problems and began research in a new direction related to these ideas. This new research direction involves recovering information about the background geometry based on information about solutions to the wave equation. I also began investigating the sharpness of my thesis result (i.e. establishing that the bounds I obtained in my thesis are the best possible bounds). Another project I began while at MSRI involves studying the long-time asymptotics of solutions to the wave equation with an inverse square potential.

Overall my experience at MSRI has been excellent. I had the opportunity to meet and connect with senior mathematicians in my field. As an early career mathematician, this was an invaluable opportunity. Growing my professional network is important for expanding my research, sharing my results, and obtaining a tenure track job in the future.



Shapiro, Jacob

Name: Jacob Shapiro
Year of Ph.D.: 2018
Institution of Ph.D.: Purdue University
Dissertation title: Semiclassical resolvent estimates and wave decay in low regularity
Ph.D. advisor: Kiril Datchev
Mentor while at MSRI: Maciej Zworski

Institution prior to MSRI: Australian National University
Mentor (if applicable): Andrew Hassell and Jesse Gell-Redman

Institution (or company) post MSRI: Australian National University
Position: Postdoctoral fellow
Anticipated length: 18 months
Mentor (if applicable): Andrew Hassell and Jesse Gell-Redman

Postdoctoral fellow's comments:

Throughout the semester, I had semi-regular meetings with Zworski, as well as Andras Vasy, about two problems they proposed to me:

1. Showing the Schwarzschild model of a black hole has no resonance at zero energy.
2. Proving a uniform resolvent estimate for a non-self adjoint harmonic oscillator.

I made progress on each of these problems, but have not yet arrived at any publishable results.

I collaborated with Jeffery Galkowski to prove semiclassical resolvent estimates for Schrödinger operators with Hölder continuous potentials. Galkowski and I are almost finished writing up this result. Soon, we will submit our paper to a journal.

I had several meetings with Datchev, in which he offered helpful suggestions about my paper with Galkowski. Datchev and I also discussed a possible future collaboration, in which we would investigate energy decay in one dimension for the wave equation with a long range, Lipschitz wavespeed. Datchev also helped me update my research and teaching statements, in preparation for going on the academic job market.

Finally, I attended many of the seminar talks given throughout the semester, as well as Zworski's UC Berkeley course on several complex variables.

My experience at MSRI was beneficial because I receive quality

mentoring from all the people I mention above, became more familiar with state-of-the-art microlocal research, and developed stronger ties with the microlocal community at large. I believe my MSRI postdoc, and the publications that will result from it, will be helpful for finding a permanent academic position.



Zhu, Hui

Name: Hui Zhu

Year of Ph.D.: 2019

Institution of Ph.D.: Université Paris-Sud, Université Paris-Saclay

Dissertation title: Contrôle, stabilisation et propagation des singularités pour des EDP dispersives

Ph.D. advisor: Thomas Alazard & Nicolas Burq

Mentor while at MSRI: Daniel Tataru

Institution prior to MSRI: Université Paris-Sud, Université Paris-Saclay

Position at that institution: Ph.D. candidate

Mentor (if applicable): Thomas Alazard & Nicolas Burq

Institution (or company) post MSRI: University of Michigan, Ann Arbor

Position: Van Loo Postdoctoral Fellow and Assistant Professor

Anticipated length: 3 years

Mentor (if applicable): Zaher Hani & Sijue Wu

Postdoctoral fellow's comments:

I arrived at MSRI 3 months later than expected due to 6-months visa processing. I received continuous help from MSRI during my wait for the visa and a warm welcome when I arrived here in late November. Even though the program was almost finished by that time, I was still able to meet other researchers in the microlocal analysis and participate in some research activities. These research activities include:

- (1) two research talks to share my work on the propagation of singularities for the gravity-capillary water wave system;
- (2) a new research project on the microlocal singularity formation for nonlinear Schrödinger equations, in collaboration with Thibault de Poyferré.

Moreover, some informal conversations with other researchers enlightened my view on the water wave propagation, where future projects might emerge.

My experience at MSRI, though very short, is undoubtedly beneficial. It is not only because of the new research project and

new ideas that I found here, but also because of the friends I made here. I think the MSRI program is very selective and of high quality, it will definitely help me find a future position. In fact I have applied for the 2021 spring program at MSRI on Mathematical problems in fluid dynamics. I do hope to come back to MSRI in the future and hope to enjoy the full program next time!



Zhu, Xuwen

Name: Xuwen Zhu
Year of Ph.D.: 2015
Institution of Ph.D.: Massachusetts Institute of Technology
Dissertation title: The eleven dimensional supergravity equations, resolutions and Lefschetz fiber metrics
Ph.D. advisor: Richard Melrose
Mentor while at MSRI: Michael Singer, Alejandro Uribe

Institution prior to MSRI: UC Berkeley
Position at that institution: Morrey Visiting Assistant Professor
Mentor (if applicable): Maciej Zworski

Institution (or company) post MSRI: Massachusetts Institute of Technology
Position: Lecturer
Anticipated length: half a year (on job market this year)
Mentor (if applicable): NA

Postdoctoral fellow's comments:

I have truly enjoyed my stay at MSRI, where I gave five research talks and a mini-course: "The moduli space of Riemann surfaces and the Weil-Petersson metric" on the HDMP Connection for Women workshop, "Introduction to microlocal analysis" on the MLA Connection for Women workshop, "Deformation of spherical conical metrics" on the conference "Recent developments in microlocal analysis", two seminar talks "Spectral properties of reducible spherical conical metrics", "Compactified configuration spaces and point collisions", and two lectures on pseudodifferential operators on the MLA Introductory Workshop. Through these talks I have communicated my results to many experts in the field. During my stay at MSRI I finished the paper "Spectral properties of reducible conical metrics" (arXiv: 1909.00546). I have discussed with many members of MSRI in both programs (MLA and HDMP), including Michael Singer and Anda Degeratu with whom I am currently collaborating on a project on constructing special Kähler metrics on degenerating elliptic fibrations, Rafe Mazzeo with whom I am currently working on a project on Fredholm properties and perturbations of a family of hyperkähler manifolds, and Richard

Melrose with whom I am working on a project on spectrum properties of fibred cusp metrics. Overall this semester at MSRI has been extremely beneficial for my career development because I had the opportunity to learn from and discuss with a large number of people whose research interests have intersections with mine.

QUANTUM SYMMETRIES



Delaney, Colleen

Name: Colleen Delaney
Year of Ph.D.: 2019
Institution of Ph.D.: UC Santa Barbara
Dissertation title: A categorical perspective on topological order, symmetry, and quantum information
Ph.D. advisor: Zhenghan Wang
Mentor while at MSRI: Chelsea Walton

Institution prior to MSRI: Indiana University Bloomington
Mentor (if applicable): Noah Snyder, Julia Plavnik

Institution (or company) post MSRI: Indiana University Bloomington
Position: NSF Mathematical Sciences Postdoctoral Research Fellow
Anticipated length: 2-3 years
Mentor (if applicable): Noah Snyder, Julia Plavnik

Postdoctoral fellow's comments:

I had several opportunities to present my research early in the semester, first with a research talk in the Quantum Symmetry Introductory Workshop and then an expository talk at MSRI's Committee of Academic Sponsors Day. In the weeks between the introductory workshops and main workshops I worked extensively with 3 other QS program members (Research Professors Eric Rowell and Julia Plavnik, and QS Postdoc Qing Zhang) to finish writing a paper wherein we developed a new construction of modular tensor categories and explored its applications. In addition to the QS and joint HC & QS seminars I participated in the weekly Blob Homology/Factorization Homology learning seminar until the semester went virtual, at which point I attended the vast majority of the online talks.

While at MSRI I had weekly meetings with my MSRI mentor Chelsea Walton, and we were able to formulate a project which we will begin working on virtually this summer. I also discussed a potential project about modeling fracton order of 3D topological phases of matter through fusion category theory with Fiona Burnell and Kevin Walker.

The seminars moving online had several benefits for me. Since there were less seminars being held and their focus shifted from technical talks for experts to research talks for the joint audience I was able to participate more fully in the aspects of the HC&C program that had felt more inaccessible in person. I was lucky to have several senior

MSRI members check in on me through virtual meetings to make sure the transition to working remotely went smoothly.

Certainly my experience at MSRI has been beneficial career-wise and the exposure to new areas related to my ongoing research will help me broaden my research program going forward. Finally, as a postdoc I am extremely grateful for the option to continue healthcare coverage over the summer.

In spite of the circumstances I still felt that I got a lot out of the semester and enjoyed the online seminars. The professional development seminar hosted by Chelsea Walton and Marcy Robertson also helped me learn about several list-servs for researchers in category theory and algebraic topology that I didn't know about but now keep me in the loop about job opportunities and conferences. As far as improving the online component of the program, I found that having the social aspect following but separate from the seminars resulted in my not participating in them. Something about that extra step was a bit daunting. I think keeping the social aspect ("tea rooms") on the same platform that we use for the seminar talks, and perhaps utilizing a breakout room feature would have worked better for me personally.



**Edie-Michell,
Cain**

Name: Cain Edie-Michell

Year of Ph.D.: 2018

Institution of Ph.D.: Australian National University

Dissertation title: The classification of categories generated by an object of small dimension

Ph.D. advisor: Scott Morrison

Mentor while at MSRI: Terry Gannon

Institution prior to MSRI: Vanderbilt

Position at that institution: Assistant Professor

Mentor (if applicable): Dietmar Bisch

Institution (or company) post MSRI: Vanderbilt

Position: Assistant Professor

Anticipated length: 1 year

Mentor (if applicable): Dietmar Bisch

Postdoctoral fellow's comments:

The majority of my time as a post-doc at the MSRI's quantum symmetries semester was spent on research and collaboration. The time at MSRI allowed me to finish off my paper "Autoequivalences of the modular tensor categories of type A, B, C, and G". This was a very long paper that I had been working on for several years. The

open nature of the semester at MSRI gave me the free time to finally finish this paper. Further, my mentor at MSRI, Terry Gannon, found a significant improvement to one of the results. This resulted in Terry Gannon writing an appendix for the paper, which improved the overall quality of the paper.

With Terry Gannon we also found that we were essentially working on the same project, and have joined forces to share our individual expertise on the problem. Our goal is to classify the "E7" like quantum subgroups for the type A Lie algebras (and potentially for the other types as well). If successful, this project will complete a significant portion of the program to classify the quantum subgroups of $SU(N)$, an open problem dating back to work of Ocneanu and Gannon from the 90's.

Overall I found my overall experience at the MSRI to be highly productive. The lack of fixed structure, and concentration of talent made research progress significantly faster than it would back at my home institution. As I will be applying for jobs next fall, it is unclear whether the program will assist in me finding a position. However, I strongly believe the research boost the program has given me will have a strong impact on my applications.

In regards to the online portion of the program, I very much disliked all of it. However this is personal preference, and not something that should reflect on the MSRI. I understand that it was the best the MSRI could do given the circumstances.



Negron, Cris

Name: Cris Negron
Year of Ph.D.: 2015
Institution of Ph.D.: University of Washington
Dissertation title: Alternate Approaches to the Cup Product and Gerstenhaber Bracket on Hochschild Cohomology
Ph.D. advisor: James Zhang
Mentor while at MSRI: Victor Ostrik

Institution prior to MSRI: University of North Carolina
Position at that institution: Assistant Professor
Mentor (if applicable):

Institution (or company) post MSRI: University of North Carolina
Position: Assistant Professor
Anticipated length: tenure-track
Mentor (if applicable):

Postdoctoral Fellow's Comments:

My experience at MSRI has been fantastic and remarkably beneficial. The fellowship I've received was very important for me, as, practically speaking, it made it easy for me to navigate the transition from my new position at UNC to my time at SRI. Without the fellowship, I do not know if I could have even attended the program. So this was very impactful for me, and has helped solidify my research program as an early faculty member at UNC.

Over the semester I have been able to advance preexisting projects, and begin new projects with a number of MSRI members. I have continued work with Julia Pevtsova on support theory for quantum groups, and began a serious project with Terry Gannon on relations between logarithmic conformal field theories and quantum groups. (Pevtsova and I completed one paper in a three part sequence while I was in residence at MSRI.) I have also begun work with Victor Ostrik, Dmitri Nikshych, Siddharth Venkatesh and Julia Plavnik regarding modular tensor categories in finite characteristic. I probably would not have been able to begin the project with Gannon, in particular, if I had not been in residence at MSRI.

In addition to these explicit collaborations, my informal discussion with MSRI members regarding topological field theories and moduli of vacua have been an extremely important aspect of my experience at MSRI. While these discussions have yet to materialize into a formal piece of mathematics, they have sown the seeds for much future research, and I expect that they will have a serious impact on my long term research program and career trajectory.

Given the unusual circumstances of this semester, we also ask that you comment on your experience with the online portions of the program. In particular, we welcome your suggestions on how to improve this experience.

I think the move to a digital program was handled very well. Of course, in person interaction is preferable, but I have been able to stay active in the program through the online seminars, and have had regular interactions with members via video conferencing applications.



Schopieray, Andrew

Name: Andrew Schopieray
Year of Ph.D.: 2017
Institution of Ph.D.: University of Oregon
Dissertation title: Relations in the Witt Group of Nondegenerate Braided Fusion Categories Arising from the Representation Theory of Quantum Groups at Roots of Unity
Ph.D. advisor: Victor Ostrik
Mentor while at MSRI: David Evans

Institution prior to MSRI: University of New South Wales
Mentor (if applicable): Pinhas Grossman

Institution (or company) post MSRI: University of Alberta
Position: PIMS Postdoctoral Fellow
Anticipated length: 2 years
Mentor (if applicable): Terry Gannon

Postdoctoral Fellow's Comments:

My stay at MSRI during the Spring 2020 semester was highly productive and here I would like to personally thank the countless individuals who I unfortunately will not have the chance to thank in person.

Despite only being at the institution for about two months before the pandemic struck, I was able to begin four separate research projects. For two of the projects I was the sole creator. One of these projects I will not pursue further, but a second resulted in a paper which will appear on the arXiv at the end of the semester: "Norm, trace, and formal codegrees of fusion categories". This paper illustrates connections between numerical invariants of fusion categories and the (classical, number-theoretic) Schur-Siegel-Smyth trace problem of identifying algebraic integers of small absolute trace. I attribute the independence I had at MSRI as the sole reason this project succeeded. Two other projects, one with Julia Plavnik and another initiated by Eric Rowell and Victor Ostrik (all three were in residence at MSRI), are producing fruitful results and will undoubtedly produce papers in the future. Of course, the pandemic disrupting the community at MSRI decelerated the progress of these projects greatly. We continue to stay in touch electronically at a much slower pace.

With regard to MSRI facilities, staff, and communication, I have nothing but positive comments. The minor administrative issues which arose were fixed with single emails, promptly answered, or a

simple walk to the main office. The MSRI response to the pandemic as a whole was prompt, clear, and thorough. My only suggestion is some consolidation of the emails sent to researchers in residence through official channels. Not including emails between researchers for seminars and the like, we received emails from perhaps 15 different staff/administrators. I have two separate email addresses on file, and about half of the official MSRI emails were only sent to one or the other, and the multitude of senders were all treated differently by spam filters and the like. At least one important administrative email was filtered as spam that I learned about from talking to other researchers.



Venkatesh, Siddharth

Name: Siddharth Venkatesh
Year of Ph.D.: 2019
Institution of Ph.D.: MIT
Dissertation title: Geometry and representation theory in the Verlinde category
Ph.D. advisor: Pavel Etingof
Mentor while at MSRI: Noah Snyder

Institution prior to MSRI: UCLA
Position at that institution: Hedrick Assistant Adjunct Professor
Mentor (if applicable): Raphael Rouquier

Institution (or company) post MSRI: UCLA
Position: Hedrick Assistant Adjunct Professor
Anticipated length: 2 years
Mentor (if applicable): Raphael Rouquier

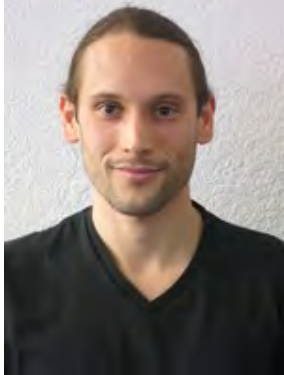
Postdoctoral Fellow's Comments:

Regarding the MSRI experience, it started extremely well. I was able to give talks on my research at some of the seminars. I had a lot of meaningful discussions with people at the program. I started a project with 4 other members (Victor Ostrik, Dmitry Nikshych, Cris Negron and Julia Plavnik) that is still ongoing albeit slowly thanks to the disruptions. Noah and I also spoke at some length about some other ideas regarding tensor categories and we had a small project we were working on but it ended up already being mostly solved.

Unfortunately, after the shutdowns due to the virus, most of my collaborators left, and it wasn't easy to speak to the people I had hoped to learn more from. Ultimately, the experience was disappointing, though entirely due to the disruptions caused by the virus.

As for the online experience, I was definitely thankful to be able to

watch many of the lectures after the fact because I couldn't always make them live. That said, it was understandably harder to engage with the other people here, which is primarily what I was hoping to do. I'm not sure anything could be done to fix that.



Wedrich, Paul

Name: Paul Wedrich
Year of Ph.D.: 2015
Institution of Ph.D.: University of Cambridge
Dissertation title: Deformations and stability properties of colored $sl(N)$ link homologies
Ph.D. advisor: Jacob Rasmussen
Mentor while at MSRI: Dan Freed

Institution prior to MSRI: Max Planck Institute for Mathematics, Bonn

Mentor (if applicable): -

Institution (or company) post MSRI: Max Planck Institute for Mathematics, Bonn

Position: Hirzebruch Research Instructor

Anticipated length: until Jan 2023

Mentor (if applicable): -

Postgraduate Fellow's Comments:

During the spring semester of 2020, I was affiliated with the MSRI program on Quantum Symmetries as a postdoctoral fellow. Additionally, I intensively followed the parallel MSRI program on Categorification and Higher Categories. The common anchor point to both programs is my research focus on the higher structures controlling the Khovanov-Rozansky link homology theories, which are categorifications of quantum invariants of knots and links, including the famous Jones polynomial. Over the last years, I have contributed to the understanding of the field-theoretic background of Khovanov-Rozansky homology, including a proof of the functoriality under link cobordism and an extension to invariants of oriented smooth 4-manifolds. The further development of this theory and the exploration of its connections to other areas in mathematics were my main goal for this semester at MSRI, and at the time of writing, in early May 2020, I am very satisfied with the progress made.

I participated in all workshops of the two programs - in person when possible, and otherwise online - and I gave three presentations at MSRI about my research, in formats ranging from a brief 5 minute introduction, to a full 75 minute seminar talk. Outside of MSRI, I have given a workshop talk at ICERM and seminar talks at UC

Davis, UMass Amherst, Stanford, UC Berkeley, George Washington University, and in the Joint Los Angeles Topology Seminar during this semester. Further talks are planned for the last weeks of the semester.

My research outputs during the semester include four new preprints:

- a) <https://arxiv.org/abs/2002.06110>
- b) <https://arxiv.org/abs/2004.10146>
- c) <https://arxiv.org/abs/2004.10392>
- d) <https://arxiv.org/abs/2004.10837>

My work on a) was completed before coming to MSRI, but the papers b), c), d) are directly connected to my activities at MSRI. I am currently working on five paper projects, with anticipated completion in the next 18 months. Three of these five projects were initiated at MSRI. Additionally, I had many discussions at MSRI, which might crystallize into concrete collaborations in the coming months.

Overall, I would say that the time at MSRI has been one of my most productive periods, thanks to the stimulating environment and the concentration of fantastic mathematicians in one place. It is very disappointing, however, that the time of in-person interaction was cut short by the start of the Covid-19 pandemic. The MSRI staff and the organizers of both programs have done an amazing job in facilitating the continuation of the programs online, to the best of everyone's ability and availability. I think they created the best possible outcome in dire circumstances. Nevertheless, I think that the migration of the programs online, together with the pandemic-induced disruption of important research phases in the lives of many participants, amount to a big setback for our general research area. I will do my best in the coming years to help compensate this shortfall, e.g. by continuing collaborations started here and by organizing follow-up events.



Zhang, Qing

Name: Qing Zhang

Year of Ph.D.: 2019

Institution of Ph.D.: Texas A&M University

Dissertation title: Super-modular Categories

Ph.D. advisor: Eric Rowell

Mentor while at MSRI: Siu-Hung Ng

Institution prior to MSRI: Texas A&M University

Position at that institution: Graduate student

Mentor (if applicable): Eric Rowell

Institution (or company) post MSRI: Purdue University

Position: Postdoc

Anticipated length: 3 years

Mentor (if applicable): Xingshan Cui

Postgraduate Fellow's Comments:

I finished two papers with my collaborators during my stay at MSRI. One is "Higher central charges and Witt groups" with Siu-Hung Ng, Eric C. Rowell, and Yilong Wang. The other is "Braided, zesting, and its applications" with Colleen Delaney, César Galindo, Julia Plavnik, and Eric C. Rowell. I'm working on a third paper with Siu-Hung Ng, my mentor at MSRI, and Yilong Wang. Joining the MSRI program on Quantum Symmetries facilitated further progress on my research topics and provided an opportunity to branch out into related areas. Attending this program allowed me to meet my collaborators and be more efficient with my research projects. The program gave me a chance to meet experts and gain a wider perspective on related areas, such as topological phases of matter, Hopf algebras, subfactors, topological field theories, and vertex operator algebras. My next position is at Purdue University. My experience at MSRI has helped me to be more prepared for future jobs. After MSRI moved online, my discussions with my collaborators and my mentor took place via zoom meetings. It took some time to get used to the online discussion, but I still found it very useful. The online seminars help get to know what other people are working on and learn new things without worrying about safety issues. One thing I think we can improve is to have some informal discussions with the graduate students or postdocs. I think it is possible junior people would be more isolated under this unusual situation.

HIGHER CATEGORIES AND CATEGORIFICATION



Campbell, Alexander

Name: Alexander Campbell

Year of Ph.D.: 2016

Institution of Ph.D. Macquarie University

Dissertation title: A higher categorical approach to Giraud's non-abelian cohomology

Ph.D. advisor: Ross Street

Mentor while at MSRI: Martin Markl

Institution prior to MSRI: Macquarie University

Mentor: Richard Garner

Institution post MSRI: Johns Hopkins University

Position: Postdoctoral Fellow

Anticipated length: 2 years

Mentor: Emily Riehl

Postdoctoral Fellow's Comments:

As a Postdoctoral Fellow in the Higher Categories and categorification program, many of my activities were related to the Working Group on $(\infty, 2)$ -categories led by Emily Riehl. I will begin this report by describing those activities. The activities of this working group began with a series of seminar talks on models for $(\infty, 2)$ -categories and on recent advances in the theory of $(\infty, 2)$ -categories. I helped Emily choose the topics and speakers for these talks, and contributed a talk titled '2-quasi-categories', in which I spoke on my recent paper 'A homotopy coherent cellular nerve for bicategories'. Following this series of talks, the working group turned its attention to open problems at the frontier of research in $(\infty, 2)$ -categories. This began with an afternoon meeting in which some of the members of the group described their current projects on $(\infty, 2)$ -categories, and/or proposed open problems for the group to work on. In this meeting, I described the following two joint projects, which I worked on while at MSRI (and which I am still working on now):

- First, a joint project with Viktoriya Ozornova and Martina Rovelli on n -complicial sets (a model for (∞, n) -categories due to Dominic Verity), which I proposed to Viktoriya and Martina back in 2019 as a project for us to work on together while at MSRI. The ultimate goal of this project is to prove that n -complicial sets are equivalent to the other accepted models for (∞, n) -categories; this is one of the major outstanding problems in the study of models for (∞, n) -categories. Our strategy is to prove that n -complicial sets are equivalent respectively to categories "weakly" enriched in $(n - 1)$ -

complicial sets (more precisely, to prove that a certain adjunction is a Quillen equivalence between the model categories for n -complicial sets and for complete Segal objects in the model category of $(n - 1)$ -complicial sets). Once we have proved this, the main result will follow easily by iteration and change of base of enrichment. Viktoria, Martina, and I met a number of times while we were at MSRI to discuss and work on this project. We have made some promising early progress, but much remains to be done.

- Second, a joint project with Yuki Maehara. The main goal of this project is to give a “model independent” construction of the Gray monoidal structure on the ∞ -category of $(\infty, 2)$ -categories, using the ∞ -categorical analogues of the results from Brian Day’s PhD thesis (viz. Day convolution and the Day reflection theorem). I proposed this project to Yuki in 2019, and in our discussions then we came up with a sketch of the argument, and identified a key combinatorial conjecture which, if we could prove it, would enable us to implement this argument. While at MSRI, Yuki and I worked on this combinatorial problem, and shortly after he departed MSRI, Yuki came up with a proof. In this same meeting, I also proposed a number of open problems, some of which I am currently working on (I hope to work on the others sometime in the future):

- In $(\infty, 2)$ -category theory, there is a notion of “homotopy coherent” lax functor, which is not simply a generalisation of the classical notion of lax functor between 2-categories. (For instance, the former notion is invariant under equivalence, whereas the latter is not, in general.) I proposed as an open problem to work out what these “homotopy coherent” lax functors amount to (in elementary, classical terms) between the images of ordinary 2-categories under the embedding of 2-categories into $(\infty, 2)$ -categories. I am currently working on this problem, and expect to produce before long a paper (provisionally titled ‘Fiat lax’) containing my solution.

- For every sufficiently nice monoidal ∞ -category V , Rune Haugseng has constructed a double ∞ -category of V -enriched ∞ -categories and V -enriched functors and profunctors between them. I proposed as an open problem to show that the homotopy double category of this double ∞ -category is an equipment (in the sense of Shulman, being a reformulation of Wood’s notion of proarrow equipment). This would give a convenient setting to develop the category theory of V -enriched ∞ -categories, which development is sorely wanted by many ∞ -category theorists. After this meeting, I had good discussions with Rune Haugseng about this problem. While we are not currently working on it, I anticipate that we will return to it in the future.

- A number of other open problems I proposed in this meeting, which haven't yet been developed further, but which should be the basis for interesting future projects, include: to prove that the $(\infty, 2)$ -category of stable ∞ -categories is monadic over the $(\infty, 2)$ -category of ∞ -categories; to prove a version of Beck's monadicity theorem for enriched ∞ -categories; to develop an ∞ -categorical analogue of the theory of 2-monads ("two-dimensional monad theory"), including notions of lax morphism between algebras and of lax algebra for an $(\infty, 2)$ -monad, and to prove that the $(\infty, 2)$ -category of algebras and lax morphisms for an $(\infty, 2)$ -monad (on a suitably complete $(\infty, 2)$ -category) admits oplax limits. Once our MSRI activities moved online, the working group on $(\infty, 2)$ -categories focused on a project to write up an account of the state of the art of $(\infty, 2)$ -category theory, and in doing so, to synthesise and develop further many of the topics we had discussed and begun to work on earlier in the semester. One topic in this work that particularly interested me was the theory of ("Grothendieck" or "cartesian") fibrations of $(\infty, 2)$ -categories. In consulting the literature, I found not only that this theory had barely progressed beyond basic definitions and examples, but that the theory of fibrations of 2-categories was little more advanced. I therefore turned my attention to developing for fibrations of 2-categories analogues of some of the interesting results in the theory of fibrations of (1-)categories. The most important of the results that I proved in this investigation on fibrations of 2-categories, from which many other interesting results follow, can be stated as follows: a 2-functor between 2-categories is a 2-fibration if and only if it is sent by the "double category of squares" functor to a fibration in the 2-category of double categories, pseudo double functors, and vertical transformations. I described these results in a few video meetings of the $(\infty, 2)$ -categories working group, and am currently writing them up in a paper provisionally titled 'A Chevalley criterion for fibrations of 2-categories'. I will now describe some of my activities at MSRI which were not directly related to the working group on $(\infty, 2)$ -categories. In addition to the joint projects described above, I also worked on a joint project with Tim Champion, the goal of which was to prove Rezk's Comonadicity Conjecture, which states that the canonical functor from the ∞ -category of ∞ -groupoids to the ∞ -category of strict ∞ -groupoids is comonadic. Our first approach was to see if we could extend a simpler (and already proved) analogue of this conjecture to a proof of the full version of Rezk's conjecture. However, I found a fundamental obstruction to this particular approach, and we have not spent much time on the problem since then. I spoke in the series of Five Minute Talks, in which I outlined my academic history and told the story of how I

came to be a category theorist, and described a few of the joint projects I was working on with other members of the MSRI semester program. After our activities had moved online, I gave a talk in the MSRI Online Seminar about my recent preprint on 'Joyal's cylinder conjecture'. I was very glad for this opportunity, not only because I got very encouraging comments from the audience, but most of all because Joyal himself was able to attend (which would not have been the case had I given the talk in person at MSRI as originally scheduled!). In total, I found my experience as a Postdoctoral Fellow at MSRI to be greatly beneficial, both to my development as a mathematician and to my future career prospects. My participation in this program has broadened my research horizons, as I have been exposed to many new ideas at the frontier of research in my subject and in closely related subjects, and also to new cultures of mathematicians, with related interests to but distinct from the ones to which I have previously belonged. This new set of mathematics and mathematicians that I got to know while at MSRI will continue to shape my mathematical interests in the next stages of my career.

During this semester, program organiser Emily Riehl offered me a job as a Postdoctoral Fellow at Johns Hopkins University, which I happily accepted. Furthermore, I am confident that my fellowship at MSRI will be of great help to me in finding future positions. Through my participation in this program, I and my work have become known to a larger group of mathematicians, which will no doubt help to establish my reputation beyond my familiar category theory community, and hopefully lead to more invitations to speak at conferences and seminars, and ultimately to increase my prominence in mathematics. Beyond these benefits, there was much about the MSRI experience that I enjoyed. For instance, I particularly valued the chance to interact with younger mathematicians in my field. I found it very rewarding to discuss their interesting ideas with them, to answer their questions, and to encourage them in their work. In addition to the social aspects, I especially enjoyed spending time in and making use of the MSRI library, whose mathematical collection surpasses those at my previous institutions. ³ Finally, while it was of course very unfortunate that our activities had to move entirely online for the second half of the program, the program organisers and MSRI staff did a great job in keeping us all connected and engaged in the program. The continuation of the meetings of seminars and working groups via Zoom made it possible to continue to share our work and to keep up with the work of others, and the creation of the Slack channel made it very easy to keep in touch with the other members of the group, both individually and in groups. (One downside

of the online portion of the semester for me was that, because I had returned home to Australia, most of the MSRI activities took place either in the middle of the night or early in the morning in my time zone, which meant that I was unable to participate live in many of these activities.) Sadly, the social aspects of the program could not continue in the same way; in the end, nothing can compare with actually being together with other mathematicians in person. So the great appeal of these MSRI semester programs, which is to be in the one place and environment with many other mathematicians of similar interests for an extended period of time, where you can work and socialise together, and learn from each other, was necessarily somewhat lost in the second half of this program. I hope that participants in future programs will have the opportunity to experience uninterrupted all that MSRI has to offer.



Gonzalez, Nicolle

Name: Nicolle Sandoval Gonzalez
Year of Ph.D.: 2019
Institution of Ph.D.: University of Southern California
Dissertation title: Categorical operators and crystal structures on the ring of symmetric functions.
Ph.D. advisor: Aaron Lauda and Sami Assaf
Mentor while at MSRI: Christopher Douglas

Institution prior to MSRI: UCLA
Mentor (if applicable): Raphael Rouquier

Institution (or company) post MSRI: UCLA
Position: Postdoctoral fellow
Anticipated length: 1 year
Mentor (if applicable): Raphael Rouquier

Postdoctoral Fellow's Comments:

Please provide a short narrative describing your experiences and activities during your fellowship. Be sure to include any collaborations you participated in, papers you wrote or worked on, new ideas that you had or research projects that you began. Please also let us know whether you found your experience at MSRI beneficial, and the reasons why. Finally, let us know if you feel your fellowship has helped (or will help) you with finding a future position.

The experience was fantastic despite the corona virus disaster. I was able to complete two papers while in residence at MSRI. I also have initiated a math podcast with fellow member Paul Wedrich. The experience provided me with excellent networking opportunities. I

learned lots of new mathematics from conversations with other members and from the ongoing seminars. In particular, the support and dedication of the MSRI staff was beyond excellent and absolutely fundamental to the life and vibrancy of the program being maintained despite the pandemic. Without a doubt, the exposure and opportunities awarded to me because of the fellowship have already helped me career wise and will undoubtedly help me in the job market in the future.



Penny, Mark

Name: Mark Penney
Year of Ph.D.: 2017
Institution of Ph.D.: Oxford
Dissertation title: Categorical bialgebras arising from 2-Segal spaces
Ph.D. advisor: Chris Douglas
Mentor while at MSRI: John Francis

Institution prior to MSRI: University of Waterloo and Perimeter Institute
Mentor (if applicable): NA

Institution (or company) post MSRI: University of Waterloo and Perimeter Institute
Position: Postdoctoral fellow
Anticipated length: Until mid-2022
Mentor (if applicable): NA

Postdoctoral Fellow's Comments:

Despite the major interruptions to the program it was still an exceptional experience. The two themes were so well matched that nearly all of the researchers whose work I read and cite would have visited the MSRI at some point.

For the first portion of the semester my work focused on preparing for the talk I gave at the Tensor Categories and Topological Quantum Field Theories workshop. Since this conference was going to be attended by many of the experts in the field, preparing for it well was a high priority for me. Before I arriving I had the core of the research completed and through conversations at the MSRI I was able to hone in on the aspects that interested others and to consider new applications. In particular, I had very productive chats with David Reutter and Nicolás Andruskiewitsch. I also began (and continue to) prepare a paper based on the research I presented. Most of the discussions I had with my mentor John Francis concerned questions I had about the writing process, as it's an aspect of the career that I've struggled with accomplishing efficiently.

Upon the closure of the MSRI I returned to my usual home in Waterloo, Canada. After giving my talk and attending the rest of the two workshops I have to admit that I struggled with focusing on my work. I was at least still able to be somewhat productive as I had previously offered to host a session of the Berkeley Math Circle. Given that the program had moved online the session on April 15th was hosted from my home office! It was my first time doing mathematics outreach activities. Despite the logistics difficulties it was an amazingly rewarding experience and I'm already looking forward to more outreach opportunities in the future.

The fact that the regular seminars continued online really helped me get back into a productive rhythm and mindset. I offered to present on the 7th of May on a different, and much less complete, project. This was quite a positive move, since it forced me to consolidate a number of different lines of thinking I had. Moreover, in the discussion afterwards in the 'tearoom' Kevin Walker suggested a number of useful references that have guided my activities since then.

I'm sure that I will look back on this semester with mixed emotions. The missed opportunities, and general circumstances, are going to leave a mark on what was otherwise an amazing experience. Despite the difficulties and interruptions I still feel that program will have a positive impact on my future career trajectory. I plan on applying for tenure track positions within a couple of years. The progress I've made on my projects will certainly make my applications noticeably stronger than they would have been otherwise.

Finally, I wanted to end by thanking the staff at the MSRI and the organizers of the programs for keeping things going so well given everything that has happened.



Name: David Reutter
Year of Ph.D.: 2019
Institution of Ph.D.: University of Oxford
Dissertation title: Higher linear algebra in topology and quantum information theory
Ph.D. advisor: Jamie Vicary
Mentor while at MSRI: Kevin Walker and David Yetter

Institution prior to MSRI: Max Planck Institute for Mathematics, Bonn

Reutter, David

Mentor (if applicable): Peter Teichner

Institution (or company) post MSRI: Max Planck Institute for Mathematics, Bonn

Position: Postdoc

Anticipated length: until January 2022

Mentor (if applicable): Peter Teichner

Postdoctoral Fellow's Comments:

Since I had finished most of my previous projects before coming to MSRI, I had time to pursue new projects, start new collaborations and generate new ideas. During my time at Berkeley, I started the following collaborations with fellow MSRI members:

— non-semisimple topological field theories with D. Jordan and K. Walker

— the spectrum of braided fusion categories with N. Snyder and C. Schommer-Pries

— fracton phases of matter with F. Burnell, P. Huston and D. Penneys

I continued writing two papers I had started before my time at MSRI, one with fellow MSRI member C. Douglas and one with C. Jones and MSRI member D. Penneys. I also continued working on a longer-term project on classifying linear, once-extended 4-dimensional topological field theories.

Besides these collaborations, I had countless very interesting and instructive discussions with various members of both programs, several of which I plan to continue in virtual weekly meetings after my time at MSRI, with potential for future collaboration.

Especially the first few months in Berkeley, before the pandemic, I count amongst the most productive experiences of my mathematical life. I met many fellow researchers for the first time in person, had countless exciting discussions, shared new ideas, and developed a much better 'big picture' perspective of the field. As a postdoc who recently changed research focus, this was especially welcoming and a great opportunity to get a better footing in the community. Even though I am not about to apply for future positions until next year, I do think that I might fall back on several of the new mathematical acquaintances I made at MSRI when it comes to securing my next position.

Regarding the online portion of the program: After the first few weeks of lock-down, and after things had settled down a little, I felt that the online seminars worked surprisingly well. I also very much appreciated the time-zone flexible scheduling, and the fact that talks were recorded for later viewing. [A big kudos to the IT staff that

made this all run really smoothly, especially in comparison to virtual seminars I've been to at other institutions.] There was also an organized virtual, tea-room where people would meet after the seminar and which was reasonably well visited. I virtually continued several conversations/collaborations I had started in person at MSRI, but I did not start any new 'purely virtual' conversations and unfortunately did not get a chance to talk to several people I was planning to talk to at Berkeley. I do not have a concrete suggestion, but I was definitely missing the informal, 'lunch/tea-time' mathematical conversations, which were a crucial part of my MSRI experience in the first months and which were a great ice-breaker for more in-depth discussions.

I would also like to take this opportunity to advocate for the possibility of a 'summer research program/re-run/reunion program' (however this might look) at MSRI once the pandemic is over/under control, to give us members of both spring 2020 programs the chance to re-connect after many of us had to leave quite hurriedly in March, and to experience a few more weeks of MSRI.



Rovelli, Martina

Name: Martina Rovelli
Year of Ph.D.: 2017
Institution of Ph.D.: Ecole Polytechnique Fédérale de Lausanne (EPFL)
Dissertation title: Towards new invariants for principal bundles
Ph.D. advisor: Kathryn Hess
Mentor while at MSRI: Ulrike Tillmann

Institution prior to MSRI: Australian National University
Mentor (if applicable): Not applicable

Institution (or company) post MSRI: Australian National University
Position: MSI Fellow (Postdoc, Level B)
Anticipated length: Position until June 2023
Mentor (if applicable): Not applicable

Postdoctoral Fellow's Comments:

I have participated in the following activities.

- Attended the Connections for Women in Quantum Symmetries workshop.
- Attended the Introductory Workshop on Quantum Symmetries.
- Attended the Connections for Women in Higher Categories and Categorification workshop, and served as a TA for Claudia's Scheimbauer's minicourse Introduction to higher categories, dualizability, and applications to topological field theories.

- Attended the Introductory Workshop on Higher Categories and Categorification.
- Attended (online) the conference on (∞, n) -categories, Factorization Homology, and Algebraic K-theory, and gave a talk (Embedding 2-categories into $(\infty, 2)$ -categories). Continued having meetings after the conference with Clark Barwick, Viktoriya Ozornova, Emily Riehl and Chris Schommer-Pries, on how to possibly enlarge the axiomatic setup for (∞, n) -categories from previous work of Barwick-Schommer-Pries to include the Verity's model of n -complicial sets.
- Attended the series of five-minute talks, and gave one.
- I Regularly participated, together with Viktoriya Ozornova, Philip Hackney, Alexander Campbell and others, in the working group on $(\infty, 2)$ -categories organized by Emily Riehl (about six hours a week and still ongoing); the long terms goal is to write a user's guide to $(\infty, 2)$ -categories from a model independent viewpoint.
- Attended the workshop on cubical sets, organized by Chris Kapulkin, and gave a talk (Model structures for ∞ -groupoids and ∞ -categories on cubical sets with faces, degeneracies, connections and diagonals). Philip Hackney and I plan to have follow up discussions on potential developments.
- Attended the early talks of the working group on blob homology.
- Frequently attended the weekly seminar(s) and colloquia, both when they were still happening in person and afterwards online.
- Attended the Postdoc and Graduate Student Seminar, organized by Marcy Robertson and Chelsea Walton.
- Had multiple meetings with my mentor Ulrike Tillmann, first at MSRI and later remotely, mostly to discuss my career path.
- Continued ongoing collaborations on several projects. During my fellowship, I wrote a new preprint with Viktoriya Ozornova (Fundamental pushouts of n -complicial sets), did revisions on previous papers, made progresses on a project with Viktoriya Ozornova and Claudia Scheimbauer (on a Waldhausen construction for symmetric monoidal ∞ -categories and topological K-theory) and on a project with Julie Bergner and Viktoriya Ozornova (on comparing certain models of (∞, n) -categories).
- Started new collaboration with Alexander Campbell and Viktoriya Ozornova, on (∞, ∞) -categories.
- Participated in social events (postdoc social dinner, conference dinners, and postdoc lunch with David Eisenbud on Zoom).

My experience at MSRI was beneficial at multiple levels.

At the beginning of the program I had a chance to attend not only

the workshops of Higher categories and categorification, but also of the parallel program on Quantum symmetries. Since the topics of the two programs are so deeply connected, it was particularly useful and stimulating for me to discover a different perspective on the role played by higher categories in other areas, such as quantum field theory and mathematical physics. During the semester, I have also obtained a tenure track job at UMass Amherst that I have accepted and will hopefully start later this year or next year, depending on the evolving of the covid-19 situation. It was extremely useful to be mentored during the process by Ulrike Tillmann, with whom I have met multiple times, as well as by other members of the program (including Emily Riehl, Claudia Scheimbauer and Teena Gerhardt). I also benefited a lot from the series of talks organized by Marcy Robertson and Chelsea Walton for early career mathematicians.

Finally but not less importantly, I of course had the invaluable opportunity to interact with many of the leaders in my research field, continuing some of my long term collaborations and starting new ones, as mentioned in the previous section.

Although online interactions cannot compare with in person interactions, the Zoom platform works quite well for both conferences and meetings, particularly allowing the speaker to share slides, write on a tablet or show a board. I also thought that there was a good dynamics in how the moderators were managing the questions that they were receiving from the audience in the chat or in the Q&A window. The platform Slack was particularly useful, and I suggest to use it in the future for other MSRI programs. It's much more direct and informal than an email communication and works really well to follow up on ongoing (math or non-math) conversations and to organize and schedule meetings and working groups; it's also a good place to pin the zoom links for meetings.



Shah, Jay

Name: Jay Shah (will send Narrative 5/23)

Year of Ph.D.: 2017

Institution of Ph.D.: MIT

Dissertation title: Parametrized higher category theory

Ph.D. advisor: Clark Barwick

Mentor while at MSRI: David Gepner

Institution prior to MSRI: University of Notre Dame

Position at that institution: Visiting Assistant Professor

Mentor (if applicable): Mark Behrens

Institution (or company) post MSRI: University of Münster

Position: Postdoc

Anticipated length: 3 years

Mentor (if applicable): Thomas Nikolaus

Postdoctoral Fellow's Comments:

During my MSRI fellowship, I pursued my research interests in stable homotopy theory and higher category theory, while also broadening my knowledge base through participating in the many seminars and workshops held at MSRI. A central theme that organized my research activities was to understand and exploit the close relationship between concepts in (infinity,2)-category theory on the one hand, and stratified and equivariant homotopy theory on the other hand - for instance, this connection is central to the work of David Ayala, Aaron Mazel-Gee, and Nick Rozenblyum on "stratified noncommutative geometry", who were all participants in the program. Joint with Aaron Mazel-Gee and Grigory Kondyrev, I am working on a characterization of dualizable objects in right-lax limits of left-lax diagrams a la the 1-dimensional cobordism hypothesis (working title: "The cobordism hypothesis for recollements"), where the manifolds and bordisms in question ought to be stratified in an appropriate sense. In terms of equivariant homotopy theory, such a theorem has application in computing the Balmer spectrum of the equivariant stable homotopy category of a finite non-abelian group, which is a major open problem in the field (this is work in progress with J.D. Quigley). Learning the theory of the Balmer spectrum and tensor triangulated geometry was also one of my major goals during this semester. Finally, these ideas also have impact in articulating a conjectural stratified version of Tannakian duality along the lines proposed by Clark Barwick.

In my judgment, my participation in the MSRI program has been beneficial to my development as a mathematician, and the connections made will likely assist me in my future career (though the direct impact of my MSRI postdoc on obtaining a future position is not possible for me to evaluate at this moment in time).

As a general rule, I think the wide variety of seminars and the consequent exposure to new mathematical ideas has helped me obtain a broader outlook on my particular area of research. Concentrating a large number of researchers together also served to foster collaborations that might not otherwise have occurred (c.f. my project with Aaron and Grigory). However, the impact of the building shutdown midway through the semester was undeniably (and unavoidably) deleterious to the effectiveness of the program, which for me is reliant on a lot of in-person and freeform interaction that cannot really be replicated virtually.

I don't have any specific suggestions as to what could have been done differently - hopefully, this semester will be the last time such a shutdown has to occur.



Williams, Brian

Name: Brian R. Williams

Year of Ph.D.: 2018

Institution of Ph.D.: Northwestern University

Dissertation title: The holomorphic sigma-model and its symmetries

Ph.D. advisor: John Francis and Kevin Costello

Mentor while at MSRI: David Ben-Zvi

Institution prior to MSRI: Northeastern University

Position at that institution: Zelevinsky Research Instructor

Mentor (if applicable): Valerio Toledano-Laredo

Institution (or company) post MSRI: University of Edinburgh

Position: Whittaker Research Fellow

Anticipated length: 3 years

Mentor (if applicable): N/A

Postdoctoral Fellow's Comments:

The time I have spent at MSRI has been extremely productive. In addition to experiencing fruitful collaborations with familiar faces, it has been great opportunity to meet many new mathematicians. Throughout the semester I attended all of the big conferences, and additionally participated in weekly seminars such as the “Blob homology seminar” and the “Configuration spaces” seminar. I have also spoken in a few seminars, including the postdoc seminar and the MSRI online seminar. My main collaborators while visiting MSRI were Pavel Safronov and Owen Gwilliam. I also regularly took part in conversations with senior research members David Ben-Zvi, Dan Freed, Ezra Getzler, and David Ayala.

In addition to providing a great mathematical resource, these senior members instilled job application and grant writing advice. The experiences I've had at MSRI have given me a much clearer window into the job market as an early career mathematician. Despite the repercussions of the COVID pandemic, the semester was a great success for me and I humbly thank the administration, donors, and organizers for all of their hard work. I look forward to returning when travel is possible again.

Peter Teichner was also a big part of my visit here. We have had regular (digital) meetings even after this COVID crisis has struck, and he has given me a lot of great career advice.



Yeakel, Sarah

Name: Sarah Yeakel
Year of Ph.D.: 2016
Institution of Ph.D.: University of Illinois Urbana-Champaign
Dissertation title: Goodwillie Calculus and Injections
Ph.D. advisor: Randy McCarthy
Mentor while at MSRI: Teena Gerhardt and Muriel Livernet

Institution prior to MSRI: University of Maryland
Position at that institution: Visiting Assistant Prof
Mentor (if applicable):

Institution (or company) post MSRI: University of California
Riverside
Position: Visiting Assistant Prof
Anticipated length: 1-3 years
Mentor (if applicable):

Postdoctoral Fellow's Comments:

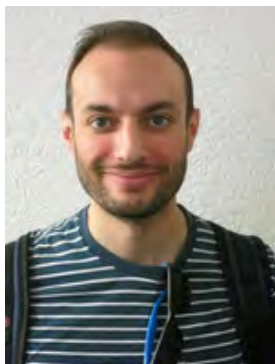
While at MSRI, I participated in a few working groups, attended weekly seminars, and met weekly with my mentors. From the stratified homotopy theory group, I am learning about connections of my work on isovariant spaces with the stratified literature. I've begun talking to a couple people in the group individually about different projects. During the first workshop, one of my collaborators (Inbar Klang) visited and we have made significant progress on a paper since then. I had another pre-existing collaboration (with mathematicians not in residence) that I continued while at MSRI. There was a project I was hoping to learn more about this semester, and I was able to talk to some people in the program about related ideas this semester, although this was cut short when the program went online. One of my mentors and I worked through a couple arxiv preprints. The organizers and others in the program frequently checked in on me.

The semester at MSRI was very beneficial for connecting me with some of the experts working with infinity categories. I feel much more likely to reach out to these people with questions in the areas of infinity-operads and stratified homotopy theory in the future. Of course, the time away from teaching was a huge boon to getting more done, especially this semester, as colleagues scrambled to get classes online halfway through. I expect that the time I was able to spend at MSRI to develop some new projects, further previous ones, and tie together my work with existing literature will help me get a position in the future.

As far as the online portion, I struggle with working from home in

general. It took about a month to adjust to getting things done from home, despite still attending seminars and working groups. I think MSRI did a great job responding to the situation and helping the program continue in its new format, and the organizers of the program did an equally great job looking out for the participants and reaching out.

COMPLEMENTARY PROGRAM



Lutz, Bob

Name: Robert (Bob) Lutz
Year of Ph.D.: 2019
Institution of Ph.D.: University of Michigan
Dissertation title: Electrical Networks, Hyperplane Arrangements and Matroids
Ph.D. advisor: Jeffrey C. Lagarias
Mentor while at MSRI: H el ene Barcelo

Institution prior to MSRI: University of Michigan
Position at that institution: Graduate student
Mentor (if applicable): Jeffrey C. Lagarias

Institution (or company) post MSRI: Life Cycle Engineering, Inc.
Position: Modeling and Simulation Specialist
Anticipated length: Indefinite term
Mentor (if applicable):

Postdoctoral Fellow's Comments:

While at MSRI, I have met weekly with H el ene Barcelo and Curtis Greene to discuss their project on discrete homotopy and homology. I wrote and submitted one paper related to this project ("Higher discrete homotopy groups of graphs"), and am currently writing another ("Discrete homotopy of token configurations"). In the fall semester, I completed and submitted a paper based on a chapter of my PhD thesis ("Matroids arising from electrical networks"). I am the sole author of these three papers, with H el ene and Curtis providing useful comments and insights in our meetings.

I found my time at MSRI beneficial because it placed me in the orbit of many excellent mathematicians in fields related to mine, and it allowed me to focus on research full-time. Although I have decided to pursue a non-academic career, I think my fellowship opened many doors for me, and would have undoubtedly helped me find a future position in academia.



Zahariuc, Adrian

Name: Adrian Zahariuc
Year of Ph.D.: 2016
Institution of Ph.D.: Harvard University
Dissertation title: Degenerations, log K3 pairs, and low genus curves on algebraic varieties
Ph.D. advisor: Joe Harris
Mentor while at MSRI: David Eisenbud

Institution prior to MSRI: UC Davis
Mentor (if applicable): Brian Osserman

Institution (or company) post MSRI: University of Windsor
Position: Assistant Professor
Anticipated length: tenure-track

Postdoctoral Fellow's Comments:

My mentor at the MSRI was Professor Eisenbud. I spent time in the (mostly virtual) company of him and his group of graduate students. I believe the exposure I have had to a new set of ideas, techniques, problems, etc. (somewhat more algebraic in nature than my own research) will prove very valuable in the future. Although this is hard to quantify, I believe I have improved my technical fluency in certain areas.

My main focus has been an individual project, whose purpose is to construct an equivariant compactification of the space of configurations of points on a line modulo translation. I have worked out a substantial part of the technical details required for this, though some work remains to be done. This project fits in the context of a larger project of studying Severi varieties of abelian and K3 surfaces.

I already have a tenure-track position at University of Windsor; however, the opportunity to be at the MSRI for a semester has been extremely beneficial in many ways. I would be very happy to return in the future, even for shorter visits, if the opportunity will ever present itself again.

I was slightly less involved in the usual MSRI seminars than most postdocs since I was in the Complementary Program. However, the experience so far with online seminars was extremely positive because the quality of all talks I attended was very high. I don't have any specific suggestions in terms of how to better organize the online activities.

3.2 Postdoctoral Fellow Placement List

2019-20 Postdoc Pre/Post-MSRI Institution Group

Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Insti	Post-MSRI Institution Name	Post-MSRI Institution Gro
Allegratti	Dylan	University of Sheffield	Foreign	University of British Columbia	Foreign
Balehowsky	Tracey	University of Helsinki	Foreign	University of Helsinki	Foreign
Campbell	Alexander	Macquarie University	Foreign	Johns Hopkins University	Private Large
Collier	Brian	University of Maryland	Public Large	University of California, Irvine	Public Medium
Delaney	Colleen	University of California, Santa Barbara	Public Large	Indiana University, Bloomington	Public Large
Deleporte	Alix	Universite de Strasbourg	Foreign	Institut fur Mathematik, Universität Zurich	Foreign
Eddie-Michell	Cain	Vanderbilt University	Private Small	Vanderbilt University	Private Small
Fougeron	Charles	Max-Planck-Institut für Mathematik	Foreign	Université Paris Diderot 7	Foreign
Fredrickson	Laura	Stanford University	Private Large	Stanford University	Private Large
Gannot	Oran	Northwestern University	Private Small	Unknown	n/a
Gonzalez	Nicolle	University of California, Los Angeles	Public Large	University of California, Los Angeles	Public Large
Lee	Dami	University of Washington	Public Large	University of Washington	Public Large
Longhi	Pietro	ETH Zurich	Foreign	ETH Zurich	Foreign
Lutz	Bob	University of Michigan	Public Large	Life Cycle Engineering	Non-group
Morgan	Katrina	University of North Carolina, Chapel Hill	Public Medium	Northwestern University	Private Small
Negron	Cris	University of North Carolina	Public Medium	University of North Carolina	Public Medium
Pei	Du	California Institute of Technology	Private Large	Harvard University	Private Large
Penney	Mark	University of Waterloo	Foreign	University of Waterloo	Foreign
Reutter	David	Max-Planck-Institut für Mathematik	Foreign	Max-Planck-Institut für Mathematik	Foreign
Rovelli	Martina	Australian National University	Foreign	Australian National University	Foreign
Schopieray	Andrew	University of Oregon	Public Medium	University of New South Wales	Foreign
Shah	Jay	University of Notre Dame	Private Large	University of Münster	Foreign
Shapiro	Jacob	Australian National University	Foreign	Australian National University	Foreign
Takeda	Alex	University of California, Berkeley	Public Large	Institut des Hautes Études Scientifiques	Foreign
Venkatesh	Siddharth	University of California, Los Angeles	Public Large	University of California, Los Angeles	Public Large
Wedrich	Paul	Max-Planck-Institut für Mathematik	Foreign	Max-Planck-Institut für Mathematik	Foreign
Williams	Brian	Northeastern University	Private Small	University of Edinburgh	Foreign
Yeakel	Sarah	University of Maryland	Public Large	University of California, Riverside	Public Small
Zahariuc	Adrian	University of California, Davis	Public Large	University of Windsor	Foreign
Zhang	Qing	Texas A & M University	Public Large	Purdue University	Public Large
Zhu	Xuwen	University of California, Berkeley	Public Large	Massachusetts Institute of Technology	Private Large
Zhu	Hui	Université de Paris XI	Foreign	University of Michigan, Ann Arbor	Public Large

Highlights

US Institutions are classified by the AMS into categories based on the size of their doctoral program and based on their Public or Private status.

A majority of the MSRI postdocs came from Public Large and Foreign institutions. Of the 11 postdocs coming from Public Large institutions, five returned to Public Large institutions, two went to Foreign institutions, one went into Industry, and one of each of the remaining three postdocs went to a Private Large, Public Medium, and Public Small institution. Of the 12 postdocs coming from Foreign institutions, 10 returned to a Foreign institution, and the other two went to a Private Large and a Public Large institution.

Of the three postdocs who came from Private Large institutions, two went back to a Private Large institution and one postdoc went to a Foreign institution.

Three postdocs came from Public Medium institutions, of whom one returned to a Public Medium institution, one went to a Private Small institution, and one went to a Foreign institution.

Three postdocs came from Private Small institutions, of whom one returned to a Private Small institution, one went to a Foreign institution, and one had not yet determined their next institution.

3.3 Postdoctoral Fellow Participant Summary

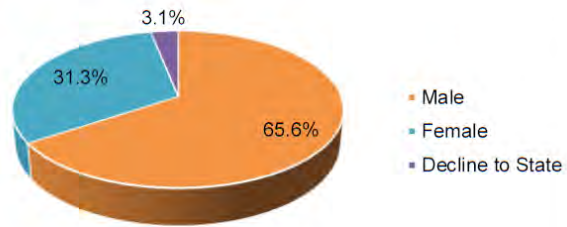
Programs	Distinct Postdocs	US Citizens & Perm. Res.	Women	%	Minorities*	%	US Home Institution	%
Holomorphic Differentials in Mathematics and Physics	8	3	2	25.0%	0	0.0%	6	75.0%
Microlocal Analysis	7	3	3	42.9%	0	0.0%	4	57.1%
Higher Categories and Categorification	8	3	3	37.5%	0	0.0%	5	62.5%
Quantum Symmetries	7	3	2	28.6%	1	33.3%	5	71.4%
Complementary Program 2019-20	2	1	0	0.0%	0	0.0%	2	100.0%
Total # of Distinct Postdocs	32	13	10	31.3%	1	7.7%	22	68.8%

* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

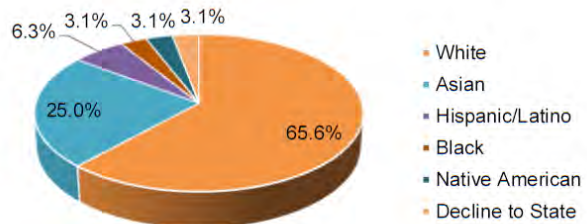
3.4 Postdoctoral Fellow Demographic Data

2019-20 Postdoctoral Fellows Demographic Summary

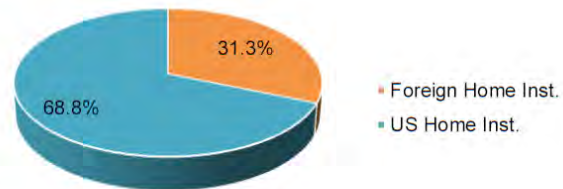
Gender	#	%
# of Distinct Members	32	100.0%
Male	21	65.6%
Female	10	31.3%
Decline to State	1	3.1%



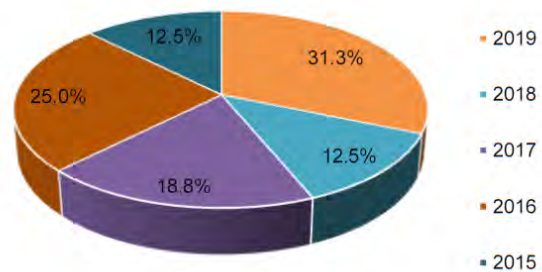
Race/Ethnicity*	#	%
White	21	65.6%
Asian	8	25.0%
Hispanic/Latino	2	6.3%
Black	1	3.1%
Native American	1	3.1%
Pacific Islander	0	0.0%
Decline to State	1	3.1%
Unavailable Info.	0	0.0%
Minorities**	1	7.7%



Citizenships	#	%
Foreign Home Inst.	10	31.3%
US Home Inst.	22	68.8%
US Citizens & Perm. Res.	13	40.6%
Foreign Citizens	19	59.4%
US Citizens	13	40.6%
US Permanent Residents	0	0.0%



Year of Ph.D	#	%
2019	10	31.3%
2018	4	12.5%
2017	6	18.8%
2016	8	25.0%
2015	4	12.5%
2014	0	0.0%
Total # of Distinct Members	32	100.0%



*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

Programs

Holomorphic Differentials in Mathematics and Physics

Microlocal Analysis

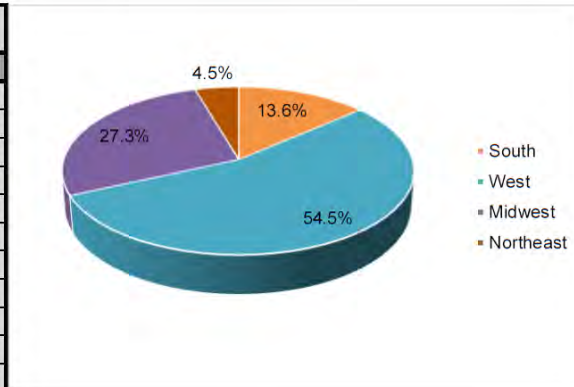
Higher Categories and Categorification

Quantum Symmetries

Complementary Program 2019-20

2019-20 Postdoctoral Fellows Classified by State

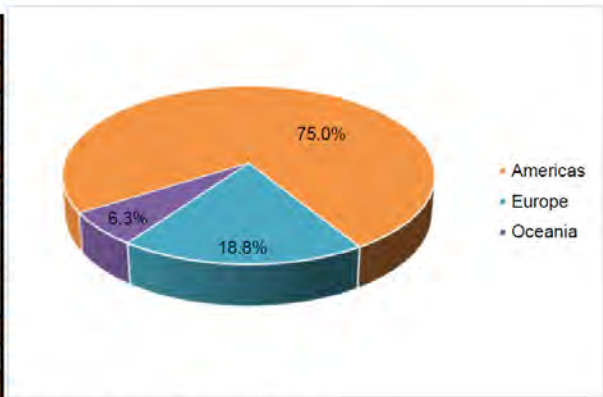
State	#	%	2010 Census
South	3	13.6%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	1	4.5%	1.9%
MS	0	0.0%	1.0%
NC	1	4.5%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	1	4.5%	2.1%
TX	0	0.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	12	54.5%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	11	50.0%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	1	4.5%	2.2%
WY	0	0.0%	0.2%
Midwest	6	27.3%	21.7%
IA	0	0.0%	4.2%
IL	2	9.1%	2.1%
IN	3	13.6%	1.0%
KS	0	0.0%	0.9%
MI	1	4.5%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	1	4.5%	17.9%
CT	0	0.0%	1.2%
MA	1	4.5%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	22	100.0%	100.0%



*Regions based on US Census classification

2019-20 Postdoctoral Fellows Classified by Country

Africa			0
Americas			24
	North America	Canada	2
		United States	22
Asia			0
Europe			6
	Northern Europe	Finland	1
	Western Europe	France	2
		Germany	2
		Switzerland	1
Oceania			2
	Australia and New Zealand	Australia	2
Grand Total			32



**Regions based on United Nations classification*

3.5 Postdoctoral Research Member Placement List

Postdoctoral Research Members (PD/RMs) are individuals who qualify at the Postdoctoral Fellows level, but were invited as Research Members. This usually happens when they are ineligible for the postdoctoral fellowship for some reason, for example, they are unable to attend the full length of the program. In 2019-20, there was one PD/RM at MSRI.

PDRM Pre/Post-MSRI Institution Group

Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Institution Group	Post-MSRI Institution Name	Post-MSRI Institution Group
Yakerson	Maria	Universitat Regensburg	Foreign	Universitat Regensburg	Foreign

4. Graduate Program

In 2019-20, 916 graduate students participated in our workshops (579 graduate students), summer graduate schools (296 graduate students), and programs (41 graduate students). While the majority of the graduate students were participants in our workshops or summer graduate schools, a smaller number of them were invited as ‘Program Associates’ in our scientific programs.

4.1 Summer Graduate School (SGS)

MSRI organized 10 summer graduate schools in the summer of 2019, four of which were held at MSRI and the other six were jointly held with other institutions. The six offsite schools were held in partnership with: the Departments of Mathematics at the University of Notre Dame and the University of Washington (Seattle); Casa Matemática Oaxaca (Mexico); Séminaire de Mathématiques Supérieures (Montréal); Istituto Nazionale di Alta Matematica (Italy); and the National Center for Theoretical Sciences (Taiwan). Attending one of these two-week summer schools can be a very motivating and exciting experience for a student; participants have often said that it was the first experience where they felt like real mathematicians, interacting with other students and mathematicians in their field.

Graduate students from one of MSRI’s Academic Sponsor Institutions or from Departments of Mathematics at U.S. Universities are eligible to attend the summer schools. For each institution MSRI provides support for up to two students per summer and, under our “2+1+1” policy, MSRI will support an additional student if one of the students is female and another one if s/he is from a group that is underrepresented in the mathematical sciences. MSRI covers travel and local expenses with the maximal allowance for travel reimbursement being \$600 for students from U.S. and Canadian universities (depending on the point of origin), and \$700 for students from other sponsoring institutions.

The application procedure is as follows: The summer graduate schools and the open enrollment period for the summer of year $n+1$ are announced in August of year n . Graduate students must be nominated by their Director of Graduate Studies during the enrollment period. MSRI accepts nominees on a first-come first-served basis up to the limits of the capacity of each school, which is around 40-50 for onsite schools. If the chosen school is already full, the students are either kept on a waiting list or the nominating institution may make nominations to other schools until their quota is reached.

Below, we list the ten Summer Graduate Schools that took place during the summer of 2019. Altogether 47 organizers, lecturers and TAs, and 296 graduate students participated in these schools. Women comprised 27% of the students and of the 147 students who were U.S. citizens or Permanent Residents, 31 (21%) were from historically underrepresented groups including 10 (7%) who identified themselves as Black, 20 (14%) as Hispanic/Latinx, 2 as Native American, and 1 as Pacific Islander. This is a clear indication that our “2+1+1” policy is working to increase the representation of these groups. See the table in section 4.2 for detailed demographic data.

For a complete report on each SGS, please refer to the Appendix (Section 13).

SGS 1: Commutative Algebra and its Interaction with Algebraic Geometry

June 03, 2019 – June 14, 2019

Location: Center for Mathematics, University of Notre Dame

Organizers: Craig Huneke (University of Virginia), Sonja Mapes (University of Notre Dame), Juan Migliore (University of Notre Dame), [Claudia Polini](#) (University of Notre Dame), Claudiu Raicu (University of Notre Dame)

SGS 2: Random and Arithmetic Structures in Topology

June 10, 2019 - June 21, 2019

Location: MSRI

Organizers: [Alexander Furman](#) (University of Illinois at Chicago), Yizhaq Gelfand (Weizmann Institute of Science)

SGS 3: Representation Stability

June 24, 2019 - July 05, 2019

Location: MSRI

Organizers: Thomas Church (Stanford University), [Andrew Snowden](#) (University of Michigan), Jenny Wilson (University of Michigan)

SGS 4: Geometric Group Theory

July 1, 2019 - July 12, 2019

Location: Casa Matemática, Oaxaca, Mexico

Organizers: [Rita Jiménez](#) Rolland (Instituto de Matemáticas, UNAM-Oaxaca), [Pierre Py](#) (Universidad Nacional Autónoma de México)

SGS 5: Séminaire de Mathématiques Supérieures 2019: Current Trends in Symplectic Topology

July 1, 2019 - July 13, 2019

Location: Montréal, QC, Canada

Organizers: Octav Cornea (Université de Montréal), Yakov Eliashberg (Stanford University), Michael Hutchings (University of California, Berkeley), Egor Shelukhin (Université de Montréal)

SGS 6: Polynomial Method

July 8, 2019 - July 19, 2019

Location: MSRI

Organizers: Adam Sheffer (Bernard M. Baruch College, CUNY), [Joshua Zahl](#) (University of British Columbia)

SGS 7: Recent Topics on Well-Posedness and Stability of Incompressible Fluid and Related Topics

July 22, 2019 - August 02, 2019

Location: MSRI

Organizers: [Yoshikazu Giga](#) (University of Tokyo), Maria Schonbek (University of California, Santa Cruz), Tsuyoshi Yoneda (University of Tokyo)

SGS 8: H-Principle (Istituto Nazionale di Alta Matematica)

July 29, 2019 - August 09, 2019

Location: Cortona, Italy

Organizers: [Emmy Murphy](#) (Northwestern University), Takashi Tsuboi (University of Tokyo)

SGS 9: Mathematics of Machine Learning

July 29, 2019 - August 09, 2019

Location: University of Washington, Seattle

Organizers: Sebastien Bubeck (Microsoft Research), Anna Karlin (University of Washington), Adith Swaminathan (Microsoft Research)

SGS 10: Toric Varieties

July 29, 2019 - August 09, 2019

Location: National Center for Theoretical Sciences, Tapei, Taiwan

Organizers: David Cox (Amherst College), Henry Schenck (Auburn University)

4.2 Summer Graduate Schools 2019 Data

Summer Graduate Schools	# of Students	Women	%	Minorities*	%	US Home Institution	%	US Citizens & Perm. Res.
Commutative Algebra and its Interaction with Algebraic Geometry (University of Notre Dame) [†]	27	11	40.7%	1	11.1%	23	85.2%	9
Geometric Group Theory (Oaxaca, Mexico) [*]	15	3	20.0%	4	36.4%	14	93.3%	11
H-Principle (INdAM, Cortona, Italy) [†]	12	1	8.3%	2	28.6%	12	100.0%	7
Mathematics of Machine Learning (University of Washington, Seattle) [†]	35	19	54.3%	6	33.3%	30	85.7%	18
Polynomial Method	34	10	29.4%	2	13.3%	30	88.2%	15
Random and arithmetic structures in topology	30	6	20.0%	1	8.3%	26	86.7%	12
Recent topics on well-posedness and stability of incompressible fluid and related topics	43	10	23.3%	3	20.0%	30	69.8%	15
Representation stability	42	7	16.7%	4	13.8%	39	92.9%	29
Seminaire de Mathematiques Superieures 2019: Current trends in Symplectic Topology (Montreal, QC, Canada) [†]	31	3	9.7%	5	29.4%	28	90.3%	17
Toric Varieties (National Center for Theoretical Sciences, Taipei) [†]	27	9	33.3%	3	21.4%	24	88.9%	14
Total # of Students	296	79	26.7%	31	21.1%	256	86.5%	147

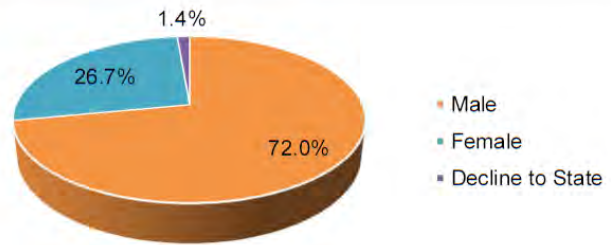
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.

[†] The number of students listed were those sponsored by MSRI. Joint summer schools had at least as many other participants sponsored by the host institution.

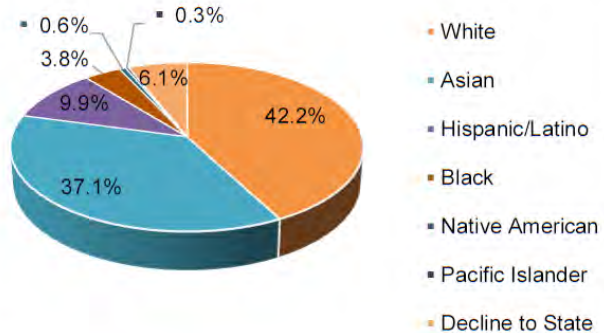
Summer Graduate School Demographic Data

2019 Summer Graduate Schools Demographic Summary

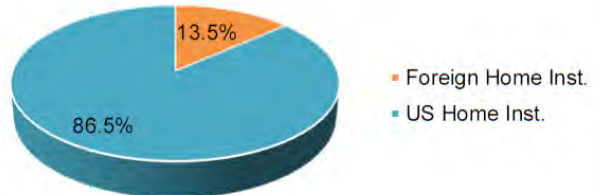
Gender	#	%
# of Students	296	100.0%
Male	213	72.0%
Female	79	26.7%
Decline to State	4	1.4%



Race/Ethnicity*	#	%
White	132	42.2%
Asian	116	37.1%
Hispanic/Latino	31	9.9%
Black	12	3.8%
Native American	2	0.6%
Pacific Islander	1	0.3%
Decline to State	19	6.1%
Unavailable Info.	0	0.0%
Minorities**	31	21.1%



Citizenships	#	%
Foreign Home Inst.	40	13.5%
US Home Inst.	256	86.5%
US Citizens & Perm. Res.	147	49.7%
Foreign Citizens	149	50.3%
US Citizens	140	95.2%
US Permanent Residents	7	4.8%



*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

Summer Graduate Schools

Commutative Algebra and its Interaction with Algebraic Geometry (University of Notre Dame)

Geometric Group Theory (Oaxaca, Mexico)

H-Principle (INdAM, Cortona, Italy)

Mathematics of Machine Learning (University of Washington, Seattle)

Polynomial Method

Random and arithmetic structures in topology

Recent topics on well-posedness and stability of incompressible fluid and related topics

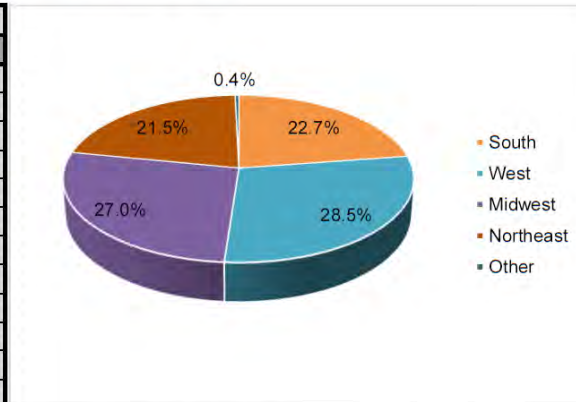
Representation stability

Seminaire de Mathematiques Superieures 2019: Current trends in Symplectic Topology (Montreal, QC, Canada)

Toric Varieties (National Center for Theoretical Sciences, Taipei)

2019 Summer Graduate School Students Classified by States

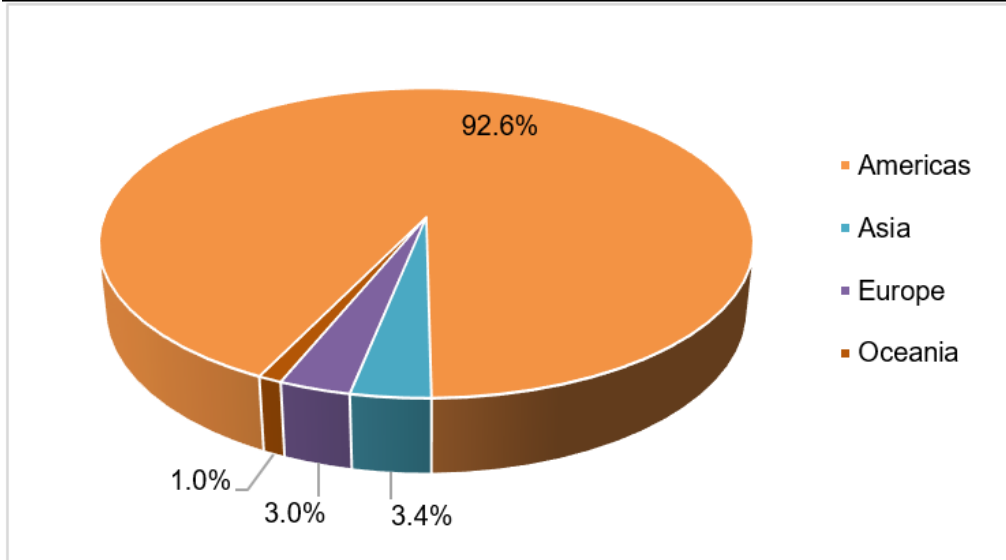
State	#	%	2010 Census
South	58	22.7%	37.1%
AL	0	0.0%	1.5%
AR	1	0.4%	0.9%
DE	2	0.8%	0.3%
DC	5	2.0%	0.2%
FL	5	2.0%	6.1%
GA	8	3.1%	3.1%
KY	2	0.8%	1.4%
LA	5	2.0%	1.5%
MD	6	2.3%	1.9%
MS	0	0.0%	1.0%
NC	7	2.7%	3.1%
OK	3	1.2%	1.2%
SC	1	0.4%	1.5%
TN	2	0.8%	2.1%
TX	6	2.3%	8.1%
VA	4	1.6%	2.6%
WV	1	0.4%	0.6%
West	73	28.5%	23.3%
AK	0	0.0%	0.2%
AZ	5	2.0%	2.1%
CA	43	16.8%	0.4%
CO	5	2.0%	0.5%
HI	1	0.4%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	10	3.9%	1.2%
UT	3	1.2%	0.9%
WA	6	2.3%	2.2%
WY	0	0.0%	0.2%
Midwest	69	27.0%	21.7%
IA	7	2.7%	4.2%
IL	16	6.3%	2.1%
IN	9	3.5%	1.0%
KS	6	2.3%	0.9%
MI	7	2.7%	3.2%
MN	4	1.6%	1.7%
MO	6	2.3%	1.9%
ND	2	0.8%	0.2%
NE	3	1.2%	0.6%
OH	5	2.0%	3.7%
SD	0	0.0%	0.3%
WI	4	1.6%	1.8%
Northeast	55	21.5%	17.9%
CT	3	1.2%	1.2%
MA	12	4.7%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	7	2.7%	2.8%
NY	18	7.0%	6.3%
PA	13	5.1%	4.1%
RI	1	0.4%	0.3%
VT	1	0.4%	0.2%
Other	1	0.4%	0.0%
PR	1	0.4%	0.0%
Other	0	0.0%	0.0%
Total	256	100.0%	100.0%



*Regions based on US Census classification

2019 Summer Graduate School Students Classified by Countries

Africa			0
Americas			274
	Central America	Mexico	4
	North America	Canada	14
		United States	256
Asia			10
	Eastern Asia	China	4
		Japan	4
		Korea, Republic of	2
Europe			9
	Southern Europe	Italy	3
	Western Europe	Austria	1
		Germany	5
Oceania			3
	Australia & New Zealand	Australia	3
Grand Total			296



**Regions based on United Nations classification*

4.3 Program Associates

Program Associates (graduate students participating in the programs) benefit greatly from the opportunity to interact with leaders of a field and postdoctoral fellows, gaining intense exposure to current ideas and trends in their area of specialization. They were closely supervised and benefited from all member privileges, including shared office space. Each Program Associate was provided with an access card to the building, which allows them to use the premises at any time, as well as bus, library and sports facilities access passes. There were 41 graduate students who resided at MSRI for an extended period of time during the academic year 2019–20. Four more graduate students canceled their planned visits due to the COVID-19 pandemic.

4.4 Program Associate Data

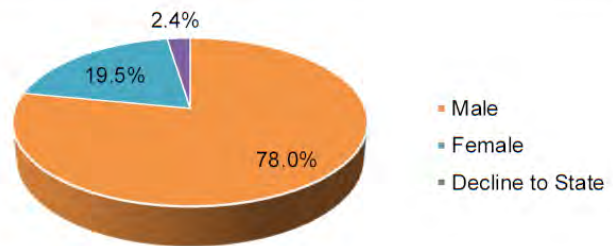
Programs	Distinct Prog. Assoc.	Women	%	Minorities*	%	US Home Institution	%	US Citizens & Perm. Res.
Holomorphic Differentials in Mathematics and Physics	16	5	31.3%	0	0.0%	8	50.0%	3
Microlocal Analysis	10	0	0.0%	1	25.0%	6	60.0%	4
Higher Categories and Categorification**	9	2	22.2%	1	50.0%	4	44.4%	2
Quantum Symmetries**	6	1	16.7%	0	0.0%	4	66.7%	2
Complementary Program 2019-20	0	0	0.0%	0	0.0%	0	0.0%	0
Total # of Distinct PAs	41	8	19.5%	2	18.2%	22	53.7%	11

* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

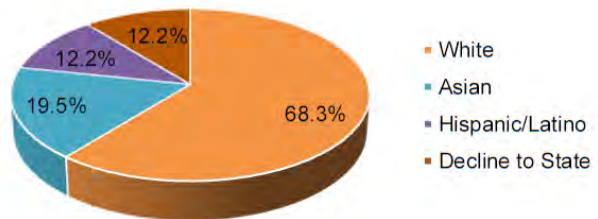
**MSRI closed on 3/10/2020 due to the COVID-19 pandemic. There were 4 Program Associates who cancelled their planned visit to the Spring programs due to COVID-19. The above numbers include only Program Associates who were physically present at MSRI prior to its closure.

2019–20 Program Associate Demographic Summary

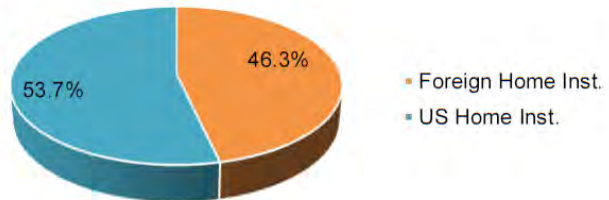
Gender	#	%
# of Distinct Members	41	100.0%
Male	32	78.0%
Female	8	19.5%
Decline to State	1	2.4%



Race/Ethnicity*	#	%
White	28	68.3%
Asian	8	19.5%
Hispanic/Latino	5	12.2%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	5	12.2%
Unavailable Info.	0	0.0%
Minorities**	2	18.2%



Citizenships	#	%
Foreign Home Inst.	19	46.3%
US Home Inst.	22	53.7%
US Citizens & Perm. Res.	11	26.8%
Foreign Citizens	30	73.2%
US Citizens	11	26.8%
US Permanent Residents	0	0.0%

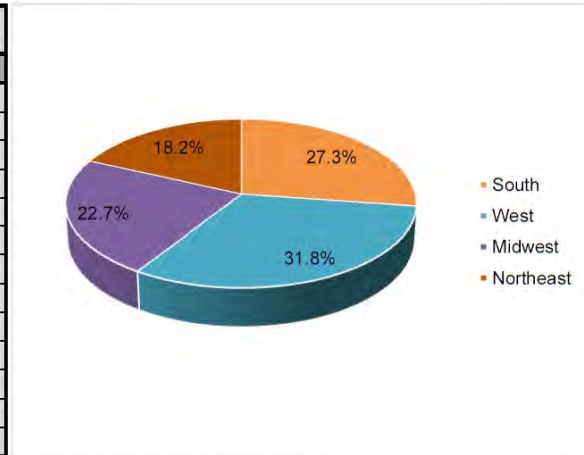


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019–20 Program Associates Classified by State

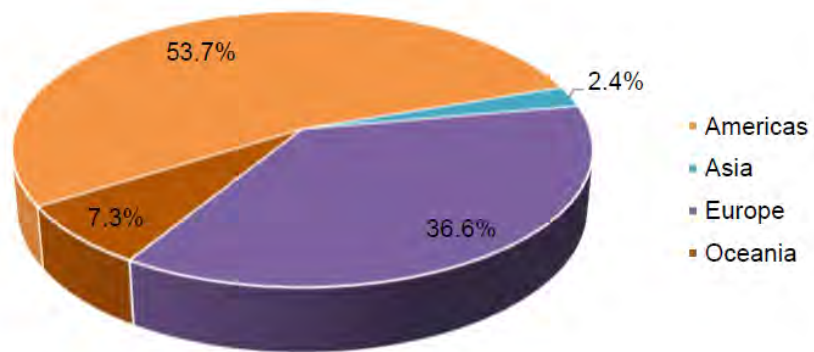
State	#	%	2010 Census
South	6	27.3%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	2	9.1%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	4	18.2%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	7	31.8%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	4	18.2%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	3	13.6%	2.2%
WY	0	0.0%	0.2%
Midwest	5	22.7%	21.7%
IA	0	0.0%	4.2%
IL	3	13.6%	2.1%
IN	2	9.1%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	4	18.2%	17.9%
CT	2	9.1%	1.2%
MA	1	4.5%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	1	4.5%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	22	100.0%	100.0%



*Regions based on US Census classification

2019–20 Program Associates Classified by Country

Africa			0
Americas			22
North America	United States		22
Asia			1
East Asia	China		1
Europe			15
Northern Europe	United Kingdom		2
Western Europe	France		4
	Germany		7
	Switzerland		2
Oceania			3
Australia & New Zealand	Australia		3
Grand Total			41



**Regions based on United Nations classification*

4.5 Graduate Student List

(Participants who attended 2019-20 workshops, excluding Summer Graduate Schools)
(See e-mail attachment)

4.6 Graduate Student Data*

(Participants who attended 2019-20 workshops, excluding Summer Graduate Schools)

Workshops	Participants	US Citizens & Perm. Res.	Women	%	Minorities*	%	US Home Institution	%
12 Scientific Workshops								
Berlekamp Memorial Workshop on Combinatorial Games	1	1	0	0.0%	0	0.0%	1	100.0%
Symposium in Honor of Julia Robinson's 100th Birthday	6	2	1	16.7%	1	50.0%	6	100.0%
Connections for Women: Holomorphic Differentials in Mathematics and Physics	16	6	7	43.8%	2	33.3%	9	56.3%
Introductory Workshop: Holomorphic Differentials in Mathematics and Physics	27	7	7	25.9%	2	28.6%	18	66.7%
Holomorphic Differentials in Mathematics and Physics	27	3	8	29.6%	1	33.3%	16	59.3%
Connections for Women: Microlocal Analysis	17	6	6	35.3%	1	16.7%	16	88.2%
Introductory Workshop: Microlocal Analysis	52	18	7	13.5%	3	16.7%	37	71.2%
Recent developments in microlocal analysis	35	14	2	5.7%	3	21.4%	28	80.0%
Connections for Women: Quantum Symmetries	24	12	12	50.0%	1	8.3%	20	83.3%
Introductory Workshop: Quantum Symmetries	59	24	15	25.4%	3	12.5%	45	76.3%
Connections for Women: Higher Categories and Categorification	38	18	15	39.5%	2	11.1%	30	78.9%
Introductory Workshop: Higher Categories and Categorification	72	35	16	22.2%	2	5.7%	57	79.2%
3 Virtual Workshops**								
Tensor categories and topological quantum field theories	43	19	6	14.0%	3	15.8%	31	72.1%
(∞ , n)-categories, factorization homology, and algebraic K-theory	47	21	9	19.1%	3	14.3%	35	74.5%
Hot Topics: Optimal transport and applications to machine learning and statistics	102	19	15	14.7%	5	26.3%	67	65.7%
All 15 Workshops Total	566	205	126	22.3%	32	15.6%	415	73.3%
Education & Outreach Workshops								
1 Onsite Workshops								
Improving the Preparation of Graduate Students to Teach Undergraduate Mathematics	0	0	0	0.0%	0	0.0%	0	0.0%
1 Virtual Workshop**								
Critical Issues in Mathematics Education 2020: Today's Mathematics, Social Justice, and Implications for Schools	13	7	10	76.9%	5	71.4%	13	100.0%
All 2 Workshops Total	13	7	10	76.9%	5	71.4%	13	100.0%
All 17 Workshops Total	579	212	136	23.5%	37	17.5%	428	73.9%

* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.
** MSRI closed on 3/10/2020 due to the COVID-19 pandemic. Workshops scheduled after this date were held virtually and registration was encouraged, but not required; therefore demographic information is only available for registered participants. These numbers include only participants for whom information is available.

*Note that the overall graduate student data in section 4.6 is not distinct as some participants attended multiple workshops, but the statistics of individual workshop found in Section 12, Appendix, were calculated on distinct participant data.

5. Undergraduate Program

5.1 Description of Undergraduate Program

Please note: MSRI-UP is funded by an independent NSF grant, DMS-1659138. The report was filed independently to the NSF in March 2020, thus there is no report attached in Section 13. Appendix.

The MSRI Undergraduate Program (MSRI-UP) is a comprehensive summer program designed for undergraduate students who have completed two years of university-level mathematics courses and would like to conduct research in the mathematical sciences. Due to funding restrictions, only U.S. citizens and permanent residents are eligible to apply and the program cannot accept foreign students regardless of funding.

The main objective of the MSRI-UP is to identify talented students, especially those from underrepresented groups, who are interested in mathematics and make available to them meaningful research opportunities, the necessary skills and knowledge to participate in successful collaborations, and a community of academic peers and mentors who can advise, encourage and support them through a successful graduate program.

This objective is designed to contribute significantly toward meeting the program goal of increasing the number of graduate degrees in the mathematical sciences, especially doctorates, earned by U.S. citizens and permanent residents by cultivating heretofore untapped mathematical talent within the U.S. Black, Hispanic/Latino and Native American communities.

During the summer, each of the 18 students:

- participates in the mathematics research program under the direction of faculty and graduate students mentors.
- completes a research project done in collaboration with other MSRI-UP students
- gives a presentation and writes a technical report on their research project
- attends a series of colloquium talks given by leading researchers in their fields
- attends workshops aimed at developing skills and techniques needed for research careers in the mathematical sciences and
- learns techniques that will maximize a student's likelihood of admissions to graduate programs as well as the likelihood of winning fellowships
- receives a \$3100 stipend, lodging, meals and round trip travel to Berkeley, CA.

After the summer, each student:

- has an opportunity to attend a national mathematics or science conference where students will present their research
- becomes part of a network of mentors that will provide continuous advice in the long term as the student makes progress in his/her studies
- may be contacted regarding future research opportunities

6. Summer Research in Mathematics

6.1 Description of Summer Research in Mathematics

Please note: Summer Research in Mathematics was not funded through this NSF grant. Thus, there is no report in Section 13, Appendix.

Existing women's mathematics conferences are valuable collaborative opportunities but they are also very short in duration, usually lasting only a week, meaning projects started during those conferences remain unfinished once the participants return to their usual professional and personal responsibilities. MSRI's Summer Research in Mathematics (SRiM) program was created in response to this problem. The program provides space, funding, and the opportunity for in-person collaboration to small groups of mathematicians, especially women and gender-expansive individuals, with established projects. Such groups may apply for funding to spend two weeks or more together at MSRI where they will live and work in close proximity to one another and can make use of the Institute's resources. This focused, distraction-free collaboration can accelerate the completion of their research project and provide an opportunity for a deeper research experience than may have been possible otherwise.

MSRI piloted the Summer Research in Mathematics program in the summer of 2017 (16 researchers participated, divided among 4 groups) and continued it in 2018 (21 researchers, 6 groups) with great success. As of May 2020, 3 groups from 2017 had papers appear in refereed journals; and 4 groups from 2018 had published or submitted papers, with a few of the groups submitting several. It is also noteworthy that some of the 2018 groups have begun work on new projects that grew out of the research they conducted during their visit to MSRI.

Summer 2019 was the third year of the SRiM program. Thirteen small groups (46 researchers in total) met at MSRI to continue their work on established projects. As of May 2020, two groups have successfully published a paper, seven groups have submitted papers for publication, one group anticipates submitting a paper by the end of the year, and three groups have papers in progress. These results are especially impressive considering COVID-19's impact on the groups, not only with regard to travel restrictions but also increased pressure from rapidly changing childcare needs and teaching obligations. Because of these factors, many groups have not been able to reunite in person after the summer program, but most have continued to meet virtually to further their research.

The strong impact of the program on the 2019 participants is clearly illustrated by the comments we received at the end of their stay; some of the comments are reproduced in the next section. The level of excitement about this program can be seen by the number of 2020 applicants (294 researchers divided among 80 groups, nearly double the number of 2019 applications). We have been able to invite 18 groups (82 researchers in total) to participate in a postponed (due to COVID-19) Summer Research experience taking place in summer 2021. The exponential growth in the number of applications over the last 4 years demonstrates the high demand for such a program, which has far exceeded our expectations. We are speaking with other institutions in the hope that some of them will also offer a similar program.

7. African Diaspora Joint Mathematics Program

7.1 Description of ADJOINT

Please note: ADJOINT was funded by an independent NSF grant, DMS-1915954. The report was filed separately to the NSF in April 2020, thus there is no report attached in Section 13. Appendix.

The African Diaspora Joint Mathematics Program (ADJOINT) begins with a two-week summer workshop at MSRI, which is designed to provide the opportunity for in-person research collaboration to U.S. mathematicians, especially those from the African American mathematical community. Small groups of mathematicians work with research leaders on various research projects for an intense period of 2 weeks during the summer. The ADJOINT program continues throughout the academic year (and beyond) by providing the means for research teams to advance their projects after leaving MSRI. We provide support for periodic virtual meetings as well as travel funds to enable visits among collaborators. Additional support is provided so that results can be presented at national and international conferences and published in peer-reviewed journals.

The 2019 ADJOINT pilot workshop ran from June 10th through August 2nd with research groups visiting MSRI for up to two weeks during that time period. Twelve mathematicians participated in one of the three research groups, and each group was led by a respected African American mathematician with a well-established research program. All teams were predominantly comprised of African American mathematicians at various stages in their careers. One research group was able to hold further in-person meetings to continue their collaboration in the Fall of 2019; unfortunately, due to the COVID-19 pandemic, all other travel plans have been postponed. MSRI has obtained a one-year no cost extension for this grant with the expectation that this will allow time for the groups to reinstate their plans once travel again becomes advisable.

MSRI is pleased with the results of the ADJOINT 2019 pilot program and the Institute has taken steps to firmly establish the ADJOINT program for future years. The success of the pilot program is illustrated through the exit surveys filled out by each participant, all of whom rated their level of professional satisfaction with the program as 5 out of 5. Some comments excerpted from the exit surveys are included in the following section. MSRI is committed to providing a welcoming, supportive, and collegial environment for all mathematicians and we are excited to continue developing ADJOINT according to those principles.

7.2 Testimonials from 2019 Participants

“It was great working with other African Americans. However, for me the best part about the program is that more African Americans will be writing papers together and presenting to the math community. [ADJOINT] can make a direct impact on the number of research papers authored and conference presentations given by African Americans. That is a huge positive.”

—**Emille Davie Lawrence (University of San Francisco)**

13. Appendix – Final Reports of Activities in 2019-20

Holomorphic Differentials in Mathematics and Physics

August 12, 2019 to December 13, 2019
MSRI, Berkeley, CA
USA

Organizers:

Jayadev Athreya (University of Washington)
Steven Bradlow (University of Illinois at Urbana-Champaign)
Sergei Gukov (California Institute of Technology)
Andrew Neitzke (Yale University)
Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)
Anton Zorich (Institute de Mathematiques de Jussieu)

HOLOMORPHIC DIFFERENTIALS IN MATHEMATICS AND PHYSICS

FALL 2019 FINAL REPORT

J. S. ATHREYA, S. BRADLOW, S. GUKOV, A. NEITZKE, A. WIENHARD, AND A. ZORICH

1. INTRODUCTION

Riemann surfaces are among the most studied objects in mathematics. They are compact surfaces (like the surface of a donut) that are endowed with a conformal class of Riemannian metrics, which is essentially a way to measure angles. One can also think of them as complex curves. They arise in differential geometry, complex analysis, algebraic geometry, differential equations, theoretical physics, dynamical systems, and many, many other fields. Riemann surfaces can be endowed with additional structure, and one such structure — holomorphic differentials — was at the heart of the program *Holomorphic Differentials in Mathematics and Physics*.

The simplest holomorphic differentials are *holomorphic 1-forms*. In local coordinates, a holomorphic 1-form is of the form $f(z)dz$, where f is a holomorphic function. More generally, one can consider holomorphic k -differentials, which are locally of the form $f(z)(dz)^k$. Holomorphic differentials arise in many different contexts, several of which will be described below. They naturally appear when gluing a surface out of a regular Euclidean polygon by identifying opposite sides, they are sections of powers of the canonical bundle of the Riemann surface, quadratic differentials arise as cotangent vectors to the moduli space of Riemann surfaces. A particularly important occurrence of holomorphic differentials is as the base of the Hitchin fibration. This provides a link to representation variety and to theoretical physics.

The program on *Holomorphic Differentials in Mathematics and Physics* brought together people from very diverse areas in which holomorphic differentials play a role. This is always a risky endeavor, and it is a great success of the program that the different communities interacted quite intensely. This interplay between different perspectives enriched our understanding and allowed us to formulate new directions for future research.

1.1. A kaleidoscope of holomorphic differentials. In the following we describe a few of the appearances of holomorphic differentials, focussing on the areas that are key to the program.

1.1.1. Billiards and Abelian Differentials. A simple way to obtain a Riemann surface is to take a Euclidean polygon and glue opposite sides. If we start with a square, we get a torus, and if we start with an octagon, we get a surface with two holes, a *genus 2* surface. Note that when we glue the square together, the grid on it continues to look the same everywhere, whereas on the genus 2 surface, twelve squares of the grid come together at one point, giving an angle of $12 \times \pi/2 = 6\pi$, though every other point looks normal.

Since we are gluing sides by translations, maps of the form $z \mapsto z + c$ which are holomorphic maps, we get a holomorphic structure on these surfaces- but in fact, since $d(z + c) = dz$, these surfaces come equipped with a *holomorphic 1-form*, which, in local coordinates, is of the form $f(z)dz$. The zeros of this form correspond to points with excess total angle; an angle of $2\pi(n + 1)$ corresponds to a zero of order n , so the genus 2 picture above has a zero of order 2. Such a holomorphic 1-form is also called an *Abelian differential*. They play an important role in understanding the dynamics of billiards in rational polygons.

More generally, we can consider holomorphic k -differentials, locally of the form $f(z)(dz)^k$, with $f(z)$ holomorphic. These correspond to surfaces obtained from polygons by gluing sides with maps of the form $z \mapsto \zeta_k z + c$, where ζ_k is a k -th root of unity, equivalently, with rotations of order k and translations. The case $k = 2$ is of particular interest, and these are known as *holomorphic quadratic differentials*. Holomorphic quadratic differentials, and cotangent vectors of the moduli space of Riemann surfaces. Quadratic differentials arise as Hopf differentials of harmonic maps, and give a parametrization of Teichmüller space.

An important tool in studying Abelian and quadratic differentials is the action of $SL(2, \mathbb{R})$ on the space of Abelian differentials. The characterization of the orbit closures of this $SL(2, \mathbb{R})$ -action is one of the results

for which Maryam Mirzakhani was awarded the Fields medal and Alex Eskin the Breakthrough Prize in Mathematics.

1.1.2. *Higgs bundles, quadratic differentials, and higher Teichmüller spaces.* A holomorphic k -differential is a holomorphic section of k -th power of the canonical bundle K of the Riemann surface. In this guise holomorphic differentials arise in the theory of Higgs bundles. A *Higgs bundle* is a pair (E, Φ) where E is the rank n holomorphic bundle and Φ , the Higgs field, is a holomorphic bundle endomorphism from E to $E \otimes K$. The coefficients of the characteristic polynomial of Φ are holomorphic differentials of degree $k = 1, \dots, n$. The map which associates to the pair (E, Φ) the family of holomorphic k -differentials is the Hitchin fibration. It plays an important role in Langlands duality, and in the connections to physics.

By providing a section to the Hitchin fibration Hitchin gave another parametrization of Teichmüller space using the space of holomorphic quadratic differentials. The construction starts with the line bundle $K_\Sigma^{1/2}$, by which we mean a line bundle whose square is isomorphic to K . The dual of this line bundle, $K^{-1/2}$, is a square root of K^{-1} . The Higgs field Φ is then a map

$$(1.1) \quad \Phi : K^{-1/2} \oplus K^{1/2} \rightarrow K^{1/2} \oplus K^{3/2}$$

One can choose Φ to have the off-diagonal form $\Phi = \begin{bmatrix} 0 & c \\ q & 0 \end{bmatrix}$ where $c : K^{1/2} \rightarrow K^{1/2}$ and $q : K^{-1/2} \rightarrow K^{3/2}$.

Holomorphic endomorphisms of line bundles are constants, so c can be normalized to be 1. Any map of line bundles from L_1 to L_2 yields a holomorphic section of the line bundle $L_1^{-1} \otimes L_2$, so q is a section of K^2 , i.e. a quadratic differential.

This construction requires a *fixed* complex structure. We can take this as a basepoint in the Teichmüller space of (marked) complex structures on the surface. Hitchin shows how a new hyperbolic metric on S can be constructed from the quadratic differential q and a bundle metric on $K^{1/2}$ provided that the induced bundle metric on $K^{-1/2} \oplus K^{1/2}$ solves a certain gauge theoretic equation on the Higgs bundle. The necessary and sufficient conditions for solutions to this equation are given by an algebro-geometric stability condition which is true for the Higgs bundles we are considering. The gauge-theoretic equations were obtained by Hitchin as a dimensional reduction of the self-duality equations on a four-manifold. More generally, for a Lie group G , and a G -Higgs bundle, the solutions of the corresponding equations yield flat connections with holonomies in G . This yields a homomorphism between the space of G -Higgs bundles, the space of G local systems, and the variety of reductive representations of the fundamental group of the surface into G . This is the celebrated non-abelian Hodge correspondence.

Via the non-abelian Hodge correspondence the section of the Hitchin fibration in the general case gave rise to a new phenomena in the representation variety of the fundamental group of the surface into G . The image of the Hitchin section forms the Hitchin component, a connected component, consisting entirely of discrete and faithful representations. In many respects the Hitchin component resembles Teichmüller space. The study of the Hitchin component, and of other higher (rank) Teichmüller space, as the space of maximal or positive representations, is a very active area. So far, mostly Thurston's hyperbolic point of view on Teichmüller space has been generalized to these higher Teichmüller spaces, and a lot of the complex analytic viewpoint is still obscure in these cases. Nevertheless, when the Lie group G has rank 2, there are mappings class group invariant parametrizations of the Hitchin component (and in a similar way of the space of maximal representations) by pairs of a conformal structure and a holomorphic k -differential. Recently flat structures on surfaces, which are determined by Abelian differentials also seems to make their appearance in new compactifications of these higher Teichmüller spaces at infinity. There are still many open questions and relations to be discovered.

1.1.3. *Quantum field theory.* Recently a new role for Riemann surfaces and holomorphic differentials has emerged in high energy physics. The starting point for this story is a certain *six*-dimensional quantum field theory $\mathfrak{X}(g)$, depending on a Lie algebra g (for example $g = sl(N)$, the algebra of $N \times N$ traceless matrices). The field theories $\mathfrak{X}(g)$ were discovered in the mid-1990s and remain rather mysterious to the present day. In 2009 physicists proposed the following thought experiment: suppose that the universe is described by one of the field theories $\mathfrak{X}(g)$, and now choose the spacetime to be of the form $M_6 = X \times M_4$. If X is much smaller than M_4 , observers living in this hypothetical spacetime will not see X directly; they will perceive their universe to be M_4 . Nevertheless, the laws of physics they will observe in M_4 , governed by a four-dimensional field theory $S(X, g)$, are intimately tied up with the structure of X .

For example, one can consider the *couplings* in $S(X, g)$ — fundamental parameters determining the strength of the various interactions in the theory, analogous to the fine-structure constant in our universe. It turns out that these couplings are most naturally considered not as numbers, but rather as coordinates on the Teichmüller space of X . Similarly, many other physical phenomena in $S(X, g)$ have translations into the geometry of X , and vice versa:

Teichmüller space of X Holomorphic differentials on X g -Higgs bundles over X Billiard trajectories between singularities on X Webs of trajectories on X	Coupling space of $S(X, g)$ Vacuum states in $S(X, g)$ on $M_4 = \mathbb{R}^4$ Vacuum states in $S(X, g)$ on $M_4 = \mathbb{R}^3 \times S^1$ Supersymmetric particles in $S(X, sl(2))$ Supersymmetric particles in $S(X, sl(N))$
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This thought experiment is not yet rigorous mathematics; nevertheless, it has turned out to be a fertile source of mathematical ideas. For example, it has led to a new scheme for understanding the hyperkähler metrics on moduli spaces of Higgs bundles, or to a new approach to the WKB method in the theory of ODEs. In the other direction, techniques in dynamics of flat surfaces have led to the solution of particle counting problems in the physical theories $S(X, sl(2))$.

2. RESEARCH DEVELOPMENTS

One of the goals of this MSRI semester was to bring people from different research communities together to start discussions and joint future research projects, in which the different points of view on holomorphic differential come together and are used to approach old and new research challenges. The most interesting research developments arose from such new collaborations, and we expect more interesting developments arise in the future.

We describe (in the words of some selected members) some of the research developments. As can be seen from the responses, the intellectual breadth of the program was crucial in developing new and interesting connections.

David Aulicino.

1) I published a paper several years earlier on meromorphic differentials, which was inspired by papers in mathematical physics directly related to the HDMP program at MSRI. I had not had the opportunity to speak to physicists about this result until this semester. I gave a talk to publicize the work and discussed the results with several of the participants. I also discussed a work in progress related to it in conversations. I was very happy to hear the positive response and they were happy to know the results of mine that are available as well as the ones that will be available in the future. Knowing exactly the people to communicate my results to in the future made the networking opportunity invaluable to me.

2) The program of the semester was very broad due to the nature of the subject. The organizers and participants did an excellent job working to get everyone on the same page so that everyone could have a greater view of the subject. In particular, I feel that I have a far greater understanding of how physics fits into the picture and what each field can contribute to the other. Having a global view will be essential for formulating and pursuing future research projects.

3) I started a project with Gabi Weitze-Schmithusen and Dami Lee concerning the computation of Siegel-Veech constants for a specific class of surfaces. This project could have only been started with the in person communication afforded to us by MSRI.

4) I started a project with Jayadev Athreya, Andy Neitzke, and Vincent Delecroix concerning a counting problem coming from the physics developed by Neitzke and his collaborators. The problem generalizes the classical problem in translation surfaces of counting saddle connections. Again this project could not have started without the regular in person communication afforded to us by a semester-long program at MSRI.

5) Finally, I came to MSRI with several projects in progress and the numerous experts, including Anton Zorich, Howard Masur, Martin Moeller to name a few, allowed me to dramatically accelerate progress on these projects through their insights and suggestions.

This would not have been possible without the open collaborative atmosphere fostered by MSRI.

Dylan Allegretti.

The main development for me would be the paper that I posted to arXiv this week (<https://arxiv.org/abs/1912.05938>). It ties together many of the themes we've been discussing over the course of the semester: holomorphic differentials, stability conditions, Fock-Goncharov coordinates, Donaldson-Thomas invariants, WKB analysis, Stokes data for differential equations, and conformal limits in the theory of Higgs bundles. The main result of the paper says that there exists a very interesting map from the space of stability conditions on a triangulated category to an associated cluster variety. On the one hand, this construction provides a way of rigorously understanding certain results of Gaiotto, Moore, and Neitzke in physics. On the other hand, it provides solutions of a certain Riemann-Hilbert problem proposed by Tom Bridgeland in a huge class of examples.

I have also begun writing a second paper which is a companion to the one above. In this second paper, I will prove a version of the Kontsevich-Soibelman wall-crossing formula describing how the number of finite-length trajectories of a quadratic differential jumps as the differential is varied. I am hoping that this will be useful to researchers working on flat surfaces or WKB analysis.

Martin Möller.

The completion of the BCGGM compactification is a major step. The joint presence of Sam and me at MSRI has significantly contributed to that. Applications are abundant (I talked about the Euler characteristic, Ben Dozier sent around the draft for the volume bounds, I am using this compactification for a similar compactification of Higgs bundles....)

Mike Wolf.

Aside from Richard Wentworth and I slogging through some technical aspects of our work that I'm not sure we would have succeeded at were we on separate coasts, I began two new projects. To be clear, neither have any results at the moment, but I think they might have some significance, if enough of the vision can be realized.

1) The first came from discussions with Marc Burger, Alessandra Iozzi, and Maria Beatrice Pozetti. These folks, together with Anne Parreau, have been developing a theory of compactifying some character varieties by buildings constructed from real non-Archimedean ordered fields, where (as I dimly understand) the field emerges from the character variety. Now at the same time, together with my collaborators David Dumas, John Loftin and Andrea Tamburelli, we have been making glacial progress towards creating a compactification of some character varieties in low rank from solutions to the Hitchin equations: the compactifications would involve a construction reflecting the partial foliations for the related holomorphic differentials. The groups held some discussions for a number of weeks and we conceived of a plan where our projects would meet in the middle. (The conversations advanced due to the participation of Yair and Andy – who acted as lubricants at crucial moments when the discussion froze up.) The holomorphic differentials team could compute asymptotic holonomies in terms of intersection numbers of curves with the partial foliations in some families, and these computations – and their error estimates – would then define a field useful to the BIPP team to define a limiting building. That building would admit a harmonic map from the Riemann surface defined in the background of the Hitchin machine – this is just a consequence of the formal machine of Korevaar-Schoen but then this would end up as the limit of the harmonic maps defined by the family. Well, maybe....but it's intriguing to try to unify the points of view. I should

2) I enjoyed a long series of discussions with Yair Minsky. Yair had an idea that a model problem to understand in pursuit of a theory of Weil-Petersson geodesics would be minimal planes of finite total curvature in symmetric spaces. This links with some work I had been doing that related minimal maps of planes in some low rank symmetric spaces that were

defined in terms of either 'finite' holomorphic data, like the order of the pole at infinity of \mathbb{C} , or the image of the minimal map being asymptotic to a finite number of flats. My sense is that Yair's finite total curvature condition might be the right setting for the phenomena that interests me. But we are trying to prove some structure theory for such minimal maps of planes. The results so far can be exaggerated to be called fragmentary.

Thanks for a wonderful semester! I thought that the tone of the semester was very welcoming and inclusive – in a broader way beyond the standard meaning where folks from groups at risk of being marginalized might have felt obstructed from participation. I mean that the physics people were eager to try to communicate to the math people, and flat structures folks evinced some interest in Higgs bundles etc.. A lot of that came from the example of the organizers, so.... well done

Dmitry Korotkin.

I have posted the following papers to ArXiv:

arXiv:1910.07140: Yang-Yang generating function and Bergman tau-function, Authors: Marco Bertola, Dmitry Korotkin

arXiv:1910.06744: Extended Goldman symplectic structure in Fock-Goncharov coordinates, Authors: Marco Bertola, Dmitry Korotkin

arXiv:1910.03370: Isomonodromic tau-function as generating function of monodromy symplectomorphisms, Authors: Marco Bertola, Dmitry Korotkin I gave a talk at the HDMP-Weekly Seminar on Symplectic properties of monodromy map for second order equation on a Riemann surface. My discussions with V.Fock led to construction of the dilogarithm line bundle for the extended $SL(2, \mathbb{R})$ Goldman symplectic form. Discussions with T.Bridgeland, A.Neitzke, M.Shapiro and D.Allegretti led to elucidation of the link between Voros symbols and Fock-Goncharov coordinates which was an essential missing element in the paper 1 above. Discussions with W.Goldman, S.Wolpert, V.Fock and A.Goncharov and M.Shapiro were crucial in establishing the relationship between the Poisson and symplectic structures studied in the paper 2 above and the Fock-Goncharov Poisson structure on higher Teichmuller spaces.

Marco Bertola.

Coming into the semester I was getting involved with the use of the Fock-Goncharov coordinates for the symplectic aspects of the so-called (iso)monodromic tau function. The focus of the activities on the various aspects of their applications was extremely important for the development of my own research. My main collaborator during the term (I was present only 2 months) was Dmitry Korotkin, with whom we have posted, while in residence, two preprints (1910.06744 and 1910.03370) which deal precisely with some of their applications. During the stay at MSRI we had chance of interacting with V. Fock, A. Goncharov, R. Wentworth, W. Goldman, A. Neitzke. With V. Fock we are now in the early stages of a paper investigating the construction of what we could term a "dilogarithm line bundle" on the moduli space of pointed Riemann surfaces. Needless to say, the interaction would not have been possible without physical proximity or without the worry free research environment and logistical support provided by MSRI during the HDMP programme.

Marc Burger.

1. The idea was to write up this semester all the results obtained since 2016 in collaboration with A.Iozzi, A.Parreau and B.Pozzetti on the compactification of character varieties. We produced a preliminary manuscript "Real spectrum compactification of character varieties" that is supposed to precede an already existing manuscript "Positive crossratios, barycenters, trees and applications to maximal representations". It turned out that the material contained in this preliminary manuscript (about 50 pages) will have to be split in several papers. Thus to gain an overview we decided to write an announcement "The real spectrum compactification of character varieties: characterizations and applications", that

offers a coherent narrative of the whole theory. This announcement (presently about 30 pages) should be available in January 2020.

2. With A.Iozzi and B.Pozzetti we started to study natural equivariant embeddings of the hyperbolic plane into buildings associated to $Sp(4)$ over non archimedean real closed fields, in particular focusing on the nature of the singular points. This is work in progress and looks very promising. Title of the paper: "Flat structures and $Sp(4)$ representations over real closed fields".

3. We had several sessions of discussions involving John Loftin, Mike Wolf, Andy Neitzke, Alessandra Iozzi, Beatrice Pozzetti, Yair Minsky and myself trying to understand the picture emerging from work of Loftin and Wolf on the asymptotic behaviour of cyclic $SL(3)$ -Hitchin representations. Eventually we succeeded seeing the connection with the viewpoint of real spectrum compactification of the $SL(3)$ -Hitchin component and came up with precise conjectures that are part of a future research project involving A.Iozzi, J.Loftin, B.Pozzetti, M.Wolf and myself.

4. The graduate student seminar dedicated a certain number of sessions to the Thurston-Parreau compactification of character varieties. The students asked me to give complementary talks; I gave three 2 hour talks focusing on the relation between the real spectrum compactification and the Thurston-Parreau one.

Laura Frederickson.

I am just about to post a paper on the asymptotic geometry of the moduli space of $SL(2, \mathbb{C})$ parabolic Higgs bundles with Rafe Mazzeo, Jan Swoboda, and Hartmut Weiss. Gaiotto-Moore-Neitzke conjectured that near the ends of the Hitchin moduli space, the hyperkahler metric is very close to a simpler hyperkahler metric known as the semiflat metric. We prove Gaiotto-Moore-Neitzke's sharp rate of exponential decay in the particular case of the four-punctured sphere. When Jan and Hartmut came to MSRI to visit, we made progress finishing this project, and on various related projects trying to prove the sharpest version of Gaiotto-Moore-Neitzke's conjecture. I started a new collaboration with Richard Wentworth and Brian Collier about conformal limits for parabolic Higgs bundles. This generalizes a paper of mine and a paper by Wentworth-Collier in the case of ordinary Higgs bundles. In the ordinary case, the Higgs bundle moduli space was fixed by a C^* action. We made crucial use of the C^* action in the proof. Extending our result to the parabolic setting is proving so be more interesting than we initially thought, because most of these parabolic Higgs bundle moduli spaces are not fixed by the C^* action. I am just finishing a project with Steve Rayan about the topology of wild Hitchin moduli spaces. I had some useful conversations with Vivek Shende about defining the moduli space of wild Higgs bundles, using algebraic geometry techniques. I continued to work on a project with Andy Neitzke, which is still in its early stages.

Qiongling Li.

Projects I started: (1) A continuation of a previous project with Subhojoy Gupta on Andy Neitzke's conjectures on relating the cross ratios of hyperbolic polygons and the zeros of polynomial Hopf differential; (2) A project with Brian Collier on investigating the energy density of harmonic maps decreases along the C^* -flow. Talks I gave at MSRI: I gave a 3-hours minicourse in the introductory workshop and also gave a 1-hour talk in the November workshop. Discussions I had that revealed unexpected connections: (1) During my time in MSRI, I had great opportunities to learn spectral network through Dylan's seminar talks and Andy Neitzke's mini-courses. I finally get to understand the framework and how it helps to understand the asymptotics of harmonic maps using differentials much deeper than before. Moreover, Andy presented a special lecture to me on his conjectures on relating the cross ratios of hyperbolic polygons and the zeros of polynomial Hopf differential in a systematic way. This greatly helps my ongoing project with Subhojoy Gupta by understanding how the conjectures arise. (2) During an afternoon tea time in MSRI, Brian Collier asked a question about the uniqueness of equivariant minimal surfaces in the product of \mathbb{H}^2 and \mathbb{H}^2

with negative hyperbolic metric on the second part for a diagonal Fuchsian representation. The answer seems unknown to several experts at the teatime. It arises my interest and thus with Brian, we try to dig more on this direction in the following two weeks with great enthusiasm. In the end, we find a classical result from geometric analysis and showed that the answer is yes. The proof is surprisingly easy but enlightening. Even though we do not turn it into a paper, but we do learn a lot like several different methods proving the uniqueness of minimal surfaces in certain symmetric spaces which could be inspiring for our future research.

Pietro Longhi.

The main highlights from my point of view: while at MSRI I put on the arxiv a couple of papers indeed (1910.06193, 1910.05296), but what really made a difference for me were the interactions with people, both those in residence and shorter-term visitors. I was able to get feedback on various projects, as well as ideas for further developments by talking to various people. The variety of backgrounds and interests of the participants in the program made it possible to develop ideas in several directions and to explore new connections between them. With Delecroix, Moeller and Takeda we started thinking about generalizations of Strebel's constructions for collections of higher differentials, to understand whether it is possible to glue a special type of spectral networks known as BPS graphs. The work is still ongoing?

Andrew Neitzke.

The main personal highlight for me was the opportunity to learn more about the fundamental objects of higher Teichmuller theory from people like Brian Collier, Vladimir Fock, Sasha Goncharov, Francois Labourie, Yair Minsky and Anna Wienhard, and about flat surfaces from people like Jayadev Athreya, David Auricino, Vincent Delecroix and Anton Zorich. I am currently trying to develop a quantum-field-theoretic perspective on higher Teichmuller spaces (partly joint with Laura Fredrickson and Ali Shehper) and, while the picture is still not complete, these discussions have clarified many of the necessary pieces.

Anna Wienhard.

Besides finishing two papers, one with Beatrice Pozzetti (research member) and Andres Sambarino, and another one with Daniele Alessandrini, Olivier Guichard and Evgenii Rogozinnikov (program associate) (arXiv:1910.06627 and arXiv:1911.08014) one of the most important research developments during the MSRI semester was to start developing an approach to realize the symplectic group (and more general all classical Hermitian Lie groups of tube type) as symplectic groups Sp over a non-commutative ring. This explains several properties shown for maximal representations in the past years, and also allows to define new models of symmetric spaces of complex Lie groups. I discussed several questions to use this approach to understand the bounded cohomology of complex groups with Marc Buger. The other exciting developments for me arose from discussions with several members from other areas, including in particular also the people from physics.

3. ORGANIZATIONAL STRUCTURE

In addition to the two workshops, our program included the following organized activities:

- A weekly two-hour seminar (on Wednesdays). Some weeks two different speakers each gave a one-hour talk, and some weeks one speaker utilized both hours. Whenever possible the two separate talks were thematically linked; when a single speaker had two hours, the first hour was used for introductory material or an overview of an area, to be followed in the second hour by a deeper dive into selected aspects of a problem. The seminar organizers were Steve Bradlow and postdoc Dami Li. A list of the speakers, with Titles and Abstracts is attached with this report (in MSRI HDMP Seminar.pdf).

- A weekly one-hour learning seminar on Stability Conditions, organized by Dylan Allegretti. Talks in this seminar covered the basics of stability conditions and the relationship with quadratic differentials, as well as more recent developments. The seminar attracted participants and speakers from MSRI as well as the Berkeley and Davis mathematics departments.
- A weekly one-hour learning seminar on spectral networks, organized by Andy Neitzke and Pietro Longhi. Early in the term Neitzke gave a series of talks intended to introduce the mathematical aspects of the theory. The seminar then moved on to aspects of the physics and some related topics.
- A weekly one-hour learning seminar on Physics: a guide for the Perplexed, organized by Yair Minsky. The purpose of the "Physics: Guide for the Perplexed" seminar was to help the geometers make some sense of the connections to quantum field theory underlying the topics of the semester. Francois Labourie, Richard Wentworth, Pietro Longhi, Du Pei and Andy Neitzke all lectured on a number of topics, including early ones on Hamiltonian and Lagrangian formalism, spinors, examples of QFTs, and the connection between QFT and spectral networks.
- A weekly lunchtime Q&A session where members were encouraged to ask about anything related to the diverse aspects of our program. The first several sessions were moderated by Beatrice Pozetti. John Smillie took over after Beatrice left, and after John left Richard Wentworth led the final sessions. Some questions were submitted in advance and some were raised on the spot. In order to encourage an informal, spontaneous ambience, respondents were not given advance notice of the questions.
- A weekly one-hour Graduate Student seminar. Research Professor Yair Minsky served as an advisor but the seminar was organized by the Program Associates themselves. Structured as a learning seminar with presentations by the graduate students themselves, they studied several topics related to the core themes of the program, including spectral networks, degenerations of hyperbolic space, measured foliations, and compactifications of representation varieties.

These organized events were essential to the success of our program but the informal aspects were equally vital. At all hours of the day the building hummed with activity as clusters of participants gathered to exchange ideas and learn from each other.

4. WORKSHOPS AND CONFERENCES

We had three programmatic workshops

Connections for Women: August 15, 2019 - August 16, 2019. This two-day workshop consisted of various talks given by prominent female mathematicians on topics of new developments in the role of holomorphic differentials on Riemann surfaces. It was designed to build connections between graduate students, post-docs, and researchers in areas related to the program.

Introductory Workshop: August 19, 2019 - August 23, 2019. Holomorphic differentials on Riemann surfaces have long held a distinguished place in low dimensional geometry, dynamics and representation theory. Recently it has become apparent that they constitute a common feature of several other highly active areas of current research in mathematics and also at the interface with physics. In this introductory workshop, we brought together junior and senior researchers from this diverse range of subjects together in order to explore common themes and unexpected connections.

Programmatic Workshop: November 18, 2019 - November 22, 2019. This workshop focused on Holomorphic differentials on Riemann surfaces and their interfaces with physics, with lectures on topics like stability conditions on Fukaya-type categories, quantum integrable systems, spectral networks, billiards in polygons, special - Hitchin or higher Teichmüller - components of representation varieties, asymptotic properties of Higgs bundle moduli spaces, and new interactions with algebraic geometry.

It is remarkable how widely scattered are the motivating questions in these areas, and how diverse are the backgrounds of the researchers pursuing them. Bringing together experts in this wide variety of fields to explore common interests and discover unexpected connections was the main goal of this workshop.

5. POSTDOCTORAL FELLOWS

As seen by the survey detail collected by MSRI, our postdoctoral fellows had a very positive experience in our program, with productive interactions with each other, starting many new collaborations, and deepening their knowledge of connections between various disciplines. They also, due to the breadth of our program, significantly expanded their professional networks.

6. GRADUATE STUDENTS

We asked our graduate student participants to describe their experiences, and as you can see from the responses below, it was a very positive experience for them.

Johannes Horn.

As a part of the program HDMP the PhD student seminar was a great opportunity for us graduate students to exchange our mathematical knowledge and learn new material together. In the first two meetings Evgenii Rogozinnikov gave a great introduction in the theory of spectral networks. This was a good preparation for the series of lectures given by Andy Neitzke in the sequel and made it much easier for me to follow his course. Thereafter, we changed the focus to the conjectural picture of the hyper-Kähler metric on Higgs bundle moduli spaces given by Gaiotto-Moore-Neitzke. Together, we went through Neitzke's survey on the topic. It was very interesting to learn, where the conjectures are coming from, which are now getting established in the Higgs bundle community.

Fernando Al-Assal.

I was in the MSRI for 4 weeks in which the seminar ran, including an organizational meeting. We decided to discuss boundaries of representation varieties. We started discussing Bestvina's paper "On degenerations of hyperbolic space", which gives a characterization of the boundary of $\text{Hom}(\Gamma, \text{Isom}^+(\mathbb{H}^n))$ (modulo conjugation) (where Γ is finitely-generated and not virtually Abelian) as a set of Γ -actions on \mathbb{R} -trees. I gave one of the talks about this, which I found to be a good learning experience. The following talk discussed the special case $n = 2$ and its relation to Thurston's theory of measured foliations and the final talk (for which I was not there) discussed the Parreau compactification of $\text{Hom}(\Gamma, G)/G$, where G is a (noncompact connected real with finite center) semisimple Lie group. Overall it was a friendly seminar that brought together people from different backgrounds and stages in graduate school.

Samantha Fairchild.

1) Research Developments/ Highlights The highlight of my experience at MSRI was that I started two new collaborations. First I met Claire Burrin who had read my first paper on higher moments of the Siegel-Veech transform on specific closed $\text{SL}(2, \mathbb{R})$ orbits, and Claire used her expertise in general lattices in $\text{SL}(2, \mathbb{R})$ and my understanding of higher moment formulas to extend the project. We were able to work for a few days before she left, outlining a potential paper extending my results to all possible closed $\text{SL}(2, \mathbb{R})$ orbits as well as using my results on higher moments to interpret discrepancies between the value of a function versus its expected value.

The second project I started was after seeing a picture Jayadev Athreya drew on the board while talking to Howard Masur which reminded me of a picture that I drew when working on my research project with Jon Chaika. After listening in I shared an idea, which resulted in many more discussions on the project understanding higher moments of the Siegel-Veech transform. We now have an outline for a paper which we can fill in the details.

Aside from the large volume of mathematics, I learned how to work with potential collaborators in person after also talking to Ben Dozier and Dia Taha (which haven't resulted in any projects right now, but we have a list of ideas that could be pursued if we can come up with some ideas). I learned that when you have ideas and meet in person, instead of filling all details, the goal is to outline a potential paper or concept, brainstorming any ideas

or arguments that we don't have confidence we can complete on our own. This allows for the crucial brainstorming that needs to happen in person, and then after leaving we can fill in details through emails and skype meetings.

(2) Synergistic activities I went to the Berkeley AWM brunch. This was great to meet other women in the Berkeley math department and learn about their experience as graduate students in a different department. I also met Katie Waddle from San Francisco State University who I didn't get to interact with much, but we met up when she visited UW as a prospective graduate school and we were able to candidly discuss the different departmental cultures between Berkeley, SFSU and UW.

(3) Grad student seminar In the graduate student seminar we learned about spectral networks, which are collections of trajectories on Riemann surfaces. We started the seminar by looking at path lifting for branched coverings and path algebras. After using path lifting which we were all familiar with on Riemann surfaces, Evgenii Rogozinnikov, who was the expert on spectral networks built from our intuition to build up to the Small Fock Gucharov SN, the path lifting rule using SNs, and learning how to construct SNs combinatorially and using quadratic differentials.

The topic of spectral networks was particularly useful as it was central to many of the ideas in the HDMP program, allowing us to use the seminar to make connections to many of the central themes in the seminar talks that we did not understand. We were also able to make connections across all of our areas of research interest resulting in discussions which helped us to build some fundamental connections understanding what each of us is studying.

Andrea Thevis.

In the beginning the graduate student seminar helped me to get in touch to the other graduate students in the program. Before attending the seminar I knew only two of the graduate students. Although the topic wasn't very close to my research I enjoyed the seminar. It was nice to have a seminar which was often more accessible for me then the other seminars. The seminar was also quite interactive. In November Marc Burger gave a series of lectures related to the seminar which I really enjoyed. It helped me to understand some of the talks during the conference in November better.

My highlight of the semester was the talk I gave in the seminar and the discussions I had afterwards (e.g., with Jayadev Athreya, Anton Zorich, and Vincent Delecroix) were helpful. They led to new research questions related to Lyapunov exponents that I am studying right now. It was a great and motivating experience to see that other people find the problems I work on interesting as well.

7. DIVERSITY

The organizers and the MSRI administration made considerable efforts to increase the diversity of the participant group. 16 of 63 (25%) of the participants in our program identify as female: 1 of 6 organizers, 2 of 12 research professors, 2 of 8 postdocs, 6 of 22 ordinary research members, and 5 of 15 program associates (students). Concerning minority representation we were less successful: among the 28 US citizens / permanent residents in the program, only 1 identifies as a minority. 35 of the participants came to Berkeley from North America, 28 from Asia and Europe.

8. SYNERGISTIC ACTIVITIES

Jayadev Athreya and Charles Fougerson led a session of the Berkeley Math Circle.

Jayadev Athreya and Anton Zorich were interviewed and consulted on a documentary about Maryam Mirzakhani, which was screened during the programmatic workshop.

Several members recorded episodes for Numberphile. Many members gave talks UC Davis, as well as several other institutions.

François Labourie was UCB Chancellor Professor and gave a semester long graduate course at the Berkeley Math Department, Anna Wienhard gave a Colloquium Talk at the Berkeley Math Department.

9. HIGHLIGHTS AND BREAKTHROUGHS

We highlight a story that involves one of our postdocs, a workshop speaker, and several other members of the program: One of the most exciting and fascinating aspects of interplay between mathematics and physics is a rather common situation when the same mathematical instruments can be used to study completely different physical phenomena. This is exactly the case of holomorphic differentials that play a key role in a few important physical models.

Consider a surface in a three-dimensional cube as in the picture. Put another cube atop of it, one more cube next to it etc. The surface in the unit cube is constructed in such a way that putting two cubes aside makes the surface extend smoothly from one cube to another. Tiling the three-dimensional space with such cubes we create a *triply-periodic surface* in space.

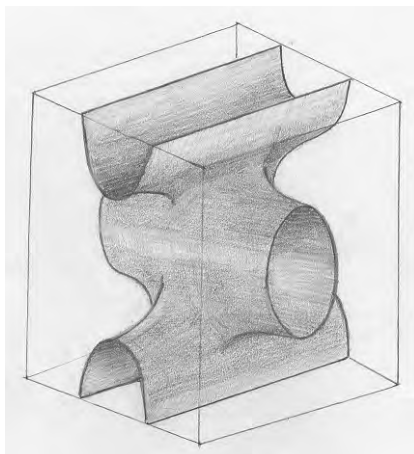
One can model periodic surfaces by gluing polygons. The classification of triply-periodic surfaces obeying certain particularly regular rules of construction is an open problem. A new surface of this kind was recently discovered by Dami Lee. She worked at MSRI on related problems during the research semester "*Holomorphic differentials in mathematics and physics*". The relation between triply periodic surfaces and holomorphic differentials is not instantly visible, but, for example, periodic surfaces constructed from equilateral triangles correspond to so-called arithmetic Teichmüller curves and in some cases are defined by explicit algebraic equations.

Tripoly-periodic surfaces appear in nature, for example, as *Fermi surfaces* of metals. In certain physical models of electron transport in metals in the presence of a magnetic field, electron trajectories are represented by plane sections of triply-periodic Fermi surfaces. In her talk at the Program Workshop, Sasha Skripchenko announced a breakthrough result obtained jointly with Ivan Dynnikov, Pascal Hubert and Paul Mercat. The authors proved Novikov's Conjecture stated in 80s claiming that chaotic electron trajectories appear exceptionally rarely for symmetric Fermi-surfaces of genus 3. Why are holomorphic differentials useful in this problem? Electron trajectories can be interpreted as leaves of a foliation defined by a harmonic 1-form on the associated Riemann surface.

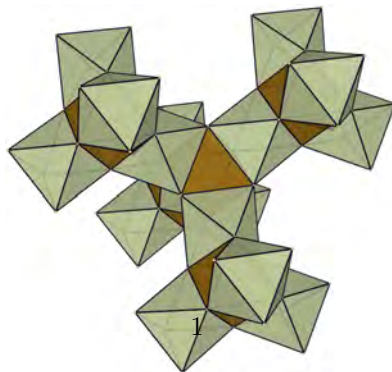
December 2019

One of the most exciting and fascinating aspects of interplay between mathematics and physics is a rather common situation when the same mathematical instruments can be used to study completely different physical phenomena. This is exactly the case of holomorphic differentials that play a key role in a few important physical models.

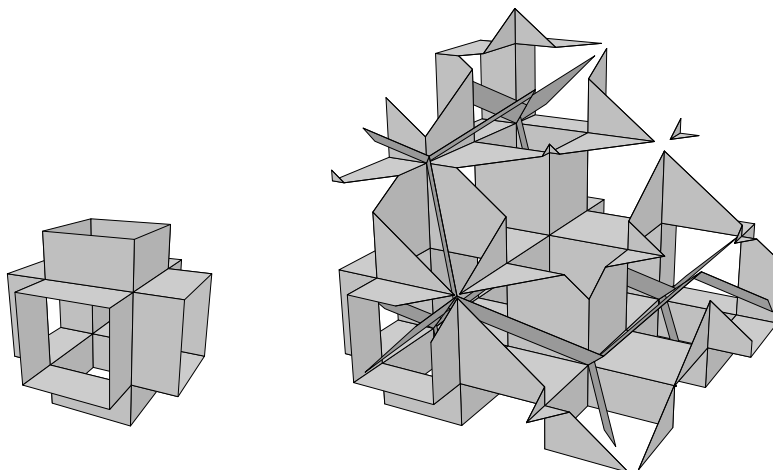
Consider a surface in a three-dimensional cube as in the picture. Put another cube atop of it, one more cube next to it etc. The surface in the unit cube is constructed in such a way that putting two cubes aside makes the surface extend smoothly from one cube to another. Tiling the three-dimensional space with such cubes we create a *triply-periodic surface* in space.



One can model periodic surfaces by gluing polygons. The classification of triply-periodic surfaces obeying certain particularly regular rules of construction is an open problem. A new surface of this kind, *Octa4*, shown in the picture below, was recently discovered by Dami Lee. She worked at MSRI on related problems during the research semester “*Holomorphic differentials in mathematics and physics*”. The relation between triply periodic surfaces and holomorphic differentials is not instantly visible, but, for example, periodic surfaces constructed from equilateral triangles correspond to so-called arithmetic Teichmüller curves and in some cases are defined by explicit algebraic equations.

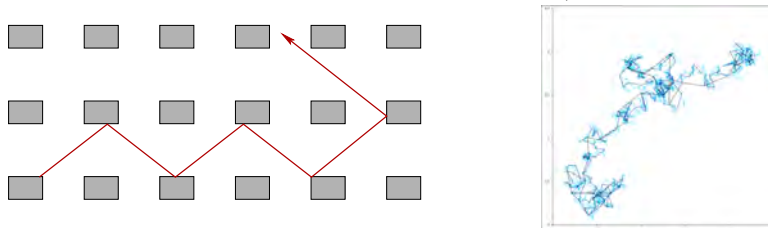


Triply-periodic surfaces appear in nature, for example, as *Fermi surfaces* of metals. In certain physical models of electron transport in metals in the presence of a magnetic field, electron trajectories are represented by plane sections of triply-periodic Fermi surfaces as in the picture below.



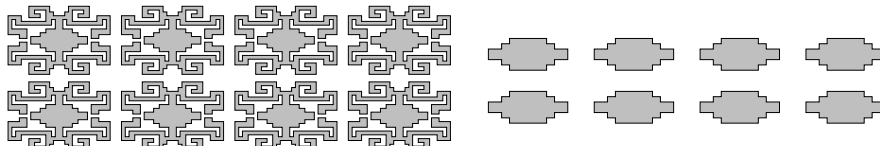
In her talk at the Program Workshop, Sasha Skripchenko announced a breakthrough result obtained jointly with Ivan Dynnikov, Pascal Hubert and Paul Mercat. The authors proved Novikov's Conjecture stated in 80s claiming that chaotic electron trajectories appear exceptionally rarely for symmetric Fermi-surfaces of genus 3. Why are holomorphic differentials useful in this problem? Electron trajectories can be interpreted as leaves of a foliation defined by a harmonic 1-form on the associated Riemann surface.

Another physical model in which holomorphic differentials play a central role is a two-dimensional *wind-tree model*, where molecules bounce as billiard balls from periodic obstacles in the plane. It was suggested by Paul and Tiana Ehrenfest more than a century ago to describe phenomena which resemble mixing of a dye in a solvent. The breakthrough in this problem was obtained only recently by means of the cutting edge technique of geometry and dynamics in the moduli space of holomorphic differentials. It is known that a plane doodle (as in the right picture below) formed by a trajectory of a random walk; a Brownian motion; and of a Sinai billiard in time T , has diameter of size roughly \sqrt{T} . Vincent Delecroix, Pascal Hubert and Samuel Lelièvre (two of the three authors participated at the research semester at MSRI) proved that a typical wind-tree trajectory spreads in the plane with the rate much faster than \sqrt{T} , no matter what are the lengths of the sides of a rectangular obstacle. (Moreover, they explicitly computed this faster *diffusion rate*.)

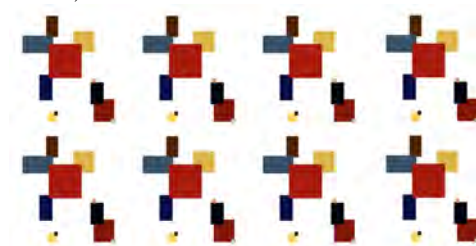


2

What happens if we change the shape of the periodic obstacle? Would it make the wind-tree trajectories spread in the plane slower? Vincent Delecroix and Anton Zorich gave an affirmative answer to the question of Jean-Christophe Yoccoz proving that for symmetric obstacles as in the picture, the trajectories spread slower and slower as the number of corners grows. Moreover, the new *diffusion rate* depends only on the number of corners and not on the particular shape of the obstacle. (The final touches of the paper were completed by the authors at MSRI.)



The problem becomes technically even more difficult when one considers asymmetric obstacles. Charles Fougerson, postdoc at MSRI, applied some of the most powerful machinery of geometry and dynamics in the moduli spaces of quadratic differentials (including the Magic Wand Theorem of Maryam Mirzakhani, 2014 Fields Medal, and of Alex Eskin, 2020 Breakthrough Prize) to prove that the wind-tree trajectories spread slower when the obstacle gets many angles. (Both results, actually, tell exactly “how slowly” in terms of the number of angles of an obstacle.)



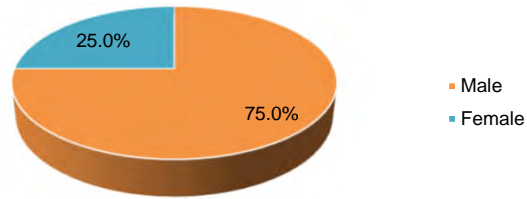
The last missing element of the proof was achieved by Martin Möller and his collaborators during the stay at MSRI. In a series of preprints published during the research semester, this group of authors (including Sam Grushevsky in residence at MSRI) published fundamental results on compactification of the moduli spaces of holomorphic differentials. This allowed them to apply machinery of intersection theory to prove several important results including the Grivaux–Hubert conjecture necessary for the wind-tree.

Postdoc Pre/Post-MSRI Institution Group

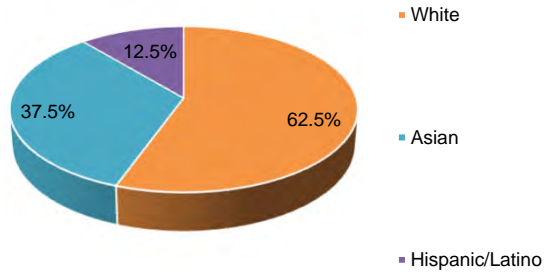
Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Institution Group	Post-MSRI Institution Name	Post-MSRI Institution Group
Allegretti	Dylan	University of Sheffield	Foreign	University of British Columbia	Foreign
Collier	Brian	University of Maryland	Math Public Large Group	University of California, Riverside	Math Public Small Group
Fougeron	Charles	Université Paris Diderot 7	Foreign	Université Paris Diderot 7	Foreign
Frederickson	Laura	Stanford University	Math Private Large Group	Stanford University	Math Private Large Group
Lee	Dami	University of Washington	Math Public Large Group	University of Washington	Math Public Large Group
Longhi	Pietro	ETH Zurich	Foreign	ETH Zurich	Foreign
Pei	Du	California Institute of Technology	Math Private Large Group	California Institute of Technology	Math Private Large Group
Takeda	Alex	University of California, Berkeley	Math Public Large Group	Institut des Hautes Études Scientifiques (IHES)	Foreign

2019-20 HDMP Postdoctoral Fellow Demographic Summary

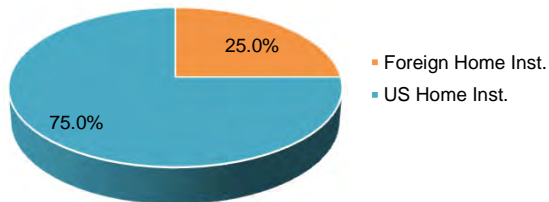
Gender	#	%
# of Distinct Members	8	100.0%
Male	6	75.0%
Female	2	25.0%
Decline to State	0	0.0%



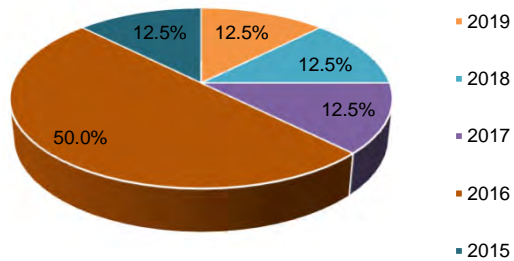
Race/Ethnicity*	#	%
White	5	62.5%
Asian	3	37.5%
Hispanic/Latino	1	12.5%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	0	0.0%
Unavailable Info.	0	0.0%
Minorities**	0	0.0%



Citizenships	#	%
Foreign Home Inst.	2	25.0%
US Home Inst.	6	75.0%
US Citizen & Perm. Residents	3	37.5%
Foreign Citizens	5	62.5%
US Citizens	3	37.5%
US Permanent Residents	0	0.0%



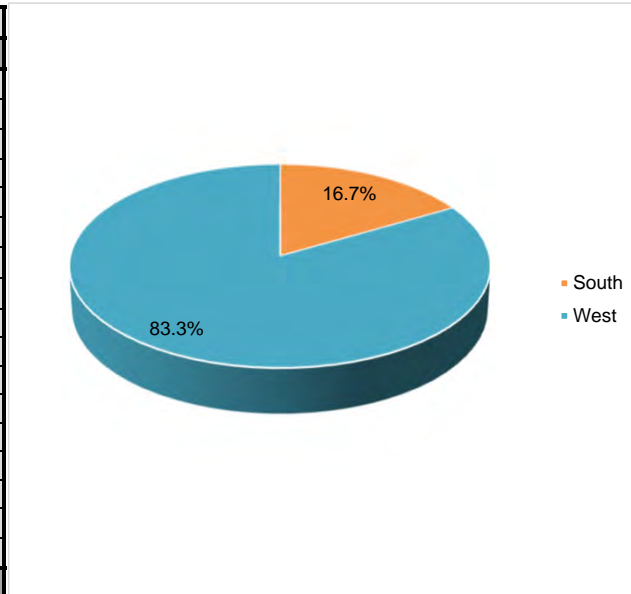
Year of Ph.D	#	%
2019	1	12.5%
2018	1	12.5%
2017	1	12.5%
2016	4	50.0%
2015	1	12.5%
2014	0	0.0%
Total # of Distinct Postdocs	8	100.0%



**Race/ethnicity selections are non-exclusive.
 **Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander.
 Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.*

2019-20 HDMP Postdoctoral Fellow Classified by States

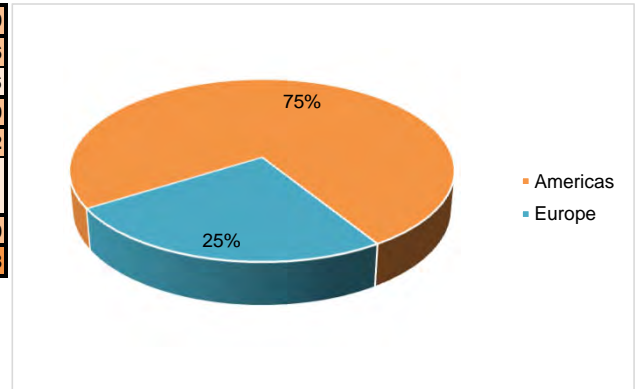
State	#	%	2010 Census
South	1	16.7%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	1	16.7%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	0	0.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	5	83.3%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	4	66.7%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	1	16.7%	2.2%
WY	0	0.0%	0.2%
Midwest	0	0.0%	21.7%
IA	0	0.0%	4.2%
IL	0	0.0%	2.1%
IN	0	0.0%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	0	0.0%	17.9%
CT	0	0.0%	1.2%
MA	0	0.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	6	100.0%	100.0%



*Regions based on US Census classification

2019-20 HDMP Postdoctoral Fellow Classified by Country

Africa			0
Americas			6
	North America	United States	6
Asia			0
Europe			2
	Western Europe	France	1
		Switzerland	1
Oceania			0
Grand Total			8



**Regions based on United Nations classification*

Holomorphic Differentials in Mathematics and Physics

Program Summary

Role	Distinct Members	%	US Citizens & Perm. Res.	%	Women	%	Minorities*	%
Organizers	6	8.8%	4	66.7%	1	16.7%	0	0.0%
Research Professors	12	17.6%	6	50.0%	2	16.7%	0	0.0%
Postdoctoral Fellows	8	11.8%	3	37.5%	2	25.0%	0	0.0%
PD/RM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Research Members	26	38.2%	14	53.8%	7	26.9%	1	7.1%
Program Associates	16	23.5%	3	18.8%	5	31.3%	0	0.0%
Total # of Distinct Members	68	100.0%	30	44.1%	17	25.0%	1	3.3%

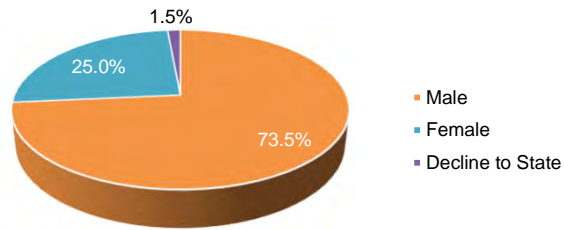
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.

Home Institution AMS Grouping

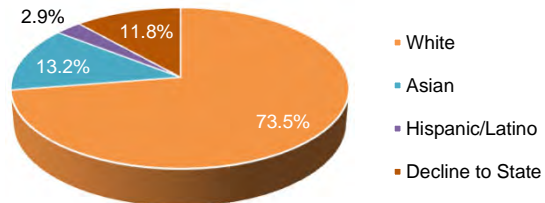
Role	US							Foreign	Total
	Private Large	Private Small	Public Large	Public Medium	Public Small	Group M or B	Non-Group		
Organizers	2	0	2	0	0	0	0	2	6
Research Professors	2	0	3	0	0	0	0	7	12
Postdoctoral Fellows	2	0	3	0	0	0	0	3	8
PD/RM	0	0	0	0	0	0	0	0	0
Research Members	3	0	5	2	1	1	0	14	26
Program Associates	3	0	5	0	0	0	0	8	16
Total	12	0	18	2	1	1	0	34	68
%	17.6%	0.0%	26.5%	2.9%	1.5%	1.5%	0.0%	50.0%	100.0%

2019–20 HDMP Program Members Demographic Summary

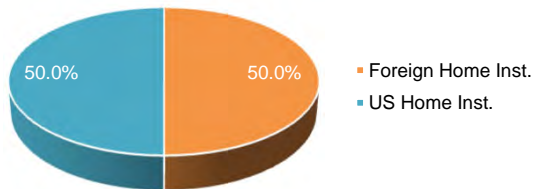
Gender	#	%
# of Distinct Members	68	100.0%
Male	50	73.5%
Female	17	25.0%
Decline to State	1	1.5%



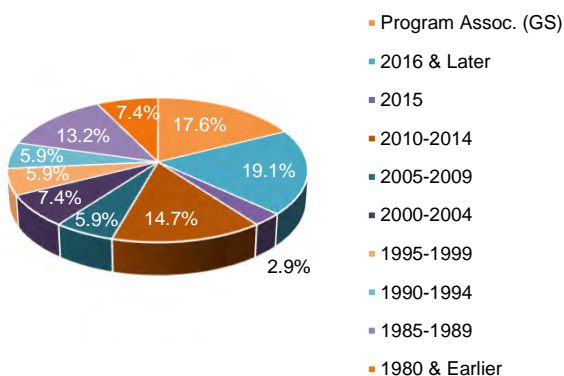
Race/Ethnicity*	#	%
White	50	73.5%
Asian	9	13.2%
Hispanic/Latino	2	2.9%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	8	11.8%
Unavailable Info.	0	0.0%
Minorities**	1	3.3%



Citizenships	#	%
Foreign Home Inst.	34	50.0%
US Home Inst.	34	50.0%
US Citizens & Perm. Residents	30	44.1%
Foreign Citizens	38	55.9%
US Citizens	29	42.6%
US Permanent Residents	1	1.5%



Year of Ph.D	#	%
Program Assoc. (GS)	12	17.6%
2016 & Later	13	19.1%
2015	2	2.9%
2010-2014	10	14.7%
2005-2009	4	5.9%
2000-2004	5	7.4%
1995-1999	4	5.9%
1990-1994	4	5.9%
1985-1989	9	13.2%
1981-1984	0	0.0%
1980 & Earlier	5	7.4%
Total # of Distinct Members	68	100.0%

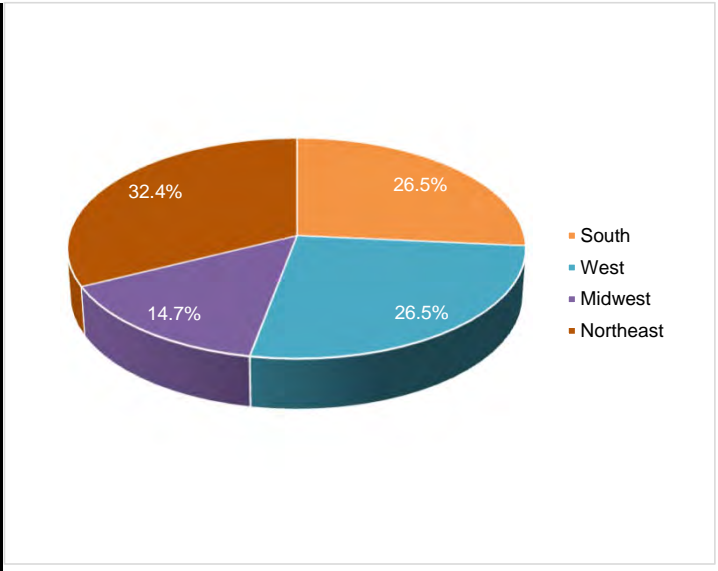


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

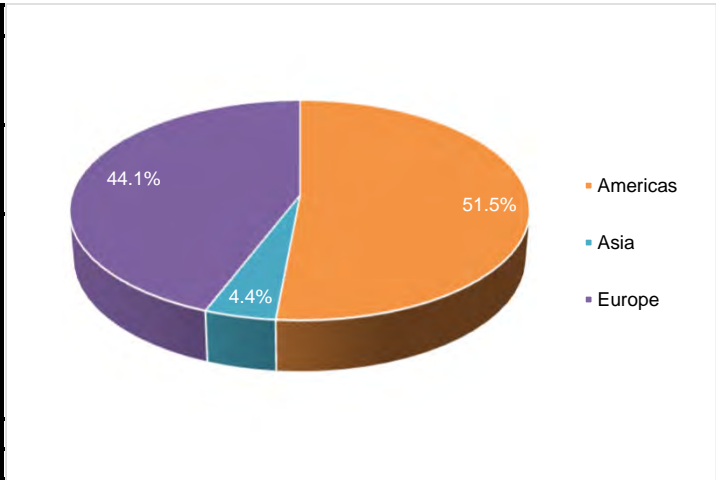
2019–20 HDMP Program Members Classified by State

State	#	%	2010 Census
South	9	26.5%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	1	2.9%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	5	14.7%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	3	8.8%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	9	26.5%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	5	14.7%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	4	11.8%	2.2%
WY	0	0.0%	0.2%
Midwest	5	14.7%	21.7%
IA	0	0.0%	4.2%
IL	4	11.8%	2.1%
IN	0	0.0%	1.0%
KS	0	0.0%	0.9%
MI	1	2.9%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	11	32.4%	17.9%
CT	5	14.7%	1.2%
MA	0	0.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	1	2.9%	2.8%
NY	5	14.7%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	34	100.0%	100.0%



2019–20 HDMP Program Members Classified by Countries

Africa		0
Americas		35
North America	Canada	1
	United States	34
Asia		3
Eastern Asia	China	2
South-central Asia	India	1
Europe		30
Northern Europe	United Kingdom	3
Southern Europe	Italy	1
	Spain	1
Western Europe	France	9
	Germany	12
	Switzerland	4
Oceania		0
Grand Total		68



**Regions based on United Nations classification*

Holomorphic Differentials in Mathematics and Physics

August 12, 2019 - December 13, 2019

Total Program Members:	68
Total Survey Respondants:	59
Response Rate:	87%

While at MSRI my research program was advanced in the following ways:

Q1. I learned new ideas/techniques which are applicable to my problems

Yes	58	98%
No	1	2%
Total Responses	59	

Q2. I had opportunities to present my work to new audiences

Yes	52	88%
No	7	12%
Total Responses	59	

Q3. I initiated research with new collaborators

Yes	47	80%
No	12	20%
Total Responses	59	

Q4. I initiated research in new areas

Yes	50	85%
No	9	15%
Total Responses	59	

Q5. My research was advanced in these other ways:

[Link to Qualitative Responses](#)

Q6. If your answer to any of the above set of questions was no, what opportunities should MSRI provide to mitigate this?

[Link to Qualitative Responses](#)

Q7. MSRI aims to provide a supportive environment for all program participants. How satisfied were you with this aspect of your experience?

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	6	11%
5 - Most Satisfying	51	89%
Total Responses (Exclusive of N/A)	57	100%

Q8. What suggestions would you have for MSRI to provide a more supportive environment?

[Link to Qualitative Responses](#)

MSRI Experience - For Postdoctoral Fellows: Please rate your level of satisfaction with...

Q9. Your assigned mentor:

1 - Least Satisfying	0	0%
2	0	0%
3	1	13%
4	2	25%
5 - Most Satisfying	5	63%
Total Responses (Exclusive of N/A)	8	100%

Q10. Your overall mentoring experience:

1 - Least Satisfying	0	0%
2	0	0%
3	2	25%
4	1	13%
5 - Most Satisfying	5	63%
Total Responses (Exclusive of N/A)	8	100%

Q11. The lunch meeting with the directorate:

1 - Least Satisfying	0	0%
2	0	0%
3	2	29%
4	1	14%
5 - Most Satisfying	4	57%
Total Responses (Exclusive of N/A)	7	100%

Q12. What suggestions do you have to improve the mentoring experience at MSRI?[Link to Qualitative Responses](#)**MSRI Experience - For Graduate Students****Q13. How much did the Graduate Student Seminar increase your ability to benefit from MSRI's other scientific activities?**

1 - Least Satisfying	0	0%
2	1	8%
3	4	33%
4	3	25%
5 - Most Satisfying	4	33%
Total Responses (Exclusive of N/A)	12	100%

MSRI Experience - Program Seminar: Please rate your level of satisfaction with...**Q14. Learning new ideas and techniques:**

1 - Least Satisfying	0	0%
2	1	2%
3	3	5%
4	15	26%
5 - Most Satisfying	38	67%
Total Responses (Exclusive of N/A)	57	100%

Q15. Forming new acquaintances and collaborations:

1 - Least Satisfying	1	2%
2	0	0%
3	7	13%
4	14	25%
5 - Most Satisfying	34	61%
Total Responses (Exclusive of N/A)	56	100%

Q16. The opportunity to present your own work:

1 - Least Satisfying	2	4%
2	1	2%
3	5	10%
4	11	22%
5 - Most Satisfying	30	61%
Total Responses (Exclusive of N/A)	49	100%

MSRI Experience - General Information**Q17. My office accommodations were**

1 - Least Satisfying	0	0%
2	1	2%
3	3	5%
4	12	20%
5 - Most Satisfying	43	73%
Total Responses (Exclusive of N/A)	59	100%

Q18. Professionally, my overall satisfaction with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	2	3%
4	9	15%
5 - Most Satisfying	48	81%
Total Responses (Exclusive of N/A)	59	100%

MSRI Experience - Feedback

Q19. Did you participate in any of the activities associated with the other MSRI programs or workshops? If so, which ones? Did you find them valuable?

[Link to Qualitative Responses](#)

Q20. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

[Link to Qualitative Responses](#)

Q21. What suggestions would you have for improvements at MSRI?

[Link to Qualitative Responses](#)

Q22. What suggestions would you have for future MSRI programs or workshops?

[Link to Qualitative Responses](#)

MSRI Experience - Computing Services and Facilities

Q23. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	7	16%
5 - Most Satisfying	37	84%
Total Responses (Exclusive of N/A)	44	100%

Q24. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	0	0%
3	4	8%
4	13	26%
5 - Most Satisfying	33	66%
Total Responses (Exclusive of N/A)	50	100%

Q25. How could we improve our computing services?

[Link to Qualitative Responses](#)

Q26. How could we improve our computing equipment and software environment?

[Link to Qualitative Responses](#)

MSRI Experience - Relocation Advisory Services: How would you rate the following services you received from MSRI?

Q27. Housing Assistance

1 - Least Satisfying	1	2%
2	0	0%
3	2	5%
4	5	12%
5 - Most Satisfying	35	81%
Total Responses (Exclusive of N/A)	43	100%

Q28. School and Childcare Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	11%
5 - Most Satisfying	8	89%
Total Responses (Exclusive of N/A)	9	100%

Q29. Visa Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	2	8%
4	1	4%
5 - Most Satisfying	22	88%
Total Responses (Exclusive of N/A)	25	100%

Q30. How could we improve our relocation advisory services?

[Link to Qualitative Responses](#)

MSRI Experience - Administrative Support Services

Q31. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	2	3%
4	7	12%
5 - Most Satisfying	49	84%
Total Responses (Exclusive of N/A)	58	100%

Q32. How could we improve our administrative services?

[Link to Qualitative Responses](#)

Q33. Your comments about MSRI:

[Link to Qualitative Responses](#)

Microlocal Analysis
August 12, 2019 to December 13, 2019
MSRI, Berkeley, CA
USA

Organizers:

Pierre Albin (University of Illinois at Urbana-Champaign)
Nalini Anantharaman (Université de Strasbourg)
Kiril Datchev (Purdue University)
Raluca Felea (Rochester Institute of Technology)
Colin Guillarmou (Université de Paris XI Paris-Sud)
Andras Vasy (Stanford University)

FINAL REPORT FOR THE MICROLOCAL ANALYSIS PROGRAM AT MSRI

P. ALBIN, N. ANANTHARAMAN, K. DATCHEV, R. FELEA, C. GUILLARMOU, A. VASY

1. INTRODUCTION

Microlocal, or phase space, analysis in its simplest form concerns itself with the study of functions or distributions on manifolds by means with which one can localize not only in the base manifold, but also conically in the fibers of its cotangent bundle. This corresponds to a description of not only where a distribution lies in, say, a Sobolev space locally, but in which (co)direction this happens. In the most basic setting of \mathbb{R}^n , it is closely related to the Fourier transform: one localizes in the base space \mathbb{R}_z^n , as well as in conic (i.e. dilation invariant) subsets of \mathbb{R}_ζ^n . This leads to a theory of pseudodifferential operators, which give an invariant and precise framework for such a microlocalization and give an important tool for studying problems such as partial differential equations and integral transforms. It is often important to have even more precise tools available: Fourier integral operators and their singular versions are extremely powerful tools in some inverse problems as in second microlocalization (microlocalization at a Lagrangian manifold).

These tools have proved their utility in a remarkably diverse set of directions. The 2019 MSRI program in microlocal analysis was organized around seven of these directions: geometric microlocal analysis, inverse problems, scattering theory and resonances, hyperbolic dynamical systems, quantum chaos and semiclassical measures, relativity and quantum field theory, and nonlinear applications. Among the main goals of the semester were to exhibit the impact of microlocal analysis on these topics, the impact of these topics on developing microlocal analysis, and emphasize the connections between them. Thus at the beginning of the semester efforts were made to introduce topics from microlocal analysis that are used in studying these topics and throughout the semester an ambitious seminar schedule presented the state of the art. At the end of the 2019 program we can report that the program was a great success. As discussed below, a lot of progress was made in all of these research directions during the program, many new collaborations were started, and cross-pollination between the various aspects of microlocal analysis will affect the field going forward.

2. RESEARCH DEVELOPMENTS

During the trimester, there were numerous collaborations and discussions between the members, postdocs, PhD students involved in the program, as well as with non-official visitors. One concrete proof of this was that finding a free blackboard to do math with a collaborator was even sometimes a bit difficult! We review some of the developments, in particular collaborations between members, noting that many of these works have been started and will probably be posted in the next months or year:

- **P. Albin** did complete the work *Compactification of semi-simple Lie groups* (now posted on arXiv) with R. Dimakis, **R. Melrose** and D. Vogan, about a geometric compactification of Lie groups. **P. Albin** also made progress with **J. Gell Redman** and **P. Piazza** a project about K-theory and the index of stratified spaces, and he also finished and posted a paper with **H. Quan** called *Sub-Riemannian limit of the differential form heat kernels of contact manifolds*.
- **N. Anantharaman** started a new collaboration with **V. Delecroix** (from the parallel program at MSRI) and L. Monk on the low eigenvalues of random hyperbolic surfaces, and she worked on her book project *Quantum ergodicity and delocalization of Schrödinger eigenfunctions*.
- **D. Baskin** started some new collaborations with **K. Datchev**, **H. Hezari** and **J. Marzuola** on inverse eigenvalue problems for singular radial potentials, and worked with **M. De Hoop** on some new estimates for interior impedance problems. He also started a project about resolvent approximation for Coulomb propagators with **J. Marzuola** and **K. Datchev**.
- **N. Burq** finished and posted his paper with C. Sun called *Time optimal observability for Grushin Schrödinger equation* about control theory. He gave a talk about it in the conference.
- **A. Degeratu** has started a project with **X. Zhu** and **M. Singer** about finding constant scalar curvature metrics on elliptic surfaces.
- **A. Deleporte** has worked on some projects on Bergman projection for degenerating metrics with **M. Hitrik** and J. Sjöstrand, and also considered the problem of understanding geodesics for the Mabuchi metric with **S. Zelditch** and P. Zhou.
- During his stay, **A. Drouot** finished and posted the paper *Microlocal analysis of the bulk edge correspondence* related to topological insulators.
- **S. Dyatlov** has worked with M. Cekic, B. Küster and **G. Paternain** on the order of Ruelle zeta function at zero for 5-dimensional contact Anosov flows (Cekic and Küster were participants at MSRI for the October conference). Another started project of Dyatlov during the trimester was with **M. Zworski** on spectral gaps for obstacle scattering.
- **R. Felea** has been collaborating with **A. Greenleaf** and C. Nolan on microlocal analysis of the bore hole inverse problem and started some work with M. de Hoop about the normal operator for the glancing and grazing rays, for inverse problems applications.
- **J. Galkowski** did some collaboration with **S. Zelditch** on obtaining lower bounds on curve restrictions in hyperbolic surfaces, he also spent some time working with **M. Zworski** which produced the preprint *Viscosity limits for 0th order pseudodifferential operators* posted on arXiv last december. This was also the topic of Zworski's talk in the October conference.
- **D. Grieser** has worked with **P. Albin** on a unified view of PDEs on noncompact and singular spaces.
- **C. Guillarmou** has been collaborating with **L. Tzou** on ray transforms, they posted the articles *Asymptotically Euclidean metrics without conjugate points are flat* with

M. Mazzucchelli and *X-ray transform in asymptotically conic spaces* with **M. Lassas**. He also finished and posted an article *Geodesic stretch, pressure metric and marked length spectrum rigidity* with **T. Lefeuvre** and G. Knieper, about the Burns-Katok conjecture.

- **D. Häfner** has been working with **M. Wrochna** on their project with C. Gerard about the Unruh state for the Dirac equation on the Kerr metric, which is related to general relativity questions.
- **M. Jezequel** has been developing with Y. Bonthonneau some analytic microlocal methods to study Analytic and Gevrey Anosov flows.
- **C. Kottke** has been developing with **R. Mazzeo** and F. Rochon some theory of quasi-fibered boundary pseudodifferential operators and worked on L^2 cohomology of quasi asymptotically conic metrics.
- **K. Krupchyk** finished and submitted a collaboration on inverse problems with G. Uhlmann called *Partial data inverse problems for semilinear elliptic equations with gradient nonlinearities*, she also worked with **M. Salo** on limiting Carleman weights for general operators.
- **J. Marzuola** finished and posted his paper *Edge-localized states on quantum graphs in the limit of large mass*.
- **F. Monard** finished his work on X-ray in inverse problems and posted the paper *Functional relations, sharp mapping properties and regularization of the X-ray transform on disks of constant curvature*. He also collaborated with **C. Guillarmou** on the structure of the set of boundary distances for simple metrics.
- **G. Paternain** has been finishing and posting the article *Resonant spaces for volume preserving Anosov flows* with M. Cekic (participant at the October conference) about order of resonance at $s = 0$ for Ruelle function. He also collaborated with **M. Salo** on obtaining sharp stability estimates for tensor tomography in non-positive curvature.
- **J. Rowlett** started a collaboration on the Dirichlet isospectral problem for trapezoids with **H. Hezari** and Z. Lu, and she finished the article *Crystallographic groups, strictly tessellating polytopes, and analytic eigenfunctions*, on which she gave a talk at the MSRI weekly seminar.
- **A. Sa Barreto** worked with Y. Wang on interactions of semi linear conformal waves and with **G. Uhlmann** on inverse scattering for the critical semilinear wave equation.
- **M. Salo** made some progress with **G. Uhlmann**, P. Stefanov and L Oksanen on the general theory of inverse problems for real principal type operators, putting many previously studied cases in a unified framework.
- **J. Shapiro** started some collaboration with **J. Galkowski** about getting semiclassical resolvent bounds for short range Hölder continuous potentials.
- **M. Singer** was working with **C. Kottke** on their project on Monopole Compactification and the Sen Conjecture, and he also studied the Nahm transform for Dirac monopoles.
- **M. Tacy** has been collaborating with **J. Rowlett** on the questions of restrictions of eigenfunctions to fractal subsets of \mathbb{R}^n

- **A. Uribe** has finished and posted his paper *Perturbations of the Landau Hamiltonian: Asymptotics of eigenvalue clusters*.
- **D. Tataru** has been collaborating with **J. Marzuola** and J. Metcalfe on the problem of large data quasilinear Schrodinger equations, and he posted the article *Low regularity solutions for 2d water waves* on arXiv about water-wave equations.
- **A. Vasy** and **P. Hintz** have been continuing their long time project on stability of Kerr metrics in relativity.
- **X. Zhu** was working with **R. Melrose** on the spectrum of metrics with multiple cusps, and she finished posted the article *Spectral properties of reducible conical metrics* with B. Xu.
- **S. Zelditch** and A. Strohmaier (speaker at the October conference) started a new project on semi-classical mass asymptotics on stationary space times, as a follow-up of their previous work in the Lorentzian setting.

3. ORGANIZATIONAL STRUCTURE

The program included three workshops described in the next section. In addition to these more intense periods of activity, there were regular seminars and working groups which met on a mostly weekly basis. The organizers made an effort to give an opportunity to all program members to give a talk in a seminar or during a workshop. This resulted in perhaps an unusually large number of lectures (still only about four per week, but this was perhaps the most common comment for improvement in the exit surveys), but had the positive effect of a more inclusive program which in addition gave opportunities to find common interests and start new collaborations.

The regular seminar slots were a double slot on Wednesday afternoons and a single slot on Thursday afternoons. However, due to the demand for available slots, we had many additional talks, mostly on Thursday mornings.

Since it was a key objective that all postdoctoral members be integrated into the program, there was no postdoc seminar, rather all postdocs gave a talk in a regular seminar, mostly in the early half of the program. There was, however, a separate graduate student seminar, described below, which was held on Monday afternoons.

In addition, we had two working groups. They first focused on spectral gaps, typically for resonances, led by Program Organizer Colin Guillarmou, and the second on singular spaces, led by Research Professor Michael Singer. These were more informal and interactive than the regular seminars (though the latter were also encouraged to facilitate active interactions between the speaker and the audience) in part due to the smaller number of participants and in part to the more relaxed setting of the boardroom.

On Thursdays a ‘What is?’ lunch was held, which gave an opportunity for program participants to ask both basic and far reaching questions. This was moderated by Research Professor Rafe Mazzeo, who designated an appropriate person to respond to the question on the spot – with additional discussions often following. This was a particularly important opportunity as there was a diversity of backgrounds among the microlocal analysts present,

from a more (now) classical perspective to the singular space approach; thus, typical questions included ‘What is the b-calculus?’ and ‘How do you choose which pseudodifferential algebra you work with?’.

During October and November there were occasions when dry weather and strong winds led the electric utility company PG&E to shut down power to parts of Berkeley and the surrounding area. MSRI was closed from Wednesday October 9 to Sunday October 13 and from Saturday October 26 to Monday October 28.

4. WORKSHOPS AND CONFERENCES

The following workshops took place during the semester, with each submitting its separate report:

- Connections for Women,
- Introductory Workshop,
- Recent Developments in Microlocal Analysis.

5. POSTDOCTORAL FELLOWS

The postdoctoral fellows played a crucial role in the program and there was a conscious effort to integrate them, for instance by giving them an opportunity to present their research early in the semester, but also the day-to-day organization of the main seminars was carried out by two postdocs, Tracey Balehowsky and Jacob Shapiro. Furthermore, our most senior postdoc Xuwen Zhu also gave lectures in the Connections for Women, the Introductory and Recent Developments workshops. The major complication was that one of the postdocs, Hui Zhu, could only arrive three months later than expected due to visa issues; nonetheless even he felt that the program was beneficial to him.

Each postdoc was assigned a mentor from among the research professors, including UC Berkeley faculty present. MSRI staff held an orientation for the mentors early in the program to make sure that the mentorship followed the expectations, such as regular meetings. The reports from the mentees confirm successful mentorship both via new collaborative projects, and also via help with preparation for job applications. For instance, postdoc Tracey Balehowsky started a project with mentor Katya Krupchyk, postdoc Katrina Morgan with mentor Gunther Uhlmann, and postdoc Jacob Shapiro with mentor Maciej Zworski.

The postdocs also enjoyed the opportunities to work with and learn from other program participants, and also from the numerous seminars and conferences, including those of the parallel program on holomorphic differentials. In particular, our postdoc Xuwen Zhu had strong existing connections with the parallel program from which she could benefit, while postdoc Alix Deleporte reported that his curiosity drove him to the introductory conference of the other program, where he could discover interesting connections between the two fields.

6. GRADUATE STUDENTS

In addition to the postdoctoral fellows, some ten graduate students, from institutions in the US and overseas, participated in the 2019 Microlocal Analysis program, becoming its integral and significant component over the course of the semester. The opportunity for advanced graduate students to be exposed to the rich and vibrant research atmosphere

at MSRI and to benefit from the remarkable variety of workshops and seminars in the program, while making progress on their thesis work, is truly invaluable and constitutes a unique experience, ideally preparing the students for the next stage of their scientific career. In exchange, the Microlocal Analysis program was greatly enhanced and indeed, invigorated by the presence of the graduate students, due to their enthusiasm, spontaneity, as well as bustling energy.

A Graduate Student Seminar, for the benefit of graduate students, was organized and met weekly, under the advisement of Research Member Julie Rowlett and Research Professor Michael Hitrik, throughout the semester. Only graduate students were allowed to participate in the seminar, with the exception of Rowlett and Hitrik. On September 9, 2019, the seminar kicked off with a talk, where the graduate students who were in residence at MSRI at the time, gave brief presentations of their research. Subsequently, by and large, the seminar was operating in the mode where the participants were giving full length, hour long research talks, typically followed by a lively period of questions and discussion. The idea behind this particular modus operandi of the seminar was also that this way, the students would be able to practice and gain experience giving this type of talks, which is such a crucial skill for an advanced graduate student. Following a decision made early on by the seminar participants, all the talks in the Graduate Student Seminar were recorded. This was a helpful tool, which gave students the opportunity to use the videos for their own talk-polishing purposes, watching them to see if there was anything that ought to be changed or improved in terms of how one gives talks.

All the talks in the Graduate Student Seminar were well attended by the students throughout the program. What follows below is the list of speakers in the seminar and the titles of the talks, along with the dates.

- Nikolaos Eptaminitakis (University of Washington), Hugo Federico (Orsay), Steven Flynn (UC Santa Cruz), Hadrian Quan (University of Illinois at Urbana-Champaign), Amir Vig (UC Irvine): Graduate students present their research (September 09, 2019)
- Amir Vig (UC Irvine): Wave invariants and inverse spectral theory (September 23, 2019)
- Malo Jézéquel (LPSM, Paris): Trace formulae for Anosov flows (September 30, 2019)
- Thibault Lefeuvre (Orsay): Geodesic stretch, pressure metric and the marked length spectrum rigidity conjecture (October 7, 2019)
- Hadrian Quan (University of Illinois at Urbana-Champaign): The Heat Kernel of a Contact Manifold in the Sub-Riemannian Limit (November 4, 2019)
- Nikolaos Eptaminitakis (University of Washington): Geodesic X-Ray Transform on Asymptotically Hyperbolic Manifolds (November 11, 2019)
- Steven Flynn (UC Santa Cruz): Noncommutative techniques for inverting the sub-Riemannian X-ray Transform on the Heisenberg Group (November 25, 2019)
- Joey Zou (Stanford): The Travel Time Tomography Inverse Problem for Transversely Isotropic Elastic Media (December 2, 2019)
- Francis White (UCLA): Weyl Symbols and Boundedness of Toeplitz Operators (December 9, 2019)

On September 16, 2019, the seminar was devoted to a panel discussion on applying for jobs. On October 21, 2019, following the program workshop “Recent developments in microlocal analysis”, there was a post-workshop discussion in the seminar.

7. DIVERSITY

Our program consisted of 62 members. Out of them, 13 were women: Nalini Anantharaman, Tracey Balehowsky, Tanya Christiansen, Anda Degeratu, Raluca Felea, Clotilde Fermanian, Katya Krupchyk, Katrina Morgan, Julie Rowlett, Mariel Saez Trumper, Melissa Tacy, Ting Zhou, and Xuwen Zhu. Out of the 62 members, 33 were US citizens or permanent residents, including 5 underrepresented minorities.

One of the exit surveys included the comment: “It was a pleasure to be in a mathematical environment with so many other women.”

8. SYNERGISTIC ACTIVITIES

Many program members gave mathematical presentations at U.S. institutions outside of MSRI during the semester. Some that we are aware of are:

- Pierre Albin: UC San Diego
- Dean Baskin: UC Berkeley
- Kiril Datchev: U Kentucky and U North Carolina
- Colin Guillarmou: Northwestern University
- Chris Kottke: UC Santa Cruz
- Thibault Lefeuvre: UC Berkeley
- Hadrian Quan: UC Santa Cruz
- Julie Rowlett: Purdue University
- Jacob Shapiro: UC Berkeley
- Jared Wunsch: UC Berkeley
- Allan Greenleaf: San Jose State
- Mikko Salo: UC Santa Cruz, UC Santa Barbara
- Gunther Uhlmann: San Jose State

One source of synergistic activity was the math department of UC Berkeley. The analysis and PDE seminar was well attended, and often presented, by members of the MSRI program as was the international Berkeley/Bonn/Paris Nord/Zurich seminar. The graduate course on several complex variables taught by program member Maciej Zworski was also very relevant.

Zworski and program organizer András Vasy organized “Microlocal analysis and spectral theory - a conference in honor of Richard Melrose” on the weekend after the program workshop, October 19-20. The conference was very well attended by members of the program and boasted an impressive list of speakers, including two Fields Medalists (Tao and Venkatesh).

A number of program participants led Berkeley Math Circle sessions: Chris Kottke, Jacob Shapiro, Daniel Grieser and Katrina Morgan. The organizers hope this helped inspire a new generation of mathematicians and scientists.

9. HIGHLIGHTS AND BREAKTHROUGHS

9.1. Highlights. Every Wednesday at 5:30pm, after two afternoon seminars, the program participants reconvened for beers and pizza in downtown Berkeley. An explicit aim of the outing, beyond just having fun and relaxing together, was to make sure there was a regular opportunity for younger researchers to interact with senior researchers in an informal setting.

There were also various hikes organized by research members, as well as musical activities. One of the postdoctoral members, Alix Deleporte, played with a local orchestra throughout the semester and kept members apprised of their concerts.

9.2. Breakthroughs. A common theme of the semester was the application of microlocal analysis to a wide range of problems from other areas of mathematics.

Ongoing efforts to apply microlocal analysis to the representation theory of noncompact Lie groups were advanced by the development of **a new approach to compactification of reductive Lie groups** in a paper of **Albin**, Dimakis, **Melrose**, and Vogan completed as part of the semester. This new, ‘hd’-compactification, of a Lie group is a manifold with corners to which the group operations have natural extensions (although necessarily no longer as group operations) and is shown in the paper to be essentially characterized by this property. The machinery of geometric microlocal analysis can then be applied to the compactification together with the left/right invariant vector fields to produce a pseudodifferential calculus. It is expected that this calculus will give new approaches to, and explanations of, objects in representation theory (e.g., through the spectral theory of the Casimir). Previous work of some of the authors, on the particular case of SL_2 , has shown that objects studied in representation theory such as Harish Chandra modules have natural formulations in geometric microlocal analysis.

Another direction of radical progress was for geometric inverse problems due to the works of Bonthonneau, **Guillarmou**, Knieper and **Lefeuvre**. These are results for Riemannian manifolds with Anosov geodesic flows on their (co)sphere bundle, such as manifolds with negative curvature, and concern the determination of the metric from the marked length spectrum, namely the knowledge of the lengths of closed geodesics, labelled by their free homotopy class. The new result of **Guillarmou**, Knieper and **Lefeuvre** extends the recent breakthroughs of the first and last author on such compact manifolds by showing that if two metrics are a priori close in a suitable Hölder sense and if their length spectrum is asymptotically the same (asymptotic in the sense of taking a sequence of free homotopy classes with lengths of the corresponding closed geodesics tending to infinity) then the metrics are isometric. On the other hand, the new result of Bonthonneau and **Lefeuvre** shows that on manifolds of negative curvature and real hyperbolic cusps, an (almost complete) analogue of the recent result of Guillarmou and Lefeuvre holds, namely if two metrics are a priori close in a suitable Hölder sense and if the length spectrum is the same then in fact the metrics are isometric — with the small proviso that the metrics must a priori lie in a codimension one submanifold of isometry classes for some technical reasons. These results are very impressive because they recover a complicated object, namely a Riemannian metric, from a very simple object, namely a sequence of lengths (with a marking), and are one of the greatest recent triumphs of microlocal analysis.

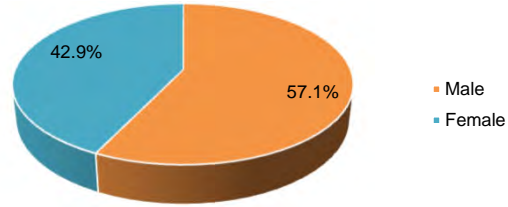
The organizers also believe that the foundations of some other breakthroughs have been laid at this very successful program, but of course only time will tell this!

Postdoc Pre/Post-MSRI Institution Group

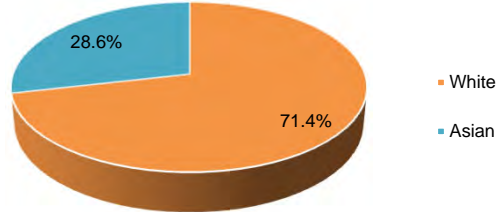
Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Institution Group	Post-MSRI Institution Name	Post-MSRI Institution Group
Balehowsky	Tracey	University of Helsinki	Foreign	University of Helsinki	Foreign
Deleporte	Alix	Université de Strasbourg	Foreign	Universität Zürich	Foreign
Gannot	Oran	Northwestern University	Math Private Large Group	Unknown	Unknown
Morgan	Katrina	Northwestern University	Math Private Large Group	Northwestern University	Math Private Large Group
Shapiro	Jacob	Australian National University	Foreign	Australian National University	Foreign
Zhu	Hui	Université de Paris XI	Foreign	University of Michigan	Math Public Large Group
Zhu	Xuwen	University of California, Berkeley	Math Public Large Group	Massachusetts Institute of Technology	Math Private Large Group

2019-20 MLA Postdoctoral Fellow Demographic Summary

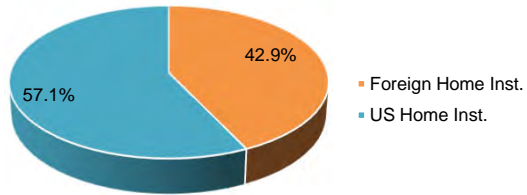
Gender	#	%
# of Distinct Members	7	100.0%
Male	4	57.1%
Female	3	42.9%
Decline to State	0	0.0%



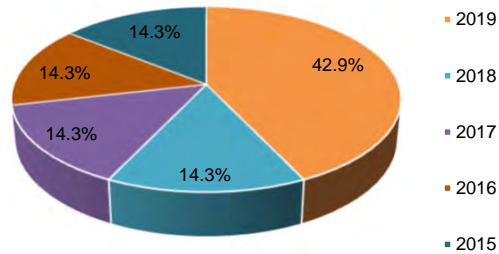
Race/Ethnicity*	#	%
White	5	71.4%
Asian	2	28.6%
Hispanic/Latino	0	0.0%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	0	0.0%
Unavailable Info.	0	0.0%
Minorities**	0	0.0%



Citizenships	#	%
Foreign Home Inst.	3	42.9%
US Home Inst.	4	57.1%
US Citizen & Perm. Residents	3	42.9%
Foreign Citizens	4	57.1%
US Citizens	3	42.9%
US Permanent Residents	0	0.0%



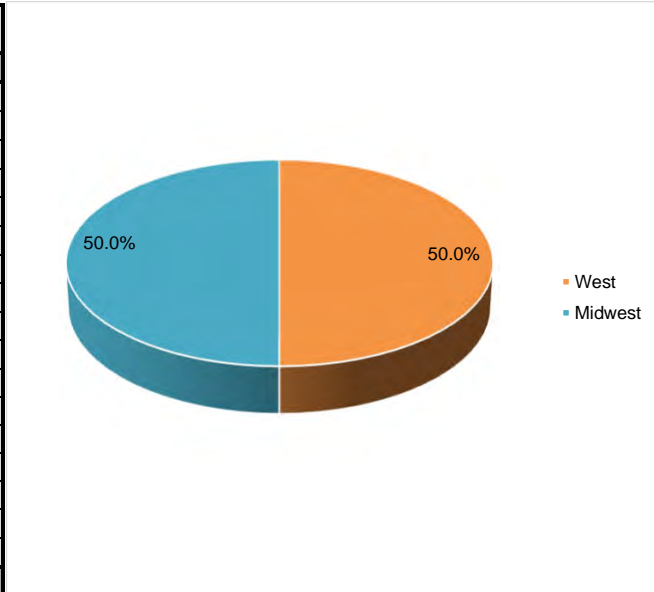
Year of Ph.D	#	%
2019	3	42.9%
2018	1	14.3%
2017	1	14.3%
2016	1	14.3%
2015	1	14.3%
2014	0	0.0%
Total # of Distinct Postdocs	7	100.0%



*Race/ethnicity selections are non-exclusive.
 **Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 MLA Postdoctoral Fellow Classified by States

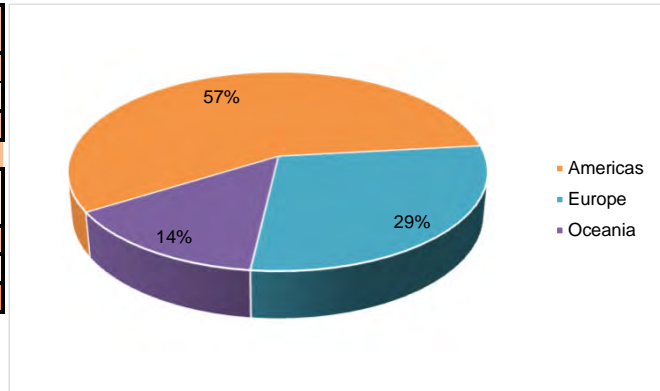
State	#	%	2010 Census
South	0	0.0%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	0	0.0%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	0	0.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	2	50.0%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	2	50.0%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	2	50.0%	21.7%
IA	0	0.0%	4.2%
IL	2	50.0%	2.1%
IN	0	0.0%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	0	0.0%	17.9%
CT	0	0.0%	1.2%
MA	0	0.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	4	100.0%	100.0%



*Regions based on US Census classification

2019-20 MLA Postdoctoral Fellow Classified by Country

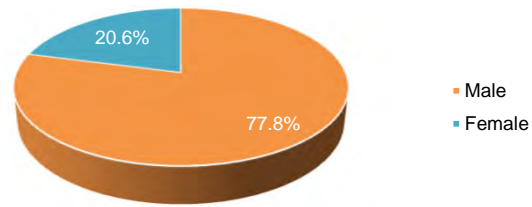
Africa	0
Americas	4
North America	United States
Asia	0
Europe	2
Northern Europe	Finland
Western Europe	France
Oceania	1
Australia and New Z	Australia
Grand Total	7



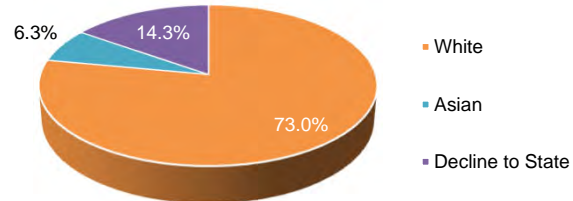
**Regions based on United Nations classification*

2019-20 MLA Program Members Demographic Summary

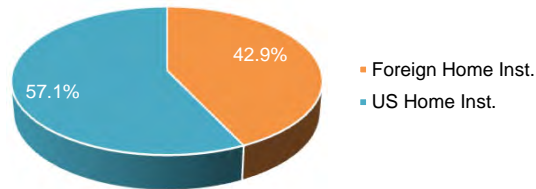
Gender	#	%
# of Distinct Members	63	100.0%
Male	49	77.8%
Female	13	20.6%
Decline to State	1	1.6%



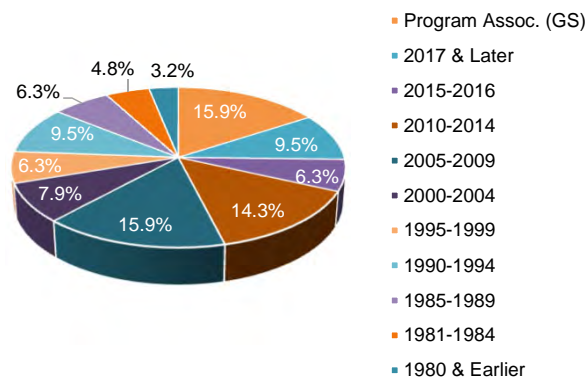
Race/Ethnicity*	#	%
White	46	73.0%
Asian	4	6.3%
Hispanic/Latino	8	12.7%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	1	1.6%
Decline to State	9	14.3%
Unavailable Info.	0	0.0%
Minorities**	5	15.2%



Citizenships	#	%
Foreign Home Inst.	27	42.9%
US Home Inst.	36	57.1%
US Citizens & Perm. Residents	33	52.4%
Foreign Citizens	30	47.6%
US Citizens	26	41.3%
US Permanent Residents	7	11.1%



Year of Ph.D	#	%
Program Assoc. (GS)	10	15.9%
2017 & Later	6	9.5%
2015-2016	4	6.3%
2010-2014	9	14.3%
2005-2009	10	15.9%
2000-2004	5	7.9%
1995-1999	4	6.3%
1990-1994	6	9.5%
1985-1989	4	6.3%
1981-1984	3	4.8%
1980 & Earlier	2	3.2%
Total # of Distinct Members	63	100.0%

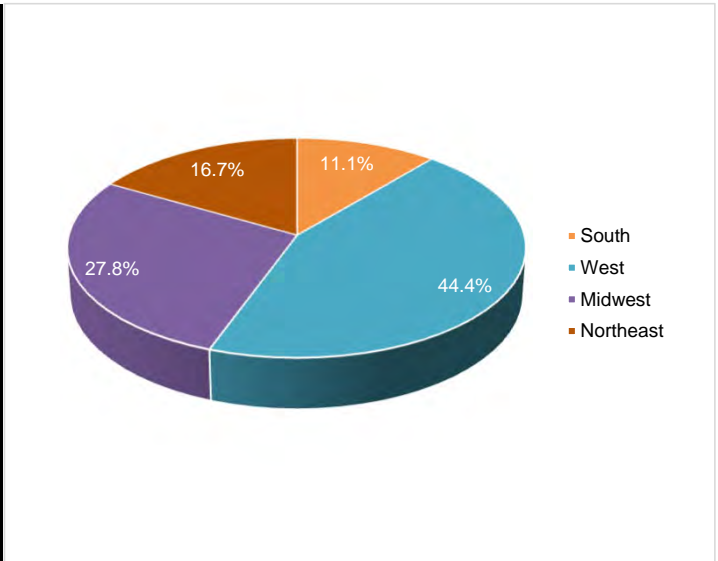


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 MLA Program Members Classified by State

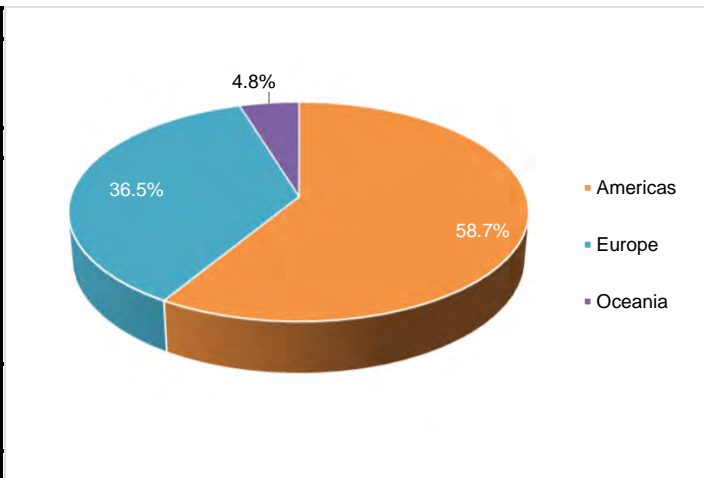
State	#	%	2010 Census
South	4	11.1%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	1	2.8%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	0	0.0%	1.9%
MS	0	0.0%	1.0%
NC	1	2.8%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	2	5.6%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	16	44.4%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	14	38.9%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	2	5.6%	2.2%
WY	0	0.0%	0.2%
Midwest	10	27.8%	21.7%
IA	0	0.0%	4.2%
IL	6	16.7%	2.1%
IN	2	5.6%	1.0%
KS	0	0.0%	0.9%
MI	1	2.8%	3.2%
MN	0	0.0%	1.7%
MO	1	2.8%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	6	16.7%	17.9%
CT	0	0.0%	1.2%
MA	3	8.3%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	3	8.3%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	36	100.0%	100.0%



*Regions based on US Census classification

2019-20 MLA Program Members Classified by Countries

Africa			0
Americas			37
	North America	United States	36
	South America	Chile	1
Asia			0
Europe			23
	Northern Europe	Finland	2
		Sweden	1
		United Kingdom	3
	Southern Europe	Italy	1
	Western Europe	France	13
		Germany	3
Oceania			3
	Australia & New Zealand	Australia	2
		New Zealand	1
Grand Total			63



**Regions based on United Nations classification*

Microlocal Analysis
August 12, 2019 - December 13, 2019

Total Program Members:	63
Total Survey Respondants:	59
Response Rate:	94%

While at MSRI my research program was advanced in the following ways:

Q1. I learned new ideas/techniques which are applicable to my problems

Yes	55	93%
No	4	7%
Total Responses	59	

Q2. I had opportunities to present my work to new audiences

Yes	58	98%
No	1	2%
Total Responses	59	

Q3. I initiated research with new collaborators

Yes	44	75%
No	15	25%
Total Responses	59	

Q4. I initiated research in new areas

Yes	43	73%
No	16	27%
Total Responses	59	

Q5. My research was advanced in these other ways:

[Link to Qualitative Responses](#)

Q6. If your answer to any of the above set of questions was no, what opportunities should MSRI provide to mitigate this?

[Link to Qualitative Responses](#)

Q7. MSRI aims to provide a supportive environment for all program participants. How satisfied were you with this aspect of your experience?

1 - Least Satisfying	0	0%
2	0	0%
3	2	3%
4	9	15%
5 - Most Satisfying	48	81%
Total Responses (Exclusive of N/A)	59	100%

Q8. What suggestions would you have for MSRI to provide a more supportive environment?

[Link to Qualitative Responses](#)

MSRI Experience - For Postdoctoral Fellows: Please rate your level of satisfaction with...

Q9. Your assigned mentor:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	6	100%
Total Responses (Exclusive of N/A)	6	100%

Q10. Your overall mentoring experience:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	17%
5 - Most Satisfying	5	83%
Total Responses (Exclusive of N/A)	6	100%

Q11. The lunch meeting with the directorate:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	17%
5 - Most Satisfying	5	83%
Total Responses (Exclusive of N/A)	6	100%

Q12. What suggestions do you have to improve the mentoring experience at MSRI?

[Link to Qualitative Responses](#)

MSRI Experience - For Graduate Students

Q13. How much did the Graduate Student Seminar increase your ability to benefit from MSRI's other scientific activities?

1 - Least Satisfying	0	0%
2	1	14%
3	2	29%
4	1	14%
5 - Most Satisfying	3	43%
Total Responses (Exclusive of N/A)	7	100%

MSRI Experience - Program Seminar: Please rate your level of satisfaction with...

Q14. Learning new ideas and techniques:

1 - Least Satisfying	0	0%
2	1	2%
3	6	10%
4	12	20%
5 - Most Satisfying	40	68%
Total Responses (Exclusive of N/A)	59	100%

Q15. Forming new acquaintances and collaborations:

1 - Least Satisfying	0	0%
2	0	0%
3	7	12%
4	18	31%
5 - Most Satisfying	34	58%
Total Responses (Exclusive of N/A)	59	100%

Q16. The opportunity to present your own work:

1 - Least Satisfying	0	0%
2	0	0%
3	3	5%
4	8	14%
5 - Most Satisfying	45	80%
Total Responses (Exclusive of N/A)	56	100%

MSRI Experience - General Information

Q17. My office accommodations were

1 - Least Satisfying	0	0%
2	0	0%
3	7	12%
4	16	27%
5 - Most Satisfying	36	61%
Total Responses (Exclusive of N/A)	59	100%

Q18. Professionally, my overall satisfaction with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	1	2%
4	10	17%
5 - Most Satisfying	48	81%
Total Responses (Exclusive of N/A)	59	100%

MSRI Experience - Feedback

Q19. Did you participate in any of the activities associated with the other MSRI programs or workshops? If so, which ones? Did you find them valuable?

[Link to Qualitative Responses](#)

Q20. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

[Link to Qualitative Responses](#)

Q21. What suggestions would you have for improvements at MSRI?

[Link to Qualitative Responses](#)

Q22. What suggestions would you have for future MSRI programs or workshops?

[Link to Qualitative Responses](#)

MSRI Experience - Computing Services and Facilities

Q23. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	1	2%
2	0	0%
3	1	2%
4	5	11%
5 - Most Satisfying	40	85%
Total Responses (Exclusive of N/A)	47	100%

Q24. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	2	4%
3	4	8%
4	10	20%
5 - Most Satisfying	33	67%
Total Responses (Exclusive of N/A)	49	100%

Q25. How could we improve our computing services?

[Link to Qualitative Responses](#)

Q26. How could we improve our computing equipment and software environment?

[Link to Qualitative Responses](#)

MSRI Experience - Relocation Advisory Services: How would you rate the following services you received from MSRI?

Q27. Housing Assistance

1 - Least Satisfying	1	2%
2	1	2%
3	4	9%
4	8	19%
5 - Most Satisfying	29	67%
Total Responses (Exclusive of N/A)	43	100%

Q28. School and Childcare Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	1	14%
4	0	0%
5 - Most Satisfying	6	86%
Total Responses (Exclusive of N/A)	7	100%

Q29. Visa Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	1	5%
4	2	10%
5 - Most Satisfying	17	85%
Total Responses (Exclusive of N/A)	20	100%

Q30. How could we improve our relocation advisory services?

[Link to Qualitative Responses](#)

MSRI Experience - Administrative Support Services

Q31. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	1	2%
4	11	20%
5 - Most Satisfying	44	79%
Total Responses (Exclusive of N/A)	56	100%

Q32. How could we improve our administrative services?

[Link to Qualitative Responses](#)

Q33. Your comments about MSRI:

[Link to Qualitative Responses](#)

Quantum Symmetries
January 21, 2020 to May 29, 2020
MSRI, Berkeley, CA
USA

Organizers:

Vaughan Jones (Vanderbilt University)
Scott Morrison (Australian National University)
Victor Ostrik (University of Oregon)
Emily Peters (Loyola University)
Eric Rowell (Texas A & M University)
Noah Snyder (Indiana University)
Chelsea Walton (University of Illinois at Urbana-Champaign)

Quantum Symmetry at MSRI: Program Report for Spring 2020

V. Jones, S. Morrison, V. Ostrik, E. Peters, E. Rowell, N. Snyder, C. Walton

1. Introduction

Symmetry, as formalized by group theory, is ubiquitous across mathematics and science. However, in some quantum settings, the notion of a group is no longer enough to capture all symmetries. Important motivating examples include Galois-like symmetries of von Neumann algebras, anyonic particles in condensed matter physics, and deformations of universal enveloping algebras. The goal of this semester was to study quantum symmetry broadly, bringing together researchers working on several closely related streams:

- Tensor categories, fusion categories, and module categories;
- Braided, symmetric, and modular tensor categories;
- Hopf algebras, and their actions on rings;
- Subfactors, planar algebras, and analytic properties of quantum symmetries;
- Quantum invariants of knots and 3-manifolds, and local topological field theories;
- Conformal nets, vertex algebras, and their representation theories; and
- Topological order and topological quantum computation.

2. Research Developments

The research development during the Quantum Symmetries program was remarkable both in the number of projects initiated prior to the shutdown and the interrupted and potential projects put on hold. While many members reported finishing papers begun elsewhere, often with other members as co-authors, a significant number of projects' development was slowed or paused by the crisis of the covid-19 pandemic. Some major projects were reported to have been completed during the 2.5 months of virtual programming, whereas certain subjects suffered as some researchers never arrived or had their visits drastically shortened. Operator algebras suffered disproportionately from this as Popa, Kawahigashi, Wenzl and Bischoff were scheduled to arrive after mid-March 2020. Connections to physics were also muted--at least three physics-focused talks in the workshop that were hastily moved online did not receive the deserved follow-up. Interdisciplinary and "branching out" research were notable casualties to the shutdown of in-person activities.

On the other hand, the program presented a unique opportunity for established research directions to advance very quickly. Only 3 of 40 respondents reported having neither written papers nor initiated research in new areas or with new collaborators. In all 3 cases the respondents missed a major proportion of their residence in Berkeley. Among the papers that were nearly finished, posted, submitted or accepted for publication we note the following examples. Quantum Symmetries members are marked with *.

- **Invertible braided tensor categories** by Adrien Brochier, David Jordan*, Pavel Safronov, Noah Snyder*. In this paper the invertibility of finite braided tensor categories is shown to be equivalent to a non-degeneracy condition, generalizing the semisimple case of modular tensor categories. This provides non-semisimple TQFTs and opens several new lines of research in this key direction.
- **Algebraic structures in group-theoretical fusion categories** by Yiby Morales, Monique Müller, Julia Plavnik*, Ana Ros Camacho, Angela Tabiri and Chelsea Walton*. The authors construct explicit Morita equivalence class representatives of indecomposable, separable algebras in group-theoretical fusion categories, generalizing results of Ostrik and Natale in the pointed case.
- **Transverse stratifications and their combinatorial classification** by Christoph Dorn and Christopher Douglas*. This is a very long paper related to the first author's PhD thesis, using topological notions (stratified manifolds) to provide combinatorial models for higher categories.
- **New incompressible symmetric tensor categories in positive characteristic** by Dave Benson, Pavel Etingof*, Victor Ostrik*. The authors construct a large family of incompressible abelian symmetric tensor categories in characteristic p , which gives a potential fiber functor target for generalizing Deligne's theorem for symmetric tensor categories in characteristic 0.
- **Semi-infinite highest weight categories** by Jonathan Brundan, Catharina Stroppel*. The authors develop axiomatics of highest weight categories and quasi-hereditary algebras in order to incorporate two semi-infinite situations which are in Ringel duality with each other.
- **Higher central charges and Witt groups** by Siu-Hung Ng*, Eric C. Rowell*, Yilong Wang, Qing Zhang*. The authors prove a long-standing conjecture about the Witt inequivalence of an infinite family of modular categories associated with quantum groups of Lie type B, that are square roots of the Witt class of the Ising categories.
- **Braided zesting and its applications** by Colleen Delaney*, César Galindo, Julia Plavnik*, Eric C. Rowell*, Qing Zhang*. A new method of constructing braided tensor categories from a given category is presented, with an accompanying obstruction theory.
- **Autoequivalences of the modular tensor categories of type A, B, C, and G** by Cain Edie-Michell* appendix by Terry Gannon*. A classification of the autoequivalences of modular categories obtained from quantum groups of Lie types A,B,C and G at roots of unity is presented.
- **Tambara-Yamagami, loop groups, bundles and KK-theory** by David Evans* and Terry Gannon*. This paper is part of a sequence interpreting quantities of conformal

field theories K-theoretically; here the authors focus on geometric constructions. They give reconstruction theorems for the doubles of Tambara-Yamagami categories.

- **Gapped boundary theories in three dimensions** by Dan Freed* and Constantin Teleman. The authors characterize which topological 3-dimensional Chern-Simons theories admit nonzero boundary theories.
- **Bergman space zero sets, von Neumann algebras, ordered groups and cusp forms** by Vaughan Jones*. Connections between number theoretical notions (cusp forms) and von Neumann algebras associated with the modular group are explored.
- **Invariants of 4-manifolds from Khovanov-Rozansky link homology** by Scott Morrison*, Kevin Walker* and Paul Wedrich*. The authors use Khovanov-Rozansky $gl(N)$ link homology to define invariants of oriented smooth 4-manifolds, as skein modules constructed from certain 4-categories with well-behaved duals.
- **Braided Picard groups and graded extensions of braided tensor categories** by Alexei Davydov* and Dmitri Nikshych*. The authors classify various types of graded extensions of a finite braided tensor category B in terms of its 2-categorical Picard groups.
- **Homotopy liftings and Hochschild cohomology of some twisted tensor products** by Pablo Ocal*, Tolulope Oke and Sarah Witherspoon*. Homotopy lifting techniques are employed to provide new proofs of isomorphisms between the Hochschild cohomology of a tensor product of algebras and graded tensor products of Hochschild cohomology algebras, as a Gerstenhaber algebras.
- **Tangle addition and the knots-quivers correspondence** by Marko Stosic, Paul Wedrich*. The authors prove that the generating functions for the one row/column colored HOMFLY-PT invariants of arborescent links are specializations of the generating functions of the motivic Donaldson-Thomas invariants of appropriate quivers that we naturally associate with these links.
- **Cohomology rings of finite-dimensional pointed Hopf algebras over abelian groups, I & II** by Nicolás Andruskiewitsch*, Iván Angiono, Julia Pevtsova*, Sarah Witherspoon*. The authors show that the cohomology ring of a finite-dimensional complex pointed Hopf algebra with an abelian group of group-like elements is finitely generated.

3. Organization Structure: Pre-Pandemic

Our standard weekly seminar calendar was:

- Monday 2-3pm, a colloquium-style talk held jointly with the Higher Categories program;
- Wednesday 11:30am-12:30am and 1:30pm-2:30pm a Postdoc and Newcomers seminar with 30-minute research talks so that new members could introduce their work;
- Thursday 2-3pm (and 3:30-4:30pm if needed) Quantum Symmetries seminar;
- Friday 2-3pm (Graduate student seminar).

Some other activities that were on a less regular schedule include the following.

- A working seminar on blob homology and factorization homology, joint with the Higher Categories program.
- A questions box where people could submit math questions anonymously and then we'd open the box to answer the questions over lunch.
- A series of 5-minute talks, joint with the Higher Categories program, for rapid introductions at the beginning of the program.

4. Organizational Structure: Post-Pandemic

The pandemic changed our scheduling dramatically in mid-March. The MSRI building shut down just as the two mid-semester conferences were happening, so we quickly switched to a new schedule after those conferences ended in late March.

- Daily research talks via Zoom at 10am (in order to include participants located in Europe) organized jointly with the HC program. Tuesdays were typically HC talks, Wednesdays were talks of joint interest, and Thursday were typically QS-focused talks.
- An MSRI slack channel for discussions.
- Daily virtual "tea" via whereby immediately after the daily talks, for more informal mathematical discussions usually related to the talk.
- Professional development meetings run by Chelsea Walton and Marcy Robertson for postdocs and graduate students on Wednesday afternoons.

5. Workshops and Conferences

The following workshops took place during the program. Individual reports for each workshop are attached.

- Connections for Women
- Introductory Workshop
- Tensor categories and topological quantum field theories (online)

6. Postdoctoral Fellows

The postdoctoral participants of the program were very strong and played a vital role in the program success. The postdocs initiated and participated in a great many mathematical conversations occurring in the corridors of the MSRI building. The postdoc seminar met 13 times plus 3 additional meetings after switching to virtual. The first 4 times the format was two half hour talks; after this it was more traditional one hour talks or one and a half hour for online talks. The talks were of high quality and were very well attended by members at all levels with typical attendance 20-30 people.

Each postdoc was assigned a mentor from more senior participants of the program. Typically the mentors met weekly with their mentees. The exit surveys indicate that the mentoring program was successful both at the level of helping the postdocs with professional issues and at the level of mathematical research. Several postdoctoral participants mention research projects initiated from their conversations with the mentors. For example Cain Edie-Michell reports that he and his mentor Terry Gannon were essentially working on the same problem and now they have joined forces in the project devoted to classification of E_7 type module categories over type A fusion categories.

Almost all postdoctoral participants were able to complete some of their projects during their stay at MSRI. This includes for example a big paper by Cain Edie-Michell on auto equivalences of modular tensor categories, new strong results by Cris Negron on finite generation of cohomology of some finite tensor categories, a paper on applications of number theory to fusion categories by Andrew Schopieray, four papers by Paul Wedrich with very interesting contributions to categorified representation theory, two papers by Qing Zhang with collaborators on modular tensor categories including a solution of a long-standing problem on the Witt group. All the postdoctoral participants reported a number of projects initiated during their stay at MSRI.

The online part of the program worked great for some postdoctoral participants and did not work at all for some others. However all of them agree that this situation was handled the best given the circumstances.

7. Graduate Students

Along with the group of postdoctoral fellows above, there were six graduate students who participated in the QS program as Program Associates. They were:

- Patrick Chu (Indiana University)
 - PhD advisor and QS program mentor: QS Program Organizer Noah Snyder;
- Arun Debray (University of Texas, Austin)
 - PhD advisor and QS program mentor: QS Clay Research Professor Dan Freed;
- Genta Latifi (University of Zurich)
 - PhD advisor and QS program mentor: QS Research Professor Anna Beliakova;
- Pablo Ocal (Texas A&M University)
 - PhD advisor: QS program Simons Visiting Professor Sarah Witherspoon
 - QS program mentor: Witherspoon and QS Program Organizer Chelsea Walton;
- Dominic Weiller (Australian National University)
 - PhD advisor and QS program mentor: QS Program Organizer Scott Morrison;
- Harshit Yadav (University of Illinois at Urbana-Champaign)
 - PhD advisor and QS program mentor: QS Program Organizer Chelsea Walton.

The Program Associates participated actively in both formal and informal discussions through the QS program, including their participation in the Higher Categories & QS Graduate Student Seminar (during the in-person program).

The seminar presentations given by the Program Associates are listed below:

- **5-minute talks:**
 - February 19, 2020: Chu, Latifi, Ocal, Weiller
 - February 21, 2020: Debray
- Higher Categories & QS Graduate Student Seminar:
 - February 28, 2020: **About lines and circles: the bordism category in dimension 1 & Frobenius algebras and embedding surfaces** by Jan Steinebrunner and Dominic Weiller
- Online Seminar (virtual programming):
 - April 1, 2020: **Topological Phases and Topological Field Theories** by Arun Debray
 - April 22, 2020: **Structures of Hochschild cohomology** by Pablo Ocal.

8. Professional Development via Zoom

Marcy Robertson (Higher Categories Program Organizer) and Chelsea Walton (QS Program Organizer) provided a series of professional development sessions solely for the Postdoctoral Researchers and Program Associates to not only provide information, but to also “check-in” with the junior members of the HC and QS programs during the initial period of virtual programming. Each 50 - 75 minute session was typically 70% lecture by either MR or CW, and 30% friendly discussion. Hand-outs and other resources were always provided by MR or CW. The topics were:

- March 18, 2020: **Collaboration**, by CW;
- March 25, 2020: **How to design a project**, by MR;
- April 1, 2020: **How to apply to postdocs in the US, Europe, and Australia**, MR and CW;
- April 8, 2020: **On the permanent position job process (applications)**, by MR;
- April 15, 2020: **On the permanent position job process II (interviews)**, by CW.

One comment in the exit-survey stated: “The professional development seminar hosted by Chelsea Walton and Marcy Robertson also helped me learn about several list-servs for researchers in category theory and algebraic topology that I didn't know about but now keep me in the loop about job opportunities and conferences.”

The meetings were very well received by the participants and provided a sense of community during the various stay-at-home orders enacted at the time.

9. Inclusivity

Our efforts at inclusivity began with the organizing committee, which included 2 women, 1 African-American, and one organizer at a Group M teaching-focused institution. We

encouraged broad participation from underrepresented groups before the program began, using MSRI's "Networking Tree" to identify and invite potential participants, building on existing infrastructure in the field like the WINART conferences and Walton's Women in Noncommutative Algebra and Representation Theory list.

With the assistance of the MSRI HR committee, we offered 1 out of 4 named Research Professorship positions and 1 out of 6 ordinary research professorships to women. For the RM positions, 5 out of 21 slots were offered to women. None of the RP or RM came from domestic underrepresented racial groups. The RMs did include two Latin Americans (a region often underrepresented at international events), and increased collaboration with Latin America has been an important trend in our field, with recent conferences in Oaxaca, Bogota, and Cordoba. There were two women and one African-American among the seven postdocs. Due to covid-19 disruptions, many invited members were unable to participate in person-- the numbers gathered on actual participants were that 28.7% of organizers, 18.2% of Research Professors, 30.8% of Research Members, 28.6% of postdocs, and 16.7% of research associates were women, and there were two African-American participants out of 44.

An area we were quite successful in was attracting women participants to the workshops. Speakers for CfW were 6/8 women (with an additional six early-career women giving shorter poster presentations, and a six woman panel discussing collaboration), speakers for the Introductory Workshop were 5/11 women, and speakers for the topical workshop were 3/16 women. In addition, there were a large number of women attending the conferences, one speaker pointed out that some of the Intro Workshop talks had the largest proportion of women she'd ever seen at a large conference (over 40% of a roughly hundred person audience). Finally, 20% of seminar speakers were women.

One senior woman participant wrote: "Relative to what I am used to, the program had a high proportion of women. For me this provided an opportunity to informally talk to women in slightly different life stages than I am about people's approaches to various challenges specific to combining motherhood with an academic career. I found this exchange helpful and reassuring."

10. Synergistic Activities

Many program members gave mathematical presentations at U.S. institutions outside of MSRI during the program. This includes:

- Ian Agol: UC Berkeley;
- Anna Beliakova: UC Davis;
- Pavel Etingof: UC Davis;
- Daniel S. Freed: UC Berkeley;
- Scott Morrison: UC Berkeley;

- Pablo Ocal led a Berkeley Math Circle session for middle and high school students and their teachers;
- Victor Ostrik: UC Berkeley, UC Riverside, UC Davis;
- Noah Snyder: UC Davis;
- Catharina Stroppel: UC Berkeley;
- Siddharth Venkatesh: UC Davis; and
- Paul Wedrich: UC Davis, UMass Amherst, Stanford, UC Berkeley, George Washington University.

11. Highlights and Breakthroughs

One of the most unexpected breakthroughs was the rapid development of the online workshop, falling exactly on the week that the mandatory shelter-in-place order in Berkeley. The remarkably smooth transition of seminars to a virtual format was exemplary. The members and participants' devotion to the subject was impressive: attendance at the virtual workshops and seminars was consistently quite high (70+ during the workshops, and 25-35 for the seminars). The virtual talks drew a very broad audience, with many attendees not officially affiliated with the program. This broad reach of the workshops and seminars partially mitigated the significant loss of members that could not attend synchronously due to family responsibilities, time zone inconvenience, connectivity issues and other difficulties.

Another highlight was that the two concurrent workshops were very well-matched and the talks in both areas drew significant cross-over participation. Many members reported that the virtual talks were particularly helpful in this way, as the breadth of the audience necessitated less technical talks. Topological quantum field theory is a particularly compelling source of cross-over breakthroughs.

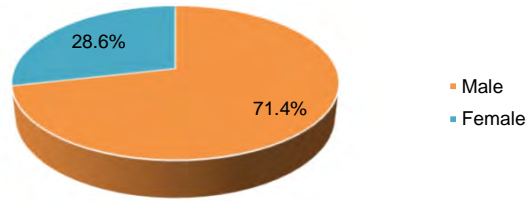
For one specific example of a breakthrough we can point to the proof of the fairly long-standing conjecture that the torsion subgroup of the Witt group is of infinite rank. Many members reported that the talks and interactions (both virtual and in-person) set the stage for potential breakthroughs, improving their understanding of the topics and fostering new ideas. This was particularly evident in the younger participants' responses, with postdocs and program associates reported a bright outlook. As many members finished long papers while at MSRI one could count this significant research output collectively as a breakthrough, although perhaps it is more accurate to compare this to incrementally moving a mountain than to characterize it as a breakthrough.

Postdoc Pre/Post-MSRI Institution Group

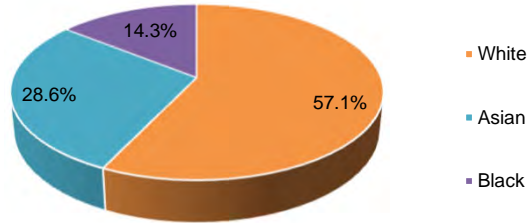
Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Institution Group	Post-MSRI Institution Name	Post-MSRI Institution Group
Delaney	Colleen	Indiana University, Bloomington	Public Large	Indiana University, Bloomington	Public Large
Edie-Michell	Cain	Vanderbilt University	Private Small	Vanderbilt University	Private Small
Negron	Cris	University of North Carolina	Public Medium	University of North Carolina	Public Medium
Schopieray	Andrew	University of New South Wales	Foreign	University of Alberta	Foreign
Venkatesh	Siddharth	University of California, Los Angeles	Public Large	University of California, Los Angeles	Public Large
Wedrich	Paul	Max Planck Institute for Mathematics	Foreign	Max Planck Institute for Mathematics	Foreign
Zhang	Qing	Texas A & M University	Public Large	Purdue University	Public Large

2019-20 QS Postdoctoral Fellow Demographic Summary

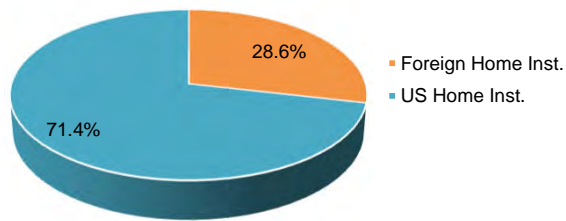
Gender	#	%
# of Distinct Members	7	100.0%
Male	5	71.4%
Female	2	28.6%
Decline to State	0	0.0%



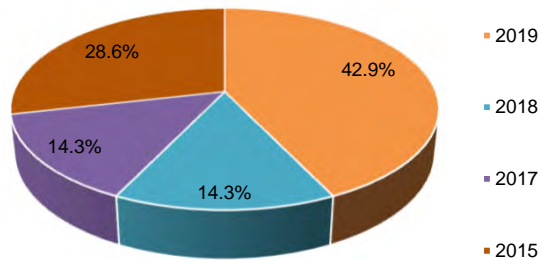
Race/Ethnicity*	#	%
White	4	57.1%
Asian	2	28.6%
Hispanic/Latino	0	0.0%
Black	1	14.3%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	0	0.0%
Unavailable Info.	0	0.0%
Minorities**	1	33.3%



Citizenships	#	%
Foreign Home Inst.	2	28.6%
US Home Inst.	5	71.4%
US Citizen & Perm. Residents	3	42.9%
Foreign Citizens	4	57.1%
US Citizens	3	42.9%
US Permanent Residents	0	0.0%



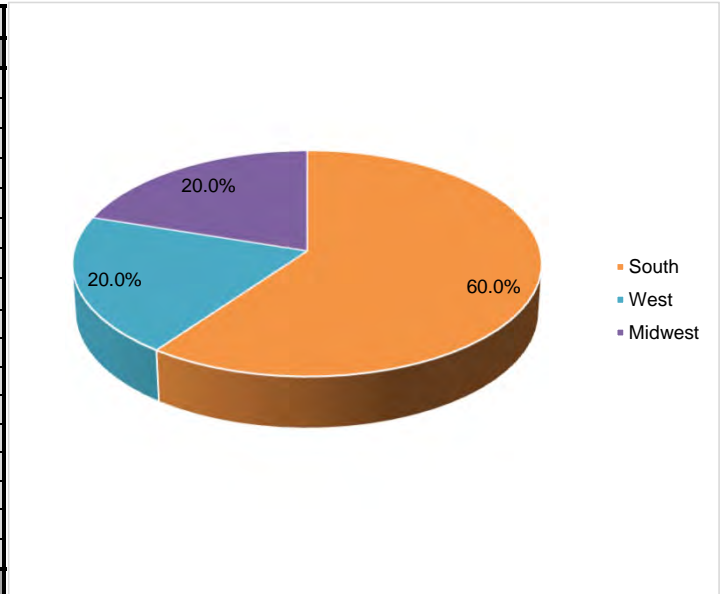
Year of Ph.D	#	%
2019	3	42.9%
2018	1	14.3%
2017	1	14.3%
2016	0	0.0%
2015	2	28.6%
2014	0	0.0%
Total # of Distinct Postdocs	7	100.0%



*Race/ethnicity selections are non-exclusive.
 **Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander.
 Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 QS Postdoctoral Fellow Classified by States

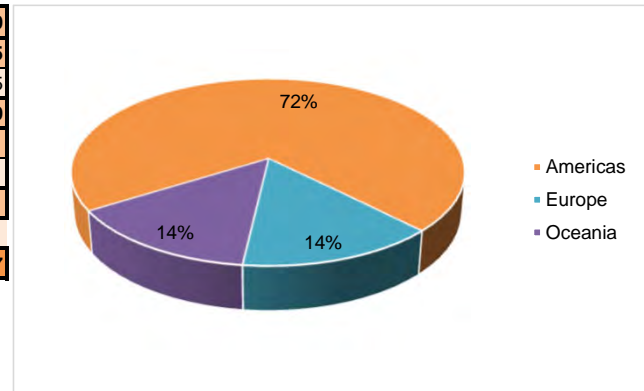
State	#	%	2010 Census
South	3	60.0%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	0	0.0%	1.9%
MS	0	0.0%	1.0%
NC	1	20.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	1	20.0%	2.1%
TX	1	20.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	1	20.0%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	1	20.0%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	1	20.0%	21.7%
IA	0	0.0%	4.2%
IL	0	0.0%	2.1%
IN	1	20.0%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	0	0.0%	17.9%
CT	0	0.0%	1.2%
MA	0	0.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	5	100.0%	100.0%



*Regions based on US Census classification

2019-20 QS Postdoctoral Fellow Classified by Country

Africa			0
Americas			5
	North America	United States	5
Asia			0
Europe			1
	Western Europe	Germany	1
Oceania			1
	Australia and New Zealand	Australia	1
Grand Total			7



**Regions based on United Nations classification*

Quantum Symmetries

Program Summary

Role	Distinct Members	%	US Citizens & Perm. Res.	%	Women	%	Minorities*	%
Organizers	7	15.9%	6	85.7%	2	28.6%	1	16.7%
Research Professors	11	25.0%	7	63.6%	2	18.2%	0	0.0%
Postdoctoral Fellows	7	15.9%	3	42.9%	2	28.6%	1	33.3%
PD/RM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Research Members	13	29.5%	9	69.2%	4	30.8%	1	11.1%
Program Associates	6	13.6%	2	33.3%	1	16.7%	0	0.0%
Total # of Distinct Members	44	100.0%	27	61.4%	11	25.0%	3	11.1%

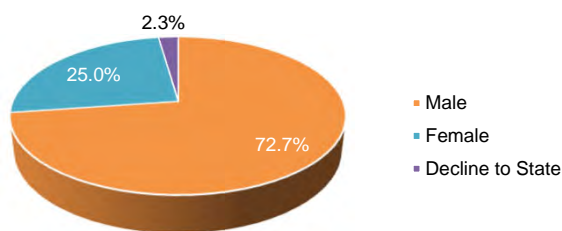
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.

Home Institution AMS Grouping

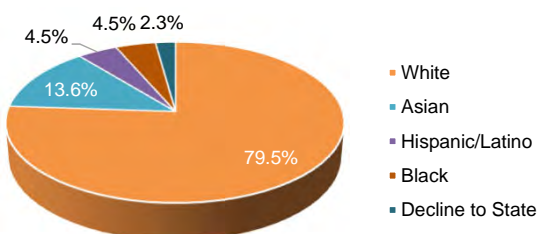
Role	US							Foreign	Total
	Private Large	Private Small	Public Large	Public Medium	Public Small	Group M or B	Non-Group		
Organizers	0	1	3	1	0	1	0	1	7
Research Professors	0	1	4	1	0	0	1	4	11
Postdoctoral Fellows	0	1	3	1	0	0	0	2	7
PD/RM	0	0	0	0	0	0	0	0	0
Research Members	1	0	3	0	2	0	0	7	13
Program Associates	0	0	4	0	0	0	0	2	6
Total	1	3	17	3	2	1	1	16	44
%	2.3%	6.8%	38.6%	6.8%	4.5%	2.3%	2.3%	36.4%	100.0%

2019-20 QS Program Members Demographic Summary

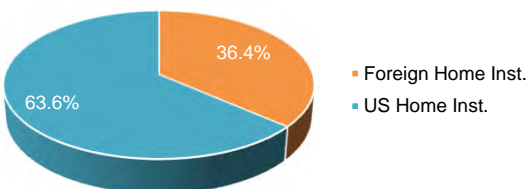
Gender	#	%
# of Distinct Members	44	100.0%
Male	32	72.7%
Female	11	25.0%
Decline to State	1	2.3%



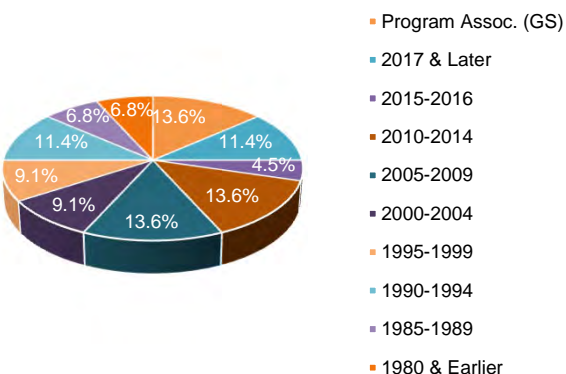
Race/Ethnicity*	#	%
White	35	79.5%
Asian	6	13.6%
Hispanic/Latino	2	4.5%
Black	2	4.5%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	1	2.3%
Unavailable Info.	0	0.0%
Minorities**	3	11.1%



Citizenships	#	%
Foreign Home Inst.	16	36.4%
US Home Inst.	28	63.6%
US Citizens & Perm. Residents	27	61.4%
Foreign Citizens	17	38.6%
US Citizens	22	50.0%
US Permanent Residents	5	11.4%



Year of Ph.D	#	%
Program Assoc. (GS)	6	13.6%
2017 & Later	5	11.4%
2015-2016	2	4.5%
2010-2014	6	13.6%
2005-2009	6	13.6%
2000-2004	4	9.1%
1995-1999	4	9.1%
1990-1994	5	11.4%
1985-1989	3	6.8%
1981-1984	0	0.0%
1980 & Earlier	3	6.8%
Total # of Distinct Members	44	100.0%

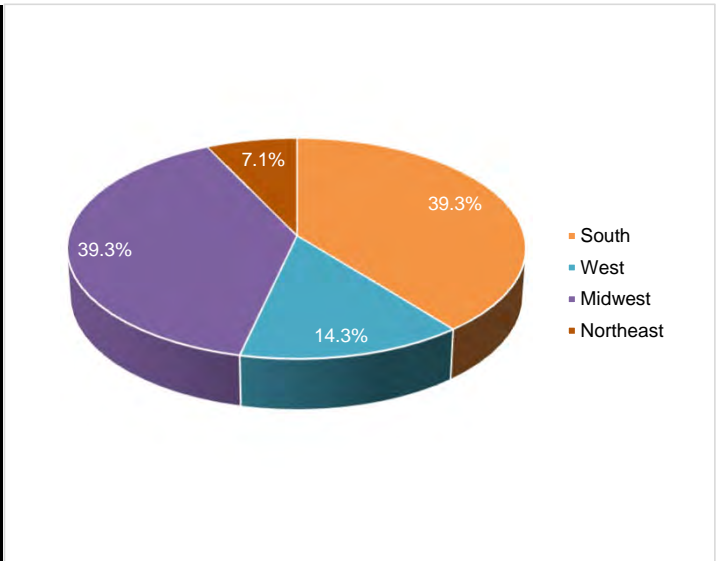


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 QS Program Members Classified by State

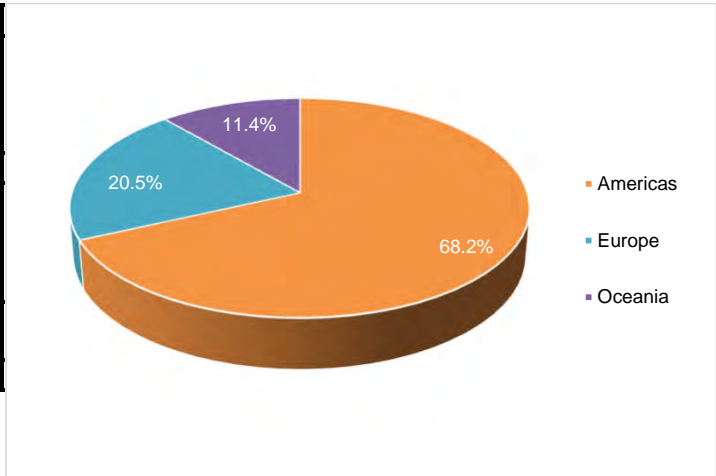
State	#	%	2010 Census
South	11	39.3%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	1	3.6%	1.5%
MD	0	0.0%	1.9%
MS	0	0.0%	1.0%
NC	1	3.6%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	3	10.7%	2.1%
TX	6	21.4%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	4	14.3%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	3	10.7%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	1	3.6%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	11	39.3%	21.7%
IA	1	3.6%	4.2%
IL	3	10.7%	2.1%
IN	4	14.3%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	1	3.6%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	2	7.1%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	2	7.1%	17.9%
CT	0	0.0%	1.2%
MA	1	3.6%	0.4%
ME	0	0.0%	2.1%
NH	1	3.6%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	28	100.0%	100.0%



*Regions based on US Census classification

2019-20 QS Program Members Classified by Countries

Africa			0
Americas			30
	North America	Canada	1
		United States	28
	South America	Argentina	1
Asia			0
Europe			9
	Northern Europe	United Kingdom	4
	Western Europe	Germany	3
		Switzerland	2
Oceania			5
	Australia & New Zealand	Australia	5
Grand Total			44



**Regions based on United Nations classification*

Quantum Symmetries
January 21, 2020 - May 29, 2020

Total Program Members:	44
Total Survey Respondants:	39
Response Rate:	89%

While at MSRI my research program was advanced in the following ways:

Q1. I learned new ideas/techniques which are applicable to my problems

Yes	39	100%
No	0	0%
Total Responses	39	

Q2. I had opportunities to present my work to new audiences

Yes	34	87%
No	5	13%
Total Responses	39	

Q3. I initiated research with new collaborators

Yes	30	77%
No	9	23%
Total Responses	39	

Q4. I initiated research in new areas

Yes	24	62%
No	15	38%
Total Responses	39	

Q5. My research was advanced in these other ways:

[Link to Qualitative Responses](#)

Q6. If your answer to any of the above set of questions was no, what opportunities should MSRI provide to mitigate this?

[Link to Qualitative Responses](#)

Q7. MSRI aims to provide a supportive environment for all program participants. How satisfied were you with this aspect of your experience?

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	6	16%
5 - Most Satisfying	32	84%
Total Responses (Exclusive of N/A)	38	100%

Q8. What suggestions would you have for MSRI to provide a more supportive environment?

[Link to Qualitative Responses](#)

MSRI Experience - For Postdoctoral Fellows: Please rate your level of satisfaction with...

Q9. Your assigned mentor:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	7	100%
Total Responses (Exclusive of N/A)	7	100%

Q10. Your overall mentoring experience:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	3	43%
5 - Most Satisfying	4	57%
Total Responses (Exclusive of N/A)	7	100%

Q11. The lunch meeting with the directorate:

1 - Least Satisfying	0	0%
2	0	0%
3	3	43%
4	1	14%
5 - Most Satisfying	3	43%
Total Responses (Exclusive of N/A)	7	100%

Q12. What suggestions do you have to improve the mentoring experience at MSRI?[Link to Qualitative Responses](#)**MSRI Experience - For Graduate Students****Q13. How much did the Graduate Student Seminar increase your ability to benefit from MSRI's other scientific activities?**

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	4	100%
5 - Most Satisfying	0	0%
Total Responses (Exclusive of N/A)	4	100%

MSRI Experience - Program Seminar: Please rate your level of satisfaction with...**Q14. Learning new ideas and techniques:**

1 - Least Satisfying	1	3%
2	0	0%
3	2	5%
4	10	26%
5 - Most Satisfying	26	67%
Total Responses (Exclusive of N/A)	39	100%

Q15. Forming new acquaintances and collaborations:

1 - Least Satisfying	0	0%
2	1	3%
3	7	19%
4	7	19%
5 - Most Satisfying	21	58%
Total Responses (Exclusive of N/A)	36	100%

Q16. The opportunity to present your own work:

1 - Least Satisfying	0	0%
2	0	0%
3	2	6%
4	8	24%
5 - Most Satisfying	24	71%
Total Responses (Exclusive of N/A)	34	100%

MSRI Experience - General Information**Q17. My office accommodations were**

1 - Least Satisfying	0	0%
2	0	0%
3	1	3%
4	6	16%
5 - Most Satisfying	31	82%
Total Responses (Exclusive of N/A)	38	100%

Q18. Professionally, my overall satisfaction with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	6	15%
5 - Most Satisfying	33	85%
Total Responses (Exclusive of N/A)	39	100%

MSRI Experience - Feedback

Q19. Did you participate in any of the activities associated with the other MSRI programs or workshops? If so, which ones? Did you find them valuable?

[Link to Qualitative Responses](#)

Q20. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

[Link to Qualitative Responses](#)

Q21. What suggestions would you have for improvements at MSRI?

[Link to Qualitative Responses](#)

Q22. What suggestions would you have for future MSRI programs or workshops?

[Link to Qualitative Responses](#)

MSRI Experience - Computing Services and Facilities

Q23. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	3%
5 - Most Satisfying	31	97%
Total Responses (Exclusive of N/A)	32	100%

Q24. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	3	10%
5 - Most Satisfying	27	90%
Total Responses (Exclusive of N/A)	30	100%

Q25. How could we improve our computing services?

[Link to Qualitative Responses](#)

Q26. How could we improve our computing equipment and software environment?

[Link to Qualitative Responses](#)

MSRI Experience - Relocation Advisory Services: How would you rate the following services you received from MSRI?

Q27. Housing Assistance

1 - Least Satisfying	0	0%
2	1	3%
3	0	0%
4	2	7%
5 - Most Satisfying	27	90%
Total Responses (Exclusive of N/A)	30	100%

Q28. School and Childcare Assistance

1 - Least Satisfying	0	0%
2	1	11%
3	1	11%
4	3	33%
5 - Most Satisfying	4	44%
Total Responses (Exclusive of N/A)	9	100%

Q29. Visa Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	8	100%
Total Responses (Exclusive of N/A)	8	100%

Q30. How could we improve our relocation advisory services?

[Link to Qualitative Responses](#)

MSRI Experience - Administrative Support Services

Q31. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	5	13%
5 - Most Satisfying	34	87%
Total Responses (Exclusive of N/A)	39	100%

Q32. How could we improve our administrative services?

[Link to Qualitative Responses](#)

Q33. Your comments about MSRI:

[Link to Qualitative Responses](#)

Higher Categories and Categorification

January 21, 2020 to May 29, 2020
MSRI, Berkeley, CA
USA

Organizers:

David Ayala (Montana State University)
Clark Barwick (University of Edinburgh)
David Nadler (University of California, Berkeley)
Emily Riehl (Johns Hopkins University)
Marcy Robertson (University of Melbourne)
Peter Teichner (Max-Planck Institut für Mathematik)
Dominic Verity (Macquarie University)

HIGHER CATEGORIES AND CATEGORIFICATION

FINAL REPORT

DAVID AYALA, CLARK BARWICK, DAVID NADLER, EMILY RIEHL, MARCY ROBERTSON,
PETER TEICHNER, AND DOMINIC VERITY

1. INTRODUCTION

The Higher Categories and Categorification program at MSRI sought to connect “end-users” who offer a vision to use higher categorical technology in mathematical physics, representation theory, differential topology, and homotopy theory, to the “engineers” who are actively developing higher categorical technologies.

Though many of the ideas in higher category theory find their origins in homotopy theory, the subject today interacts with a broad spectrum of areas of mathematical research. Unforeseen descent, or local-to-global formulas, for familiar objects can be articulated in terms of higher invertible morphisms. Compatible associative deformations of a sequence of maps of spaces, or derived schemes, can putatively be represented by higher categories, as Koszul duality for E_n -algebras suggests. Higher categories offer unforeseen characterizing universal properties for familiar constructions such as K-theory. Manifold theory is natively connected to higher category theory and adjunction data, a connection that is most famously articulated by the recently proven Cobordism Hypothesis.

In parallel, the idea of “categorification” is playing an increasing role in algebraic geometry, representation theory, mathematical physics, and manifold theory, and higher categorical structures also appear in the very foundations of mathematics in the form of univalent foundations and homotopy type theory. A central mission of this semester was to mitigate the exorbitantly high “cost of admission” for mathematicians in other areas of research who aim to apply higher categorical technology and to create opportunities for potent collaborations between mathematicians from these different fields and experts from within higher category theory. We also sought to build bridges to the complementary Quantum Symmetries Program, built around the fulcrum of the jointly-appointed members (or members who were formally affiliated with just one program, but had applied to both). Exit surveys confirmed a high level of cross-program engagement, resulting in several collaborations and at least one paper.

2. RESEARCH DEVELOPMENTS

The scope of the research that took place during the program was very broad, with topics including topological quantum field theory, $(\infty, 2)$ -categories, (∞, n) -categories, cobordism categories, n -fold categories, operads in low dimensional topology, quantum algebra, stratified homotopy theory, deformation theory (both quantized and not), L_∞ -algebras, type theory, cubical sets, Hodge theory, and the Langlands program.

Our members reported the following research outputs during the program:

Submitted papers.

- “Comical sets: a cubical model for (∞, n) -categories” by Tim Campion, Chris Kapulkin, Yuki Maehara, a research member and two program associates. The paper introduces a new model for the theory of (∞, n) -categories (including the case $n = \infty$) in the category of marked cubical

sets with connections, which is similar in flavor to complicial sets. The main advantage of this model is a simple construction of the Gray tensor product, which is simultaneously associative and biclosed.

- “On lax transformations, adjunctions, and monads in $(\infty, 2)$ -categories” by Rune Haugseng, presented to the $(\infty, 2)$ -categories working group
- “2-limits and 2-terminal objects are too different” by tsil clingman and Lyne Moser, a program associate and unofficial graduate student affiliate
- “Integral representation theorems for DQ-modules” by D. Gepner, F. Petit
- “On equivariant topological modular forms” by D. Gepner and L. Meier, a research professor and the partner of a research member, who visited early in the semester
- “Computational tools for twisted topological Hochschild homology of equivariant spectra” by Katharine Adamyk, Teena Gerhardt, Kathryn Hess, Inbar Klang, Hana Jia Kong
- “Affine Demazure crystals for nonsymmetric Macdonald polynomials” by Sami Assaf, Nicolle Gonzalez
- “On Khovanov homology and related invariants” by Radmilla Sazdanovic, Melissa Zhang, Carmen Caprau, Adam Lowrance, Christine Lee, Nicolle Gonzalez
- “The Duskin nerve of Joyal’s cell category Θ_2 ” by Viktoriya Ozornova and Martina Rovelli
- “Fundamental pushouts of n -complicial sets” by Viktoriya Ozornova and Martina Rovelli, part of a continuation of a long-term project of understanding the models of (∞, n) -categories given by variants of complicial sets. This should be in particular a step towards the comparison of complicial models to other models.
- “The classifying space of the one-dimensional bordism category and a cobordism model for TC of spaces” by Jan Steinebrunner
- “Galois symmetries of knot spaces” by Pedro Boavida de Brito, Geoffroy Horel, a research member and a visitor from the early weeks of the program
- “Cubical models of $(\infty, 1)$ -categories by Brandon Doherty, Zachery Lindsey, Chris Kapulkin, Christian Sattler
- “Minimal models for graphs-related operadic algebras” by M. Batanin, M. Markl, J. Obradovic
- “Permutads via operadic categories and the hidden associahedron” by M. Markl
- “Which homotopy algebras come from transfer?” by M. Markl and C. Rogers, which is described in more detail in the highlights section below.
- “A taxonomy of twists of supersymmetric Yang–Mills theory” by Chris Elliott, Pavel Safronov and Brian Williams
- “Corks Involutions and Heegaard Floer homology” by Irving Dai, Matthew Hedden, Abhishek Mallick
- “Factorization algebras and abelian CS/WZW-type correspondences” by Owen Gwilliam, Eugene Rabinovich and Brian Williams
- “Homotopical algebra via filtered L_∞ -algebras: obstructions and transfer” by C. Rogers

Papers in progress.

- “Decoupling in Higher Dimensions” by Luciana Basualdo Bonatto
- “A weak operad of normlized cacti” by L. Banotto, S. Chettih, A. Linton, S. Raynor, M. Robertson, N. Wahl
- “Duality in the Relative Langlands Program” D. Ben-Zvi, Yiannis Sakellaridis, Akshay Venkatesh
- “a Chevalley criterion for fibrations of 2-categories” by Alexander Campbell
- “Bi-initial objects and bi-representations are not so different” by tsil clingman and Lyne Moser, a program associate and unofficial graduate student affiliate
- “the K-theory of singular characteristic zero rings” by Gabriel Angelini-Knoll, Vignleik Angeltveit, Martin Speirs, Teena Gerhardt

- “Real topological Hochschild homology and Witt vectors for Hermitian Mackey functors” by Teena Gerhardt, Gabriel Angelini-Knoll, Michael Hill
- “Topological coHochschild homology and the homology of free loop spaces” Anna Marie Bohmann, Teena Gerhardt, Brooke Shipley, a team that includes a research professor and a member who was supposed to have visited in May
- “An analogue of Hodge theory for Sullivan forms on simplices and cubes” by Ezra Getzler
- “Cocartesian fibrations for higher Lie groupoids” by Ezra Getzler
- “On rectification and enrichment of infinity properads” by Hongyi Chu, Philip Hackney
- “étale descent for linear n -categories” by David Gepner, Rune Haugseng
- “Free algebras through Day convolution by” Hongyi Chu, Rune Haugseng
- “the AKSZ construction in derived algebraic geometry as an extended TQFT” by Damien Calaque, Rune Haugseng, Claudia Scheimbauer
- “Knot Floer homology and relative adjunction inequalities” by Matthew Hedden, Katherine Raoux
- “Comical sets II: homotopy coherent nerve” by Chris Kapulkin, Yuki Maehara, a research member and a program associate
- “Constraints in the BV formalism: six-dimensional supersymmetry and its twists” by Ingmar Saberi and Brian Williams
- “Bicategorical Reconstruction ” by Nick Gurski and D. Yetter
- “Weakly ω -categorified models of algebraic theories” by Phillip Bressie and David Yetter
- “wheeled props and circuit algebras” by Z. Dancso, I. Halacheva, M. Robertson
- “Stratified Tannaka duality” by Clark Barwick, Aaron Mazel-Gee, Peter Haine, et al.
- “Tensor 2-categories of Hall modules” by M. Penney, a postdoc
- “A 3-categorical perspective on G-crossed braided categories” by David Penneys, David Reutter, Corey Jones
- “ A type theory for strictly unital weak infinity-categories” by Eric Finster, David Reutter, Jamie Vicary
- “A Waldhausen construction for symmetric monoidal categories and topological K-theory” by Viktoriya Ozornova, Martina Rovelli, and Claudia Scheimbauer, two research members and a postdoctoral fellow
- “a Stratified approach to nil sheaves” by Peter Heine, Clark Barwick, Tomer Schlank
- “Invertible field theories are SKK-manifold invariants” by Matthias Kreck, Stephan Stolz, Peter Teichner
- “The 1-dimensional cobordism hypothesis” by David Ayala, John Francis
- “Stratified non-commutative geometry” by David Ayala, Aaron Mazel-Gee, Nick Rozenblyum
- “Some computations in genuine equivariant $C_p^n - \mathbb{Z}$ -modules” by David Ayala, Aaron Mazel-Gee, Nick Rozenblyum
- “Complete filtered L_∞ -algebras and their homotopy theory” Chris Rogers (benefitting significantly from informal discussions with other members, most notably Martin Markl)

Work in progress.

- According to Dyckerhoff and Kapranov, each simplicial set determines a non-symmetric colored cooperad in Set , which we show can be dualized (under an appropriate finiteness condition) to give an operad in vector spaces. Muriel Livernet and Philip Hackney explores how the geometry of the original simplicial set influences the algebras over the resultant operad, following ideas from Drummond-Cole and Hackney on the one hand, and exploring examples of Livernet and Ronco on the other hand.
- Aaron Mazel-Gee, Grigory Kondyrev, Jay Shah, a research member, a postdoctoral fellow, and a program associate report work in progress on the cobordism hypothesis for recollements that

characterizes dualizable objects in a symmetric monoidal recollement, in terms of projection formulas. Using this (and the cobordism hypothesis in dimension 1), they give a cobordism-style description of the stratified ∞ -category that corepresents dualizable objects in symmetric monoidal recollements.

- Philip Hackney and Martina Rovelli report work in progress that gives a sufficient condition for left-transferring Quillen model structures in the presence of adjoint triples, which is often easy to check in concrete situations. One interesting example are the model structures, due to Martina, on cubical sets that were presented in the MSRI cubical sets seminar (<https://www.msri.org/seminars/25048>).
- Marcy Robertson and Chris Rogers report work in progress on the Kashiwara-Vergne conjecture and Duflo isomorphisms in the derived category. In previous work with Dolgushev and Willwacher on deformation theory and the Grothendieck–Teichmüller group, we conjectured a link between Alekseev and Torossian’s solution to the Kashiwara-Vergne problem, and the set of isomorphisms between the harmonic and Hochschild structures on a smooth algebraic variety X (in the sense of Caldararu and Calaque-Van den Bergh.) With Robertson, we are exploring a PROP based approach for proving this conjecture (building on previous work by Kapranov and Hinich-Vaintrob), which involves characterizing Duflo-like isomorphisms for Lie objects in the derived category $D(\text{Mod } \mathcal{O}_X)$.
- A joint investigation towards lax-type ω -functors by tsil clingman, D. Yetter, a program associate and research professor.
- An investigation of $(\infty, 2)$ -categories of homotopy coherent monads by Yuki Maehara, Paula Verdugo, Dominic Verity.
- Revisions to a book under contract *Elements of ∞ -Category Theory* by Emily Riehl and Dominic Verity.
- Work on a Complicial Compendium by Emily Riehl and Dominic Verity.
- Work in progress on a model independent theory of $(\infty, 2)$ -categories by a working group that includes Emily Riehl, Martina Rovelli, Viktoriya Ozornova, Philip Hackney, Alexander Campbell, Grigory Kondyrev, and others.

Unforeseen challenges. Inevitably research productivity was affected by the coronavirus pandemic. We illustrate the effects this had on a few of our member’s research activities in their own words. Simona Paoli reports that

I had several fruitful and promising mathematical discussions during the time MSRI was open during my stay, then the closure made it difficult to continue, but I am hopeful at least one direction will carry on in the future — this is on model structures for weakly globular double categories, together with Alexander Campbell.

Another project I undertook at MSRI is single author and so it was less adversely affected by the closure. I made very good progress, and I will post a preprint in the coming weeks. This concerns the weak units conjecture, originally formulated by Carlos Simpson over 20 years ago, which states that there exists a notion of weak n -category with strictly associative compositions but only weak unit laws, that constitutes a good model, that is satisfies the homotopy hypothesis, and that is suitably equivalent to the fully weak models. To date, this conjecture is open. Kock proposed a formulation of this conjecture with a specific model, but the proof of the equivalence with the fully weak models is still missing. Although I have not yet proved the conjecture for general n , the progress I made in dimension $n = 2$ is very significant as a possible basis for the higher dimensional case, as well as for further generalizations. It also contains new insights into the model of weak n -categories I introduced in the book I published in 2019.

David Jordan reports

I co-authored a paper with Adrien Brochier, Pavel Safronov, and Noah Snyder, called “Invertible braided tensor categories”, arXiv:2003.13812. The paper was written during intensive working sessions with Pavel and Noah afforded by our time at MSRI. This was greatly aided by having access to Dan Freed, Constantin Teleman, and Kevin Walker for informal chats over lunch.

I began a collaboration with David Reutter and Kevin Walker, which built on this latter one, geared at constructing skein theoretic topological field theories in the non-semisimple setting. However, due to family obligations around daycare being cancelled indefinitely, I have asked them to proceed without me.

I have furthered a collaboration with Sam Gunningham and Monica Vazirani, whose goal is to understand the category of strongly equivariant $D_q(G)$ modules for $G = SL_N, GL_N$, using higher categorical techniques which were highlighted in the program. We expect to finish this summer. Talking with Kevin Walker was very helpful.

I have furthered — and am presently finalizing — a collaboration with Gus Schrader and Sasha Shapiro, concerning cluster quantization stratified factorization homology. Although these two were not formally affiliated to the program, Sasha was in Berkeley, so the collaboration was accelerated by my time at MSRI, and I was also very fortunate to be able to discuss with David Ayala and John Francis.

3. ORGANIZATIONAL STRUCTURE

The Spring 2020 semester passed through three phases:

- the *introductory phase* (4 weeks), from mid January to mid February, spanned by the Connections for Women and Introductory Programs, which were widely attended by members of both programs,
- the *ordinary phase* (3 weeks), from the end of the Higher Categories and Categorification Introductory Workshop in mid February to the announcement of MSRI’s shutdown on March 9th, and
- the *coronavirus phase* (12 weeks), from mid March to the end of May, during which the majority of members left Berkeley, scattering to their homes around the world.

The semester-opening workshops followed the typical schedule and will be described in the next section. Here we describe the organizational structure in the in-person and virtual phases of the program.

Ordinary phase. Given the close scientific connections between our programs, the organizers of the Higher Categories and Quantum Symmetries program jointly agreed upon the following seminar schedule:

- Mondays 2:00 - 3:00, Joint HC & QS Seminar — organized by David Jordan and David Gepner, with 60 min colloquium-style talks. Speakers were instructed to be “down to earth” and not necessarily required to speak about their own work. Unfortunately there were only four speakers in this series before the COVID-19 shutdown — David Ayala, Teena Gerhardt, Vaughan Jones, and David Ben-Zvi — but all gave excellent talks that were well-attended.
- Tuesdays 2:00 - 4:30, HC Seminar — organized by David Ayala, with two one hour talks surrounding a tea break. This was preceded by an organizational meeting during which topics for themed lecture series were proposed and voted on.

The first lecture series was on operadic categories, organized by Martin Markl, with talks by Martin Markl, Philip Hackney, and Muriel Livernet. This series was very well-attended, with the Baker Boardroom nearly at capacity on each occasion.

The second lecture series was on pyknotic/condensed sets, with two two-hour lectures each by Clark Barwick and Peter Haine. The first two of these took place in person and featured a lot of audience engagement. The second two lectures were filmed in an empty Simons auditorium during the week after MSRI's closure but before the shelter in place order. We attempted to live-stream these talks and had a moderator set up to relay questions from the audience, but technical issues with the audio broadcast meant we had to cancel the live-stream at the last minute, much to everyone's disappointment.

Other focus topics included K -Theory & L -functions, Homotopy Type Theory, and Enriched Higher Category Theory / Categorical Patterns, though regrettably we did not have time to include them with the shortened semester.

- Wednesdays 11:30 - 12:30 & 1:30 - 2:30 — Joint Newcomers Seminar — organized by Chris Douglas, with 30 minute talks intended to display one's current or recent work. Invitations prioritized postdocs. We ensured that every postdoctoral fellow had an opportunity to speak in at least one venue: in this seminar, in a workshop, or in an online seminar.
- Thursdays 2:00 - 4:30, QS Seminar — organized by Terry Gannon and Richard Ng.
- Fridays 2:00 - 3:00, Grad Student Seminar — organized by David Reutter. This group was structured as a learning seminar, but also gave graduate students an opportunity to give talks, and continued to meet during the virtual phase of the program.

In addition to these activities, members organized reading groups and working groups: on $(\infty, 2)$ -category theory, blob homology, configuration spaces and diffeomorphisms, factorization homology, and stratified homotopy theory.

It is not an accident that all of the seminar organizers are male. A few women were proposed as co-organizers for some of the higher categories seminars, but the female organizers argued that these women should be given a break from taking on a service role. We confirmed this view afterwards with the individuals in question and were gratified to learn that our instinct was correct: they were happy not to have been asked to organize the seminar series. Unfortunately, there was one negative consequence of this decision: a female member told us after the semester was over that their offer to give a talk in one of the lecture series was turned down, since they were “not fancy enough.” The talks also did not equally represent all of the mathematical areas in our program. We believe we could have done more to correct these issues had the program continued in person, but the pandemic brought additional complications: time zone issues proved insurmountable, a large proportion of our membership was accidentally removed from the members mailing list for a period of about a month, and members with childcare responsibilities had limited opportunities to participate after the shutdown.

Coronavirus phase. Once MSRI announced the shutdown the organizers of both programs reconvened to develop a new seminar schedule for the last two months of the program, after the online March workshops. We elected to host a single joint virtual seminar series, featuring one 90 minute talk per day from 10-11:30am Berkeley time. Each talk was moderated by one of the seminar organizers: David Ayala (a HC organizer), Chris Douglas (a joint HC/QS research professor), and Noah Snyder (a QS organizer). Nominations were solicited from the full membership, and in addition speakers were encouraged to self-nominate.

At the beginning, this seminar met three days a week — Tuesday, Wednesday, and Thursdays — but we expanded to include some Monday and Friday talks as well to accommodate all the nominated speakers. The postdoctoral fellows who had not yet had an opportunity to give an in-person talk were invited to speak early in this series.

The online talks were hosted on zoom with IT support provided by MSRI. Initially the plan had been not to film the talks, but members in other time zones or with childcare responsibilities requested filming, which was done with the speaker’s permission.

Participation counts in each seminar varied between 13 and 78. The mean participation count was 30, the median was 27. Attendees were encouraged to attend the talk with video on when possible to make it feel more like an in-person meeting. In a typical seminar, 4 participants would interrupt a seminar with a question or a comment, and there was some additional discussion at the end, some of which took place in a separate “tea room” where everyone was invited to retire to after the talk.

Additional seminar series were launched spontaneously during the coronavirus phase, including notably a highly-regarded series on stratified homotopy theory organized by Clark Barwick. The graduate student seminar, lead by David Reutter, continued to meet. In addition, one of our research members, Chris Kapulkin, organized a seminar series on cubical sets, with 16 talks spread out over the month of May.

4. WORKSHOPS AND CONFERENCES

Two of the three regularly scheduled workshops took place as planned; the March topical workshop took place online. What follows are excerpts from the workshop reports.

Connections for women. The two-day workshop, organized by Emily Riehl and Marcy Robertson, surveyed notable developments in the foundations and applications of higher category theory. It consisted of two mini-courses given by emerging female leaders in the subject: Claudia Scheimbauer and Nathalie Wahl. It was paired with problem sessions lead by selected “TAs”, themselves experts in higher structures, each of whom were female PhD students or early career researchers. The TAs diligently prepared before the workshop, having the unexpected side-effect of building strong connections between young researchers to natural collaborators and colleagues. Each lecture series tailored to a diverse audience, accessible to graduate students and non-expert researchers with some background in homological algebra. The majority of the speakers and panelists for this event were women and gender minorities, and members of these groups and of other underrepresented groups were especially encouraged to attend. This workshop was open to all mathematicians.

We were delighted that many of the most attentive students were research professors and more senior academics participating in the program. One research professor was so determined to work through all the problems that we often had to tear her away from the problems to participate in the panel discussion.

Marcy and Emily attended the panel discussion for the Quantum Symmetries connections for women workshop and copied a few of their best practices. In particular, they organized their panel around a narrow theme (collaboration, in that case) and chose a panel that represented a diversity of career stages. Our panel centered around the theme of

The panel discussion was organized around the theme of making space “creating space for yourself and others.” It was moderated by Emily Peters (an organizer from the Quantum Symmetries program) and featured Teena Gerhardt, Muriel Livernet, Marcy Robertson, Nancy Scherich, and Jieru Zhu.

Topics discussed included:

- speaking up in seminars
- setting the tone in the classroom
- saying no
- making time for a personal life
- creating something that doesn’t exist
- coming out/being out (Emily Riehl spoke to this point from the audience)

- self promotion

Introductory workshop. This workshop, co-organized by David Ayala, Emily Riehl, Christopher Schommer-Pries, and Peter Teichner, surveyed notable developments and applications of higher category theory; it was a venue for end-users to share their vision of how to apply the theory, as well as developers to share technical advancements. The workshop consisted of 6 series, each given by an instrumental end-user or developer of higher category theory. The format of a given series was three 1-hour slots; the first two slots were devoted to lectures, the last hour was devoted to a mix of exercises and lecture. Each lecture series was tailored to a diverse audience, accessible to graduate students and non-expert researchers with some background in homological algebra. Each problem session was designed to catch interest of both experts and non-experts, and a few colleagues to each lecturer volunteered their time as a “TA” to assist groups working through exercises.

Tasked with delivering self-contained accessible presentations, the lecturers presented beautifully distilled content that represents their field well.

- Both Catharina Stroppel’s and Aaron Lauda’s lecture series on link invariants and categorification gave novel access to many in the audience whose training is in the field of homotopy theory.
- Nick Rozenblyum’s lecture series offered a tantalizing and conceptual lens into the Geometric Langlands Program.
- Dominic Verity’s lecture series toured through some notoriously abstract notions in a friendly and approachable way, with an especially engaging exercise session over lunch.
- Pavel Safronov’s lecture series focused on approachable and classical instances of the cobordism hypothesis, in dimensions 3 and 4.
- Ulrike Tillmann’s lecture series toured through several standard constructions in homotopy theory and manifold topology in a way that demonstrated the operational practice of such techniques.

For all of these lecture series, MSRI’s video library will certainly be a resource for mathematicians to initiate their engagement with the presented subjects. Two weeks after the workshop, there are more than 200 total views of these lectures.

Ulrike Tillmann reports

As part of the Introductory Workshop I gave a series of three sessions on Cobordism categories, classifying spaces and (invertible) TQFTs. The goal of the lectures was to give the audience an appreciation of how by translating — via the classifying space functor — the topological quantum field theories to the realm of topology one can use the powerful tools of stable homotopy theory to study invertible field theories. I started this line of research in the mid 1990s by studying classifying spaces of cobordism categories and deducing consequences for TQFTs. But it is due to Dan Freed and Mike Hopkins that we fully understand the significance for invertible TQFTs. Recently they have proved a far reaching classification theorem. It was gratifying to see the problem session well attended and well received. Preparing the lectures and discussions that followed them made me rethink one of the elementary examples in the field. I am now writing a short research note on invertible one dimensional TQFTs.

This workshop’s format was somewhat experimental — notably the exercise sessions. About half of these exercise sessions captured surprise and lasting engagement from many of the participants. For instance, the tables on decks of MSRI’s facilities were dominated by groups of postdocs and graduate students working over notes of the lecture series and their accompanying exercise sets. On several occasions, more senior, or expert, mathematicians joined the enthusiasm by jumping into such discussions, nearly unsolicited, to explain terms or walk through some of the exercises. Also,

these exercise sets served to offer an anchor for junior researchers to connect. Now weeks after the event, a couple groups of postdocs have continued their independent inquiries spawned through this workshop: one group continues their discussions about cobordism categories and classifying spaces; another about categorifications of Heisenberg Lie algebras. In these ways, the workshop brought together junior mathematicians in a visibly healthy way. The workshop’s format also lent to experts from somewhat disparate fields connecting in a mathematically substantive way.

Workshop on (∞, n) -categories, factorization homology, and algebraic K -theory. This workshop, co-organized by Clark Barwick, David Gepner, David Nadler, and Marcy Robertson, happened to occur just as the coronavirus shutdown occurred. Some of the talks were delivered in advance with MSRI’s video facilities, and others were delivered through Zoom.

Even with the surprise change of format (and a number of cancellations and schedule changes), the conference was a success. Akhil Mathew, David Ben-Zvi, and Martina Rovelli and Viktoriya Ozornova all offered lecture series. Mathew focused on his and his collaborators’ exciting work on structures in topological cyclic homology from the past two years. Ben-Zvi gave an inspiring introduction to a relative form of the geometric Langlands conjectures. And Rovelli and Ozornova shared a surprising new nerve construction for 2-categories, relating them to Verity’s 2-complicial sets.

In addition, we learned of a number of very exciting new results in areas adjacent to algebraic K -theory. Here are just a few highlights:

- Markus Land started our week off with a discussion of his extraordinary work with Georg Tamme on excision in algebraic K -theory.
- Teena Gerhardt described her recent work with Angeltveit, Blumberg, Hill, Lawson, and Mandell on a twisted form of THH that takes as input an equivariant ring spectrum.
- Ben Antieau, in recent work with Akhil Mathew, Matthew Morrow, and Thomas Nikolaus, generalized a result of Beilinson characterizing the fiber of a cyclotomic trace map after passing to suitable p -adic coefficients.
- Aaron Mazel-Gee offered a glimpse of the future in his work with Stern on secondary algebraic K -theory and a new approach to stable $(\infty, 2)$ -categories.

5. POSTDOCTORAL FELLOWS

From the exit-surveys, it seems the postdoctoral fellows whose research areas were closer to the main subjects of the program were more successful in furthering their research objectives. For instance, Martina Rovelli, David Reutter and Alexander Campbell, all initiated new research directions while at the program. Martina Rovelli also interviewed for a tenure-track position in early February (that she was later offered and accepted), and gave a practice job talk that was attended by several of the senior women affiliated with the program. David Reutter reports two new draft papers, including a collaboration with David Penneys, a member from the Quantum Symmetries program.

Maria Yakerson reported that she learned a lot about pyknotic/condensed math while at MSRI, particularly from Peter Haine. She is now studying this area in more detail at a seminar at Regensburg co-organized by research member Claudia Scheimbauer and is hopeful that these discussions eventually grow into a solid research project.

Two of our postdoctoral fellows — Sarah Yeakel and Nicolle Gonzalez — expressed strong interest in moving into higher categories from their related areas of expertise, but didn’t find time to do so with the abbreviated schedule. Nevertheless, they were able to use the time productively. Yeakel launched a new collaboration with Barwick and Haine on stratified homotopy theory, and Gonzalez was extraordinarily productive with her time this Spring, submitting two papers and delivering an absurd number of invited lectures at nearby institutions. The organizers feared that both were less

engaged with the program than would have been ideal, and take full responsibility for this, but independently each of them made excellent use of their time.

In the first weeks of the virtual program, Marcy Robertson and Chelsea Walton organized a seminar series on professional development for postdocs and graduate students that met for a few weeks in a row. During this time, the MSRI directorate also convened a meeting of the research professors and program organizers to ensure that everyone was checking in on their postdoctoral mentee. We believe that many pairs continued to meet regularly during the virtual phase of the program.

6. GRADUATE STUDENTS

On average it seems that our younger participants were remarkably productive, despite the chaotic end to the MSRI semester. Three program associates — Luci Bonatto, tsilil clingman, and Yuki Maehara — reported new collaborations with senior mathematicians outside of their institution.

Peter Haine, was mentioned also in two new collaborations, generally with younger members of the program, including one with Aaron Mazel-Gee, diversifying his collaboration pool. He also gave several high-profile talks during the semester on his work on pyknotic/condensed sets and on the related subject of stratified homotopy theory.

Other graduate students spoke about their work in the $(\infty, 2)$ -categories working group (Yuki Maehara) or in the cubical sets seminar (Tim Champion and Yuki Maehara).

The cohort of graduate students included a handful of unofficial participants, including Lyne Moser, who secured a Swiss National Science Foundation mobility fellowship that allowed her to spend the entire semester in Berkeley. Since her advisor was not affiliated with the program, she was not eligible to apply to be a program associate. The organizers created a special mailing list to make sure that Lyne and others in a similar position (including interested Berkeley students and faculty) would hear about working group announcements and seminar activities. Lyne was a very active participant, giving a two hour standing room only talk in the Baker Boardroom on 2-fold complete Segal spaces and θ_2 -spaces that one of the organizers reports was “perfect.”

7. INCLUSIVITY

Higher category theory has acquired a reputation for being less welcoming than other areas of mathematics. As organizers, we worked very hard to counteract this in our participant selection and in the way we structured our program.

This work began a year and half before the start of our program, when David Ayala lead the organizers in an effort to develop rubrics to use to evaluate applications in each of the three membership categories. In our proposal to MSRI we committed to setting a selection procedure while behind a “veil of ignorance” (i.e., in advance of receiving any applications) with the aim of counter-balancing the biases that come with familiarity, and promised to take considerable care in settling on such a selection procedure. These rubrics and their rationale appear at the end of this section.

With similar aims in mind, we asked MSRI staff to help us partially-blind the postdoctoral fellow applications. Applicants were instructed to prepare their one-page research statement without including any identifying details (institution, names of collaborators). MSRI staff then re-arranged the PDFs of their applications generated by mathjobs so that these research statements appeared as the first page of each application. They also hand-redacted identifying details from applicants who did not follow instructions, which must have taken an incredible amount of work.

Of course part of the postdoctoral fellow application included letters of reference and a CV, so we eventually learned the names of each applicant. But in our experience, first impressions of how

strong a candidate is are made quickly, and we felt it was much healthier to form those impressions when focused solely on the research of each candidate, without being distracted by biographical details. Since applicants were proposing future research projects, we found them less identifiable than one might think. Even when we realized we knew who was writing, it felt like we were seeing them through new eyes.

The organizers appreciated this positive review from Teena Gerhardt, who has previously served on the MSRI Human Resources Advisory Committee:

The program organizers did a great job making it clear that they wanted to include and support all participants in the program. The program brought together researchers from a number of different subfields in a very welcoming and inclusive way.

One the other hand, there were areas where we certainly could have done better. For instance, several members noticed that the professional development seminar series, hastily convened to give moral support to the postdoctoral fellows and graduate students in the coronavirus phase of the program, was lead by the only two senior women of color affiliated with our joint programs.

Research Professorship Rubric. Here are the scoring categories.

- Research: 0-5
- Engagement: 0-5
- Diversity: 0-3

Here are the marking categories.

- End-user ↔ technician (eg. 60:40)
- Human Resources (eg. note any aspects, such as gender, race (URM status), academic affiliation with less research opportunities, etc.)
- US affiliate (yes/no)

Recollection: Purpose, Reasoning, and implementation. Generally, using a Rubric to evaluate applications is an effort three-fold:

- To avert unconscious bias in the evaluation process.
- To keep discussions about applications focused on specific reference-able content therein, which can be measured according to our stated priorities.
- To establish a process prior to the evaluation of applications that we, as evaluators, consent to honor.

Our Rubric has 3 categories of scoring, and 4 other bits of information of note. The cumulative score of the scoring categories will be used to isolate the top 18 applications (for which there are 5 (Research Professorship) positions). We will then discuss this list of 18 in more detail, using the output of the Rubric as useful information though not the only information.

The scoring categories are Research, Engagement, and Diversity. Here are some examples of reference-able such aspects of an application that we might look for.

Research:

- the extent are the research interests revealed in an application relevant to our program (per our proposal, for instance). Indications of bringing new, even breakthrough, ideas into higher category theory, both in the way of theory as well as application.
- Indications of asking exacting questions that call on well-motivated developments of higher category theory and connections of it to other fields.
- Evidence of working with higher categories, in any specific form.
- Evidence of working on problems that prompt the development of higher category theory.
- Evidence of a sense for which questions/problems higher category theory can be used to address.

- Evidence of a sense how higher category theory fits, or will fit, into the larger landscape of mathematics.

Engagement:

- the extent to which an application reveals an interest to be actively engaged in the program. (This is especially relevant for the Research Professorship positions.)
- Experience mentoring.
- Experience with diverse collaborators, in the way of research interests and seniority.
- Experience organizing, and actively participating in, seminars.
- Evidence of having outward-oriented questions, interests, and discussions.
- Evidence of openness/interest in learning new techniques.
- Evidence of being a leader in a field, and drawing others into their field.

Diversity:

- the extent to which an application represents or advocates for an underrepresented groups in our corner of math.
- Geography (both national, and international)
- Human Resources (eg. gender, race (URM status), other aspects ...)
- Academic institution, such as with limited research opportunities.

Research Member Rubric. Here are the scoring categories.

- Research Strength: 0-3
- Research Fit: 0-3
- Engagement: 0-4
- Diversity: 0-3

Here are the marking categories.

- End-user \leftrightarrow technician (eg. 60:40)
- Human Resources (eg. note any aspects, such as gender, race (URM status), academic affiliation with less research opportunities, etc.)
- US affiliate (yes/no)

Postdoctoral Fellow Rubric. Here are the scoring categories.

- Research Strength: 0-3
- Research Fit: 0-3
- Diversity: 0-2

Here are the marking categories.

- End-user \leftrightarrow technician (eg. 60:40)
- Human Resources (eg. note any aspects, such as gender, race (URM status), academic affiliation with less research opportunities, etc.)
- US affiliate (yes/no)

8. SYNERGISTIC ACTIVITIES

Regrettably, there was less synergistic activity from our program members than is typical for an MSRI semester. Much of this decrease in activity was pandemic related: for instance, Emily Riehl, one of organizers, was scheduled to give four talks down the hill in April and May, only one of which was rescheduled online. On the other hand, that single online talk reached a much broader audience than would have attended in person (roughly 60 attendees at the originally scheduled talk, and another 250 when it was repeated by request a week later).

We certainly could have generated similar engagement in our virtual seminar series during April and May if we had advertised it more broadly, but the organizers chose to prioritize the well-being

of program members over the the interests of the broader mathematical community. We thought having closed relatively small talks would facilitate more direct interaction. We did however include young mathematicians who heard about the talks via word of mouth. For instance, the majority of the attendees in the cubical sets lecture series were graduate students with no formal affiliation with the MSRI program.

At least one research member who visited for a month or so early in the program, Zsuzsi Dancso, participated in UC Berkley’s Math Circle. Ulrike Tillman took advantage of being in North America and gave a lecture series as Distinguished Lecturer at the Fields Institute, Toronto, at the end of her stay. Other members frequently absented themselves for a day or two during the first months of the program to give talks at other US-based institutions.

9. HIGHLIGHTS AND BREAKTHROUGHS

- After the pandemic forced the semester online, Barwick started a working group on stratified homotopy theory and related problems. Beginning at an elementary level, participants shared the burst of new advances relating stratifications in topology and geometry to higher categorical structures from the past ten years. Over time, the aim and nature of the working group shifted away from exposition to proving new theorems.

The working group is now developing a framework in which to prove a stratified form of *tannakian duality*. This is a fundamental connection between some extremely abstract objects of category theory and higher category theory and much more concrete geometric objects — topological groups, group schemes, and stacks. The original forms of this duality were developed by Grothendieck and his school in the 60s and 70s, and their vision was fully realized by Deligne in 1990. This duality has been critical for the modern understanding of cohomology theories in algebraic geometry.

The scope of this classical form of tannakian duality was always limited by the fact that there was no way to deal with a very general class of coefficients. Now, the participants in the stratified working group have found what appears to be the correct language in which to come to grips with that more general class of coefficients – often called *constructible* coefficients. Their work will, we hope, make it possible to prove a number of conjectures about cohomologies with these sorts of coefficients.

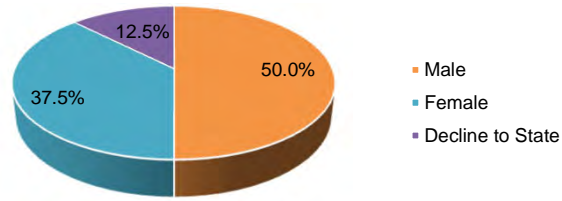
- During their stay at MSRI, discussions among resident members (Clark Barwick, Tim Champion, David Gepner, Peter Haine, Tomer Schlank, and Jay Shah) elucidated numerous aspects of the theory of the Balmer spectrum and the relevance of theorems on Tate blueshift in its determination for the category of equivariant spectra with respect to a finite abelian group. Computing the Balmer spectrum of the category of dihedral equivariant spectra is the focus of an ongoing project joint with J.D. Quigley, and the insights gleaned at MSRI should prove useful for that project.
- In a preprint “Which homotopy algebras come from transfer?” submitted to *Proceedings of the AMS*, Martin Markl and Chris Rogers give necessary and sufficient conditions for an A_∞ -structure on a chain complex of R -modules to be isotopic to one arising via transfer over a chain homotopy equivalence or a quasi-isomorphism. This answers a question posed in June 2019 by Dennis Sullivan. We then generalize this result to \mathcal{P}_∞ -structures, for any quadratic Koszul operad \mathcal{P} . Our approach combines classical obstruction theory with more recent results from derived deformation theory.

Postdoc Pre/Post-MSRI Institution Group

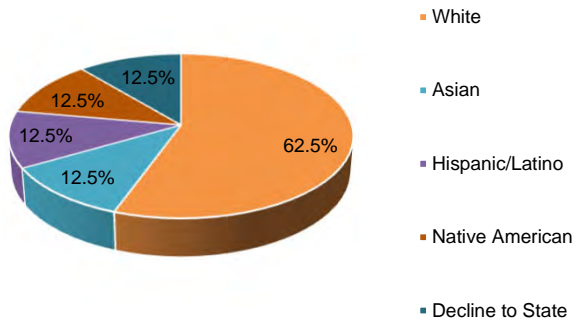
Family Name	First Name	Pre-MSRI Institution Name	Pre-MSRI Institution Group	Post-MSRI Institution Name	Post-MSRI Institution Group
Campbell	Alexander	Macquarie University	Foreign	Johns Hopkins University	Private Large
Gonzalez	Nicolle	University of California, Los Angeles	Public Large	University of California, Los Angeles	Public Large
Penney	Mark	University of Waterloo	Foreign	University of Waterloo	Foreign
Reutter	David	Max-Planck-Institut für Mathematik	Foreign	Max-Planck-Institut für Mathematik	Foreign
Rovelli	Martina	Australian National University	Foreign	Australian National University	Foreign
Shah	Jay	University of Notre Dame	Private Large	University of Münster	Foreign
Williams	Brian	Northeastern University	Private Small	University of Edinburgh	Foreign
Yeakel	Sarah	University of Maryland	Public Large	University of California, Riverside	Public Small

2019-20 HCC Postdoctoral Fellow Demographic Summary

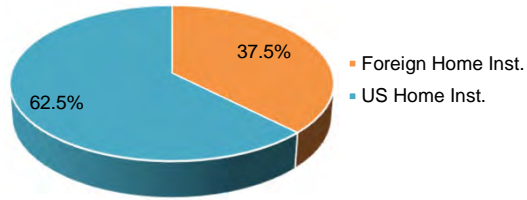
Gender	#	%
# of Distinct Members	8	100.0%
Male	4	50.0%
Female	3	37.5%
Decline to State	1	12.5%



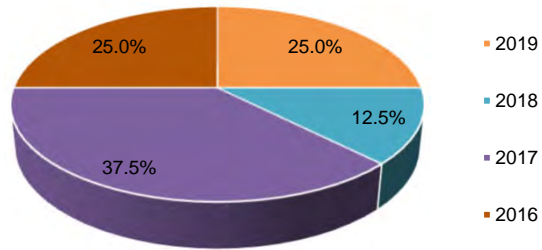
Race/Ethnicity*	#	%
White	5	62.5%
Asian	1	12.5%
Hispanic/Latino	1	12.5%
Black	0	0.0%
Native American	1	12.5%
Pacific Islander	0	0.0%
Decline to State	1	12.5%
Unavailable Info.	0	0.0%
Minorities**	0	0.0%



Citizenships	#	%
Foreign Home Inst.	3	37.5%
US Home Inst.	5	62.5%
US Citizen & Perm. Residents	3	37.5%
Foreign Citizens	5	62.5%
US Citizens	3	37.5%
US Permanent Residents	0	0.0%



Year of Ph.D	#	%
2019	2	25.0%
2018	1	12.5%
2017	3	37.5%
2016	2	25.0%
2015	0	0.0%
2014	0	0.0%
Total # of Distinct Postdocs	8	100.0%

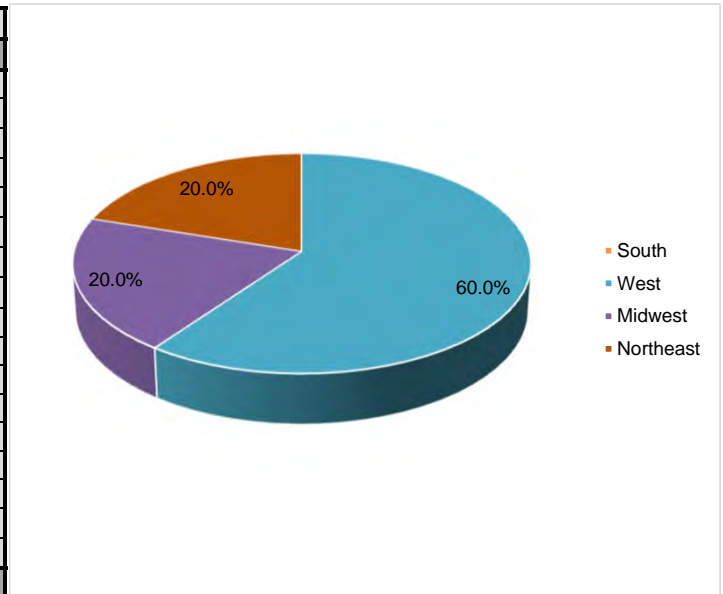


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 HCC Postdoctoral Fellow Classified by States

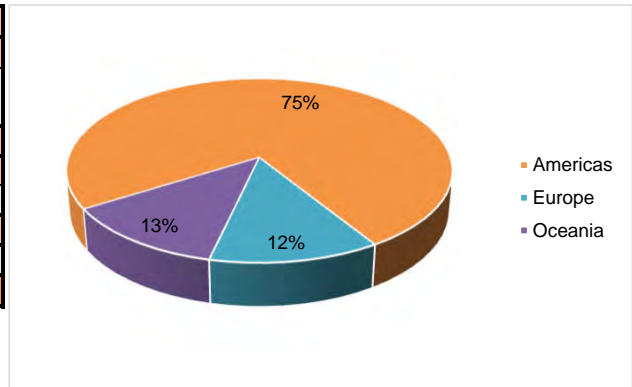
State	#	%	2010 Census
South	0	0.0%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	0	0.0%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	0	0.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	3	60.0%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	3	60.0%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	1	20.0%	21.7%
IA	0	0.0%	4.2%
IL	0	0.0%	2.1%
IN	1	20.0%	1.0%
KS	0	0.0%	0.9%
MI	0	0.0%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	1	20.0%	17.9%
CT	0	0.0%	1.2%
MA	1	20.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	5	100.0%	100.0%



*Regions based on US Census classification

2019-20 HCC Postdoctoral Fellow Classified by Country

Africa	0
Americas	6
North America	United States 5
	Canada 1
Asia	0
Europe	1
Western Europe	Germany 1
Oceania	1
Australia and New Ze	Australia 1
Grand Total	8



**Regions based on United Nations classification*

Higher Categories & Categorification

Program Summary

Role	Distinct Members	%	US Citizens & Perm. Res.	%	Women	%	Minorities*	%
Organizers	7	14.6%	6	85.7%	2	28.6%	1	16.7%
Research Professors	9	18.8%	6	66.7%	3	33.3%	0	0.0%
Postdoctoral Fellows	8	16.7%	3	37.5%	3	37.5%	0	0.0%
PD/RM	1	2.1%	0	0.0%	1	100.0%	0	0.0%
Research Members	14	29.2%	6	42.9%	2	14.3%	0	0.0%
Program Associates	9	18.8%	2	22.2%	2	22.2%	1	50.0%
Total # of Distinct Members	48	100.0%	23	47.9%	13	27.1%	2	8.7%

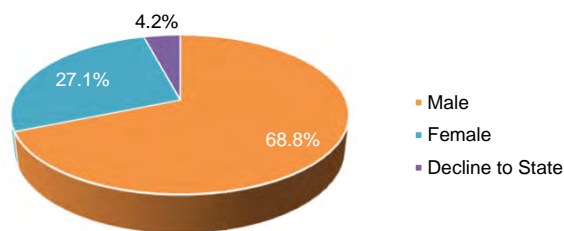
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.

Home Institution AMS Grouping

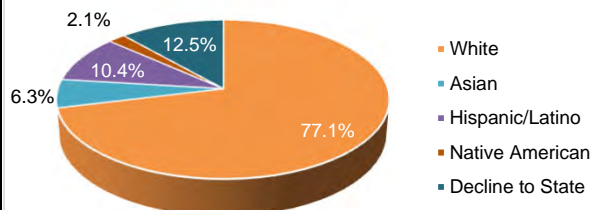
Role	US							Foreign	Total
	Private Large	Private Small	Public Large	Public Medium	Public Small	Group M or B	Non-Group		
Organizers	1	0	1	1	0	0	0	4	7
Research Professors	2	0	2	0	1	0	0	4	9
Postdoctoral Fellows	1	1	2	0	0	0	0	4	8
PD/RM	0	0	0	0	0	0	0	1	1
Research Members	2	0	1	2	0	1	0	8	14
Program Associates	4	0	0	0	0	0	0	5	9
Total	10	1	6	3	1	1	0	26	48
%	20.8%	2.1%	12.5%	6.3%	2.1%	2.1%	0.0%	54.2%	100.0%

2019-20 HCC Program Members Demographic Summary

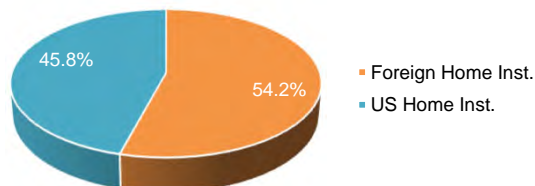
Gender	#	%
# of Distinct Members	48	100.0%
Male	33	68.8%
Female	13	27.1%
Decline to State	2	4.2%



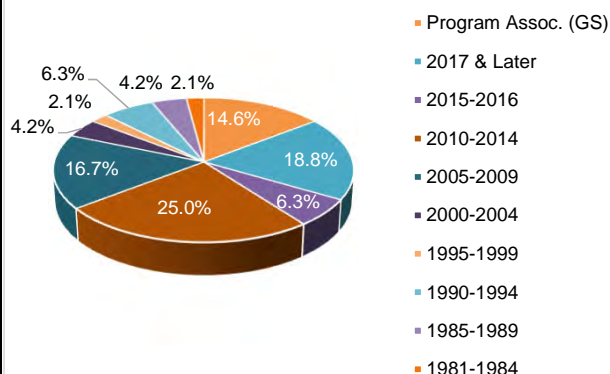
Race/Ethnicity*	#	%
White	37	77.1%
Asian	3	6.3%
Hispanic/Latino	5	10.4%
Black	0	0.0%
Native American	1	2.1%
Pacific Islander	0	0.0%
Decline to State	6	12.5%
Unavailable Info.	0	0.0%
Minorities**	2	8.7%



Citizenships	#	%
Foreign Home Inst.	26	54.2%
US Home Inst.	22	45.8%
US Citizens & Perm. Residents	23	47.9%
Foreign Citizens	25	52.1%
US Citizens	23	47.9%
US Permanent Residents	0	0.0%



Year of Ph.D	#	%
Program Assoc. (GS)	7	14.6%
2017 & Later	9	18.8%
2015-2016	3	6.3%
2010-2014	12	25.0%
2005-2009	8	16.7%
2000-2004	2	4.2%
1995-1999	1	2.1%
1990-1994	3	6.3%
1985-1989	2	4.2%
1981-1984	1	2.1%
1980 & Earlier	0	0.0%
Total # of Distinct Members	48	100.0%

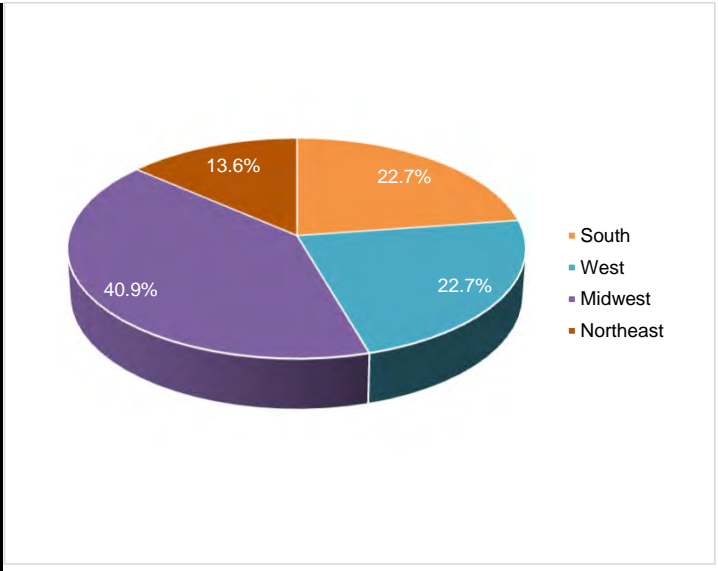


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 HCC Program Members Classified by State

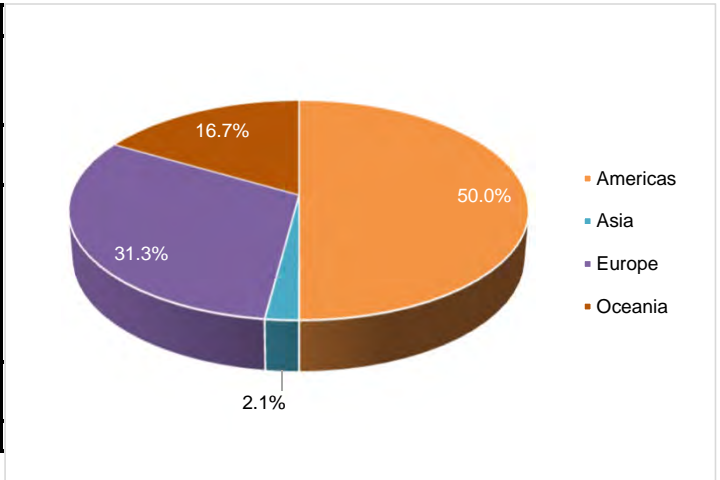
State	#	%	2010 Census
South	5	22.7%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	1	4.5%	1.5%
MD	3	13.6%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	1	4.5%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	5	22.7%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	3	13.6%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	1	4.5%	1.6%
NM	0	0.0%	0.9%
NV	1	4.5%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	9	40.9%	21.7%
IA	0	0.0%	4.2%
IL	3	13.6%	2.1%
IN	3	13.6%	1.0%
KS	1	4.5%	0.9%
MI	2	9.1%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	3	13.6%	17.9%
CT	0	0.0%	1.2%
MA	3	13.6%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	22	100.0%	100.0%



*Regions based on US Census classification

2019-20 HCC Program Members Classified by Countries

Africa		0
Americas		24
North America	Canada	2
	United States	22
Asia		1
Western Asia	Israel	1
Europe		15
Eastern Europe	Czech Republic	1
Northern Europe	Norway	1
	United Kingdom	6
Western Europe	France	2
	Germany	5
Oceania		8
Australia & New Zealand	Australia	8
Grand Total		48



**Regions based on United Nations classification*

Higher Categories and Categorification

January 21, 2020 - May 29, 2020

Total Program Members:	48
Total Survey Respondants:	43
Response Rate:	90%

While at MSRI my research program was advanced in the following ways:

Q1. I learned new ideas/techniques which are applicable to my problems

Yes	42	98%
No	1	2%
Total Responses	43	

Q2. I had opportunities to present my work to new audiences

Yes	40	93%
No	3	7%
Total Responses	43	

Q3. I initiated research with new collaborators

Yes	34	79%
No	9	21%
Total Responses	43	

Q4. I initiated research in new areas

Yes	34	79%
No	9	21%
Total Responses	43	

Q5. My research was advanced in these other ways:

[Link to Qualitative Responses](#)

Q6. If your answer to any of the above set of questions was no, what opportunities should MSRI provide to mitigate this?

[Link to Qualitative Responses](#)

Q7. MSRI aims to provide a supportive environment for all program participants. How satisfied were you with this aspect of your experience?

1 - Least Satisfying	0	0%
2	0	0%
3	1	2%
4	6	14%
5 - Most Satisfying	36	84%
Total Responses (Exclusive of N/A)	43	100%

Q8. What suggestions would you have for MSRI to provide a more supportive environment?

[Link to Qualitative Responses](#)

MSRI Experience - For Postdoctoral Fellows: Please rate your level of satisfaction with...

Q9. Your assigned mentor:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	2	25%
5 - Most Satisfying	6	75%
Total Responses (Exclusive of N/A)	8	100%

Q10. Your overall mentoring experience:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	2	25%
5 - Most Satisfying	6	75%
Total Responses (Exclusive of N/A)	8	100%

Q11. The lunch meeting with the directorate:

1 - Least Satisfying	0	0%
2	0	0%
3	1	14%
4	2	29%
5 - Most Satisfying	4	57%
Total Responses (Exclusive of N/A)	7	100%

Q12. What suggestions do you have to improve the mentoring experience at MSRI?[Link to Qualitative Responses](#)**MSRI Experience - For Graduate Students****Q13. How much did the Graduate Student Seminar increase your ability to benefit from MSRI's other scientific activities?**

1 - Least Satisfying	1	14%
2	0	0%
3	3	43%
4	3	43%
5 - Most Satisfying	0	0%
Total Responses (Exclusive of N/A)	7	100%

MSRI Experience - Program Seminar: Please rate your level of satisfaction with...**Q14. Learning new ideas and techniques:**

1 - Least Satisfying	1	2%
2	0	0%
3	3	7%
4	9	21%
5 - Most Satisfying	30	70%
Total Responses (Exclusive of N/A)	43	100%

Q15. Forming new acquaintances and collaborations:

1 - Least Satisfying	1	2%
2	1	2%
3	5	12%
4	12	28%
5 - Most Satisfying	24	56%
Total Responses (Exclusive of N/A)	43	100%

Q16. The opportunity to present your own work:

1 - Least Satisfying	1	2%
2	0	0%
3	5	12%
4	10	24%
5 - Most Satisfying	25	61%
Total Responses (Exclusive of N/A)	41	100%

MSRI Experience - General Information**Q17. My office accommodations were**

1 - Least Satisfying	0	0%
2	0	0%
3	2	5%
4	8	19%
5 - Most Satisfying	32	76%
Total Responses (Exclusive of N/A)	42	100%

Q18. Professionally, my overall satisfaction with MSRI was

1 - Least Satisfying	0	0%
2	1	2%
3	1	2%
4	3	7%
5 - Most Satisfying	37	88%
Total Responses (Exclusive of N/A)	42	100%

MSRI Experience - Feedback

Q19. Did you participate in any of the activities associated with the other MSRI programs or workshops? If so, which ones? Did you find them valuable?

[Link to Qualitative Responses](#)

Q20. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

[Link to Qualitative Responses](#)

Q21. What suggestions would you have for improvements at MSRI?

[Link to Qualitative Responses](#)

Q22. What suggestions would you have for future MSRI programs or workshops?

[Link to Qualitative Responses](#)

MSRI Experience - Computing Services and Facilities

Q23. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	2	5%
5 - Most Satisfying	37	95%
Total Responses (Exclusive of N/A)	39	100%

Q24. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	0	0%
3	3	8%
4	5	13%
5 - Most Satisfying	31	79%
Total Responses (Exclusive of N/A)	39	100%

Q25. How could we improve our computing services?

[Link to Qualitative Responses](#)

Q26. How could we improve our computing equipment and software environment?

[Link to Qualitative Responses](#)

MSRI Experience - Relocation Advisory Services: How would you rate the following services you received from MSRI?

Q27. Housing Assistance

1 - Least Satisfying	0	0%
2	2	7%
3	1	3%
4	4	14%
5 - Most Satisfying	22	76%
Total Responses (Exclusive of N/A)	29	100%

Q28. School and Childcare Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	6	100%
Total Responses (Exclusive of N/A)	6	100%

Q29. Visa Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	4	22%
5 - Most Satisfying	14	78%
Total Responses (Exclusive of N/A)	18	100%

Q30. How could we improve our relocation advisory services?

[Link to Qualitative Responses](#)

MSRI Experience - Administrative Support Services

Q31. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	1	2%
4	6	15%
5 - Most Satisfying	34	83%
Total Responses (Exclusive of N/A)	41	100%

Q32. How could we improve our administrative services?

[Link to Qualitative Responses](#)

Q33. Your comments about MSRI:

[Link to Qualitative Responses](#)

Complementary Program 2019-20

August 12, 2019 to May 29, 2020

MSRI

Berkeley, CA

USA

Complementary Program (2019-20)

August 12, 2019 – May 29, 2020

The Complementary Program has a limited number of memberships that are open to both mathematicians whose interests align with those of the Director or Deputy Director, and mathematicians who are partners of invited members of a core program.

During the 2019-20 year, MSRI had a small Complementary Program comprised of two postdoctoral fellows, Bob Lutz (University of Michigan) and Adrian Zahariuc (University of California, Davis) and the following researchers: Indira Chatterji (Université Nice Sophia-Antipolis), Brian Collier (University of California, Riverside), Christian Haesemeyer (University of Melbourne), Bernd Ulrich (Purdue University), James Unwin (University of Illinois at Chicago), Anna Wienhard (Ruprecht-Karls-Universität Heidelberg), Sarah Yeakel (University of Maryland, College Park), Paul Ziegler (Technical University of Munich).

Indira Chatterji

Research Member, August 19, 2019 to December 13, 2019

Spouse of François Labourie (UC Berkeley Chancellor Professor for the *Holomorphic Differentials in Mathematics and Physics* program).

Université Nice Sophia-Antipolis
Nice, France

At MSRI, Dr. Chatterji mainly collaborated with Ian Agol, Yair Minsky, Ursula Hamenstadt, and Karen Vogtmann. She commented, “The overall work ambient is very inspiring....Great place to work!”

Brian Collier

Research Member, January 21, 2020 to May 29, 2020

Spouse of Sarah Yeakel (Postdoc for the *Higher Categories and Categorification* program and Research Member in the *Complementary Program*)

University of California, Riverside
Riverside, CA
United States

Brian Collier also held a Postdoctoral Fellowship in the Fall *Holomorphic Differentials in Mathematics and Physics* program. At MSRI, he co-authored one posted paper *(G,P)-opers and global Slodowy slices* and one rough draft *A Cayley correspondence for Higher Teichmuller spaces*.

Christian Haesemeyer

Research Member, January 21, 2020 to January 31, 2020

Spouse of Marcy Robertson (Organizer for the *Higher Categories and Categorification* program)

University of Melbourne
Melbourne, Australia

Bob Lutz (worked with Deputy Director H el ene Barcelo and Curtis Greene)
Postdoc, August 12, 2019 to May 29, 2020
University of Michigan
Ann Arbor, MI
United States

At MSRI, he worked mainly with H el ene Barcelo and Curtis Greene. He submitted a paper, *Higher Discrete Homotopy Groups of Graphs*, and posted a paper, *Discrete Homotopy of Token Configurations*.

Bernd Ulrich (worked with Director David Eisenbud)
Research Member, December 20, 2019 to January 7, 2020
Purdue University
Lafayette, IN
United States

While at MSRI, he co-authored and posted a paper with David Eisenbud and Craig Huneke, *Residual Intersections and Linear Powers*. He commented, "MSRI provides a fantastic environment for collaborative research."

James Unwin
Research Member, September 12, 2019 to November 12, 2019
Spouse of Laura Schaposnik, (Research Member for the *Holomorphic Differentials in Mathematics and Physics* program)
University of Illinois at Chicago
Chicago, IL
United States

Anna Wienhard
Research Member, December 14, 2019 to January 31, 2020
Spouse of Dr. Daniel Roggenkamp (Research Member in *Holomorphic Differentials in Mathematics and Physics* program)
Ruprecht-Karls-Universitat Heidelberg
Heidelberg, D-69120
Germany

Anna Wienhard also held a Research Professorship in the Fall *Holomorphic Differentials in Mathematics and Physics* program. At MSRI, she co-authored two papers which have now been posted, *Anosov representations with Lipschitz limit set* and *Noncommutative coordinates for symplectic representations*. She also co-authored two rough drafts, *Generalizing positivity* and *Positive representations*.

Sarah Yeakel

Research Member, August 12, 2019 to December 3, 2019

Spouse of Brian Collier (Postdoc in the *Holomorphic Differentials in Mathematics and Physics* program and Research Member in the *Complementary Program*)

University of Maryland, College Park

College Park, MD

United States

Sarah Yeakel also held a Postdoctoral Fellowship in the Spring *Higher Categories and Categorification* program. At MSRI, she co-authored and created a rough draft of a paper, *Chain Rules and Operads in Abelian Functor Calculus*.

Adrian Zahariuc (worked with Director David Eisenbud and his group of students)

Postdoc, January 21, 2020 to May 29, 2020

University of California, Davis,

Davis, CA

United States

At MSRI, he created a rough draft of a paper, *Configurations of Points on a Line up to Translation*.

Paul Ziegler

Research Member, February 18, 2020 to March 13, 2020

Spouse of Claudia Scheimbauer (Research Member in the *Quantum Symmetries and the Higher Categories and Categorification* programs)

Technical University of Munich

Garching, Germany

2019-20 Complementary Program

Program Summary

Role	Distinct Members	%	US Citizens & Perm. Res.	%	Women	%	Minorities*	%
Organizers	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Research Professors	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Postdoctoral Fellows	2	20.0%	1	50.0%	0	0.0%	0	0.0%
PD/RM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Research Members	8	80.0%	3	37.5%	3	37.5%	0	0.0%
Program Associates	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Guests	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total # of Distinct Members	10	100.0%	4	40.0%	3	30.0%	0	0.0%

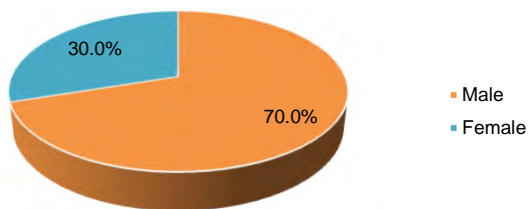
* Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic/Latino, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.

Home Institution Grouping

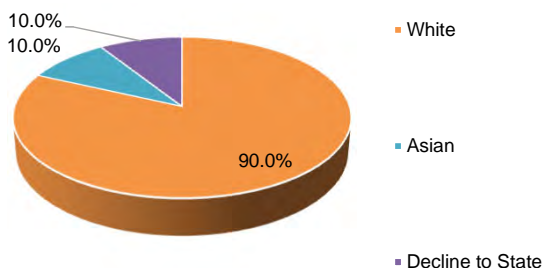
Role	US							Foreign	Total
	Private Large	Private Small	Public Large	Public Medium	Public Small	Group M or B	Non-Group		
Organizers	0	0	0	0	0	0	0	0	0
Research Professors	0	0	0	0	0	0	0	0	0
Postdoctoral Fellows	0	0	2	0	0	0	0	0	2
PD/RM	0	0	0	0	0	0	0	0	0
Research Members	0	0	2	0	2	0	0	4	8
Program Associates	0	0	0	0	0	0	0	0	0
Total	0	0	4	0	2	0	0	4	10
%	0.0%	0.0%	40.0%	0.0%	20.0%	0.0%	0.0%	40.0%	100.0%

2019-20 CP Members Demographic Summary

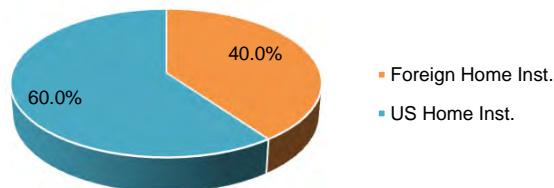
Gender	#	%
# of Distinct Members	10	100.0%
Male	7	70.0%
Female	3	30.0%
Decline to State	0	0.0%



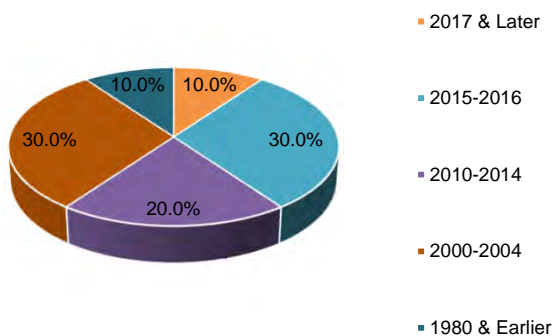
Race/Ethnicity*	#	%
White	9	90.0%
Asian	1	10.0%
Hispanic/Latino	0	0.0%
Black	0	0.0%
Native American	0	0.0%
Pacific Islander	0	0.0%
Decline to State	1	10.0%
Unavailable Info.	0	0.0%
Minorities**	0	0.0%



Citizenships	#	%
Foreign Home Inst.	4	40.0%
US Home Inst.	6	60.0%
US Citizen & Perm. Residents	4	40.0%
Foreign	6	60.0%
US Citizen	3	30.0%
Perm. Residents	1	10.0%



Year of Ph.D	#	%
Program Assoc. (GS)	0	0.0%
2017 & Later	1	10.0%
2015-2016	3	30.0%
2010-2014	2	20.0%
2005-2009	0	0.0%
2000-2004	3	30.0%
1995-1999	0	0.0%
1990-1994	0	0.0%
1985-1989	0	0.0%
1981-1984	0	0.0%
1980 & Earlier	1	10.0%
Total # of Distinct Members	10	100.0%

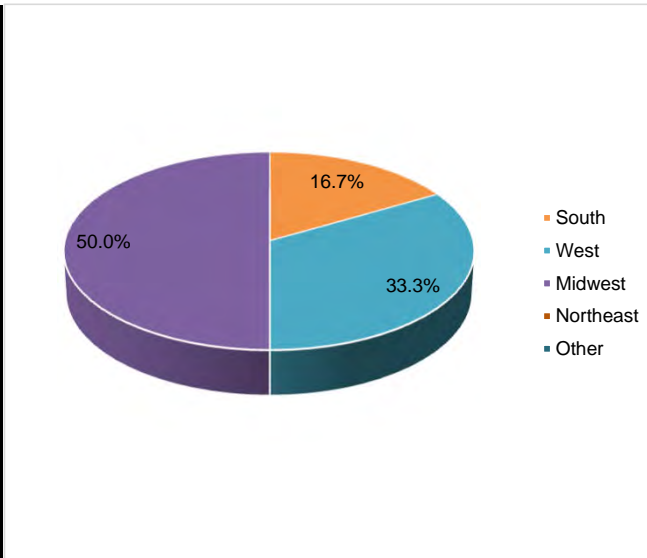


*Race/ethnicity selections are non-exclusive.

**Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, Hispanic, or Pacific Islander. Minority percentage is calculated by dividing the number of Minorities by the number of US citizens & Permanent Residents.

2019-20 CP Members Classified by State

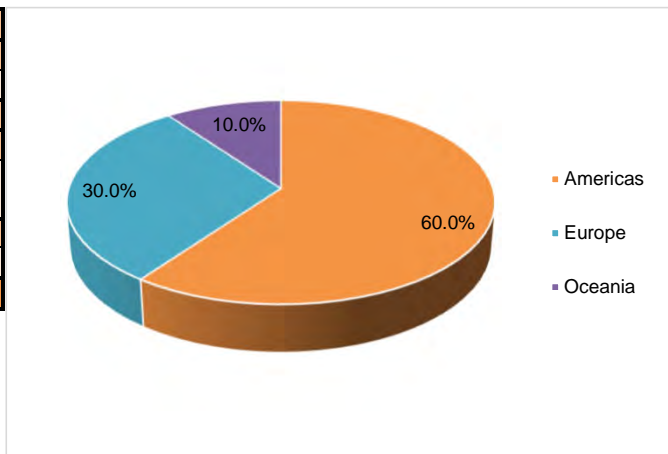
State	#	%	2010 Census
South	1	16.7%	37.1%
AL	0	0.0%	1.5%
AR	0	0.0%	0.9%
DE	0	0.0%	0.3%
DC	0	0.0%	0.2%
FL	0	0.0%	6.1%
GA	0	0.0%	3.1%
KY	0	0.0%	1.4%
LA	0	0.0%	1.5%
MD	1	16.7%	1.9%
MS	0	0.0%	1.0%
NC	0	0.0%	3.1%
OK	0	0.0%	1.2%
SC	0	0.0%	1.5%
TN	0	0.0%	2.1%
TX	0	0.0%	8.1%
VA	0	0.0%	2.6%
WV	0	0.0%	0.6%
West	2	33.3%	23.3%
AK	0	0.0%	0.2%
AZ	0	0.0%	2.1%
CA	2	33.3%	0.4%
CO	0	0.0%	0.5%
HI	0	0.0%	0.3%
ID	0	0.0%	12.1%
MT	0	0.0%	1.6%
NM	0	0.0%	0.9%
NV	0	0.0%	0.7%
OR	0	0.0%	1.2%
UT	0	0.0%	0.9%
WA	0	0.0%	2.2%
WY	0	0.0%	0.2%
Midwest	3	50.0%	21.7%
IA	0	0.0%	4.2%
IL	1	16.7%	2.1%
IN	1	16.7%	1.0%
KS	0	0.0%	0.9%
MI	1	16.7%	3.2%
MN	0	0.0%	1.7%
MO	0	0.0%	1.9%
ND	0	0.0%	0.2%
NE	0	0.0%	0.6%
OH	0	0.0%	3.7%
SD	0	0.0%	0.3%
WI	0	0.0%	1.8%
Northeast	0	0.0%	17.9%
CT	0	0.0%	1.2%
MA	0	0.0%	0.4%
ME	0	0.0%	2.1%
NH	0	0.0%	0.4%
NJ	0	0.0%	2.8%
NY	0	0.0%	6.3%
PA	0	0.0%	4.1%
RI	0	0.0%	0.3%
VT	0	0.0%	0.2%
Other	0	0.0%	0.0%
PR	0	0.0%	0.0%
Other	0	0.0%	0.0%
Total	6	100.0%	100.0%



*Regions based on US Census classification

2019-20 CP Members Classified by Countries

Africa			0
Americas			6
	North America	United States	6
Asia			0
Europe			3
	Western Europe	Germany	2
		France	1
Oceania			1
	Australia and New Zealand	Australia	1
Grand Total			10



**Regions based on United Nations classification*

Complementary Program 2019-20

August 12, 2019 - May 29, 2020

Total Program Members:	10
Total Survey Respondants:	6
Response Rate:	60%

While at MSRI my research program was advanced in the following ways:

Q1. I learned new ideas/techniques which are applicable to my problems

Yes	5	83%
No	1	17%
Total Responses	6	

Q2. I had opportunities to present my work to new audiences

Yes	3	50%
No	3	50%
Total Responses	6	

Q3. I initiated research with new collaborators

Yes	1	17%
No	5	83%
Total Responses	6	

Q4. I initiated research in new areas

Yes	5	83%
No	1	17%
Total Responses	6	

Q5. My research was advanced in these other ways:

[Link to Qualitative Responses](#)

Q6. If your answer to any of the above set of questions was no, what opportunities should MSRI provide to mitigate this?

[Link to Qualitative Responses](#)

Q7. MSRI aims to provide a supportive environment for all program participants. How satisfied were you with this aspect of your experience?

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	6	100%
Total Responses (Exclusive of N/A)	6	100%

Q8. What suggestions would you have for MSRI to provide a more supportive environment?

[Link to Qualitative Responses](#)

MSRI Experience - For Postdoctoral Fellows: Please rate your level of satisfaction with...

Q9. Your assigned mentor:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	2	100%
Total Responses (Exclusive of N/A)	2	100%

Q10. Your overall mentoring experience:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	2	100%
Total Responses (Exclusive of N/A)	2	100%

Q11. The lunch meeting with the directorate:

1 - Least Satisfying	0	0%
2	0	0%
3	1	50%
4	0	0%
5 - Most Satisfying	1	50%
Total Responses (Exclusive of N/A)	2	100%

Q12. What suggestions do you have to improve the mentoring experience at MSRI?[Link to Qualitative Responses](#)**MSRI Experience - For Graduate Students****Q13. How much did the Graduate Student Seminar increase your ability to benefit from MSRI's other scientific activities?**

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	0	0%
Total Responses (Exclusive of N/A)	0	0%

MSRI Experience - Program Seminar: Please rate your level of satisfaction with...**Q14. Learning new ideas and techniques:**

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	4	100%
Total Responses (Exclusive of N/A)	4	100%

Q15. Forming new acquaintances and collaborations:

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	3	100%
Total Responses (Exclusive of N/A)	3	100%

Q16. The opportunity to present your own work:

1 - Least Satisfying	1	50%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	1	50%
Total Responses (Exclusive of N/A)	2	100%

MSRI Experience - General Information**Q17. My office accommodations were**

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	5	100%
Total Responses (Exclusive of N/A)	5	100%

Q18. Professionally, my overall satisfaction with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	6	100%
Total Responses (Exclusive of N/A)	6	100%

MSRI Experience - Feedback

Q19. Did you participate in any of the activities associated with the other MSRI programs or workshops? If so, which ones? Did you find them valuable?

[Link to Qualitative Responses](#)

Q20. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

[Link to Qualitative Responses](#)

Q21. What suggestions would you have for improvements at MSRI?

[Link to Qualitative Responses](#)

Q22. What suggestions would you have for future MSRI programs or workshops?

[Link to Qualitative Responses](#)

MSRI Experience - Computing Services and Facilities

Q23. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	5	100%
Total Responses (Exclusive of N/A)	5	100%

Q24. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	0	0%
3	1	20%
4	0	0%
5 - Most Satisfying	4	80%
Total Responses (Exclusive of N/A)	5	100%

Q25. How could we improve our computing services?

[Link to Qualitative Responses](#)

Q26. How could we improve our computing equipment and software environment?

[Link to Qualitative Responses](#)

MSRI Experience - Relocation Advisory Services: How would you rate the following services you received from MSRI?

Q27. Housing Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	1	25%
4	0	0%
5 - Most Satisfying	3	75%
Total Responses (Exclusive of N/A)	4	100%

Q28. School and Childcare Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	1	100%
Total Responses (Exclusive of N/A)	1	100%

Q29. Visa Assistance

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	3	100%
Total Responses (Exclusive of N/A)	3	100%

Q30. How could we improve our relocation advisory services?

[Link to Qualitative Responses](#)

MSRI Experience - Administrative Support Services

Q31. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	0	0%
5 - Most Satisfying	6	100%
Total Responses (Exclusive of N/A)	6	100%

Q32. How could we improve our administrative services?

[Link to Qualitative Responses](#)

Q33. Your comments about MSRI:

[Link to Qualitative Responses](#)

Connections for Women: Holomorphic Differentials in Mathematics and Physics

August 15, 2019 - August 16, 2019

MSRI, Berkeley, CA, USA

Organizers:

Laura Fredrickson (Stanford University)

Lotte Hollands (Heriot-Watt University, Riccarton Campus)

Qionglin Li (Chern Institute of Mathematics)

Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)

Grace Work (Massachusetts Institute of Technology)

REPORT ON THE MSRI WORKSHOP
**“Connections for Women: Holomorphic Differentials in Mathematics
and Physics”**
August 15 – 16, 2019

Organizers

- Laura Fredrickson (Stanford University)
- Lotte Hollands (Heriot-Watt University, Riccarton Campus)
- Qionglin Li (Chern Institute of Mathematics)
- Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)
- Grace Work (Massachusetts Institute of Technology)

Scientific Description

Holomorphic differentials on Riemann surfaces have long held a distinguished place in low dimensional geometry, dynamics and representation theory. Recently it has become apparent that they constitute a common feature of several other highly active areas of current research in mathematics and also at the interface with physics. In some cases the areas themselves (such as stability conditions on Fukaya-type categories, links to quantum integrable systems, or the physically derived construction of so-called spectral networks) are new, while in others the novelty lies more in the role of the holomorphic differentials (for example in the study of billiards in polygons, special - Hitchin or higher Teichmüller - components of representation varieties, asymptotic properties of Higgs bundle moduli spaces, or in new interactions with algebraic geometry).

It is remarkable how widely scattered are the motivating questions in these areas, and how diverse are the backgrounds of the researchers pursuing them. Bringing together experts in this wide variety of fields to explore common interests and discover unexpected connections was the main goal of the Holomorphic Differentials in Mathematics and Physics semester-long program.

This two-day *Connections for Women* workshop at the beginning of the program consisted of various talks given by prominent female mathematicians on topics of new developments in the role of holomorphic differentials on Riemann surfaces. The workshop was open to all mathematicians.

Highlights of the Workshop

In the panel discussion, Laura Schaposnik (UIC) shared some incredibly practical advice about how she's interacted with the arXiv at the different stages in her career. Earlier on, she would pick one article from the daily e-mail to read for 30 minutes, concluding by sending the author a question. Some of these questions led to collaborations. The audience members were intrigued by this deliberate and concrete practice, and asked many follow-up questions. A few younger participants were later discussing how to implement this themselves, and the personal benefits

like understanding the main point of articles quickly, and learning to ask better questions in seminars.

One of the best talks was given by graduate student Xian Dai (Rice University), who is going on the postdoc job market this year. This was Dai's first chalkboard talk at a conference---a milestone in her career---, and she was excited for the opportunity to speak. To prepare the lecture well, she asked her advisor and academic friends around for good practical advices on how to a nice chalkboard talk. She says "from the preparation of the lecture, I learned first time that giving a good talk is as important as doing good research". As it turned out, she did an amazing job--she didn't even look nervous! In the end, her talk got lots of good feedback from experts in the field.

Another amazing talk was given by Xuwen Zhu (UC Berkeley). She is a postdoc in residence of the microlocal analysis program. People from both programs are interested in her research on the study of Weil-Petersson metric on Teichmüller space using microlocal analysis techniques. Some audience from microlocal analysis program were attracted by her talk on this research to attend our workshop. Meanwhile, her talk also motivated a few members from Holomorphic differential program to continue to participate the introductory workshop in microlocal analysis program to learn more details about the technique. Her talk is cited very often in later communications between people from different programs in occasions like 5-minutes talks, or conversations in lunch meetings.

Organizers

First Name	Last Name	Institution
Laura	Fredrickson	Stanford University
Lotte	Hollands	Heriot-Watt University, Riccarton Campus
Qionglng	Li	Chern Institute of Mathematics
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Grace	Work	Massachusetts Institute of Technology

Speakers

First Name	Last Name	Institution
Anna	Barbieri	University of Sheffield
Xian	Dai	Rice University
Elise	Goujard	Institut de mathématiques de Bordeaux
Natalie	Paquette	California Institute of Technology
Maria Beatrice	Pozzetti	Ruprecht-Karls-Universität Heidelberg
Laura	Schaposnik	University of Illinois at Chicago
Fei	Yan	New High Energy Theory Center
Xuwen	Zhu	University of California, Berkeley

Mathematical Sciences Research Institute

Connections for Women: Holomorphic Differentials in Mathematics and Physics

August 15 to August 16, 2019

Friday, August 15, 2019

9:15AM - 9:30AM	Simons Auditorium		Welcome
9:30AM - 10:30AM	Simons Auditorium	Maria Beatrice Pozzetti	Orbit growth rate for maximal representations
10:30AM - 11:00AM	Atrium		Tea
11:00AM - 12:00PM	Simons Auditorium	Natalie Paquette	(0, 2) dualities and the 4-simplex
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Xuwen Zhu	The moduli space of Riemann surfaces and the Weil-Petersson metric
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium	Fei Yan	q-abelianization for line defects
4:30PM - 5:30PM	Commons		Panel Discussion
5:30PM - 7:00PM	Atrium		Dinner at MSRI

Friday, August 16, 2019

9:30AM - 10:30AM	Simons Auditorium	Laura Schaposnik	Geometric correspondances between singular fibres of the Hitchin fibration
10:30AM - 11:00AM	Atrium		Break
11:00AM - 12:00PM	Simons Auditorium	Xian Dai	Geodesic coordinates for the pressure metric along fuchsias locus
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Anna Barbieri	Kontsevich-Soibelman wall-crossing formula and a Riemann-Hilbert problem
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium	Elise Goujard	Volumes of principal strata of quadratic differentials and intersection numbers



Participants

First Name	Last Name	Institution
Dylan	Allegretti	MSRI - Mathematical Sciences Research Institute
Hanan	Alolaiyan	King Saud University
Jayadev	Athreya	University of Washington
Anna	Barbieri	University of Sheffield
Steven	Bradlow	University of Illinois at Urbana-Champaign
Marc	Burger	ETH Zürich
Daniel	Chupin	University of California, Berkeley
Brian	Collier	University of Maryland
Xian	Dai	Rice University
Melissa	Darejeh	Raytheon Company
Anda	Degeratu	Universität Stuttgart
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Kealey	Dias	Bronx Community College
Shanna	Dobson	University of California, Los Angeles
Samantha	Fairchild	University of Washington
James	Farre	Yale University
Hugo	Federico	Université de Paris XI
Steven	Flynn	University of California, Santa Cruz
Laura	Fredrickson	Stanford University
Elise	Goujard	Institut de mathématiques de Bordeaux
Johannes	Horn	Ruprecht-Karls-Universität Heidelberg
Alessandra	Iozzi	ETH Zürich
Robert	Korsan	Carnegie Mellon University
Heather	Lee	University of Washington
Dami	Lee	University of Washington
Chanel	Lee	California State University
Qiongling	Li	Chern Institute of Mathematics
John	Loftin	Rutgers University
Pietro	Longhi	ETH Zurich
Marta	Magnani	Ruprecht-Karls-Universität Heidelberg
Arnaud	Maret	Ruprecht-Karls-Universität Heidelberg
Martin	Moeller	Johann Wolfgang Goethe-Universität Frankfurt
Katrina	Morgan	MSRI - Mathematical Sciences Research Institute
Andrew	Neitzke	University of Texas, Austin
Stephane	Nonnenmacher	Université de Paris XI
Chaya	Norton	University of Michigan
Natalie	Paquette	California Institute of Technology
Du	Pei	California Institute of Technology
Mareike	Pfeil	Ruprecht-Karls-Universität Heidelberg
Maria Beatrice	Pozzetti	Ruprecht-Karls-Universität Heidelberg
Alexander	Rasmussen	Yale University
Daniel	Roggenkamp	Universität Mannheim
Evgenii	Rogozinnikov	Ruprecht-Karls-Universität Heidelberg
Barbara	Sanborn	Whitman College

Participants

First Name	Last Name	Institution
Laura	Schaposnik	University of Illinois at Chicago
John	Smillie	University of Warwick
Peter	Smillie	California Institute of Technology
Tom	Sutherland	University of Lisbon
Alex	Takeda	University of California, Berkeley
Andrea Hanna	Thevis	Universität des Saarlandes
Karen	Vogtmann	University of Warwick
Richard	Wentworth	University of Maryland
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Michael	Wolf	Rice University
Grace	Work	Massachusetts Institute of Technology
Fei	Yan	New High Energy Theory Center
Yuan	Yao	University of California, Berkeley
Ione	Zarate	Rutgers University
Xuwen	Zhu	University of California, Berkeley

Officially Registered Participants Information

Participants		59
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Gender		59
Male	49.15%	29
Female	50.85%	30
Declined to state	0.00%	0

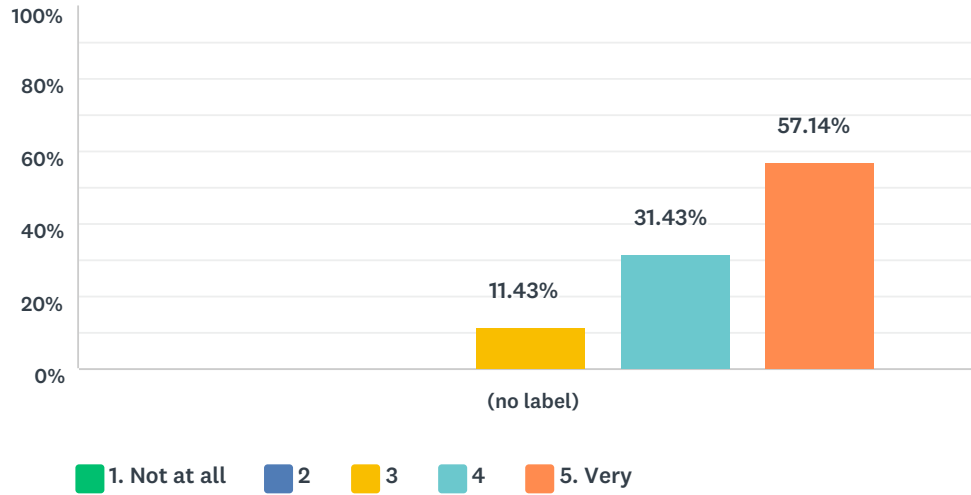
Ethnicity*		63
White	68.25%	43
Asian	17.46%	11
Hispanic	4.76%	3
Pacific Islander	0.00%	0
Black	1.59%	1
Native American	0.00%	0
Mixed	3.17%	2
Declined to state	4.76%	3

* ethnicity specifications are not exclusive

35 out of 59 participants = 59% response rate

Q1 The workshop was intellectually stimulating

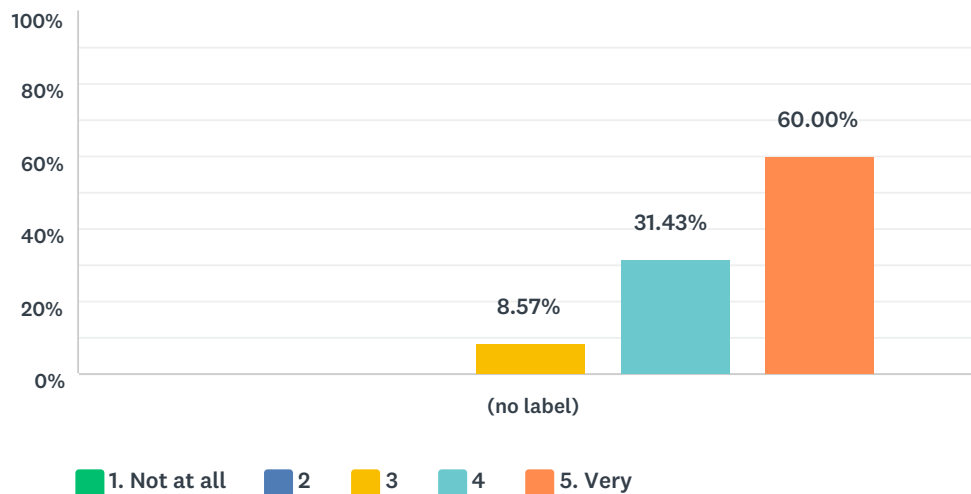
Answered: 35 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	11.43%	31.43%	57.14%	35	4.46
	0	0	4	11	20		

Q2 The overall experience of the workshop was worthwhile

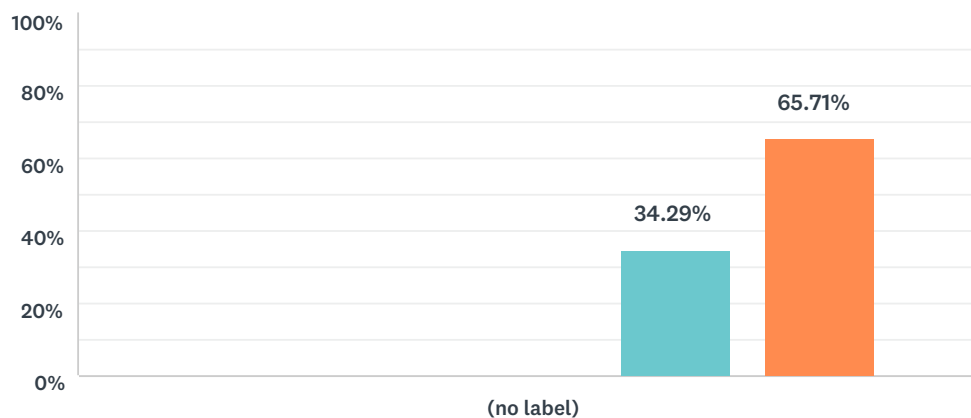
Answered: 35 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	8.57%	31.43%	60.00%	35	4.51
	0	0	3	11	21		

Q3 The time between lectures was adequate for discussion

Answered: 35 Skipped: 0



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	34.29%	65.71%		
	0	0	0	12	23	35	4.66

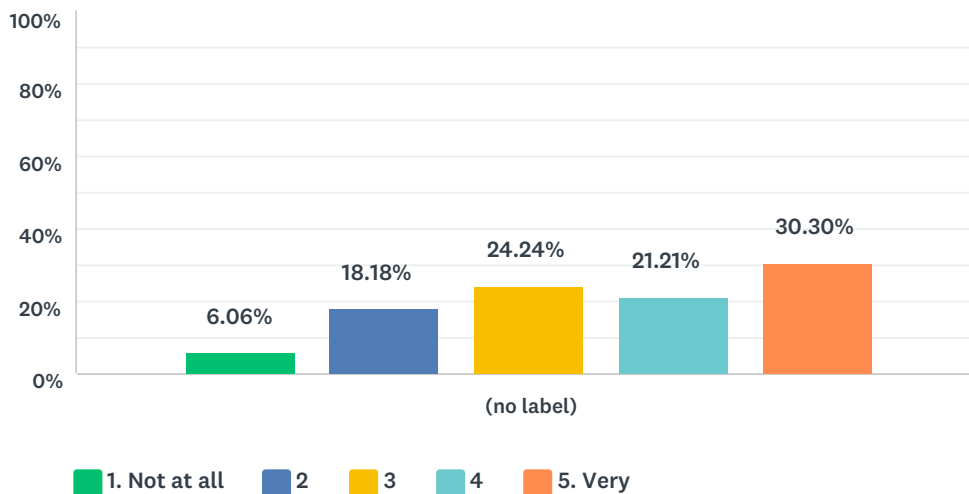
Q4 Additional comments

Answered: 5 Skipped: 30

#	RESPONSES	DATE
1	I think that the workshop was really good for the researchers who are in the field and are familiar with its problems and its techniques. However, many women seemed to be not right in the field, and therefore, I had the feeling that the talks in the workshop were way too technical. This would have been fine, if the talks were right after the Introductory workshop (the week after), in which the main techniques and the corresponding problems were presented. (This works also for other connection workshops.) My personal opinion was that the big picture of the program and the motivation was kind of missing. I will suggest to start the connection workshop with an overview talk, discussing the main problems of the field and the techniques available so far. And it really has to be at graduate student level, if the audience is so diverse.	9/12/2019 2:48 AM
2	The lectures were at wildly different levels, only about half seemed to be at an introductory level.	8/23/2019 1:18 PM
3	The only bad point in my opinion is the lunch. But that's probably because I'm a picky, traditionalist European.	8/22/2019 6:00 AM
4	The group of mathematicians attending the workshop was diverse which was ideal for learning new ideas. The experience of this workshop was inspiring. I especially enjoyed the panel discussion.	8/21/2019 1:57 PM
5	I enjoyed many things including the panel discussion on career development but I also think round table discussions could be helpful. Say, have people from different levels (professor, assistant professor, lecturer, postdoc, graduate student, etc) sit together and with a prepared list of questions to discuss. I've seen this in a women in math conference before and I really liked it.	8/21/2019 11:11 AM

Q5 I was well prepared to benefit from the lectures

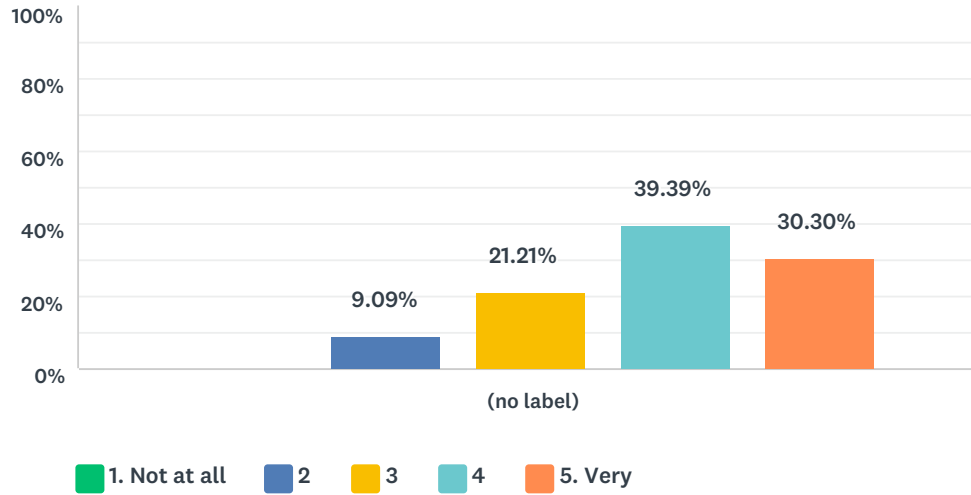
Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	6.06%	18.18%	24.24%	21.21%	30.30%	33	3.52
	2	6	8	7	10		

Q6 My interest in the subject matter was increased by the workshop

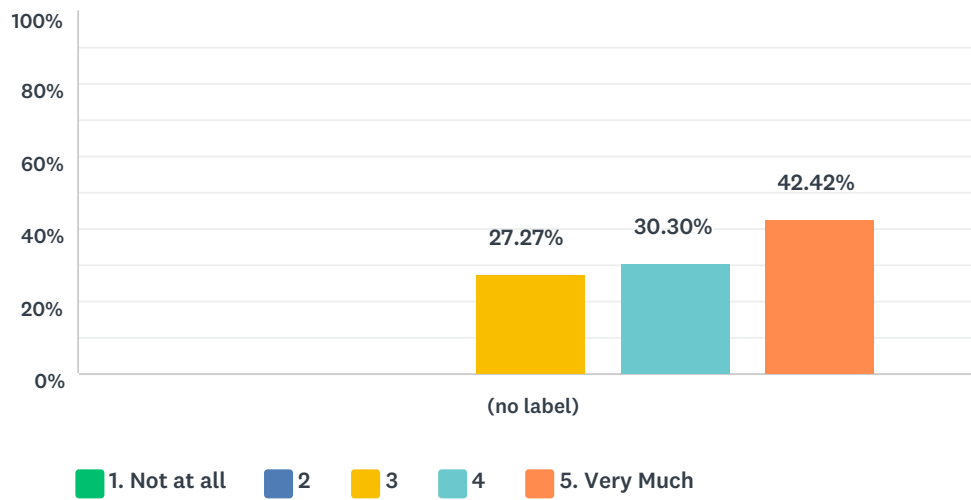
Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	9.09%	21.21%	39.39%	30.30%	33	3.91
	0	3	7	13	10		

Q7 The workshop helped me meet people with similar scientific interests

Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	27.27%	30.30%	42.42%	33	4.15
	0	0	9	10	14		

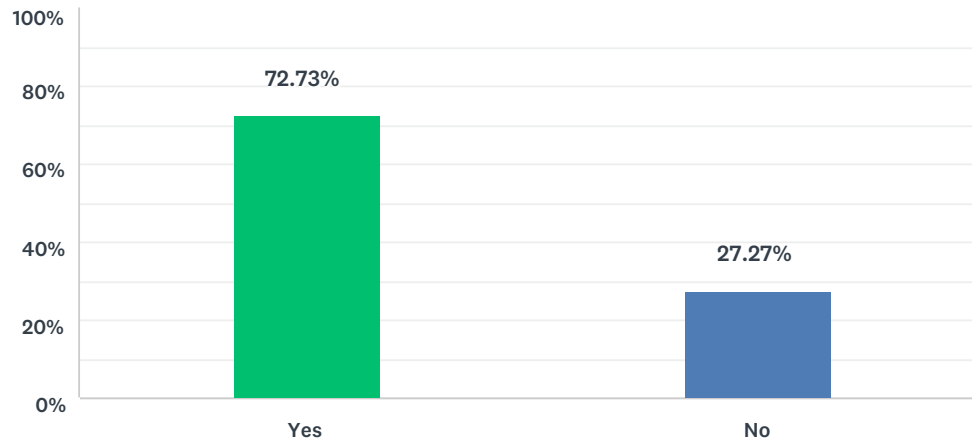
Q8 Additional comments on your personal assessment

Answered: 0 Skipped: 35

#	RESPONSES	DATE
	There are no responses.	

Q9 Did you attend the panel discussion?

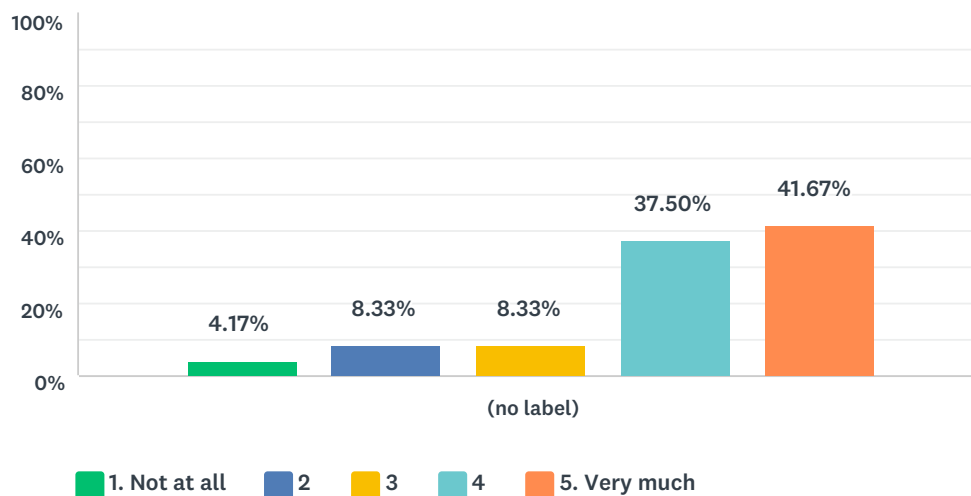
Answered: 33 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	72.73%	24
No	27.27%	9
TOTAL		33

Q10 Did you find the panel discussion worthwhile?

Answered: 24 Skipped: 11



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	4.17%	8.33%	8.33%	37.50%	41.67%	24	4.04
	1	2	2	9	10		

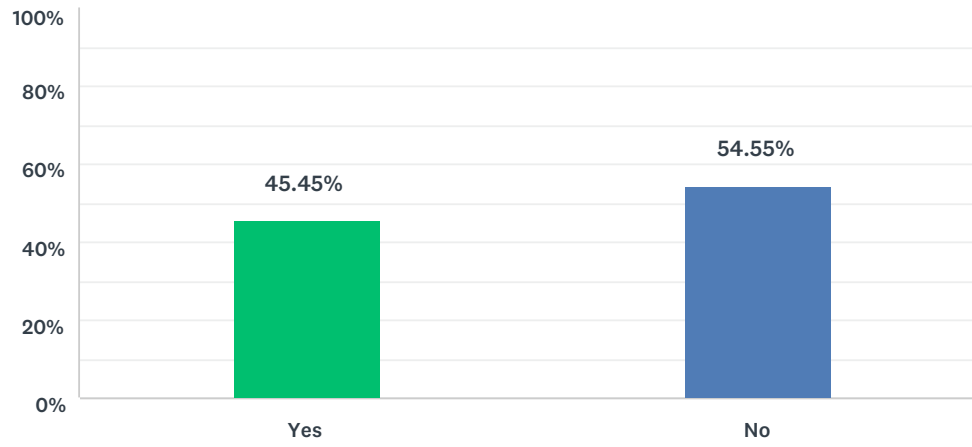
Q11 What other subjects should be discussed in future panel discussions?

Answered: 5 Skipped: 30

#	RESPONSES	DATE
1	The format the moderator used was not reasonable	9/11/2019 10:15 AM
2	I think the discussion would have benefitted from more interaction among the panelists and the audience.	8/23/2019 1:18 PM
3	I would be interested in a targeted discussion for mothers though this is a subset of the female mathematicians.	8/21/2019 1:58 PM
4	The panel discussion was very interesting for me. A longer time slot would have even better in my opinion.	8/21/2019 12:54 PM
5	How to improve research writing/projects?	8/21/2019 12:30 PM

Q12 Did you attend the dinner?

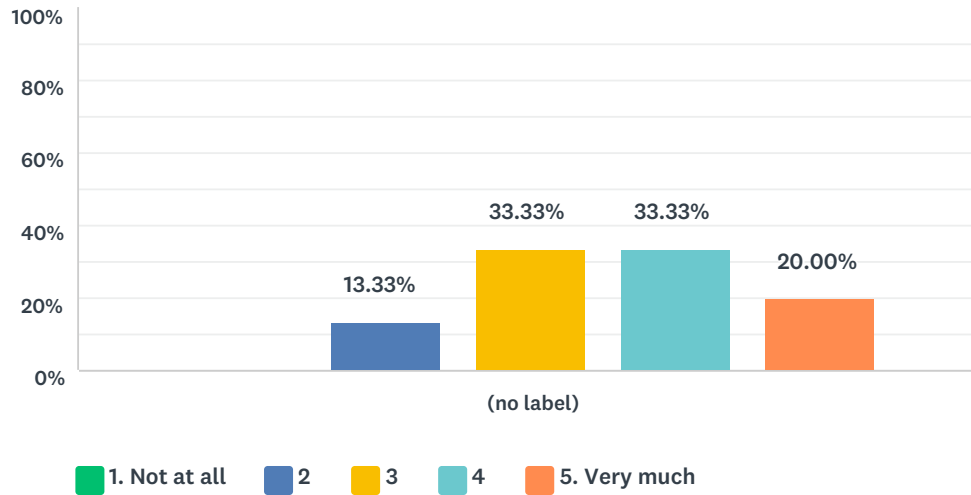
Answered: 33 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	45.45%	15
No	54.55%	18
TOTAL		33

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 15 Skipped: 20



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	13.33%	33.33%	33.33%	20.00%	15	3.60
	0	2	5	5	3		

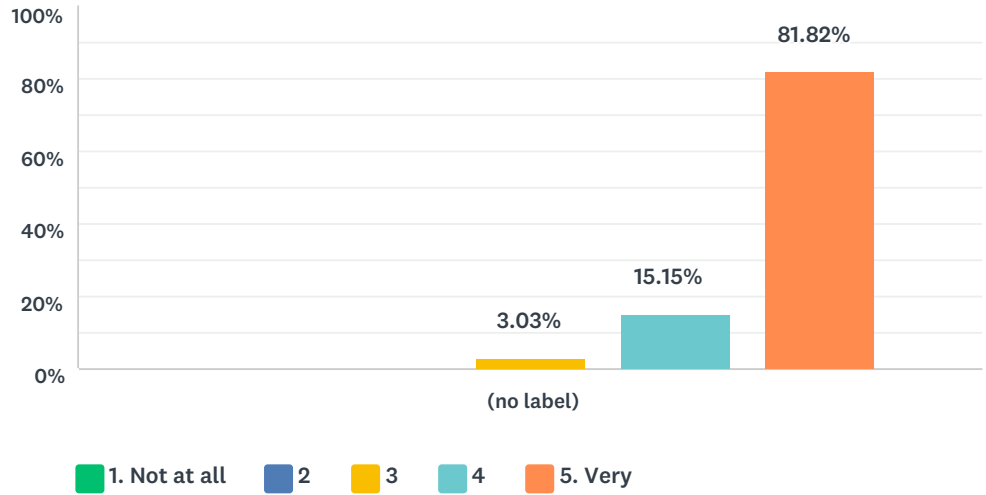
Q14 Please provide any comments about the dinner

Answered: 3 Skipped: 32

#	RESPONSES	DATE
1	We didn't really know what to talk about relating to women's issues, so it was just a regular dinner. The point of the segregated dinner was unclear.	9/12/2019 5:05 AM
2	Good brownie, the rest was mediocre at best	9/11/2019 10:15 AM
3	It would have helped to have more time. Maybe to have some reservation at a bar or restaurant to meet in an informal surrounding. It was sometimes hard to change the table and to get to know the people at other tables. Maybe it would have helped to have finger food or not to sit at the tables to engage people to talk to more people.	8/21/2019 12:54 PM

Q15 I found the MSRI staff helpful

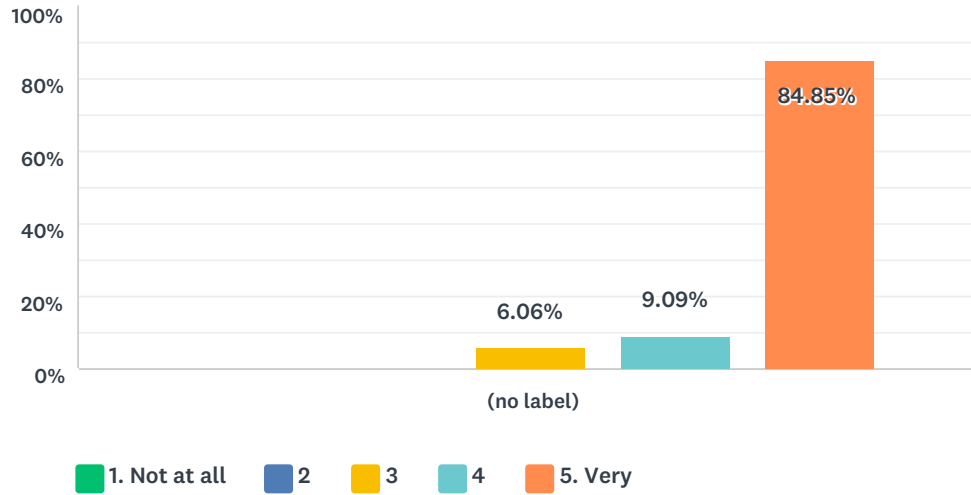
Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.03%	15.15%	81.82%	33	4.79
	0	0	1	5	27		

Q16 The MSRI facilities were conducive for such a workshop

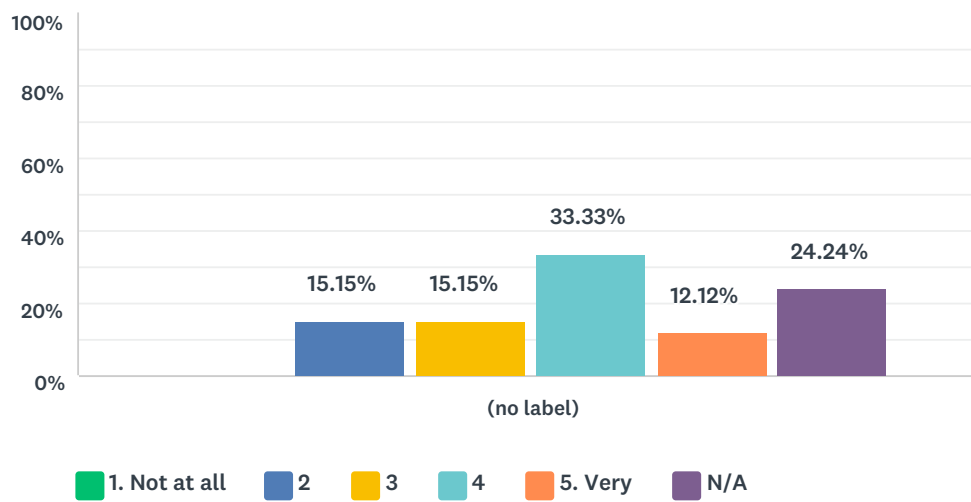
Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.06%	9.09%	84.85%	33	4.79
	0	0	2	3	28		

Q17 The MSRI lunch arrangements were satisfactory

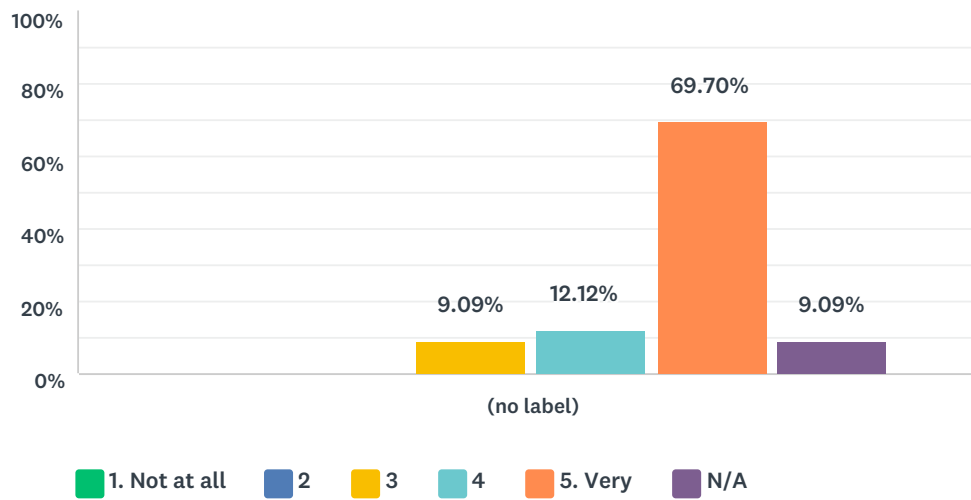
Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	15.15%	15.15%	33.33%	12.12%	24.24%	33	3.56
	0	5	5	11	4	8		

Q18 The MSRI tea arrangements were satisfactory

Answered: 33 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.09%	12.12%	69.70%	9.09%	33	4.67
	0	0	3	4	23	3		

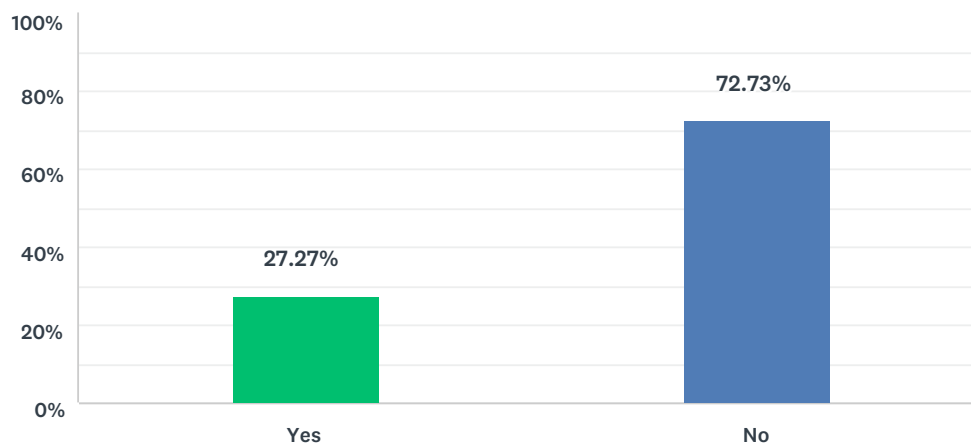
Q19 Additional comments about MSRI staff, facilities and food

Answered: 2 Skipped: 33

#	RESPONSES	DATE
1	Thanks!	8/23/2019 1:18 PM
2	A bit of variety in the lunch arrangements would have been good.	8/23/2019 7:53 AM

Q20 Did you use the computer facilities located in the library?

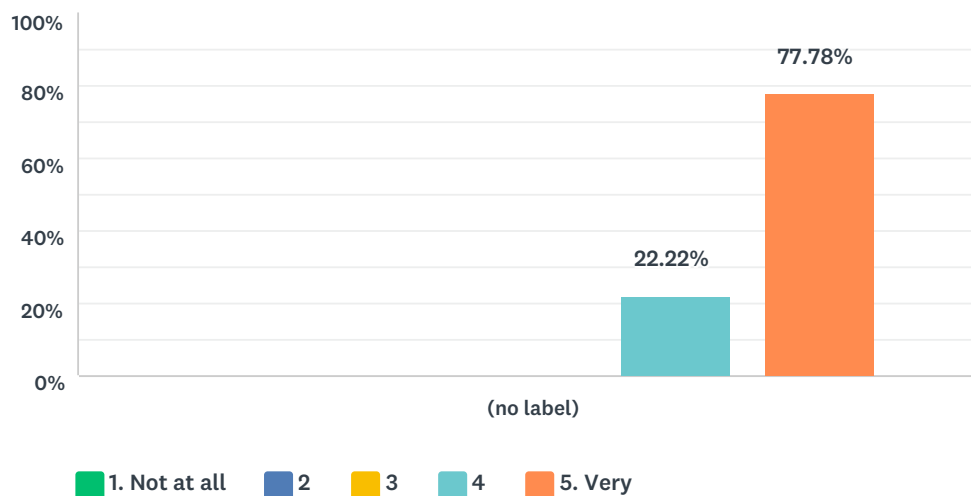
Answered: 33 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	27.27%	9
No	72.73%	24
TOTAL		33

Q21 The MSRI computer facilities in the library were adequate

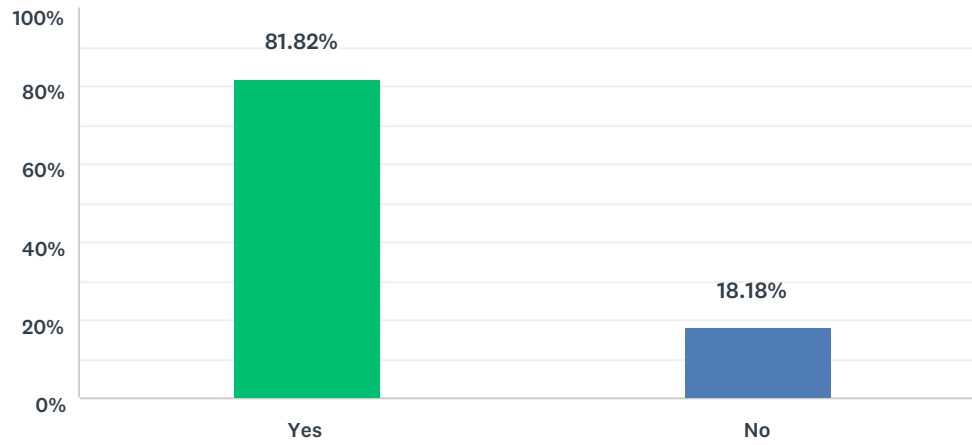
Answered: 9 Skipped: 26



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	22.22%	77.78%	9	4.78
	0	0	0	2	7		

Q22 Did you use MSRI's wireless network?

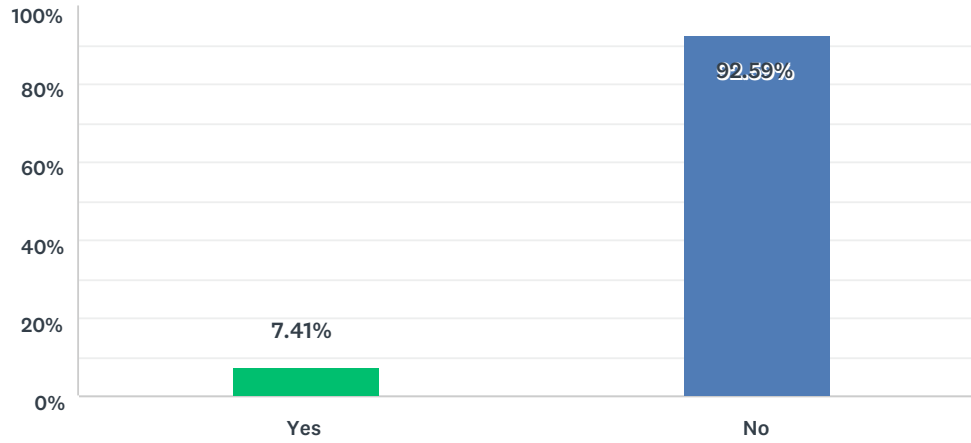
Answered: 33 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	81.82%	27
No	18.18%	6
TOTAL		33

Q23 Did you experience any difficulties with the network?

Answered: 27 Skipped: 8



ANSWER CHOICES	RESPONSES	
Yes	7.41%	2
No	92.59%	25
TOTAL		27

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	It does not work well in some places	9/11/2019 11:18 AM
2	not always great reception in some parts of the building, especially in some parts of the ground floor and inside offices of the top floor	8/21/2019 2:04 PM
3	There are only 5G networks, old phones do not have WiFi connection.	8/21/2019 10:01 AM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 31

#	RESPONSES	DATE
1	Instead of making a separate workshop with female speakers, maybe the efforts would be better spent incorporating more female speakers into the regular program.	9/12/2019 5:06 AM
2	I hope to be back at MSRI	8/21/2019 1:59 PM
3	For me it would have been helpful to have had the introduction workshop before the connections for women. First of all, because they would have helped me to understand the talks better. But also because I got to know other participants better during the introductory workshop and networking would have been easier for me. Still, I really enjoyed the workshop and it was motivating to see that many role models.	8/21/2019 12:59 PM
4	Visa issues might be tricky and some people doesn't even know what specific question to ask. I would appreciate more explicit help with this, and maybe specific instruction per country/position.	8/21/2019 9:47 AM

Introductory Workshop: Holomorphic Differentials in Mathematics and Physics

August 19, 2019 - August 23, 2019

MSRI, Berkeley, CA, USA

Organizers:

Jayadev Athreya (University of Washington)

Sergei Gukov (California Institute of Technology)

Andrew Neitzke (University of Texas, Austin)

Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)

REPORT ON THE MSRI WORKSHOP
**“Introductory Workshop: Holomorphic Differentials in Mathematics and
Physics”**
August 19 – 23, 2019

Organizers

- Jayadev Athreya (University of Washington)
- Sergei Gukov (California Institute of Technology)
- Andrew Neitzke (University of Texas, Austin)
- Anna Wienhard (Ruprecht-Karls-Universität Heidelberg)

Scientific Description

Holomorphic differentials on Riemann surfaces have long held a distinguished place in low dimensional geometry, dynamics and representation theory. Recently it has become apparent that they constitute a common feature of several other highly active areas of current research in mathematics and also at the interface with physics. In some cases the areas themselves (such as stability conditions on Fukaya-type categories, links to quantum integrable systems, or the physically derived construction of so-called spectral networks) are new, while in others the novelty lies more in the role of the holomorphic differentials (for example in the study of billiards in polygons, special - Hitchin or higher Teichmüller - components of representation varieties, asymptotic properties of Higgs bundle moduli spaces, or in new interactions with algebraic geometry).

It is remarkable how widely scattered are the motivating questions in these areas, and how diverse are the backgrounds of the researchers pursuing them. Bringing together experts in this wide variety of fields to explore common interests and discover unexpected connections was the main goal of the Holomorphic Differentials in Mathematics and Physics semester-long program.

Holomorphic differentials on Riemann surfaces have long held a distinguished place in low dimensional geometry, dynamics and representation theory. Recently it has become apparent that they constitute a common feature of several other highly active areas of current research in mathematics and also at the interface with physics. In the introductory workshop, we brought junior and senior researchers from this diverse range of subjects together in order to explore common themes and unexpected connections.

Highlights of the Workshop

The workshop consisted of four 3-lecture minicourses and four research lectures. We kept Wednesday and Friday afternoons free in order to facilitate informal discussions. The four minicourses were meant to introduce the broad workshop audience to the range of topics in the program, and consisted of Mike Wolf speaking on Holomorphic Differentials, Elise Goujard on Flat surfaces and the $GL(2, \mathbb{R})$ action, Qionglin Li on Higgs Bundles, and Du Pei on BPS states. The research lectures, towards the end of the workshop, were by Brian Collier, Laura

Frederickson, Dylan Allegretti, and Marc Burger. The way the courses dovetailed toward the end, with concepts from one appearing in different guises in the other, and the deep connections to the research talks, was a particular highlight. In particular, Wolf's lectures, introducing holomorphic differentials in a variety of contexts, naturally connected to Li's and Goujard's. Li's beautiful series of lectures used a principle-G bundle perspective on Higgs bundles which was wonderful to build connections to differential geometric ideas and in particular Lie theory, an idea built upon by Collier in his research talk. Goujard introduced the flat geometry of differentials, which was built upon by Allegretti in his talk on polynomial quadratic differentials on CP^1 , which he motivated by the classical theory of differential equations. This in turn built connections to Du Pei's lectures, where he discussed BPS states arising from various families of differential equations (with the addition of supersymmetry).

Organizers

First Name	Last Name	Institution
Jayadev	Athreya	University of Washington
Sergei	Gukov	California Institute of Technology
Andrew	Neitzke	University of Texas, Austin
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg

Speakers

First Name	Last Name	Institution
Dylan	Allegretti	MSRI - Mathematical Sciences Research Institute
Marc	Burger	ETH Zürich
Brian	Collier	University of Maryland
Laura	Fredrickson	Stanford University
Elise	Goujard	Institut de mathématiques de Bordeaux
Qionglng	Li	Chern Institute of Mathematics
Du	Pei	California Institute of Technology
Michael	Wolf	Rice University

Mathematical Sciences Research Institute

Introductory Workshop: Holomorphic Differentials in Mathematics and Physics

August 19 - 23, 2019

Monday, August 19, 2019

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Michael Wolf	Introduction to holomorphic differentials, I
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Elise Goujard	An introduction to flat surfaces - I
12:00 PM - 2:15 PM	Atrium		Lunch
2:15 PM - 3:15 PM	Simons Auditorium	Qiongling Li	An introduction to Higgs bundles - I
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 4:45 PM	Simons Auditorium	Du Pei	Geometry and Physics of BPS States - I

Tuesday, August 20, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Michael Wolf	Introduction to holomorphic differentials, II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Elise Goujard	An introduction to flat surfaces - II
12:00 PM - 2:15 PM	Atrium		Lunch
2:15 PM - 3:15 PM	Simons Auditorium	Qiongling Li	An introduction to Higgs bundles - II
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 4:45 PM	Simons Auditorium	Du Pei	Geometry and Physics of BPS States - II
4:45 PM - 6:20 PM	Atrium		Reception

Wednesday, August 21, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Michael Wolf	Introduction to holomorphic differentials, III
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Elise Goujard	An introduction to flat surfaces - III

Thursday, August 22, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Dylan Allegretti	TBA
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Laura Fredrickson	The asymptotic geometry of the Hitchin moduli space
12:00 PM - 2:15 PM	Atrium		Lunch
2:15 PM - 3:15 PM	Simons Auditorium	Qiongling Li	An introduction to Higgs bundles - III
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 4:45 PM	Simons Auditorium	Du Pei	Geometry and Physics of BPS States - III

Friday, August 23, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Marc Burger	Maximal Representations, real Spectrum, and harmonic Maps
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Brian Collier	Magical nilpotents and higher Teichmuller spaces
12:00 PM - 2:15 PM	Atrium		Lunch



Participants

First Name	Last Name	Institution
Fernando	Al Assal	Yale University
Dylan	Allegretti	MSRI - Mathematical Sciences Research Institute
Jayadev	Athreya	University of Washington
David	Aulicino	Brooklyn College CUNY
Tracey	Balehowsky	University of Helsinki
Anna	Barbieri	University of Sheffield
Dori	Bejleri	Massachusetts Institute of Technology
Jonas	Beyrer	Ruprecht-Karls-Universität Heidelberg
Evans	Boadi	Brock University
Steven	Bradlow	University of Illinois at Urbana-Champaign
Marc	Burger	ETH Zürich
Claire	Burrin	Rutgers University
Aaron	Calderon	Yale University
Brian	Collier	University of Maryland
Khalifa	dabbek	Faculté des sciences de Gabès
Xian	Dai	Rice University
Anda	Degeratu	Universität Stuttgart
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Kealey	Dias	Bronx Community College
Benjamin	Dozier	State University of New York, Stony Brook
Eduard	Duryev	Institut de Mathematiques de Jussieu
Philip	Engel	University of Georgia
Nikolaos	Eptaminitakis	University of Washington
Samantha	Fairchild	University of Washington
James	Farre	Yale University
Hugo	Federico	Université de Paris XI
Charles	Fougeron	MSRI - Mathematical Sciences Research Institute
Laura	Fredrickson	Stanford University
Elise	Goujard	Institut de mathématiques de Bordeaux
Samuel	Grushevsky	State University of New York, Stony Brook
Qianyu	Hao	University of Texas, Austin
Johannes	Horn	Ruprecht-Karls-Universität Heidelberg
Zheng	Huang	CUNY, Graduate Center
Alessandra	Iozzi	ETH Zürich
Nada	Khogeer	University of San Francisco
Heather	Lee	University of Washington
Dami	Lee	University of Washington
Qionglng	Li	Chern Institute of Mathematics
Luen-Chau	Li	Pennsylvania State University
John	Loftin	Rutgers University
Pietro	Longhi	ETH Zurich
Marcello	Lucia	CUNY, Graduate Center
Bob	Lutz	University of Michigan
Mark	Macerato	University of California, Berkeley

Participants

First Name	Last Name	Institution
Marta	Magnani	Ruprecht-Karls-Universität Heidelberg
Albert	Marden	University of Minnesota, Twin Cities
Arnaud	Maret	Ruprecht-Karls-Universität Heidelberg
Sven	Marquardt	Christian-Albrechts Universität Kiel
Howard	Masur	University of Chicago
Rafe	Mazzeo	Stanford University
Yair	Minsky	Yale University
Martin	Moeller	Johann Wolfgang Goethe-Universität Frankfurt
Kirk	Morgan	University of the West Indies, Mona
Benedict	Morrissey	University of Pennsylvania
Xuesen	Na	University of Maryland
Andrew	Neitzke	University of Texas, Austin
Stephane	Nonnenmacher	Université de Paris XI
Chaya	Norton	University of Michigan
Kunio	Obitsu	Kagoshima University
Andrew	Ortegaray	California Institute of Technology
Charles	Ouyang	Rice University
Du	Pei	California Institute of Technology
John Gabriel	Pelias	University of California, Santa Cruz
Mareike	Pfeil	Ruprecht-Karls-Universität Heidelberg
Maria Beatrice	Pozzetti	Ruprecht-Karls-Universität Heidelberg
Alexander	Rasmussen	Yale University
Daniel	Roggenkamp	Universität Mannheim
Evgenii	Rogozinnikov	Ruprecht-Karls-Universität Heidelberg
Nathaniel	Sagman	California Institute of Technology
Barbara	Sanborn	Whitman College
Anthony	Sanchez	University of Washington
Laura	Schaposnik	University of Illinois at Chicago
Sebastian	Schulz	University of Texas, Austin
Michael	Shapiro	Michigan State University
Michael	Singer	University College
John	Smillie	University of Warwick
Peter	Smillie	California Institute of Technology
Weixu	Su	Fudan University
Tom	Sutherland	University of Lisbon
Diaaeldin	Taha	University of Washington
Alex	Takeda	University of California, Berkeley
Andrea	Tamburelli	Rice University
Andrea Hanna	Thevis	Universität des Saarlandes
Caglar	Uyanik	Yale University
Karen	Vogtmann	University of Warwick
Gabriela	Weitze-Schmithu	Universität des Saarlandes
Richard	Wentworth	University of Maryland
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg

Participants

First Name	Last Name	Institution
Michael	Wolf	Rice University
Fei	Yan	Rutgers University
Ione	Zarate	Rutgers University
Xuwen	Zhu	University of California, Berkeley
Anton	Zorich	Institut de Mathematiques de Jussieu

Officially Registered Participants Information

Participants		93
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Gender		93
Male	68.82%	64
Female	30.11%	28
Declined to state	1.08%	1

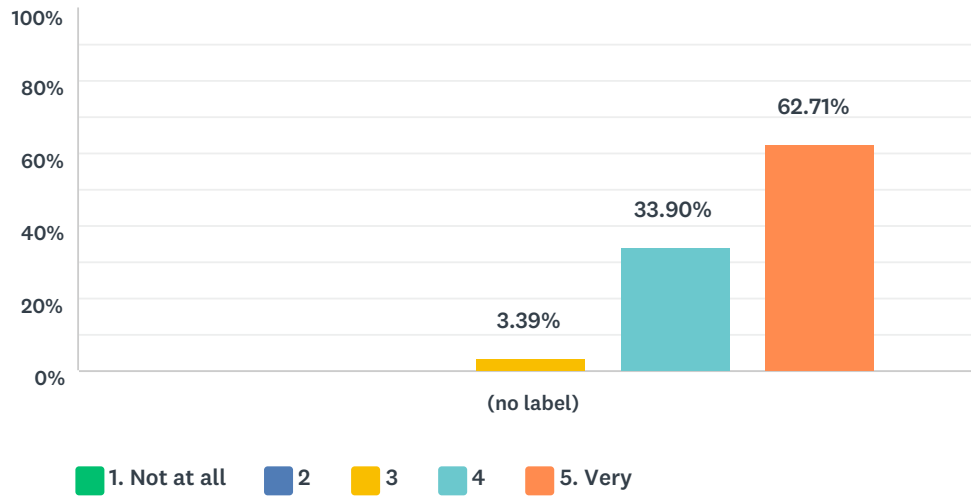
Ethnicity*		101
White	63.37%	64
Asian	18.81%	19
Hispanic	5.94%	6
Pacific Islander	0.00%	0
Black	1.98%	2
Native American	0.00%	0
Mixed	3.96%	4
Declined to state	5.94%	6

* ethnicity specifications are not exclusive

59 responses out of 93 participants = 63% response rate

Q1 The workshop was intellectually stimulating

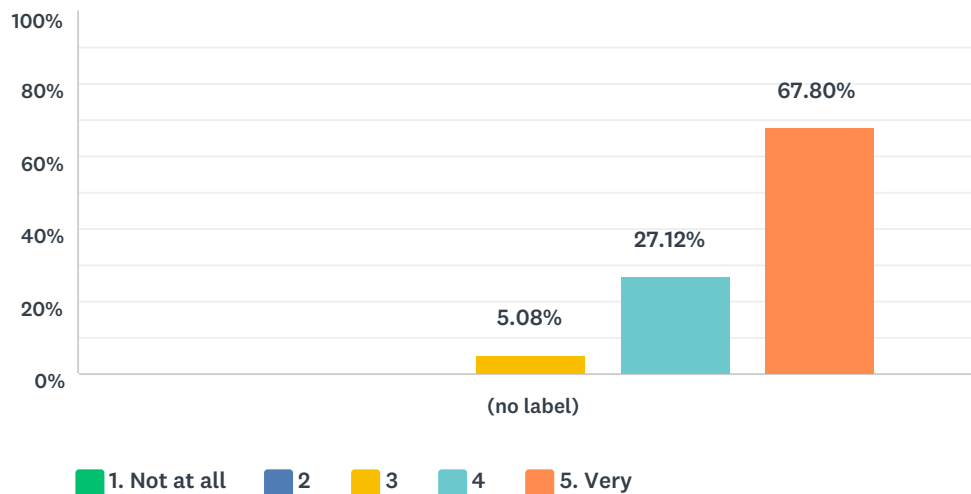
Answered: 59 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.39%	33.90%	62.71%	59	4.59
	0	0	2	20	37		

Q2 The overall experience of the workshop was worthwhile

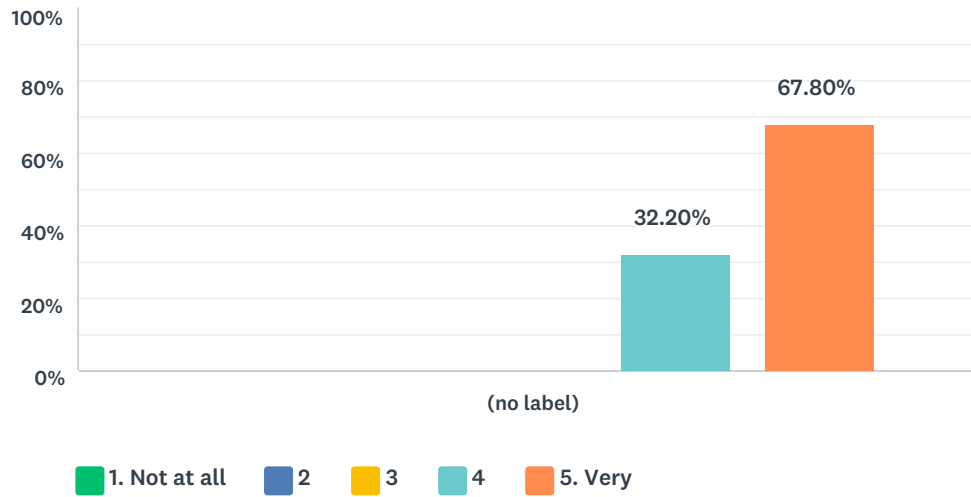
Answered: 59 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	5.08%	27.12%	67.80%	59	4.63
	0	0	3	16	40		

Q3 The time between lectures was adequate for discussion

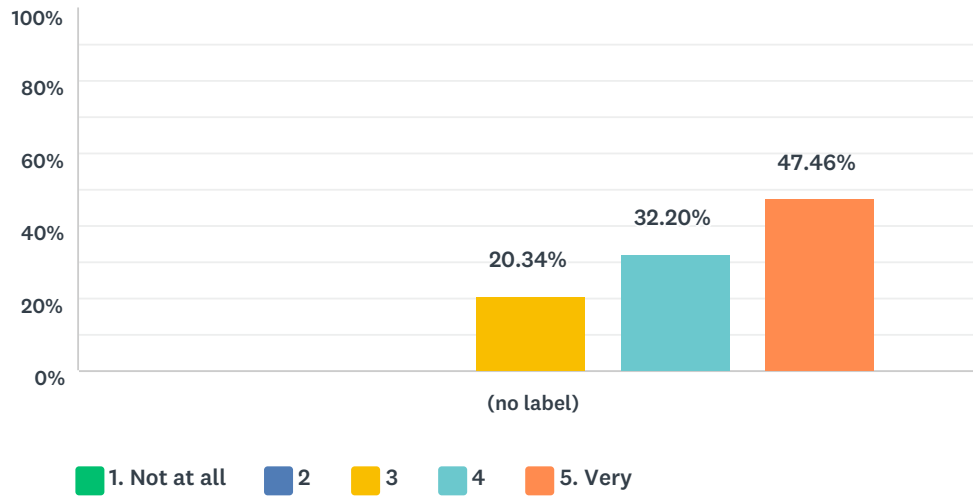
Answered: 59 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	32.20%	67.80%	59	4.68
	0	0	0	19	40		

Q4 The lectures were at at an appropriate level

Answered: 59 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	20.34%	32.20%	47.46%	59	4.27
	0	0	12	19	28		

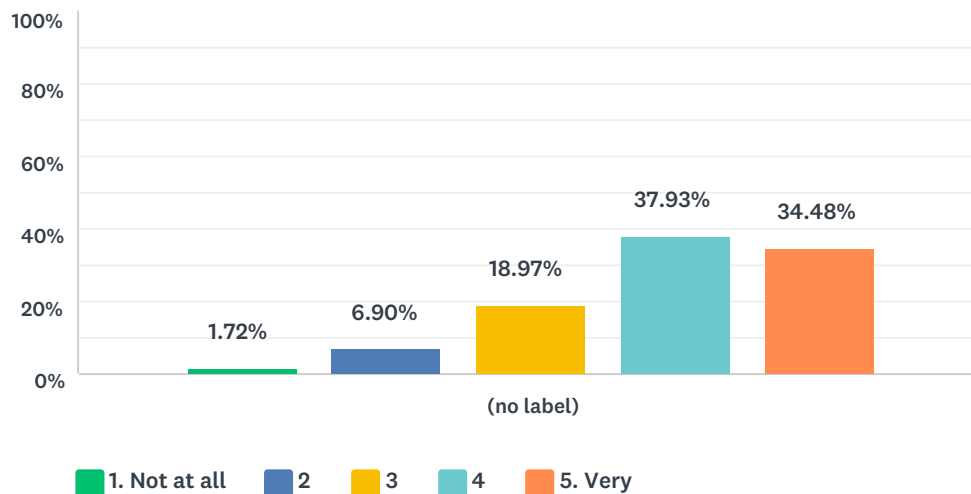
Q5 Additional comments

Answered: 7 Skipped: 52

#	RESPONSES	DATE
1	The workshop is definitely pitched at people outside the program, and that is appropriate. It was well done! Mike Wolf and Qiongling Li in particular gave beautiful sets of lectures. As a part of the HDMP program, the biggest benefit for me was just having people around to talk to.	9/17/2019 1:27 AM
2	The big range in interests and specialties made it difficult to get much out of talks that were away from my specialty and so that when talks were close to my areas, I did not get much either. There were also some very good talks.	9/16/2019 9:19 AM
3	It's my first time to attend MSRI workshop. It was a great experience and the lectures were meaningful and understandable. I learned of new things.	9/9/2019 8:50 PM
4	The lectures were a great mix of perspectives on the general topic.	9/9/2019 4:28 AM
5	The mini courses were fantastic!	8/25/2019 6:03 AM
6	Re 4 -- I was hoping for some lectures bridging the gap between the physics and mathematics aspects. This is a particularly difficult gap to bridge.	8/25/2019 1:26 AM
7	The lectures were rather hit or miss - some of them went very well, and some were way too fast for newbies to the field (and I'd assume too slow for experts)	8/23/2019 10:50 AM

Q6 I was well prepared to benefit from the lectures

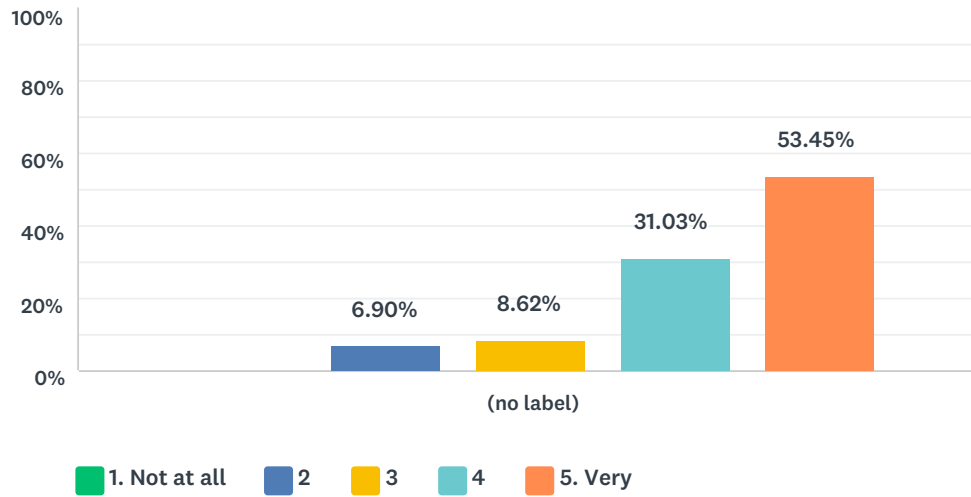
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.72%	6.90%	18.97%	37.93%	34.48%	58	3.97
	1	4	11	22	20		

Q7 My interest in the subject matter was increased by the workshop

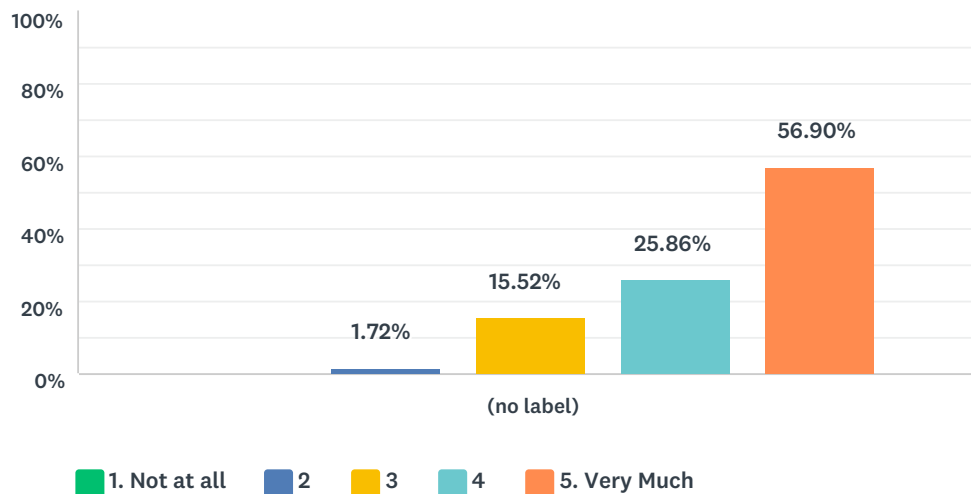
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	6.90%	8.62%	31.03%	53.45%	58	4.31
	0	4	5	18	31		

Q8 The workshop helped me meet people with similar scientific interests

Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.72%	15.52%	25.86%	56.90%	58	4.38
	0	1	9	15	33		

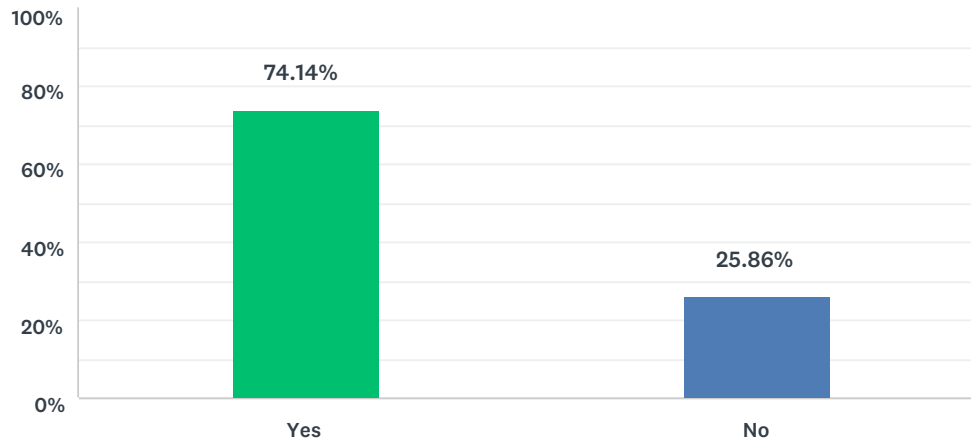
Q9 Additional comments on your personal assessment

Answered: 2 Skipped: 57

#	RESPONSES	DATE
1	It was beneficial to be in the same location as many of my collaborators (and other people I would like to work with in the future).	9/9/2019 4:29 AM
2	The workshop gave me the opportunities to meet many researchers I had wanted to meet.	8/25/2019 6:04 AM

Q10 Did you attend the reception?

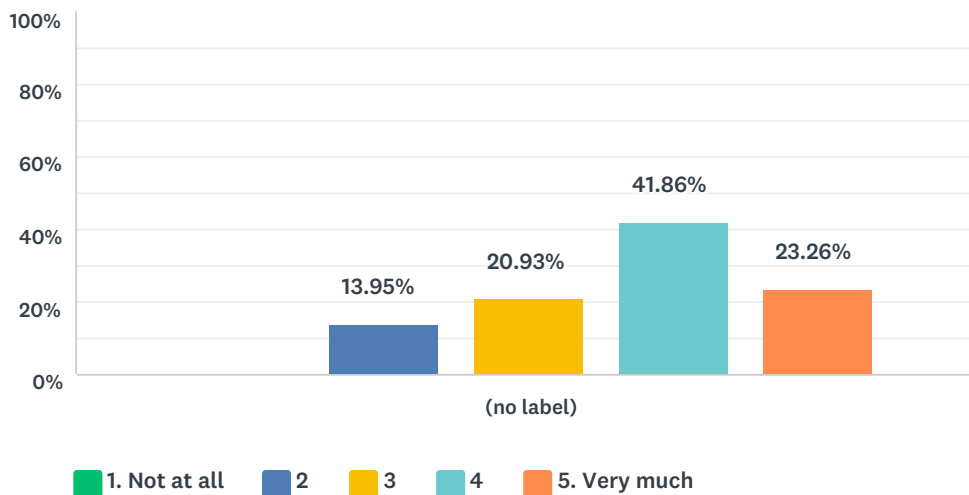
Answered: 58 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	74.14%	43
No	25.86%	15
TOTAL		58

Q11 Did the reception help to solidify the contacts you made during the workshop?

Answered: 43 Skipped: 16



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	13.95%	20.93%	41.86%	23.26%	43	3.74
	0	6	9	18	10		

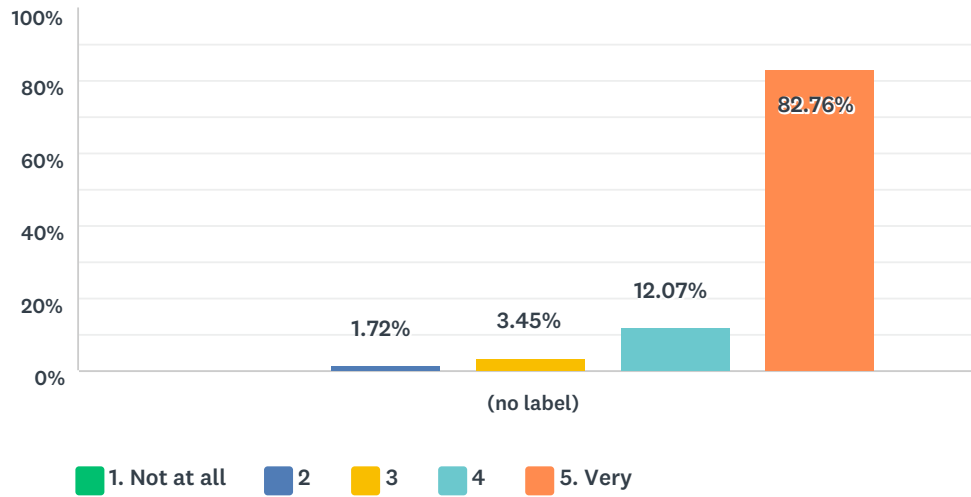
Q12 Please provide any comments about the reception

Answered: 4 Skipped: 55

#	RESPONSES	DATE
1	It was very nice! Thanks.	9/16/2019 9:19 AM
2	The food was great, it would have been nice to have a little more mingling happen.	8/23/2019 10:51 AM
3	The reception was nice	8/23/2019 10:05 AM
4	This is largely my fault. I am quite awkward with people in social gatherings in general.	8/23/2019 8:15 AM

Q13 I found the MSRI staff helpful

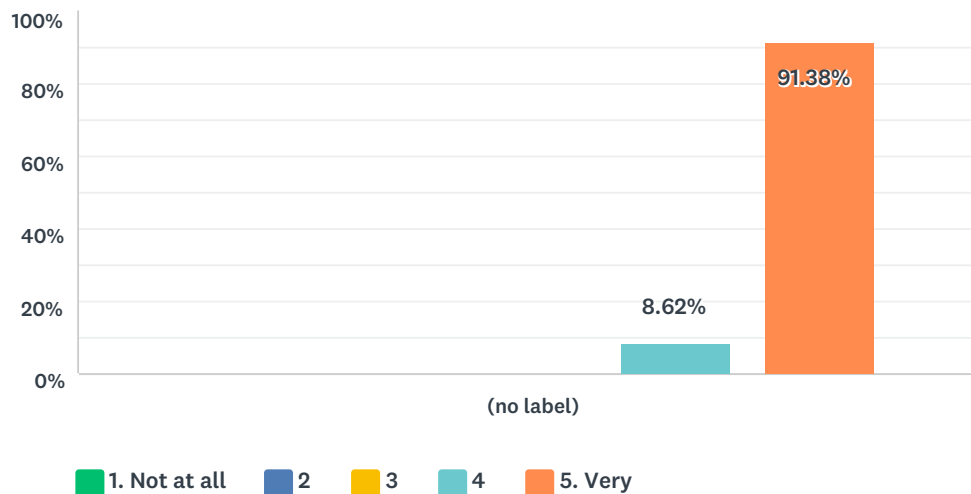
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.72%	3.45%	12.07%	82.76%	58	4.76
	0	1	2	7	48		

Q14 The MSRI facilities were conducive for such a workshop

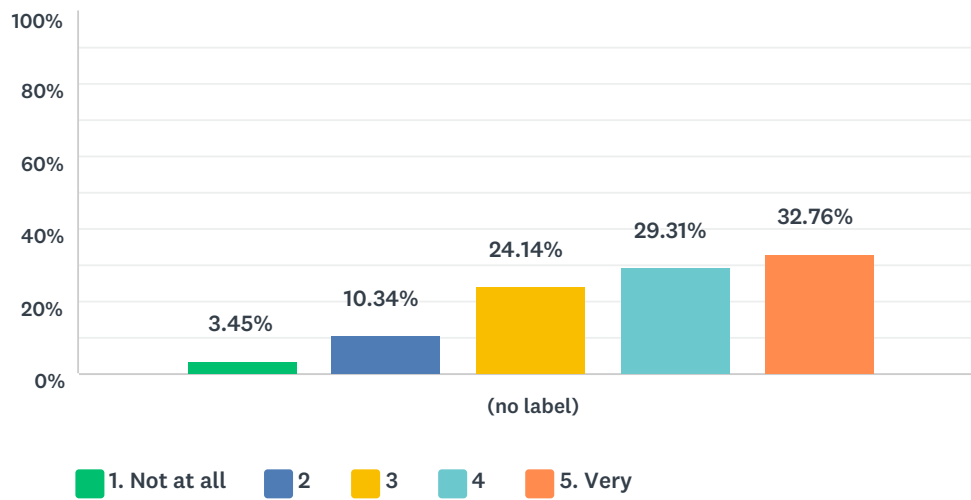
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	8.62%	91.38%	58	4.91
	0	0	0	5	53		

Q15 The MSRI lunch arrangements were satisfactory

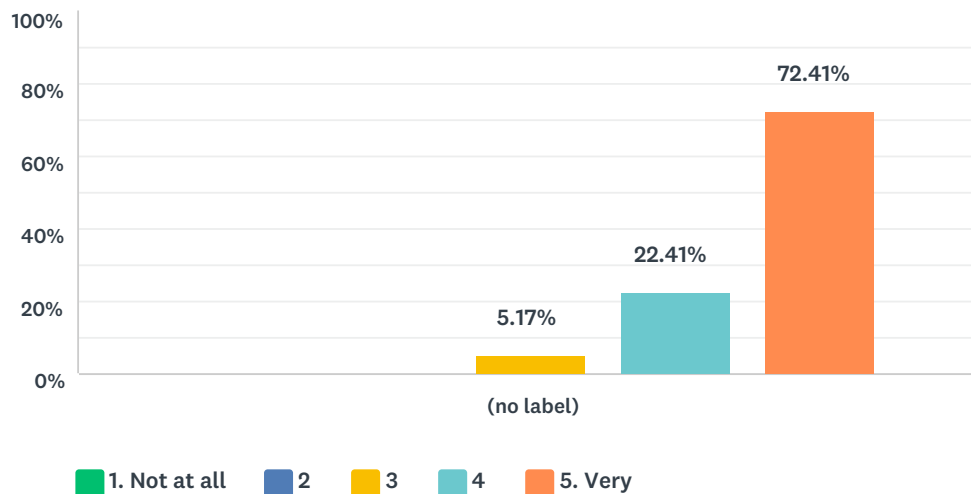
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.45%	10.34%	24.14%	29.31%	32.76%	58	3.78
	2	6	14	17	19		

Q16 The MSRI tea arrangements were satisfactory

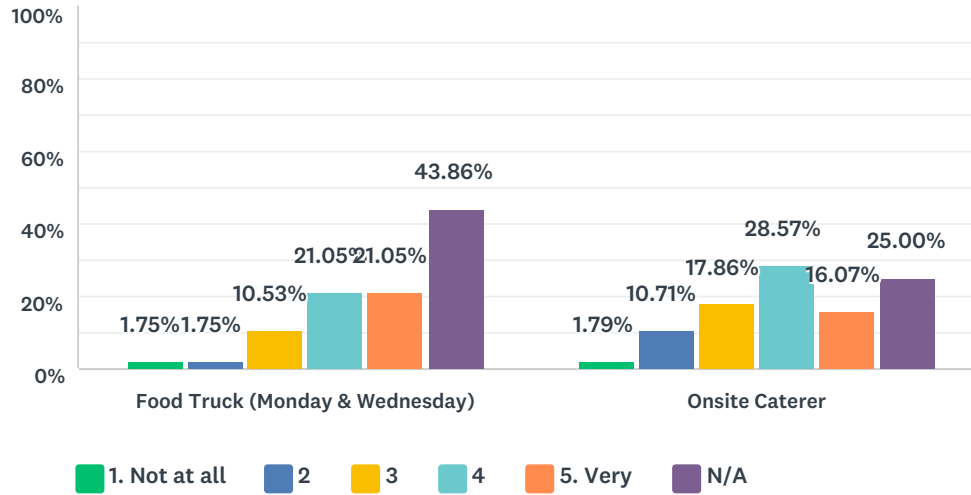
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	5.17%	22.41%	72.41%	58	4.67
	0	0	3	13	42		

Q17 I found the food from the following vendors satisfactory:

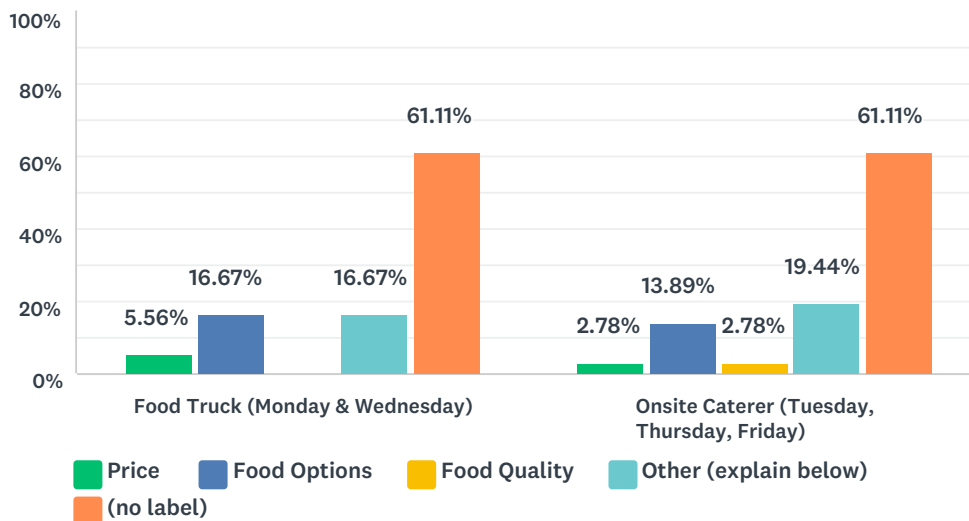
Answered: 58 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Monday & Wednesday)	1.75%	1.75%	10.53%	21.05%	21.05%	43.86%	
	1	1	6	12	12	25	57
Onsite Caterer	1.79%	10.71%	17.86%	28.57%	16.07%	25.00%	
	1	6	10	16	9	14	56

Q18 I did NOT purchase from the following vendors because:

Answered: 38 Skipped: 21



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	(NO LABEL)	TOTAL
Food Truck (Monday & Wednesday)	5.56% 2	16.67% 6	0.00% 0	16.67% 6	61.11% 22	36
Onsite Caterer (Tuesday, Thursday, Friday)	2.78% 1	13.89% 5	2.78% 1	19.44% 7	61.11% 22	36

#	OTHER (PLEASE SPECIFY)	DATE
1	brought my own lunch	9/17/2019 10:36 AM
2	I didn't want to wait longer than usual to get lunch.	9/9/2019 4:34 AM
3	Price, but just because packing is cheaper, not because it was too expensive for eating out prices	8/23/2019 2:57 PM
4	I brought my own lunch every day except M/T	8/23/2019 10:51 AM
5	I had my own lunch	8/23/2019 9:53 AM
6	I prefer packing my own	8/23/2019 8:38 AM

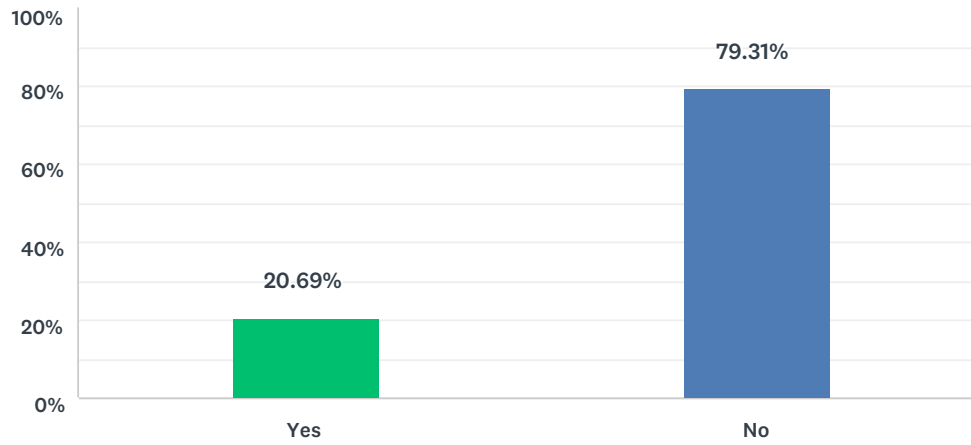
Q19 Additional comments about the MSRI staff, facilities and food

Answered: 10 Skipped: 49

#	RESPONSES	DATE
1	The food provided by the onsite caterer is of good quality but who really sandwiches for lunch ? And, even the same sandwiches for a whole week ? Well, I guess my southern european standards for decent food are probably too high. If you improve food facilities, then this would make it a perfect workshop.	9/16/2019 6:34 PM
2	The staff were welcoming	9/11/2019 12:09 PM
3	Great.	9/9/2019 4:30 AM
4	Excellent and very helpful staff.	8/27/2019 1:38 AM
5	More vegan options would be nice	8/25/2019 6:06 AM
6	MSRI staff are fantastic	8/25/2019 12:57 AM
7	The MSRI staff is great, always nice and helpful! It would be great if the on-site caterer had more variety - not the same food every day. Also, the announcement for pre-ordering food on Friday was only sent to current program members, not to all workshop participants.	8/23/2019 2:41 PM
8	The lunch on Friday had to be pre-ordered via an email that was sent out the night before, but it was not explained clearly in the email that you cannot get food unless placing a pre-order. Some participants and residents either didn't receive the email or didn't do the "survey", and that caused some confusion and inconvenience.	8/23/2019 12:33 PM
9	Do MSRI and Space Science together not justify a cafeteria?	8/23/2019 8:44 AM
10	A bit of variety in the lunch arrangements (onsite caterer) would have been good.	8/23/2019 7:54 AM

Q20 Did you use the computer facilities located in the library?

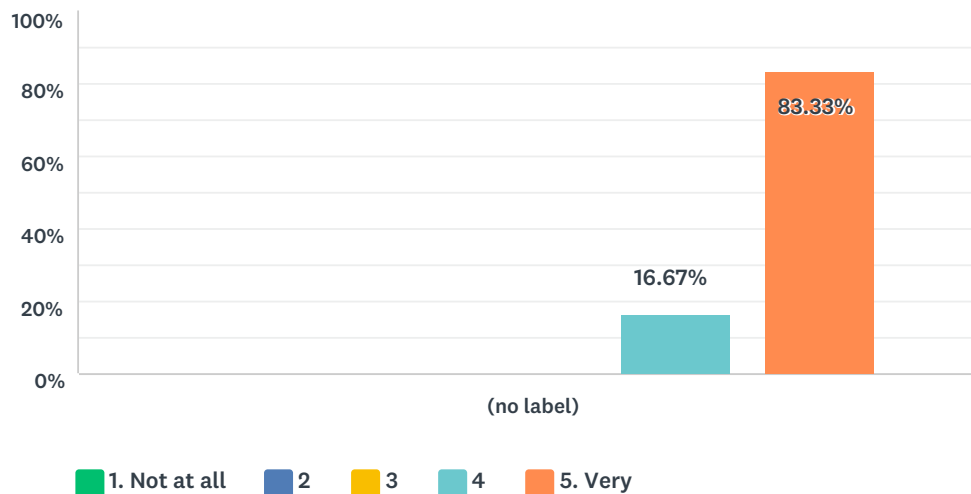
Answered: 58 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	20.69%	12
No	79.31%	46
TOTAL		58

Q21 The MSRI computer facilities in the library were adequate

Answered: 12 Skipped: 47

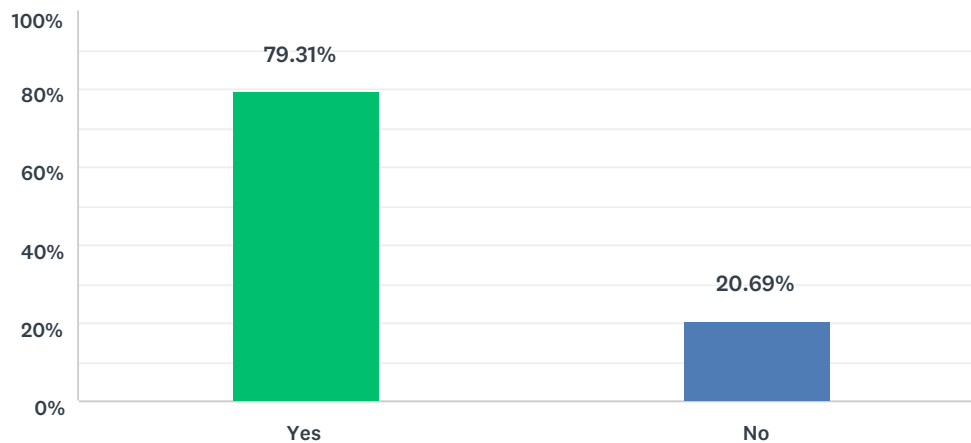


	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	16.67%	83.33%	12	4.83
	0	0	0	2	10		

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	I only used the scanner, but it was fast and worked fantastically well	8/23/2019 10:52 AM

Q22 Did you use MSRI's wireless network?

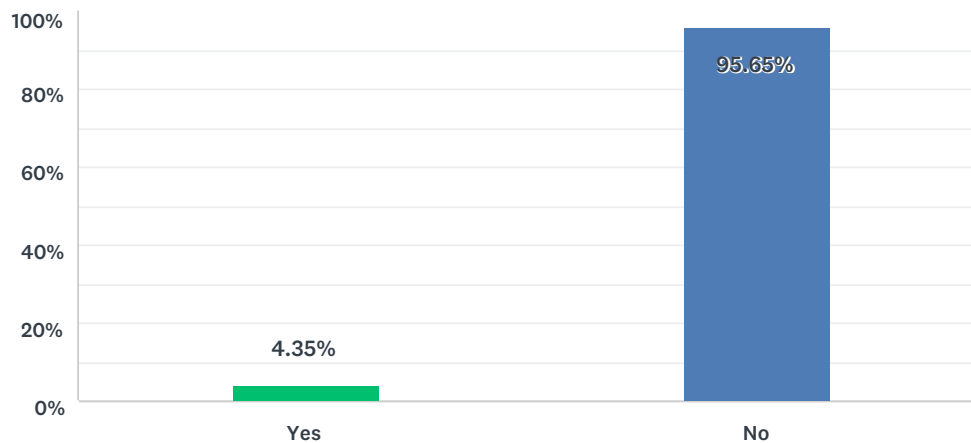
Answered: 58 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	79.31%	46
No	20.69%	12
TOTAL		58

Q23 Did you experience any difficulties with the network?

Answered: 46 Skipped: 13



ANSWER CHOICES	RESPONSES	
Yes	4.35%	2
No	95.65%	44
TOTAL		46

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	sometimes the connection was slow	8/23/2019 7:57 AM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 2 Skipped: 57

#	RESPONSES	DATE
1	Keep up	9/11/2019 12:10 PM
2	It was a great conference with very good and well-prepared minicourses and very interesting talks!	8/25/2019 11:18 PM

**Connections for Women:
Microlocal Analysis**

August 29, 2019 - August 30, 2019

MSRI, Berkeley, CA, USA

Organizers:

Tanya Christiansen (University of Missouri)

Raluca Felea (Rochester Institute of Technology)

REPORT ON THE MSRI WORKSHOP

“Connections for Women: Microlocal Analysis”

AUGUST 29 – 30, 2019

Organizers

- Tanya Christiansen (University of Missouri)
- Raluca Felea (Rochester Institute of Technology)

Scientific Description

Microlocal analysis provides tools for the precise analysis of problems arising in areas such as partial differential equations or integral geometry by working in the phase space, i.e. the cotangent bundle, of the underlying manifold. It has origins in areas such as quantum mechanics and hyperbolic equations, in addition to the development of a general PDE theory, and has expanded tremendously over the last 40 years to the analysis of singular spaces, integral geometry, nonlinear equations, scattering theory. This program brought together researchers from various parts of the field to facilitate the transfer of ideas, and provided a comprehensive introduction to the field for postdocs and graduate students.

This workshop provided a gentle introduction to a selection of applications of microlocal analysis. These included geometric microlocal analysis, inverse problems, quantum chaos, and blowups and their application to geometric problems. In addition, speakers introduced the basics of pseudodifferential operators. The workshop also included a panel discussion and a poster session. This workshop was open to all mathematicians.

Highlights of the Workshop

1. The workshop was a success, the talks were very interesting, at the right level and the right pace, engaging the audience and the speakers.
2. The talks in the workshop included not only a range of topics, but also a range of styles. Some talks focused on introducing one or two important results in an area. Consequently these speakers were able to focus on fundamentals and to outline proofs, showing microlocal analysis at work. Other talks introduced the audience to open research problems, and were of necessity less detailed. One talk focused on a particular technique, introducing it with relatively simple examples. This variety of styles made the workshop interesting and ensured that there was something for everyone.
3. The panel discussion was about how to apply for jobs and it was very informative: we discussed how the first job influenced the panelists' future research, how to apply for academic jobs in US and abroad, how to address a two body problem, how to negotiate for a good position, how to search for academic jobs. The panelists were: Tanya Christiansen,

Anna Mazzucato, Katya Krupchyk, Julie Rowlett, and Xuwen Zhu. Raluca Felea served as moderator.

4. The poster session (8 posters) on Friday afternoon was well attended and enabled lively discussions. A number of early-career mathematicians took advantage of this opportunity to share their work.
5. The workshop attracted participants diverse by many measures: by gender, by country of origin, by field of study (at least two engineering students in addition to mathematicians across a range of subdisciplines), by career stage.
6. Breaks and dinner allowed time for informal conversations between participants.

Organizers

First Name	Last Name	Institution
Jayadev	Athreya	University of Washington
Sergei	Gukov	California Institute of Technology
Andrew	Neitzke	University of Texas, Austin
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg

Speakers

First Name	Last Name	Institution
Nalini	Anantharaman	Université de Strasbourg
Katya	Krupchyk	University of California, Irvine
Anna	Mazzucato	Pennsylvania State University
Julie	Rowlett	Chalmers University of Technology/University of Göteborg
Xuwen	Zhu	University of California, Berkeley

Mathematical Sciences Research Institute

Connections for Women: Microlocal Analysis

August 29 to August 30, 2019

Friday, August 29, 2019

9:15AM - 9:30AM	Simons Auditorium		Welcome
9:30AM - 10:30AM	Simons Auditorium	Anna Mazzucato	Microlocal analysis/inverse problems/PSDOs
10:30AM - 11:00AM	Atrium		Tea
11:00AM - 12:00PM	Simons Auditorium	Nalini Anantharaman	Quantum chaos
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Katya Krupchyk	Introduction to inverse boundary problems
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium	Xuwen Zhu	Introduction to microlocal analysis
4:30PM - 5:30PM	Commons Room		Panel Discussion
5:30PM - 7:00PM	Atrium		Dinner at MSRI

Friday, August 30, 2019

9:30AM - 10:30AM	Simons Auditorium	Anna Mazzucato	Microlocal analysis/inverse problems/PSDOs
10:30AM - 11:00AM	Atrium		Break
11:00AM - 12:00PM	Simons Auditorium	Nalini Anantharaman	Quantum chaos
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Julie Rowlett	Geometric analysis
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium		Poster Session

Participants

First Name	Last Name	Institution
Pierre	Albin	University of Illinois at Urbana-Champaign
Nalini	Anantharaman	Université de Strasbourg
Tracey	Balehowsky	University of Helsinki
Victor	Bermudez	University of California, Santa Cruz
Jonas	Beyrer	Ruprecht-Karls-Universität Heidelberg
Nisha	Chandramoorthy	Massachusetts Institute of Technology
Tanya	Christiansen	University of Missouri
Marija	Cvetkovic	Faculty of Science and Mathematics
Thibault	de Poyferré	University of California, Berkeley
Anda	Degeratu	Universität Stuttgart
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Jan	Derezinski	University of Warsaw
Shanna	Dobson	University of California, Los Angeles
Timothy	Drake	University of Illinois at Urbana-Champaign
Alexis	Drouot	Columbia University
Nikolaos	Eptaminotakis	University of Washington
Di	Fang	University of California, Berkeley
Hugo	Federico	Université de Paris XI
Raluca	Felea	Rochester Institute of Technology
Elise	Goujard	Institut de mathématiques de Bordeaux
Dietrich	Hafner	Université de Grenoble I (Joseph Fourier)
Hamid	Hezari	University of California, Irvine
Mahaarachchige	Jayasinghe	University of Illinois at Urbana-Champaign
Fushuai	Jiang	University of California, Davis
Nada	Khogeer	University of San Francisco
Christopher	Kottke	New College of Florida
Katya	Krupchyk	University of California, Irvine
Tim	Laux	University of California, Berkeley
Qionglng	Li	Chern Institute of Mathematics
Anna	Mazzucato	Pennsylvania State University
Evangelos	Nastas	Florida Atlantic University
Fagueye	NDIAYE	UCAD
Stephane	Nonnenmacher	Université de Paris XI
Jennifer	Pi	University of California, Irvine
Alessandra	Pluda	Università di Pisa
Hadrian	Quan	University of Illinois at Urbana-Champaign
Julie	Rowlett	Chalmers University of Technology/University of Göteborg
Mariel	Saez Trumper	Pontificia Universidad Católica de Chile
Jacob	Shapiro	Australian National University
Yonathan	Stone	University of California, Irvine
Tom	Sutherland	University of Lisbon
Amir	Vig	University of California, Irvine
Qian	Wang	University of Massachusetts Lowell
Francis	White	University of California, Los Angeles

Participants

First Name	Last Name	Institution
Zoe	Wyatt	University of Edinburgh
Jingni	Xiao	Rutgers University
Lili	Yan	University of California, Irvine
Yang	Zhang	Purdue University
Xuwen	Zhu	University of California, Berkeley

Officially Registered Participants Information

Participants		49
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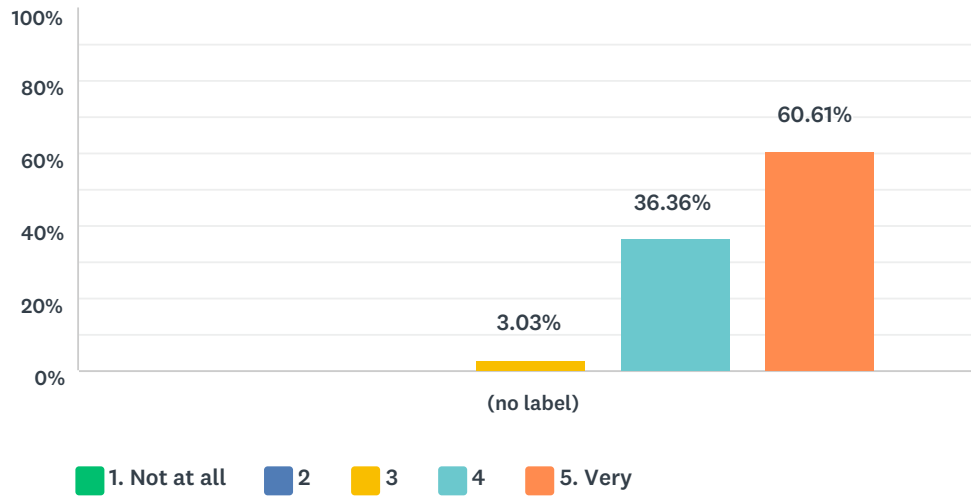
Gender		49
Male	44.90%	22
Female	51.02%	25
Declined to state	2.04%	1
Other/Non-Binary	2.04%	1

Ethnicity*		52
White	57.69%	30
Asian	21.15%	11
Hispanic	7.69%	4
Pacific Islander	0.00%	0
Black	1.92%	1
Native American	0.00%	0
Mixed	1.92%	1
Declined to state	9.62%	5

* ethnicity specifications are not exclusive

Q1 The workshop was intellectually stimulating

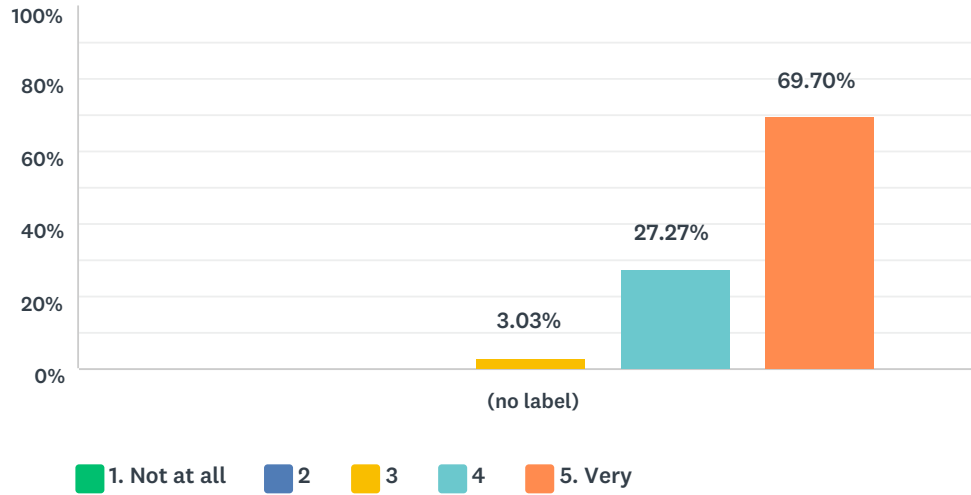
Answered: 33 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.03%	36.36%	60.61%	33	4.58
	0	0	1	12	20		

Q2 The overall experience of the workshop was worthwhile

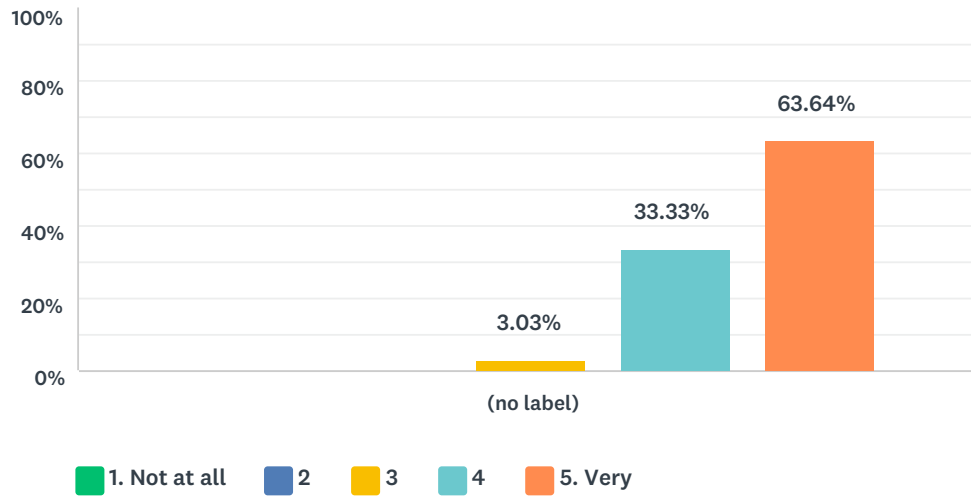
Answered: 33 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.03%	27.27%	69.70%	33	4.67
	0	0	1	9	23		

Q3 The time between lectures was adequate for discussion

Answered: 33 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.03%	33.33%	63.64%	33	4.61
	0	0	1	11	21		

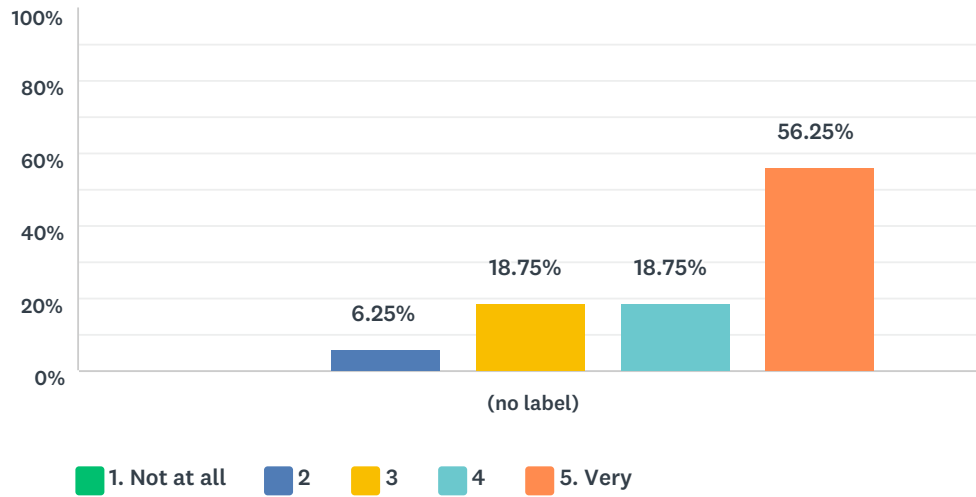
Q4 Additional comments

Answered: 6 Skipped: 27

#	RESPONSES	DATE
1	It was not convenient at all to have 3 free days between the Women Connections and the Introductory Workshop. This means being away from family for 3 days (or having to chose between the two workshops)	9/18/2019 3:54 AM
2	A great experience overall to learn new mathematics and connect with leading experts in the field.	9/16/2019 12:52 PM
3	Adding pronouns to nametags would be good	9/16/2019 9:55 AM
4	It was great!	9/3/2019 6:52 AM
5	It's my first time in MSRI. I find the discussions between lectures at a very high-level English. The speaking are few fast for me. But I had many practice my English.	9/3/2019 6:19 AM
6	The speakers are great, and the job application session is super useful.	9/3/2019 3:16 AM

Q5 I was well prepared to benefit from the lectures

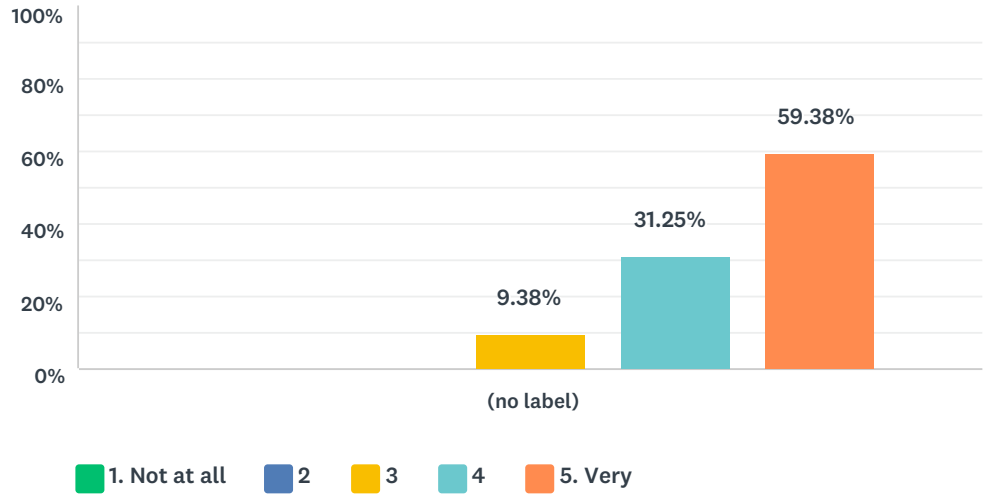
Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	6.25%	18.75%	18.75%	56.25%	32	4.25
	0	2	6	6	18		

Q6 My interest in the subject matter was increased by the workshop

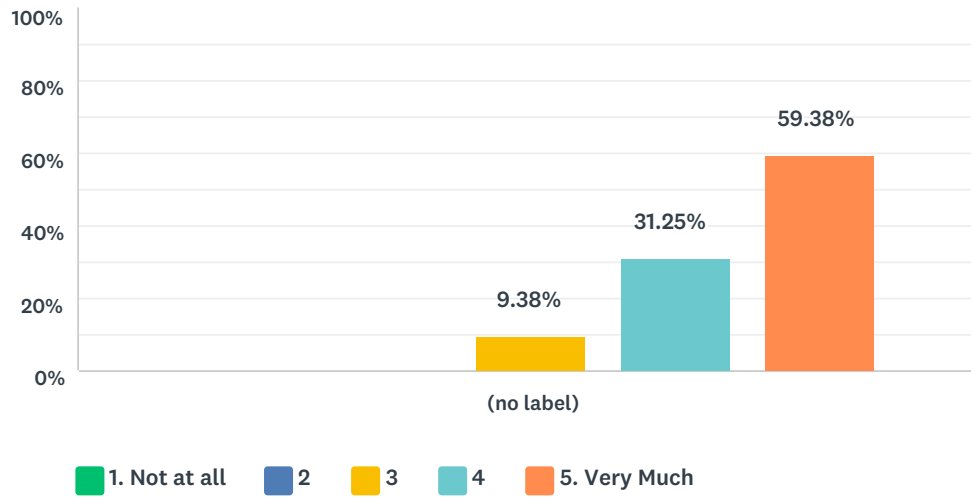
Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.38%	31.25%	59.38%		
	0	0	3	10	19	32	4.50

Q7 The workshop helped me meet people with similar scientific interests

Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.38%	31.25%	59.38%	32	4.50
	0	0	3	10	19		

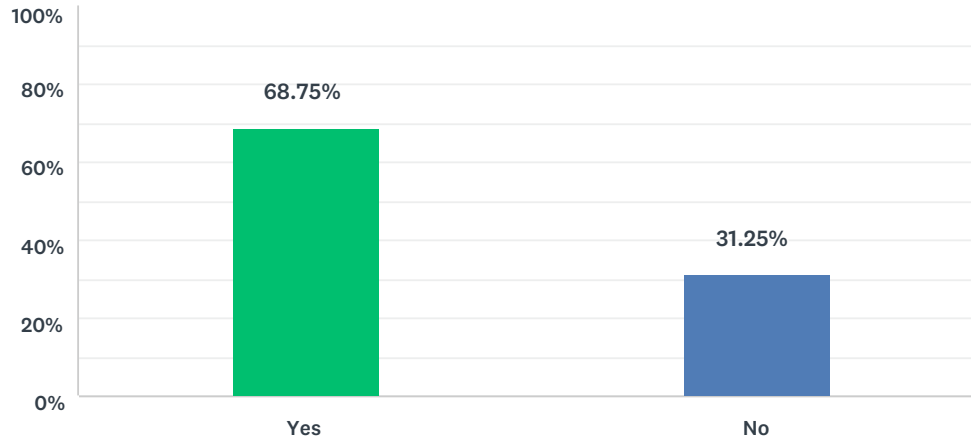
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 32

#	RESPONSES	DATE
1	I find the lectures very interesting, they will allow me to be more easy in the tools of microlocal analysis in my research.	9/3/2019 6:19 AM

Q9 Did you attend the panel discussion?

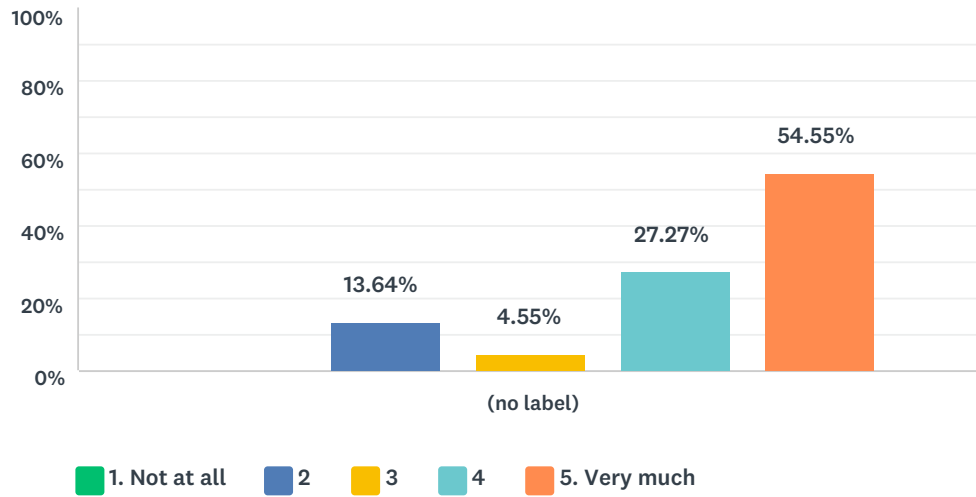
Answered: 32 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	68.75%	22
No	31.25%	10
TOTAL		32

Q10 Did you find the panel discussion worthwhile?

Answered: 22 Skipped: 11



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	13.64%	4.55%	27.27%	54.55%	22	4.23
	0	3	1	6	12		

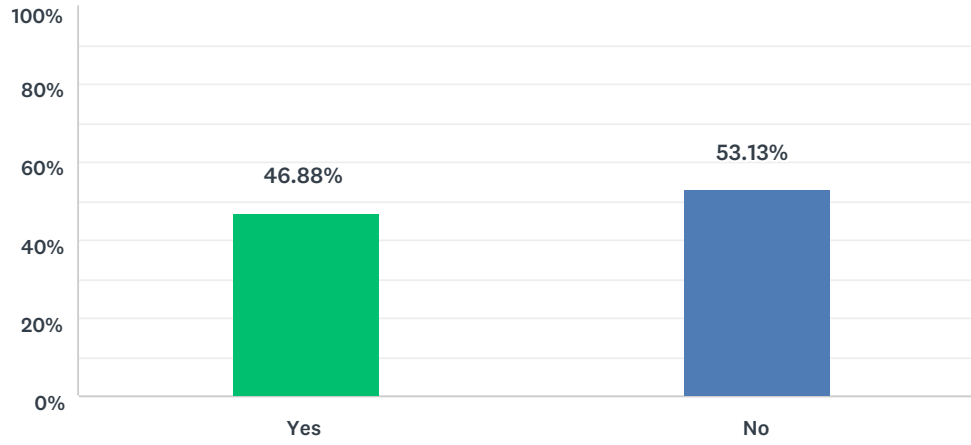
Q11 What other subjects should be discussed in future panel discussions?

Answered: 5 Skipped: 28

#	RESPONSES	DATE
1	Mentoring for young women mathematicians.	9/17/2019 10:34 AM
2	I am not sure (overall) why this was a discussion in the workshop "Connections for women" and not at the introductory workshop, as it seemed oriented to young researchers, but not specifically for women.	9/16/2019 4:34 PM
3	The topic for the panel was a good one, however it would have been more helpful to have more people on the panel who were familiar with hiring committees.	9/3/2019 11:23 AM
4	Maybe relevant to discuss having children at different stages of one's career (before PhD, during PhD, during postdoc, etc).	9/3/2019 6:53 AM
5	May be look at how women have do to find job in others universities for example in Asie, in Africa. So, share experience between all continents attending the workshop.	9/3/2019 6:23 AM

Q12 Did you attend the dinner?

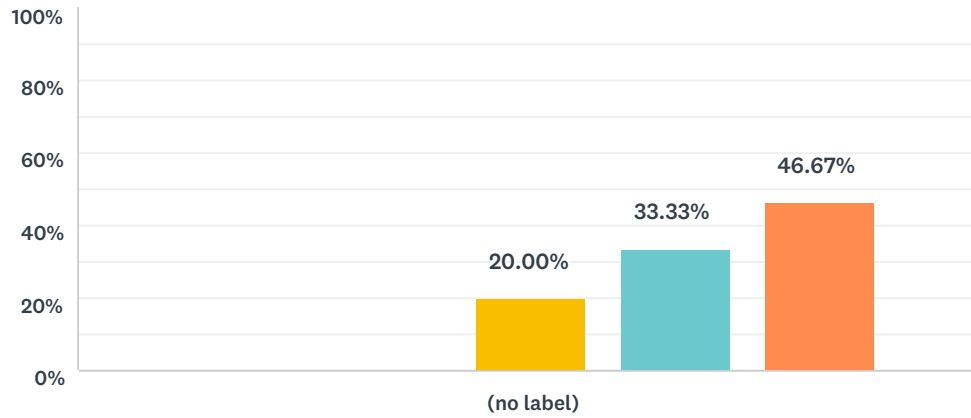
Answered: 32 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	46.88%	15
No	53.13%	17
TOTAL		32

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 15 Skipped: 18



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	20.00%	33.33%	46.67%	15	4.27
	0	0	3	5	7		

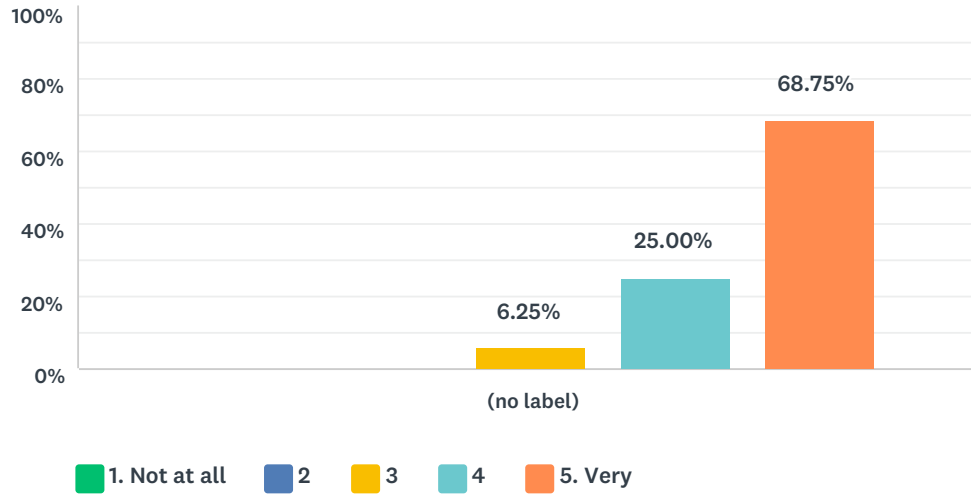
Q14 Please provide any comments about the dinner

Answered: 1 Skipped: 32

#	RESPONSES	DATE
1	It's very delicious and very fanny.	9/3/2019 6:24 AM

Q15 I found the MSRI staff helpful

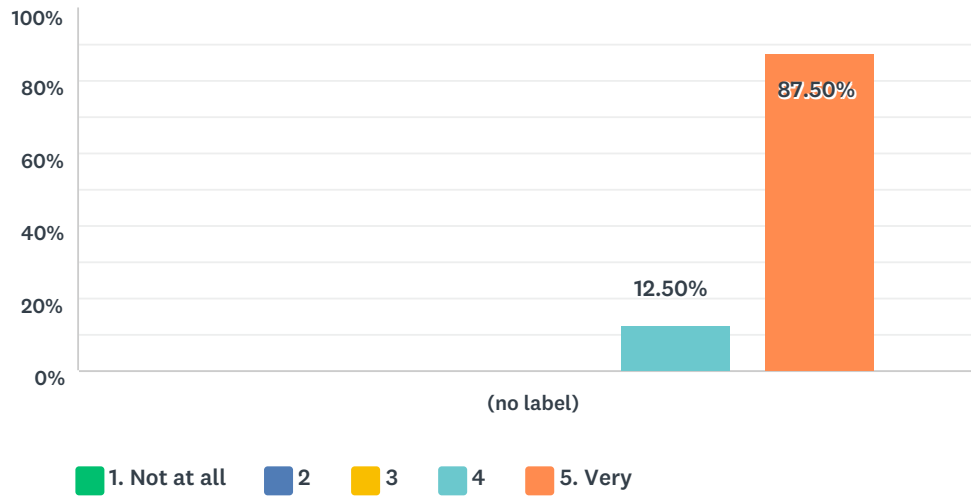
Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.25%	25.00%	68.75%	32	4.63
	0	0	2	8	22		

Q16 The MSRI facilities were conducive for such a workshop

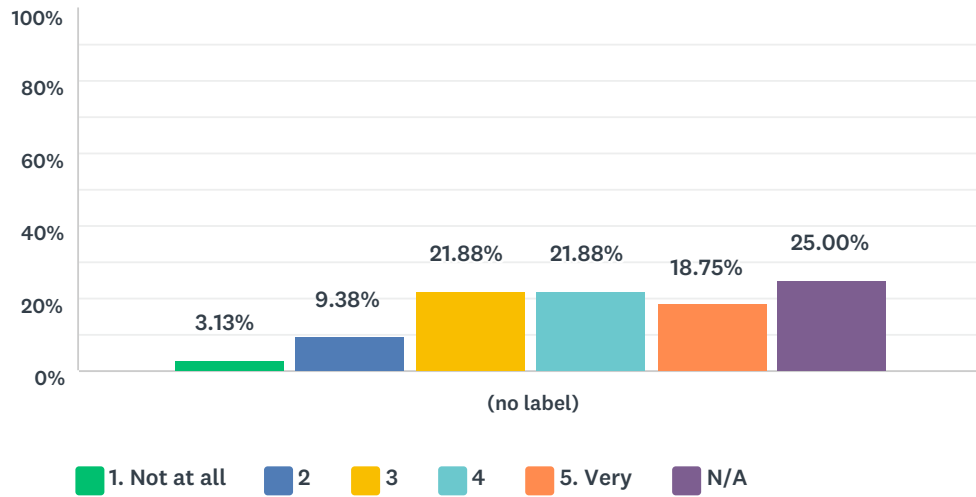
Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	12.50%	87.50%		
	0	0	0	4	28	32	4.88

Q17 The MSRI lunch arrangements were satisfactory

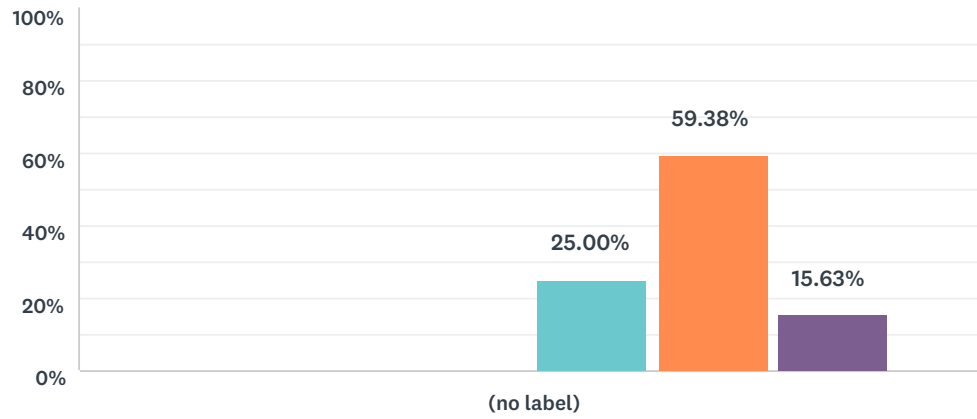
Answered: 32 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	3.13%	9.38%	21.88%	21.88%	18.75%	25.00%	32	3.58
	1	3	7	7	6	8		

Q18 The MSRI tea arrangements were satisfactory

Answered: 32 Skipped: 1



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very
 ■ N/A

	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	25.00%	59.38%	15.63%	32	4.70
	0	0	0	8	19	5		

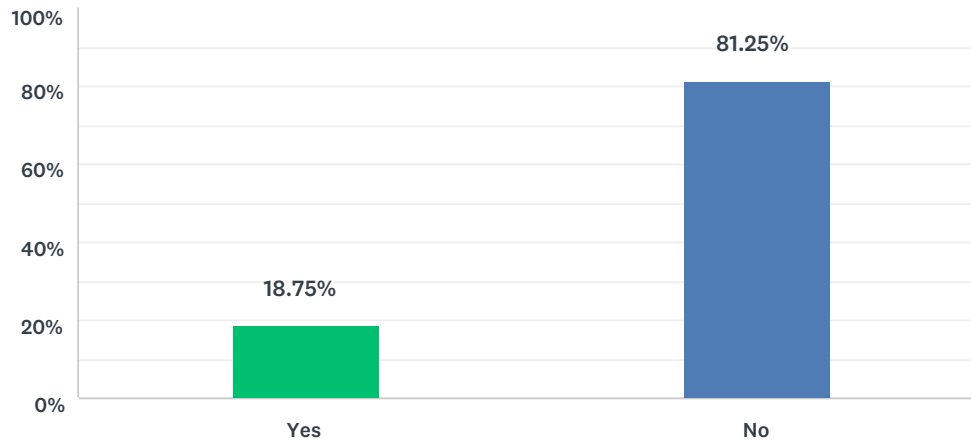
Q19 Additional comments about MSRI staff, facilities and food

Answered: 5 Skipped: 28

#	RESPONSES	DATE
1	Often, there is not enough food for all participants.	9/18/2019 3:55 AM
2	More variety in the lunch arrangements would have been nice.	9/17/2019 3:21 AM
3	The vegan sandwiches ran out quickly.	9/4/2019 12:33 AM
4	Your staff is awesome. I hope they are paid well enough to live comfortably in the area, cause this area is super expensive!	9/3/2019 6:54 AM
5	May be give hot food.	9/3/2019 6:25 AM

Q20 Did you use the computer facilities located in the library?

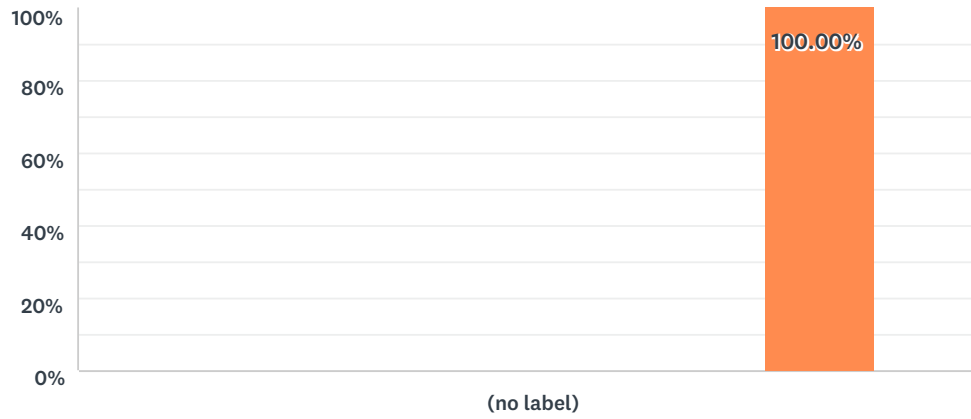
Answered: 32 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	18.75%	6
No	81.25%	26
TOTAL		32

Q21 The MSRI computer facilities in the library were adequate

Answered: 6 Skipped: 27

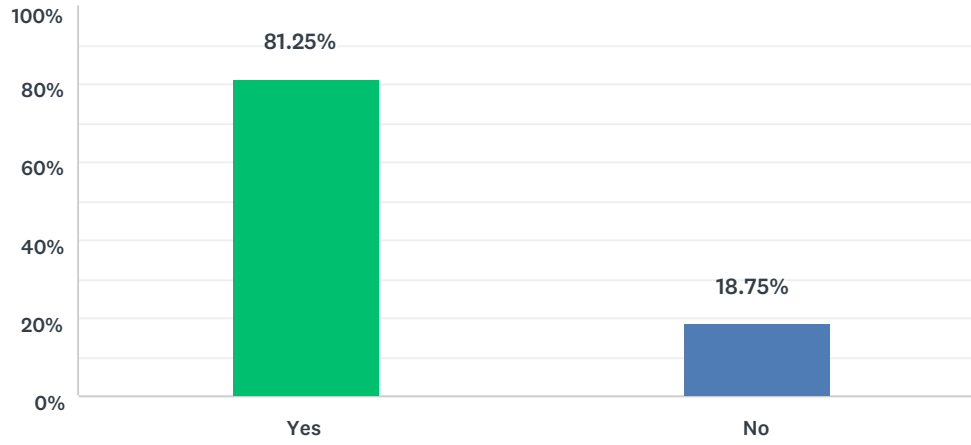


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	0.00%	100.00%	6	5.00
	0	0	0	0	6	6	

Q22 Did you use MSRI's wireless network?

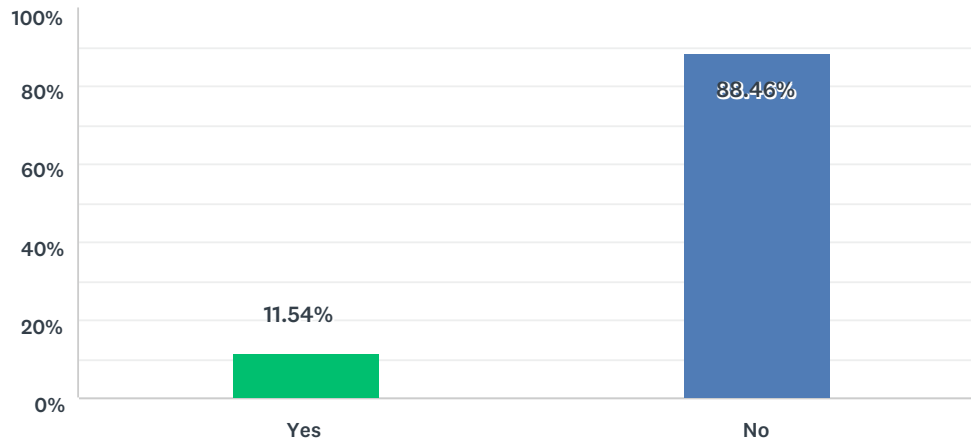
Answered: 32 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	81.25%	26
No	18.75%	6
TOTAL		32

Q23 Did you experience any difficulties with the network?

Answered: 26 Skipped: 7



ANSWER CHOICES	RESPONSES	
Yes	11.54%	3
No	88.46%	23
TOTAL		26

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
	There are no responses.	

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 30

#	RESPONSES	DATE
1	I am not sure what was the aim of the workshop (in which sense was oriented for women) and for that reason, I am not sure if it was fulfilling the objectives or not.	9/16/2019 4:36 PM
2	It would have been nice if more people could attend. Not sure why there were fewer people than at the introductory workshop(?)	9/3/2019 6:55 AM
3	To give any recommendation for booking. It may be help to choice an hotel more accessible.	9/3/2019 6:28 AM

**Introductory Workshop:
Microlocal Analysis**

September 03, 2019 - September 06, 2019
MSRI, Berkeley, CA, USA

Organizers:

Pierre Albin (University of Illinois at Urbana-Champaign)

Raluca Felea (Rochester Institute of Technology)

Andras Vasy (Stanford University)

REPORT ON THE MSRI WORKSHOP “Introductory Workshop: Microlocal Analysis” September 3 – 6, 2019

Organizers

- Pierre Albin (University of Illinois at Urbana-Champaign)
- Raluca Felea (Rochester Institute of Technology)
- Andras Vasy (Stanford University)

Scientific Description

Microlocal analysis provides tools for the precise analysis of problems arising in areas such as partial differential equations or integral geometry by working in the phase space, i.e. the cotangent bundle, of the underlying manifold. It has origins in areas such as quantum mechanics and hyperbolic equations, in addition to the development of a general PDE theory, and has expanded tremendously over the last 40 years to the analysis of singular spaces, integral geometry, nonlinear equations, scattering theory. This program brought together researchers from various parts of the field to facilitate the transfer of ideas, and will also provide a comprehensive introduction to the field for postdocs and graduate students.

Microlocal analysis provides tools for the precise analysis of problems arising in areas such as partial differential equations or integral geometry by working in the phase space, i.e. the cotangent bundle, of the underlying manifold. It has origins in areas such as quantum mechanics and hyperbolic equations, in addition to the development of a general PDE theory, and has expanded tremendously over the last 40 years to the analysis of singular spaces, integral geometry, nonlinear equations, scattering theory. This workshop provided a comprehensive introduction to the field for postdocs and graduate students as well as specialists outside the field, building up from standard facts about the Fourier transform, distributions and basic functional analysis.

Highlights of the Workshop

The workshop was organized to start with four lecture series, consisting of three lectures each, on pseudodifferential operators, Fourier integral operators, geometric microlocal analysis and scattering theory, to provide introduction at the appropriate level to the subject. This was followed by single lectures on more advanced topics to make the connection between the more basic material and cutting edge research on topics like quantum chaos, hyperbolic dynamics, inverse problems, non-linear waves, general relativity and quantum field theory.

A very novel part of the workshop was the scattering theory lecture series of Maciej Zworski, which got combined with the hyperbolic dynamics lecture of Semyon Dyatlov: . Rather than using the classical geometric (Laplacian-based) problems of scattering theory, they approached the topic from the angle of flows on compact manifolds, where

infinity is within the fibers of the cotangent bundle over it. This was an excellent introduction to the subject for a broad audience — even those familiar with more ‘classical’ scattering theory could learn a lot, and the proofs were essentially complete.

The talks in the workshop displayed a variety of styles and included both blackboard talks and slides talks. The level was appropriate for an introductory workshop. The videotaped lectures are also a very useful resource for students wishing a quick introduction to the vast subject: already these lectures have been pointed out as useful resources to students in the field who could not attend.

The organizers also chose several books related to the talks which were displayed in the library for the duration of the workshop.

There were continuous discussion among the participants during the breaks, though it would have been helpful to have the workshop over the usual five days to enable even more discussions.

Overall, we believe that the workshop served its purpose very well both for the participants, and also for future students via the videotaped lectures.

Organizers

First Name	Last Name	Institution
Pierre	Albin	University of Illinois at Urbana-Champaign
Raluca	Felea	Rochester Institute of Technology
Andras	Vasy	Stanford University

Speakers

First Name	Last Name	Institution
Nalini	Anantharaman	Université de Strasbourg
Semyon	Dyatlov	University of California, Berkeley
Raluca	Felea	Rochester Institute of Technology
Allan	Greenleaf	University of Rochester
Peter	Hintz	Massachusetts Institute of Technology
Rafe	Mazzeo	Stanford University
Gunther	Uhlmann	University of Washington
Andras	Vasy	Stanford University
Michał	Wrochna	Université de Cergy-Pontoise
Xuwen	Zhu	University of California, Berkeley
Maciej	Zworski	University of California, Berkeley

Mathematical Sciences Research Institute

Introductory Workshop: Microlocal Analysis

September 3 - 6, 2019

Monday, September 2, 2019

Labor Day - MSRI Closed

Tuesday, September 3, 2019

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Andras Vasy, Xuwen Zhu	Ps.d.o's lecture 1
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Andras Vasy, Xuwen Zhu	Ps.d.o's lecture 2
12:00 PM - 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM		Andras Vasy, Xuwen Zhu	Ps.d.o's lecture 3
2:30 PM - 3:30 PM	Simons Auditorium	Rafe Mazzeo	Geom microlocal analysis lecture 1
3:30 PM - 4:00 PM	Atrium		Tea
4:00 PM - 5:00 PM	Simons Auditorium	Maciej Zworski	Scattering theory lecture 1

Wednesday, September 4, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Raluca Felea, Allan Greenleaf	Lecture on FIOs 1
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Rafe Mazzeo	Lecture on geometric microlocal analysis
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Semyon Dyatlov	Lecture on hyperbolic dynamical systems
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Maciej Zworski	Scattering theory lecture 2
4:30 PM - 6:20 PM	Atrium		Reception

Thursday, September 5, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Rafe Mazzeo	Lecture on geometric microlocal analysis
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Raluca Felea, Allan Greenleaf	Lecture on FIOs 2
12:00 PM - 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium	Raluca Felea, Allan Greenleaf	Lecture on FIOs 3
2:30 PM - 3:30 PM	Simons Auditorium	Peter Hintz	Lecture on nonlinear waves
3:30 PM - 4:00 PM	Atrium		Tea
4:00 PM - 5:00 PM	Simons Auditorium	Gunther Uhlmann	Lecture on inverse problems

Friday, September 6, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Nalini Anantharaman	Lecture on quantum chaos
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Michał Wrochna	Lecture on quantum field theory
12:00 PM - 2:00 PM	Atrium		
2:00 PM - 3:00 PM	Simons Auditorium	Peter Hintz	Lecture on general relativity
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Maciej Zworski	Scattering theory lecture 3



Participants

First Name	Last Name	Institution
Anuj	Abhishek	Drexel University
Pierre	Albin	University of Illinois at Urbana-Champaign
Nalini	Anantharaman	Université de Strasbourg
Tracey	Balehowsky	University of Helsinki
Victor	Bermudez	University of California, Santa Cruz
Nicholas	Braun Rodrigues	Instituto de Matematica e Estatistica da Universidade de Sao Paulo (IME-USP)
Bjoern	Bringmann	University of California, Los Angeles
Mihajlo	Cekic	Max-Planck-Institut für Mathematik
Kevin	Chien	University of Washington
Alejandro	Coyoli Valencia	Tufts University
Marija	Cvetkovic	Faculty of Science and Mathematics
Xian	Dai	Rice University
Jaume	de Dios Pont	University of California, Los Angeles
Thibault	de Poyferré	University of California, Berkeley
Anda	Degeratu	Universität Stuttgart
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Timothy	Drake	University of Illinois at Urbana-Champaign
Alexis	Drouot	Columbia University
Semyon	Dyatlov	University of California, Berkeley
Nikolaos	Eptaminotakis	University of Washington
Allen	Fang	Université de Paris VI (Pierre et Marie Curie)
Di	Fang	University of California, Berkeley
Frederic	Faure	Fourier institute
Hugo	Federico	Université de Paris XI
Raluca	Felea	Rochester Institute of Technology
Steven	Flynn	University of California, Santa Cruz
Laura	Fredrickson	Stanford University
Benjamin	Godkin	University of California, Davis
Gérôme	Graf	École Polytechnique Fédérale de Lausanne (EPFL)
Allan	Greenleaf	University of Rochester
Dietrich	Hafner	Université de Grenoble I (Joseph Fourier)
Mads	Henriksen	Technical University of Denmark
Hamid	Hezari	University of California, Irvine
Peter	Hintz	Massachusetts Institute of Technology
Michael	Hitrik	University of California, Los Angeles
Jiaxi	Huang	University of Science and Technology of China
Manh Khang	Huynh	University of California, Los Angeles
Mahaarachchi	Jayasinghe	University of Illinois at Urbana-Champaign
Malo	Jezequel	Laboratoire de Probabilités, Statistique et Modélisation
Fushuai	Jiang	University of California, Davis
Blake	Keeler	University of North Carolina
Christoph	Kehle	University of Cambridge
Nada	Khogeer	University of San Francisco
Peter	Kleinhenz	Northwestern University
Christopher	Kottke	New College of Florida
Katya	Krupchyk	University of California, Irvine
Thierry	Laurens	University of California, Los Angeles
Tim	Laux	University of California, Berkeley
Albert	Lawrence	University of California, San Diego
Thibault	Lefeuvre	Université de Paris XI
Da	Li	University of Calgary
Qionglng	Li	Chern Institute of Mathematics
Boya	Liu	University of California, Irvine
John	Loftin	Rutgers University

Participants

First Name	Last Name	Institution
Pietro	Longhi	ETH Zurich
Matthieu	Ménard	École Normale Supérieure de Lyon
Rafe	Mazzeo	Stanford University
Michael	McNulty	University of California, Riverside
Francois	Monard	University of California, Santa Cruz
Katrina	Morgan	MSRI - Mathematical Sciences Research Institute
Fagueye	NDIAYE	UCAD
Manh Tien	NGUYEN	Université Libre de Bruxelles
Stephane	Nonnenmacher	Université de Paris XI
Andrew	Ortegaray	California Institute of Technology
Matthew	Overduin	University of California, Riverside
John Gabriel	Pelias	University of California, Santa Cruz
Paolo	Piazza	Università di Roma "La Sapienza"
Alessandra	Pluda	Università di Pisa
Hadrian	Quan	University of Illinois at Urbana-Champaign
Daniel	Roggenkamp	Universität Mannheim
Julie	Rowlett	Chalmers University of Technology/University of Göteborg
Jan	Rozendaal	Australian National University
Antônio	Sá Barreto	Purdue University
Mariel	Saez Trumper	Pontificia Universidad Católica de Chile
Tuomas	Sahlsten	University of Manchester
Jacob	Shapiro	Australian National University
Michael	Singer	University College
Nikhil	Srivastava	University of California, Berkeley
Yonathan	Stone	University of California, Irvine
Hunter	Stufflebeam	University of Pennsylvania
Ethan	Sussman	Massachusetts Institute of Technology
Craig	Sutton	Dartmouth College
Alex	Takeda	University of California, Berkeley
Gunther	Uhlmann	University of Washington
Alejandro	Uribe	University of Michigan
Marco	Usula	Université Libre de Bruxelles
Andras	Vasy	Stanford University
Amir	Vig	University of California, Irvine
Qian	Wang	University of Massachusetts Lowell
Richard	Wentworth	University of Maryland
Francis	White	University of California, Los Angeles
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
David	Winterrose	Technical University of Denmark
Michał	Wrochna	Université de Cergy-Pontoise
Xiaoxu	Wu	Rutgers University
Zoe	Wyatt	University of Edinburgh
Jingni	Xiao	Rutgers University
Jie	Xu	Boston University
Lili	Yan	University of California, Irvine
Mengxuan	Yang	Northwestern University
Yuan	Yao	University of California, Berkeley
Evangelie	Zachos	Stanford University
Yang	Zhang	Purdue University
Xuwen	Zhu	University of California, Berkeley
Beite	Zhu	Stanford University
Yuzhou	Zou	Stanford University
Maciej	Zworski	University of California, Berkeley

Officially Registered Participants Information

Participants		107
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Gender		107
Male	73.83%	79
Female	23.36%	25
Declined to state	1.87%	2
Other/Non-Binary	0.93%	1

Ethnicity*		124
White	50.81%	63
Asian	22.58%	28
Hispanic	9.68%	12
Pacific Islander	0.00%	0
Black	1.61%	2
Native American	0.00%	0
Mixed	6.45%	8
Declined to state	8.87%	11

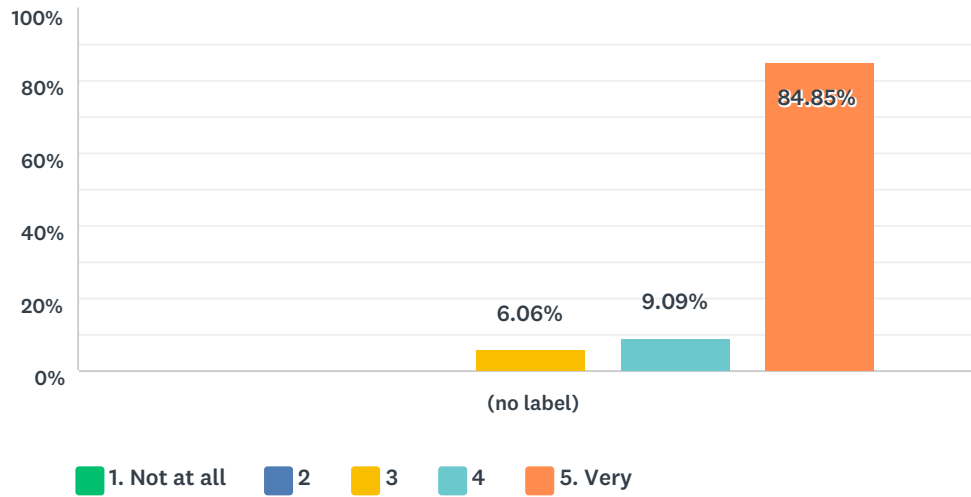
* ethnicity specifications are not exclusive

897 - Introductory Workshop: Microlocal Analysis - Participant Survey

66 responses out of 107 participants = 62% response rate

Q1 The workshop was intellectually stimulating

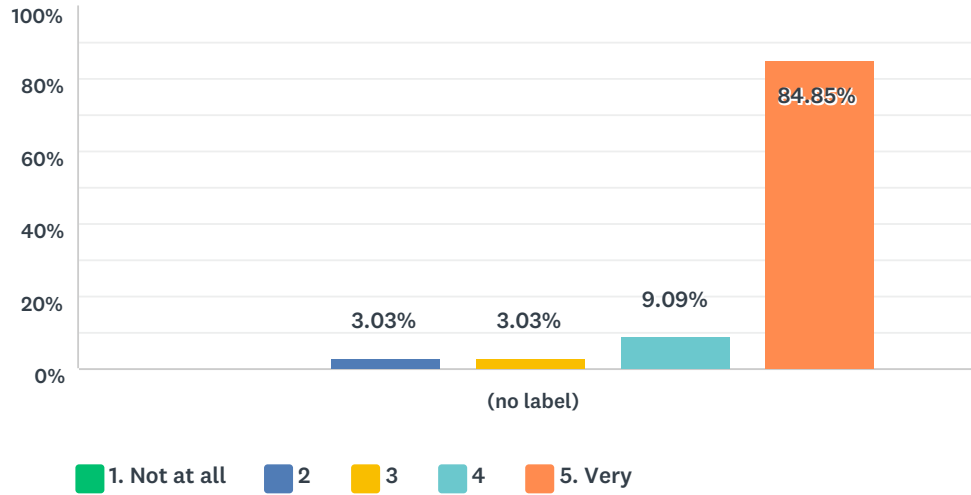
Answered: 66 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.06%	9.09%	84.85%	66	4.79
	0	0	4	6	56		

Q2 The overall experience of the workshop was worthwhile

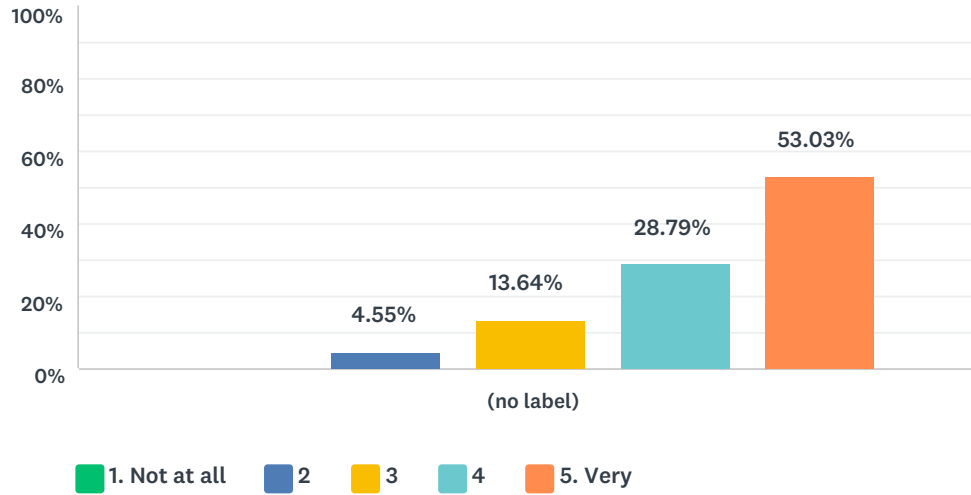
Answered: 66 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.03%	3.03%	9.09%	84.85%	66	4.76
	0	2	2	6	56		

Q3 The time between lectures was adequate for discussion

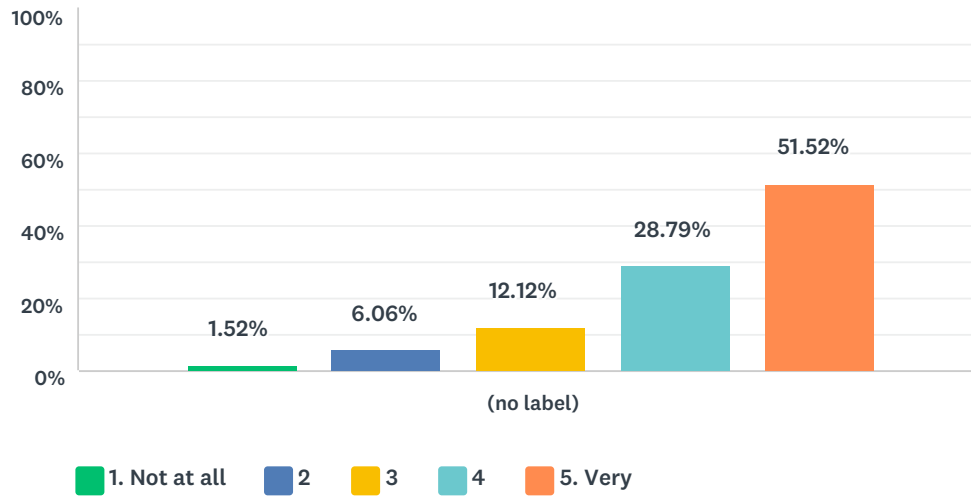
Answered: 66 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.55%	13.64%	28.79%	53.03%	66	4.30
	0	3	9	19	35		

Q4 The lectures were at an appropriate level

Answered: 66 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.52%	6.06%	12.12%	28.79%	51.52%	66	4.23
	1	4	8	19	34		

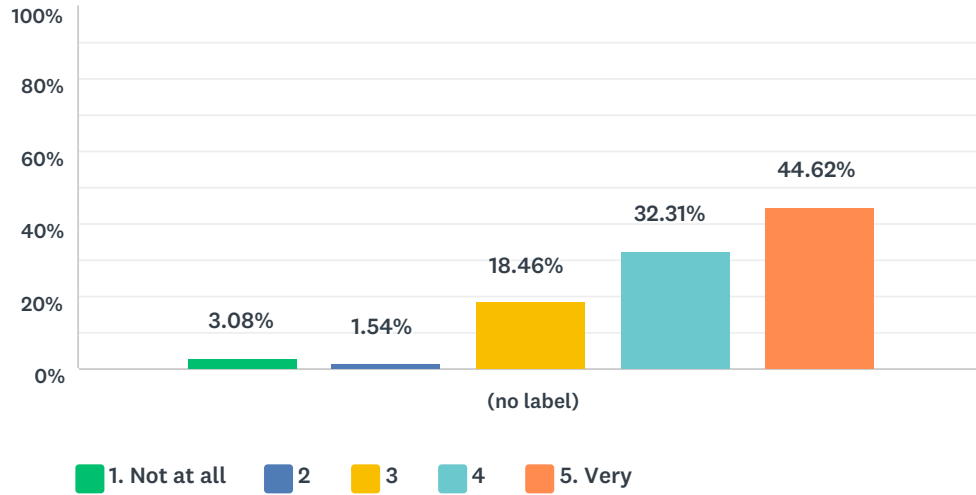
Q5 Additional comments

Answered: 9 Skipped: 57

#	RESPONSES	DATE
1	Good Workshop. Learned a lot.	9/20/2019 4:00 AM
2	I would like that presentations be made by writing on the board. Not only the demonstrations are clearly made but also it allows to take note properly. Otherwise, the slides are quickly unrolled and this discourages those who want to take note. The speed of communication was too fast for those who are used to speaking another language. But it did help us improve the practice of English.	9/18/2019 7:54 AM
3	Keep up the great work!	9/18/2019 7:33 AM
4	I thought the organisers did a great job of mixing introductory lectures with more advanced, specialist presentations. The overall quality was very high!	9/18/2019 3:10 AM
5	Some lectures were a bit more advanced than "introductory"	9/12/2019 12:42 AM
6	Some discussions got cut short, but otherwise no issues.	9/9/2019 9:11 PM
7	Some lectures were at a level advertised but the vast majority were not. Most lectures assumed lots of knowledge that the average graduate student may or may not have a firm understanding of let alone have seen before.	9/9/2019 6:26 AM
8	Very interesting workshop.	9/9/2019 6:06 AM
9	The compressed 4-day schedule unfortunately strongly limited the possible discussions between the participants.	9/9/2019 4:24 AM

Q6 I was well prepared to benefit from the lectures

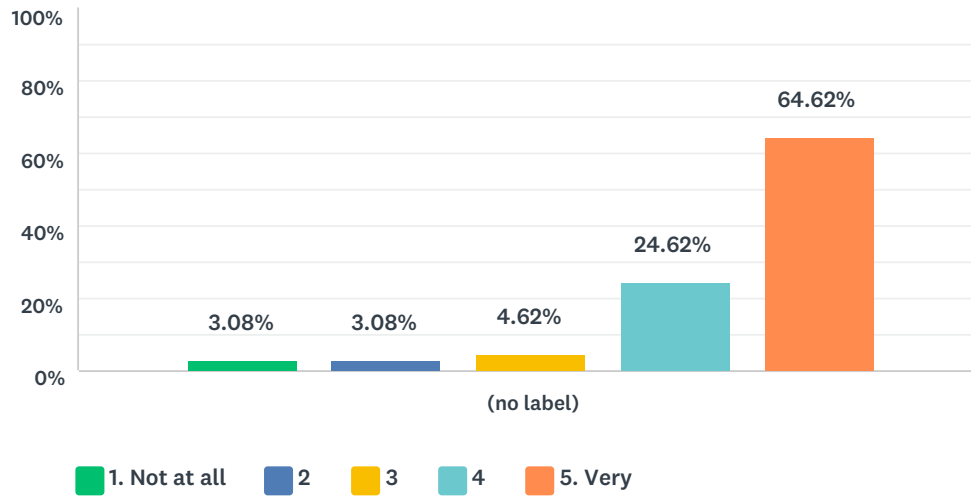
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.08%	1.54%	18.46%	32.31%	44.62%	65	4.14
	2	1	12	21	29		

Q7 My interest in the subject matter was increased by the workshop

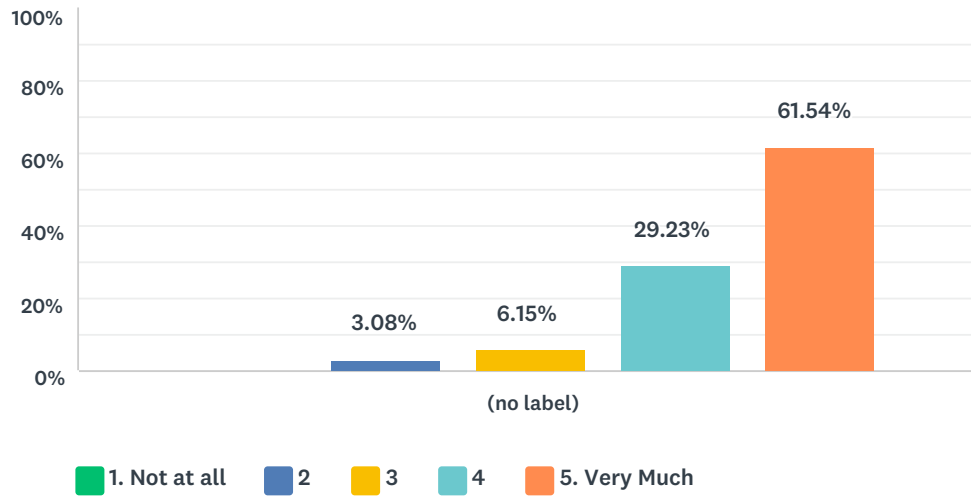
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.08%	3.08%	4.62%	24.62%	64.62%	65	4.45
	2	2	3	16	42		

Q8 The workshop helped me meet people with similar scientific interests

Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.08%	6.15%	29.23%	61.54%	65	4.49
	0	2	4	19	40		

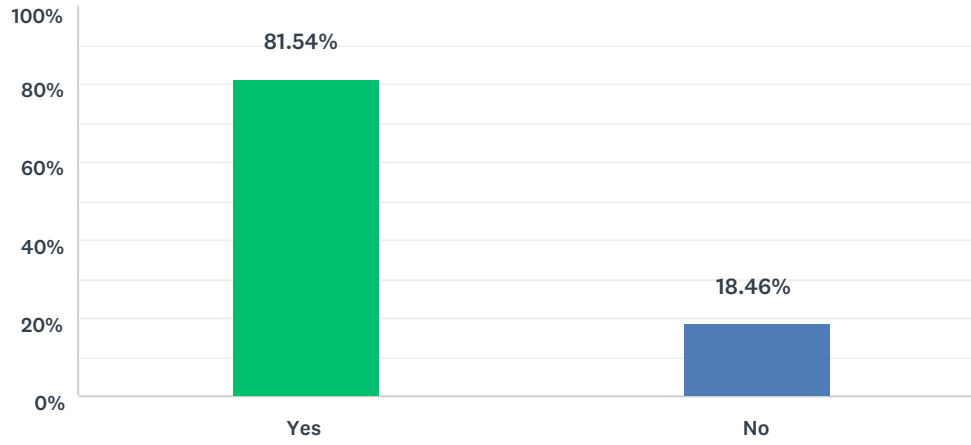
Q9 Additional comments on your personal assessment

Answered: 4 Skipped: 62

#	RESPONSES	DATE
1	It was extremely fulfilling and encouraging.	9/19/2019 11:10 PM
2	The workshop allowed me to have clearer ideas about Microlocal Analysis. This will allow me to use his tools in my research activities.	9/18/2019 7:59 AM
3	It's not clear the introductory workshop was really aimed at me as a senior MSRI member on the MLA programme.	9/18/2019 3:10 AM
4	Personally, I would have benefited from a list of knowledge to be assumed of me to have followed the lectures.	9/9/2019 6:27 AM

Q10 Did you attend the reception?

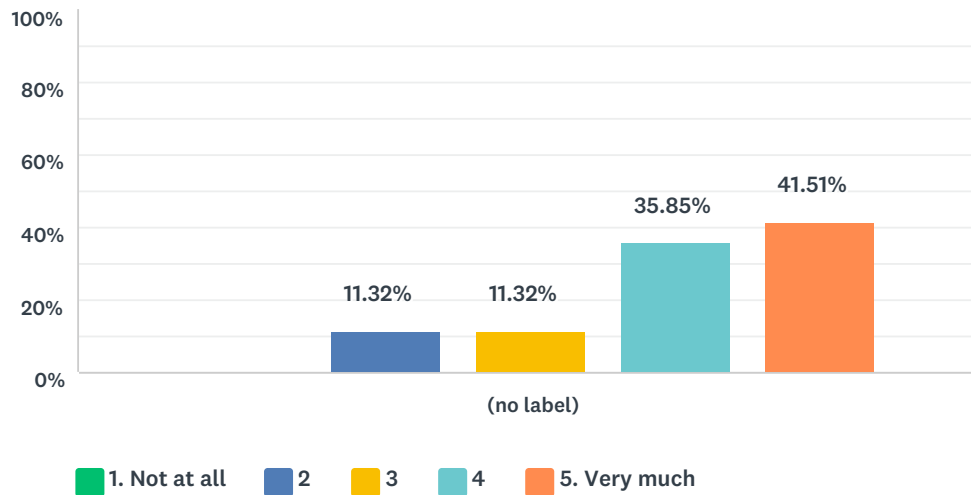
Answered: 65 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	81.54%	53
No	18.46%	12
TOTAL		65

Q11 Did the reception help to solidify the contacts you made during the workshop?

Answered: 53 Skipped: 13



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	11.32%	11.32%	35.85%	41.51%	53	4.08
	0	6	6	19	22		

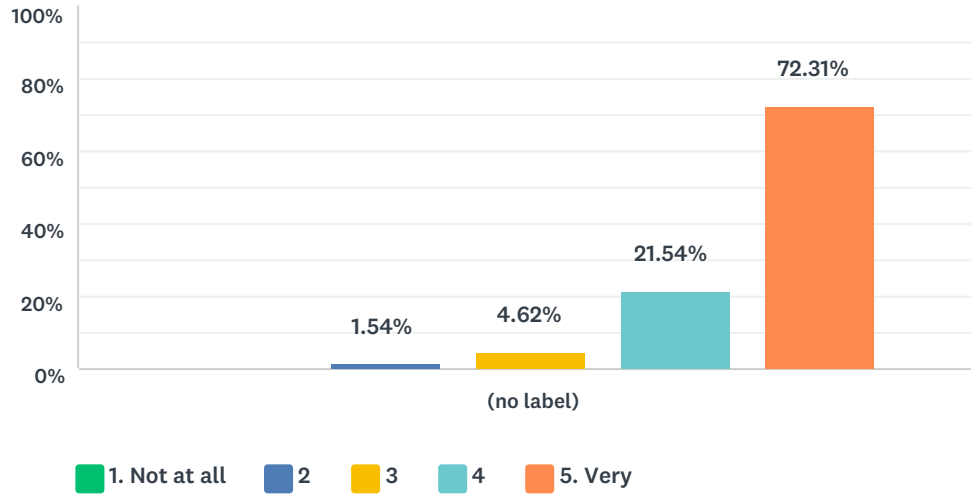
Q12 Please provide any comments about the reception

Answered: 2 Skipped: 64

#	RESPONSES	DATE
1	The reception was well organized and meals were delicious.	9/18/2019 8:04 AM
2	Some sort of speech from the organizers would have helped to create a deeper sense of unity amongst the attendees.	9/9/2019 6:28 AM

Q13 I found the MSRI staff helpful

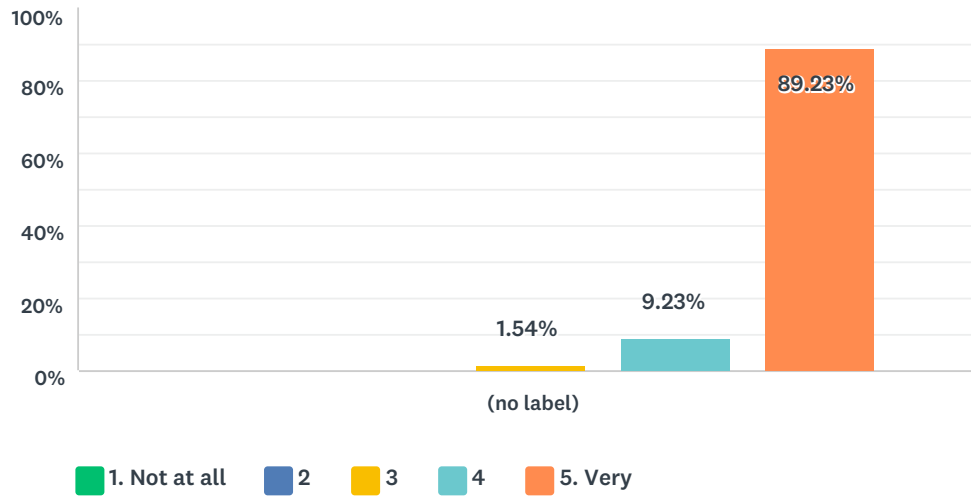
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.54%	4.62%	21.54%	72.31%	65	4.65
	0	1	3	14	47		

Q14 The MSRI facilities were conducive for such a workshop

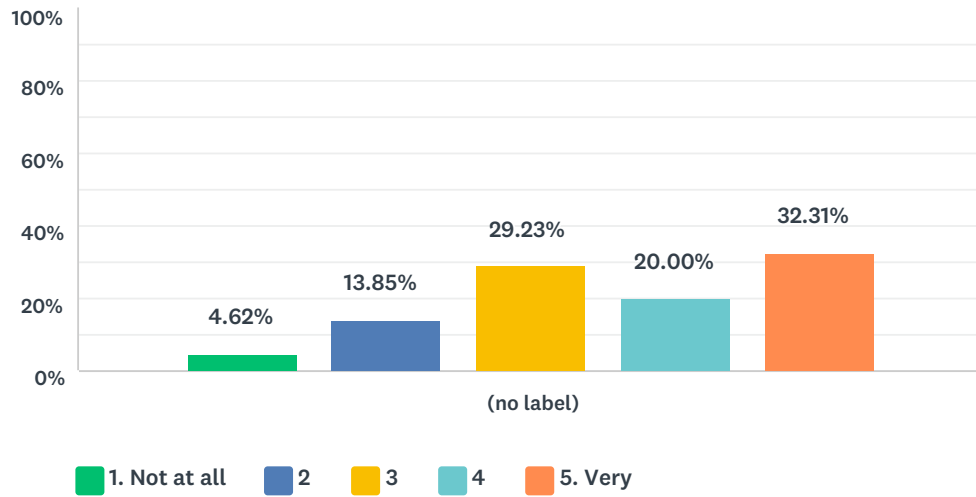
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	1.54%	9.23%	89.23%	65	4.88
	0	0	1	6	58		

Q15 The MSRI lunch arrangements were satisfactory

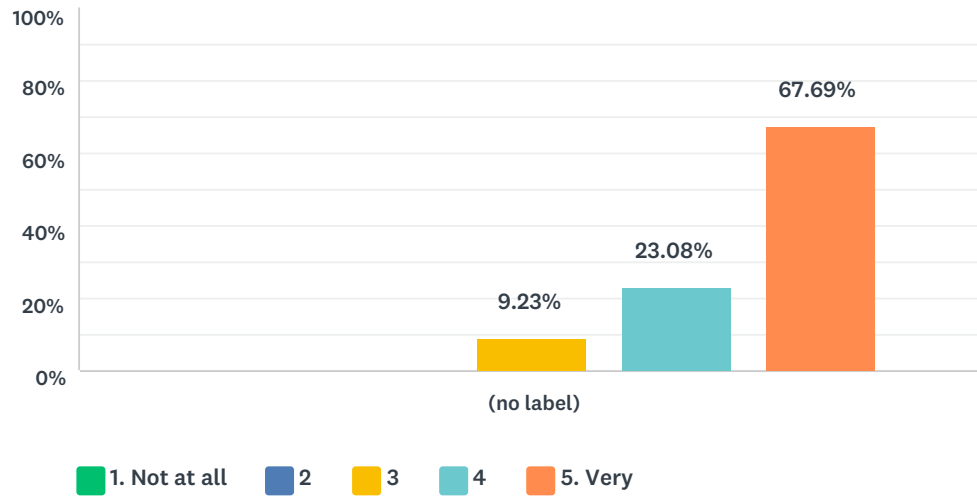
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	4.62%	13.85%	29.23%	20.00%	32.31%	65	3.62
	3	9	19	13	21		

Q16 The MSRI tea arrangements were satisfactory

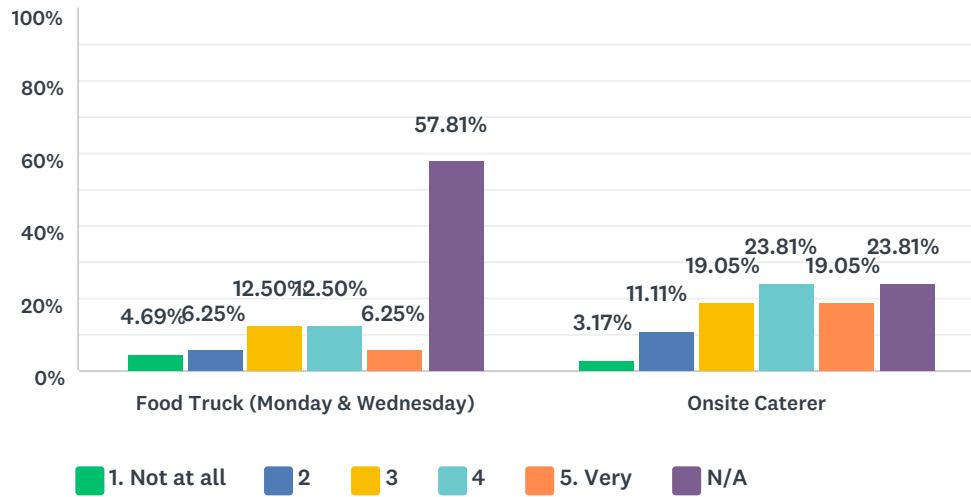
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.23%	23.08%	67.69%	65	4.58
	0	0	6	15	44		

Q17 I found the food from the following vendors satisfactory:

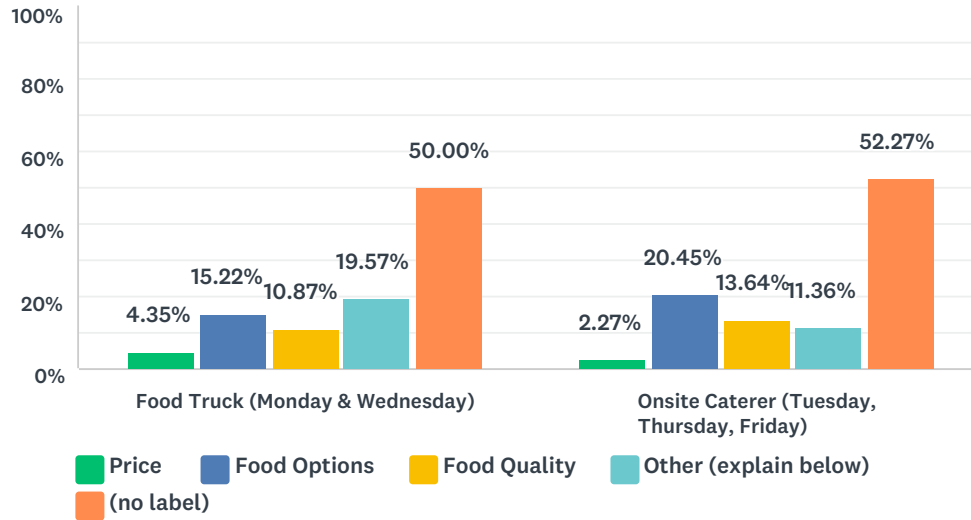
Answered: 65 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Monday & Wednesday)	4.69%	6.25%	12.50%	12.50%	6.25%	57.81%	
	3	4	8	8	4	37	64
Onsite Caterer	3.17%	11.11%	19.05%	23.81%	19.05%	23.81%	
	2	7	12	15	12	15	63

Q18 I did NOT purchase from the following vendors because:

Answered: 47 Skipped: 19



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	(NO LABEL)	TOTAL
Food Truck (Monday & Wednesday)	4.35% 2	15.22% 7	10.87% 5	19.57% 9	50.00% 23	46
Onsite Caterer (Tuesday, Thursday, Friday)	2.27% 1	20.45% 9	13.64% 6	11.36% 5	52.27% 23	44

#	OTHER (PLEASE SPECIFY)	DATE
1	I brought my own food most days	9/18/2019 10:02 AM
2	brought my own lunch	9/18/2019 3:51 AM
3	The sandwiches seem very expensive for what they are. I just bring my own lunch.	9/18/2019 3:12 AM
4	I did not know about the food truck.	9/12/2019 12:43 AM
5	Didn't know about the truck	9/10/2019 8:39 PM
6	lack of vegetarian options unless you managed to be at the front of the line :(9/10/2019 3:45 AM
7	Both for dietary reasons and to save time, I brought my own lunches.	9/9/2019 9:06 AM
8	I make my own lunch and bring it instead.	9/9/2019 6:47 AM
9	Did not know the food truck existed.	9/9/2019 6:30 AM
10	I brought lunch with me	9/9/2019 4:25 AM

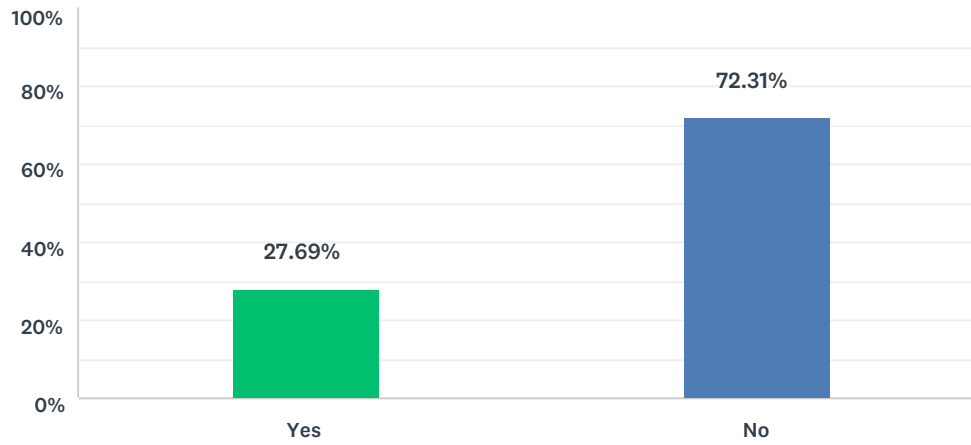
Q19 Additional comments about the MSRI staff, facilities and food

Answered: 4 Skipped: 62

#	RESPONSES	DATE
1	I have a comment for the food: it was cold and we would like to have hot sandwiches a few times. Staff and facilities were proper for me.	9/18/2019 8:16 AM
2	I ended up bringing food because I was fed up with eating the same stuff four weeks in a row.	9/18/2019 3:14 AM
3	find a better caterer. Very uninteresting food.	9/9/2019 2:05 PM
4	Having to pay \$1 to take the UC Berkeley shuttle up the hill was annoying, it would be nice if MSRI could make an arrangement with UC Berkeley so that all conference participants could ride the shuttle for free and not just MSRI members	9/9/2019 4:07 AM

Q20 Did you use the computer facilities located in the library?

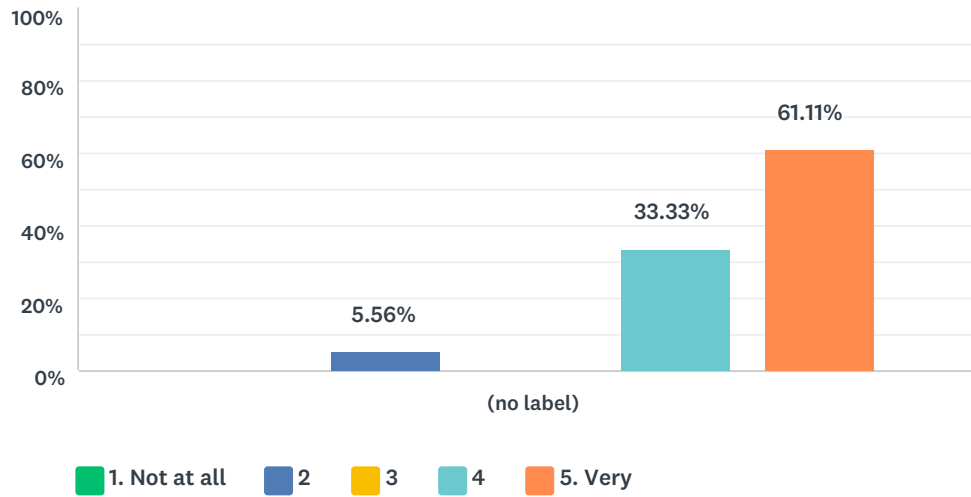
Answered: 65 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	27.69%	18
No	72.31%	47
TOTAL		65

Q21 The MSRI computer facilities in the library were adequate

Answered: 18 Skipped: 48

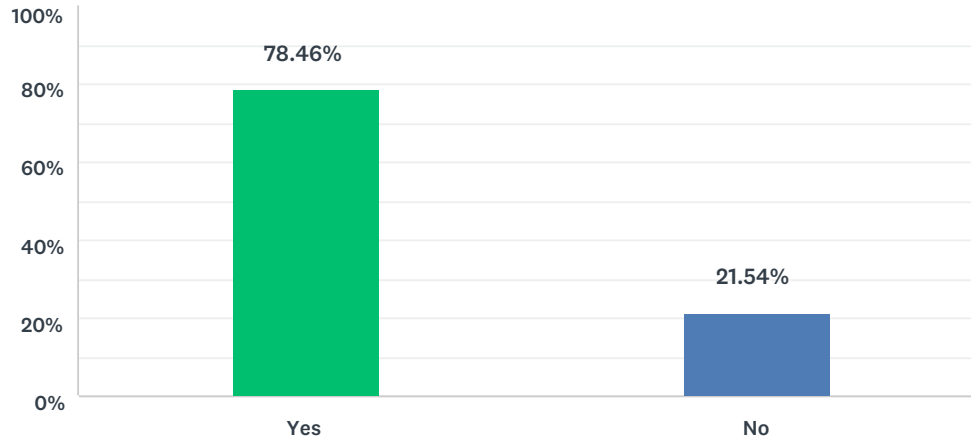


	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.56%	0.00%	33.33%	61.11%		
	0	1	0	6	11	18	4.50

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	I had significant technical difficulties when attempting to print from the library computers.	9/18/2019 3:06 AM

Q22 Did you use MSRI's wireless network?

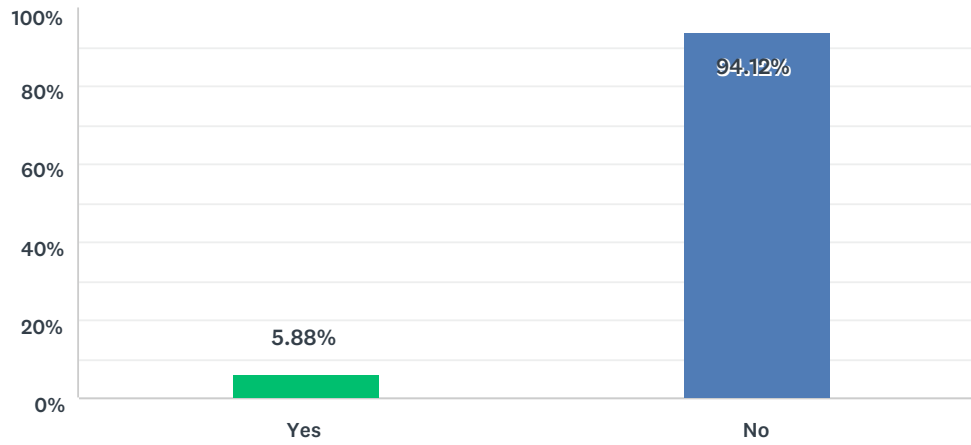
Answered: 65 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	78.46%	51
No	21.54%	14
TOTAL		65

Q23 Did you experience any difficulties with the network?

Answered: 51 Skipped: 15



ANSWER CHOICES	RESPONSES	
Yes	5.88%	3
No	94.12%	48
TOTAL		51

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	Weak signal	9/18/2019 3:15 AM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 2 Skipped: 64

#	RESPONSES	DATE
1	For additional comments or suggestions I suggest you to ask all lecturers in Mathematics to write on the board explaining, to multiplicate practises cases for our fast understanding.	9/18/2019 8:23 AM
2	The lecture room was really cold. It was not even 25 degrees outside and then the lecture room was freezing. This makes it not particularly nice for female participants who generally are not wearing long trousers like men.	9/12/2019 12:44 AM

**Holomorphic Differentials in
Mathematics and Physics Workshop**
November 18, 2019 - November 22, 2019
MSRI, Berkeley, CA, USA

Organizers:

Jayadev Athreya (University of Washington)

Steven Bradlow (University of Illinois at Urbana-Champaign),

Sergei Gukov (California Institute of Technology)

Andrew Neitzke (University of Texas, Austin)

Laura Schaposnik (University of Illinois at Chicago)

Gabriela Weitze-Schmithuesen (Universität des Saarlandes)

Anton Zorich (Institut de Mathematiques de Jussieu)

REPORT ON THE MSRI WORKSHOP
“Holomorphic Differentials in Mathematics and Physics”
November 18 – 22, 2019

Organizers

- Jayadev Athreya (University of Washington)
- Steven Bradlow (University of Illinois at Urbana-Champaign)
- Sergei Gukov (California Institute of Technology)
- Andrew Neitzke (University of Texas, Austin)
- Laura Schaposnik (University of Illinois at Chicago)
- Gabriela Weitze-Schmithuesen (Universität des Saarlandes)
- Anton Zorich (Institut de Mathématiques de Jussieu)

Scientific Description

Holomorphic differentials on Riemann surfaces have long held a distinguished place in low dimensional geometry, dynamics and representation theory. Recently it has become apparent that they constitute a common feature of several other highly active areas of current research in mathematics and also at the interface with physics. In some cases the areas themselves (such as stability conditions on Fukaya-type categories, links to quantum integrable systems, or the physically derived construction of so-called spectral networks) are new, while in others the novelty lies more in the role of the holomorphic differentials (for example in the study of billiards in polygons, special - Hitchin or higher Teichmüller - components of representation varieties, asymptotic properties of Higgs bundle moduli spaces, or in new interactions with algebraic geometry).

It is remarkable how widely scattered are the motivating questions in these areas, and how diverse are the backgrounds of the researchers pursuing them. Bringing together experts in this wide variety of fields to explore common interests and discover unexpected connections was a main goal of the semester-long program. The topical workshop was of interest to those working in many different fields, including low-dimensional dynamical systems (via the connection to billiards); differential geometry (Higgs bundles and related moduli spaces); and different types of theoretical physics (electron transport and supersymmetric quantum field theory).

Highlights of the Workshop

The sixteen talks of the workshop impressively demonstrated the diversity and surprising interdependence of the research areas involving the study of holomorphic differentials.

A series of talks in the currently large and well-established field of the theory of flat surfaces touched a great variety of contents : starting from Ivanov-type rigidity theorems for the complex of saddle connections (talk by Randecker) over new approaches to the computation of Euler characteristics of the projectivised strata of translation surfaces (talk by Möller) and the completion of the classification of Teichmüller curves that are in the same time Shimura curves by ruling them out in genus 5 (talk by Norton) up to the study of counting problems for meanders with the help of the theory of translation surfaces using the Masur Veech volumes of certain strata (talk by Delecroix). Ellegaard Andersen gave a unified picture of geometric recursion in the frame of category theory which has as one application a recursive formula for the Masur Veech volumes of strata. The state-of-the-art for dilation surfaces – as generalization of translation surfaces – was presented in the talk of Wang together with her results about the realization problem. Teichmüller dynamics played a crucial role in the talk of Skripchenko who related Novikov’s problem about triply periodic surfaces to results about interval exchange transformations and the Rauzy gasket. An excursion to higher dimension in the talk of Filip lead to the study of K3 surfaces and analogs of counting results for closed trajectories on flat surfaces in this setting.

A sequence of talks related to representations and moduli spaces of bundles gave an interesting glimpse on new developments in this direction. Here the main players were a generalization of the Toledo invariant in the setting of moduli spaces of G-Higgs bundles – with G being a real semisimple Lie group – over compact Riemann surfaces (talk by Garcia-Prada), the space of Toda-like harmonic metrics for cyclic Higgs bundles over noncompact Riemann surfaces (talk by Li), higher Teichmüller spaces and Anosov representations and their contribution to the study of discrete subgroups in higher rank Lie groups (talk by Wienhard), the moduli space of torsion-free sheaves on irreducible nodal curves (talk by Kaur), maximal surfaces in the pseudo-hyperbolic space $H_{2,n}$ (talk by Labourie) and the $PSL(2,R)$ -character variety of the fundamental group of surfaces of small complexity and dynamical aspects (talk by Maloni).

The exciting relation to physics in the context of spectral networks – which can be considered as a generalization of the saddle connections of flat surfaces – was a prominent part of the whole program. During the workshop generalizations of spectral networks were discussed in the talk of Haiden accompanied by very concrete examples where the spectral networks with “spider web shape” can be obtained explicitly by a recursive process. Complementary, the broader goal to develop a theory of non-commutative Kähler geometry and its category-theoretic framework was presented in the talk by Pandit.

Although the threat of a power shut-off lead to an interruption of the workshop on Wednesday, the full program could be accommodated. A conference diner (privately paid by the participants) was warmly welcomed by the participants and supported the pleasant and stimulating atmosphere for discussions of new ideas and the exchange of concepts from different fields which was in general decisive for the whole workshop.

Organizers

First Name	Last Name	Institution
Jayadev	Athreya	University of Washington
Steven	Bradlow	University of Illinois at Urbana-Champaign
Sergei	Gukov	California Institute of Technology
Andrew	Neitzke	University of Texas, Austin
Laura	Schaposnik	University of Illinois at Chicago
Gabriela	Weitze-Schmithuesen	Universität des Saarlandes
Anton	Zorich	Institut de Mathematiques de Jussieu

Speakers

First Name	Last Name	Institution
Jorgen Ellegaard	Andersen	Syddansk Universitet (University of Southern Denmark)
Vincent	Delecroix	Université de Bordeaux I
Simion	Filip	University of Chicago
Oscar	Garcia-Prada	Consejo Superior de Investigaciones Científicas (CSIC)
Fabian	Haiden	University of Oxford
Inder	Kaur	Institute of Pure and Applied Mathematics (IMPA)
François	Labourie	Université C�te d'Azur
Qionglng	Li	Chern Institute of Mathematics
Sara	Maloni	University of Virginia
Martin	Moeller	Johann Wolfgang Goethe-Universit�t Frankfurt
Chaya	Norton	University of Michigan
Pranav	Pandit	International Centre for Theoretical Sciences
Anja	Randecker	University of Toronto
Alexandra	Skripchenko	Higher School of Economics
Jane	Wang	Indiana University
Anna	Wienhard	Ruprecht-Karls-Universit�t Heidelberg

Mathematical Sciences Research Institute

Holomorphic Differentials in Mathematics and Physics

November 18 - 22, 2019

Monday, November 18, 2019

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Oscar Garcia-Prada	Arakelov-Milnor inequalities and maximal variations of Hodge structure
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Alexandra Skripchenko	Novikov's problem: from physics of metals to modern dynamical systems
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Jorgen Ellegaard Andersen	Geometric Recursion
3:00 PM - 4:00 PM	Atrium		Tea
4:00 PM - 5:00 PM	Simons Auditorium	Anja Randecker	The saddle connection complex
5:15 PM - 6:15 PM	Simons Auditorium		Screening of Secrets of the Surface: The Mathematical Vision of Maryam Mirzakhani

Tuesday, November 19, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Martin Moeller	The Euler characteristic of moduli spaces of meromorphic differentials
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Fabian Haiden	Spectral networks and stability conditions
12:00 PM - 1:15 PM	Atrium		Lunch
1:15 PM - 2:15 PM	Simons Auditorium	Simion Filip	K3 surfaces: dynamics and moduli spaces
2:30 PM - 3:30 PM	Simons Auditorium	Jane Wang	The realization problem for twisted quadratic differentials (dilation surfaces)
3:30 PM - 4:00 PM	Atrium		Tea
4:00 PM - 5:00 PM	Simons Auditorium	Qiongling Li	Cyclic harmonic bundles on noncompact surfaces
5:00 PM - 7:00 PM	Atrium		Reception

Wednesday, November 20, 2019

No Workshop Talks Scheduled

Thursday, November 21, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Vincent Delecroix	Meanders and holomorphic differentials
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Anna Wienhard	Higher Teichmüller spaces and Anosov representations
12:00 PM - 1:15 PM	Atrium		Lunch
1:15 PM - 2:15 PM	Simons Auditorium	Inder Kaur	Aspects of the cohomology ring of the moduli space of torsion-free sheaves on an irreducible nodal curve
2:30 PM - 3:30 PM	Simons Auditorium	Chaya Norton	Degeneration of the Period Matrix and Shimura-Teichmüller Curves
3:30 PM - 4:00 PM	Atrium		Tea
4:00 PM - 5:00 PM	Simons Auditorium	François Labourie	Maximal surfaces in pseudo-hyperbolic spaces of rank 2

Friday, November 22, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Pranav Pandit	Holomorphic differentials and the geometry of dg-categories
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Sara Maloni	On type-preserving representations of thrice punctured projective plane group
12:00 PM - 2:00 PM	Atrium		Lunch
3:00 PM - 4:00 PM	Atrium		Tea



Participants		
First Name	Last Name	Institution
Ian	Agol	University of California, Berkeley
Fernando	Al Assal	Yale University
Dylan	Allegretti	MSRI - Mathematical Sciences Research Institute
Jorgen Ellegaard	Andersen	Syddansk Universitet (University of Southern Denmark)
Mehmet	àœnver	Ankara University
Jayadev	Athreya	University of Washington
David	Aulicino	Brooklyn College, CUNY
Shinpei	Baba	Osaka University
Eric	Babson	University of California, Davis
Frederik	Benirschke	State University of New York, Stony Brook
Marco	Bertola	International School for Advanced Studies (SISSA/ISAS)
Francis	Bonahon	University of Southern California
Steven	Bradlow	University of Illinois at Urbana-Champaign
Aaron	Calderon	Yale University
John	Chae	University of California, Davis
mondher	chouikhi	ISSAT
Brian	Collier	University of Maryland
Matteo	Costantini	Johann Wolfgang Goethe-Universität Frankfurt
Xian	Dai	Rice University
Luca	De Rosa	Università di Napoli ``Federico II''
Vincent	Delecroix	Université de Bordeaux I
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Richard	Derryberry	Perimeter Institute of Theoretical Physics
Valentina	Disarlo	Ruprecht-Karls-Universität Heidelberg
Benjamin	Dozier	State University of New York, Stony Brook
David	Dumas	University of Illinois at Chicago
Philip	Engel	University of Georgia
Aaron	Fenyés	Institut des Hautes Études Scientifiques (IHES)
Simion	Filip	University of Chicago
Xenia	Flamm	ETH Zurich
Francesco	Fournier Facio	ETH Zurich
Laura	Fredrickson	Stanford University
Oscar	Garcia-Prada	Consejo Superior de Investigaciones Científicas (CSIC)
Michael	Gekhtman	University of Notre Dame
William	Goldman	University of Maryland
Elise	Goujard	Université de Bordeaux I
Samuel	Grushevsky	State University of New York, Stony Brook
Sergei	Gukov	California Institute of Technology
Subhojoy	Gupta	Indian Institute of Science
Fabian	Haiden	University of Oxford
Ursula	Hamenstädt	Rheinische Friedrich-Wilhelms-Universität Bonn
Qianyu	Hao	University of Texas, Austin
Zheng	Huang	CUNY, Graduate Center
Alessandra	Iozzi	ETH Zürich
Hongtaek	Jung	Institute for basic science
Inder	Kaur	Institute of Pure and Applied Mathematics (IMPA)

Participants		
First Name	Last Name	Institution
Inkang	Kim	Korea Institute for Advanced Study (KIAS)
Takashi	Kimura	Boston University
Dmitry	Korotkin	Concordia University
Yannick	Krifka	ETH Zurich
François	Labourie	Université Cà'te d'Azur
Heather	Lee	University of Washington
Qionglng	Li	Chern Institute of Mathematics
Luen-Chau	Li	Pennsylvania State University
Shuo	Liu	Capital Normal University
Pietro	Longhi	ETH Zurich
Biao	MA	Université Nice Sophia-Antipolis
Sara	Maloni	University of Virginia
Kishore	Marathe	BrooklynCollege. CUNY
Yair	Minsky	Yale University
Babak	Modami	State University of New York, Stony Brook
Martin	Moeller	Johann Wolfgang Goethe-Universität Frankfurt
Benedict	Morrissey	University of Pennsylvania
Sara	Motlaghian	Georgia State University
Patrícia	Muñoz Ewald	Institute of Mathematics and Statistics (IME)
Scott	Mullane	Johann Wolfgang Goethe-Universität Frankfurt
Xuesen	Na	University of Maryland
Patrik	Nabelek	Oregon State University
Richard	Nally	Stanford University
Andrew	Neitzke	University of Texas, Austin
Chaya	Norton	University of Michigan
Murat	Olgun	Ankara University
André	Oliveira	Centro de Matemática da Universidade do Porto
Charles	Ouyang	Rice University
Pranav	Pandit	International Centre for Theoretical Sciences
Du	Pei	California Institute of Technology
John Gabriel	Pelias	University of California, Santa Cruz
Anja	Randecker	University of Toronto
Lisa	Ricci	ETH Zurich
Daniel	Roggenkamp	Universität Mannheim
Lorenzo	Ruffoni	Florida State University
Nathaniel	Sagman	California Institute of Technology
Nick	Salter	Columbia University
Kwamou ngaha	Sandy Frank	Mathematics and sciences institute
Eugenia	Sapir	Binghamton University (SUNY)
Laura	Schaposnik	University of Illinois at Chicago
Sebastian	Schulz	University of Texas, Austin
Hiroshige	Shiga	Kyoto Sangyo University
Michael	Singer	University College
Alexandra	Skripchenko	Higher School of Economics
Ivo	Slegers	Max-Planck-Institut für Mathematik
John	Smillie	University of Warwick

Participants		
First Name	Last Name	Institution
Peter	Smillie	California Institute of Technology
Alex	Takeda	University of California, Berkeley
Andrea	Tamburelli	Rice University
Valdo	Tatitscheff	Université de Strasbourg
Faouzi	Thabet	Higher institute of applied sciences and technology of Gabes
Andrea Hannah	Thevis	Universität des Saarlandes
Alejandro	Uribe	University of Michigan
FERRAN	VALDEZ	Universidad Nacional Autónoma de México campus Morelia
Karen	Vogtmann	University of Warwick
Qiang	Wang	Kansas State University
Jane	Wang	Indiana University
Gabriela	Weitze-Schmithuesen	Universität des Saarlandes
Richard	Wentworth	University of Maryland
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Michael	Wolf	Rice University
Fei	Yan	Rutgers University
Seyhmus	YARDIMCI	Ankara University
Jonathan	Zachhuber	Johann Wolfgang Goethe-Universität Frankfurt
Xuwen	Zhu	University of California, Berkeley
Anton	Zorich	Institut de Mathematiques de Jussieu

Officially Registered Participants Information

Participants		112
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Gender		112
Male	74.11%	83
Female	25.00%	28
Declined to state	0.89%	1
Other/Non-Binary	0.00%	0

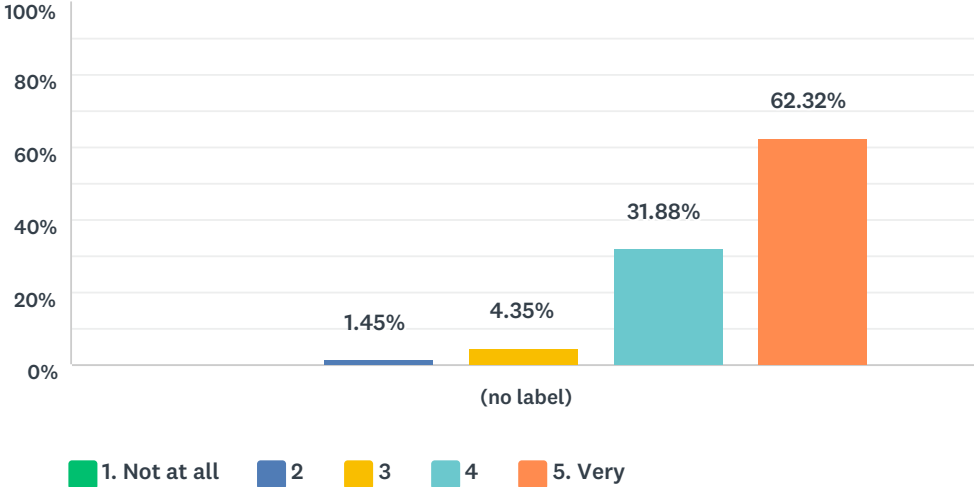
Ethnicity*		122
White	57.38%	70
Asian	23.77%	29
Hispanic	4.92%	6
Pacific Islander	0.00%	0
Black	0.82%	1
Native American	0.00%	0
Mixed	4.10%	5
Declined to state	9.02%	11

* ethnicity specifications are not exclusive

69 responses out of 111 participants = 62% response rate

Q1 The workshop was intellectually stimulating

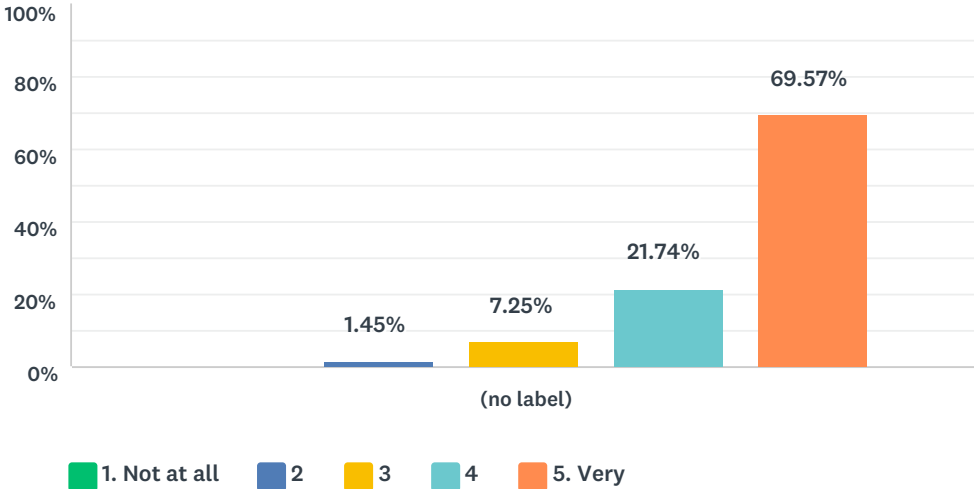
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.45%	4.35%	31.88%	62.32%	69	4.55
	0	1	3	22	43		

Q2 The overall experience of the workshop was worthwhile

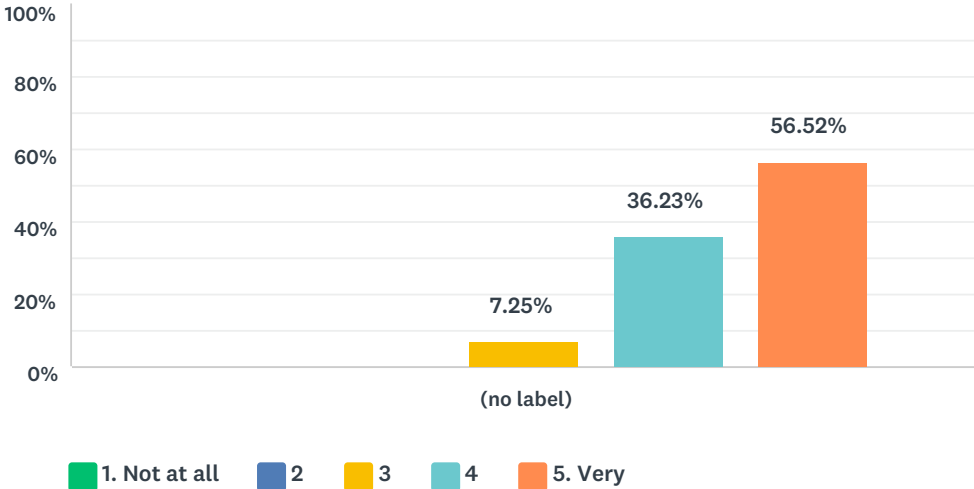
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.45%	7.25%	21.74%	69.57%	69	4.59
	0	1	5	15	48		

Q3 The time between lectures was adequate for discussion

Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	7.25%	36.23%	56.52%	69	4.49
	0	0	5	25	39		

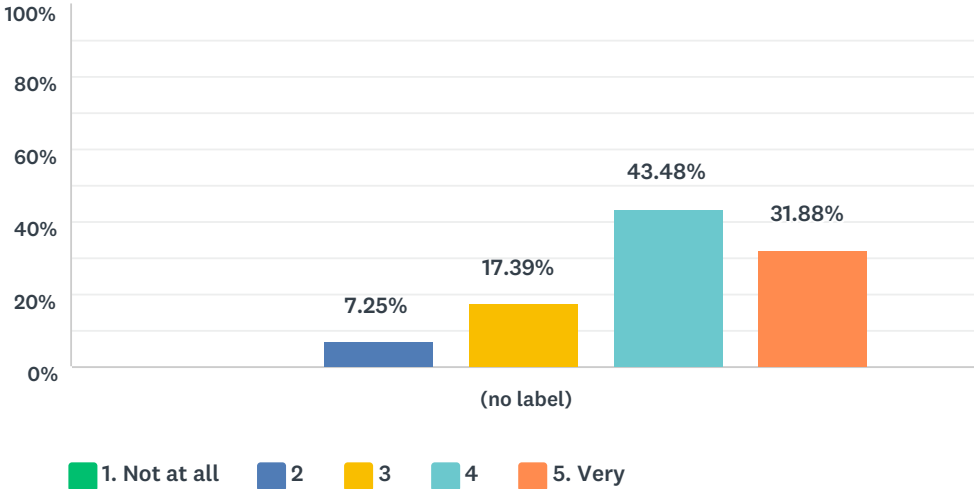
Q4 Additional comments

Answered: 2 Skipped: 67

#	RESPONSES	DATE
1	Hour-long breaks are a bit too long.	12/13/2019 6:45 PM
2	with the schedule change, Thursday was a bit too cramped; but there's nobody to blame for that	11/28/2019 11:02 AM

Q5 I was well prepared to benefit from the lectures

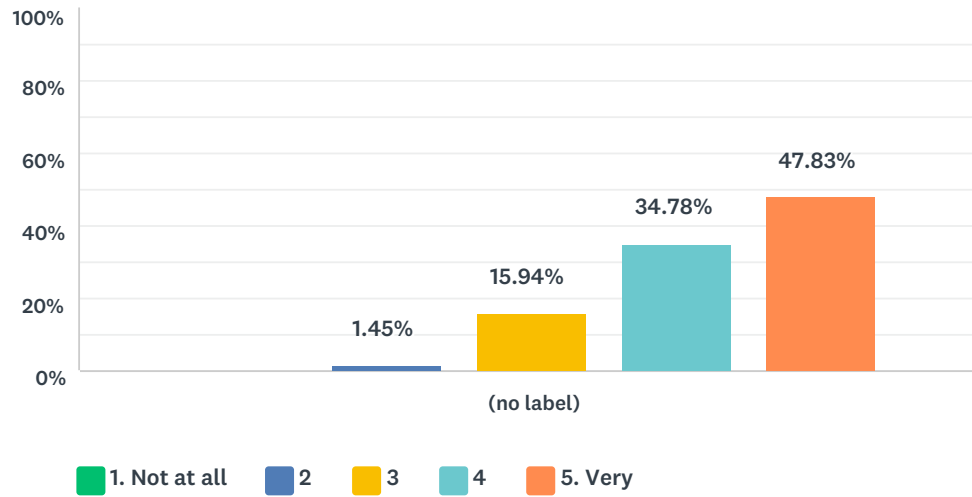
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	7.25%	17.39%	43.48%	31.88%	69	4.00
	0	5	12	30	22		

Q6 My interest in the subject matter was increased by the workshop

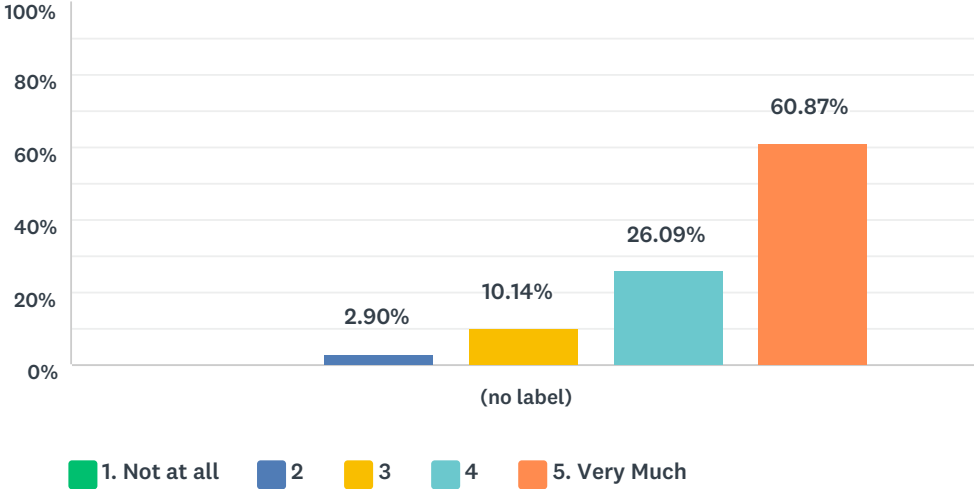
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.45%	15.94%	34.78%	47.83%	69	4.29
	0	1	11	24	33		

Q7 The workshop helped me meet people with similar scientific interests

Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.90%	10.14%	26.09%	60.87%	69	4.45
	0	2	7	18	42		

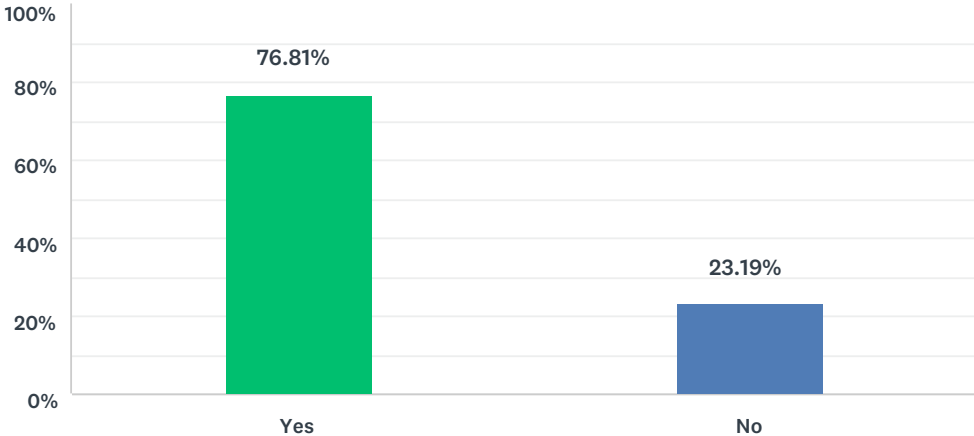
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 68

#	RESPONSES	DATE
1	It was perfect	12/5/2019 1:16 PM

Q9 Did you attend the reception?

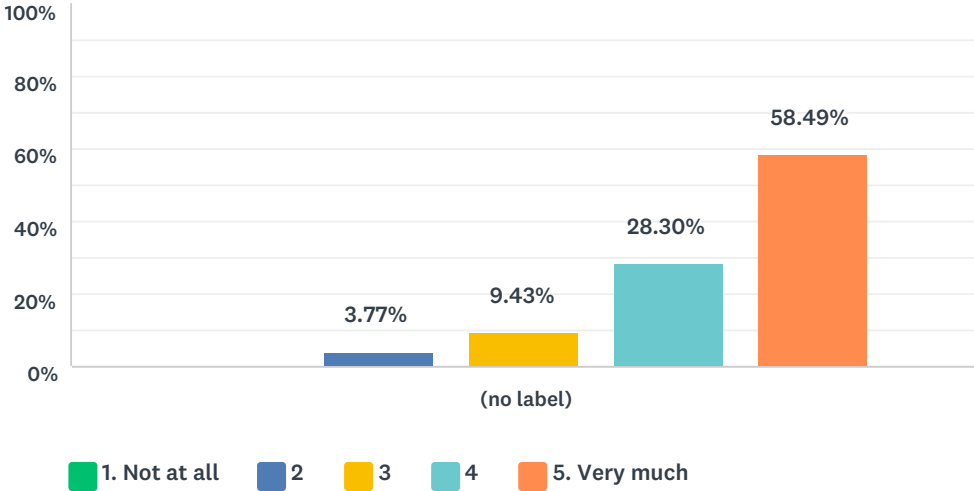
Answered: 69 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	76.81%	53
No	23.19%	16
TOTAL		69

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 53 Skipped: 16



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.77%	9.43%	28.30%	58.49%	53	4.42
	0	2	5	15	31		

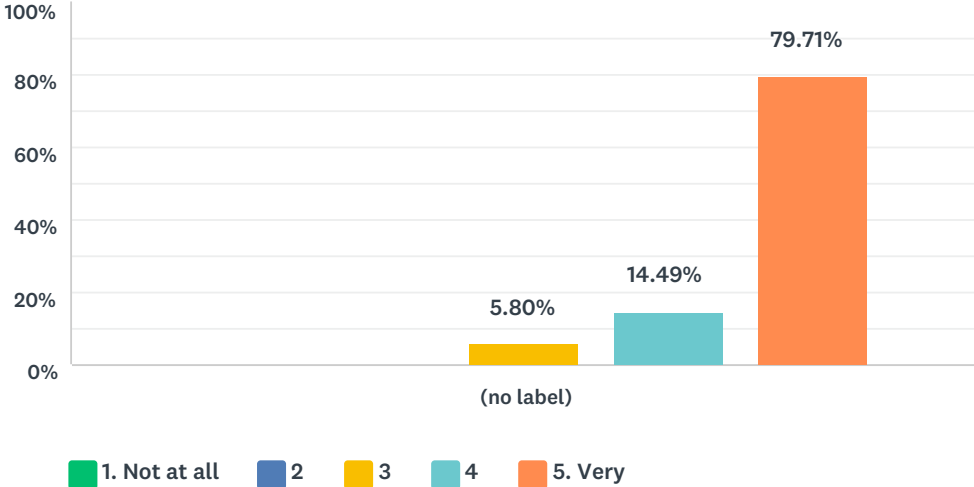
Q11 Please provide any comments about the reception

Answered: 2 Skipped: 67

#	RESPONSES	DATE
1	The food was excellent..but not the red wine!	12/5/2019 2:46 PM
2	Food was fine and well served.	11/25/2019 6:42 PM

Q12 I found the MSRI staff helpful

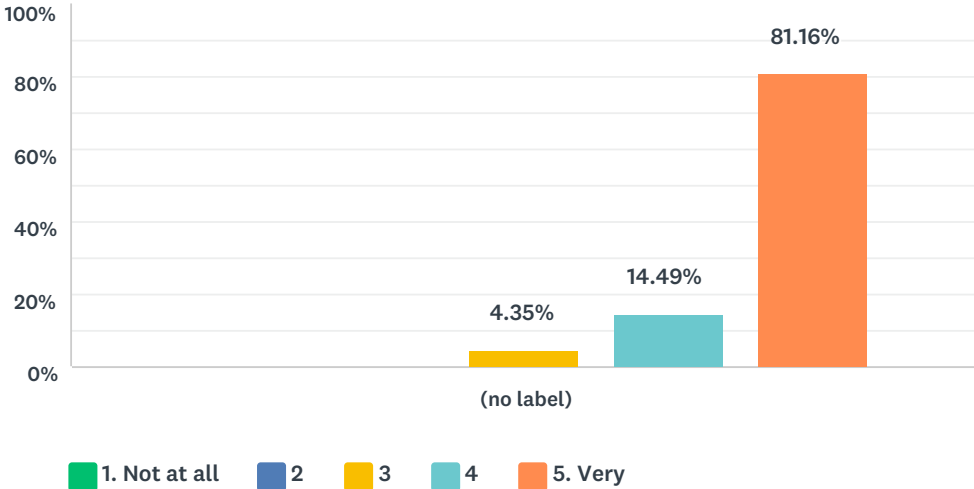
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	5.80%	14.49%	79.71%	69	4.74
	0	0	4	10	55		

Q13 The MSRI facilities were conducive for such a workshop

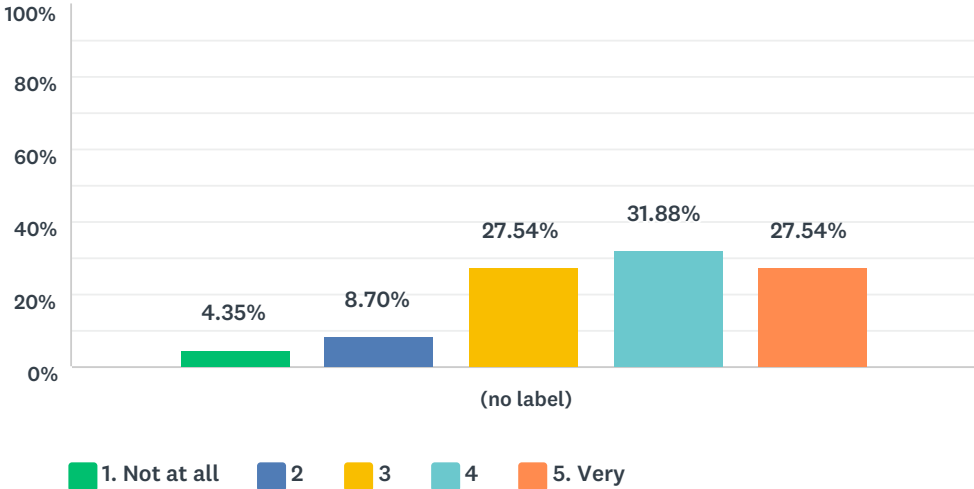
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.35%	14.49%	81.16%	69	4.77
	0	0	3	10	56		

Q14 The MSRI lunch arrangements were satisfactory

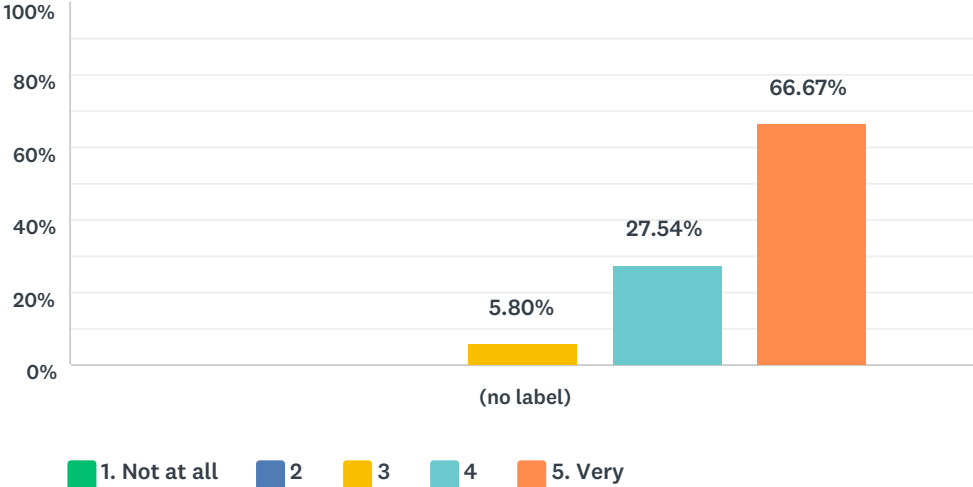
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	4.35%	8.70%	27.54%	31.88%	27.54%	69	3.70
	3	6	19	22	19		

Q15 The MSRI tea arrangements were satisfactory

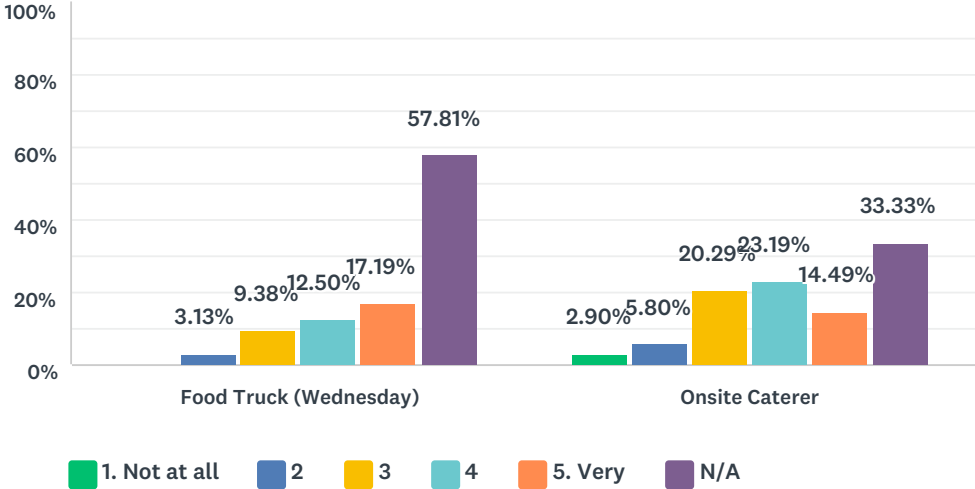
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	5.80% 4	27.54% 19	66.67% 46	69	4.61

Q16 I found the food from the following vendors satisfactory:

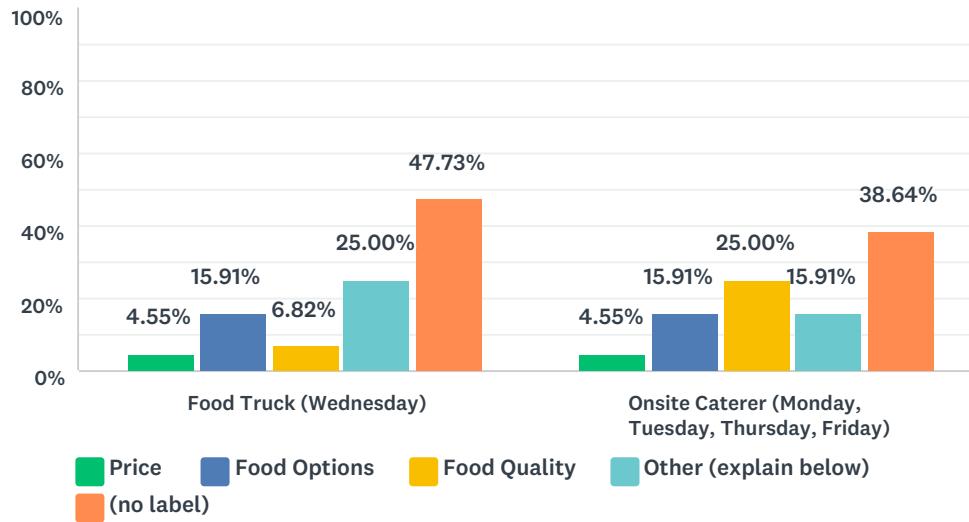
Answered: 69 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Wednesday)	0.00%	3.13%	9.38%	12.50%	17.19%	57.81%	
	0	2	6	8	11	37	64
Onsite Caterer	2.90%	5.80%	20.29%	23.19%	14.49%	33.33%	
	2	4	14	16	10	23	69

Q17 I did NOT purchase from the following vendors because:

Answered: 48 Skipped: 21



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	(NO LABEL)	TOTAL
Food Truck (Wednesday)	4.55% 2	15.91% 7	6.82% 3	25.00% 11	47.73% 21	44
Onsite Caterer (Monday, Tuesday, Thursday, Friday)	4.55% 2	15.91% 7	25.00% 11	15.91% 7	38.64% 17	44

#	OTHER (PLEASE SPECIFY)	DATE
1	Brought my own	12/13/2019 6:01 PM
2	Food quality from onsite caterer was terrible. Most food looked terrible, and I purchased some to test on two days. It was terrible, so I simply skipped eating lunch on the other days.	12/6/2019 1:13 AM
3	There was a free day on Wednesday because of blackout	12/5/2019 6:14 AM
4	brought lunch	12/5/2019 5:51 AM
5	I prefer to bring a small lunch from home.	12/4/2019 11:04 PM
6	I prefer to bring food rather than buy it, since I had a kitchen where I was staying.	12/1/2019 2:26 PM
7	I brought my lunch from home	11/26/2019 1:49 PM
8	Conference was rescheduled on Wed because of wind/electricity issues	11/26/2019 4:36 AM
9	I arrived Wednesday afternoon	11/25/2019 8:23 PM
10	I usually skip lunch	11/25/2019 6:36 PM
11	Prefer to bring my own food	11/25/2019 6:14 PM

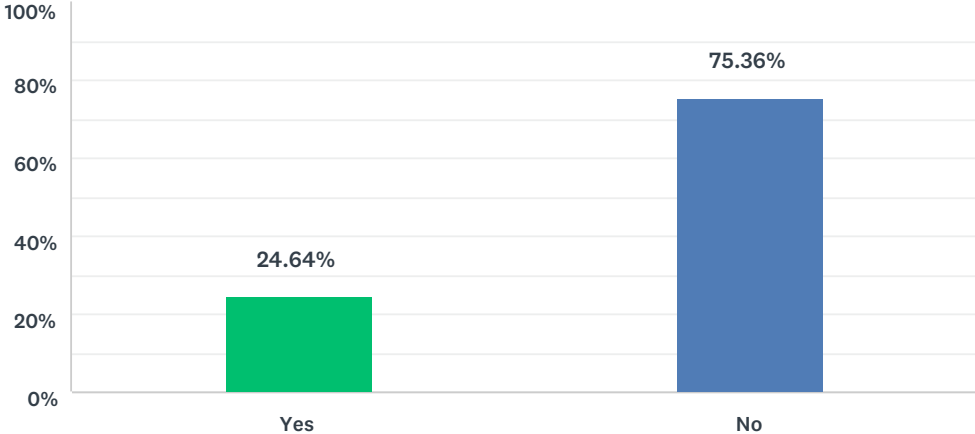
Q18 Additional comments about the MSRI staff, facilities and food

Answered: 6 Skipped: 63

#	RESPONSES	DATE
1	Good teasnacks	12/13/2019 6:46 PM
2	Lunch really was terrible, and since it is so hard to get in to and back from Berkeley in a timely fashion that significantly impacted the experience of the conference. I attempted to find a place to purchase lunch before catching to bus in the morning, but talks started early enough that many places were not yet open to sell food.	12/6/2019 1:13 AM
3	a couple of Wednesdays I was expecting the food truck (like today and last week (Thanksgiving eve)) but it wasn't there. As a result I hadn't ordered food online. (but i need to reduced my food intake anyway...)	12/5/2019 6:58 AM
4	A cafeteria would be nice.	11/26/2019 1:49 PM
5	Staff very helpful and kind. Nice to have coffee always available. Thank you for all you do.	11/26/2019 4:36 AM
6	I didn't like the food stuffed inn so much, but it's ok and nicely priced.	11/26/2019 1:49 AM

Q19 Did you use the computer facilities located in the library?

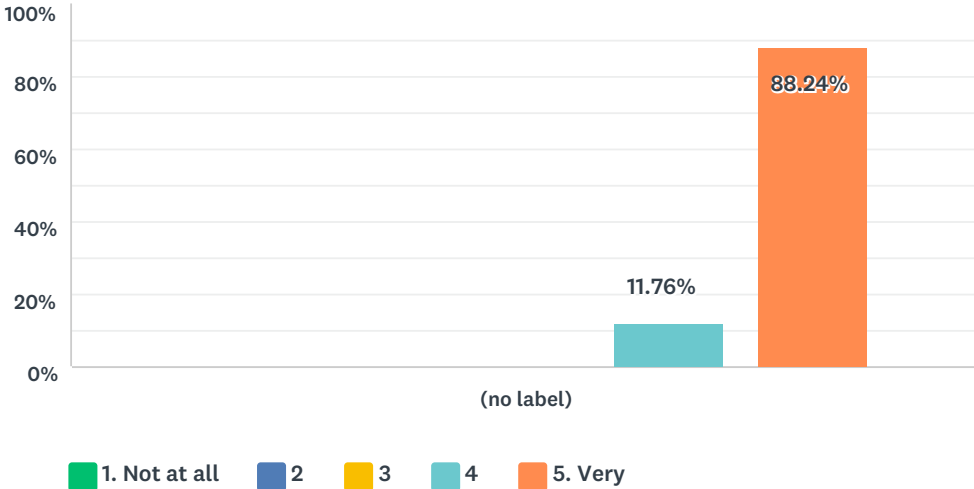
Answered: 69 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	24.64%	17
No	75.36%	52
TOTAL		69

Q20 The MSRI computer facilities in the library were adequate

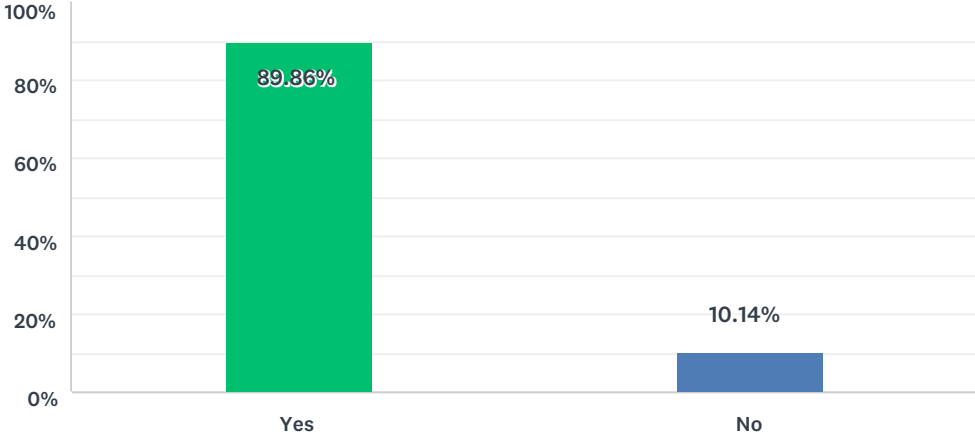
Answered: 17 Skipped: 52



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	11.76%	88.24%	17	4.88
	0	0	0	2	15		

Q21 Did you use MSRI's wireless network?

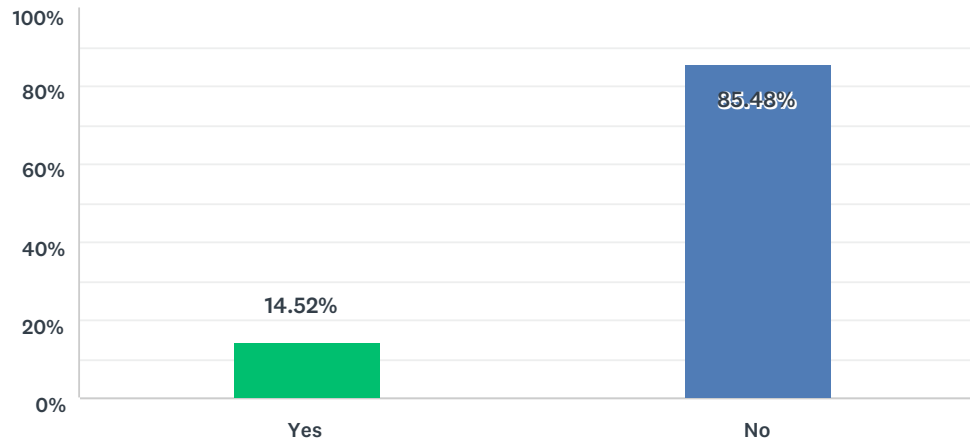
Answered: 69 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	89.86%	62
No	10.14%	7
TOTAL		69

Q22 Did you experience any difficulties with the network?

Answered: 62 Skipped: 7



ANSWER CHOICES	RESPONSES	
Yes	14.52%	9
No	85.48%	53
TOTAL		62

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	Dropped out occasionally, but not too badly.	12/6/2019 1:15 AM
2	Occasionally weak signal.	11/26/2019 10:59 PM
3	Eduroam wasn't working.	11/26/2019 12:55 AM
4	Problems with Eduroam (not unusual). MSRI Guest worked fine.	11/25/2019 6:15 PM
5	It is spotty in some parts of the building (outside the library, on the terrace)	11/25/2019 5:49 PM
6	Eduroam stopped working at some point.	11/25/2019 5:40 PM

Q23 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 9 Skipped: 60

#	RESPONSES	DATE
1	I really enjoyed the conference and stay in MSRI very much!	12/11/2019 12:10 AM
2	It was a very benefic experience for me...all my thanks to the organizers.	12/5/2019 2:48 PM
3	The number of participants for the workshop was very high, so sometimes the building/rooms were very crowded, e.g. during lunch and tea.	12/5/2019 7:07 AM
4	i will say more when I fill out the survey for long term visitors.	12/5/2019 6:59 AM
5	The big picture problem that MSRI needs to address is thinking about how workshops and programs will run under potential power outages. This was a serious issue during the workshop and resulted in my colleague missing Thursday and Friday due to being forced to fly home early after his accommodations became uncertain. Coming up with a strategy so that workshops and programs can effectively run without interruption from the power outages either through the use of alternate facilities, methods of organization via the website, or creating a virtual MSRI to replace the institute when power is out would be a start toward handling a problem that will probably continue to get worse in the coming years.	12/5/2019 2:49 AM
6	Great Workshop!	11/26/2019 5:30 PM
7	I very much appreciate the banquet organized by Laura Schaposnik and the fact that it was affordable for students and postdocs.	11/26/2019 2:37 AM
8	I had to check out of BLG due to fire hazzard. No other accommodation was found. I had to return to NY on Tuesday night with substantial cost to me.	11/25/2019 6:47 PM
9	Why not putting a small caffeteria in the space where the tea food is prepared? I m very very happy with all the staff, they did great and we're always helpful and supportive.	11/25/2019 6:01 PM

**Recent Developments in
Microlocal Analysis**

October 14, 2019 - October 18, 2019

MSRI, Berkeley, CA, USA

Organizers:

Pierre Albin (University of Illinois at Urbana-Champaign)

Nalini Anantharaman (Université de Strasbourg)

Colin Guillarmou (Université de Paris XI (Paris-Sud))

REPORT ON THE MSRI WORKSHOP

“Recent developments in microlocal analysis”

October 14 – 18, 2019

Organizers

- Pierre Albin (University of Illinois at Urbana-Champaign)
- Nalini Anantharaman (Université de Strasbourg),
- Colin Guillarmou (Université de Paris XI (Paris-Sud))

Scientific Description

Microlocal analysis provides tools for the precise analysis of problems arising in areas such as partial differential equations or integral geometry by working in the phase space, i.e. the cotangent bundle, of the underlying manifold. It has origins in areas such as quantum mechanics and hyperbolic equations, in addition to the development of a general PDE theory, and has expanded tremendously over the last 40 years to the analysis of singular spaces, integral geometry, nonlinear equations, scattering theory, hyperbolic dynamical systems, probability... As this description shows microlocal analysis has become a very broad area. Due to its breadth, it is a challenge for researchers to be aware of what is happening in other parts of the field, and the impact this may have in their own research area. The purpose of this workshop was to bring together researchers from different parts of microlocal analysis and its applications to facilitate the transfer of new ideas.

Highlights of the Workshop

The goal of our conference was to gather several leaders of the microlocal communities in order to present the diverse applications of these methods based on phase-space analysis, focusing in particular on the recent developments. These applications included Index theory, spectral analysis and quantum resonances, inverse problems and spectral rigidity, hyperbolic dynamics, quantum chaos, the analysis of dispersive PDEs, random geometry.

The first day was focused on geometric microlocal analysis, that is application to geometric problems using microlocal methods on manifolds with boundaries or corners. We somehow had a tour of the recent progresses on this topic. Richard Melrose opened the conference with some very interesting talk explaining how to approach the possible construction of the Dirac-Raymond operator on loop spaces. It was followed by an exciting talk by Xuwen Zhu, explaining how to analyze the deformation space of metrics with conic singularities, some joint work she has been doing with Rafe Mazzeo. In the same spirit of describing geometric operators on manifolds with singular strata, Jesse Gell Redman spoke about his work with Albin on wedge spaces with some APS type index formula, while Rafe Mazzeo concluded the day by showing several approaches for studying fractional Laplacians on manifolds with boundary, making a bridge between scattering theory of asymptotically hyperbolic spaces and the edge-calculus and Grubb/Boutet de Monvel calculus of pseudodifferential operators on manifolds with boundary.

Our second day of conference was the opportunity to hear new exciting advances on spectral problems obtained thanks to microlocal and semiclassical analysis. Tanya Christiansen showed how to localize scattering resonances on manifolds with cylindrical ends, Fabricio Macia explained some analysis of semiclassical measures and quasimodes for integrable systems using semiclassical tools, while Jeff Galkowski presented his strong recent L^p estimates with Canzani on the eigenfunctions of Laplacians in terms of dynamical quantities. Maciej Zworski closed the day with a high-tech talk using analytic microlocal methods (joint work with Galkowski) to study viscosity limits for certain 0-th order pseudodifferential operators, in relation with the recent works of Colin de Verdière-Saint Raymond in fluid mechanics. Finally, somehow closer to the first day's topics, Alex Strohmaier showed how to use microlocal tools in order to prove Index theorems for globally hyperbolic Lorentzian manifolds, opening a new range of possible problems in that direction.

Our third day was a half-day, with two PDE/semiclassical problems on control theory and dispersive estimates by two strong members of the French microlocal school, namely Nicolas Burq and Oana Ivanovici. Burq gave a beautiful talk on how to get control and observability for the Grushin-Schrödinger equation on a cylinder, while Ivanovici went quite far in the technical aspects of how to obtain dispersive estimates for Schrödinger equation on strictly convex domains, some works she has been developing for several years with Lebeau, Planchon and by herself. Such estimates in the compact settings are notoriously very hard to obtain.

On Thursday, we had a morning session dedicated to Inverse Problems. Mikko Salo gave the first talk, presenting some interesting general setting for inverse boundary problems associated to real principal type operators, somehow including most of the known and studied problems so far in the literature and opening new possible directions of research. Katya Krupchyk then gave a great overview of the new results in the field of inverse problems for non-linear elliptic PDEs. In the afternoon, Viet Dang explained his beautiful new results with Yann Chaubet on the Fried conjecture, relating Farber-Turaev/Reidemeister torsion to the value at $s=0$ of the twisted Ruelle zeta function, a question on which much activities is being done this last couple of years. Finally, Damien Gayet presented some striking new results about random complex curves of CP^2 , in particular about their systoles in high degree, in relations with Mirzakhani's result for hyperbolic surfaces. This combination of probabilistic/analytic methods has been developing considerably in the recent years.

Our last day was a half day, where Frédéric Faure first gave an impressive survey on his long collaboration with Masato Tsujii on the spectral analysis of contact Anosov flows and band structure of the Ruelle spectrum, emphasizing new relations with certain quantum operators in the case of geodesic flows. Faure, Roy and Sjöstrand were the researchers who made the bridge between hyperbolic dynamical systems and microlocal analysis, generating many strong developments by microlocal analysts these last 10 years. Clotilde Fermanian presented her new results with Veronique Fischer on sub-Riemannian operators, in particular the notion of semiclassical measures in that setting for studying Schrödinger equations in sub-Riemannian cases, a field where several exciting activities on these questions, including quantum ergodicity, have been achieved in the last years. The conference was concluded by Hamid Hezari who explained the proof of his new striking rigidity theorem with Zelditch on Kac's problem "can we hear the shape of a drum": ellipses with small eccentricity are spectrally rigid, that is, no other domain of the plane with strictly convex boundary can have the same Laplace spectrum.

Organizers

First Name	Last Name	Institution
Pierre	Albin	University of Illinois at Urbana-Champaign
Nalini	Anantharaman	Université de Strasbourg
Colin	Guillarmou	Université de Paris XI (Paris-Sud)

Speakers

First Name	Last Name	Institution
Nicolas	Burq	Université de Paris XI
Tanya	Christiansen	University of Missouri
Nguyen Viet	Dang	Institut Camille Jordan
Frederic	Faure	Université de Grenoble I (Joseph Fourier)
Clotilde	Fermanian Kammerer	Université Paris-Est Créteil Val-de-Marne
Jeffrey	Galkowski	University College
Damien	Gayet	Université de Grenoble I (Joseph Fourier)
Jesse	Gell-Redman	University of Melbourne
Hamid	Hezari	University of California, Irvine
Oana	Ivanovici	Sorbonne University
Katya	Krupchyk	University of California, Irvine
Fabricio	Macia	Universidad Politécnica de Madrid
Rafe	Mazzeo	Stanford University
Richard	Melrose	Massachusetts Institute of Technology
Mikko	Salo	University of Jyväskylä
Alexander	Strohmaier	University of Leeds
Xuwen	Zhu	University of California, Berkeley
Maciej	Zworski	University of California, Berkeley

Mathematical Sciences Research Institute

Recent Developments in Microlocal Analysis

October 14 -18, 2019

Monday, October 14, 2019

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Richard Melrose	Loops, Toeplitz operators and representations
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Xuwen Zhu	Deformation of spherical conical metrics
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Jesse Gell-Redman	Analysis on singular spaces
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Rafe Mazzeo	Reflections on fractional Laplacians

Tuesday, October 15, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Tanya Christiansen	Asymptotic location of resonances for Schrödinger operators on infinite cylinders
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Fabrizio Macia	Quasimodes and completely integrable systems
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Alex Stohmaier	Local Index Theory in Lorentzian Geometry
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Jeffrey Galkowski	L_p norms via geodesic beams
4:40 PM - 5:40 PM	Simons Auditorium	Maciej Zworski	Viscosity Limits for 0th order operators
5:40 PM - 7:00 PM	Atrium		Reception

Wednesday, October 16, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Nicolas Burq	Exact controllability for the Schrödinger-Grushin equation
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Oana Ivanovici	Dispersive estimates for the semi-classical Schrödinger equation inside a strictly convex domain

Thursday, October 17, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Mikko Salo	Inverse problems for real principal type operators
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Katya Krupchyk	Recent developments in microlocal analysis
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Nguyen Viet Dang	Recent progress on the Fried conjecture
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Damien Gayet	Systoles and Lagrangians of random complex projective hypersurfaces

Friday, October 18, 2019

9:00 AM - 10:00 AM	Simons Auditorium	Frédéric Faure	Microlocal analysis of contact Anosov flows
10:00 AM - 10:30 AM	Atrium		Break
10:30 AM - 11:30 PM	Simons Auditorium	Clotilde Fermanian Kammerer	Semi-classical analysis of Schrödinger equation on H-type groups
11:30 AM - 12:30 PM	Simons Auditorium	Hamid Hezari	The inverse spectral problem for strictly convex domains
12:30 PM - 2:00 PM	Atrium		Lunch



Participants

First Name	Last Name	Institution
Pierre	Albin	University of Illinois at Urbana-Champaign
Clara	Aldana Dominguez	Universidad del Norte
Lior	Alon	Technion---Israel Institute of Technology
Nalini	Anantharaman	Université de Strasbourg
Tracey	Balehowsky	University of Helsinki
Dean	Baskin	Texas A & M University
Malte	Behr	Universität Oldenburg
Victor	Bermudez	University of California, Santa Cruz
Yonah	Borns-Weil	University of California, Berkeley
David	Borthwick	Emory University
Nicolas	Burq	Université de Paris XI
Yaiza	Canzani	University of North Carolina
Mihajlo	Cekic	Max-Planck-Institut für Mathematik
Yann	Chaubet	Université de Paris VI (Pierre et Marie Curie)-Université de Paris XI (Paris-Sud)
Kevin	Chien	University of Washington
Tanya	Christiansen	University of Missouri
Nguyen Viet	Dang	Institut Camille Jordan
Thibault	de Poyferré	University of California, Berkeley
Alix	Deleporte	MSRI - Mathematical Sciences Research Institute
Nils	Dencker	Lund University
Panagiotis	Dimakis	Stanford University
Moritz	Doll	Universität Bremen
Alexis	Drouot	Columbia University
Semyon	Dyatlov	University of California, Berkeley
Nikolaos	Eptaminitakis	University of Washington
Frederic	Faure	Université de Grenoble I (Joseph Fourier)
Clotilde	Fermanian Kammerer	Université Paris-Est Créteil Val-de-Marne
Steven	Flynn	University of California, Santa Cruz
Gabor	Francsics	Michigan State University
Laura	Fredrickson	Stanford University
Jeffrey	Galkowski	University College
Oran	Gannot	Northwestern University
Jorge	Garcia	University of Texas - Rio Grande Valley
Damien	Gayet	Université de Grenoble I (Joseph Fourier)
Jesse	Gell-Redman	University of Melbourne
Allan	Greenleaf	University of Rochester
Daniel	Grieser	Universität Oldenburg
Colin	Guillarmou	Université de Paris XI (Paris-Sud)
Wesley	Hamilton	University of North Carolina
Andrew	Hassell	Australian National University
Hamid	Hezari	University of California, Irvine
Peter	Hintz	Massachusetts Institute of Technology
Jiayi	Huang	University of Science and Technology of China
Manh Khang	Huynh	University of California, Los Angeles
Oana	Ivanovici	Sorbonne University
Dmitry	Jakobson	McGill University
Mahaarachchi	Jayasinghe	University of Illinois at Urbana-Champaign
Malo	Jezequel	Laboratoire de Probabilités, Statistique et Modélisation
Benjamin	Küster	Université de Paris XI
Blake	Keeler	University of North Carolina
Peter	Kleinhenz	Northwestern University
Christopher	Kottke	New College of Florida
Katya	Krupchyk	University of California, Irvine
Matti	Lassas	University of Helsinki

Participants

First Name	Last Name	Institution
Thibault	Lefeuvre	Université de Paris XI
Li	Li	University of Washington
Bingyuan	Liu	University of Arkansas
Boya	Liu	University of California, Irvine
Pietro	Longhi	ETH Zurich
Robert	Lopez	University of California, Riverside
Ursula	Ludwig	Universität Duisburg-Essen
Fabricio	Macia	Universidad Politécnica de Madrid
Jeremy	Marzuola	University of North Carolina
Chase	Mathison	Purdue University
Rafe	Mazzeo	Stanford University
Patrick	McDonald	New College of Florida
Michael	McNulty	University of California, Riverside
Richard	Melrose	Massachusetts Institute of Technology
Keita	Mikami	Riken
Francois	Monard	University of California, Santa Cruz
Katrina	Morgan	MSRI - Mathematical Sciences Research Institute
Georgios	Moschidis	University of California, Berkeley
Xuesen	Na	University of Maryland
Gaetan	Nfuala	Unikin
Gabriel	Paternain	Center for Mathematical Sciences
Fabrice	Planchon	Université Nice Sophia-Antipolis
Valter	Pohjola	Basque Center for Applied Mathematics
Igor	Prokhorenkov	Texas Christian University
Hadrian	Quan	University of Illinois at Urbana-Champaign
Eric	Quinto	Tufts University
Gueorgui	Raykov	Pontificia Universidad Católica de Chile
Victoria	Rayskin	Tufts University
Matthew	Redmond	Massachusetts Institute of Technology
Julie	Rowlett	Chalmers University of Technology/University of Göteborg
Antônio	Sá Barreto	Purdue University
Mikko	Salo	University of Jyväskylä
Nikhil	Savale	Universität zu Köln
Emmanuel	Schenck	Université de Paris XIII (Paris-Nord)
Jacob	Shapiro	Australian National University
David	Sher	DePaul University
Michael	Singer	University College
Alexander	Strohmaier	University of Leeds
Melissa	Tacy	University of Otago
Alex	Takeda	University of California, Berkeley
Andrea	Tamburelli	Rice University
Alejandro	Uribe	University of Michigan
Andras	Vasy	Stanford University
Amir	Vig	University of California, Irvine
Yiran	Wang	Stanford University
Ruoyu	Wang	Northwestern University
Francis	White	University of California, Los Angeles
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Jens	Wittsten	Lund University
Michał	Wrochna	Université de Cergy-Pontoise
Jared	Wunsch	Northwestern University
Jie	Xu	Boston University
Lili	Yan	University of California, Irvine
Mengxuan	Yang	Northwestern University

Participants

First Name	Last Name	Institution
Evangelie	Zachos	Stanford University
Steven	Zelditch	Northwestern University
Jian	Zhai	The Hong Kong University of Science and Technology
Ting	Zhou	Northeastern University
Hanming	Zhou	University of California, Santa Barbara
Xuwen	Zhu	University of California, Berkeley
Yuzhou	Zou	Stanford University
Maciej	Zworski	University of California, Berkeley

Officially Registered Participants Information

Participants		116
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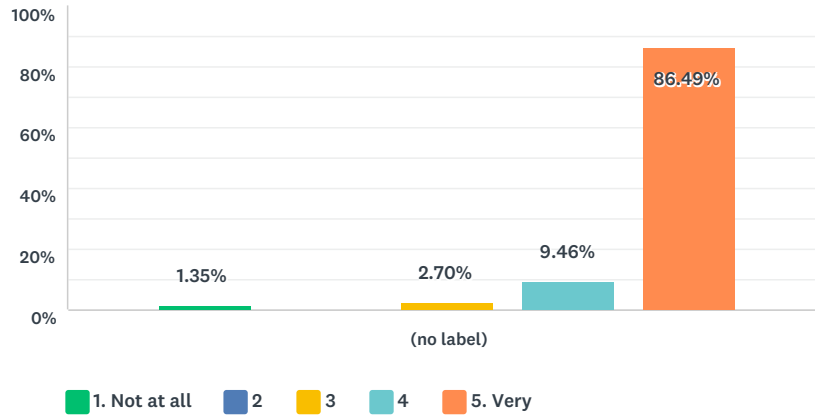
Gender		116
Male	81.90%	95
Female	16.38%	19
Declined to state	1.72%	2
Other/Non-Binary	0.00%	0

Ethnicity*		131
White	56.49%	74
Asian	16.79%	22
Hispanic	8.40%	11
Pacific Islander	0.00%	0
Black	0.76%	1
Native American	0.00%	0
Mixed	5.34%	7
Declined to state	12.21%	16

* ethnicity specifications are not exclusive

Q1 The workshop was intellectually stimulating

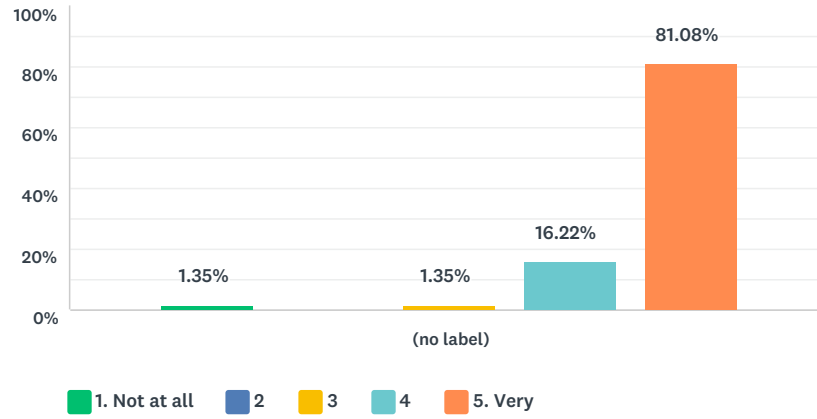
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	0.00%	2.70%	9.46%	86.49%	74	4.80
	1	0	2	7	64		

Q2 The overall experience of the workshop was worthwhile

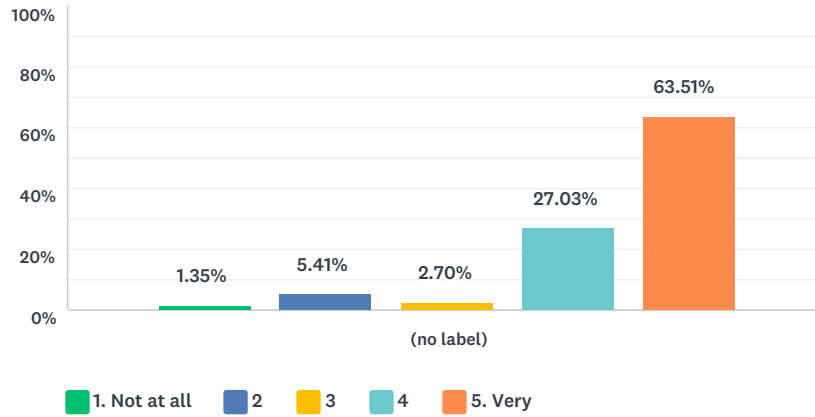
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	0.00%	1.35%	16.22%	81.08%	74	4.76
	1	0	1	12	60		

Q3 The time between lectures was adequate for discussion

Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	5.41%	2.70%	27.03%	63.51%	74	4.46
	1	4	2	20	47		

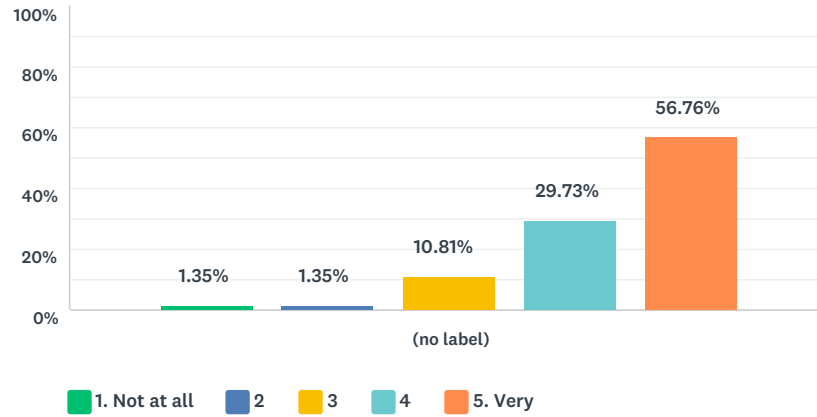
Q4 Additional comments

Answered: 8 Skipped: 66

#	RESPONSES	DATE
1	I enjoyed very much this workshop as well for the quality of the talks as for the discussions opportunities.	11/6/2019 2:47 AM
2	We definitely got caught up in discussions so the time between lectures felt short, but I believe were more than adequate.	11/5/2019 5:29 PM
3	I was very happy to attend the workshop. It was very interesting and enriching to attend the talks, as well as to meet and discuss with the speakers and other participants.	11/3/2019 7:01 AM
4	It was an excellent workshop. I really enjoyed it!	10/30/2019 6:20 PM
5	A very well organized event.	10/21/2019 4:42 PM
6	What a wonderful event! Very happy to be a participant and very grateful to be invited to speak.	10/21/2019 11:44 AM
7	The small number of lectures was a real plus for talking informally. I wish there had been grad student posters or lightning talks so that I would have been able to get to know the students' work. This would have provided more opportunity for research collaborations and mentorship. I know there was an introductory workshop at the start of the semester (which my students found valuable and stimulating), but even so, this would have helped the grad students to integrate more in the community.	10/21/2019 10:04 AM
8	Very high level talks, lots of time for discussion, the open environment of MSRI was supportive of contacts between participants.	10/21/2019 9:44 AM

Q5 I was well prepared to benefit from the lectures

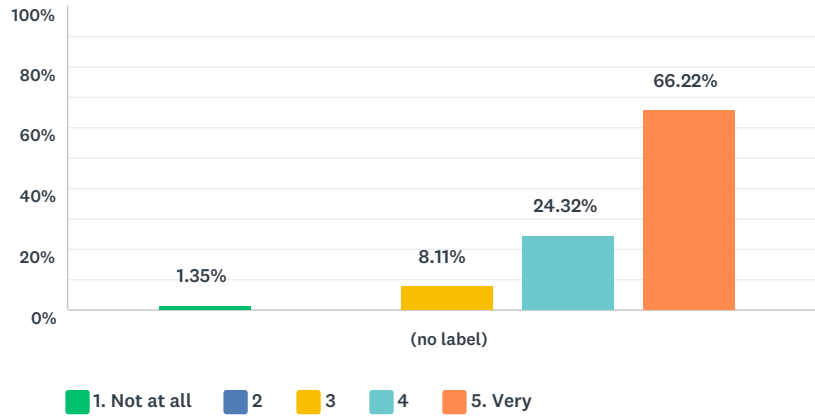
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	1.35%	10.81%	29.73%	56.76%	74	4.39
	1	1	8	22	42		

Q6 My interest in the subject matter was increased by the workshop

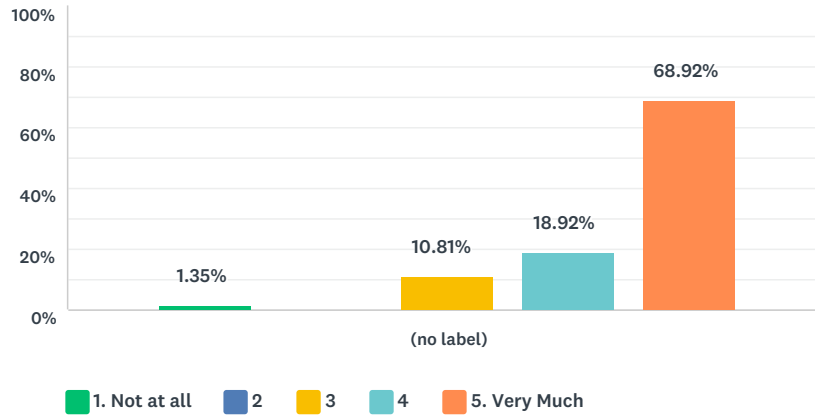
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	0.00%	8.11%	24.32%	66.22%	74	4.54
	1	0	6	18	49		

Q7 The workshop helped me meet people with similar scientific interests

Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	0.00%	10.81%	18.92%	68.92%	74	4.54
	1	0	8	14	51		

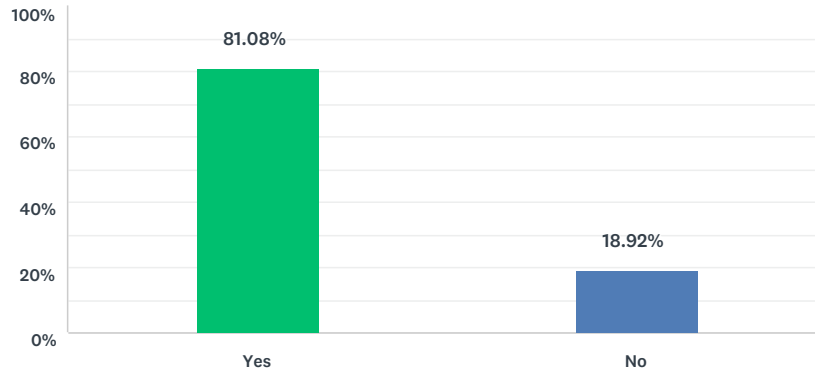
Q8 Additional comments on your personal assessment

Answered: 3 Skipped: 71

#	RESPONSES	DATE
1	About question 6, I was already very interested in the subject.	11/3/2019 7:06 AM
2	It was a very stimulating and very useful week for me.	10/30/2019 6:21 PM
3	Well planned, excellent, workshop.	10/30/2019 5:42 PM

Q9 Did you attend the reception?

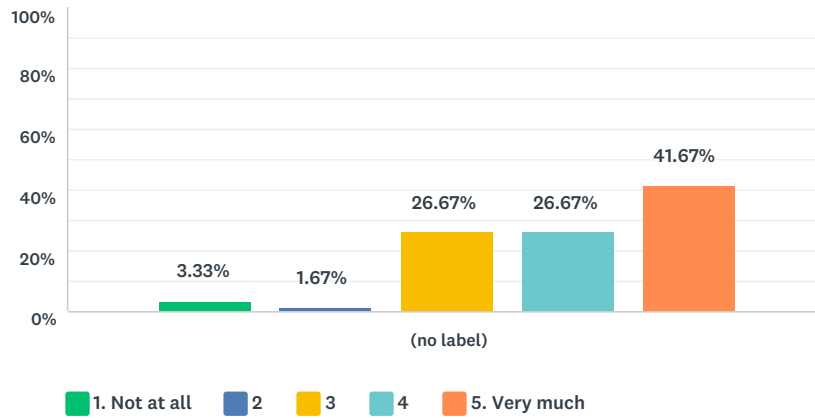
Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	81.08%	60
No	18.92%	14
TOTAL		74

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 60 Skipped: 14



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	3.33% 2	1.67% 1	26.67% 16	26.67% 16	41.67% 25	60	4.02

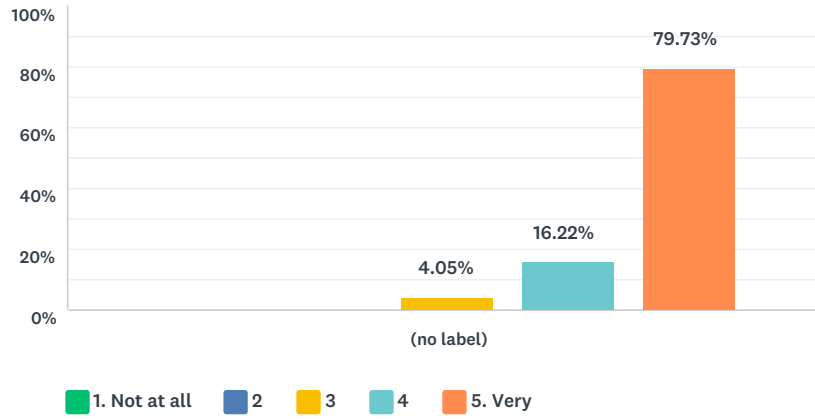
Q11 Please provide any comments about the reception

Answered: 6 Skipped: 68

#	RESPONSES	DATE
1	The timing of the reception at the end of the day seemed to encourage people to leave early since the institute closes in the evening	11/8/2019 12:54 PM
2	I had a lot of entertaining conversations at the reception.	10/30/2019 6:23 PM
3	The reception was a bit overly crowded, considering the limited available space. This made it somewhat difficult to comfortably talk at any meaningful length with the other attendees.	10/30/2019 2:41 PM
4	Food could have been better.	10/24/2019 3:39 PM
5	Food was good.	10/22/2019 4:11 AM
6	Enjoyed the food and drinks!	10/21/2019 9:17 AM

Q12 I found the MSRI staff helpful

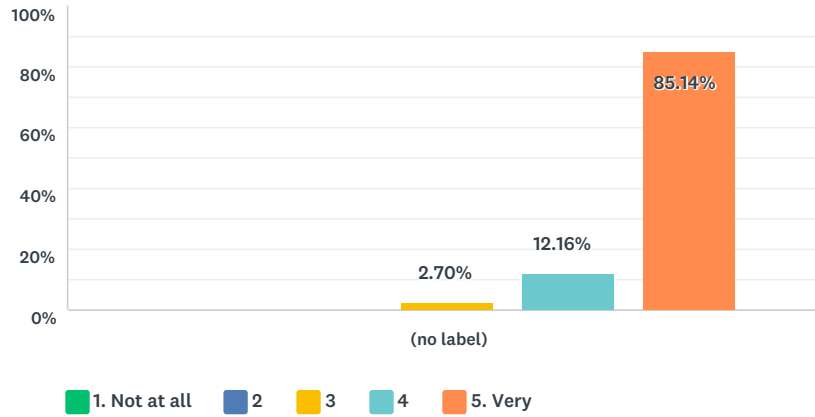
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.05%	16.22%	79.73%	74	4.76
	0	0	3	12	59		

Q13 The MSRI facilities were conducive for such a workshop

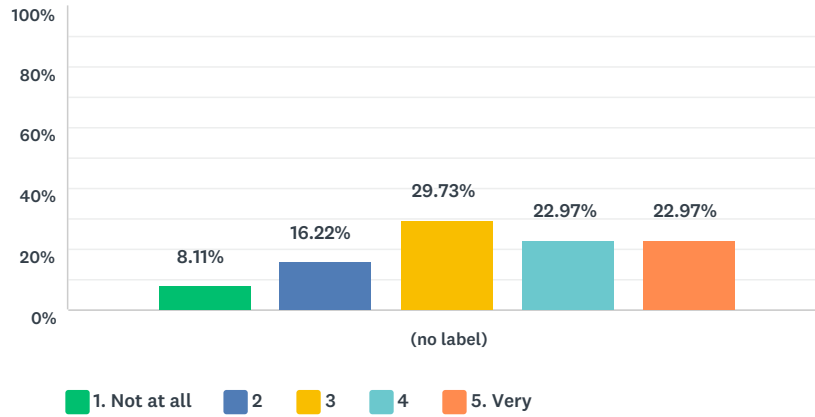
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	2.70%	12.16%	85.14%	74	4.82
	0	0	2	9	63		

Q14 The MSRI lunch arrangements were satisfactory

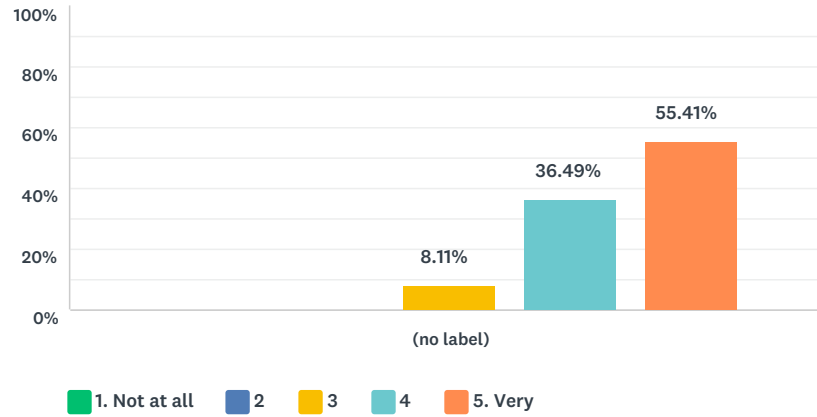
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	8.11%	16.22%	29.73%	22.97%	22.97%	74	3.36
	6	12	22	17	17		

Q15 The MSRI tea arrangements were satisfactory

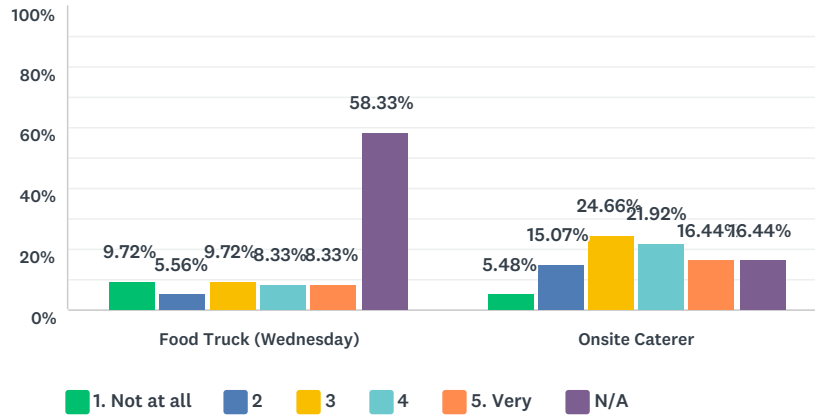
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	8.11%	36.49%	55.41%	74	4.47
	0	0	6	27	41		

Q16 I found the food from the following vendors satisfactory:

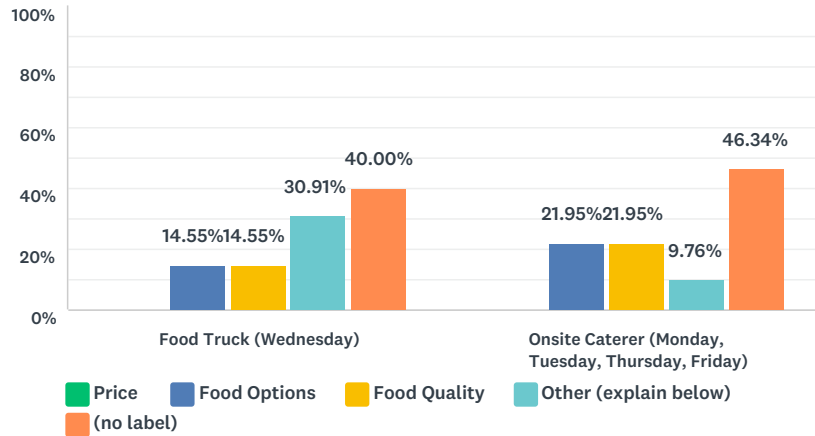
Answered: 74 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Wednesday)	9.72% 7	5.56% 4	9.72% 7	8.33% 6	8.33% 6	58.33% 42	72
Onsite Caterer	5.48% 4	15.07% 11	24.66% 18	21.92% 16	16.44% 12	16.44% 12	73

Q17 I did NOT purchase from the following vendors because:

Answered: 56 Skipped: 18



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	(NO LABEL)	TOTAL
Food Truck (Wednesday)	0.00% 0	14.55% 8	14.55% 8	30.91% 17	40.00% 22	55
Onsite Caterer (Monday, Tuesday, Thursday, Friday)	0.00% 0	21.95% 9	21.95% 9	9.76% 4	46.34% 19	41

#	OTHER (PLEASE SPECIFY)	DATE
1	brought my own food	11/8/2019 12:55 PM
2	So slow that I took the bus downhill to get lunch instead	11/6/2019 3:00 AM
3	Not enough sandwiches for all participants (the sandwiches are also bought by participants of the other program)	11/5/2019 11:53 PM
4	Food truck line was very long, and I didn't stay for the special seminars on Wednesday afternoon.	11/5/2019 5:30 PM
5	I took something to eat. I do not like to buy food from Food Trucks.	11/3/2019 7:10 AM
6	The line didn't seem to move at all for the food truck. The large workshop meant a long line for the onsite caterer.	11/3/2019 6:54 AM
7	lunch in Berkeley	10/30/2019 5:44 PM
8	line was much too long -- faster to go down hill by bus, eat, then return	10/22/2019 11:10 AM
9	long lines	10/22/2019 10:23 AM
10	Long queue	10/22/2019 7:08 AM
11	went to town	10/22/2019 4:17 AM
12	Queue for foodtruck was too long so we went down the mountain.	10/21/2019 4:45 PM
13	I bring my own lunch.	10/21/2019 2:31 PM
14	I had a conflict that morning.	10/21/2019 10:45 AM
15	Food truck much too slow, no way he could serve all these people in time.	10/21/2019 9:46 AM
16	Wait time	10/21/2019 9:28 AM
17	The food truck is very slow!	10/21/2019 8:56 AM

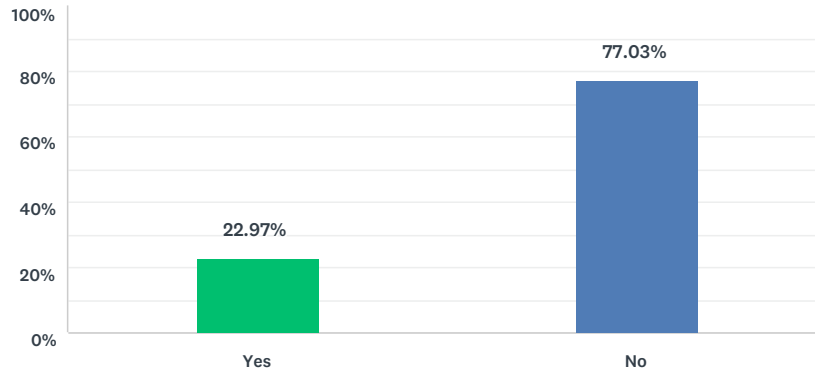
Q18 Additional comments about the MSRI staff, facilities and food

Answered: 6 Skipped: 68

#	RESPONSES	DATE
1	One day, when I was near the back of the line for lunch, there was very little left to choose from. While the lunch situation is minimally satisfactory, it's quite a contrast to the excellence of the facilities at MSRI otherwise.	11/6/2019 3:00 AM
2	Staff was very helpful. Onsite caterer under estimated the number of people attending the workshop a bit.	10/30/2019 6:28 PM
3	My experience with the food truck on Wednesday was overall quite poor. The food was not very good, and the service was slow. I waited in line for nearly an hour before I was able to place my order.	10/30/2019 2:42 PM
4	One food truck (though it was very good food) can't reasonably feed the entire space telescope institute plus 30 people from MSRI. The line was absurd. Well over 30 minutes.	10/21/2019 1:22 PM
5	The onsite caterer was fine. Especially the soup was good, although he did run out of bread a few times. On wednesday there was a talk after lunch and the food truck was totally overburdened and it took forever to get lunch.	10/21/2019 11:47 AM
6	The sponges in the kitchen could be replaced more often.	10/21/2019 8:56 AM

Q19 Did you use the computer facilities located in the library?

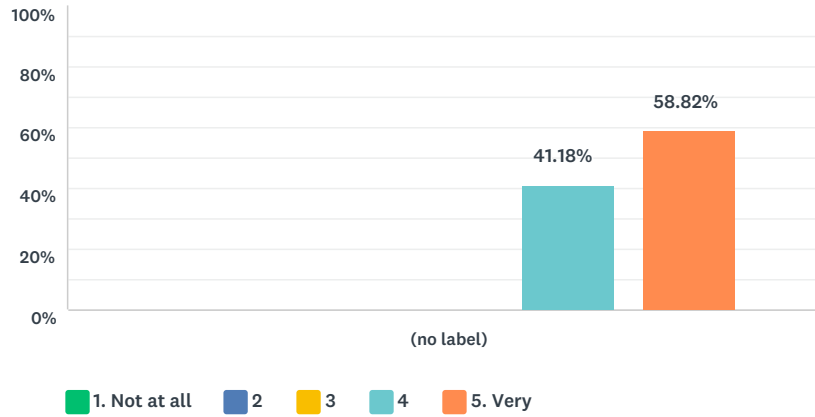
Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	22.97%	17
No	77.03%	57
TOTAL		74

Q20 The MSRI computer facilities in the library were adequate

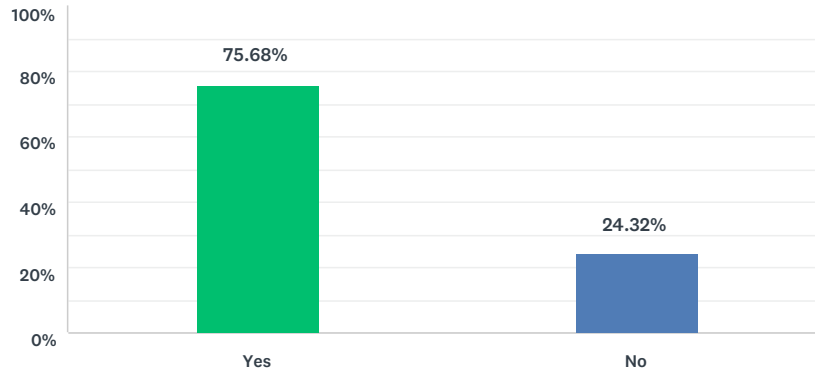
Answered: 17 Skipped: 57



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	41.18%	58.82%	17	4.59
	0	0	0	7	10		

Q21 Did you use MSRI's wireless network?

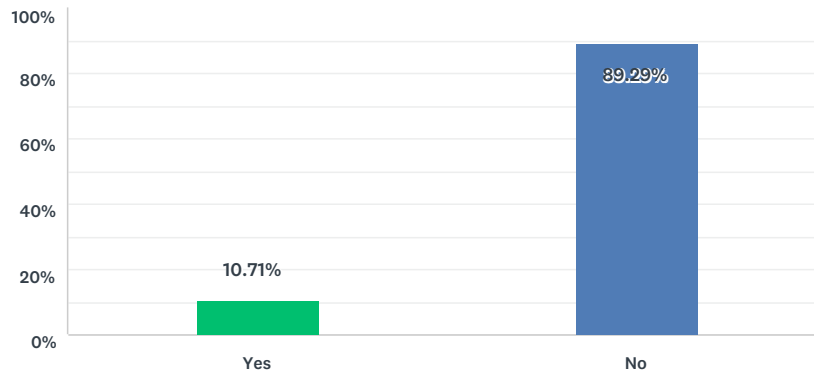
Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	75.68%	56
No	24.32%	18
TOTAL		74

Q22 Did you experience any difficulties with the network?

Answered: 56 Skipped: 18



ANSWER CHOICES	RESPONSES	
Yes	10.71%	6
No	89.29%	50
TOTAL		56

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	I couldn't connect to wi-fi using my laptop in the auditorium, but everywhere else was fine. My phone could connect to wi-fi in the auditorium though, so it could have just been my laptop.	11/5/2019 5:31 PM
2	Sometimes my telephone did not recognize the network.	11/3/2019 7:11 AM
3	Eduroam connection quality was often poor.	10/28/2019 2:31 AM
4	Occasional troubles with eduroam not connecting.	10/24/2019 3:40 PM
5	Could not always connect in the lecture room. But that was ok.	10/22/2019 4:18 AM

Q23 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 5 Skipped: 69

#	RESPONSES	DATE
1	How about a lunch ordering system during the workshop, where you can choose, order and pay for lunch the day before, and then have it ready to pick up at lunchtime.	11/6/2019 3:03 AM
2	Everything was good. Excellent academic level, good resources, helpful staff.	11/3/2019 7:13 AM
3	Very good job, well done.	10/30/2019 6:29 PM
4	The lecture room was generally a bit too cold.	10/21/2019 9:47 AM
5	MSRI might consider structuring non-introductory workshops to have fewer talks and more time for interaction.	10/21/2019 9:36 AM

Connections for Women: Quantum Symmetries

January 23, 2020 - January 24, 2020

MSRI, Berkeley, CA, USA

Organizers:

Emily Peters (Loyola University)

Chelsea Walton (University of Illinois at Urbana-Champaign)

REPORT ON THE MSRI WORKSHOP

“Connections for Women: Quantum Symmetries”

January 23 – 24, 2020

Organizers

- Emily Peters (Loyola University)
- Chelsea Walton (University of Illinois at Urbana-Champaign)

Scientific Description

Symmetry, as formalized by group theory, is ubiquitous across mathematics and science. Classical examples include point groups in crystallography, Noether's theorem relating differentiable symmetries and conserved quantities, and the classification of fundamental particles according to irreducible representations of the Poincaré group and the internal symmetry groups of the standard model. However, in some quantum settings, the notion of a group is no longer enough to capture all symmetries. Important motivating examples include Galois-like symmetries of von Neumann algebras, anyonic particles in condensed matter physics, and deformations of universal enveloping algebras. The language of tensor categories provides a unified framework to discuss these notions of quantum symmetry.

This workshop featured several talks by experts, along with numerous 5-minute presentations by junior mathematicians, on topics related to Quantum Symmetry. Such topics includes tensor categories, subfactors, Hopf algebras, topological quantum field theory and more. There was also a panel discussion on professional development. The majority of the speakers and panelists for this event were women and gender minorities, and members of these groups and of other underrepresented groups were especially encouraged to attend.

Highlights of the Workshop

Highlights of the workshop included several talks on open problems and recent results in the area of Quantum Symmetry. Topics included Modular Tensor Categories (by Julia Plavnik), Noncommutative Invariant Theory (by Ellen Kirkman), Subfactor Theory (by David Penneys), Topological Quantum Invariants (by Efstratia Kalfagianni), Fusion Categories (by Pavel Etingof), Representation Theory of Hopf algebras (by Susan Montgomery), and Phases of Quantum Matter (by Fiona Burnell). There were several 5-minute talks and posters given by junior female graduate students and postdoctoral researchers (Karina Batistelli, Rekha Biswal, Colleen Delaney, Kari Eifler, Priyanga Ganesan, Angela Tabiri, Fiona Torzewska, Elizabeth Wicks, Jieru Zhu), which created networking opportunities that enabled the presenters to share their research results. The poster sessions also created avenues for collaboration and potential employment later for its participants. The last highlight of the workshop is that we included a panel on “Tips and Tricks for Collaboration”, with panelists Gail Letzter (senior government researcher), Van Nguyen (assistant professor), Jennifer Vasquez (associate professor), Chelsea Walton (associate professor), Elizabeth Wicks (graduate student in her last stage of program), Helen Wong (associate professor). Navigating the various stages of the collaborative process in research were discussed, including how to find collaborators, how to keep up momentum in projects, and how to wrap up projects successfully.

Organizers

First Name	Last Name	Institution
Emily	Peters	Loyola University
Chelsea	Walton	University of Illinois at Urbana-Champaign

Speakers

First Name	Last Name	Institution
Fiona	Burnell	University of Minnesota
Pavel	Etingof	Massachusetts Institute of Technology
Efstratia	Kalfagianni	Michigan State University
Ellen	Kirkman	Wake Forest University
M. Susan	Montgomery	University of Southern California
David	Penneys	Ohio State University
Julia	Plavnik	Indiana University

Poster Presenters

First Name	Last Name	Institution
Karina	Batistelli	Universidad de Chile
Rekha	Biswal	Max Planck Institute for Mathematics
Colleen	Delaney	Indiana University
Kari	Eifler	Texas A & M University
Priyanga	Ganesan	Texas A&M University
Angela	Tabiri	African Institute for Mathematical Sciences Ghana
Fiona	Torzewska	University of Leeds
Elizabeth	Wicks	University of Washington
Jieru	Zhu	University at Buffalo (SUNY)

Mathematical Sciences Research Institute

Connections For Women: Quantum Symmetries

January 23 - January 24, 2020

Thursday, January 23, 2020

9:00AM - 9:15AM	Simons Auditorium		Welcome
9:15AM - 10:15AM	Simons Auditorium	Julia Plavnik	Modular Tensor Categories
10:15AM - 10:30AM	Simons Auditorium	Rekha Biswal, Angela Tabiri, Elizabeth Wicks	Poster Previews 1
10:30AM - 11:00AM	Atrium		Tea
11:00AM - 12:00PM	Simons Auditorium	Ellen Kirkman	Invariants of actions on Artin-Schelter regular algebras
12:00PM - 1:30PM	Atrium		Lunch
1:30PM - 2:30PM	Simons Auditorium	David Penneys	Open problems on subfactors and unitary tensor categories
2:30PM - 2:45PM	Simons Auditorium	Colleen Delaney, Kari Eifler, Priyanga Ganesan	Poster Previews 2
2:45PM - 3:15PM	Atrium		Tea
3:15PM - 4:15PM	Simons Auditorium	Efstratia Kalfagianni	Topology and geometry of quantum invariants
4:15PM - 5:15PM	Simons Auditorium	Chelsea Walton (moderator), Gail Letzter, Van Nguyen, Jennifer Vasquez, Elizabeth Wicks, Helen Wong	Panel Discussion on Tips & Tricks for Collaboration

Friday, January 24, 2020

9:00AM - 10:00AM	Simons Auditorium	Pavel Etingof	Open problems in the theory of tensor categories
10:00AM - 10:15AM	Simons Auditorium	Karina Batistelli, Fiona Torzewska, Jieru Zhu	Poster Previews 3
10:15AM - 10:20AM	Atrium		Photo Session
10:20AM - 11:00AM	Atrium		Tea
11:00AM - 12:00PM	Simons Auditorium	M. Susan Montgomery	Frobenius-Schur indicators: from groups, to Hopf algebras, to tensor categories
12:00PM - 1:30PM	Atrium		Lunch
1:30PM - 2:20PM	Simons Auditorium	Fiona Burnell	Symmetry and new phases of quantum matter: a physicist's perspective
2:20PM - 2:30PM	Simons Auditorium		Closing Remarks
2:30PM - 3:00PM	Atrium		Tea



Participants

First Name	Last Name	Institution
David	Ayala	Montana State University
Clark	Barwick	University of Edinburgh
Karina	Batistelli	Universidad de Chile
Rekha	Biswal	Max Planck Institute for Mathematics
Fiona	Burnell	University of Minnesota
Alexander	Campbell	Macquarie University
Carmen	Caprau	California State University, Fresno
Fei Yu	Chen	University of California, Berkeley
Patrick	Chu	Indiana University
Brian	Collier	University of California, Riverside
Andrew	Conner	Saint Mary's College of California
Thibault	Decoppet	University of Oxford
Colleen	Delaney	Indiana University
Shanna	Dobson	California State University, at Los Angeles
Kari	Eifler	Texas A & M University
Pavel	Etingof	Massachusetts Institute of Technology
Zhaobidan	Feng	Texas A & M University
John	Francis	Northwestern University
Priyanga	Ganesan	Texas A&M University
Shlomo	Gelaki	Iowa State University
Nicolle	Gonzalez	University of California, Los Angeles
Evgeny	Gorskiy	University of California, Davis
Philip	Hackney	University of Louisiana--Lafayette
Erin	Hausmann	University of Oklahoma
David	Jordan	University of Edinburgh
Efstratia	Kalfagianni	Michigan State University
Yevgenia	Kashina	DePaul University
Ellen	Kirkman	Wake Forest University
Robert	Korsan	Carnegie Mellon University
Arundhathi	Krishnan	National University of Ireland, University College Cork
Genta	Latifi	University of Zurich
Gail	Letzter	NSA - National Security Agency
Aaron	Mazel-Gee	University of Southern California
Calvin	McPhail-Snyder	University of California, Berkeley
Luz adriana	Mejia castaño	Universidad del Norte
M. Susan	Montgomery	University of Southern California
Scott	Morrison	Australian National University
Lyne	Moser	École Polytechnique Fédérale de Lausanne
Lang	Mou	University of California, Davis
Naofumi	Muraki	Iwate Prefectural University
Cris	Negron	University of North Carolina
Siu-Hung	Ng	Louisiana State University
Van	Nguyen	United States Naval Academy
Anh Tuong	Nguyen	University of Illinois at Urbana-Champaign

Participants

First Name	Last Name	Institution
Pablo	Ocal	Texas A & M University
Kayla	Orlinsky	University of Southern California
Amrei	Oswald	The University of Iowa
David	Penneys	Ohio State University
Emily	Peters	Loyola University
Julia	Plavnik	Indiana University
Eugene	Rabinovich	University of California, Berkeley
Joseph	Randich	University of Oklahoma
David	Reutter	Max-Planck-Institut für Mathematik
Emily	Riehl	Johns Hopkins University
Marcy	Robertson	University of Melbourne
Martina	Rovelli	Australian National University
Sean	Sanford	Indiana University
Cecily	Santiago	University of Minnesota Twin Cities
Noah	Snyder	Indiana University
Kursat	Sozer	Indiana University
Angela	Tabiri	African Institute for Mathematical Sciences Ghana
James	Tener	Australian National University
Fiona	Torzewska	University of Leeds
Jennifer	Vasquez	University of Scranton
Monica	Vazirani	University of California, Davis
Padmini	Veerapen	Tennessee Technological University
Paula	Verdugo	Macquarie University
Chelsea	Walton	University of Illinois at Urbana-Champaign
Elizabeth	Wicks	University of Washington
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Brian	Williams	Northeastern University
Helen	Wong	Claremont McKenna College
Harshit	Yadav	University of Illinois at Urbana-Champaign
Qing	Zhang	Texas A & M University
Jieru	Zhu	University at Buffalo (SUNY)

Officially Registered Participants Information

Participants		75
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Gender		75
Male	44.00%	33
Female	54.67%	41
Declined to state	1.33%	1
Other/Non-Binary	0.00%	0

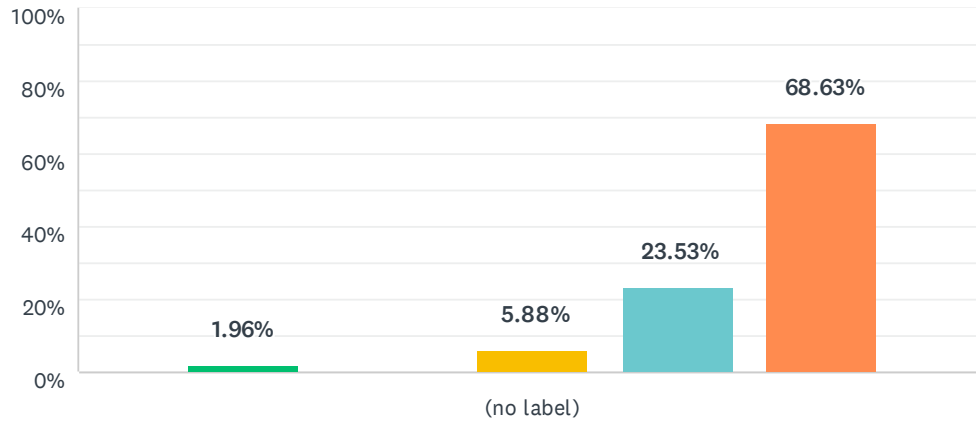
Ethnicity*		87
White	52.87%	46
Asian	21.84%	19
Hispanic	8.05%	7
Pacific Islander	0.00%	0
Black	3.45%	3
Native American	1.15%	1
Mixed	6.90%	6
Declined to state	5.75%	5

* ethnicity specifications are not exclusive

51 responses out of 75 participants = 68% response rate

Q1 The workshop was intellectually stimulating

Answered: 51 Skipped: 0

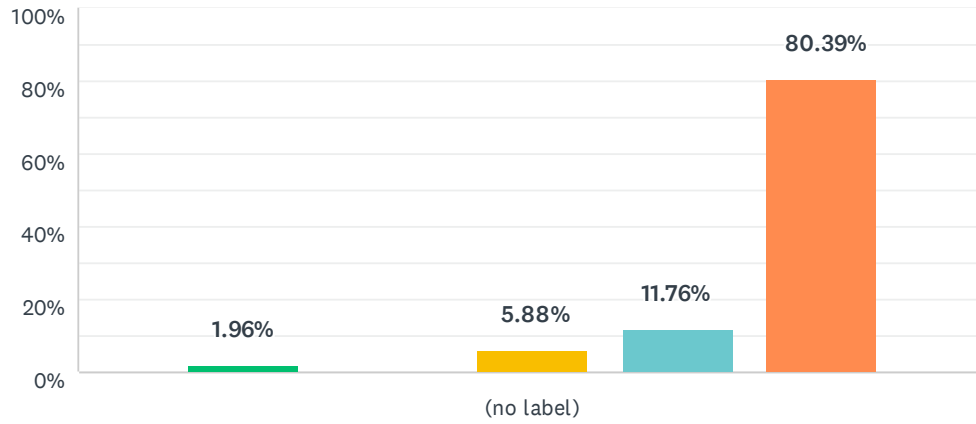


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.96%	0.00%	5.88%	23.53%	68.63%	51	4.57
	1	0	3	12	35		

Q2 The overall experience of the workshop was worthwhile

Answered: 51 Skipped: 0

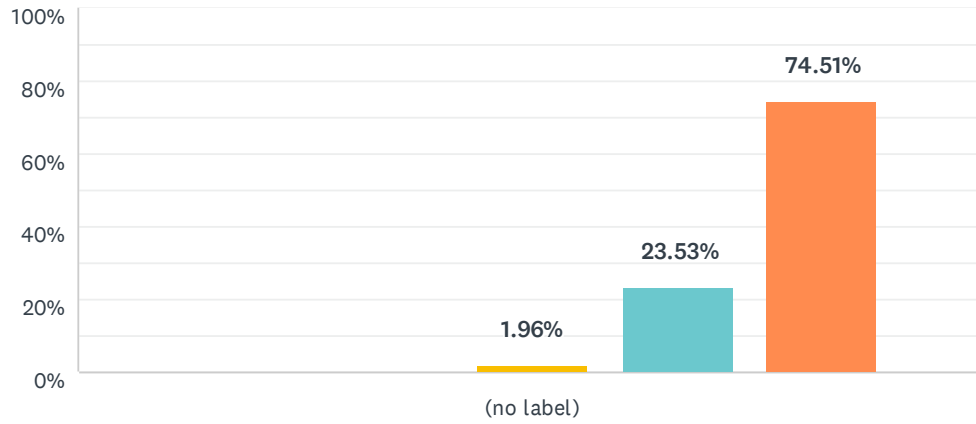


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.96%	0.00%	5.88%	11.76%	80.39%	51	4.69
	1	0	3	6	41		

Q3 The time between lectures was adequate for discussion

Answered: 51 Skipped: 0



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	1.96% 1	23.53% 12	74.51% 38	51	4.73

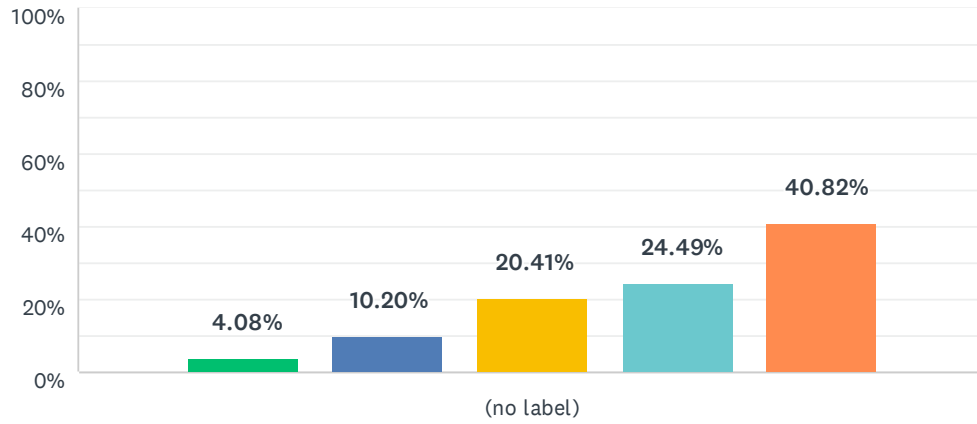
Q4 Additional comments

Answered: 11 Skipped: 40

#	RESPONSES	DATE
1	I absolutely enjoyed meeting all these women mathematicians from around the world. I hope that these connections will remain through the rest of our lives and we'll provide support to each other as we navigate academia.	2/4/2020 10:48 AM
2	The poster sessions and 5-minute previews were outstanding. It is a great way to find out what the new junior people are doing and to meet them and hopefully set the stage for future mentoring. The dinner was also wonderful for discussion. The whole workshop was extremely well organized.	1/28/2020 9:05 PM
3	Some of the lectures were only for experts, and I do not think that was the intent.	1/28/2020 4:12 PM
4	Very worthwhile, will follow others.	1/28/2020 9:11 AM
5	Great conference! I learned a lot, the atmosphere was amazing and everyone was so supportive and friendly. The organization was also amazing!	1/28/2020 7:52 AM
6	The pace and spread of talks was just right. There were breaks in between for discussion and/or questions.	1/27/2020 8:23 PM
7	Chelsea was the best moderator! Keeping the speakers on track and giving us helping info about relevant literature. Love her!	1/27/2020 6:48 PM
8	It was hard hearing about open problems in the field before having the introductory workshop	1/27/2020 5:46 PM
9	Excellent spacing of talks	1/27/2020 3:28 PM
10	I would have gotten more out of the workshop if it had been scheduled after the introductory workshop	1/27/2020 3:19 PM
11	Could have better lunch options.	1/27/2020 3:18 PM

Q5 I was well prepared to benefit from the lectures

Answered: 49 Skipped: 2

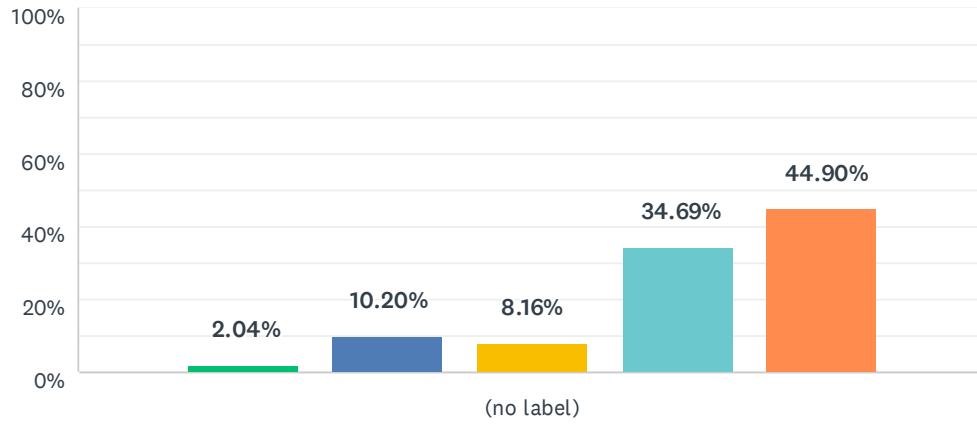


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	4.08%	10.20%	20.41%	24.49%	40.82%	49	3.88
	2	5	10	12	20		

Q6 My interest in the subject matter was increased by the workshop

Answered: 49 Skipped: 2

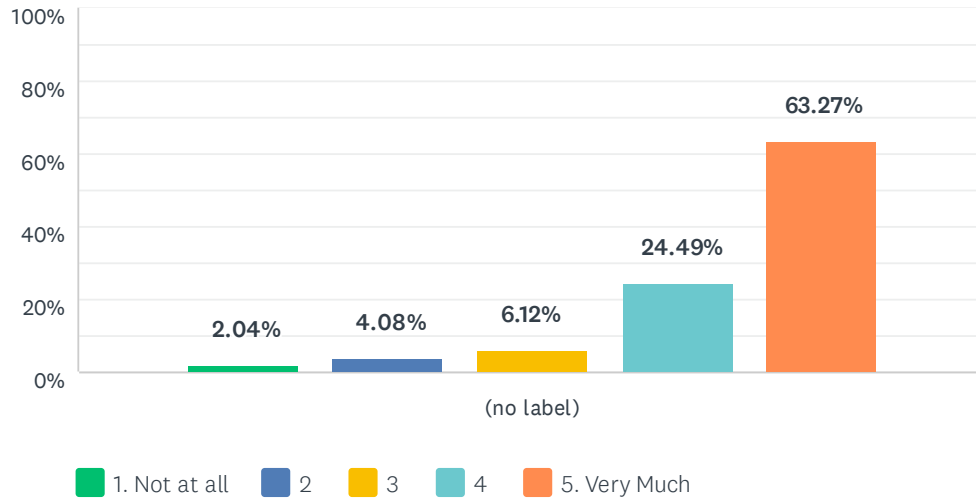


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	2.04%	10.20%	8.16%	34.69%	44.90%	49	4.10
	1	5	4	17	22		

Q7 The workshop helped me meet people with similar scientific interests

Answered: 49 Skipped: 2



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	2.04%	4.08%	6.12%	24.49%	63.27%	49	4.43
	1	2	3	12	31		

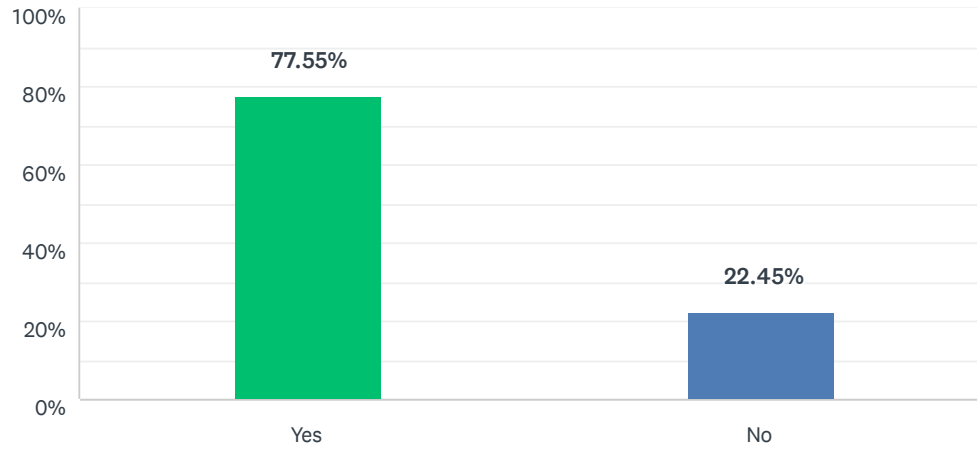
Q8 Additional comments on your personal assessment

Answered: 7 Skipped: 44

#	RESPONSES	DATE
1	I think this would have been much more useful after the Introductory Workshop. The topics introduced at the Introductory Workshop were discussed at a much higher level here, and I think I would have gotten more out of it with that foundation. I did like the focus on open questions.	2/21/2020 9:49 AM
2	I hope the talks could be given in the format of lecture series, so each speaker could set up the basic definitions while being able to go into depths in each topic. In summary I prefer fewer speakers with more talks per speaker. Some of the "open problems" seem less motivated for people outside this area, because we haven't got an intuition of what has already been understood.	2/4/2020 10:57 AM
3	I like the idea of open questions, it is good to start the semester with this in mind	2/4/2020 10:49 AM
4	With the two concurrent programs going on, there are people from various areas, and it's quite beneficial especially when the two programs are related.	1/27/2020 8:25 PM
5	Good speakers!	1/27/2020 4:19 PM
6	My background was developed enough to understand definitions and the basics, but I had a tough time fully understanding the open questions posed and some of the larger implications. But I'm excited to keep learning!	1/27/2020 3:28 PM
7	I really enjoyed the experience!	1/27/2020 3:26 PM

Q9 Did you attend the panel discussion?

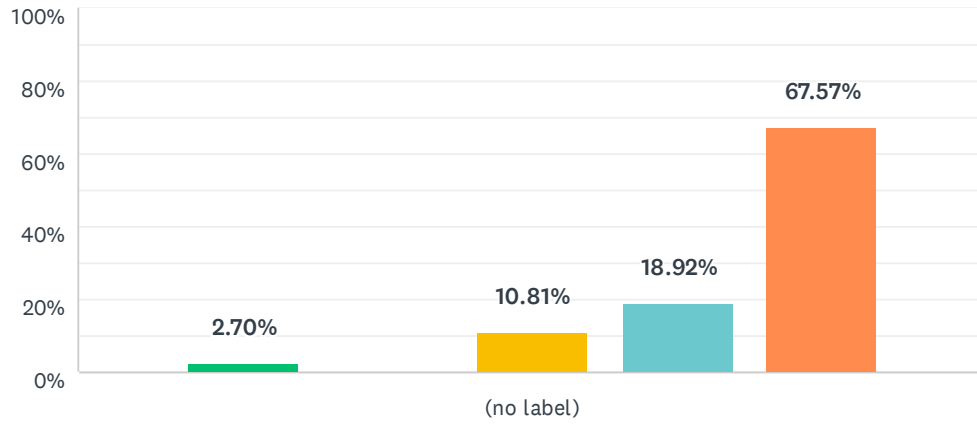
Answered: 49 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	77.55%	38
No	22.45%	11
TOTAL		49

Q10 Did you find the panel discussion worthwhile?

Answered: 37 Skipped: 14



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	2.70%	0.00%	10.81%	18.92%	67.57%	37	4.49
	1	0	4	7	25		

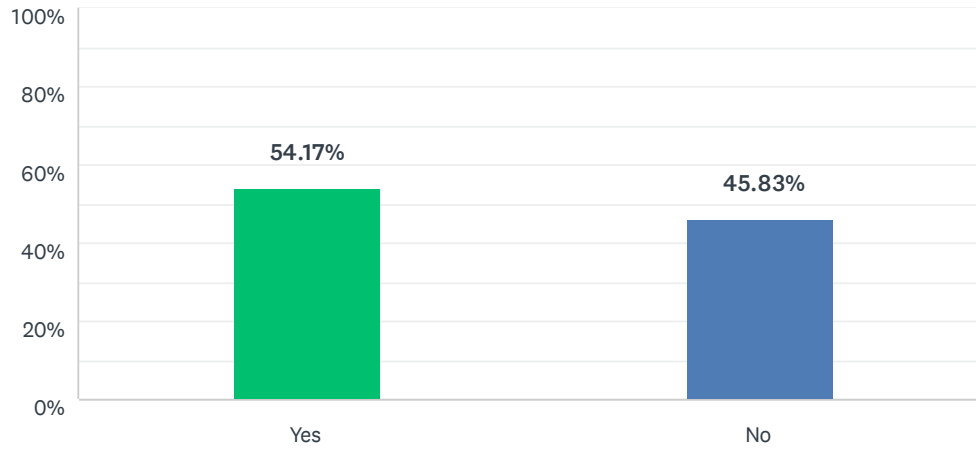
Q11 What other subjects should be discussed in future panel discussions?

Answered: 6 Skipped: 45

#	RESPONSES	DATE
1	I think women have a lot of other responsibilities to deal with in life that can detract from their career. This was brought up in the panel, and that part was some of the most helpful to me. I think discussions about how to navigate that would be helpful.	2/21/2020 9:52 AM
2	1. time management; 2. systematic disadvantages against women and how we could overcome them	2/4/2020 10:58 AM
3	I would have enjoyed, even within the same subject, discussing how being a woman affects it. For instance I think 4 of the 5 panelists described their best collaboration as being with another woman-- but no one commented on that or drew that summarizing conclusion to ask if it was a coincidence.	1/28/2020 9:07 PM
4	Work-life-balance	1/27/2020 8:26 PM
5	I am not sure. This one was great!	1/27/2020 3:27 PM
6	Research advice for grad students	1/27/2020 3:19 PM

Q12 Did you attend the dinner?

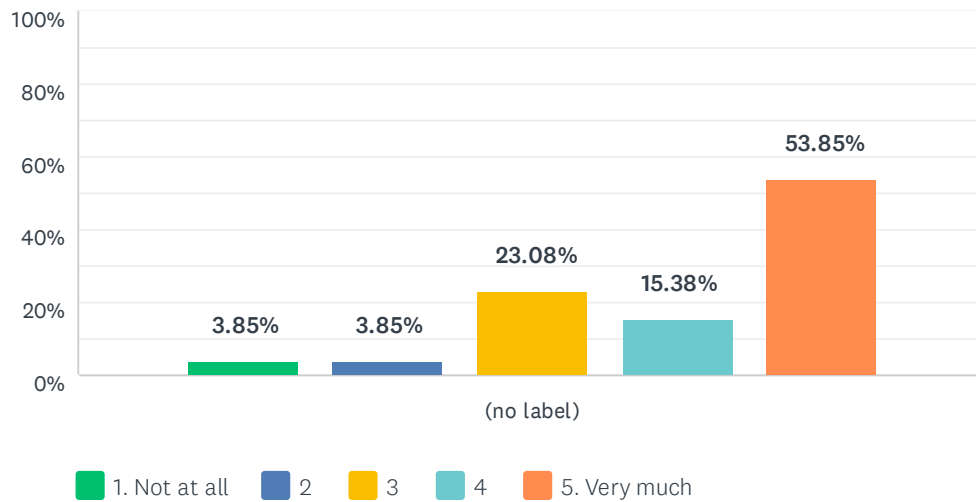
Answered: 48 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	54.17%	26
No	45.83%	22
TOTAL		48

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 26 Skipped: 25



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	3.85%	3.85%	23.08%	15.38%	53.85%	26	4.12
	1	1	6	4	14		

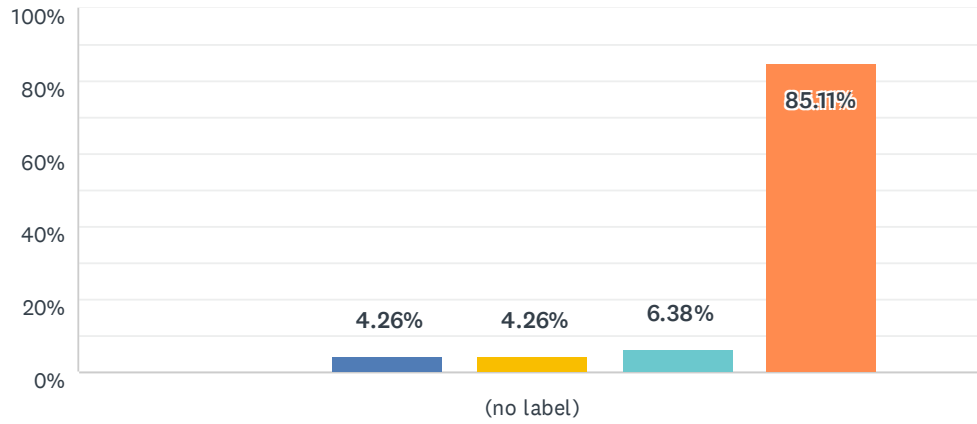
Q14 Please provide any comments about the dinner

Answered: 6 Skipped: 45

#	RESPONSES	DATE
1	I have a lot of mixed feelings about the concept of a "woman only" dinner, and I'm not sure how much to say because this is not anonymous as far as I know. However, there are a lot of people who do not fit into male dominated math culture who do not identify as women. I think when opportunities to create protected spaces like this are so rare, it is a massive failure of inclusion to exclude those people.	2/21/2020 10:00 AM
2	The dinner was fantastic. I think the new venue made it easier to talk with more people.	1/28/2020 9:08 PM
3	The food was not very good.	1/28/2020 4:13 PM
4	The food at the dinner was good. I thought the dinner could be a bit more organized by mixing up participants (randomize? name tags? Oberwolfach style?) to have a good mixed of junior & senior participants on the same tables.	1/27/2020 8:31 PM
5	Very pleasant atmosphere, we had the chance to talk more to the other women in math.	1/27/2020 8:15 PM
6	Yummy food.	1/27/2020 3:27 PM

Q15 I found the MSRI staff helpful

Answered: 47 Skipped: 4

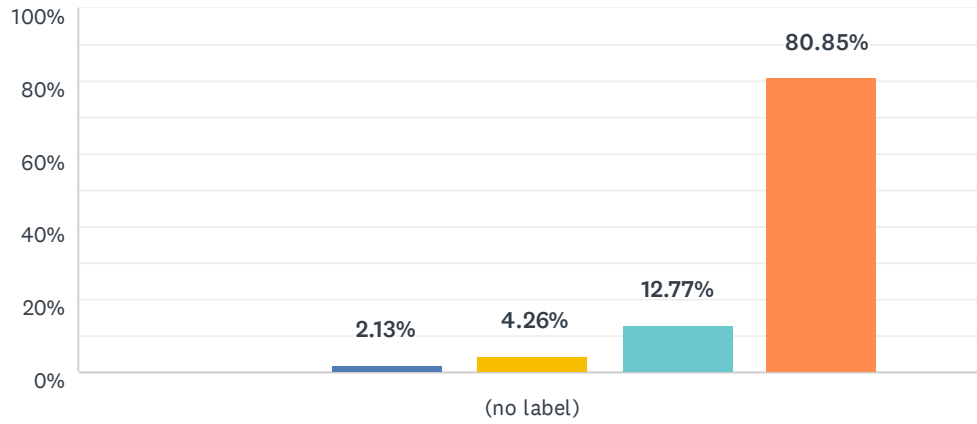


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.26%	4.26%	6.38%	85.11%		
	0	2	2	3	40	47	4.72

Q16 The MSRI facilities were conducive for such a workshop

Answered: 47 Skipped: 4

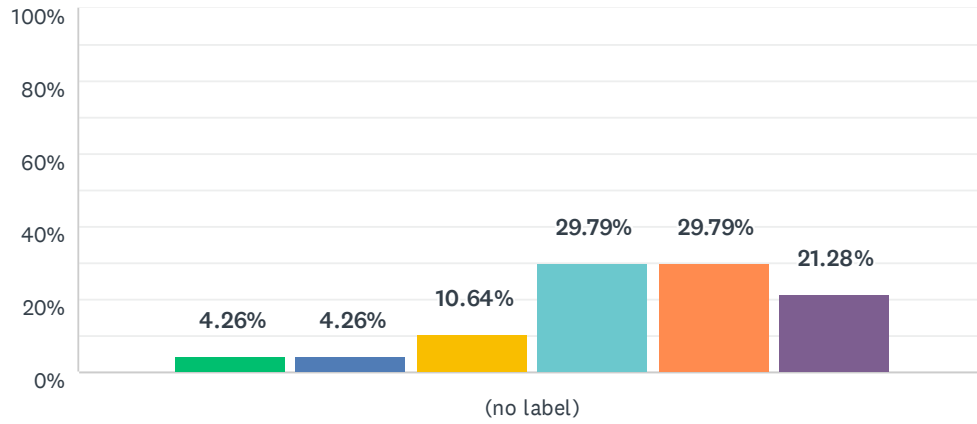


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.13%	4.26%	12.77%	80.85%	47	4.72
	0	1	2	6	38		

Q17 The MSRI lunch arrangements were satisfactory

Answered: 47 Skipped: 4

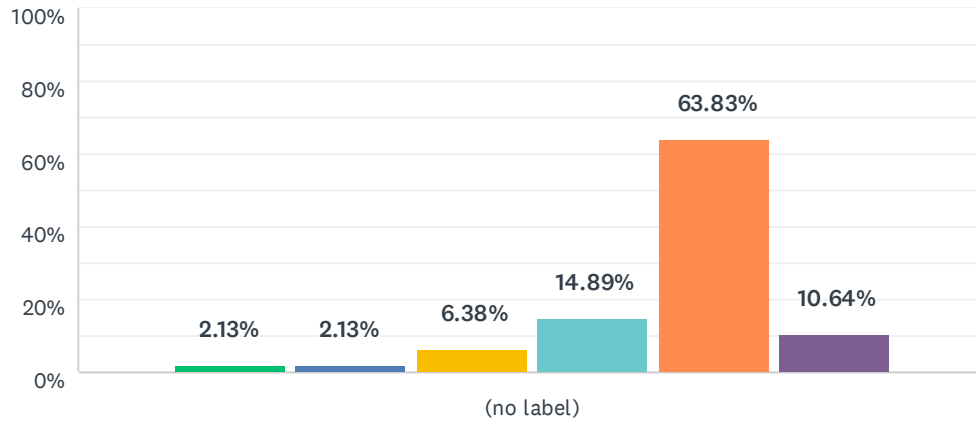


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very
 ■ N/A

	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	4.26%	4.26%	10.64%	29.79%	29.79%	21.28%	47	3.97
	2	2	5	14	14	10		

Q18 The MSRI tea arrangements were satisfactory

Answered: 47 Skipped: 4



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very
 ■ N/A

	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	2.13%	2.13%	6.38%	14.89%	63.83%	10.64%	47	4.52
	1	1	3	7	30	5		

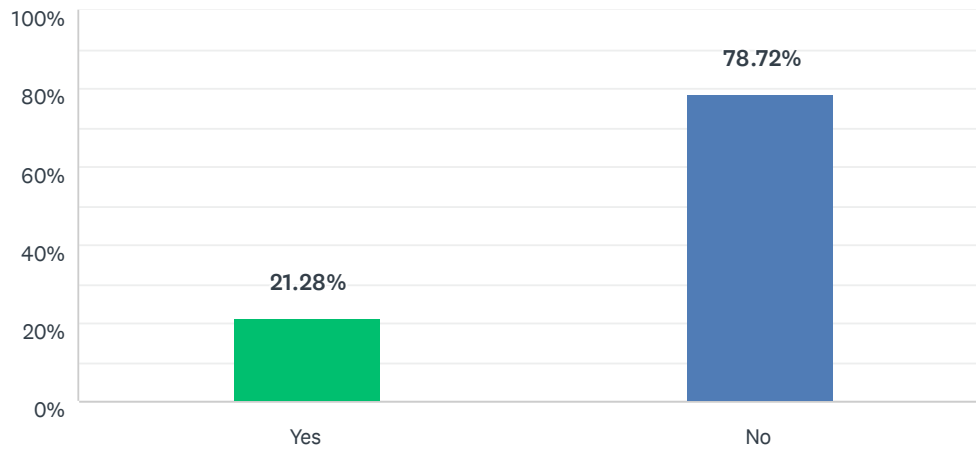
Q19 Additional comments about MSRI staff, facilities and food

Answered: 7 Skipped: 44

#	RESPONSES	DATE
1	Several attendees mentioned to me that the vegetarian/vegan options would run out before they arrived at the vendor.	2/18/2020 10:43 AM
2	I loved that the afternoon tea had vegetables and nuts. I did not care for the morning tea that was more like pastries and bagels, but that's fine for others. The dinner was great.	1/28/2020 9:09 PM
3	The vegetarian food options were quite limited - especially the vegan ones. There was sometimes a shortage of places to sit to eat.	1/27/2020 8:35 PM
4	Lunch was good, but a bit boring	1/27/2020 5:48 PM
5	MSRI is an amazing facility!	1/27/2020 4:19 PM
6	Tracy was really kind! Excellent job	1/27/2020 4:08 PM
7	The ingredients were not listed for the sandwiches which all seemed to have condiments on them.	1/27/2020 3:30 PM

Q20 Did you use the computer facilities located in the library?

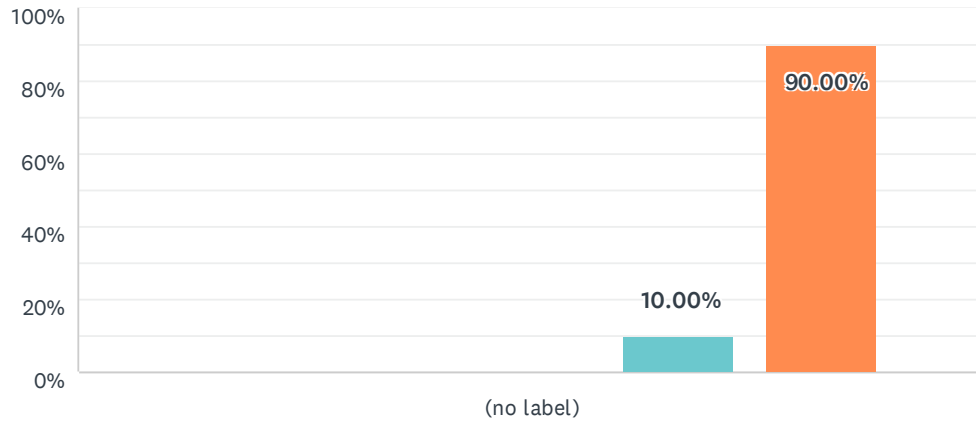
Answered: 47 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	21.28%	10
No	78.72%	37
TOTAL		47

Q21 The MSRI computer facilities in the library were adequate

Answered: 10 Skipped: 41



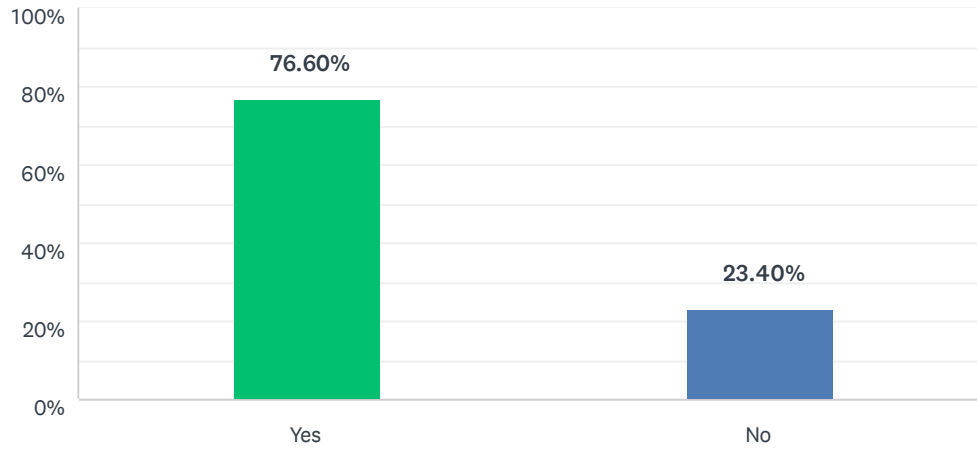
■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	10.00%	90.00%	10	4.90
	0	0	0	1	9		

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	The mouse pads don't grip the table, so they end up moving when you try to move the mouse.	2/18/2020 10:45 AM

Q22 Did you use MSRI's wireless network?

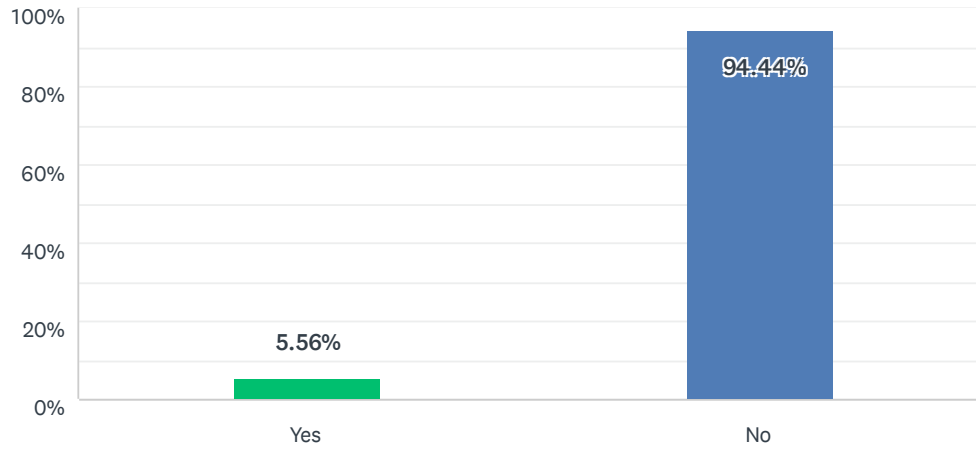
Answered: 47 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	76.60%	36
No	23.40%	11
TOTAL		47

Q23 Did you experience any difficulties with the network?

Answered: 36 Skipped: 15



ANSWER CHOICES	RESPONSES	
Yes	5.56%	2
No	94.44%	34
TOTAL		36

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	A couple of times connection could not be established. It also happened to other participants.	1/27/2020 4:54 PM
2	No eduroam in the lecture hall	1/27/2020 3:20 PM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 47

#	RESPONSES	DATE
1	Superbly done.	1/28/2020 9:13 AM
2	I felt that at some points, the room was half men and half women. I don't think that's the right ratio for a women's workshop, but I'm not sure what can be done about it. I also felt like men did most of the talking and asking of questions during talks. Again, I'm not sure what can be done about this - just an observation. It would have been nicer if it was mostly women. Overall, I thoroughly enjoyed the workshop. It was very well organized and the speakers were excellent. The amount of time/breaks in between talks were perfect for socializing.	1/27/2020 8:38 PM
3	Excellent workshop. Kudos to the organizers!	1/27/2020 3:30 PM
4	Thank you!	1/27/2020 3:28 PM

Introductory Workshop: Quantum Symmetries

January 27, 2020 - January 31, 2020

MSRI, Berkeley, CA, USA

Organizers:

Vaughan Jones (Vanderbilt University)

Victor Ostrik (University of Oregon)

Emily Peters (Loyola University)

Noah Snyder (Indiana University)

REPORT ON THE MSRI WORKSHOP

“Introductory Workshop: Quantum Symmetries”

January 27 – 31, 2020

Organizers

- Vaughan Jones (Vanderbilt University)
- Victor Ostrik (University of Oregon)
- Emily Peters (Loyola University)
- Noah Snyder (Indiana University)

Scientific Description

Symmetry, as formalized by group theory, is ubiquitous across mathematics and science. Classical examples include point groups in crystallography, Noether's theorem relating differentiable symmetries and conserved quantities, and the classification of fundamental particles according to irreducible representations of the Poincaré group and the internal symmetry groups of the standard model. However, in some quantum settings, the notion of a group is no longer enough to capture all symmetries. Important motivating examples include Galois-like symmetries of von Neumann algebras, anyonic particles in condensed matter physics, and deformations of universal enveloping algebras. The language of tensor categories provides a unified framework to discuss these notions of quantum symmetry.

This workshop consisted of introductory minicourses on key topics in Quantum Symmetry: fusion categories, modular tensor categories, Hopf algebras, subfactors and planar algebras, topological field theories, conformal nets, and topological phases of matter. These minicourses were introductory and aimed to give semester participants exposure to the main ideas of subfields other than their own.

Highlights of the Workshop

Sarah Witherspoon gave two talks about Hopf Algebras. The first was a very clear introduction to Hopf Algebras and their actions on rings, while the second concentrated on their cohomology. One of the named postdocs, Cris Negron, gave a third talk building on Witherspoon's series. Victor Ostrik gave two talks about fusion categories, which went through the main definitions in the theory of fusion categories using pointed fusion categories as a running example. He also introduced the relationship between fusion categories and diagrammatics. Diagrammatic techniques were further developed in Emily Peters's talks about Planar Algebras, which also touched on their connections to subfactors.

Eric Rowell gave two talks about modular tensor categories, which are closely related to topology and to physics. His first talk went through the somewhat involved definition, which was delightfully illustrated in a handout made by Chelsea Walton. His second talk went through several key examples, and gave some of the highlights of recent developments in the field including the celebrated Rank Finiteness theorem. Named postdoc Colleen Delaney gave a talk

building on Eric's talks, which discussed the main combinatorial invariant of modular tensor categories called the modular invariant. She discussed recent work on the failure of the modular data to be a complete invariant, and what the prospects were for further invariants beyond the modular data. The audience raised a number of interesting questions in this direction. Zhenghan Wang, a mathematical physicist working on the relationship between modular tensor categories and physics, gave two talks on topological orders. In particular he discussed two key models called the toric code and the Ising model.

Anna Beliakova gave two talks about quantum invariants of links and 3-manifolds. A particular focus of this talk was on "universal invariants" in the sense of Habiro. Her second talk developed her joint work with Chen and Lê. We also had a third talk on the topological side of quantum symmetry, given by Claudia Scheimbauer who was a member of both our program and the Higher Category program, which introduced the higher categorical perspective on topological field theory. Finally we had three talks about conformal field theory, two by Terry Gannon which discussed conformal nets and their relationship to conformal field theory and vertex operator algebras, and one by James Tener on Segal's functorial approach to conformal field theory.

One particularly notable aspect of these talks is that they were well attended by participants in the Higher Category program, and several people from that program mentioned that the talks were unusually accessible and helped allow the two programs to communicate.

Organizers

First Name	Last Name	Institution
Vaughan	Jones	Indiana University
Victor	Ostrik	University of Oregon
Emily	Peters	Loyola University
Noah	Snyder	Indiana University

Speakers

First Name	Last Name	Institution
Anna	Beliakova	University of Zurich
Colleen	Delaney	Indiana University
Terry	Gannon	University of Alberta
Cris	Negron	University of North Carolina
Victor	Ostrik	University of Oregon
Emily	Peters	Loyola University
Eric	Rowell	Texas A & M University
Claudia	Scheimbauer	TU München
James	Tener	Australian National University
Zhenghan	Wang	University of California, Santa Barbara
Sarah	Witherspoon	Texas A & M University

Mathematical Sciences Research Institute

Introductory Workshop: Quantum Symmetries

January 27 - 31, 2020

Monday, January 27, 2020

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Witherspoon	Hopf Algebras I
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Ostrik	Fusion Categories I
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Rowell	Modular Tensor Categories I
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Peters	Subfactors and Planar Algebras

Tuesday, January 28, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Ostrik	Fusion Categories II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Rowell	Modular Tensor Categories II
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Beliakova	Quantum invariants of links and 3-manifolds I
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Gannon	Conformal Nets I
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, January 29, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Witherspoon	Hopf Algebras II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Negron	Non-semisimple Hopf Algebras and Tensor Categories

Thursday, January 30, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Peters	Subfactors and Planar Algebras II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Wang	Topological Orders I
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Beliakova	Quantum invariants of links and 3-manifolds II
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Delaney	Modular Data and Beyond

Friday, January 31, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Scheimbauer	TQFTs and Higher Categories
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Gannon	Conformal Nets II
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Wang	Topological orders II
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Tener	Segal CFTs



Participants

First Name	Last Name	Institution
Mostafa	Adnane	University of California, Berkeley
Semeon	Artamonov	University of California, Berkeley
Adam	Artymowicz	California Institute of Technology
David	Ayala	Montana State University
Eric	Babson	University of California, Davis
Emily	Bain	University of California, Berkeley
Clark	Barwick	University of Edinburgh
Luciana	Basualdo Bonatto	University of Oxford
Karina	Batistelli	Universidad de Chile
Anna	Beliakova	University of Zurich
Sandipan	Bhattacharjee	National Institute of Science Education and Research
Rekha	Biswal	Max Planck Institute for Mathematics
Arkadiusz	Bochniak	Institute of Physics
Jennifer	Brown	University of California, Davis
Alexander	Campbell	Macquarie University
Tim	Campion	University of Notre Dame
Carmen	Caprau	California State University, Fresno
Ian	Charlesworth	University of California, Berkeley
Fei Yu	Chen	University of California, Berkeley
Quan	Chen	Ohio State University
Wonhyung	Choi	Korea University
Patrick	Chu	Indiana University
Brian	Collier	University of California, Riverside
Andrew	Conner	Saint Mary's College of California
David	Corwin	University of California, Berkeley
Jordan	Cotler	Stanford University
Charlie	Cummings	University of California, Berkeley
Agustina	Czenky	University of Oregon
Arun	Debray	University of Texas, Austin
Thibault	Decoppet	University of Oxford
Colleen	Delaney	Indiana University
Zachary	Dell	Ohio State University
Christoph	Dorn	University of Oxford
Christopher	Douglas	University of Oxford
Arpit	Dua	Yale University
Cain	Edie-Michell	Vanderbilt University
Pavel	Etingof	Massachusetts Institute of Technology
Zhaobidan	Feng	Texas A & M University
John	Francis	Northwestern University
Dan	Freed	University of Texas, Austin
Michael	Freedman	University of California, San Diego
Jason	Gaddis	Miami University
Terry	Gannon	University of Alberta
Shlomo	Gelaki	Iowa State University

Participants

First Name	Last Name	Institution
Peter	Goetz	Humboldt State University
Nicolle	Gonzalez	University of California, Los Angeles
Frederick	Goodman	The University of Iowa
Evgeny	Gorskiy	University of California, Davis
David	Green	Ohio State University
Sam	Gunningham	King's College London
Philip	Hackney	University of Louisiana--Lafayette
Peter	Haine	Massachusetts Institute of Technology
Rune	Haug seng	Norwegian University of Science and Technology (NTNU)
Erin	Hausmann	University of Oklahoma
Matthew	Hedden	Michigan State University
Roberto	Hernandez Paloma	Ohio State University
Peng Hui	How	University of Chicago
Samuel	Hsu	University of California, Berkeley
Peter	Huston	Ohio State University
David	Jordan	University of Edinburgh
Chris	Kapulkin	University of Western Ontario
Kwangjoong	Kim	Kookmin University
Ellen	Kirkman	Wake Forest University
Robert	Korsan	Carnegie Mellon University
Arundhathi	Krishnan	National University of Ireland, University College Cork
Peter	Kristel	Ernst-Moritz-Arndt-Universität Greifswald
Genta	Latifi	University of Zurich
Gail	Letzter	NSA - National Security Agency
Runliang	LIN	Tsinghua University
Chen-wei	Lin	University of Melbourne
Larsen	Linov	University of California, Berkeley
Muriel	Livernet	Institut de Mathematiques de Jussieu
Mehdi	Maleki Sanukesh	University of Iowa
Aaron	Mazel-Gee	University of Southern California
Matthew	McMillan	University of California, Los Angeles
Calvin	McPhail-Snyder	University of California, Berkeley
Luz adriana	Mejia castaño	Universidad del Norte
Scott	Morrison	Australian National University
Lyne	Moser	École Polytechnique Fédérale de Lausanne
Lang	Mou	University of California, Davis
Naofumi	Muraki	Iwate Prefectural University
Cris	Negron	University of North Carolina
Siu-Hung	Ng	Louisiana State University
Van	Nguyen	United States Naval Academy
Anh Tuong	Nguyen	University of Illinois at Urbana-Champaign
Dmitri	Nikshych	University of New Hampshire
Pablo	Ocal	Texas A & M University
Victor	Ostrik	University of Oregon

Participants

First Name	Last Name	Institution
Amrei	Oswald	The University of Iowa
David	Penneys	Ohio State University
Maximilien	Peroux	University of Illinois at Chicago
Emily	Peters	Loyola University
Julia	Plavnik	Indiana University
Anup	Poudel	The University of Iowa
Eugene	Rabinovich	University of California, Berkeley
Joseph	Randich	University of Oklahoma
David	Reutter	Max-Planck-Institut für Mathematik
Emily	Riehl	Johns Hopkins University
Marcy	Robertson	University of Melbourne
Daniel	Roggenkamp	Universität Mannheim
Ilan	Roth	University of California, Berkeley
Martina	Rovelli	Australian National University
Eric	Rowell	Texas A & M University
Yuze	Ruan	Vanderbilt University
Sean	Sanford	Indiana University
Guillermo	Sanmarco	Universidad Nacional de Cordoba
Cecily	Santiago	University of Minnesota Twin Cities
Claudia	Scheimbauer	TU München
Christopher	Schommer-Pries	University of Notre Dame
Andrew	Schopieray	University of New South Wales
Asif	Shakeel	University of California, San Diego
Abhishek	Shivkumar	University of California, Berkeley
Maithreya	Sitaraman	Columbia University
Noah	Snyder	Indiana University
Kursat	Sozer	Indiana University
Luuk	Stehouwer	Max-Planck-Institut für Mathematik
Jan	Steinebrunner	University of Oxford
William	Stewart	University of Texas, Austin
Angela	Tabiri	African Institute for Mathematical Sciences Ghana
Frank	Taïpe	Université Paris-Sud
James	Tener	Australian National University
Fiona	Torzewska	University of Leeds
Henry	Tucker	University of California, Riverside
Kent	Vashaw	Louisiana State University
Monica	Vazirani	University of California, Davis
Padmini	Veerapen	Tennessee Technological University
Siddharth	Venkatesh	University of California, Los Angeles
Paula	Verdugo	Macquarie University
Dominic	Verity	Macquarie University
Kevin	Walker	Microsoft Research Station Q
Chelsea	Walton	University of Illinois at Urbana-Champaign
Zhengan	Wang	University of California, Santa Barbara

Participants

First Name	Last Name	Institution
Yilong	Wang	Louisiana State University
Dominic	Weiller	Australian National University
Elizabeth	Wicks	University of Washington
Anna	Wienhard	Ruprecht-Karls-Universität Heidelberg
Brian	Williams	Northeastern University
Sarah	Witherspoon	Texas A & M University
Ramona	Wolf	Leibniz Universität Hannover
Robert	Won	University of Washington
Harshit	Yadav	University of Illinois at Urbana-Champaign
Ramy	Yamine	Temple University
Jun	Yang	Vanderbilt University
Yuan	Yao	University of California, Berkeley
Sarah	Yeakel	MSRI - Mathematical Sciences Research Institute
David	Yetter	Kansas State University
Wataru	Yuasa	Kyoto University
Qing	Zhang	Texas A & M University
Jieru	Zhu	University at Buffalo (SUNY)

Officially Registered Participants Information

Participants		149
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Gender		149
Male	69.80%	104
Female	28.19%	42
Declined to state	2.01%	3
Other/Non-Binary	0.00%	0

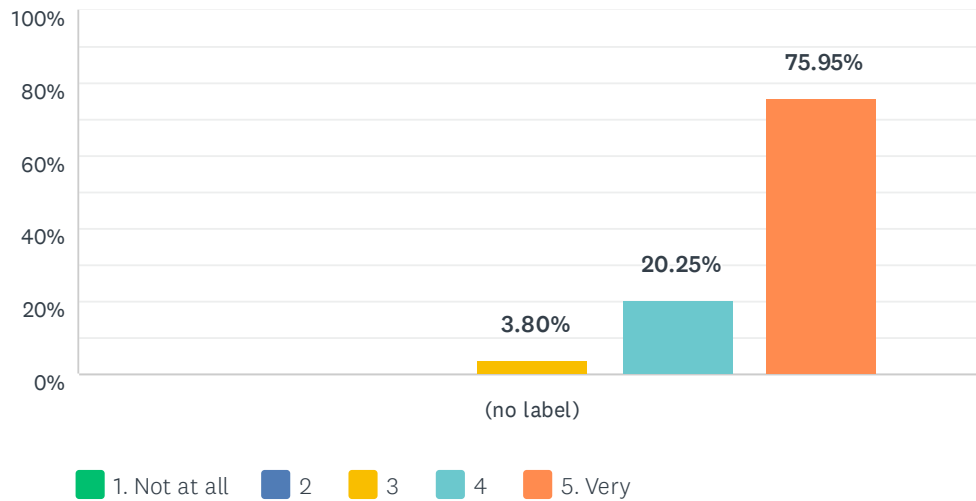
Ethnicity*		171
White	54.39%	93
Asian	22.22%	38
Hispanic	7.02%	12
Pacific Islander	0.00%	0
Black	2.34%	4
Native American	0.58%	1
Mixed	6.43%	11
Declined to state	7.02%	12

* ethnicity specifications are not exclusive

79 responses out of 149 participants = 53% response rate

Q1 The workshop was intellectually stimulating

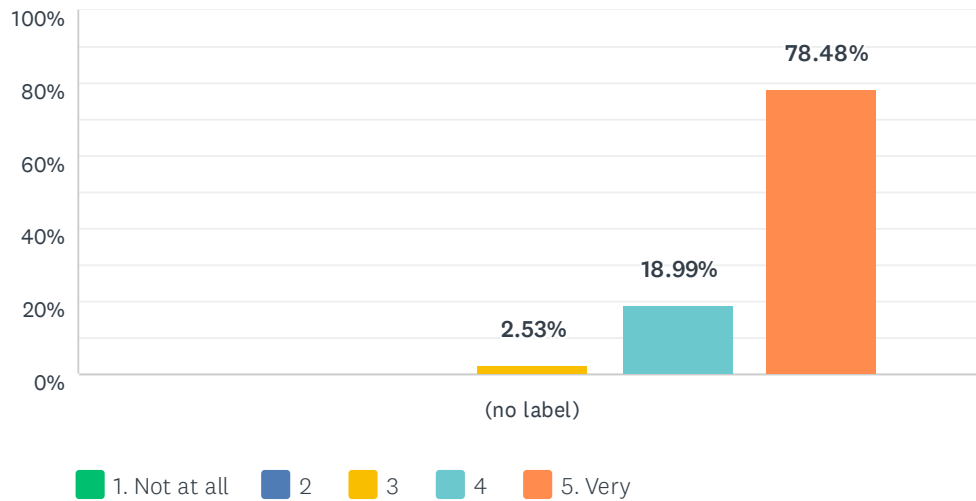
Answered: 79 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	3.80% 3	20.25% 16	75.95% 60	79	4.72

Q2 The overall experience of the workshop was worthwhile

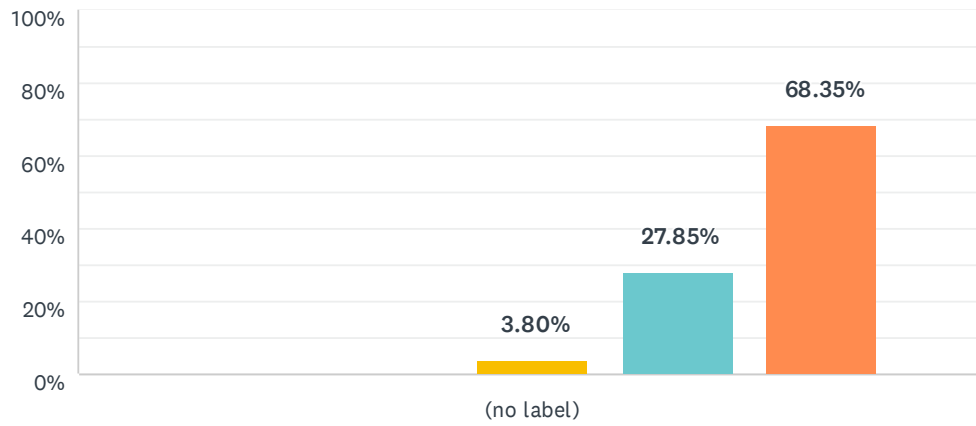
Answered: 79 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	2.53% 2	18.99% 15	78.48% 62	79	4.76

Q3 The time between lectures was adequate for discussion

Answered: 79 Skipped: 0

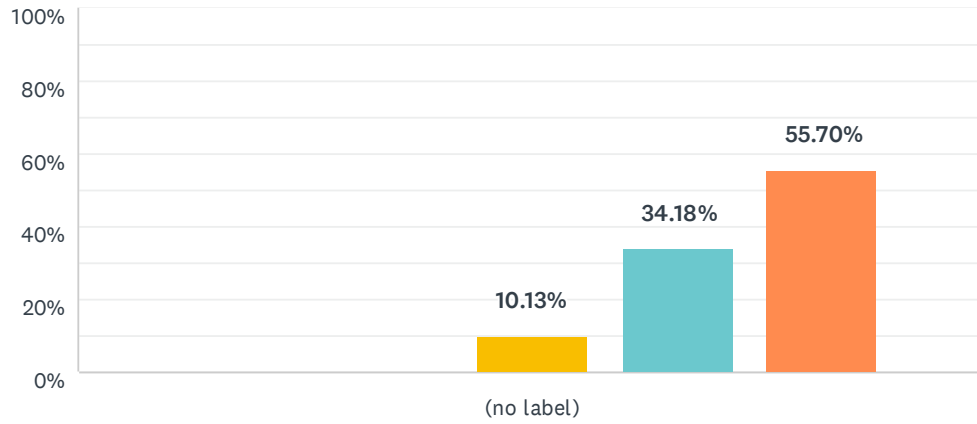


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	3.80% 3	27.85% 22	68.35% 54	79	4.65

Q4 The lectures were at at an appropriate level

Answered: 79 Skipped: 0



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	10.13% 8	34.18% 27	55.70% 44	79	4.46

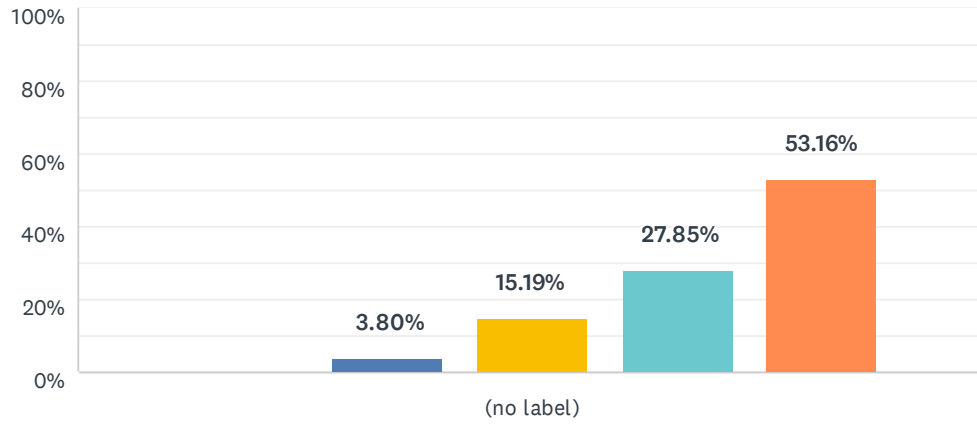
Q5 Additional comments

Answered: 14 Skipped: 65

#	RESPONSES	DATE
1	Expect Fewer lectures on each day Need time to think and review before the next ones	2/20/2020 1:08 PM
2	.	2/13/2020 7:41 AM
3	I am an assistant professor working in the area, so the talks were not (and should not have been) so intellectually stimulating for me. Certainly, more cutting edge materials will be presented later in the semester.	2/12/2020 5:35 PM
4	It was a very well-planned workshop!	2/12/2020 5:12 PM
5	The topic was a little far from my interests but was s as good introduction...	2/12/2020 4:25 PM
6	It was an excellent workshop. Also, the reimbursement process was the quickest and most efficient of any meeting I have ever attended!	2/5/2020 9:52 AM
7	Some speakers were too sketchy at times.	2/3/2020 8:59 PM
8	Really well planned.	2/3/2020 6:01 PM
9	Some lecture topics are not in my area, I have a harder time understanding those, but it is good to have a wide variety of topics to target many audience.	2/3/2020 2:07 PM
10	The level of most talks was perfect for me. But I am only a beginning graduate student, so the level for more advanced researchers could have been slightly too low.	2/3/2020 1:16 PM
11	I only rated 4) a 4 because some lectures were more approachable and organized than others. Overall, for this only being related to my field; I felt as if I walked away with knowing a big picture viewpoint. I'm more comfortable with how all the concepts were connected to each other. In the future, it would be nice to have small working sessions. With a few problems or even just food for thought at varying levels of difficulty.	2/3/2020 1:05 PM
12	Incredible experience as someone new to the field.	2/3/2020 12:14 PM
13	I was happy with the balance of introductory and more specialized talks. The facilities and opportunities for discussion were fantastic.	2/3/2020 12:05 PM
14	Some talks were a bit repetitive in the subjects they approached	2/3/2020 11:57 AM

Q6 I was well prepared to benefit from the lectures

Answered: 79 Skipped: 0

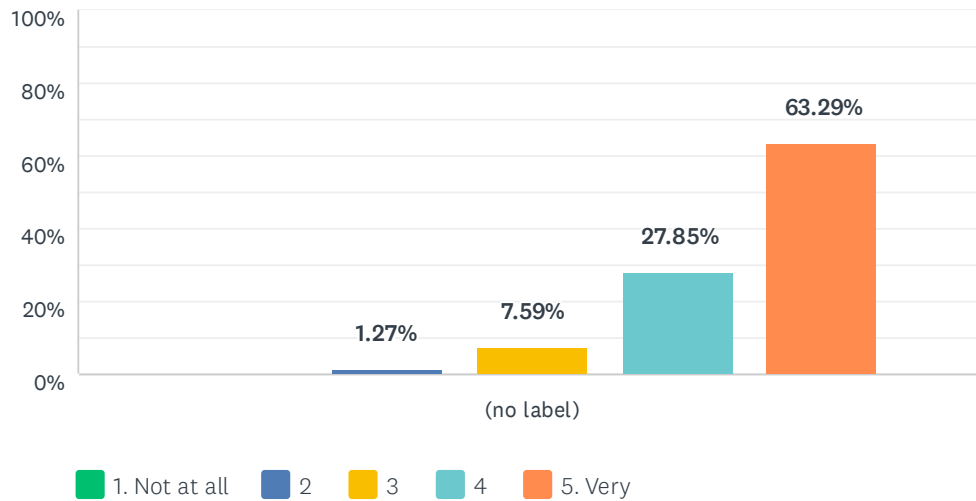


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.80%	15.19%	27.85%	53.16%	79	4.30
	0	3	12	22	42		

Q7 My interest in the subject matter was increased by the workshop

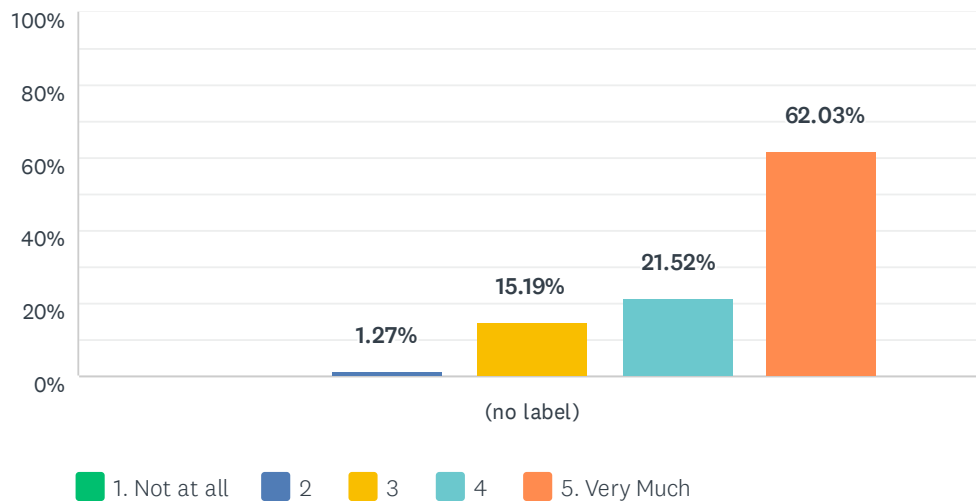
Answered: 79 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.27%	7.59%	27.85%	63.29%	79	4.53
	0	1	6	22	50		

Q8 The workshop helped me meet people with similar scientific interests

Answered: 79 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.27%	15.19%	21.52%	62.03%	79	4.44
	0	1	12	17	49		

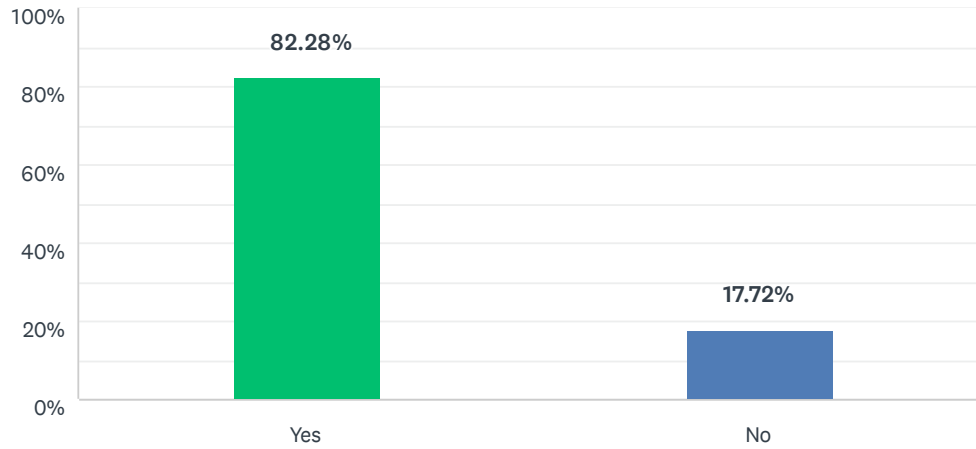
Q9 Additional comments on your personal assessment

Answered: 2 Skipped: 77

#	RESPONSES	DATE
1	It was a very valuable experience for me as a physicist to get in contact with so many mathematicians who have a very different point of view on the subject than I do.	2/5/2020 4:21 AM
2	I have enjoyed it!	2/3/2020 8:59 PM

Q10 Did you attend the reception?

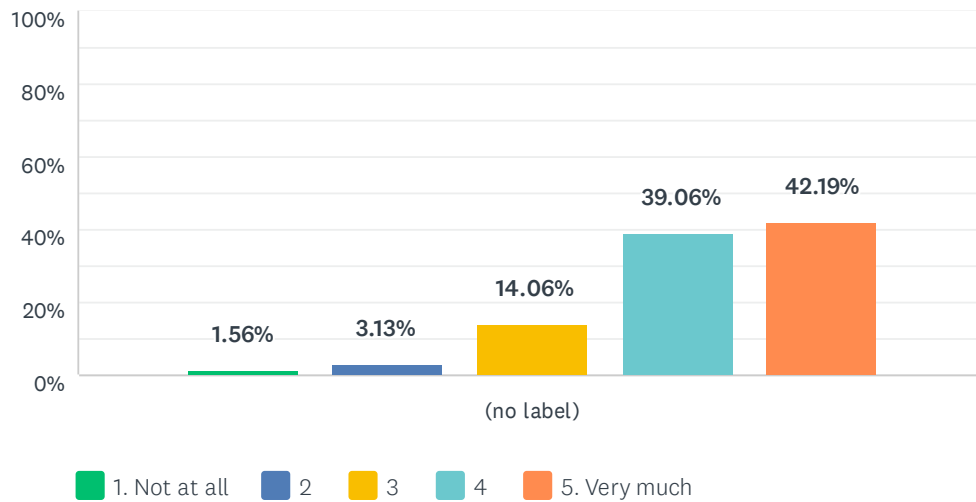
Answered: 79 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	82.28%	65
No	17.72%	14
TOTAL		79

Q11 Did the reception help to solidify the contacts you made during the workshop?

Answered: 64 Skipped: 15



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	1.56%	3.13%	14.06%	39.06%	42.19%	64	4.17
	1	2	9	25	27		

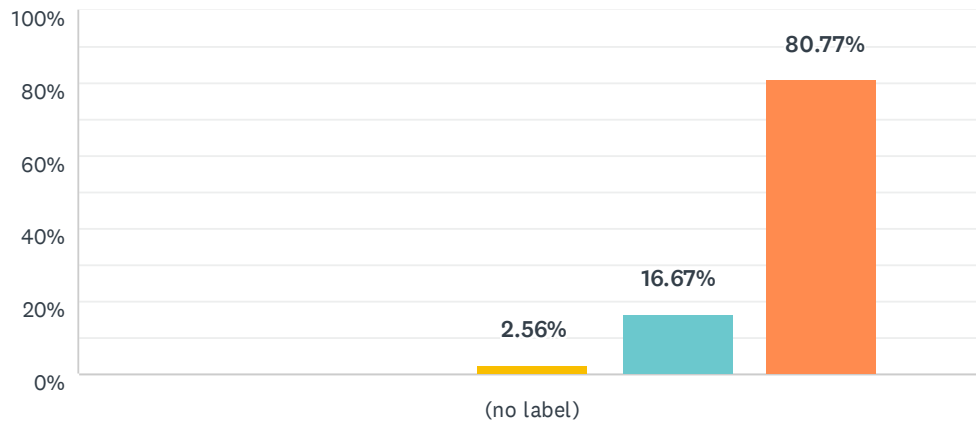
Q12 Please provide any comments about the reception

Answered: 5 Skipped: 74

#	RESPONSES	DATE
1	It didn't seem that different from coffee breaks and such. I had to struggle to remember what you were talking about.	2/21/2020 9:46 AM
2	I can't actually remember if I went to the reception or not...	2/12/2020 5:37 PM
3	The reception was fantastic! My compliments to the chef!	2/5/2020 9:53 AM
4	The food was great. It was nice to talk to people but since it was early in the week I talked more to people I already know	2/4/2020 11:14 AM
5	I enjoyed the reception a lot! But I can't really say for certain to what extent it influenced the people I talk to about mathematics. No doubt it helped somewhat.	2/3/2020 3:57 PM

Q13 I found the MSRI staff helpful

Answered: 78 Skipped: 1

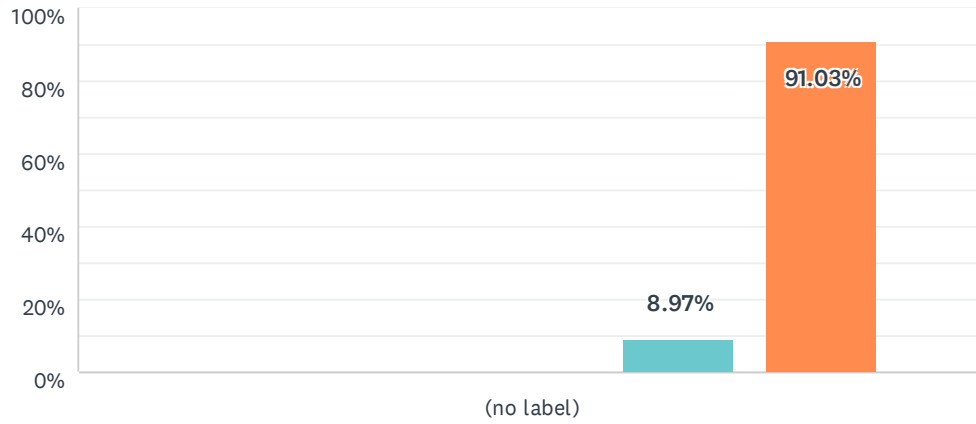


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	2.56%	16.67%	80.77%	78	4.78
	0	0	2	13	63		

Q14 The MSRI facilities were conducive for such a workshop

Answered: 78 Skipped: 1

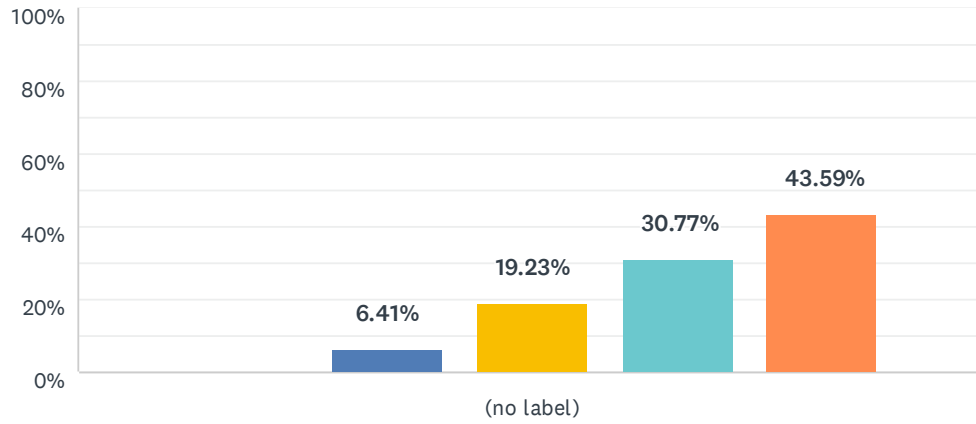


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	8.97%	91.03%	78	4.91
	0	0	0	7	71		

Q15 The MSRI lunch arrangements were satisfactory

Answered: 78 Skipped: 1

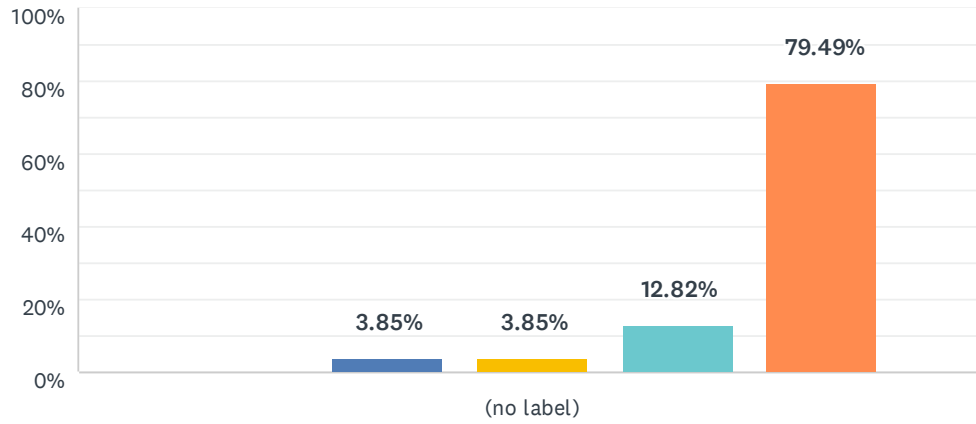


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	6.41%	19.23%	30.77%	43.59%		
	0	5	15	24	34	78	4.12

Q16 The MSRI tea arrangements were satisfactory

Answered: 78 Skipped: 1

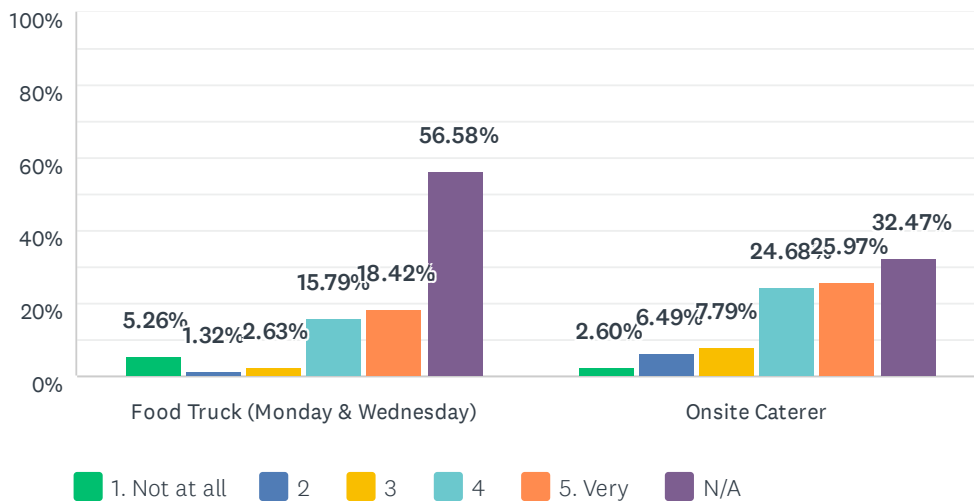


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.85%	3.85%	12.82%	79.49%	78	4.68
	0	3	3	10	62		

Q17 I found the food from the following vendors satisfactory:

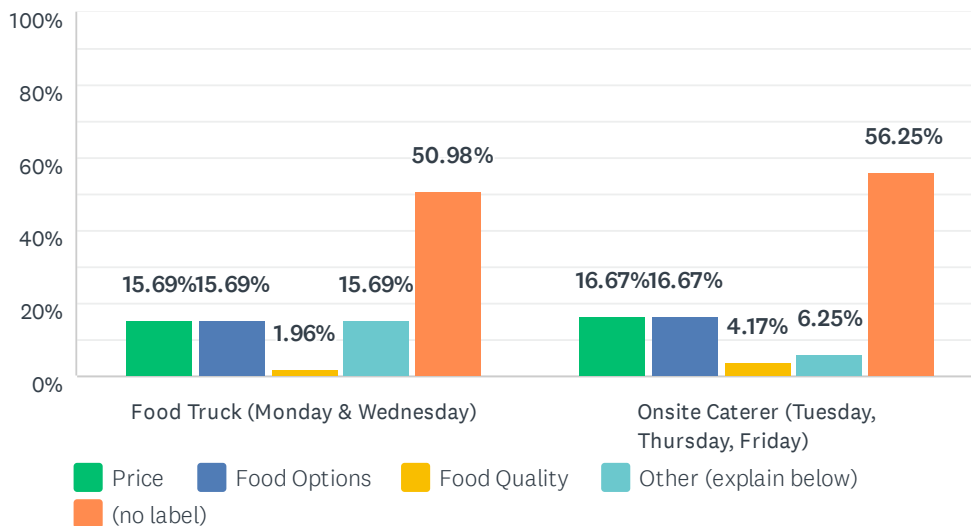
Answered: 78 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Monday & Wednesday)	5.26% 4	1.32% 1	2.63% 2	15.79% 12	18.42% 14	56.58% 43	76
Onsite Caterer	2.60% 2	6.49% 5	7.79% 6	24.68% 19	25.97% 20	32.47% 25	77

Q18 I did NOT purchase from the following vendors because:

Answered: 53 Skipped: 26



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	(NO LABEL)	TOTAL
Food Truck (Monday & Wednesday)	15.69% 8	15.69% 8	1.96% 1	15.69% 8	50.98% 26	51
Onsite Caterer (Tuesday, Thursday, Friday)	16.67% 8	16.67% 8	4.17% 2	6.25% 3	56.25% 27	48

#	OTHER (PLEASE SPECIFY)	DATE
1	Was not present.	2/16/2020 4:01 AM
2	Not very vegan friendly	2/12/2020 5:58 PM
3	I brought my own food.	2/5/2020 4:22 AM
4	I bring my own since it is cheaper	2/4/2020 11:15 AM
5	I wanted to try food options in Berkeley the day that the food truck was on campus.	2/4/2020 6:45 AM
6	I brought lunch those days.	2/3/2020 9:01 PM
7	I brought my own lunch for ease of planning	2/3/2020 3:58 PM
8	Did not know there was a food truck	2/3/2020 2:12 PM
9	Wed was a short day, ate elsewhere. Mon brought a sandwich	2/3/2020 1:18 PM
10	The food that the caterer sold dont like me!	2/3/2020 12:41 PM
11	brought my lunch	2/3/2020 12:36 PM

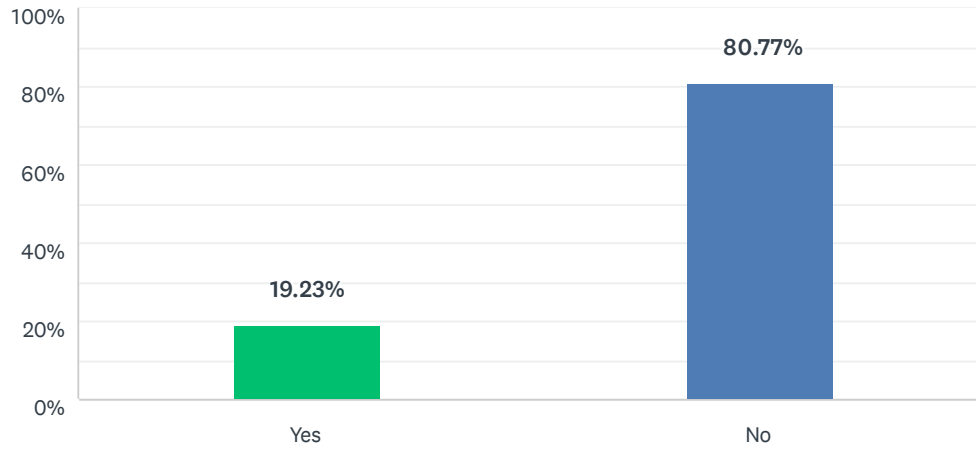
Q19 Additional comments about the MSRI staff, facilities and food

Answered: 11 Skipped: 68

#	RESPONSES	DATE
1	There were very few vegan options at lunch.	2/29/2020 5:59 PM
2	It got really old having the same thing everyday. The salads were not particularly appealing. The sandwiches were fine, but not every day of the week.	2/21/2020 9:47 AM
3	Nice	2/20/2020 1:09 PM
4	The vegetarian/vegan options with the caterer would occasionally run out.	2/18/2020 10:50 AM
5	All of the MSRI staff were super friendly and helpful. I especially thought that Tracy was extra helpful and quick with the reimbursement process.	2/5/2020 9:54 AM
6	Thank you for all your great work!	2/3/2020 9:01 PM
7	My answer to #15 should be N/A, because I brought my lunch from home all 5 days, but there was no N/A option.	2/3/2020 3:58 PM
8	I found the MSRI staff extremely friendly and helpful. The bagels and fruits & veggies available during the tea were excellent, compared to these, the pastries packed in plastic were a little disappointing.	2/3/2020 2:40 PM
9	It was a bit expensive, but the selection and quality of the food was very good. MSRI staff gave good suggestions on what to do in the weekend as well.	2/3/2020 1:19 PM
10	For those of us who are very, very hard of hearing, there are no facilities to bring the lectures to our hearing aids. This basically means that in the future I won't be able to participate.	2/3/2020 1:18 PM
11	Everyone was super friendly and helpful; don't let me leave out organized!	2/3/2020 1:08 PM

Q20 Did you use the computer facilities located in the library?

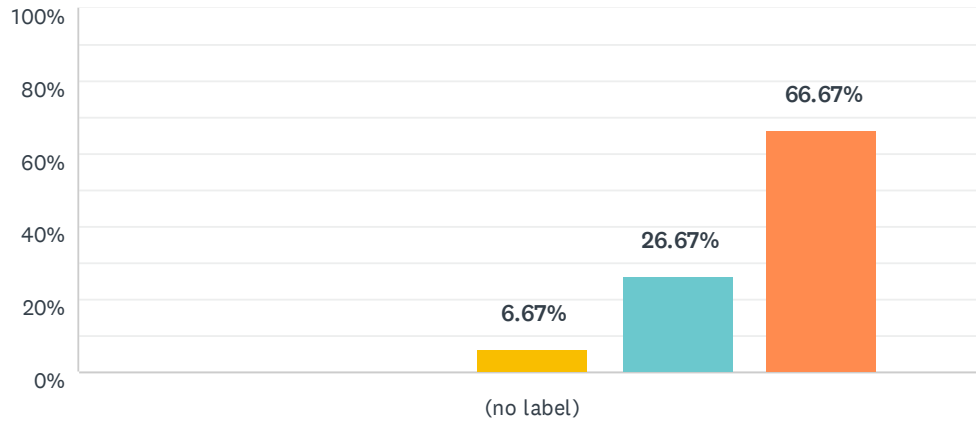
Answered: 78 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	19.23%	15
No	80.77%	63
TOTAL		78

Q21 The MSRI computer facilities in the library were adequate

Answered: 15 Skipped: 64



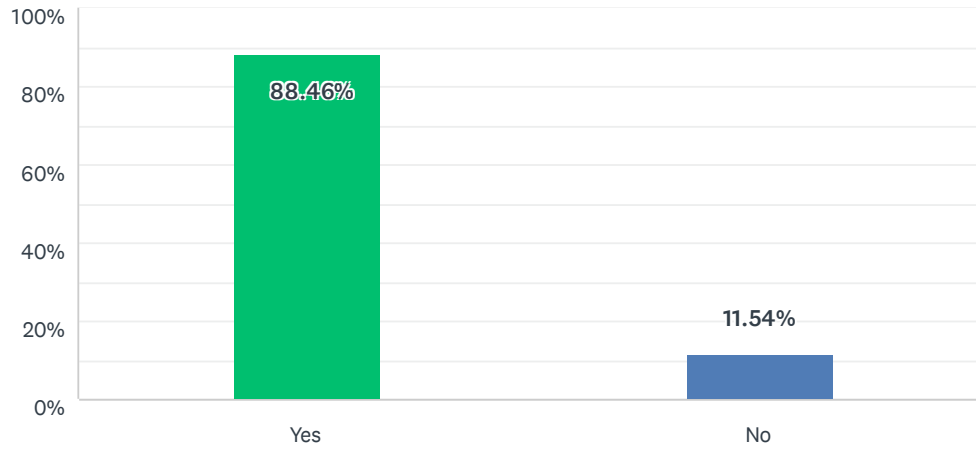
■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.67%	26.67%	66.67%	15	4.60
	0	0	1	4	10		

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	The mouse pads don't stick to the table very well.	2/18/2020 10:51 AM
2	minor issue printing from laptop, resolved by printing from MSRI desktop	2/3/2020 12:15 PM

Q22 Did you use MSRI's wireless network?

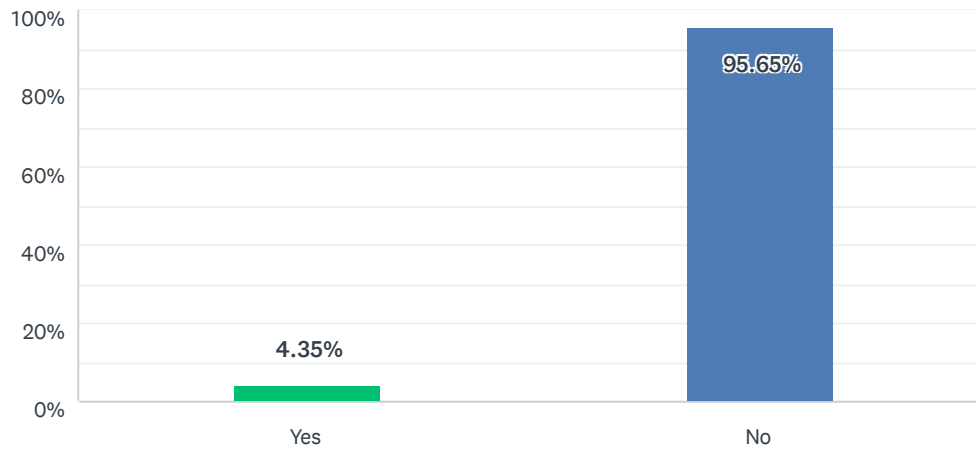
Answered: 78 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	88.46%	69
No	11.54%	9
TOTAL		78

Q23 Did you experience any difficulties with the network?

Answered: 69 Skipped: 10



ANSWER CHOICES	RESPONSES	
Yes	4.35%	3
No	95.65%	66
TOTAL		69

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	For the most part no. Eduroam had some problems at one point.	2/12/2020 5:38 PM
2	Speeds on MSRI-guest were inconsistent at times	2/4/2020 2:34 AM
3	Not about the network, but for some reason I have very poor phone signal inside MSRI building.	2/3/2020 2:09 PM
4	Generally unreliable.	2/3/2020 12:33 PM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 8 Skipped: 71

#	RESPONSES	DATE
1	It is great the videos are uploaded right away. I watched several, especially if I had to miss one day of talks but return for the next day.	2/26/2020 12:53 AM
2	Please change the reimbursement system. Receiving a check on the last day when you are from a foreign country is not helpful at all. It requires either to cash in the check on the last day and have many dollars in your pocket (since you can't spend it afterwards since you are leaving) or cashing a check in a foreign currency which is very expensive.	2/19/2020 12:25 PM
3	MSRI is really an exemplary model for any other research facility or meeting. Other hosts of conferences in mathematics should look to MSRI for guidance! (In particular, the AMS could probably benefit from consulting from MSRI's management team.)	2/5/2020 9:56 AM
4	Great Workshop, thank you!	2/5/2020 9:36 AM
5	Thanks for your organization and help!	2/3/2020 4:47 PM
6	Thank you for organizing an excellent workshop!	2/3/2020 2:41 PM
7	Most modern hearing aids connect to Bluetooth. Having the audio of the lectures on Bluetooth would make a world of difference.	2/3/2020 1:20 PM
8	Everything was great, Thanks a lot	2/3/2020 12:42 PM

**Connections for Women: Higher
Categories and Categorification**

February 06, 2020 - February 07, 2020

MSRI, Berkeley, CA, USA

Organizers:

Emily Riehl (Johns Hopkins University)

Marcy Robertson (University of Melbourne)

REPORT ON THE MSRI WORKSHOP

“Connections for Women: Higher Categories and Categorification”

February 6 – 7, 2020

Organizers

- Emily Riehl (Johns Hopkins University)
- Marcy Robertson (University of Melbourne)

Scientific Description

Though many of the ideas in higher category theory find their origins in homotopy theory — for instance as expressed by Grothendieck’s “homotopy hypothesis” — the subject today interacts with a broad spectrum of areas of mathematical research. Unforeseen descent, or local-to-global formulas, for familiar objects can be articulated in terms of higher invertible morphisms. Compatible associative deformations of a sequence of maps of spaces, or derived schemes, can putatively be represented by higher categories, as Koszul duality for E_n -algebras suggests. Higher categories offer unforeseen characterizing universal properties for familiar constructions such as K-theory. Manifold theory is natively connected to higher category theory and adjunction data, a connection that is most famously articulated by the recently proven Cobordism Hypothesis.

The two-day workshop surveyed notable developments in the foundations and applications of higher category theory. It consisted of two mini-courses given by emerging female leaders in the subject: Claudia Scheimbauer and Nathalie Wahl. It was paired with problem sessions lead by selected "TA's", themselves experts in higher structures, and all female Ph.D students or early career researchers. The TA's diligently prepared before the workshop, having the unexpected side-effect of building strong connections between young researchers to natural collaborators and colleagues. Each lecture series tailored to a diverse audience, accessible to graduate students and non-expert researchers with some background in homological algebra. The majority of the speakers and panelists for this event were women and gender minorities, and members of these groups and of other underrepresented groups were especially encouraged to attend. This workshop was open to all mathematicians.

Highlights of the Workshop

We were delighted that many of the most attentive students were research professors and more senior academics participating in the program. One research professor was so determined to work through all the problems that we often had to tear her away from the problems to participate in the panel discussion.

Our panel consisted of early career researchers and established researchers based on three continents. Our discussion was titled “Creating space for yourself and others” and was centered around the experiences our panelists have had doing things a bit outside the traditional role of a mathematician. We had young researchers discuss how they have interwoven their love of

performance dance with mathematics, a discussion that moved from the panel to the audience on how one navigates being queer in mathematics, and asked more established researchers explain how they worked family into their careers. All discussed how to promote themselves in a way that feels natural and honest to their experience.

Organizers

First Name	Last Name	Institution
Emily	Riehl	Johns Hopkins University
Marcy	Robertson	University of Melbourne

Speakers

First Name	Last Name	Institution
Claudia	Scheimbauer	TU München
Nathalie	Wahl	University of Copenhagen

Teaching Assistants

First Name	Last Name	Institution
Viktoriya	Ozornova	Ruhr-Universität Bochum
Laura	Murray (Wells)	Notre Dame University

Mathematical Sciences Research Institute

Connections For Women: Higher Categories And Categorification

February 6 - February 7, 2020

Thursday, February 6, 2020

8:45AM - 9:00AM	Simons Auditorium		Welcome
9:00AM - 10:30AM	Simons Auditorium	Nathalie Wahl	2-dimensional topological field theories
10:30AM - 11:00AM	Atrium		Break
11:00AM - 12:30PM	Simons Auditorium	Claudia Scheimbauer	Introduction to higher categories, dualizability, and applications to topological field theories
12:30PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Nathalie Wahl	Problem Session
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium	Claudia Scheimbauer	Problem Session
4:30PM - 5:30PM	Simons Auditorium	Teena Gerhardt, Muriel Livernet, Marcy Robertson, Nancy Scherich, Jieru Zhu	Panel Discussion
5:45PM - 7:00PM	Atrium		Dinner at MSRI

Friday, February 7, 2020

9:00AM - 10:30AM	Simons Auditorium	Nathalie Wahl	2-dimensional topological field theories
10:30AM - 11:00AM	Atrium		Break
11:00AM - 12:30PM	Simons Auditorium	Claudia Scheimbauer	Introduction to higher categories, dualizability, and applications to topological field theories
12:30PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Nathalie Wahl	Problem Session
3:00PM - 3:30PM	Atrium		Tea
3:30PM - 4:30PM	Simons Auditorium	Claudia Scheimbauer	Problem Session



Participants

First Name	Last Name	Institution
Stefano	Ariotta	Westfälische Wilhelms-Universität Münster
David	Ayala	Montana State University
Clark	Barwick	University of Edinburgh
Luciana	Basualdo Bonatto	University of Oxford
Rekha	Biswal	Max Planck Institute for Mathematics
Pedro	Boavida	Instituto Superior Técnico
Olivia	Borghi	University of Washington
Alexander	Campbell	Mathematical Sciences Research Institute
Anna	Cepek	Institute for basic science
Fei Yu	Chen	University of California, Berkeley
Quan	Chen	Ohio State University
Chang-Yeon	Chough	Institute for basic science
Patrick	Chu	Indiana University
Zsuzsanna	Dancso	University of Sydney
Thibault	Decoppet	University of Oxford
Colleen	Delaney	Indiana University
Zachary	Dell	Ohio State University
Shanna	Dobson	California State University, at Los Angeles
Christoph	Dorn	University of Oxford
Will	Dumm	Montana State University
Pavel	Etingof	Massachusetts Institute of Technology
Neeti	Gaunyal	Kansas State University
Teena	Gerhardt	Michigan State University
Nicolle	Gonzalez	University of California, Los Angeles
Frederick	Goodman	The University of Iowa
Evgeny	Gorskiy	University of California, Davis
Serap	Gürer	Galatasaray University
Philip	Hackney	University of Louisiana--Lafayette
Peter	Haine	Massachusetts Institute of Technology
Rune	Haug seng	Norwegian University of Science and Technology
Renee	Hoekzema	Max-Planck-Institut für Mathematik
Geoffroy	Horel	Université de Paris XIII (Paris-Nord)
Katerina	Hristova	University of East Anglia
Samuel	Hsu	University of California, Berkeley
Peter	Huston	Ohio State University
Yajit	Jain	Northwestern University
David	Jordan	University of Edinburgh
Eilind	Karlsson	TU München
Inbar	Klang	Columbia University
Christopher	Kuo	University of California, Berkeley
Edoardo	Lanari	Czech Academy of Sciences (AVCR)
Genta	Latifi	University of Zurich
Suhyeon	Lee	University of California, Berkeley
Chen-wei	Lin	University of Melbourne

Participants

First Name	Last Name	Institution
Yun	Liu	Cornell University
Muriel	Livernet	Institut de Mathematiques de Jussieu
Martin	Markl	Czech Academy of Sciences (AVCR)
Guillaume	Massas	University of California, Berkeley
Aaron	Mazel-Gee	University of Southern California
Lennart	Meier	Universiteit Utrecht
Patricia	Milham	University of Nevada
Benjamin	Moldstad	Montana State University
Scott	Morrison	Australian National University
Lyne	Moser	École Polytechnique Fédérale de Lausanne
Laura	Murray	University of Notre Dame
Ian	Musson	University of Wisconsin
Cris	Negron	University of North Carolina
Pablo	Ocal	Texas A & M University
Morgan	Opie	Harvard University
Sebastian	Ørsted	Aarhus University
Viktoriya	Ozornova	Ruhr-Universität Bochum
Simona	Paoli	University of Leicester
Maximilien	Peroux	University of Illinois at Chicago
Emily	Peters	Loyola University
Julia	Plavnik	Indiana University
Eugene	Rabinovich	University of California, Berkeley
Arun	Ram	University of Melbourne
David	Reutter	Max-Planck-Institut für Mathematik
Emily	Riehl	Johns Hopkins University
Marcy	Robertson	University of Melbourne
Martina	Rovelli	Australian National University
Eric	Rowell	Texas A & M University
Sean	Sanford	Indiana University
Cecily	Santiago	University of Minnesota Twin Cities
Maru	Sarazola	Cornell University
Claudia	Scheimbauer	TU München
Nancy	Scherich	Wake Forest University
Jay	Shah	University of Notre Dame
Noah	Snyder	Indiana University
Kursat	Sozer	Indiana University
Martin	Speirs	University of California, Berkeley
James	Tener	Australian National University
Scott	Tilton	Montana State University
Guillermo	Tochi	Northwestern University
Monica	Vazirani	University of California, Davis
Paula	Verdugo	Macquarie University
Dominic	Verity	Macquarie University
Nathalie	Wahl	University of Copenhagen

Participants

First Name	Last Name	Institution
Chelsea	Walton	University of Illinois at Urbana-Champaign
Luya	Wang	University of California, Berkeley
Paul	Wedrich	Max-Planck-Institut für Mathematik
Katrin	Wehrheim	University of California, Berkeley
Brian	Williams	Northeastern University
Carol	Wood	Wesleyan University
Harshit	Yadav	University of Illinois at Urbana-Champaign
Lucy	Yang	Harvard University
Yuan	Yao	University of California, Berkeley
Sarah	Yeakel	Mathematical Sciences Research Institute
Qing	Zhang	Texas A & M University
Jieru	Zhu	University at Buffalo (SUNY)

Officially Registered Participants Information

Participants		100
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Gender		100
Male	52.00%	52
Female	44.00%	44
Declined to state	3.00%	3
Other/Non-Binary	1.00%	1

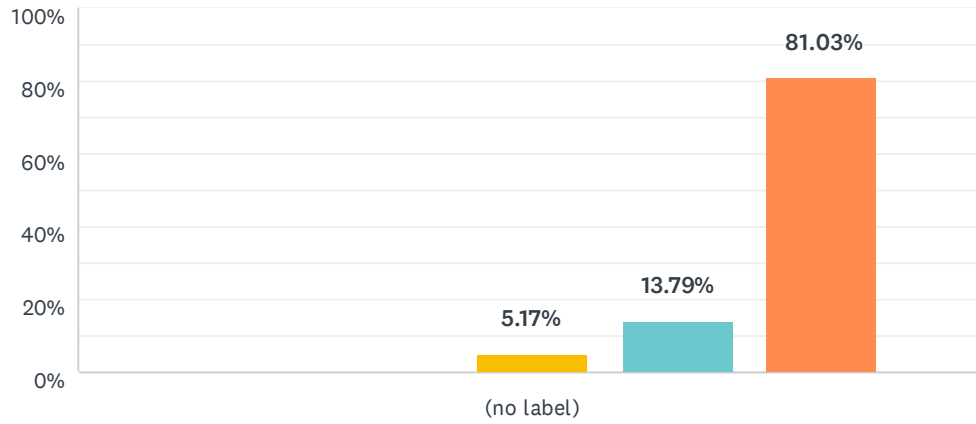
Ethnicity*		122
White	59.02%	72
Asian	17.21%	21
Hispanic	8.20%	10
Pacific Islander	0.00%	0
Black	1.64%	2
Native American	1.64%	2
Mixed	8.20%	10
Declined to state	4.10%	5

* ethnicity specifications are not exclusive

58 responses out of 100 participants = 58% response rate

Q1 The workshop was intellectually stimulating

Answered: 58 Skipped: 0

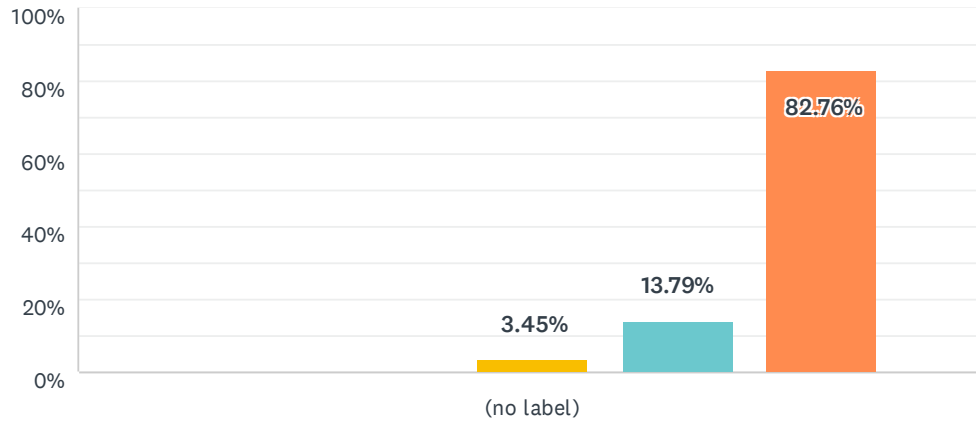


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	5.17%	13.79%	81.03%	58	4.76
	0	0	3	8	47		

Q2 The overall experience of the workshop was worthwhile

Answered: 58 Skipped: 0

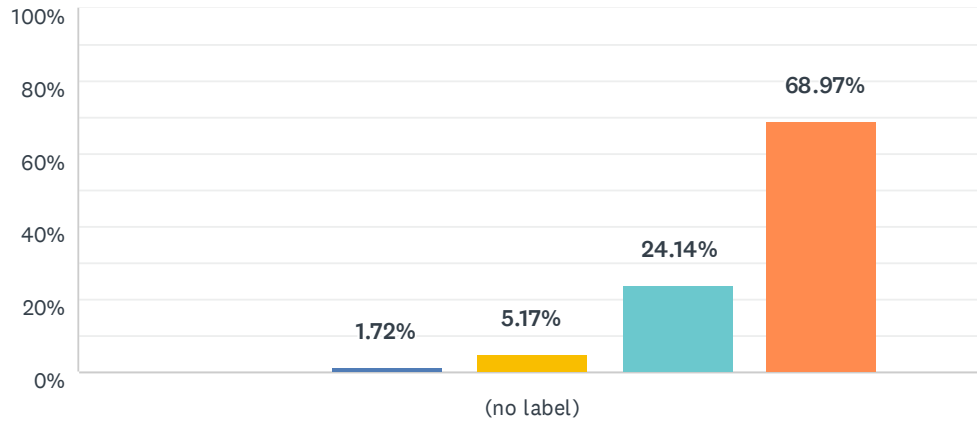


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.45%	13.79%	82.76%	58	4.79
	0	0	2	8	48		

Q3 The time between lectures was adequate for discussion

Answered: 58 Skipped: 0



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.72%	5.17%	24.14%	68.97%	58	4.60
	0	1	3	14	40		

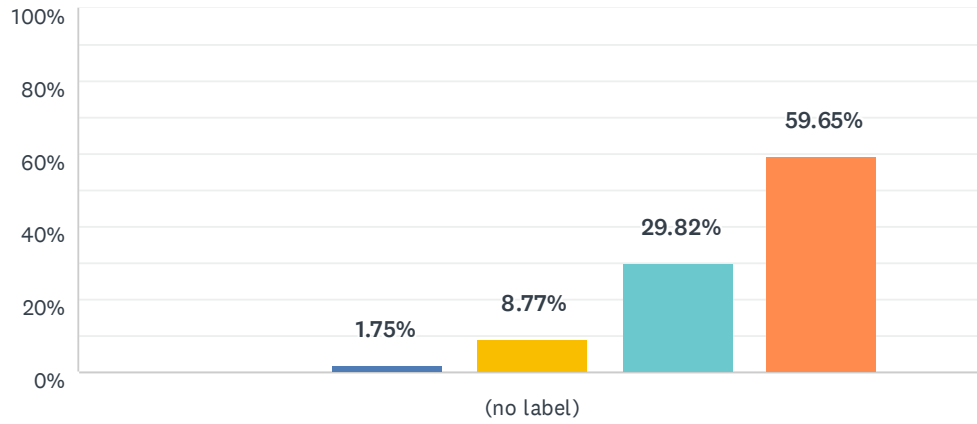
Q4 Additional comments

Answered: 6 Skipped: 52

#	RESPONSES	DATE
1	The problem sessions were a great way to get a better grasp on the content, as well as to interact with other people at the workshop.	2/26/2020 10:47 AM
2	The workshop was fantastic mathematically ... but really shouldn't be called "for women" ... when the talks are dominated by the most famous and socially inept cis white males using the opportunity to ask all their personal curiosities. None of their questions were of any use to the larger audience. And they very quickly dissuaded women from asking anything. Also, it didn't help that males in the audience started answering the few questions of women (in the "sush, that was stupid" way) instead of letting the speaker take them and use the opportunity to catch everyone up. I almost left because this happening - despite the "for women" label - gave me stomach cramps. The reason I made myself stay was the wonderful talk preparation of both speakers.	2/11/2020 8:01 PM
3	I loved how the workshops had problem sessions and were prepared for beginners.	2/11/2020 1:01 PM
4	This was my favorite workshop ever at MSRI. The talks were great and the exercises were very fun and helped cement the concepts.	2/11/2020 11:05 AM
5	Problem sessions sucked for me because I am very easily overstimulated by sound, and the amount of ambient chatter made it impossible for me to concentrate	2/11/2020 10:57 AM
6	The problem session was very interesting and super useful	2/11/2020 10:01 AM

Q5 I was well prepared to benefit from the lectures

Answered: 57 Skipped: 1

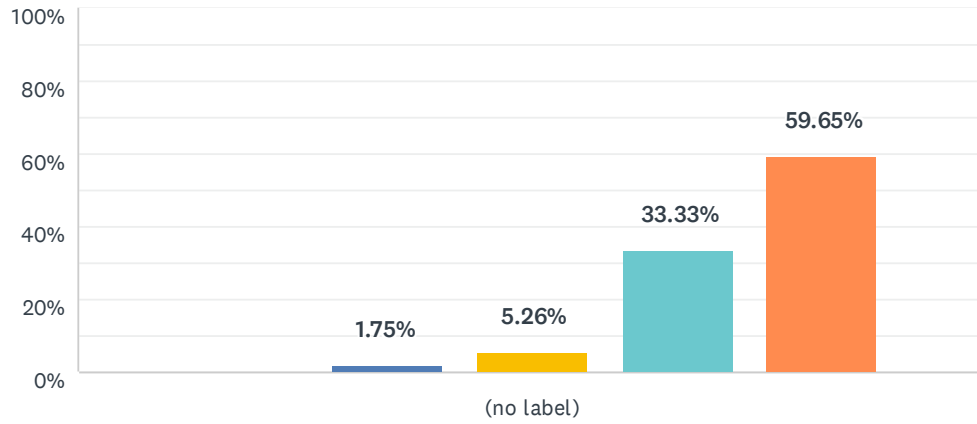


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.75%	8.77%	29.82%	59.65%	57	4.47
	0	1	5	17	34		

Q6 My interest in the subject matter was increased by the workshop

Answered: 57 Skipped: 1

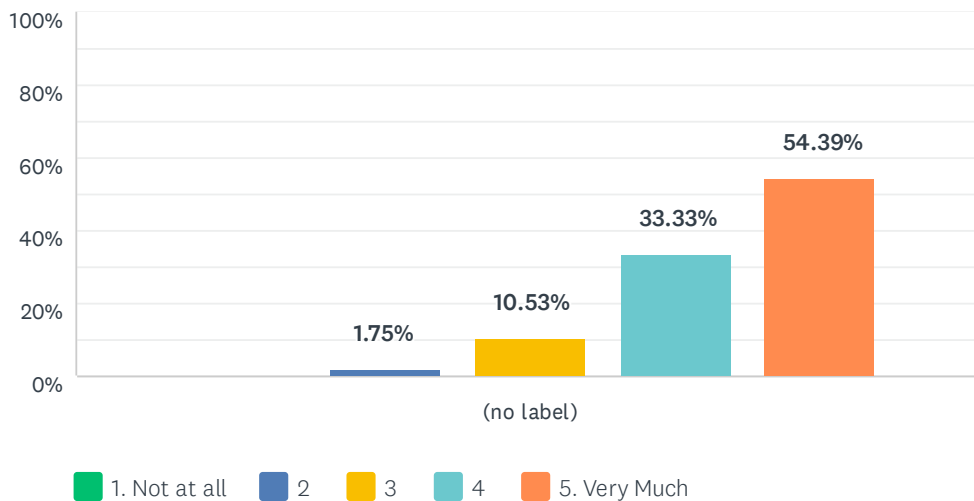


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.75%	5.26%	33.33%	59.65%	57	4.51
	0	1	3	19	34		

Q7 The workshop helped me meet people with similar scientific interests

Answered: 57 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.75%	10.53%	33.33%	54.39%	57	4.40
	0	1	6	19	31		

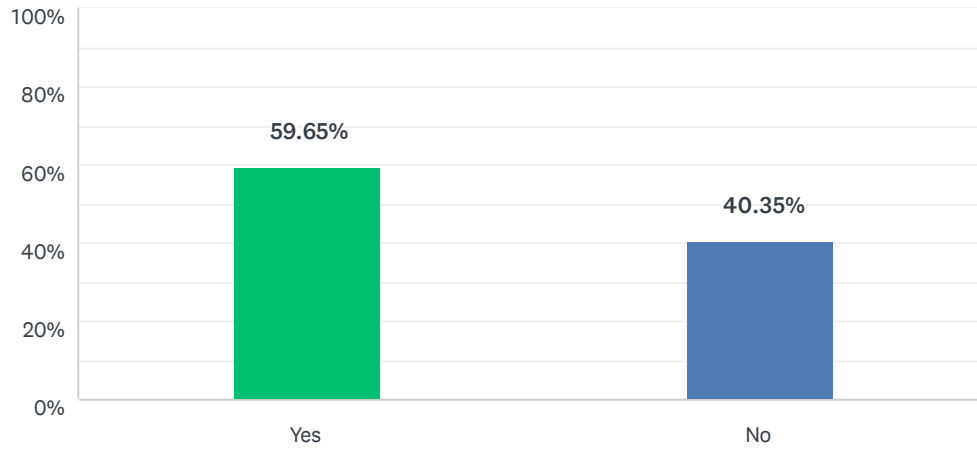
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 57

#	RESPONSES	DATE
1	it was hard to meet women I didn't already know in this sea of men dominating also the tea-time conversations	2/11/2020 8:01 PM

Q9 Did you attend the problem sessions?

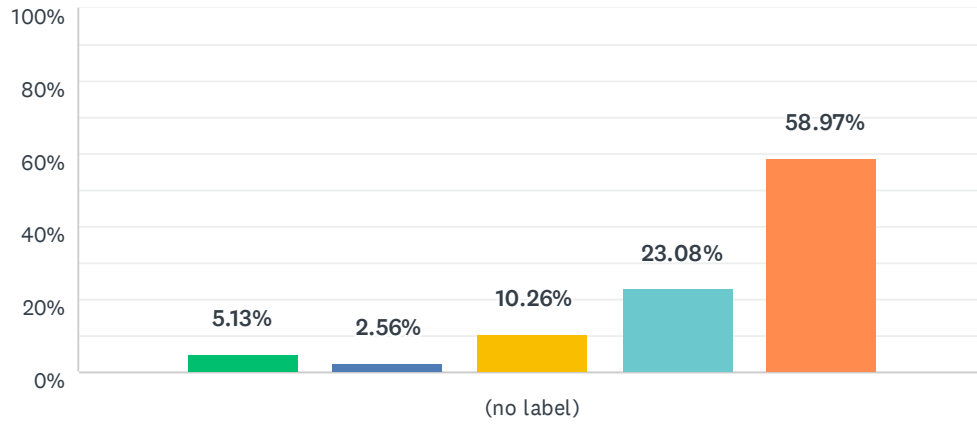
Answered: 57 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	59.65%	34
No	40.35%	23
TOTAL		57

Q10 Did you find the problem sessions worthwhile?

Answered: 39 Skipped: 19

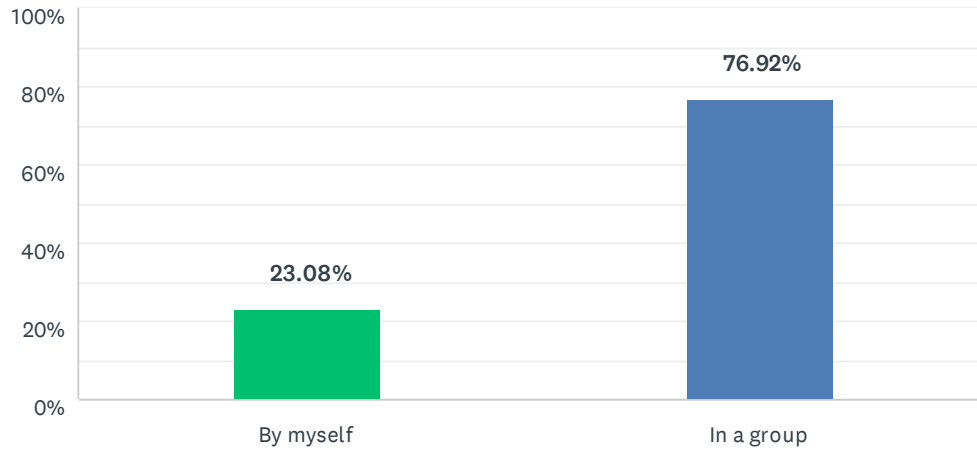


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	5.13%	2.56%	10.26%	23.08%	58.97%	39	4.28
	2	1	4	9	23		

Q11 Did you work on the problems by yourself or in a group?

Answered: 39 Skipped: 19



ANSWER CHOICES	RESPONSES	
By myself	23.08%	9
In a group	76.92%	30
TOTAL		39

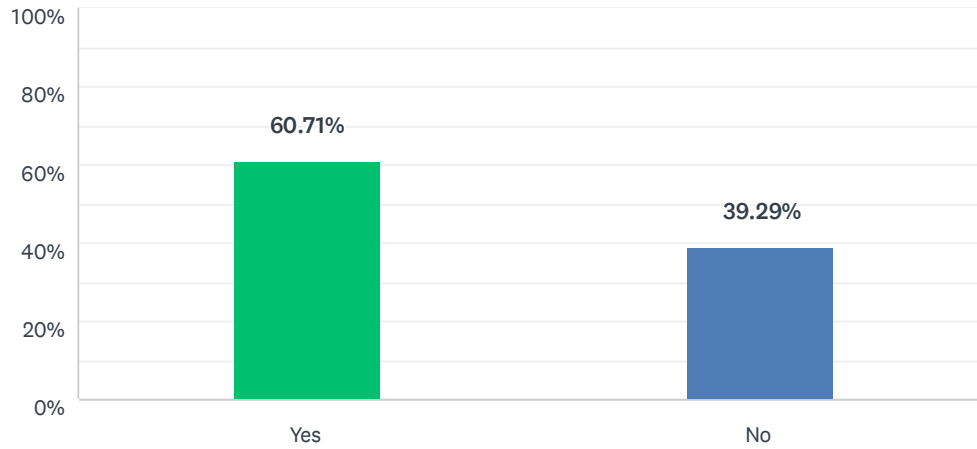
Q12 Please provide any comments about the problem sessions

Answered: 14 Skipped: 44

#	RESPONSES	DATE
1	They were a great opportunity to better understand the new material that was all new, as well as this is where I had the best opportunities to meet others at the workshop.	2/26/2020 10:48 AM
2	I appreciate the time and effort the speakers put in to creating the exercises. Thank you.	2/26/2020 12:49 AM
3	I think it would have been nice to have the lecturers more involved in their problem sessions. For example, during her problem session the next week, Ulrike Tillman did a format that involved working on problems for a bit and then she summarized some things at the board. While the other problem sessions were useful, I think having a bit more contact with the speaker was nice. The TAs were very helpful.	2/19/2020 4:37 PM
4	These were fantastic! Would definitely recommend a similar format for future workshops.	2/19/2020 8:25 AM
5	The problem sessions were great! Both speakers made great problem sets and it worked really well to just join a group and work together.	2/19/2020 2:48 AM
6	I attended the first problem session of each course, during the second ones I was working with a group in a research project.	2/12/2020 9:13 PM
7	These were great for getting something more permanent from the lectures.	2/12/2020 9:34 AM
8	that was the only time with fewer men, so finally some useful math conversations ... the kind that develops only when the competitive/posturing aspect of general math culture is shut out of the room ... which I find often happens when it's women-only	2/11/2020 8:02 PM
9	I think the problem sessions were a unique place to learn and digest the material we heard for an hour and a half. Often at these conferences, the speakers whip through notation and verbiage that I am seeing for the first time, and these problem sessions provided a fantastic opportunity to truly engage with the material. I hope the problem sessions continue in the future.	2/11/2020 1:48 PM
10	Too noisy to concentrate on the problems... picked a partner just based off who I was sitting next to and she worked too fast for me and didn't explain what she was doing well. I felt overwhelmed and embarrassed. Skipped the subsequent problem sessions. I see that they may be very worthwhile for others though	2/11/2020 10:59 AM
11	I attended the first, and skipoed the second to work on other things	2/11/2020 10:11 AM
12	The TAs were very helpful!	2/11/2020 9:46 AM
13	I didn't go so I have not a real answer	2/11/2020 9:46 AM
14	(did not attend)	2/11/2020 9:41 AM

Q13 Did you attend the panel discussion?

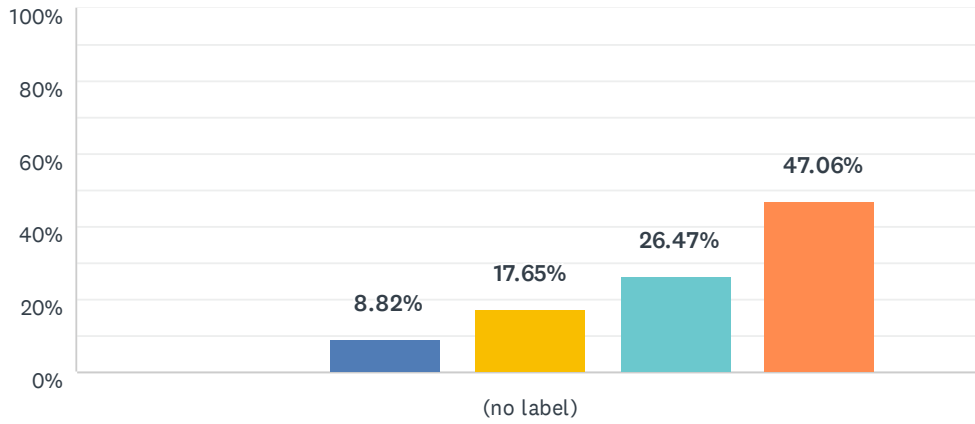
Answered: 56 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	60.71%	34
No	39.29%	22
TOTAL		56

Q14 Did you find the panel discussion worthwhile?

Answered: 34 Skipped: 24



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	8.82%	17.65%	26.47%	47.06%	34	4.12
	0	3	6	9	16		

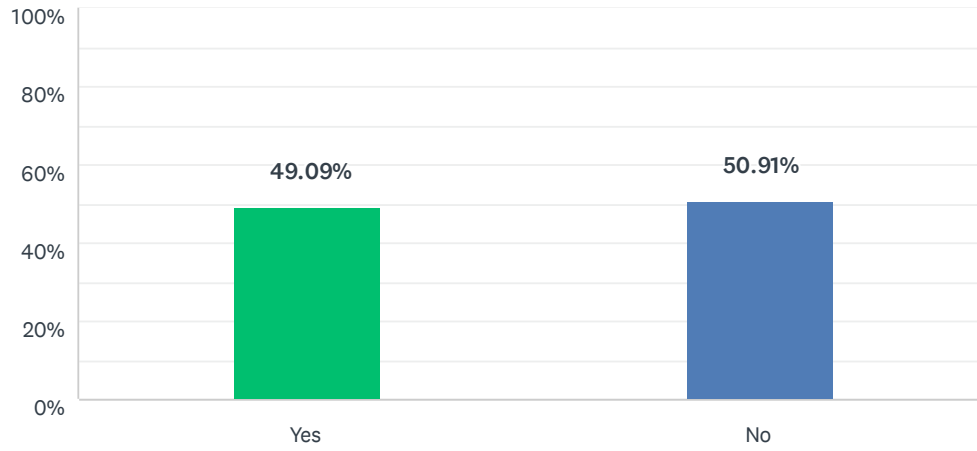
Q15 What other subjects should be discussed in future panel discussions?

Answered: 9 Skipped: 49

#	RESPONSES	DATE
1	How should those not in the group being discussed (in this case men) handle situations to be more inclusive without making anyone uncomfortable? There's difficulty navigating being inclusive without feeling like I'm coming across as overbearing, aggressive, and/or nosy/intrusive	2/25/2020 6:57 AM
2	I like just hearing stories about people's careers and lives, especially from senior women.	2/21/2020 4:32 PM
3	General analysis/thoughts of the situation and fewer anecdotal stories would be more helpful.	2/12/2020 9:15 PM
4	not a safe space with all the senior men with bad diversity track records listening in	2/11/2020 8:03 PM
5	Although I had heard a lot of this advice in the past, it did make me feel that there was more of a sense of community and shared life experience than if the panel had not happened.	2/11/2020 1:49 PM
6	More general advice and fewer specific anecdotal stories?	2/11/2020 10:12 AM
7	I was on the panel so discard the previous rating since it is not appropriate	2/11/2020 10:03 AM
8	More about having a family as a women in academia. More on how we can help everybody feel welcome in academia, what actions can make an impact	2/11/2020 9:48 AM
9	No specific suggestions, but it was nice that the discussion had a theme more specific than "being women in math".	2/11/2020 9:45 AM

Q16 Did you attend the dinner?

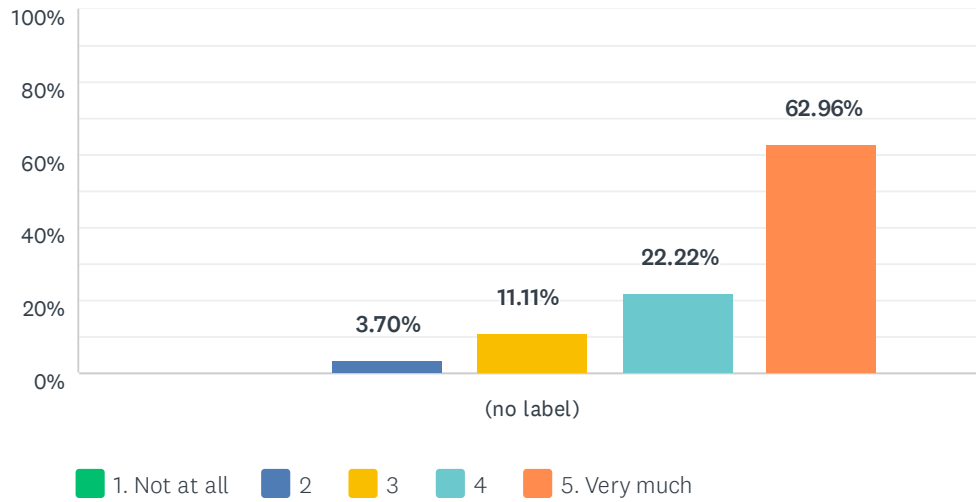
Answered: 55 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	49.09%	27
No	50.91%	28
TOTAL		55

Q17 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 27 Skipped: 31



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.70%	11.11%	22.22%	62.96%	27	4.44
	0	1	3	6	17		

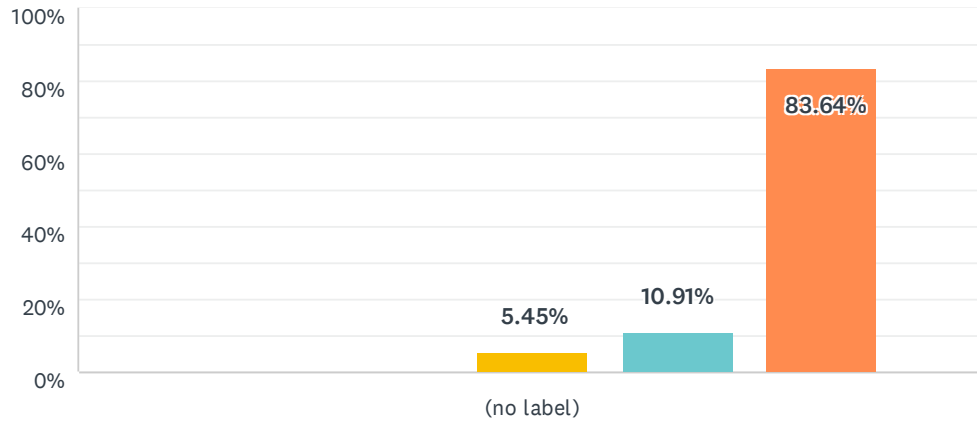
Q18 Please provide any comments about the dinner

Answered: 4 Skipped: 54

#	RESPONSES	DATE
1	Fantastic!	2/26/2020 12:49 AM
2	It was great!	2/19/2020 2:49 AM
3	finally a safe space to have real conversations !!! ... more of that, please !?!	2/11/2020 8:03 PM
4	There were very few options for food	2/11/2020 10:13 AM

Q19 I found the MSRI staff helpful

Answered: 55 Skipped: 3

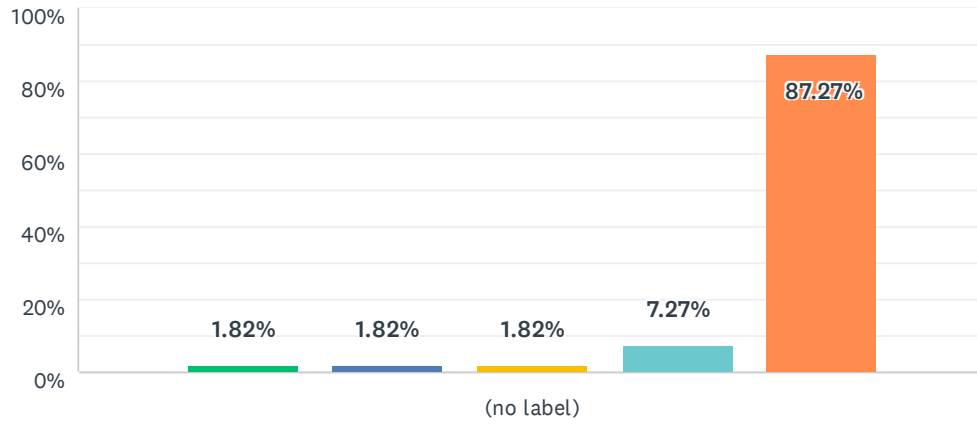


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	5.45%	10.91%	83.64%	55	4.78
	0	0	3	6	46		

Q20 The MSRI facilities were conducive for such a workshop

Answered: 55 Skipped: 3

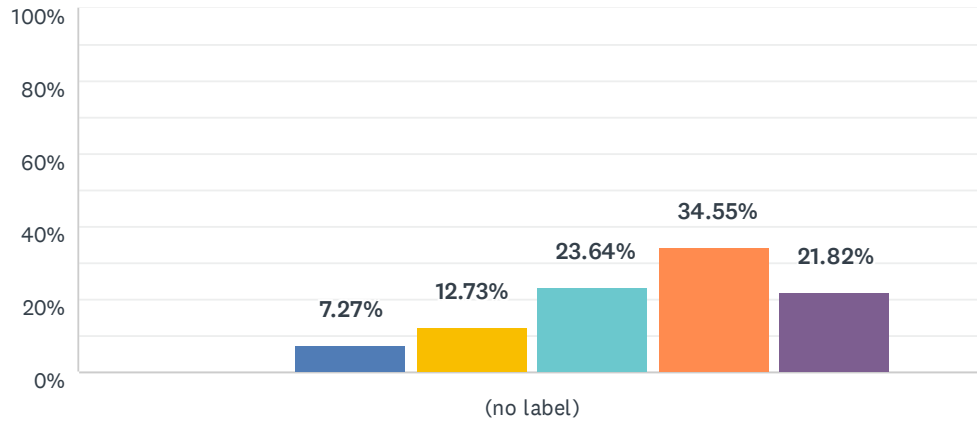


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.82%	1.82%	1.82%	7.27%	87.27%	55	4.76
	1	1	1	4	48		

Q21 The MSRI lunch arrangements were satisfactory

Answered: 55 Skipped: 3

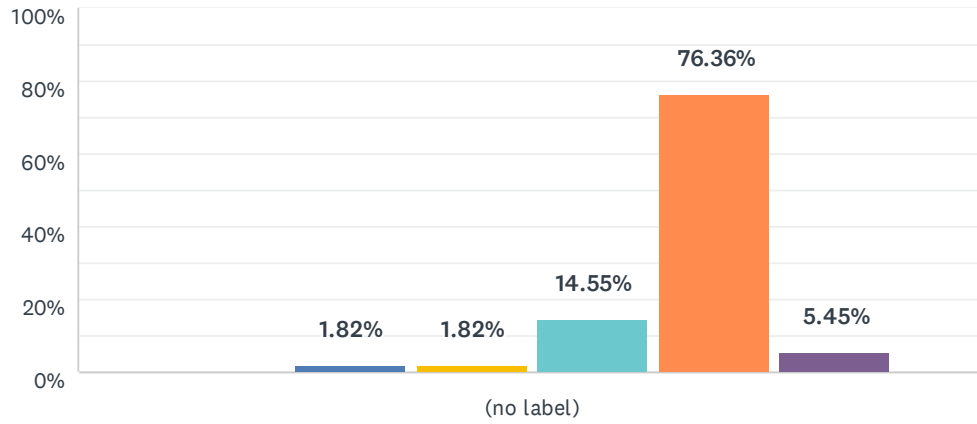


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very
 ■ N/A

	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	7.27%	12.73%	23.64%	34.55%	21.82%		
	0	4	7	13	19	12	55	4.09

Q22 The MSRI tea arrangements were satisfactory

Answered: 55 Skipped: 3



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very
 ■ N/A

	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.82%	1.82%	14.55%	76.36%	5.45%	55	4.75
	0	1	1	8	42	3		

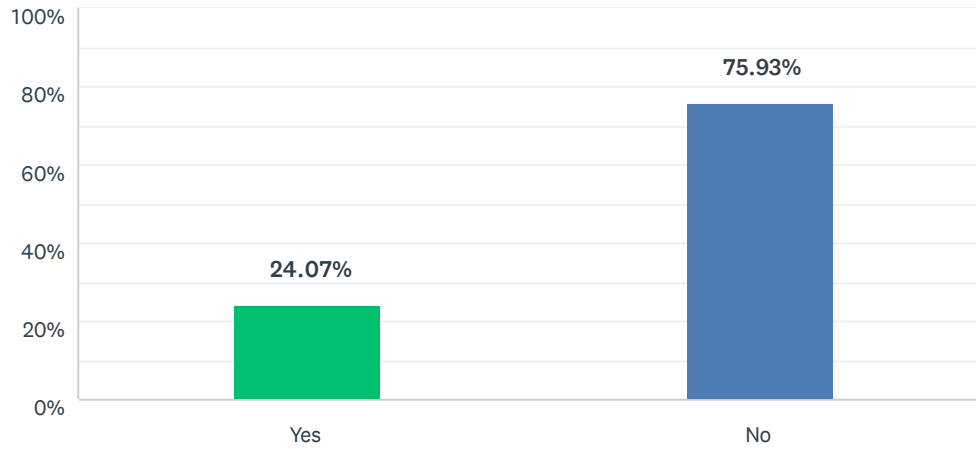
Q23 Additional comments about MSRI staff, facilities and food

Answered: 5 Skipped: 53

#	RESPONSES	DATE
1	I like Stuffed Inn, but the balance of vegetarian offerings could be improved, there was often little choice left, once there was no veggie option left.	2/26/2020 10:46 AM
2	More vegan food options would be appreciated. For instance, vegan food with ample protein.	2/12/2020 9:36 AM
3	The food does get pretty boring after a while .. but I understand the challenge. For an actual "connections for WOMEN" workshop, it would be really helpful to be in a space where it's naturally just women ... so we don't have to have the awfully awkward "no, you're not welcome here - and no, you'll never understand why because you can't see the magic that happens without you" conversations.	2/11/2020 8:06 PM
4	The place is pretty hard to get to, there's scarcity of seats and most importantly of tables	2/11/2020 11:04 AM
5	Bagel day is so much better than packaged pastries day. Could every day be bagel day? Or could bagel day alternate with fresh croissants day? :) The lineup at the food truck is a bit impossible.	2/11/2020 9:48 AM

Q24 Did you use the computer facilities located in the library?

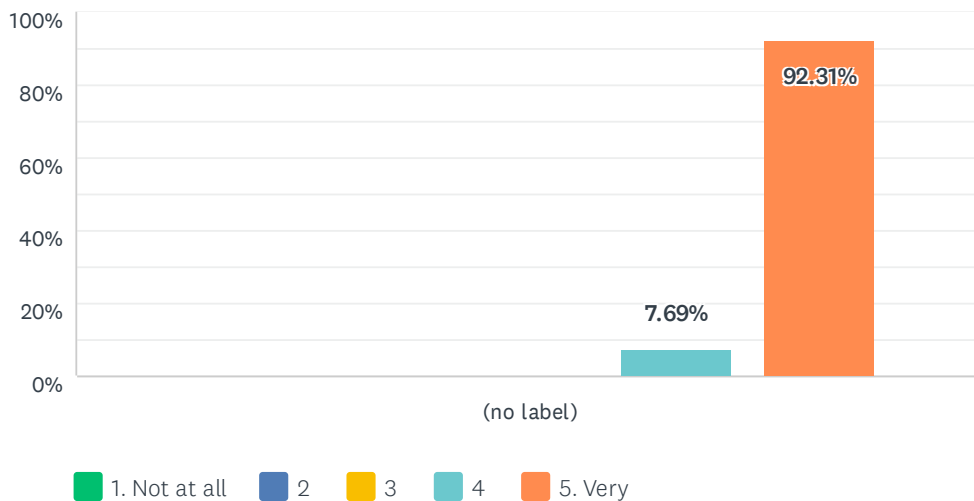
Answered: 54 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	24.07%	13
No	75.93%	41
TOTAL		54

Q25 The MSRI computer facilities in the library were adequate

Answered: 13 Skipped: 45

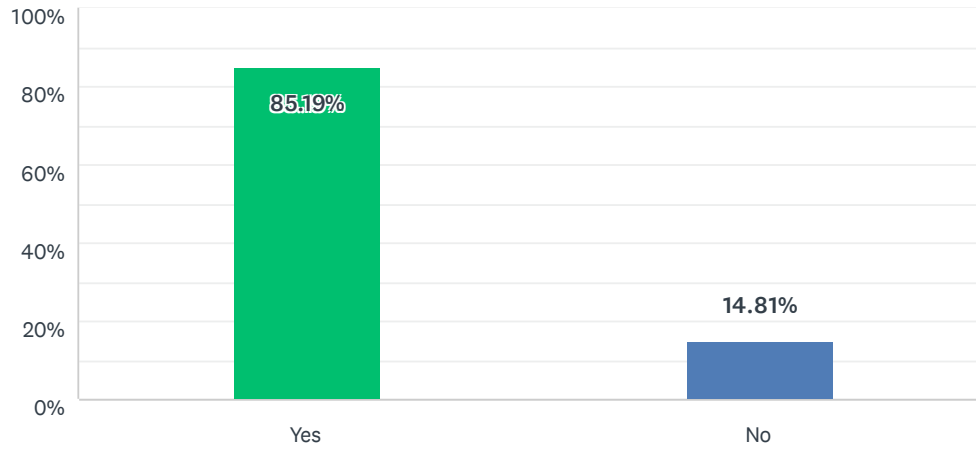


	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	7.69%	92.31%	13	4.92
	0	0	0	1	12		

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	The mouse pads don't stick to the table very well.	2/18/2020 10:53 AM

Q26 Did you use MSRI's wireless network?

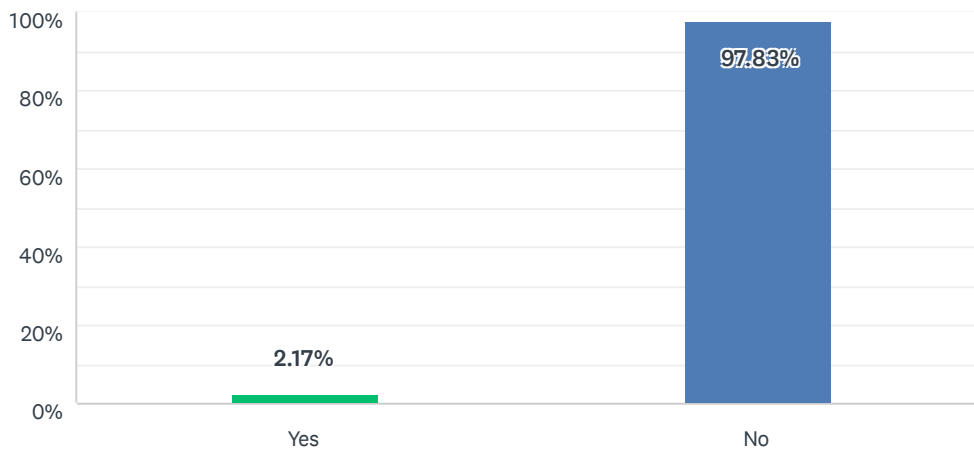
Answered: 54 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	85.19%	46
No	14.81%	8
TOTAL		54

Q27 Did you experience any difficulties with the network?

Answered: 46 Skipped: 12



ANSWER CHOICES	RESPONSES
Yes	2.17% 1
No	97.83% 45
TOTAL	46

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	Network was weak outside Simons Auditorium at times	2/11/2020 10:11 AM

Q28 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 5 Skipped: 53

#	RESPONSES	DATE
1	It was a bit awkward that nowadays the connections for women has very many male participants who also ask many questions.	2/21/2020 4:33 PM
2	Great workshop! The speakers did a wonderful job, and it was very well organized.	2/11/2020 9:54 PM
3	Think about what you're trying to do with these workshops, please! If it's "... FOR WOMEN" ... let's make sure it actually is not just another platform for male posturing?!?	2/11/2020 8:07 PM
4	The 1.5 hour talks were too long to keep steady attention. I would prefer two shorter talks. Also, the entire workshop was 15 minutes behind schedule both days, which was annoying.	2/11/2020 11:02 AM
5	Thank you for running a great workshop!	2/11/2020 9:49 AM

Introductory Workshop: Higher Categories and Categorification

February 10, 2020 - February 14, 2020

MSRI, Berkeley, CA, USA

Organizers:

David Ayala (Montana State University)

Emily Riehl (Johns Hopkins University)

Christopher Schommer-Pries (University of Notre Dame)

Peter Teichner (Max-Planck-Institut für Mathematik)

REPORT ON THE MSRI WORKSHOP

“Introductory Workshop: Higher Categories and Categorification”

February 10 – 14, 2020

Organizers

- David Ayala (Montana State University)
- Emily Riehl (Johns Hopkins University)
- Christopher Schommer-Pries (University of Notre Dame)
- Peter Teichner (Max-Planck-Institut für Mathematik)

Scientific Description

Though many of the ideas in higher category theory find their origins in homotopy theory — for instance as expressed by Grothendieck’s “homotopy hypothesis” — the subject today interacts with a broad spectrum of areas of mathematical research. Unforeseen descent, or local-to-global formulas, for familiar objects can be articulated in terms of higher invertible morphisms. Compatible associative deformations of a sequence of maps of spaces, or derived schemes, can putatively be represented by higher categories, as Koszul duality for E_n -algebras suggests. Higher categories offer unforeseen characterizing universal properties for familiar constructions such as K-theory. Manifold theory is natively connected to higher category theory and adjunction data, a connection that is most famously articulated by the Cobordism Hypothesis.

This workshop surveyed notable developments and applications of higher category theory; it was a venue for end-users to share their vision of how to apply the theory, as well as developers to share technical advancements. The workshop consisted of 6 series, each given by an instrumental end-user or developer of higher category theory. The format of a given series was three 1-hour slots; the first two slots were devoted to lectures, the last hour was devoted to a mix of exercises and lecture. Each lecture series was tailored to a diverse audience, accessible to graduate students and non-expert researchers with some background in homological algebra. Each problem session was designed to catch interest of both experts and non-experts, and a few colleagues to each lecturer volunteered their time as a “TA” to assist groups working through exercises.

Highlights of the Workshop

Tasked with delivering self-contained accessible presentations, the lecturers presented beautifully distilled content that represents their field well.

- Both Catharina Stroppel’s and Aaron Lauda’s lecture series on link invariants and categorification gave novel access to many in the audience whose training is in the field of homotopy theory.
- Nick Rozenblyum’s lecture series offered a tantalizing and conceptual lens into the Geometric Langlands Program.

- Dominic Verity’s lecture series toured through some notoriously abstract notions in a friendly and approachable way, with an especially engaging exercise session over lunch.
- Pavel Safronov’s lecture series focused on approachable and classical instances of the cobordism hypothesis, in dimensions 3 and 4.
- Ulrike Tillmann’s lecture series toured through several standard constructions in homotopy theory and manifold topology in a way that demonstrated the operational practice of such techniques.

For all of these lecture series, MSRI’s video library will certainly be a resource for mathematicians to initiate their engagement with the presented subjects. Two weeks after the workshop, there are more than 200 total views of these lectures.

This workshop’s format was somewhat experimental — notably the exercise sessions. About half of these exercise sessions captured surprise and lasting engagement from many of the participants. For instance, the tables on decks of MSRI’s facilities were dominated by groups of postdocs and graduate students working over notes of the lecture series and their accompanying exercise sets. On several occasions, more senior, or expert, mathematicians joined the enthusiasm by jumping into such discussions, nearly unsolicited, to explain terms or walk through some of the exercises. Also, these exercise sets served to offer an anchor for junior researchers to connect. Now weeks after the event, a couple groups of postdocs have continued their independent inquiries spawned through this workshop: one group continues their discussions about cobordism categories and classifying spaces; another about categorifications of Heisenberg Lie algebras. In these ways, the workshop brought together junior mathematicians in a visibly healthy way. The workshop’s format also lent to experts from somewhat disparate fields connecting in a mathematically substantive way.

Organizers

First Name	Last Name	Institution
David	Ayala	Montana State University
Emily	Riehl	Johns Hopkins University
Christopher	Schommer-Pries	University of Notre Dame
Peter	Teichner	Max-Planck-Institut für Mathematik

Speakers

First Name	Last Name	Institution
Aaron	Lauda	University of Southern California
Nick	Rozenblyum	University of Chicago
Pavel	Safronov	Universität Zürich
Michael	Shulman	University of San Diego
Catharina	Stroppel	Rheinische Friedrich-Wilhelms-Universität Bonn
Ulrike	Tillmann	University of Oxford
Dominic	Verity	Macquarie University

Mathematical Sciences Research Institute

Introductory Workshop: Higher Categories And Categorification

February 10 - 14, 2020

Monday, February 10, 2020

9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Lauda	An introduction to categorification of quantum groups and link invariants - I
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Tillmann	Cobordism categories, classifying spaces and (invertible) TQFTs I
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Safronov	Crane-Yetter TFT, quantum groups and skein modules - I
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Lauda	An introduction to categorification of quantum groups and link invariants - II

Tuesday, February 11, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Tillmann	Cobordism categories, classifying spaces and (invertible) TQFTs II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Lauda	An introduction to categorification of quantum groups and link invariants - III
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Safronov	Crane-Yetter TFT, quantum groups and skein modules - II
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Safronov	Crane-Yetter TFT, quantum groups and skein modules - III
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, February 12, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Stroppel	Categorifications and Lie algebra actions on categories arising from representation theory - I
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Tillmann	Cobordism categories, classifying spaces and (invertible) TQFTs - II

Thursday, February 13, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Stroppel	Categorifications and Lie algebra actions on categories arising from representation theory - II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Stroppel	Categorifications and Lie algebra actions on categories arising from representation theory - III
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Shulman	Internal languages of higher categories - I
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Rozenblyum	Higher categorical traces in geometric representation theory - I

Friday, February 14, 2020

9:30 AM - 10:30 AM	Simons Auditorium	Shulman	Internal languages of higher categories - II
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Shulman	Internal languages of higher categories - III
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Rozenblyum	Higher categorical traces in geometric representation theory - II
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Rozenblyum	Higher categorical traces in geometric representation theory - III



Participants

First Name	Last Name	Institution
Andrew	Adair	University of North Carolina
Sanjana	Agarwal	Indiana University
Ian	Agol	University of California, Berkeley
Nicolás	Andruskiewitsch	Universidad Nacional de Cordoba
Stefano	Ariotta	Westfälische Wilhelms-Universität Münster
David	Ayala	Montana State University
Abhishek	Banerjee	Indian Institute of Science
Clark	Barwick	University of Edinburgh
Luciana	Basualdo Bonatto	University of Oxford
Rekha	Biswal	Max Planck Institute for Mathematics
Jonathan	Block	University of Pennsylvania
Olivia	Borghi	University of Washington
Phillip	Bressie	Spring Hill College
Jennifer	Brown	University of California, Davis
Tim	Campion	University of Notre Dame
Nickolas	Castro	University of Arkansas
Anna	Cepek	Institute for basic science
John	Chae	University of California, Davis
Fei Yu	Chen	University of California, Berkeley
Quan	Chen	Ohio State University
Chang-Yeon	Chough	Institute for basic science
Patrick	Chu	Indiana University
Daniel	Chupin	University of California, Berkeley
Andrew	Conner	Saint Mary's College of California
David	Corwin	University of California, Berkeley
Zsuzsanna	Dancso	University of Sydney
Arun	Debray	University of Texas, Austin
Thibault	Decoppet	University of Oxford
Colleen	Delaney	Indiana University
Zachary	Dell	Ohio State University
David	DeMark	University of Minnesota Twin Cities
Sanath	Devalapurkar	Massachusetts Institute of Technology
Souvik	Dey	University of Kansas
Shanna	Dobson	California State University, at Los Angeles
Christoph	Dorn	University of Oxford
Christopher	Douglas	University of Oxford
Filip	Dul	University of Massachusetts Amherst
Will	Dumm	Montana State University
Cain	Edie-Michell	Vanderbilt University
Inna	Entova-Aizenbud	Ben Gurion University of the Negev
Pavel	Etingof	Massachusetts Institute of Technology
David	Evans	Cardiff University
James	Francese	Texas Tech University
John	Francis	Northwestern University

Participants

First Name	Last Name	Institution
Dan	Freed	University of Texas, Austin
Serap	Gürer	Galatasaray University
Neeti	Gauniyal	Kansas State University
David	Gepner	University of Melbourne
Teena	Gerhardt	Michigan State University
Nicolle	Gonzalez	University of California, Los Angeles
Frederick	Goodman	The University of Iowa
Evgeny	Gorskiy	University of California, Davis
Nick	Gurski	Case Western Reserve University
Philip	Hackney	University of Louisiana--Lafayette
Peter	Haine	Massachusetts Institute of Technology
Rune	Haug seng	Norwegian University of Science and Technology (NTNU)
Matthew	Hedden	Michigan State University
Jacob	Hegna	University of Minnesota
Eivind	Hjelle`	Northwestern University
Renee	Hoekzema	Max-Planck-Institut für Mathematik
Adam	Holeman	Northwestern University
Julian	Holstein	Universität Hamburg
Geoffroy	Horel	Université de Paris XIII (Paris-Nord)
Katerina	Hristova	University of East Anglia
Samuel	Hsu	University of California, Berkeley
Shengyuan	Huang	University of Wisconsin-Madison
Peter	Huston	Ohio State University
Yajit	Jain	Northwestern University
Andy	Jiang	University of Michigan
David	Jordan	University of Edinburgh
Chris	Kapulkin	University of Western Ontario
Eilind	Karlsson	TU München
Liam	Keenan	University of Minnesota, Twin Cities
Grigory	Kondyrev	Northwestern University
Peter	Kristel	Ernst-Moritz-Arndt-Universität Greifswald
Malte	Kunath	Ernst-Moritz-Arndt-Universität Greifswald
Christopher	Kuo	University of California, Berkeley
Namhee	Kwon	Daegu University
Edoardo	Lanari	Czech Academy of Sciences (AVCR)
Genta	Latifi	University of Zurich
Aaron	Lauda	University of Southern California
Cailan	Li	Columbia University
Chen-wei	Lin	University of Melbourne
John	Lind	California State University
Larsen	Linov	University of California, Berkeley
Yun	Liu	Cornell University
Muriel	Livernet	Institut de Mathematiques de Jussieu
Yuki	Maehara	Macquarie University

Participants

First Name	Last Name	Institution
Roy	Magen	Columbia University
Martin	Markl	Czech Academy of Sciences (AVCR)
Aaron	Mazel-Gee	University of Southern California
Jonas	McCandless	Westfälische Wilhelms-Universität Münster
Alex	McCleary	Colorado State University
Calvin	McPhail-Snyder	University of California, Berkeley
Lennart	Meier	Universiteit Utrecht
Benjamin	Moldstad	Montana State University
Scott	Morrison	Australian National University
Lyne	Moser	École Polytechnique Fédérale de Lausanne (EPFL)
Laura	Murray	University of Notre Dame
Ian	Musson	University of Wisconsin
David	Nadler	University of California, Berkeley
Cris	Negron	University of North Carolina
Siu-Hung	Ng	Louisiana State University
Anh Tuong	Nguyen	University of Illinois at Urbana-Champaign
Dmitri	Nikshych	University of New Hampshire
Pablo	Ocal	Texas A & M University
Morgan	Opie	Harvard University
Sebastian	Ørsted	Aarhus University
Viktoriya	Ozornova	Ruhr-Universität Bochum
Simona	Paoli	University of Leicester
Amit	Patel	Colorado State University
Dmitri	Pavlov	Texas Tech University
Maximilien	Peroux	University of Illinois at Chicago
Emily	Peters	Loyola University
Julia	Plavnik	Indiana University
Eugene	Rabinovich	University of California, Berkeley
Arun	Ram	University of Melbourne
David	Reutter	Max-Planck-Institut für Mathematik
Emily	Riehl	Johns Hopkins University
Noah	Riggenbach	Indiana University
Marcy	Robertson	University of Melbourne
Christopher	Rogers	University of Nevada
Martina	Rovelli	Australian National University
Eric	Rowell	Texas A & M University
Nick	Rozenblyum	University of Chicago
Pavel	Safronov	Universität Zürich
Alberto	San Miguel Malana	University of Texas, Austin
Sean	Sanford	Indiana University
Cecily	Santiago	University of Minnesota Twin Cities
Maru	Sarazola	Cornell University
Tomer	Schlank	The Hebrew University of Jerusalem
Christopher	Schommer-Pries	University of Notre Dame

Participants

First Name	Last Name	Institution
Iuliia	Semikina	Hausdorff Research Institute for Mathematics, University of Bonn
Jay	Shah	University of Notre Dame
Brandon	Shapiro	Cornell University
Amit	Sharma	Kent State University
Michael	Shulman	University of San Diego
Saad	Slaoui	University of Texas, Austin
Stephan	Snegirov	Northwestern University
Noah	Snyder	Indiana University
Kursat	Sozer	Indiana University
Martin	Speirs	University of California, Berkeley
Toby	Stafford	University of Manchester
Luuk	Stehouwer	Max-Planck-Institut für Mathematik
Jan	Steinebrunner	University of Oxford
Peter	Teichner	Max-Planck-Institut für Mathematik
James	Tener	Australian National University
Ulrike	Tillmann	University of Oxford
Scott	Tilton	Montana State University
Guillermo	Tochi	Northwestern University
Monica	Vazirani	University of California, Davis
Siddharth	Venkatesh	University of California, Los Angeles
Paula	Verdugo	Macquarie University
Dominic	Verity	Macquarie University
Kevin	Walker	Microsoft Research Station Q
Chelsea	Walton	University of Illinois at Urbana-Champaign
Luya	Wang	University of California, Berkeley
Paul	Wedrich	Max-Planck-Institut für Mathematik
Katrin	Wehrheim	University of California, Berkeley
Christoph	Weis	University of Oxford
Brian	Williams	Northeastern University
Harshit	Yadav	University of Illinois at Urbana-Champaign
Maria	Yakerson	Universität Regensburg
Lucy	Yang	Harvard University
haiping	yang	University of Southern California
Sarah	Yeakel	MSRI - Mathematical Sciences Research Institute
David	Yetter	Kansas State University
Qing	Zhang	Texas A & M University
Jieru	Zhu	University at Buffalo (SUNY)

Officially Registered Participants Information

Participants		169
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Gender		169
Male	72.19%	122
Female	25.44%	43
Declined to state	1.78%	3
Other/Non-Binary	0.59%	1

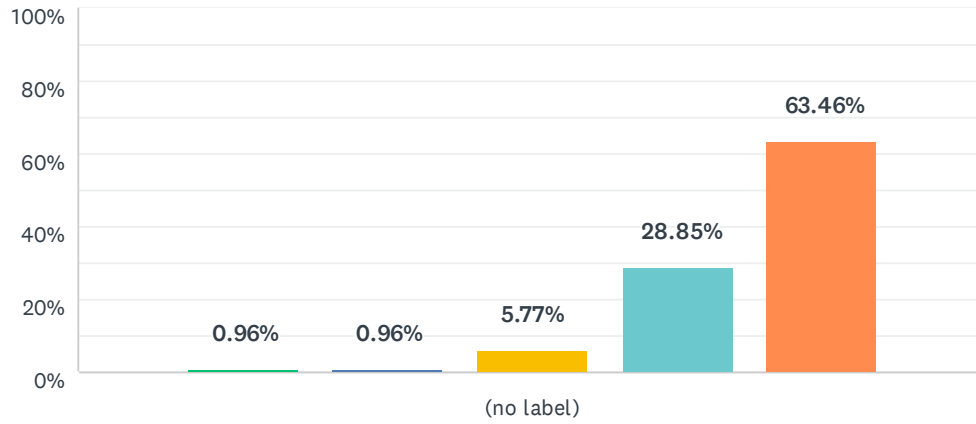
Ethnicity*		193
White	61.14%	118
Asian	18.65%	36
Hispanic	6.22%	12
Pacific Islander	0.00%	0
Black	1.04%	2
Native American	1.04%	2
Mixed	5.70%	11
Declined to state	6.22%	12

* ethnicity specifications are not exclusive

104 responses out of 169 participants = 62% response rate

Q1 The workshop was intellectually stimulating

Answered: 104 Skipped: 0

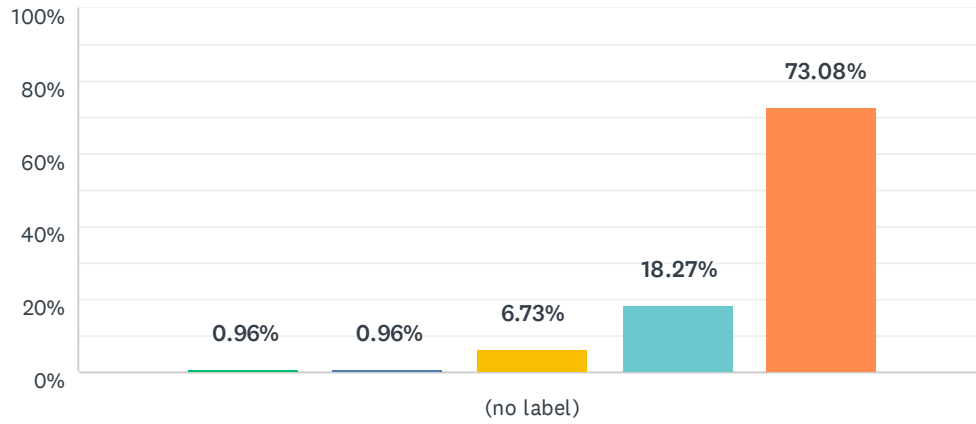


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.96%	0.96%	5.77%	28.85%	63.46%	104	4.53
	1	1	6	30	66		

Q2 The overall experience of the workshop was worthwhile

Answered: 104 Skipped: 0

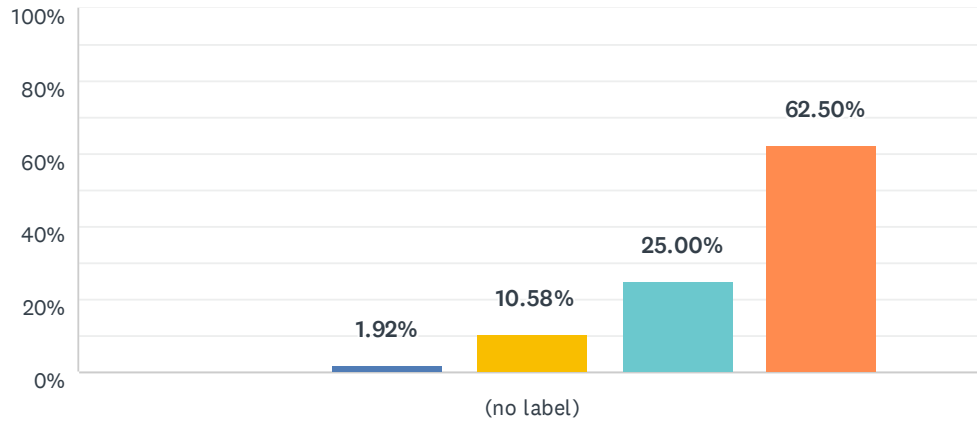


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.96%	0.96%	6.73%	18.27%	73.08%	104	4.62
	1	1	7	19	76		

Q3 The time between lectures was adequate for discussion

Answered: 104 Skipped: 0

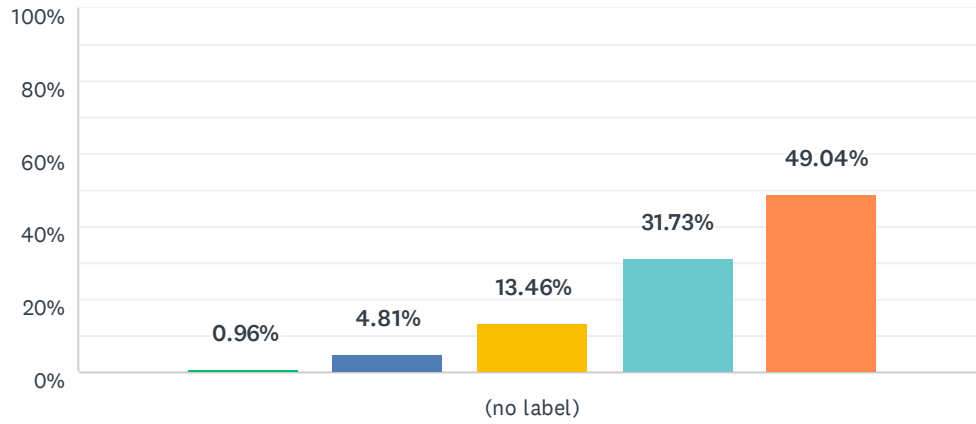


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.92% 2	10.58% 11	25.00% 26	62.50% 65	104	4.48

Q4 The lectures were at an appropriate level

Answered: 104 Skipped: 0



1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.96%	4.81%	13.46%	31.73%	49.04%	104	4.23
	1	5	14	33	51		

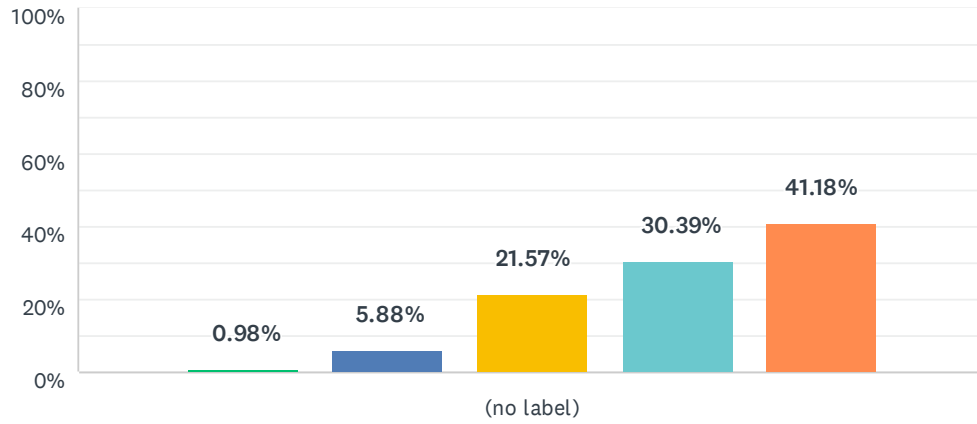
Q5 Additional comments

Answered: 18 Skipped: 86

#	RESPONSES	DATE
1	I learned so much from talking to people there! It was great!	3/3/2020 10:57 AM
2	Some of the last lectures were a beyond my scope, but they were probably good for others that had a better grasp of the material.	2/26/2020 10:51 AM
3	The organizers did an amazing job of fusing together the two themes of the MSRI semesters.	2/24/2020 3:59 PM
4	I've been at few conferences that have made such an effort to be genuinely accessible and introductory.	2/24/2020 1:57 PM
5	It's an excellent idea! The selection of lecturers is of course key.	2/24/2020 1:40 PM
6	It was so great you allowed me to join even after the funding application deadline. The workshop was great. I highly appreciated the exercises and that lectures were recorded, both are very helpful for diving into the subject. Thank you!	2/24/2020 12:47 PM
7	Some of the speakers took the "introductory" in the title of the workshop seriously, but some did not and those talks were bad.	2/20/2020 9:54 AM
8	a few lectures were "introductory" ... but even those often got derailed into private conversation with a few (often just 1) specialists in the audience	2/19/2020 11:14 AM
9	I am not an expert on the subject and I didn't go to all the talks, but still I found it stimulating. Thank you.	2/19/2020 10:00 AM
10	The problem sessions were a great format!	2/19/2020 8:11 AM
11	I was hoping this workshop would be an introduction to higher category theory. In all the talks, a working knowledge of higher category theory was assumed. This was really a workshop on applications of higher category theory to representation theory. For me, this was a big waste of time and resources.	2/19/2020 7:31 AM
12	For the introductory workshop everyone gauged the level well apart from the last speaker (Nick Rozenblyum) which for me at least gave a bit too complicated talks. The concept with problem sessions were great and I really appreciated the effort many of the speakers put into the problem sheets. I'll definitely spend more time on what I didn't finish at MSRI!	2/19/2020 1:39 AM
13	*Most* of the lectures were at an appropriate level. There were, however exceptions (notably Rozenblyum). Future organizers should give their speakers for an introductory workshop a better sense of the likely background of the audience than seems to have been done for the hapless Prof. Rozenblyum -- whose talks might well have been fine for a different audience.	2/18/2020 1:33 PM
14	It felt like the most of the lectures had no coherent target audience in mind. It would have been nice to see the various subject areas described in terms of higher categories (with the relevant categorical structures introduced) to facilitate interaction between the subject area and category theory. Instead most of the talks involved very little category theory and at times seemed to intentionally avoid describing higher categorical content, focusing rather on advanced material in the subject area itself that a lot of the audience wasn't comfortable with and couldn't follow.	2/18/2020 12:41 PM
15	Lecturers seemed to have very different ideas about what an appropriate level was.	2/18/2020 12:13 PM
16	As an outsider to most of the topics I definitely enjoyed the workshop	2/18/2020 11:11 AM
17	Some material presented was too old (over 20 years old). Modern results by David Ayala and Chris Schommer-Pries should have been presented.	2/18/2020 10:34 AM
18	Thanks a lot for organizing it! I liked the idea of having several minicourses instead of all talks being separate.	2/18/2020 10:32 AM

Q6 I was well prepared to benefit from the lectures

Answered: 102 Skipped: 2

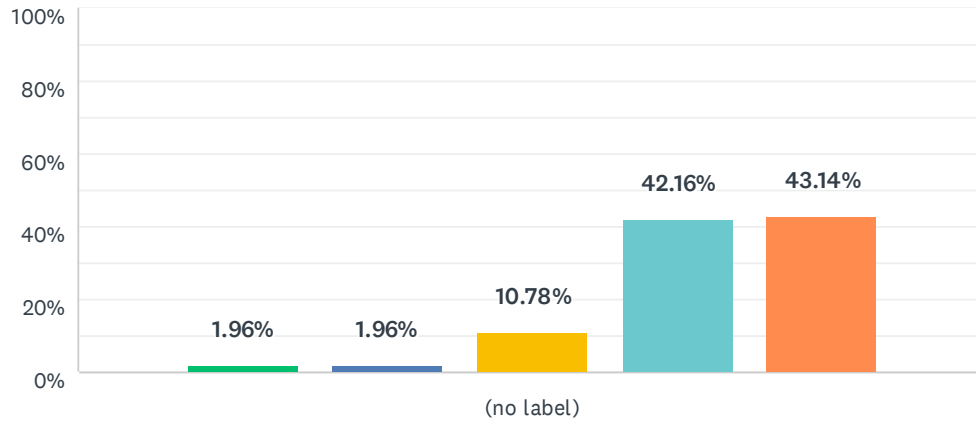


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.98%	5.88%	21.57%	30.39%	41.18%	102	4.05
	1	6	22	31	42		

Q7 My interest in the subject matter was increased by the workshop

Answered: 102 Skipped: 2

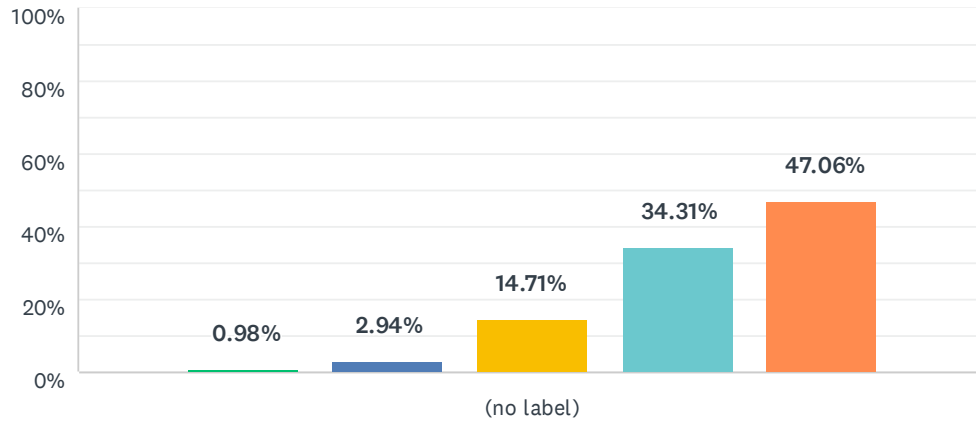


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.96%	1.96%	10.78%	42.16%	43.14%	102	4.23
	2	2	11	43	44		

Q8 The workshop helped me meet people with similar scientific interests

Answered: 102 Skipped: 2



■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very Much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.98%	2.94%	14.71%	34.31%	47.06%		
	1	3	15	35	48	102	4.24

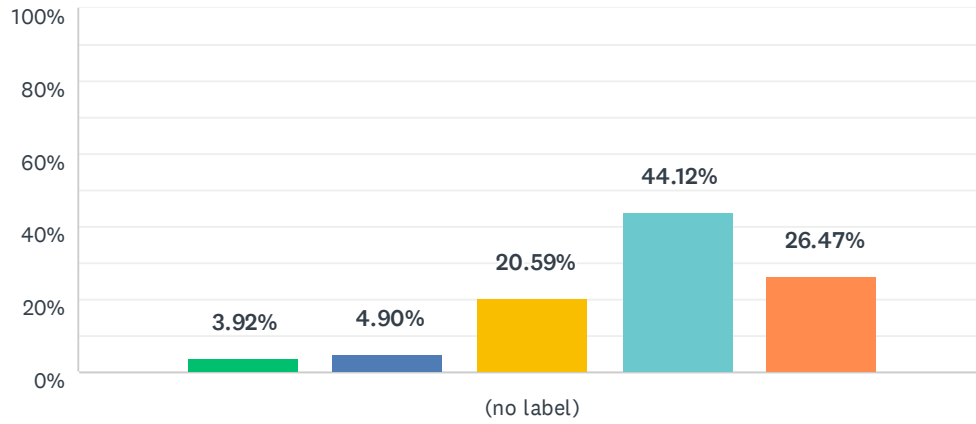
Q9 Additional comments on your personal assessment

Answered: 4 Skipped: 100

#	RESPONSES	DATE
1	As with most workshops, the opportunity to talk to many different researchers was of greater value than the actual talks.	2/20/2020 9:55 AM
2	Replacing som talks with problem/exercise sessions was lame from the point of view was not useful to me, but then again, I'm senior enough to have too many problems of my own to work on. If, however, it was well liked by many of the respondents (presumably the more junior, who are interested in finding problem) it should be encouraged in the future. If, on the other hand, enough respondents indicated disliking it that this plainly includes many more junior participants, future organizers should be discouraged from repeating this practice.	2/18/2020 1:37 PM
3	I had a very nice time and would definitely go again.	2/18/2020 12:42 PM
4	The workshop was not quite on my subject, so I was happy to meet people from other areas and discuss mathematics productively together.	2/18/2020 10:33 AM

Q10 gaining some purchase, or ownership, over the material?

Answered: 102 Skipped: 2

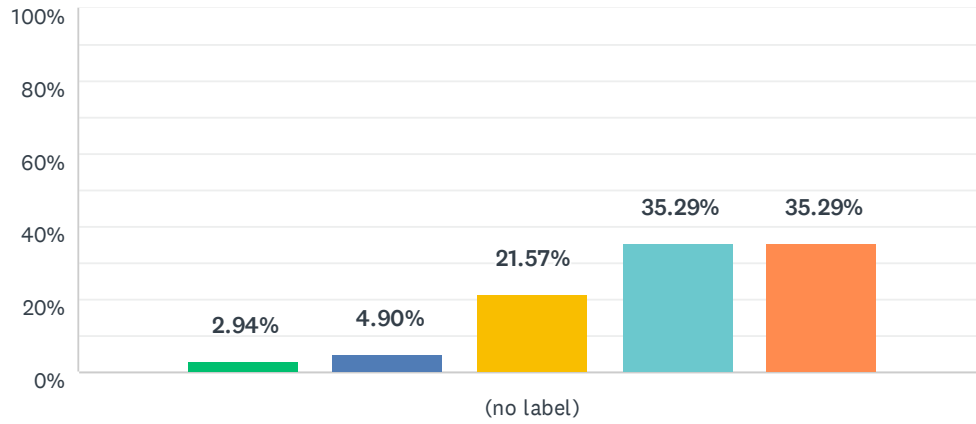


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.92%	4.90%	20.59%	44.12%	26.47%	102	3.84
	4	5	21	45	27		

Q11 connecting with colleagues?

Answered: 102 Skipped: 2

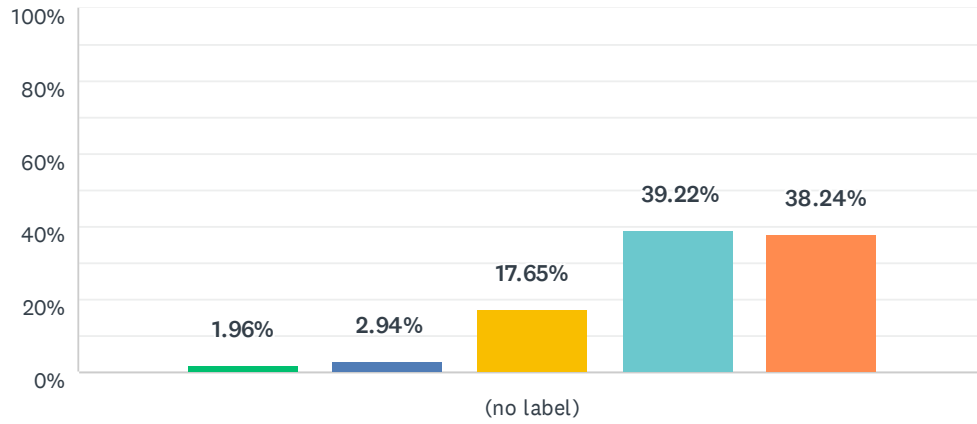


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	2.94%	4.90%	21.57%	35.29%	35.29%	102	3.95
	3	5	22	36	36		

Q12 increasing your interest in the subject matter?

Answered: 102 Skipped: 2

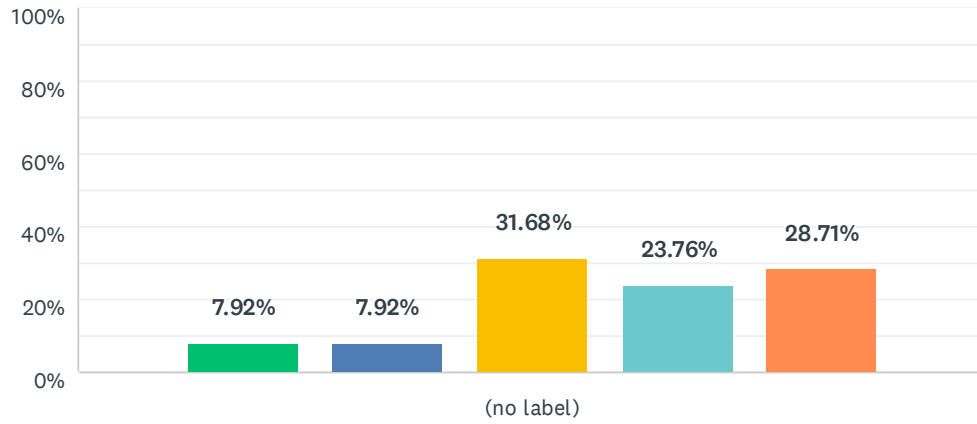


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.96%	2.94%	17.65%	39.22%	38.24%		
	2	3	18	40	39	102	4.09

Q13 gaining purchase over the material?

Answered: 101 Skipped: 3

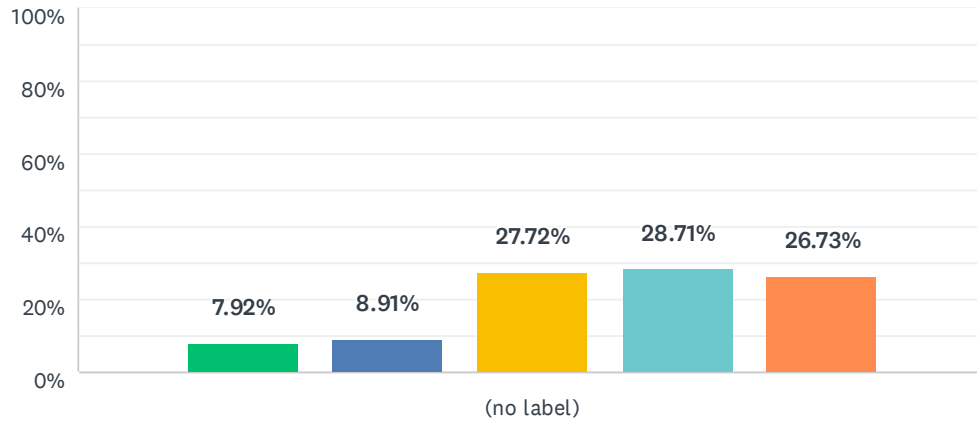


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	7.92% 8	7.92% 8	31.68% 32	23.76% 24	28.71% 29	101	3.57

Q14 connecting with colleagues?

Answered: 101 Skipped: 3

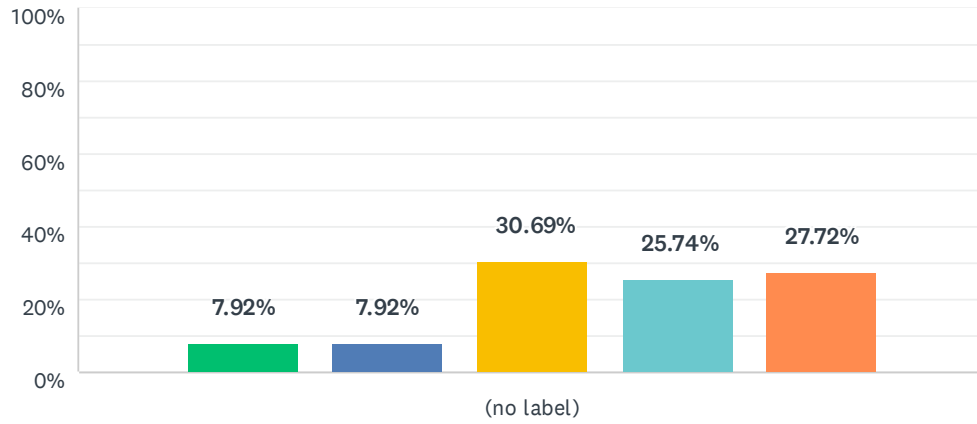


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	7.92%	8.91%	27.72%	28.71%	26.73%	101	3.57
	8	9	28	29	27		

Q15 increasing your interest in the subject matter?

Answered: 101 Skipped: 3

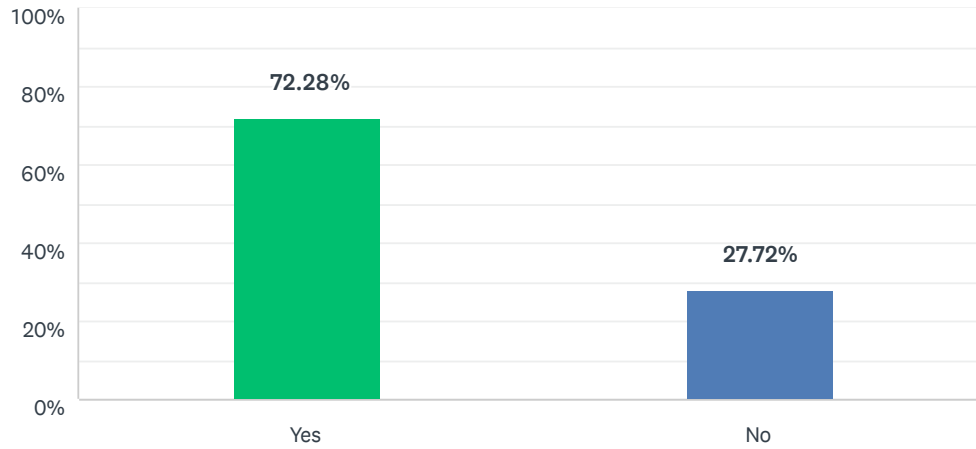


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	7.92% 8	7.92% 8	30.69% 31	25.74% 26	27.72% 28	101	3.57

Q16 Did you attend the reception?

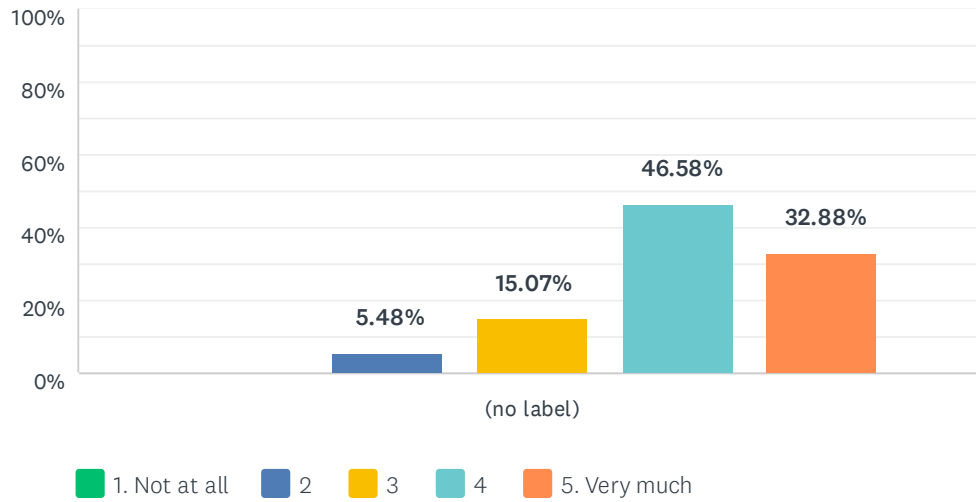
Answered: 101 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	72.28%	73
No	27.72%	28
TOTAL		101

Q17 Did the reception help to solidify the contacts you made during the workshop?

Answered: 73 Skipped: 31



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.48%	15.07%	46.58%	32.88%	73	4.07
	0	4	11	34	24		

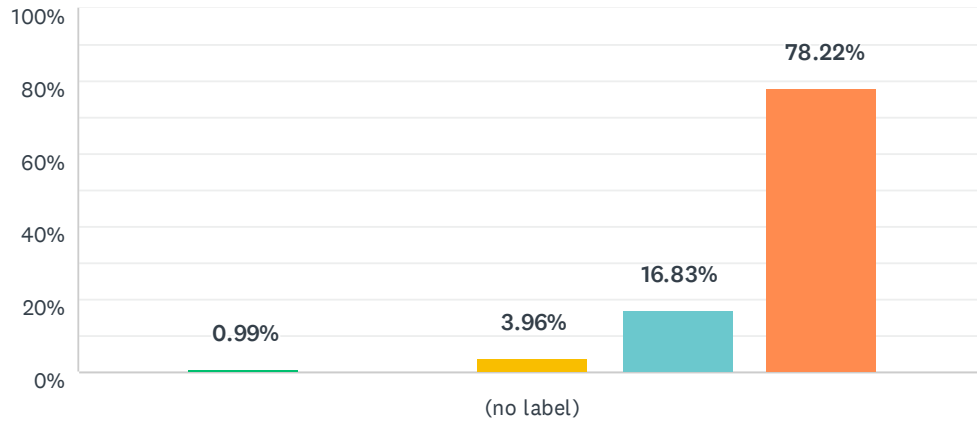
Q18 Please provide any comments about the reception

Answered: 3 Skipped: 101

#	RESPONSES	DATE
1	It definitely gave an opportunity to talk to people in a more relaxed atmosphere that just in between the lectures.	2/24/2020 12:49 PM
2	While I attended the reception, I arrived late, as I was working with a colleague who was only at MSRI for the workshop until it was well under way, so not much attention should be paid the my low rating on the question. (Though the food and wine were good.)	2/18/2020 1:39 PM
3	It was lovely	2/18/2020 12:45 PM

Q19 I found the MSRI staff helpful

Answered: 101 Skipped: 3

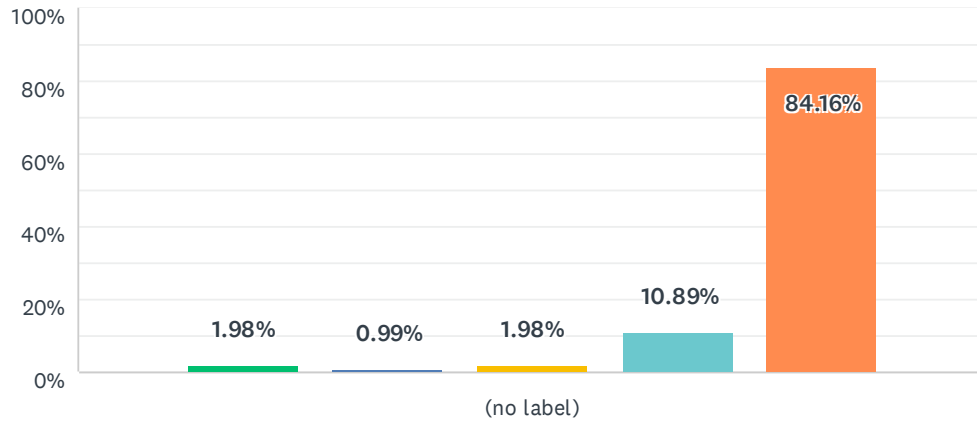


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.99%	0.00%	3.96%	16.83%	78.22%	101	4.71
	1	0	4	17	79		

Q20 The MSRI facilities were conducive for such a workshop

Answered: 101 Skipped: 3

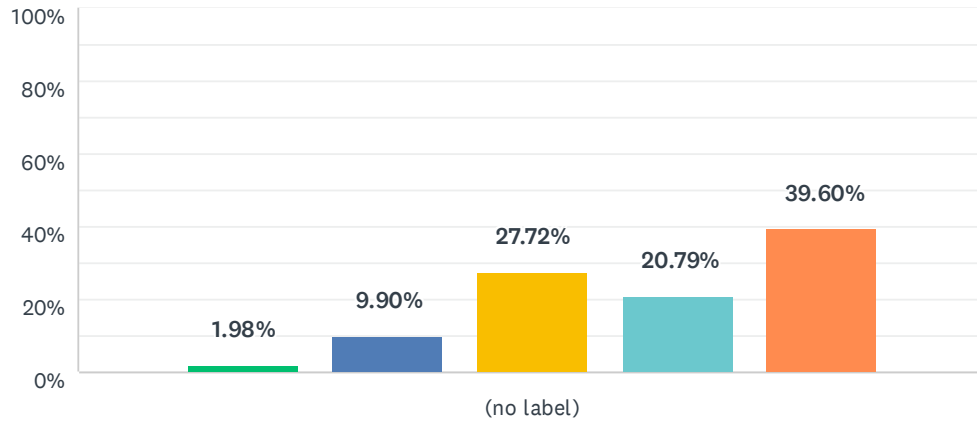


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.98%	0.99%	1.98%	10.89%	84.16%		
	2	1	2	11	85	101	4.74

Q21 The MSRI lunch arrangements were satisfactory

Answered: 101 Skipped: 3

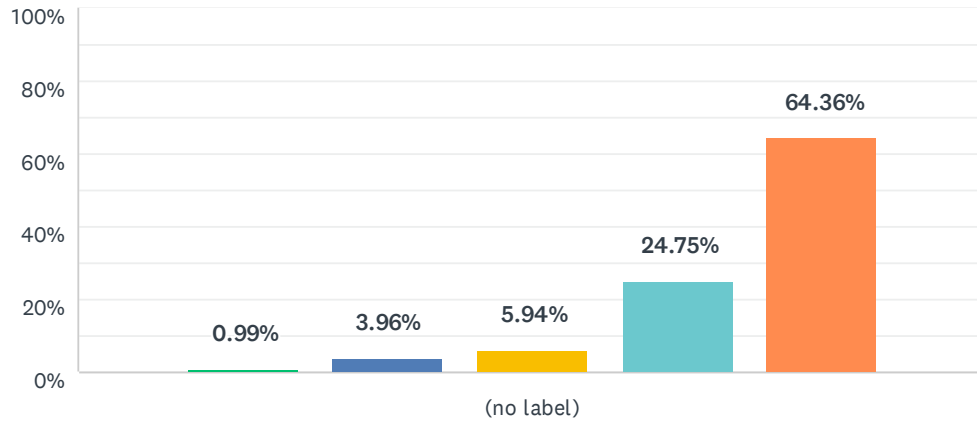


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.98%	9.90%	27.72%	20.79%	39.60%	101	3.86
	2	10	28	21	40		

Q22 The MSRI tea arrangements were satisfactory

Answered: 101 Skipped: 3

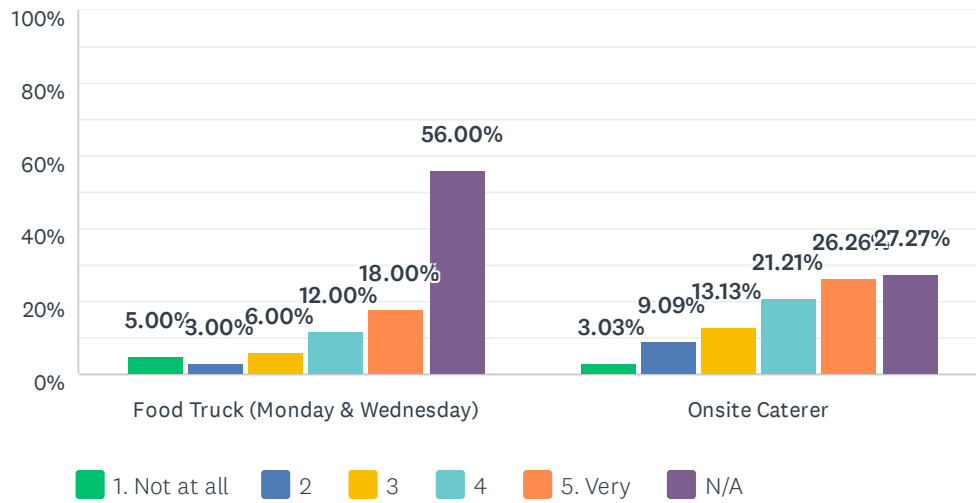


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.99%	3.96%	5.94%	24.75%	64.36%	101	4.48
	1	4	6	25	65		

Q23 I found the food from the following vendors satisfactory:

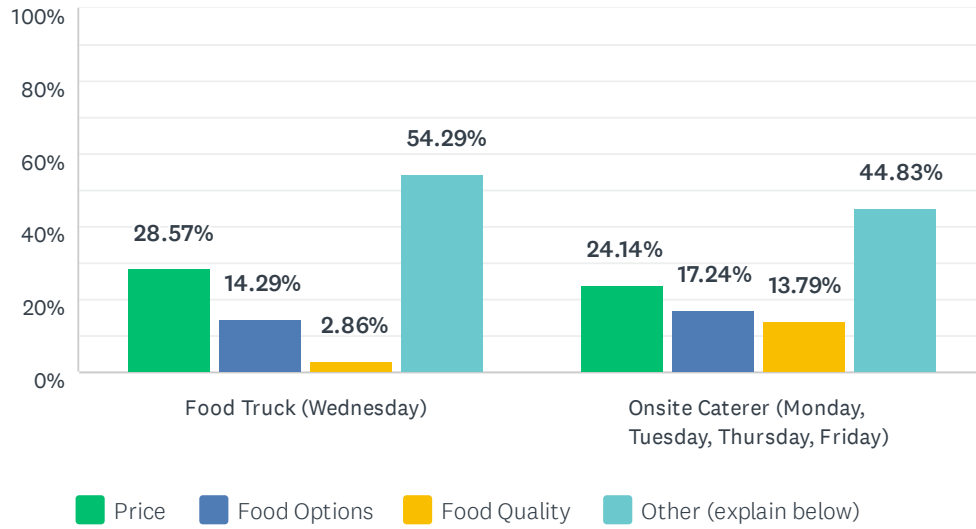
Answered: 101 Skipped: 3



	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL
Food Truck (Monday & Wednesday)	5.00% 5	3.00% 3	6.00% 6	12.00% 12	18.00% 18	56.00% 56	100
Onsite Caterer	3.03% 3	9.09% 9	13.13% 13	21.21% 21	26.26% 26	27.27% 27	99

Q24 I did NOT purchase from the following vendors because:

Answered: 42 Skipped: 62



	PRICE	FOOD OPTIONS	FOOD QUALITY	OTHER (EXPLAIN BELOW)	TOTAL
Food Truck (Wednesday)	28.57% 10	14.29% 5	2.86% 1	54.29% 19	35
Onsite Caterer (Monday, Tuesday, Thursday, Friday)	24.14% 7	17.24% 5	13.79% 4	44.83% 13	29

908 - Introductory Workshop: Higher Categories and Categorification - Participant Survey

#	OTHER (PLEASE SPECIFY)	DATE
1	brought my own food	3/3/2020 11:38 PM
2	Being vegan, I pack my own lunch.	3/3/2020 9:35 AM
3	I had to go down the hill anyway so I got lunch there	3/3/2020 9:16 AM
4	Didn't even know there was a food truck	2/26/2020 10:52 AM
5	I decided to bring my own lunch	2/21/2020 4:30 PM
6	Bring my own	2/20/2020 1:50 PM
7	I bring my own food as usual	2/19/2020 4:38 PM
8	special diet	2/19/2020 11:16 AM
9	purchased elsewhere	2/19/2020 8:12 AM
10	Prefer to bring my own lunch	2/19/2020 2:12 AM
11	preferred to bring my own food	2/18/2020 9:48 PM
12	brought my own food	2/18/2020 8:32 PM
13	Went elsewhere for lunch.	2/18/2020 3:43 PM
14	Let MSRI after the last Wed. talk to find mor food options.	2/18/2020 1:43 PM
15	brought my own lunch; but I like this caterer	2/18/2020 12:54 PM
16	Missed that meal	2/18/2020 11:36 AM
17	Skipped lunch	2/18/2020 11:28 AM
18	Like my own food	2/18/2020 11:27 AM
19	Went off-campus at lunch since the proceedings ended at noon.	2/18/2020 11:16 AM
20	Vegetarian and vegan options were rather limited, which prevented multiple participants including myself from purchasing lunch onsite.	2/18/2020 10:48 AM
21	re #21, I brought my own lunch every day. My response should be "N/A" but that is not an option	2/18/2020 10:12 AM

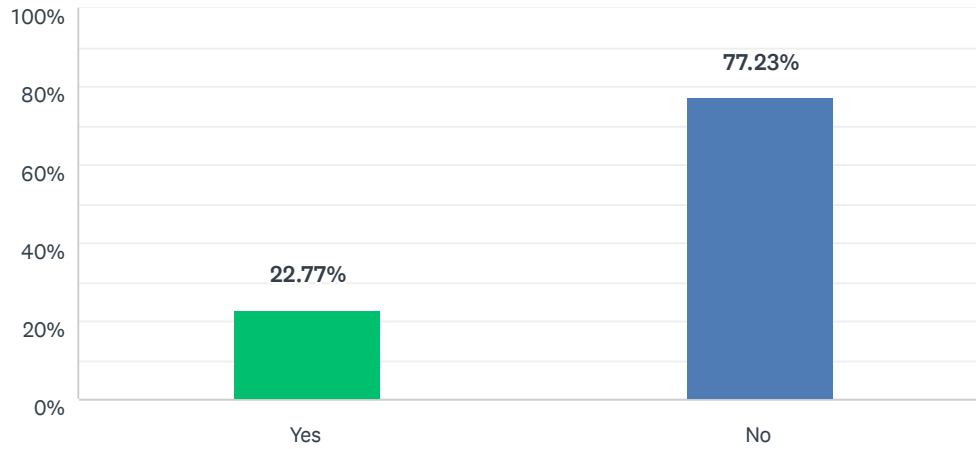
Q25 Additional comments about the MSRI staff, facilities and food

Answered: 15 Skipped: 89

#	RESPONSES	DATE
1	There were very few vegan options at lunch	2/29/2020 6:02 PM
2	Would be good not to have the same sandwiches every day, especially when there are conferences two weeks in a row.	2/26/2020 10:41 AM
3	Afternoon tea was lovely. But the lines were long and slow. Perhaps if the cheese were at the end and not the beginning, lines would have moved faster, as people were very slow to cut it-- but very fast in just picking up a spoon of nuts or piece of fruit. Yes cheese was at the start and fruit/nuts at the end.	2/26/2020 12:46 AM
4	I'm vegan. The vegan options often ran out quickly.	2/24/2020 2:00 PM
5	I found it much more convenient for me to bring my own food, it was cheaper and much more suitable for my needs. I don't think that the caterer was bad, since anyway bringing my own food would be a priority for me	2/24/2020 12:51 PM
6	It would be better to have a free lunch buffet during conferences.	2/21/2020 4:30 PM
7	Coffee ran out a lot.	2/20/2020 9:56 AM
8	The staff and facilities are great. It would be nice to have more vegan options (and more volume of the vegan options already offered) at the morning and afternoon teas.	2/18/2020 1:43 PM
9	Question "21. The MSRI lunch arrangements were satisfactory" should have an "N/A" option	2/18/2020 1:08 PM
10	Onsite caterer has good quality food, but not a lot of variation. The food truck is a nice way to spice this up. Prices are on the high side, but workable.	2/18/2020 12:54 PM
11	The staff was, as always, fantastic.	2/18/2020 11:28 AM
12	Lines for tea breaks too long to get anything between talks	2/18/2020 11:20 AM
13	vegetarian/vegan options would occasionally run out.	2/18/2020 10:56 AM
14	Please hire better caterers for lunch. Berkeley has a huge variety of affordable caterers. They can serve much better food than some pathetic sandwiches and salads.	2/18/2020 10:36 AM
15	The MSRI doesn't really have the best facilities for the exercise sessions	2/18/2020 10:28 AM

Q26 Did you use the computer facilities located in the library?

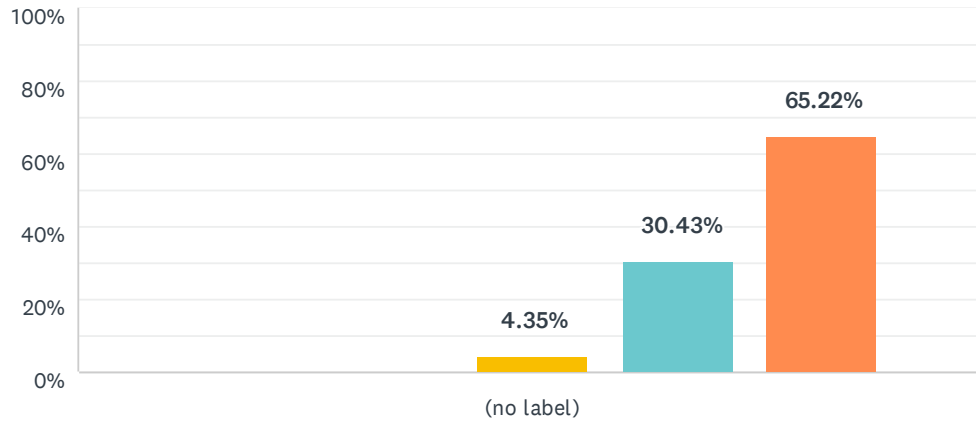
Answered: 101 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	22.77%	23
No	77.23%	78
TOTAL		101

Q27 The MSRI computer facilities in the library were adequate

Answered: 23 Skipped: 81



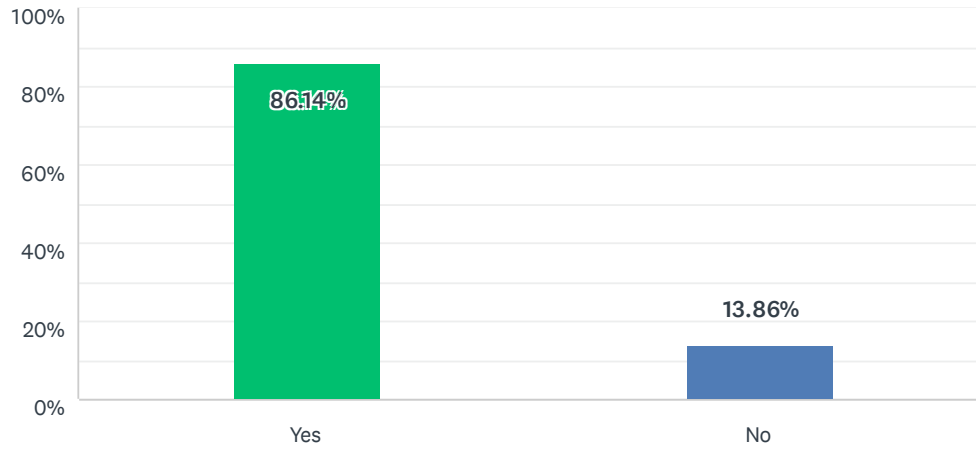
■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.35%	30.43%	65.22%	23	4.61
	0	0	1	7	15		

#	COMMENTS ABOUT COMPUTER FACILITIES	DATE
1	It would be helpful to allow color printing.	2/24/2020 2:00 PM
2	I could not find windows after minimizing them on the particular machine I was using.	2/20/2020 10:58 AM
3	The mouse pads don't stick to the table very well.	2/18/2020 10:57 AM

Q28 Did you use MSRI's wireless network?

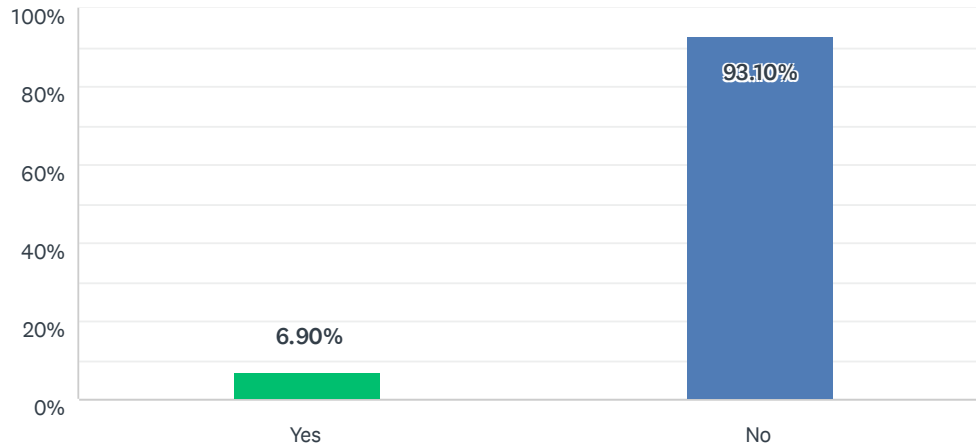
Answered: 101 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	86.14%	87
No	13.86%	14
TOTAL		101

Q29 Did you experience any difficulties with the network?

Answered: 87 Skipped: 17



ANSWER CHOICES	RESPONSES	
Yes	6.90%	6
No	93.10%	81
TOTAL		87

#	PLEASE IF YES, PLEASE DESCRIBE YOUR DIFFICULTIES	DATE
1	only during/just before lectures in which the lecture hall was packed to the brim	3/5/2020 2:50 PM
2	Oftentimes slow and dropped connection	3/3/2020 12:43 PM
3	Generally, the network was somewhat slow.	2/24/2020 7:21 PM
4	Unfortunately, the connection was often quite poor...	2/24/2020 12:52 PM
5	Every now and again it drops out while out on the deck.	2/18/2020 3:44 PM
6	Often got disconnected (from eduroam mainly)	2/18/2020 12:46 PM

Q30 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 7 Skipped: 97

#	RESPONSES	DATE
1	I thought the exercise sessions were a great idea. I also liked that several speakers had a series of lectures. It really felt like a teaching/introductory workshop, and not like a research conference, which so many Intro workshops seem to turn into.	2/26/2020 12:47 AM
2	It would be great to improve Wi-Fi	2/24/2020 12:52 PM
3	I appreciated the format.	2/21/2020 6:23 PM
4	the special format wasn't actually followed by any of the lectures I attended ... or at least not in useful ways ... I do like the idea, but suspect that lecturers need a *lot* more instructions - starting with how to make lectures accessible. ... possibly including how to avoid getting into specialist discussions, though that's also a place where session chairs ought to intervene - especially when there's a power differential between persistent questioner and lecturer.	2/19/2020 11:18 AM
5	I found the exercise sessions extremely valuable in understanding the material. Since this was an introductory workshop, introducing the concepts and definitions through exercises is the best path. I found the exercise sessions with no presentations to be the most valuable for my learning, i.e., the exercise sessions where we went into groups and worked on the math together without a plan of anyone presenting solutions. This workshop had participants from every level of understanding, so solutions that are valuable to some are incoherent to others. Allowing participants to work at their own pace with those who want to work on exercises together gives people a chance to learn at every level. Great workshop!	2/18/2020 11:23 AM
6	As usual it runs very smoothly	2/18/2020 11:13 AM
7	It would be nice to have a list of participants with affiliations and emails available, so that we could easily contact each other after the workshop!	2/18/2020 10:36 AM

**Tensor categories and topological
quantum field theories**

(Workshop Held Online)

March 16, 2020 – March 20, 2020

MSRI, Berkeley, CA, USA

Organizers:

Scott Morrison (Australian National University)

Eric Rowell (Texas A & M University)

Claudia Scheimbauer (TU München)

Christopher Schommer-Pries (University of Notre Dame)

REPORT ON THE MSRI WORKSHOP
“Tensor categories and topological quantum field theories (Virtual workshop)”
March 16 – 20, 2020

Organizers

- Scott Morrison (Australian National University)
- Eric Rowell (Texas A & M University)
- Claudia Scheimbauer (TU München)
- Christopher Schommer-Pries (University of Notre Dame)

Scientific Description

This workshop concerned the latest developments in the mathematical study of quantum field theories. The focus was on the interplay among topics such as higher category theory, as illustrated by the cobordism hypothesis, conformal field theory, tensor categories describing the quantum symmetries, and the relation to topological phases of matter.

Highlights of the Workshop

The clear highlight of the workshop was that it took place at all, through the extraordinary effort of the MSRI staff, the dedication of the speakers and the avid interest of the participants. As this workshop was moved online abruptly, it provided an opportunity to experience and experiment with an entirely new format. The speakers adjusted admirably to speaking remotely, sometimes from Europe and Australia at inconvenient times. Nearly all originally scheduled speakers presented their talks, either pre-recorded or live. It was remarkable that so many of the participants attended the talks remotely in uncertain times. The international reach of the workshop was also extended--many of the attendees had not originally planned on traveling to Berkeley but were able to join remotely.

The talks illustrated the myriad perspectives on quantum symmetries, from fracton models in condensed matter physics to 4-dimensional TQFTs, new constructions of braided fusion categories, and connections to higher categories and topological invariants. Several of the talks dealt with connections to the subject of the complementary program, i.e. categorification and higher categories.

To illustrate the depth and breadth of the workshop we describe an essentially random selection of the talks.

Reutter spoke about a recent result proving that semisimple 4-dimensional topological field theories cannot detect exotic smooth structure. Freedman showed in 1982 that there are 4-manifolds that are homeomorphic to \mathbb{R}^4 but not diffeomorphic to \mathbb{R}^4 . One might hope that there are 4-D TQFTs that could distinguish manifolds that were homeomorphic but not diffeomorphic and this result shows that semisimple 4-D TQFTs cannot.

Chen spoke about a new class of 3-D phases of matter that have topological properties, but do not exhibit all of the hallmarks of topological phases of matter in 2-D, such as mobility of excitations. These phases of matter have some potential applications to quantum information as they provide quantum error correcting codes.

Walker discussed a general framework incorporating various constructions of G-TQFTs where G is a Lie group encoding various structures on the manifold, such as orientation and spin, in various low dimensions.

Embedding premodular categories into modular categories in a minimal way was the subject of Nikshych's talk, with some progress towards the outstanding minimal modular extension conjecture.

Plavnik's talk was postponed to take place during the following week's workshop on Higher Category Theory, which discussed a new cohomological construction of categories from old ones by twisting the fusion rules.

Organizers		
First Name	Last Name	Institution
Scott	Morrison	University of Washington
Eric	Rowell	Texas A&M University
Claudia	Scheimbauer	TU München
Christopher	Schommer-Pries	University of Notre Dame
Speakers		
First Name	Last Name	Institution
David	Ayala	Montana State University
Xie	Chen	California Institute of Technology
Emily	Cliff	University of Sydney
Xingshan	Cui	Purdue University
Michael	Freedman	University of California, San Diego
Owen	Gwilliam	University of Massachusetts Amherst
Theo	Johnson-Freyd	Perimeter Institute of Theoretical Physics
David	Jordan	University of Edinburgh
Dmitri	Nikshych	University of New Hampshire
Mark	Penney	University of Waterloo
David	Reutter	Max-Planck-Institut für Mathematik
Christoph	Schweigert	Universität Hamburg
Noah	Snyder	Indiana University
Catharina	Stoppel	Rheinische Friedrich-Wilhelms-Universität Bonn
Kevin	Walker	Microsoft Research Station Q

Mathematical Sciences Research Institute

Tensor Categories And Topological Quantum Field Theories

March 16 -20, 2020

Monday, March 16, 2020

9:15 AM - 9:30 AM	Online/Virtual		Welcome to MSRI
9:30 AM - 10:30 AM	Online/Virtual	Noah Snyder	What is a homotopy coherent $SO(3)$ action on a 3-groupoid?
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	David Jordan	Cluster quantization from factorization homology
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	David Reutter	Semisimple 4-dimensional topological field theories cannot detect exotic smooth structure
3:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	Xingshan Cui	Invariants of 4-manifolds from Hopf algebras

Tuesday, March 17, 2020

9:30 AM - 10:30 AM	Online/Virtual	Theo Johnson-Freyd	Gapped condensation in higher categories
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Mark Penney	Tensor 2-categories of Hall modules

Wednesday, March 18, 2020

9:30 AM - 10:30 AM	Online/Virtual	Michael Freedman	Lecture
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Xie Chen	Fraction order: relation to and features beyond TQFT
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Nicholas Jewell	COVID-19: The Exponential Power of Now

Thursday, March 19, 2020

9:30 AM - 10:30 AM	Online/Virtual	Christoph Schweigert	Bulk fields in conformal field theory
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Catharina Stroppel	Fusion rings for quantum groups and DAHAs
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Dmitri Nikshych	On minimal non-degenerate extensions of braided tensor categories
3:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	Emily Cliff	Modules over factorization spaces, and moduli spaces of parabolic G -bundles

Friday, March 20, 2020

9:30 AM - 10:30 AM	Online/Virtual	Owen Gwilliam	A survey of factorization algebras in TFTs
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	David Ayala	The 1-dimensional tangle hypothesis
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Kevin Walker	Low-dimensional G -bordism and G -modular TQFTs



Participants

First Name	Last Name	Institution
Ian	Agol	University of California, Berkeley
Tair	Akhmejanov	University of California, Davis
Nicolás	Andruskiewitsch	Universidad Nacional de Cordoba
David	Ayala	Montana State University
Andreas	Bauer	Freie Universität Berlin
Dietmar	Bisch	Vanderbilt University
Marcel	Bischoff	Ohio University
Thomas	Brunner	University of Oregon
Alex	Bullivant	University of Leeds
Alexander	Campbell	MSRI - Mathematical Sciences Research Institute
Anna	Cepek	Institute for basic science
John	Chae	University of California, Davis
Xie	Chen	California Institute of Technology
Michael	Ching	Amherst College
Patrick	Chu	Indiana University
Emily	Cliff	University of Sydney
Xingshan	Cui	Purdue University
Alexei	Davydov	Ohio University
Arun	Debray	University of Texas, Austin
Thibault	Decoppet	University of Oxford
Colleen	Delaney	Indiana University
Tanmay	Deshpande	Tata Institute of Fundamental Research
Christopher	Douglas	University of Oxford
David	Evans	Cardiff University
John	Francis	Northwestern University
Michael	Freedman	University of California, San Diego
Shlomo	Gelaki	Iowa State University
Ezra	Getzler	Northwestern University
Luca	Giorgetti	Vanderbilt University
Frederick	Goodman	The University of Iowa
Jason	Green	University of New Hampshire
David	Green	Ohio State University
Vesselin	Gueorguiev	Ronin Institute for Independent Scholarship
Owen	Gwilliam	University of Massachusetts Amherst
Philip	Hackney	University of Louisiana--Lafayette
Peter	Haine	Massachusetts Institute of Technology
Sebastian	Halbig	TU Dresden
Matthew	Harper	Ohio State University
Asaf	Horev	Stockholm University
Samuel	Hsu	University of California, Berkeley
Peter	Huston	Ohio State University
Theo	Johnson-Freyd	Perimeter Institute of Theoretical Physics
David	Jordan	University of Edinburgh
Ajinkya	Kulkarni	Institut de Mathématiques de Bourgogne
Christopher	Kuo	University of California, Berkeley

Participants

First Name	Last Name	Institution
James	LaDouce	Boston University
MOHAMMAD JAV	LATIFI JEBELLI	University of Arizona
Muriel	Livernet	Institut de Mathematiques de Jussieu
Aaron	Mazel-Gee	University of Southern California
Matthew	McMillan	University of California, Los Angeles
Calvin	McPhail-Snyder	University of California, Berkeley
Shuang	Ming	Texas A & M University
Scott	Morrison	Australian National University
Florian	Naef	Massachusetts Institute of Technology
Cris	Negron	University of North Carolina
Siu-Hung	Ng	Louisiana State University
Anh Tuong	Nguyen	University of Illinois at Urbana-Champaign
Dmitri	Nikshych	University of New Hampshire
Pablo	Ocal	Texas A & M University
Victor	Ostrik	University of Oregon
Mark	Penney	University of Waterloo
Eugene	Rabinovich	University of California, Berkeley
David	Reutter	Max-Planck-Institut für Mathematik
Eric	Rowell	Texas A & M University
Eric	Samperton	University of Illinois at Urbana-Champaign
Claudia	Scheimbauer	TU München
Christopher	Schommer-Pries	University of Notre Dame
Christoph	Schweigert	Universität Hamburg
Noah	Snyder	Indiana University
Kursat	Sozer	Indiana University
Luuk	Stehouwer	Max-Planck-Institut für Mathematik
Catharina	Stoppel	Rheinische Friedrich-Wilhelms-Universität Bonn
Michelle	Strumila	University of Melbourne
Israt	Suhi	Shahjalal University of Science & Technology, Sylhet
Ying Hong	Tham	State University of New York, Stony Brook
Mrudul	Thatte	Columbia University
Connor	Tumelty	University of California, Berkeley
Sachin	Valera	University of Bergen
Jackson	Van Dyke	University of Texas, Austin
Kevin	Walker	Microsoft Research Station Q
Yilong	Wang	Louisiana State University
Luya	Wang	University of California, Berkeley
Paul	Wedrich	Max-Planck-Institut für Mathematik
Katrin	Wehrheim	University of California, Berkeley
Dominic	Weiller	Australian National University
Samuel	Wilson	Louisiana State University
Lukas	Woike	Universität Hamburg
Harshit	Yadav	University of Illinois at Urbana-Champaign
Bowen	Yang	California Institute of Technology
David	Yetter	Kansas State University

Participants

First Name	Last Name	Institution
Qing	Zhang	Texas A & M University
Lucy Liuxuan	Zhang	University of Toronto
Shan	Zhou	University of California, Santa Barbara

Officially Registered Participants Information

Participants		93
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Gender		93
Male	81.72%	76
Female	12.90%	12
Declined to state	4.30%	4
Other/Non-Binary	1.08%	1

Ethnicity*		109
White	57.80%	63
Asian	20.18%	22
Hispanic	2.75%	3
Pacific Islander	0.00%	0
Black	1.83%	2
Native American	0.92%	1
Mixed	7.34%	8
Declined to state	9.17%	10

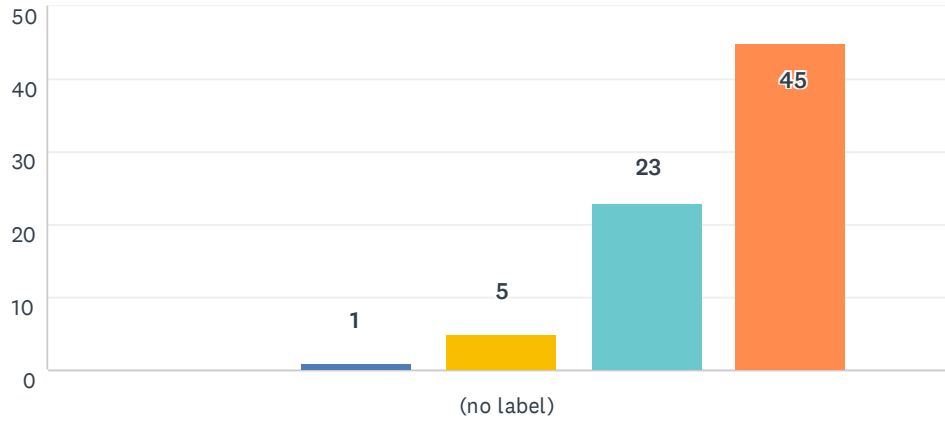
* ethnicity specifications are not exclusive

Demographic information is only available for the 93 registered workshop participants. Because registration was encouraged but not required for the virtual workshops, an additional 53 workshop participants attended without registering, bringing the total number of workshop attendees to 146.

74 responses out of 146 total attended participants = 51% response rate

Q1 The workshop was intellectually stimulating

Answered: 74 Skipped: 0

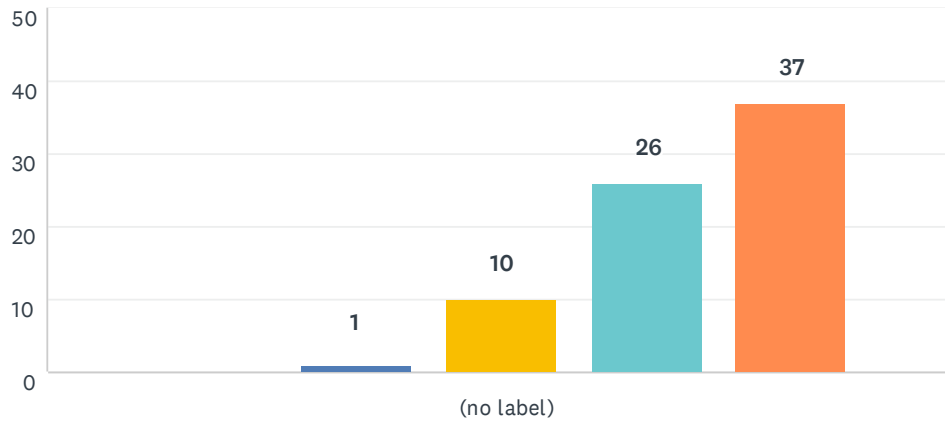


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.35% 1	6.76% 5	31.08% 23	60.81% 45	74	4.51

Q2 The overall experience of the workshop was worthwhile

Answered: 74 Skipped: 0

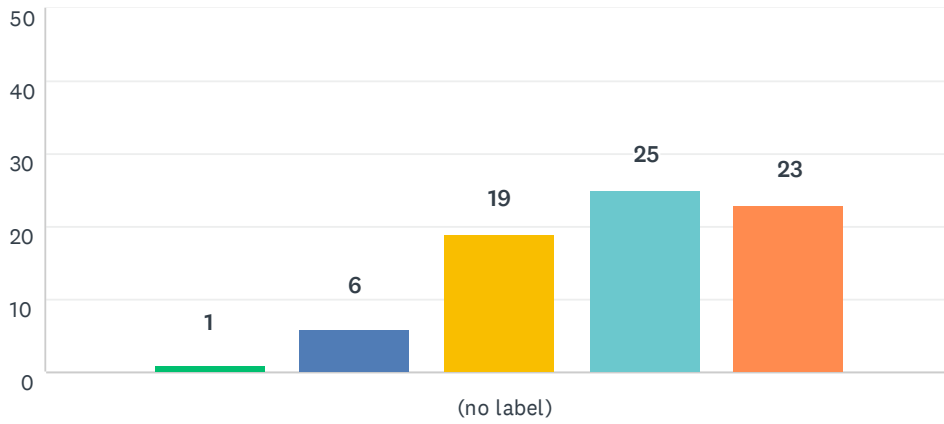


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.35% 1	13.51% 10	35.14% 26	50.00% 37	74	4.34

Q3 I was well prepared to benefit from the lectures

Answered: 74 Skipped: 0

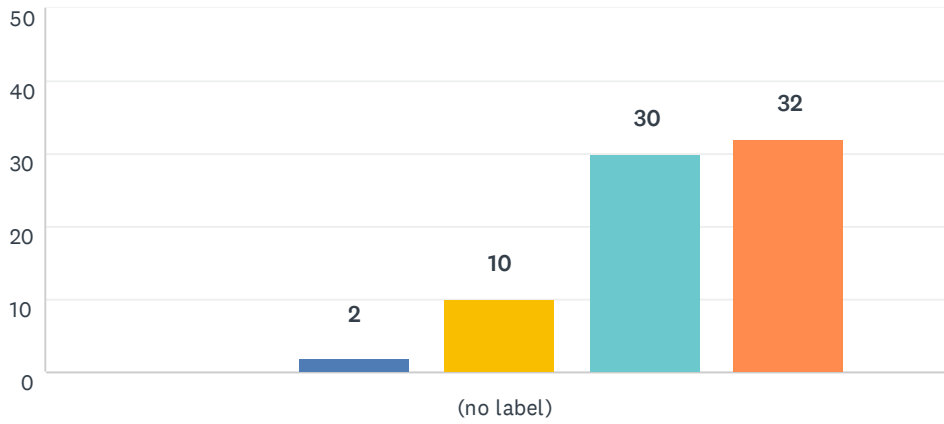


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	1.35%	8.11%	25.68%	33.78%	31.08%	74	3.85
	1	6	19	25	23		

Q4 My interest in the subject matter was increased by the workshop

Answered: 74 Skipped: 0

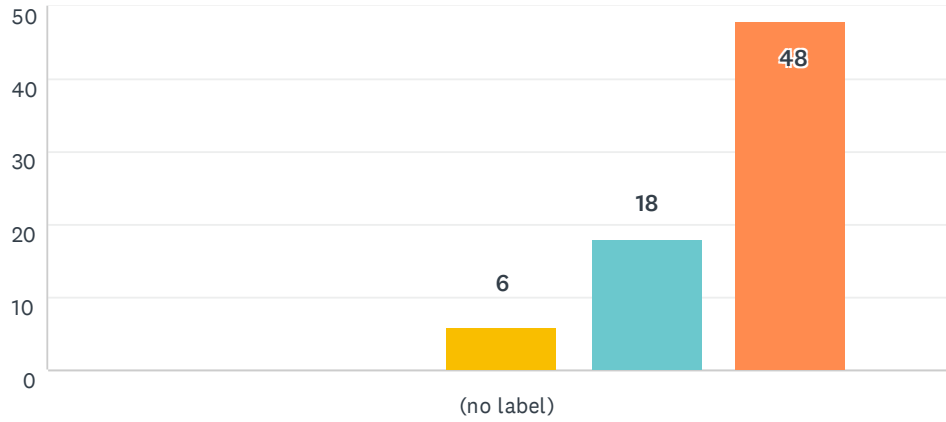


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.70%	13.51%	40.54%	43.24%	74	4.24
	0	2	10	30	32		

Q5 I found the MSRI staff helpful

Answered: 72 Skipped: 2

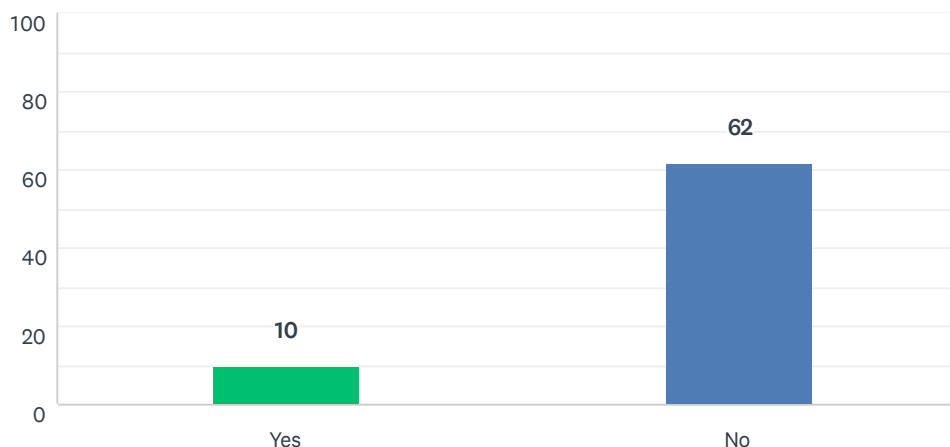


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	8.33% 6	25.00% 18	66.67% 48	72	4.58

Q6 Did you experience any technical difficulties accessing the online workshop?

Answered: 72 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	13.89%	10
No	86.11%	62
TOTAL		72

#	IF YES, PLEASE EXPLAIN	DATE
1	I gave a talk, and, for whatever reason, I wasn't able to connect through Zoom. So we had to postpone the start of my talk by 30 minutes. This was stressful. Though I did a systems check with one of the organizers a couple days prior to my talk, that could have benefited from being a systems check through the same zoom system that I used for my talk. For instance, in the week prior to the virtual conference, it might make sense for MSRI IT staff to facilitate quick systems checks -- each for only 7 minutes (or something).	5/21/2020 1:58 PM
2	problem is that my connection at home is not really good, and it appears that I miss part of the talks because of that	5/19/2020 3:47 PM
3	Zoom has real problems when some participants, such as myself, have weak cpus. An alternative broadcast on any video streaming service would solve this problem.	5/19/2020 3:28 PM
4	The video was not always stable; talks using the blackboard were often hard to read. Talks using slides were much easier to see.	5/19/2020 3:20 PM
5	My internet connection kept dropping	5/12/2020 12:17 AM
6	One talk never got recorded. There were other issues such as speakers getting panelist permission, but these were eventually sorted out.	5/11/2020 2:24 PM
7	There were some minor difficulties with streaming some of the talks.	5/7/2020 5:43 AM
8	It was my first time seriously using Zoom; it got better by day 3 or 4. All the issues were on my end	5/6/2020 5:05 PM
9	Zoom is a software that requires a big RAM and a good Internet connection. It destroyed my RAM, my bandwidth couldn't handle it, my video and audio froze and cut constantly... There was a plethora of difficulties if one did not have a powerful computer and a good bandwidth.	5/6/2020 12:06 PM
10	It is my first time to attend a online conference. I did face some minor technical difficulties at the very beginning.	5/6/2020 11:41 AM

Q7 How did having the workshop held online impact your participation?

Answered: 72 Skipped: 2

917 - Tensor categories and topological quantum field theories: Participant Survey

#	RESPONSES	DATE
1	I appreciated you offered it online instead of canceling it. However, if it had been in person I would have focused my attention better on the talks and had real interactions with participants. It was great to have the virtual tea room, but I did not figure out how to have a side conversation of 2-3 people versus a group conversation.	5/25/2020 12:30 AM
2	It's more convenient since I don't need to prepare for the traveling.	5/21/2020 11:41 PM
3	I found it much more draining, and less engaging, to participate online. Also, it was hard, if not impossible, to connect with speakers and other participants in more informal ways (besides asking questions to those few who gave talks).	5/21/2020 1:58 PM
4	wasn't regular because of time diff	5/21/2020 2:56 AM
5	I was unable to attend some of the talk live as I am staying in Europe.	5/21/2020 2:08 AM
6	I missed the informal interactions.	5/20/2020 4:37 AM
7	not much	5/19/2020 8:48 PM
8	I scarcely participated. I gave a talk and watched snippets of a few. It was early during the lockdown period at my home (I had just returned to my family from the Bay Area), and it was difficult to find the time, focus, or enthusiasm to participate.	5/19/2020 8:33 PM
9	It actually made it easier, since I didn't have to travel. On the other hand, I couldn't talk to people (as the next question points out).	5/19/2020 8:26 PM
10	See point 8	5/19/2020 7:00 PM
11	I enjoyed the online lectures, but of course in-person communication is an important aspect of workshops that was not really available because of the online format.	5/19/2020 4:14 PM
12	A lot, because of what I said and because its harder to concentrate on line than on site	5/19/2020 3:47 PM
13	I partipated much less than I would have.	5/19/2020 3:39 PM
14	Technical difficulties made it hard for me to attend certain lectures.	5/19/2020 3:28 PM
15	It was fine; I was able to attend all the talks online.	5/19/2020 3:20 PM
16	Financially easier to attend	5/19/2020 3:14 PM
17	attended few talks	5/19/2020 3:14 PM
18	Not much	5/19/2020 3:10 PM
19	actually not much	5/19/2020 3:10 PM
20	less than I expected	5/19/2020 7:07 AM
21	It hindered interaction and collaboration. Time difference between Europe and US was a contributing factor.	5/15/2020 3:08 AM
22	Time difference played a role.	5/13/2020 11:55 PM
23	It was much harder to remain focused.	5/12/2020 8:51 AM
24	Watching videos of talks all day is a test of one's patience. It's worse when speakers run over their allotted time, which happened with many of the talks.	5/12/2020 8:03 AM
25	Allowed for participation even though I couldn't have been in San Franscisco for the original workshop. Did however loose the chance of interaction/asking questions etc because of the online format and time difference	5/12/2020 2:23 AM
26	Yes. I visited only a few talks, given that it's not my primary topic of research and due to time difference.	5/12/2020 2:20 AM
27	As this week was the week of lockdowns and closing borders, I had to travel home during that week and therefore, I could not attend many of the talks, which was a shame. When I could attend, I enjoyed the talks a lot, although it is more difficult to concentrate actively during an online talk. It was easier for me when I was a moderator as opposed to an anonymous participant, so having the option of joining per video when asking a question might help.	5/12/2020 1:59 AM

917 - Tensor categories and topological quantum field theories: Participant Survey

Sometimes questions posed in the chat were only addressed to the panellists, which was awkward when you can't read them as a normal participant. I would like to add that I only gave a 3 for "overall experience" due to the fact that that particular week was very stressful due to the sudden lockdowns and border closings and I had the feeling that many participants and speakers would have profited if the workshop had been moved by 2-3 weeks.

28	I would not have participated otherwise.	5/12/2020 12:17 AM
29	My original plan was not to attend the conference due to thesis defense preparation. Thanks to the online conference option, I was able to participate.	5/11/2020 9:47 PM
30	Was in a different time zone, so was unable to attend many of the talks live. Missed interactions with speakers and other participants.	5/11/2020 8:32 PM
31	I was unable to attend in-person and discuss a recent paper of mine.	5/11/2020 6:06 PM
32	My primary collaborator wasn't able to visit/attend in person, so I missed having someone to watch/discuss the seminar talks with.	5/11/2020 3:18 PM
33	I definitely attended less. It was too easy to oversleep or to get distracted by other things happening at home.	5/11/2020 3:06 PM
34	Less communication with the other people.	5/11/2020 3:00 PM
35	The time difference.	5/11/2020 2:47 PM
36	It was not as good as in person, but went very smoothly and bestp ossible.	5/11/2020 2:46 PM
37	It made it easier to participate	5/11/2020 2:38 PM
38	As a moderator I had to be paying attention to the chat and Q&A to ensure things went smoothly.	5/11/2020 2:24 PM
39	I wouldn't have been able to attend the talks in person, so I'm very grateful for the online format.	5/11/2020 2:12 PM
40	For me one of the most important aspects of a workshop are the opportunities to speak directly to speakers and other participants. One can easily ask reasonably precise questions online. But there is no opportunity for the kind of informal and often rather vague discussions which often can be the beginning of new ideas.	5/11/2020 2:00 PM
41	I attended few lectures. I tended to pay less attention sometimes and dropped off between lectures. However having it online made it easier for me to attend.	5/11/2020 1:47 PM
42	Not much at all, as I would likely have watched some of the recordings anyway.	5/11/2020 1:46 PM
43	it was ok otherwise I wouldn't have take part.. but live is better for sure, let's hope to see each others soon!	5/8/2020 12:19 PM
44	More difficult to interact personally.	5/7/2020 7:03 AM
45	It was harder to have informal discussions in the breaks and impossible to have dinner or beers together. But the talks were very good. The chat function and the communication via the organizing host was an excellent method of communication.	5/7/2020 5:43 AM
46	Due to time-zones differences I was only able to attend approx half of the lectures. I also was unable to participate in any of the surrounding things (informal chats over lunch, opportunities for collaboration, etc)	5/6/2020 7:15 PM
47	Obviously it isn't ideal, though it was valuable nonetheless.	5/6/2020 6:28 PM
48	I don't think I have anything non-obvious to say. The talks were fine, and I asked questions, but I didn't participate much in the tea room/talk with people informally later, even via social media	5/6/2020 5:05 PM
49	Made me able to participate without travel	5/6/2020 4:35 PM
50	restricted	5/6/2020 4:32 PM
51	It had positive impact on my participation	5/6/2020 2:29 PM
52	Not much, I was in Berkeley anyway and used the online options.	5/6/2020 2:13 PM
53	I felt less desire to communicate with speakers digitally. I.e. there are things I would have said if	5/6/2020 2:04 PM

917 - Tensor categories and topological quantum field theories: Participant Survey

I was there in person that I did not say over Zoom.

54	I participated less than I would have in person, because of other local duties.	5/6/2020 1:16 PM
55	I thought the workshop went very well.	5/6/2020 1:11 PM
56	Absence of direct interaction between participants was unfortunate	5/6/2020 1:09 PM
57	Interaction with other participants was very limited. The online nature of the workshop was one aspect, The time difference between Europe and the US was another.	5/6/2020 1:02 PM
58	it made it possible.	5/6/2020 12:33 PM
59	It was inevitable that it would, but it went as well as could be hoped for.	5/6/2020 12:30 PM
60	Despite the time shift California-Europe, I was attending most of the talks. I had my first online jetlag!	5/6/2020 12:12 PM
61	Unfortunately it negatively impacted my participation. I couldn't always follow the speaker because of technical difficulties with Zoom, and sometimes my computer simply would crash because of Zoom. I couldn't even access some of the talks because of this. I was also looking forward to talking with some of the senior participants, and to asking questions attempting to clarify some of my current research, and doing this online is between impossible and horribly awkward.	5/6/2020 12:06 PM
62	I would not have participated otherwise	5/6/2020 12:05 PM
63	In depth discussions about the talks was missing. It was more like an introductory workshop in that sense, although the subject matter was more technical. Somehow online talks are more exhausting, despite the fact that I could just walk away. The talks I moderated were difficult as I had to pay attention to several different question sources, and interrupt the speaker. This meant I could not focus on the talk as well.	5/6/2020 12:05 PM
64	I experienced no negative impact.	5/6/2020 11:56 AM
65	Didn't impact	5/6/2020 11:52 AM
66	Well, I participated with pleasure but it is not the same as being present. I tried to attend most of the lectures.	5/6/2020 11:45 AM
67	Participating online will always be different than in person. I particularly found it much easier to be distracted because things in my household	5/6/2020 11:41 AM
68	The online participation is more one sided as it is not convenient to ask questions during or after the talks.	5/6/2020 11:41 AM
69	Easier to attend the talks but probably interacted with people less	5/6/2020 11:40 AM
70	I participated regularly in the online lectures. So, while not preferable to in person lectures, it was OK.	5/6/2020 11:36 AM
71	I participated less	5/6/2020 11:35 AM
72	Not too much.	5/6/2020 11:34 AM

Q8 One important aspect that was missing due to the online format was interaction between participants. Do you have any suggestions on how we can provide this interaction if we hold future workshops online?

Answered: 30 Skipped: 44

917 - Tensor categories and topological quantum field theories: Participant Survey

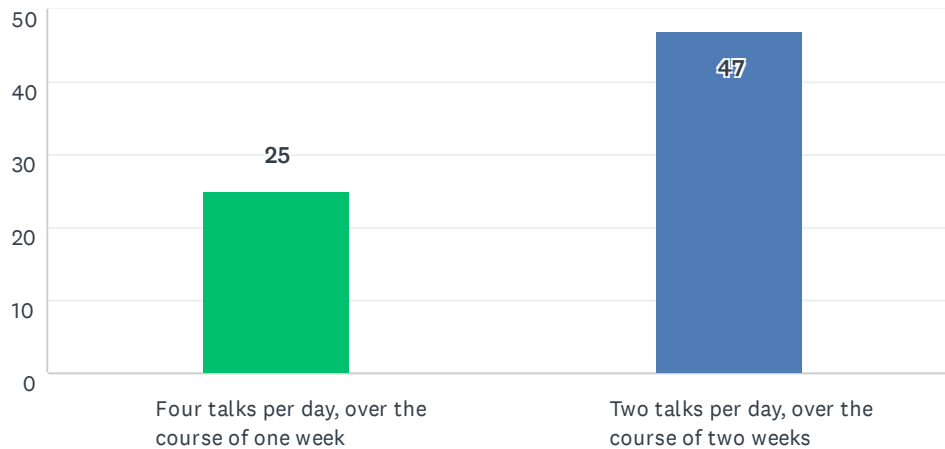
#	RESPONSES	DATE
1	?	5/25/2020 12:30 AM
2	One idea is to have fewer speakers, and have each speaker hold "office hours". In those "office hours", the speaker would have a few points prepared: foundational aspects/results/definitions of the theory their talk was premised on; working through basic/illustrative examples; responding to anticipated natural questions, etcetera. But them running through their prepared material would take a much lesser priority than responding to any questions or comments, or having discussions, with others in the `office hours'. Also, having a few people seed basic questions could be useful in order to kick off a precedent in each such office hour. Another idea is to be creative with the Tea Rooms. Such rooms could be assigned by `random numbers', or topic specific. Another idea is to have shorter talks, by more junior participants. These could play the role of how one might respond to the question "what sort of math are you working on?", which is commonly asked to junior participants during Snacks.	5/21/2020 1:58 PM
3	It is a difficult problem for which I do not (yet) have good experience to base useful suggestions on.	5/20/2020 4:37 AM
4	Set up some sort of direct messaging and small group messaging environment to be up during the week of the conference? Maybe a constant chat room that you can be logged into? This may make it better than email to feel like one is "at" the conference.	5/19/2020 8:26 PM
5	Allow participants to upload topics they'd be interested in discussing with other participants. Then people can search for participants with common interests and organise off-shoot virtual sessions.	5/19/2020 7:00 PM
6	I would suggest more "tea rooms" and other online interactions of this type.	5/19/2020 4:14 PM
7	I do think that MSRI did a great job with all the team rooms available after the talks; I have no idea of how this can be improved	5/19/2020 3:47 PM
8	Maybe use zoom.us breakout room feature?	5/19/2020 7:07 AM
9	Instead of using the webinar mode on Zoom, maybe just hold a standard zoom meeting and allow participants to ask their own questions.	5/12/2020 8:03 AM
10	Maybe something similar to the problem sessions in the introductory workshops where the participant are sent to breakout-rooms in zoom. Or a shorter version of that but still splitting the participants into smaller groups so that one can put on video and chat a bit.	5/12/2020 2:23 AM
11	I liked the concept of the tearoom. Encouraging the tearoom to be available also during hours that are convenient for other time zones would help, say, one time slot every 6 hours so that people from Europe and Australia can also participate at odd times.	5/12/2020 1:59 AM
12	No	5/12/2020 12:17 AM
13	Randomly assign small groups for synchronous virtual lunches!	5/11/2020 3:18 PM
14	I definitely think keeping the camera on for everyone helps a lot, although I'm not sure if everyone is comfortable with it. Otherwise I'm not really sure...	5/11/2020 3:06 PM
15	Maybe have a participant social on zoom after, possible with the integration of break out rooms	5/11/2020 2:38 PM
16	?	5/11/2020 2:00 PM
17	Tea rooms	5/11/2020 1:47 PM
18	Hmm, maybe sth like a chatroom...	5/7/2020 7:03 AM
19	Virtual breaks with the possibility to break out in smaller groups are good. Sometimes select groups at random to promote new people to get to know each other, sometimes allow participants to create groups to discuss a common interest. Other idea: have one room dedicated to the speaker of the last talk for informal questions after the talk.	5/7/2020 5:43 AM
20	No suggestions, but I agree that this should be improved.	5/6/2020 7:15 PM
21	Post lecture chat rooms seem like the best way to encourage this.	5/6/2020 6:28 PM
22	I wish I knew. Thank you for putting thought into this though!	5/6/2020 5:05 PM

917 - Tensor categories and topological quantum field theories: Participant Survey

23	hard to say	5/6/2020 4:32 PM
24	It is harder to get to meet and talk with people that one does not already know. Some sessions for (non-speaker) participants to introduce themselves might be helpful.	5/6/2020 2:13 PM
25	david litt has prepared a write up after WAGON, i contributed a few comments to it, as did others. please us it as it applies to the use by MSRI of ZOOM (tm) n-to-m feeds. brief: use separate text mechanisms, this isn't zoom's sweet spot. slack, discord, ... many. also, expectations: is social for job interviews or subject matter expertise or aculturation?	5/6/2020 12:33 PM
26	Would tools of virtual reality from gaming help to simulate standing for a discussion in front of the same blackboard?	5/6/2020 12:12 PM
27	Possibly breakout virtual rooms with whiteboards. The problem is that it is hard to track down the people you want to talk to!	5/6/2020 12:05 PM
28	This depends a lot on the personality of anyone. Personally I am not inclined to participate at the tearoom	5/6/2020 11:45 AM
29	This is really tough. One idea I've had is to organize some sort of 'matchmaker' program for one-on-one meetings. Have each participant list a few others they would be interested in talking to during the workshop. Then the organizers can pair people up, and schedule a time where everyone meets with the person they've been paired with. Another idea could be to do something along the lines of speed dating.	5/6/2020 11:41 AM
30	Having more pseudo-organized discussions may have been good. For example, it would have been nice to have lunch time informal discussion groups, if possible.	5/6/2020 11:36 AM

Q9 In the event that we must hold future workshops online, which of the following would be preferable?

Answered: 72 Skipped: 2



ANSWER CHOICES	RESPONSES	
Four talks per day, over the course of one week	34.72%	25
Two talks per day, over the course of two weeks	65.28%	47
TOTAL		72

#	OTHER (PLEASE SPECIFY)	DATE
1	maybe online workshops longer than a day or two are too difficult	5/19/2020 3:14 PM
2	I think the 2 per day / 2 weeks format is worth experimenting with	5/19/2020 7:07 AM
3	During weekends 4 is better, if conference happens on weekends.	5/11/2020 9:47 PM
4	two talks per day is the most I can attend until my kid is back at school	5/6/2020 1:16 PM
5	Both are fine but I have a slight preference to the second option.	5/6/2020 11:45 AM
6	3 or 4 but no more than 4	5/6/2020 11:41 AM

Q10 We welcome any additional comments or suggestions you may have to improve the overall online experience for future participants.

Answered: 11 Skipped: 63

#	RESPONSES	DATE
1	I think it is very important to hold conferences in person. However I understand the need to isolate. It is great for those who could not travel to participate online and it will be great if those options continue in the future, even if some components return to in-person. I have begun past collaborations with people I met at MSRI (live) and I cannot imagine how that sort of interaction would arise online.	5/25/2020 12:30 AM
2	In general, being creative with format for conferences to prioritize interactions, over more familiar conference formats, makes sense to me. I'd even go so far as to be willing to discard the idea of 'one-hour talks on a select few peoples' research' as being the premise of a conference.	5/21/2020 1:58 PM
3	I would suggest having less time between the talks if there are 4 hour-long talks. It is quite awkward with timing if one sits alone at home for half an hour waiting for the next talk. Maybe 15 minutes would suffice. Also, encouraging speakers to provide a handout or summary with key definitions and Theorems, or even better: having participants being able to access the file they are writing on helps to be able to "scroll up" and be more active during the talk.	5/12/2020 1:59 AM
4	For short workshops, consider making funds available to "buy out" participants time: e.g. paying for childcare, or for participants to stay in hotels locally so that they can negotiate themselves out of domestic work and focus on conference participation.	5/11/2020 3:18 PM
5	Make sure that schedule changes are announced clearly and as far in advance as possible.	5/11/2020 2:47 PM
6	If people are spread to the winds it is hard to find time slots that people in Europe, Australia/Asia and the Americas can all attend. On the other hand, the interaction is pretty limited so recorded talks is probably not hugely different than attending live.	5/11/2020 2:24 PM
7	The overall the quality of work and dedication of the staff was exceptional	5/7/2020 5:43 AM
8	thanks!	5/6/2020 12:33 PM
9	I am very grateful to the staff and speakers for having made it possible in these difficult circumstances.	5/6/2020 11:45 AM
10	I just wanted to use this space to thank all of the staff at the MSRI and the organizers of the workshop for managing to pull together a great conference under such difficult circumstances.	5/6/2020 11:41 AM
11	Thank you for the effort!	5/6/2020 11:36 AM

**(∞, n) -categories, factorization
homology, and algebraic K-theory
(Workshop Held Online)**

March 23, 2020 – March 27, 2020

MSRI, Berkeley, CA, USA

Organizers:

Clark Barwick (University of Edinburgh)

David Gepner (University of Melbourne)

David Nadler (University of California, Berkeley)

Marcy Robertson (University of Melbourne)

REPORT ON THE MSRI WORKSHOP
“(∞, n)-categories, factorization homology, and algebraic K-theory
(Virtual workshop)”
March 23 – 27, 2020

Organizers

- Clark Barwick (University of Edinburgh)
- David Gepner (University of Melbourne)
- David Nadler (University of California, Berkeley)
- Marcy Robertson (University of Melbourne)

Scientific Description

This workshop focused on recent developments in factorization homology, parametrized homotopy theory, and algebraic K-theory. These seemingly disparate topics are unified by a common methodology, which leverages universal properties and unforeseen descent by way of higher category theory. Furthermore, they enjoy powerful and complementary roles in application to the cyclotomic trace. This workshop allowed for experts in these areas to present new results, make substantive connections across fields, and suggest and contextualize outstanding questions and problems. It consisted of 4 two-part lecture series and 10 one-hour talks.

Highlights of the Workshop

This workshop happened to occur just as the coronavirus shutdown occurred. Some of the talks were delivered in advance with MSRI's video facilities, and others were delivered through Zoom.

Even with the surprise change of format (and a number of cancellations and schedule changes), the conference was a success. Akhil Mathew, David Ben-Zvi, and Martina Rovelli and Viktoriya Ozornova all offered lecture series. Mathew focused on his and his collaborators' exciting work on structures in topological cyclic homology from the past two years. Ben-Zvi gave an inspiring introduction to a relative form of the geometric Langlands conjectures. And Rovelli and Ozornova shared a surprising new nerve construction for 2-categories, relating them to Verity's 2-complicial sets.

In addition, we learned of a number of very exciting new results in areas adjacent to algebraic K-theory. Here are just a few highlights: Markus Land started our week off with a discussion of his extraordinary work with Georg Tamme on excision in algebraic K-theory. Teena Gerhardt described her recent work with Angeltveit, Blumberg, Hill, Lawson, and Mandell on a twisted form of *THH* that takes as input an equivariant ring spectrum. Ben Antieau, in recent work with Akhil Mathew, Matthew Morrow, and Thomas Nikolaus, generalized a result of Beilinson characterizing the fiber of a cyclotomic trace map after passing to suitable p -adic coefficients. Aaron Mazel-Gee offered a glimpse of the future in his work with Stern on secondary algebraic K-theory and a new approach to stable $(\infty, 2)$ -categories.

Organizers		
First Name	Last Name	Institution
Clark	Barwick	University of Edinburgh
David	Gepner	University of Melbourne
David	Nadler	University of California, Berkeley
Marcy	Robertson	University of Melbourne
Speakers		
First Name	Last Name	Institution
Benjamin	Antieau	University of Illinois, Chicago
David	Ben-Zvi	University of Texas, Austin
Teena	Gerhardt	Michigan State University
Rune	Haug seng	Norwegian University of Science and Technology (NTNU)
Xin	Jin	Boston College
Markus	Land	University of Copenhagen
Akhil	Mathew	University of Chicago
Aaron	Mazel-Gee	University of Southern California
Mona	Merling	University of Pennsylvania
Viktoriya	Ozornova	Ruhr-Universität Bochum
Julia	Plavnik	Indiana University
Martina	Rovelli	Australian National University
Hiro	Tanaka	Texas State University

Mathematical Sciences Research Institute

(∞, \mathbf{N}) -Categories, Factorization Homology, And Algebraic K-Theory

March 23 -27, 2020

Monday, March 23, 2020

10:45 AM - 11:00 AM	Online/Virtual		Welcome to MSRI
11:00 AM - 12:00 PM	Online/Virtual	Markus Land	Excision and algebraic K-theory
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Teena Gerhardt	Twisted topological Hochschild homology of equivariant spectra
3:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	Benjamin Antieau	The Beilinson fiber square

Tuesday, March 24, 2020

11:00 AM - 12:00 PM	Online/Virtual	Akhil Mathew	p-adic K-theory and topological cyclic homology
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Mona Merling	Equivariant A-theory & stable h-cobordism spaces
3:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	David Ben-Zvi	Relative Geometric Langlands Duality - I

Wednesday, March 25, 2020

9:30 AM - 10:30 AM	Online/Virtual	Julia Plavnik	How to zest your modular categories
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Akhil Mathew	The motivic filtration on topological cyclic homology

Thursday, March 26, 2020

9:30 AM - 10:30 AM	Online/Virtual	Aaron Mazel-Gee	Secondary algebraic K-theory and traces
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Martina Rovelli	Embedding 2-categories into $(\infty, 2)$ -categories
12:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	David Ben-Zvi	Relative Geometric Langlands Duality - II

Friday, March 27, 2020

9:30 AM - 10:30 AM	Online/Virtual	Viktoriya Ozornova	Embedding 2-categories into $(\infty, 2)$ -categories
10:30 AM - 11:00 AM			Break
11:00 AM - 12:00 PM	Online/Virtual	Rune Haugseng	The universal property of bispans
12:00 PM - 2:00 PM			Break
2:00 PM - 3:00 PM	Online/Virtual	Xin Jin	Microlocal sheaf categories and the J-homomorphism
3:00 PM - 3:30 PM			Break
3:30 PM - 4:30 PM	Online/Virtual	Hiro Tanaka	The paracyclic geometry of Fukaya categories



Participants

First Name	Last Name	Institution
Sanjana	Agarwal	Indiana University
Gabriel	Angelini-Knoll	Freie Universität Berlin
Benjamin	Antieau	University of Illinois, Chicago
Umamaheswaran	Arunachalam	Periyar University, Salem, TN, INDIA
David	Ayala	Montana State University
Clark	Barwick	University of Edinburgh
David	Ben-Zvi	University of Texas, Austin
John	Berman	University of Texas, Austin
Attilio	Castano	University of Michigan
Anna	Cepek	Institute for basic science
CHIRANTAN	CHOWDHURY	Universität Duisburg-Essen
Patrick	Chu	Indiana University
Hongyi	Chu	Max-Planck-Institut für Mathematik
Ian	Coley	Rutgers University
Carlos	Cortez Lemos	Northwestern University
Micah	Darrell	University of Illinois at Chicago
James	Davis	Indiana University
Arun	Debray	University of Texas, Austin
Thibault	Decoppet	University of Oxford
Shanna	Dobson	California State University, Los Angeles
Christopher	Douglas	University of Oxford
Matthew	Feller	University of Virginia
Matthias	Flach	California Institute of Technology
John	Francis	Northwestern University
Thomas	Gannon	University of Texas, Austin
David	Gepner	University of Melbourne
Teena	Gerhardt	Michigan State University
Ezra	Getzler	Northwestern University
Rok	Gregoric	University of Texas, Austin
Elijah	Gunther	University of Pennsylvania
Philip	Hackney	University of Louisiana--Lafayette
Peter	Haine	Massachusetts Institute of Technology
Rune	Haugsgeng	Norwegian University of Science and Technology (NTNU)
Jacob	Hegna	University of Minnesota
Asaf	Horev	Stockholm University
Samuel	Hsu	University of California, Berkeley
Daniel	Isaksen	Wayne State University
Andy	Jiang	University of Michigan
Xin	Jin	Boston College
Liam	Keenan	University of Minnesota, Twin Cities
Andrei	Konovalov	Higher School of Economics
Christopher	Kuo	University of California, Berkeley
Markus	Land	University of Copenhagen
Ayelet	Lindenstrauss	Indiana University
Muriel	Livernet	Institut de Mathematiques de Jussieu

Participants

First Name	Last Name	Institution
Kirill	Magidson	Higher School of Economics
Ioannis	Markakis	University of Maryland
Akhil	Mathew	University of Chicago
Aaron	Mazel-Gee	University of Southern California
Jonas	McCandless	Westfälische Wilhelms-Universität Münster
Mona	Merling	University of Pennsylvania
Lyne	Moser	École Polytechnique Fédérale de Lausanne (EPFL)
David	Nadler	University of California, Berkeley
Dmitri	Nikshych	University of New Hampshire
Pablo	Ocal	Texas A & M University
Morgan	Opie	Harvard University
Victor	Ostrik	University of Oregon
Viktoriya	Ozornova	Ruhr-Universität Bochum
Maximilien	Peroux	University of Illinois at Chicago
Julia	Plavnik	Indiana University
David	Reutter	Max-Planck-Institut für Mathematik
Emily	Riehl	Johns Hopkins University
Noah	Riggenbach	Indiana University
Martina	Rovelli	Australian National University
Carmen	Rovi	Ruprecht-Karls-Universität Heidelberg
Eric	Rowell	Texas A & M University
Claudia	Scheimbauer	TU München
Christopher	Schommer-Pries	University of Notre Dame
Jay	Shah	University of Notre Dame
Brandon	Shapiro	Cornell University
Noah	Snyder	Indiana University
Martin	Speirs	University of California, Berkeley
Jan	Steinebrunner	University of Oxford
Hiro	Tanaka	Texas State University
Marco	Varisco	University at Albany (SUNY)
Paula	Verdugo	Macquarie University
Kevin	Walker	Microsoft Research Station Q
Chelsea	Walton	University of Illinois at Urbana-Champaign
Paul	Wedrich	Max-Planck-Institut für Mathematik
Katrin	Wehrheim	University of California, Berkeley
Zhaoting	Wei	Kent State University at Geauga
Lucy	Yang	Harvard University
Sarah	Yeakel	MSRI - Mathematical Sciences Research Institute
David	Yetter	Kansas State University
Shan	Zhou	University of California, Santa Barbara
Foling	Zou	University of Chicago

Officially Registered Participants Information

Participants		97
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Gender		97
Male	73.20%	71
Female	22.68%	22
Declined to state	3.09%	3
Other/Non-Binary	1.03%	1

Ethnicity*		107
White	62.62%	67
Asian	18.69%	20
Hispanic	6.54%	7
Pacific Islander	0.00%	0
Black	0.93%	1
Native American	0.00%	0
Mixed	4.67%	5
Declined to state	6.54%	7

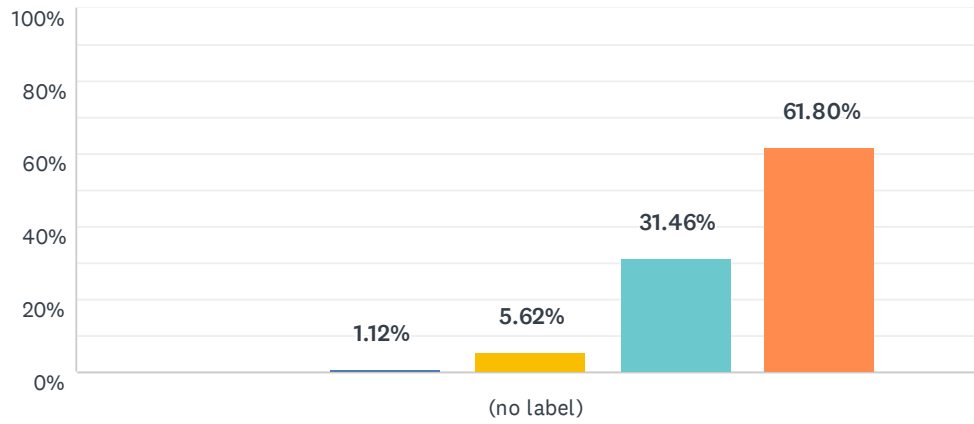
* ethnicity specifications are not exclusive

Demographic information is only available for the 97 registered workshop participants. Because registration was encouraged but not required for the virtual workshops, an additional 109 workshop participants attended without registering, bringing the total number of workshop attendees to 206.

89 responses out of 206 participants = 43% response rate

Q1 The workshop was intellectually stimulating

Answered: 89 Skipped: 0

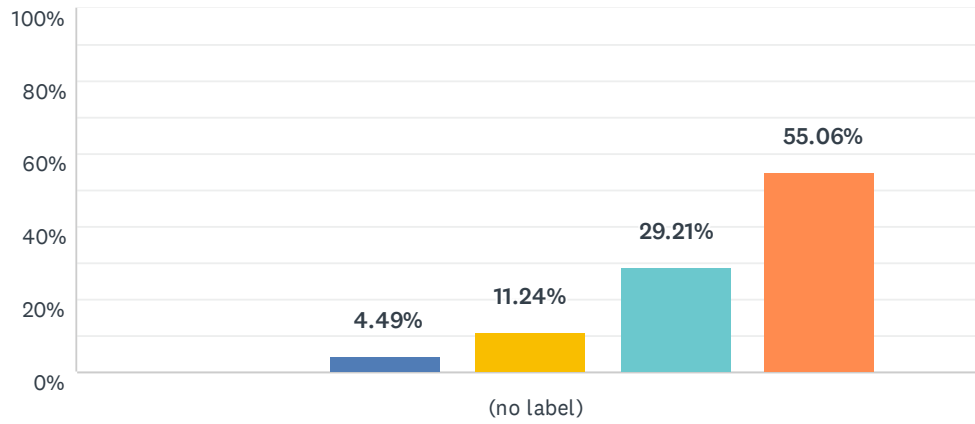


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.12% 1	5.62% 5	31.46% 28	61.80% 55	89	4.54

Q2 The overall experience of the workshop was worthwhile

Answered: 89 Skipped: 0

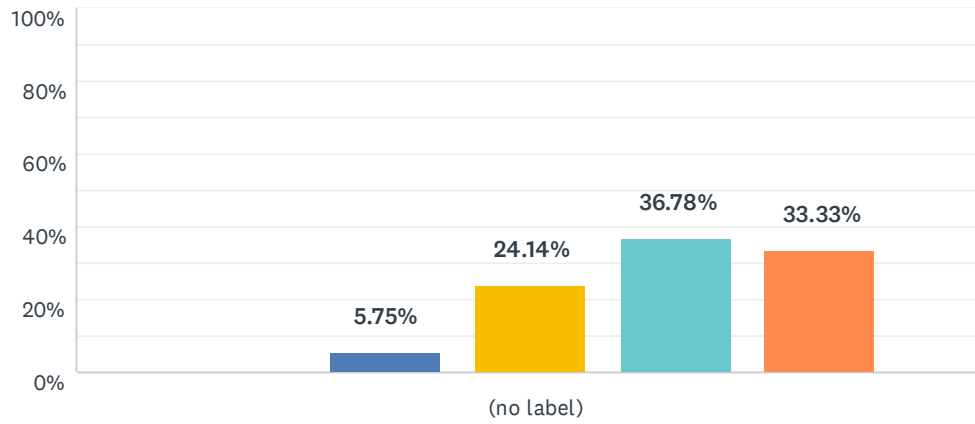


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.49%	11.24%	29.21%	55.06%	89	4.35
	0	4	10	26	49		

Q3 I was well prepared to benefit from the lectures

Answered: 87 Skipped: 2

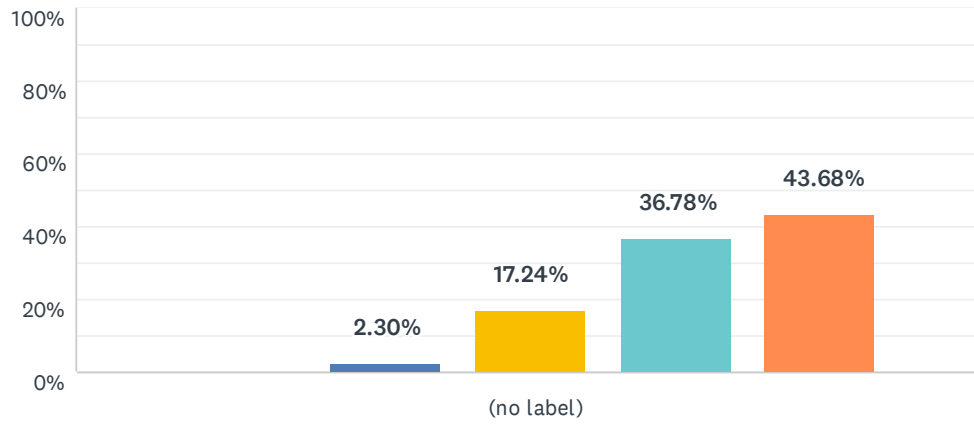


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.75%	24.14%	36.78%	33.33%	87	3.98
	0	5	21	32	29		

Q4 My interest in the subject matter was increased by the workshop

Answered: 87 Skipped: 2

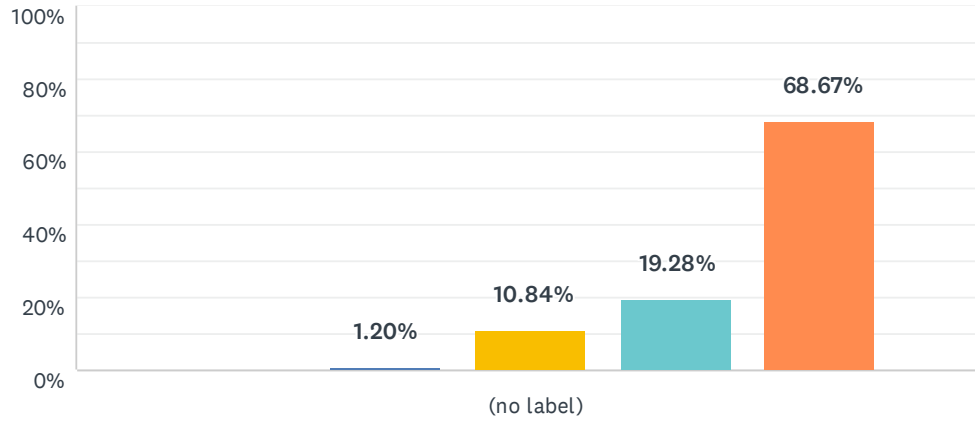


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.30%	17.24%	36.78%	43.68%	87	4.22
	0	2	15	32	38		

Q5 I found the MSRI staff helpful

Answered: 83 Skipped: 6

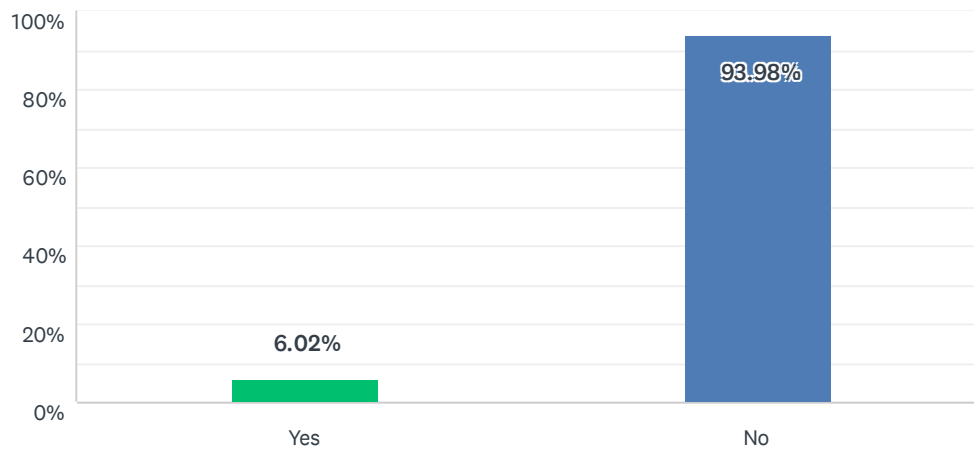


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.20% 1	10.84% 9	19.28% 16	68.67% 57	83	4.55

Q6 Did you experience any technical difficulties accessing the online workshop?

Answered: 83 Skipped: 6



ANSWER CHOICES	RESPONSES	
Yes	6.02%	5
No	93.98%	78
TOTAL		83

#	IF YES, PLEASE EXPLAIN	DATE
1	I had problems entering the tea room	5/27/2020 11:33 PM
2	Only thought: it seems the first talk started a bit early	5/27/2020 1:18 PM
3	my only difficulty was my home connection, but sometimes very hard to focus on a talk where you don't hear all the words	5/19/2020 3:53 PM
4	My home internet was slow.	5/15/2020 6:40 AM
5	Zoom is a software that requires a big RAM and a good Internet connection. It destroyed my RAM, my bandwidth couldn't handle it, my video and audio froze and cut constantly... There was a plethora of difficulties if one did not have a powerful computer and a good bandwidth.	5/6/2020 12:06 PM
6	I missed a few talks because the late changes in schedule were not announced (only listed on the website) and I was going off the original schedule. The same held true for the workshop in the previous week.	5/6/2020 11:50 AM

Q7 How did having the workshop held online impact your participation?

Answered: 83 Skipped: 6

918 (∞ , n)-categories, factorization homology, and algebraic K-theory: Participant Survey

#	RESPONSES	DATE
1	Sadly, it was difficult to impossible to have side discussions "between talks".	6/2/2020 12:37 PM
2	...	5/29/2020 7:48 PM
3	Less interactive	5/28/2020 11:10 AM
4	I was only able to participate because the workshop was online.	5/28/2020 8:44 AM
5	Yes, I did not attend all of the talks.	5/28/2020 8:21 AM
6	i couldn't participate otherwise	5/27/2020 11:33 PM
7	I watched only very few of the talks.	5/27/2020 10:44 PM
8	It made it possible for me to go	5/27/2020 5:48 PM
9	More selective in attending talks, less overall participation	5/27/2020 3:09 PM
10	Given that now this was a regular teaching week that I couldn't take off from, I was able to give my talk, but I was not able to participate as much as if I could have if I had taken the week off to travel there and be fully immersed in the workshop.	5/27/2020 2:36 PM
11	a little bit because I couldn't discuss with others	5/27/2020 2:22 PM
12	I was unaware of some of the schedule changes and was confused about when there is talk. It is helpful to have announcements online.	5/27/2020 2:13 PM
13	It was so nice! It is difficult for me to travel, so having immediate access eased my learning ability.	5/27/2020 1:41 PM
14	Harder to focus properly	5/27/2020 1:27 PM
15	.	5/27/2020 1:21 PM
16	Unfortunately, I was a selective in which talks I attended. The biggest part of attending a conference is the interaction with the other participants. Staying at home, I was more set on working on my own research than just watching talks all day without much interaction with the other participants.	5/27/2020 1:21 PM
17	I probably was a more passive participant since it was online	5/27/2020 1:18 PM
18	The only problem was with the difference is time zones.	5/27/2020 1:18 PM
19	That's ok	5/27/2020 1:17 PM
20	It allowed me to participate safely.	5/27/2020 1:17 PM
21	I would have likely attended more of the talks if not online. A collaborator was planning to come from Germany for the conference, and we likely would have made much progress on our project during that week.	5/21/2020 11:23 AM
22	I was unable to attend some of the lectures live as I am currently in Europe.	5/21/2020 2:08 AM
23	A lot, it was at the very beginning of shelter in place and I guess that I was not focused at all	5/19/2020 3:53 PM
24	online made participation possible.	5/19/2020 7:16 AM
25	less than I expected	5/19/2020 7:09 AM
26	I wasn't able to view as many of the lectures as I might have otherwise.	5/18/2020 8:45 AM
27	I found it a bit easier to become distracted/unfocused (although this may just be because I don't have a great home office setup). I was also less likely to attend talks that were inconvenient for my time zone.	5/17/2020 1:06 PM
28	The level of my participation was greatly reduced.	5/16/2020 12:18 PM
29	It made me less inclined to mingle with people during the coffee hours.	5/15/2020 11:30 AM
30	It helps me.	5/15/2020 7:42 AM
31	No	5/15/2020 7:34 AM

918 (∞ , n)-categories, factorization homology, and algebraic K-theory: Participant Survey

32	There is no impact.	5/15/2020 7:17 AM
33	It was significantly worse: hard for me to hold attention, feel engaged, feel like I could ask questions, feel like a talk would spark a discussion afterwards.	5/15/2020 6:40 AM
34	I was able to participate because it was online!	5/15/2020 4:56 AM
35	I was only able to participate because the workshop was online. It was extremely useful to watch the talks the day after they were recorded.	5/15/2020 1:55 AM
36	I attended one talk in this workshop, which had been moved from the workshop the previous week.	5/14/2020 8:53 PM
37	not much.	5/14/2020 3:57 PM
38	For me it is complicated to attend online talks given the current situation (no daycare, for example)	5/14/2020 2:30 PM
39	I was able to participate (was not planning to)	5/14/2020 2:23 PM
40	To be honest, I probably participated much less than I would have if the workshop had been held in person.	5/14/2020 2:20 PM
41	Could participate from across the globe, but the time difference made it hard to attend all talks live so not the same as being at MSRI in person	5/12/2020 2:24 AM
42	My original plan was not to attend the conference due to thesis defense preparation. Since the conference was virtual, I was able to attend.	5/11/2020 9:49 PM
43	I talked less or not at all with other participants	5/11/2020 3:01 PM
44	If it hadn't been online, I wouldn't have been able to participate.	5/11/2020 6:48 AM
45	It is certainly much less direct. Most of all, I missed the discussions that happen over coffee breaks with a smaller amount of people. It seems this is not replaceable with such an online format.	5/9/2020 2:38 AM
46	It was harder for me to stay focused, particularly for prerecorded talks.	5/8/2020 1:11 PM
47	It was OK otherwise I wouldn't have attended, but live is more of a true experience and you learn more.	5/8/2020 12:20 PM
48	I attended fewer talks than I would have in person.	5/7/2020 11:55 AM
49	I noticed little impact. In fact, I found it easier to focus in this online format compared to a lecture hall environment.	5/7/2020 7:18 AM
50	I felt that the moderators did a great job of simulating an in person conference experience.	5/7/2020 12:46 AM
51	Much more convenient	5/7/2020 12:41 AM
52	It is not ideal, obviously, but we have to make do.	5/6/2020 6:30 PM
53	Very good	5/6/2020 6:04 PM
54	I felt not easy to ask questions.	5/6/2020 5:52 PM
55	It was great to have it online. I wouldn't be able to attend in person	5/6/2020 5:04 PM
56	I attended talks more selectively than I would have otherwise. However, that may be just because of the starting covid crisis, rather than because of the online format.	5/6/2020 2:15 PM
57	It was definitely harder to motivate myself to stay engaged through all the talks without in-person socialization between. I'm also generally struggling with paying attention while staring at a screen, so this isn't really an MSRI-specific thing...	5/6/2020 1:38 PM
58	absence of direct interaction between participants was unfortunate	5/6/2020 1:10 PM
59	It mostly prevented interactions with other members. As a young researcher, I was hoping to start new collaborations during this workshop. I was not able to do that in this workshop, mostly due to having an online workshop. The time difference between Europe and the US didn't help either.	5/6/2020 1:07 PM

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60	I missed interacting with other participants.	5/6/2020 12:52 PM
61	I just listened to lectures that I really wanted to hear in advance. Having been present physically at the workshop I would have gone to more talks since I'd already made the effort to travel to MSRI.	5/6/2020 12:42 PM
62	I would've enjoyed it in real life much better, but the talks were still good. The coffee-breaks were definitely not as good, as question 8 is getting at.	5/6/2020 12:38 PM
63	I couldn't attend all the lectures because of a very big time difference with California. The participation through the chat was awkward when the speaker didn't notice the comments. Also, it wasn't good when there were long discussions on the chat without the speaker.	5/6/2020 12:32 PM
64	Of course, it did not replace actually being present.	5/6/2020 12:31 PM
65	It allowed me to take part in it even if I was unable to come to MSRI this spring (independently of the pandemic)	5/6/2020 12:30 PM
66	It helped greatly, given all the coronavirus related issues going on!	5/6/2020 12:07 PM
67	Unfortunately it negatively impacted my participation. I couldn't always follow the speaker because of technical difficulties with Zoom, and sometimes my computer simply would crash because of Zoom. I couldn't even access some of the talks because of this. I was also looking forward to talking with some of the senior participants, and to asking questions attempting to clarify some of my current research, and doing this online is between impossible and horribly awkward.	5/6/2020 12:06 PM
68	Due to funding from my university, it wouldn't have been possible to be at Mari physically, so having the workshop online gave me the chance to participate.	5/6/2020 12:02 PM
69	I attended fewer talks.	5/6/2020 12:00 PM
70	It was sort of difficult because I wasn't in the same timezone.	5/6/2020 11:59 AM
71	It made interacting with the other participants worse. Made travel easier.	5/6/2020 11:55 AM
72	Did not impact	5/6/2020 11:52 AM
73	I attended way fewer talks than I would have done otherwise.	5/6/2020 11:50 AM
74	Not all talk have been possible to attend because of being in germany during that time.	5/6/2020 11:50 AM
75	It was better than nothing, but obviously not really a replacement for a real workshop.	5/6/2020 11:49 AM
76	I did not attend most talks.	5/6/2020 11:44 AM
77	For the remainder please refer to my comments for the Tensor Categories workshop	5/6/2020 11:42 AM
78	Felt less inclined to interact with the other participants of the workshop	5/6/2020 11:42 AM
79	I didn't take the week off teaching as I had expected, so I could only make some talks.	5/6/2020 11:41 AM
80	It made it easier for me to participate, since I didn't have to take time off from the office to attend.	5/6/2020 11:36 AM
81	I would not have participated otherwise.	5/6/2020 11:36 AM
82	Yes - since I'm in Europe, I could attend only half of the talks.	5/6/2020 11:35 AM
83	No	5/6/2020 11:34 AM

Q8 One important aspect that was missing due to the online format was interaction between participants. Do you have any suggestions on how we can provide this interaction if we hold future workshops online?

Answered: 30 Skipped: 59

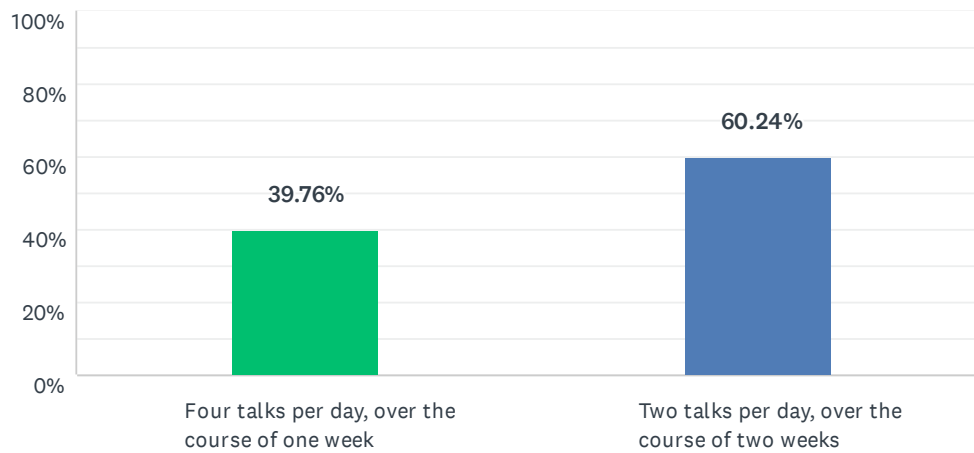
918 (∞ , n)-categories, factorization homology, and algebraic K-theory: Participant Survey

#	RESPONSES	DATE
1	it was great the way it run	5/27/2020 11:33 PM
2	More coffee breaks and breakout rooms that participants can move themselves in between.	5/27/2020 2:36 PM
3	Some sort of chatting platform?	5/27/2020 2:22 PM
4	The tea rooms are really nice and you can do breakout rooms too :).	5/27/2020 1:41 PM
5	Virtual coffee breaks between the talks	5/27/2020 1:21 PM
6	I think virtual coffee breaks would have been helpful to facilitate interaction.	5/27/2020 1:18 PM
7	I have no suggestions, I do really think that MSRI made it the most comfortable and easy going due to the situation	5/19/2020 3:53 PM
8	parallel text mechanism(s).	5/19/2020 7:16 AM
9	Provide opportunites for small group chat, perhaps by using the zoom breakout room feature.	5/19/2020 7:09 AM
10	Discord might be a good way to chat	5/15/2020 7:34 AM
11	The "Tea Rooms", coupled with the Seminars, might serve well. A speaker holding "office hours" after their talk might serve well.	5/15/2020 6:40 AM
12	That is the most interesting part of attending to conferences to me but I am not sure how to do this online. The tearoom is good but again due to my personal situation it is almost impossible to join	5/14/2020 2:30 PM
13	Make a disco! Look at Zoomerfest (a maths online seminar) discos, aren't they cool?	5/14/2020 2:23 PM
14	I think virtual coffee breaks with breakout rooms would be very helpful.	5/14/2020 2:20 PM
15	Unfortunately, I do not really know. Maybe having many small "tea rooms" with topics assigned to them (e.g. K-theory, chromatic homotopy theory, ...) so that people with same current interests can meet directly?	5/9/2020 2:38 AM
16	It would have been nice to see a list of participants, or have participants visible in gallery mode as they filter in to the talk ahead of time (before recording), to get a sense of who else was there. Maybe this was the purpose of the tearoom.	5/8/2020 1:11 PM
17	Maybe let people see the participants list and be able to message each other?	5/7/2020 7:18 AM
18	After the talks, there was a virtual coffee hour where participants could converse. Even though it wasn't a perfect replacement, there was some aspect of interaction between participants, which I appreciated.	5/7/2020 12:46 AM
19	Virtual tea room is enough	5/7/2020 12:41 AM
20	Sessions where non-speaker participants introduce themselves.	5/6/2020 2:15 PM
21	It is very hard to simulate informality online. Some mingling at virtual tea time is possible but there is always a barrier to approach people one has never met in person before.	5/6/2020 12:42 PM
22	I'm not sure, and I don't envy you the challenge	5/6/2020 12:38 PM
23	Interaction with other participants is difficult to substitute online. The coffee rooms were a good try.	5/6/2020 12:32 PM
24	Some kind of small breakout study/discussion groups?	5/6/2020 12:07 PM
25	It would be nice if participants could unmute themselves and ask questions during the talks. Perhaps even if the talks were prerecorded there could be a "live" viewing where the speaker is present and can pause the recording to answer "live" questions.	5/6/2020 11:50 AM
26	Keep having the "tea rooms."	5/6/2020 11:44 AM
27	The "tea rooms" held after some talks were useful, but not perfect.	5/6/2020 11:41 AM
28	I have heard that pre-recording the lecture and then having the lecturer fully available to answer audience questions goes well.	5/6/2020 11:36 AM

29	This is really hard.	5/6/2020 11:36 AM
30	I'm afraid - although online tearooms are nice - there is no actual replacement.	5/6/2020 11:35 AM

Q9 In the event that we must hold future workshops online, which of the following would be preferable?

Answered: 83 Skipped: 6



ANSWER CHOICES	RESPONSES	
Four talks per day, over the course of one week	39.76%	33
Two talks per day, over the course of two weeks	60.24%	50
TOTAL		83

#	OTHER (PLEASE SPECIFY)	DATE
1	3 per day would be better	5/28/2020 11:10 AM
2	Maybe it would be nice to have a few Q&A sessions with the speakers?	5/17/2020 1:06 PM

Q10 We welcome any additional comments or suggestions you may have to improve the overall online experience for future participants.

Answered: 10 Skipped: 79

#	RESPONSES	DATE
1	This workshop is great. Thanks!	5/27/2020 2:13 PM
2	Thank you for your lovely workshops. I'm so glad you are hosting virtually rather than canceling :).	5/27/2020 1:41 PM
3	Pre-recorded talks are much worse.	5/15/2020 6:40 AM
4	I was disappointed that MSRI chose to "lock down" a lot of features of Zoom. For example, I could not see the names of other participants, nor could I make a comment or ask a question except through the moderators. These choices may have been out of fear of disruption by bad actors. That's a legitimate concern. Unfortunately, fear of a ruined meeting led to administrative decisions that ruined the meeting! MSRI faces particularly difficult challenges in our new online environment, since the institute's whole existence is based on participant travel! I encourage MSRI to think hard about its role in the future of the mathematics research community.	5/11/2020 6:48 AM
5	It was frustrating to see only some comments in the zoom chat. The onus was put on the participants to change the settings from visible to panelists to visible to all, but people continued to forego this. Is it possible to change the zoom setting so that the default chat is visible to all?	5/8/2020 1:11 PM
6	I like that the videos are posted online. I hope MSRI has something like a youtube account so that everything is at one place.	5/7/2020 7:18 AM
7	Talks should continue online accessibility even after pandemic clears. I know msri makes talks available afterwards	5/6/2020 5:04 PM
8	I think it would be cool to have some social events/ platforms just for junior participants. While it's very good to get to talk to speakers, etc., one thing I have really enjoyed about in-person MSRI conferences is that I get to know a good number of the grad students in attendance pretty well.	5/6/2020 1:38 PM
9	Make slides/records of talks available online if the speaker agrees.	5/6/2020 12:42 PM
10	The difference in time zones is an issue to participation, but I am not sure how to solve it.	5/6/2020 11:59 AM

**Hot Topics: Optimal transport and
applications to machine learning and
statistics**

May 4, 2020 – May 8, 2020

MSRI, Berkeley, CA, USA (Online/Remote)

Organizers:

Luigi Ambrosio (Scuola Normale Superiore)

**Francis Bach (École Normale Supérieure; Institut National de
Recherche en Informatique Automatique (INRIA))**

Katy Craig (University of California, Santa Barbara)

Carola-Bibiane Schönlieb (University of Cambridge)

Stefano Soatto (University of California, Los Angeles)

REPORT ON THE MSRI WORKSHOP
“Hot Topics: Optimal transport and applications to machine learning and statistics”
May 4 – 8, 2020

Organizers

- Luigi Ambrosio (Scuola Normale Superiore)
- Francis Bach (École Normale Supérieure; Institut National de Recherche en Informatique Automatique (INRIA))
- Katy Craig (University of California, Santa Barbara)
- Carola-Bibiane Schönlieb (University of Cambridge)
- Stefano Soatto (University of California, Los Angeles)

Scientific Description

The goal of the workshop was to explore the many emerging connections between the theory of Optimal Transport and models and algorithms currently used in the Machine Learning community. In particular, the use of Wasserstein metrics and the relation between discrete models and their continuous counterparts will be presented and discussed.

Highlights of the Workshop

- Gabriel Peyré provided an introduction to how optimal transport can be used in high dimensional machine learning contexts and discussed recent work on how deep generative models can be used to learn cost functions.
- Matthew Thorpe presented new results on a linearization of the Hellinger-Kantorovich metric, which give rise to a fast numerical method for image processing applications.
- Phillip Rigollet introduced a new method for computing barycenters in the Wasserstein metric, based on the interesting observation that one can obtain better curvature properties of the Wasserstein metric by restricting to certain classes of probability measures.
- Yunan Yang presented results on the behavior of the Wasserstein metric as a loss function, contrasting the behavior of the Wasserstein metric with negative Sobolev norms in terms of sensitivity to noise in the dataset.
- Nicolas Garcia Trillos showed how optimal transport can provide a framework for studying large data limits of operators on graphs and presented new quantitative results on the rate of convergence of graph Laplacians.
- Justin Solomon surveyed several ways in which optimal transport can be used to fuse different types of data, including federated learning.
- Lénaïc Chizat presented recent results using Wasserstein gradient flows to study the long time behavior of training two layer neural networks, as well as the overparametrized (continuum) limits.

- Andrea Montanari presented new gradient flow models for the training dynamics of neural networks.
- Dejan Slepčev showed how the Benamou-Brenier dynamic characterization of the Wasserstein metric can be used to define a Wasserstein gradient flow structure on graphs and presented results on the continuum limit of aggregation equations on graphs.

Organizers

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Francis	Bach	École Normale Supérieure
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Lenaic	Chizat	Centre National de la Recherche Scientifique (CNRS)
Codina	Cotar	University College London
Nicolas	Garcia Trillos	University of Wisconsin-Madison
Aude	Genevay	Massachusetts Institute of Technology
Franca	Hoffman	California Institute of Technology
Mikaela	Iacobelli	ETH Zurich
Andrea	Montanari	Stanford University
Adam	Oberman	Simon Fraser University
Gabriel	Peyré	École Normale Supérieure
Philippe	Rigollet	Massachusetts Institute of Technology
Dejan	Slepcev	Carnegie Mellon University
Justin	Solomon	Massachusetts Institute of Technology
Matthew	Thorpe	University of Manchester
Samy	Wu Fung	University of California, Los Angeles
Yunan	Yang	New York University, Courant Institute

Mathematical Sciences Research Institute

Hot Topics: Optimal transport and applications to machine learning and statistics (Moved Online)

May 4 - 8, 2020

Monday, May 4, 2020

9:15 AM - 9:30 AM		Welcome
9:30 AM - 10:30 AM	Gabriel Peyré	Scaling Optimal Transport for High dimensional Learning
10:30 AM - 11:00 AM		Break
11:00 AM - 12:00 PM	Matthew Thorpe	Linear Unbalanced Optimal Transport
12:00 PM - 2:00 PM		Break
2:00 PM - 3:00 PM	Philippe Rigollet	Computing Wasserstein barycenters using gradient descent algorithms

Tuesday, May 5, 2020

9:30 AM - 10:30 AM	Franca Hoffman	Kalman-Wasserstein Gradient Flows
10:30 AM - 11:00 AM		Break
11:00 AM - 12:00 PM	Yunan Yang	A Deeper Understanding of the Quadratic Wasserstein Metric in Inverse Data Matching
12:00 PM - 2:00 PM		Break
2:00 PM - 3:00 PM	Samy Wu Fung	A Machine Learning Framework for Solving High-Dimensional Mean Field Game and Mean Field Control Problems

Wednesday, May 6, 2020

9:30 AM - 10:30 AM	Mikaela Iacobelli	From quantization of measures to weighted ultrafast diffusion equations
10:30 AM - 11:00 AM		Break
11:00 AM - 12:00 PM	Codina Cotar	Equality of the Jellium and Uniform Electron Gas next-order asymptotic terms for Coulomb and Riesz potentials

Thursday, May 7, 2020

9:30 AM - 10:30 AM	Nicolas Garcia Trillos	Regularity theory and uniform convergence in the large data limit of graph Laplacian eigenvectors on random data clouds
10:30 AM - 11:00 AM		Break
11:00 AM - 12:00 PM	Adam Oberman	From an ODE to accelerated stochastic gradient descent: convergence rate and empirical results
12:00 PM - 2:00 PM		Break
2:00 PM - 3:00 PM	Pratik Chaudhari	Learning with Few Labeled Data
3:00 PM - 3:30 PM		Break
3:30 PM - 4:30 PM	Justin Solomon	Fusion with Optimal Transport

Friday, May 8, 2020

9:30 AM - 10:30 AM	Aude Genevay	Learning with entropy-regularized optimal transport
10:30 AM - 11:00 AM		Break
11:00 AM - 12:00 PM	Lenaic Chizat	Analysis of Gradient Descent on Wide Two-Layer ReLU Neural Networks
12:00 PM - 2:00 PM		Break
2:00 PM - 3:00 PM	Andrea Montanari	Mean field theory of neural networks: From stochastic gradient descent to Wasserstein gradient flows
3:00 PM - 3:30 PM		Break
3:30 PM - 4:30 PM	Dejan Slepcev	Nonlocal-interaction equations on graphs and gradient flows in nonlocal Wasserstein metric



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Micah	Pedrick	University of California, Santa Barbara
Gabriel	Peyré	École Normale Supérieure
Huy Tuan	Pham	Stanford University
Thomas	Pinder	University of Lancaster
Christopher	Policastro	New York University, Courant Institute
Donlapark	Pornopparath	Chiang Mai University
Anant	Raj	Max-Planck-Institut für Biologische Kybernetik
alain	rakotomamonjy	Université de Rouen (Haute-Normandie)
Robert	Ravier	Duke University
Kui	Ren	Columbia University
Philippe	Rigollet	Massachusetts Institute of Technology
Jorge	Rivero	University of Washington
Siddharth	Roheda	North Carolina State University
JAMES	RONAN	Dartmouth College
Joseph	Root	University of California, Berkeley
Hrittik	Roy	Università Della Svizzera Italiana
Soutrik	Roy Chowdhury	Katholieke Universiteit Leuven
Naoki	Saito	University of California, Davis
Adil	Salim	KAUST
Cristopher	Salvi	University of Oxford
flavia	santarcangelo	SISSA
Matheus	Santos	Universidade Federal do Rio Grande do Sul
Soham	Sarkar	École Polytechnique Fédérale de Lausanne (EPFL)
Meyer	Scetbon	École Nationale de la Statistique et de l'Administration Économique
Carola-Bibiane	Schönlieb	University of Cambridge

Participants

First Name	Last Name	Institution
Jan	Segert	University of Missouri
Christof	Seiler	Maastricht University
Alessandro	Selvitella	Purdue University Fort Wayne
Albert	Senen	Technische Universiteit Eindhoven
Patricio	Sepúlveda	University of Concepción
Vera	Shalaeva	INRIA Lille
Chao	Shen	Duke University
Zebang	Shen	University of Pennsylvania
Qin	Sheng	Baylor University
Ankita	Shukla	IIIT Delhi
David	Simmons	University of Washington
Umut	Simsekli	École Nationale Supérieure de Télécommunications (ENST)
Sidak Pal	Singh	École Polytechnique Fédérale de Lausanne (EPFL)
PRIYANKA	SINHA	North Carolina State University
Robert	Smits	New Mexico State University
Stefano	Soatto	University of California, Los Angeles
Justin	Solomon	Massachusetts Institute of Technology
Rishi	Sonthalia	University of Michigan
Bharath	Sriperumbudur	Pennsylvania State University
Jan	Stanczuk	University of Cambridge
Austin	Stomme	Massachusetts Institute of Technology
Pablo	Suarez-Serrato	UNAM - Universidad Nacional Autónoma de México
Abiodun	Sumonu	University of Alabama
Shengding	Sun	Georgia Institute of Technology
Li-yeng	Sung	Louisiana State University
Lukasz	Szpruch	University of Edinburgh
Amirhossein	Taghvaei	University of California Irvine
Florian	Theil	University of Warwick
Matthew	Thorpe	University of Manchester
Diego	Tomassi	CONICET - Universidad Nacional del Litoral
Thanh-Son	Trinh	Sung Kyun Kwan University
Raghavendra	Tripathi	University of Washington
Janos	Turi	University of Texas at Dallas
Son	Van	Carnegie Mellon University
Raghav	Venkatraman	Carnegie Mellon University
Oleksandr	Vlasiuk	Florida State University
Dmitry	Vorotnikov	University of Coimbra
Neha	Wadia	University of California, Berkeley
Jun-Kun	Wang	Georgia Institute of Technology
erchi	wang	University of Illinois at Urbana-Champaign
Li	Wang	University of Minnesota, Twin Cities
Robert	Warnock	SLAC National Accelerator Laboratory
Andrew	Warren	Carnegie Mellon University
Julia	Wei	Reservoir Labs
Andre	Wibisono	Georgia Institute of Technology
Stephan	Wojtowytsch	Princeton University
Marie-Therese	Wolfram	University of Warwick
Jae Oh	Woo	Samsung SDS America
Samy	Wu Fung	University of California, Los Angeles
Qinglan	Xia	University of California, Davis
Lantian	Xu	Carnegie Mellon University
Miles	Yan	Brown University
Yongzhe	Yan	Université de Clermont-Ferrand II (Blaise Pascal)
Sho	Yokoi	Tohoku University
Tingzhou	Yu	University of Victoria
Sergey	Zagoruyko	Facebook AI Research
Jun	Zhang	University of Michigan
Shuangjian	Zhang	École Normale Supérieure

Participants

First Name	Last Name	Institution
Xiaomin	Zhang	University of Wisconsin-Madison
Cong	Zhou	Indiana University
Bohan	Zhou	University of California, Davis
Danlei	Zhu	Carnegie Mellon University

Officially Registered Participants Information

Participants		238
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Gender		236
Male	81.36%	192
Female	16.95%	40
Declined to state	1.27%	3
Other/Non-Binary	0.42%	1

Ethnicity*		252
White	39.29%	99
Asian	39.68%	100
Hispanic	5.56%	14
Pacific Islander	0.00%	0
Black	1.98%	5
Native American	0.79%	2
Mixed	3.17%	8
Declined to state	9.52%	24

* ethnicity specifications are not exclusive

Demographic information is only available for the 238 registered workshop participants. Because registration was encouraged but not required for the virtual workshops, an additional 26 workshop participants attended without registering, bringing the total number of workshop attendees to 264.

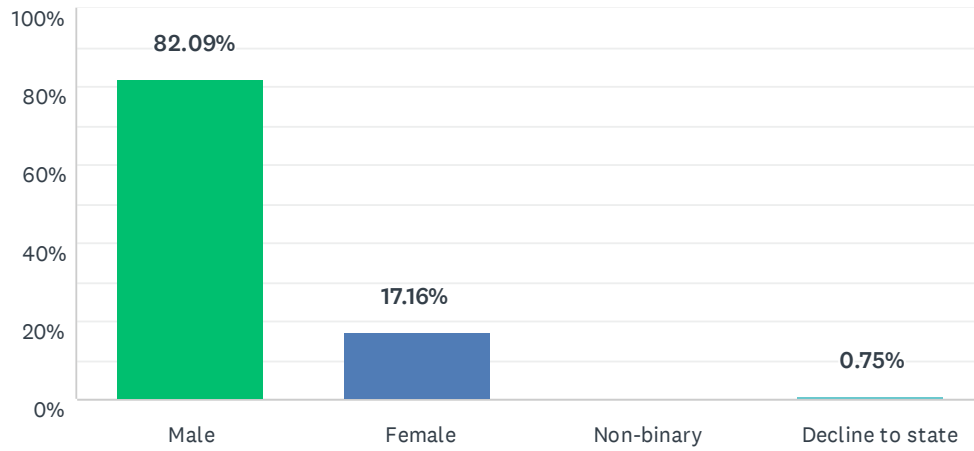
No expenses were incurred by participants as the workshop was solely held online.

MSRI incurred the usual costs associated with the work provided by the staff, as well as those associated with videorecording.

134 responses out of 264 participants = 51% response rate

Q1 Gender

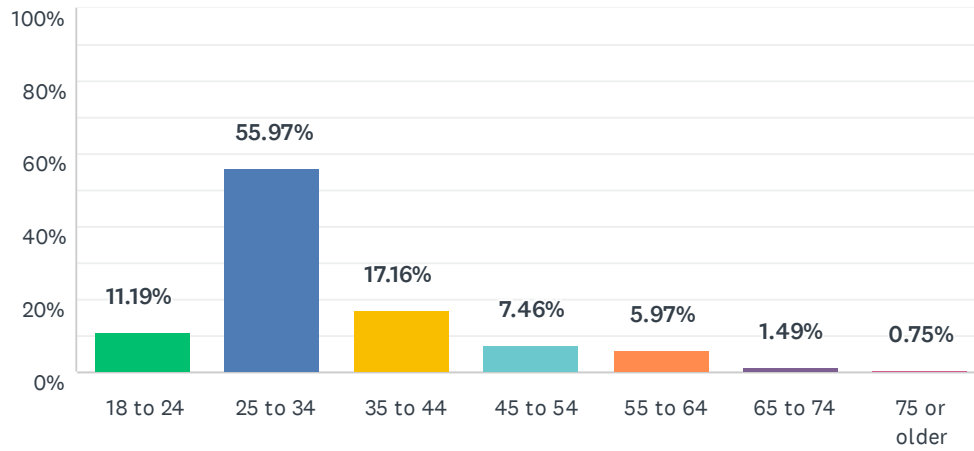
Answered: 134 Skipped: 0



ANSWER CHOICES	RESPONSES	
Male	82.09%	110
Female	17.16%	23
Non-binary	0.00%	0
Decline to state	0.75%	1
TOTAL		134

Q2 What is your age?

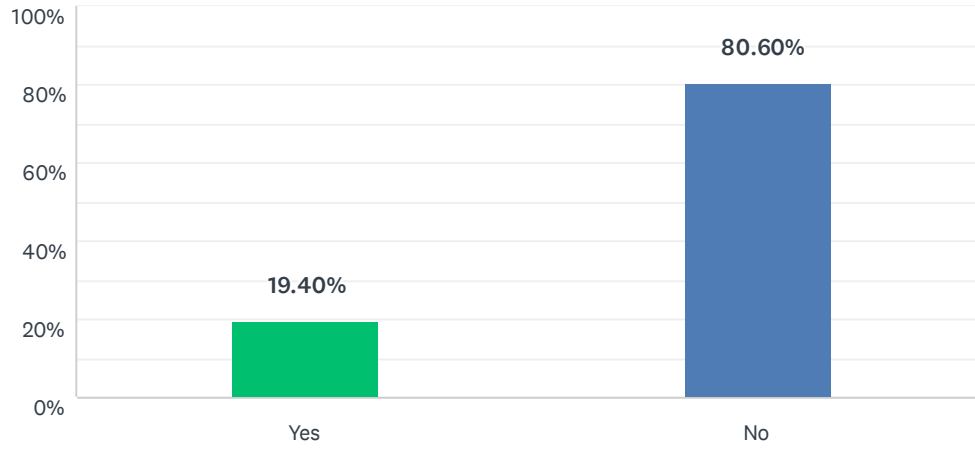
Answered: 134 Skipped: 0



ANSWER CHOICES	RESPONSES	
18 to 24	11.19%	15
25 to 34	55.97%	75
35 to 44	17.16%	23
45 to 54	7.46%	10
55 to 64	5.97%	8
65 to 74	1.49%	2
75 or older	0.75%	1
TOTAL		134

Q3 Do you have children at home?

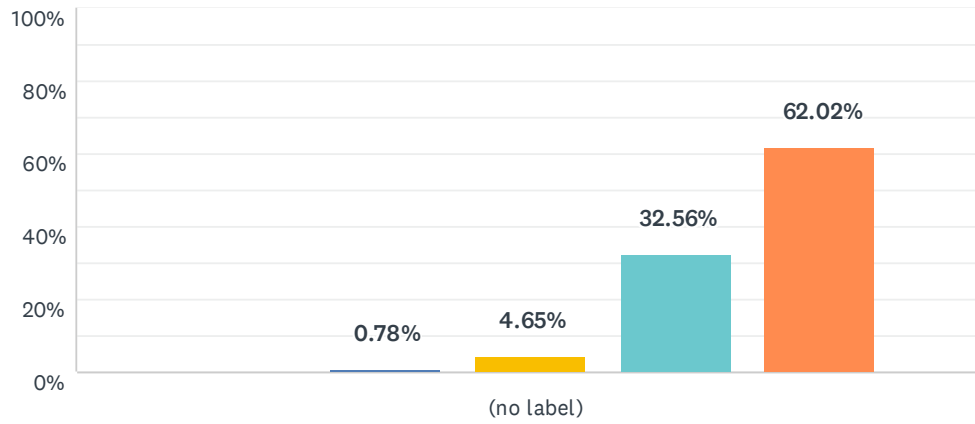
Answered: 134 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	19.40%	26
No	80.60%	108
TOTAL		134

Q4 The workshop was intellectually stimulating

Answered: 129 Skipped: 5

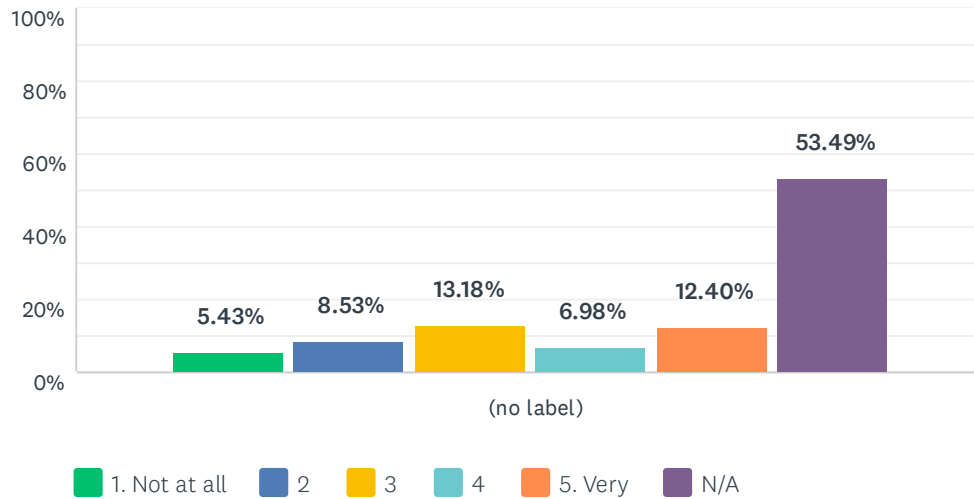


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.78%	4.65%	32.56%	62.02%	129	4.56
	0	1	6	42	80		

Q5 The virtual teas were useful

Answered: 129 Skipped: 5

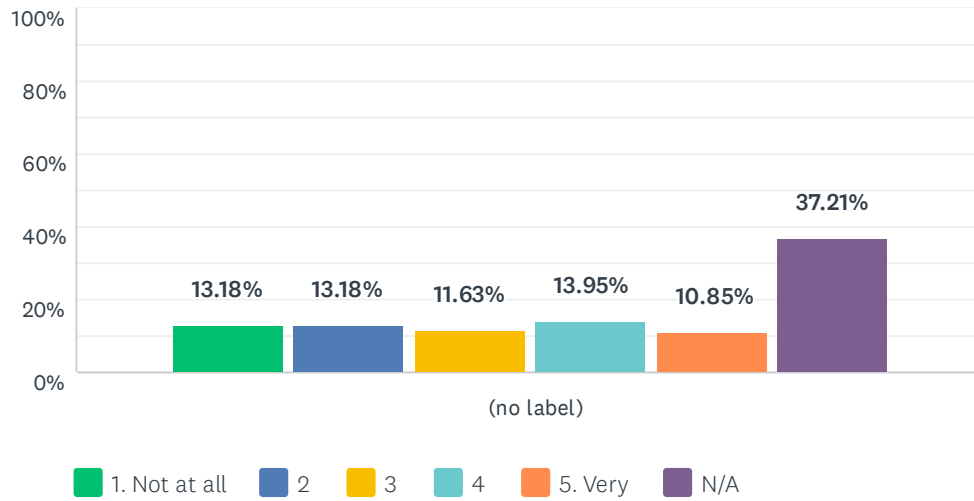


	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	5.43%	8.53%	13.18%	6.98%	12.40%	53.49%	129	3.27
	7	11	17	9	16	69		

#	COMMENTS ON THE VIRTUAL TEAS	DATE
1	Very helpful in conjunction with Slack Channel	5/28/2020 7:45 AM
2	did not attend	5/27/2020 2:35 PM
3	Started late, and it's hard to participate as only one person can speak a ta time.	5/16/2020 10:29 AM
4	Very few people attended the tea after my talk, and many of them were "lurkers" with the video off who didn't say anything. Perhaps it was just because my talk was at the end of the day.	5/15/2020 6:49 PM
5	I couldn't participate (due to time restrictions), but the idea seemed very enjoyable.	5/11/2020 6:16 PM
6	People don't utilize it as much as I hoped.	5/11/2020 12:54 PM
7	I didn't join	5/11/2020 11:56 AM
8	I only attended mine, had 3 participants but the discussion was useful	5/11/2020 11:52 AM
9	unfortunately could not attend the teas	5/11/2020 11:40 AM
10	Unfortunately I was not able to participate	5/11/2020 11:37 AM

Q6 The Slack channel was useful

Answered: 129 Skipped: 5

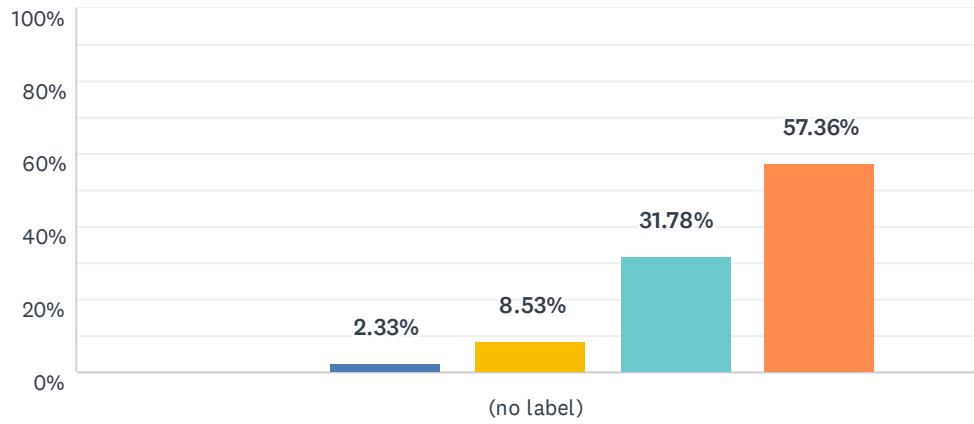


	1. NOT AT ALL	2	3	4	5. VERY	N/A	TOTAL	WEIGHTED AVERAGE
(no label)	13.18%	13.18%	11.63%	13.95%	10.85%	37.21%	129	2.94
	17	17	15	18	14	48		

#	COMMENTS ON THE SLACK CHANNEL	DATE
1	Great way to stay connected after the workshop	5/28/2020 7:45 AM
2	did not use	5/27/2020 2:35 PM
3	I joined but nobody used it. I regularly use Slack with my research group, but no-one used it for this event.	5/16/2020 10:29 AM
4	I have not yet seen any useful post on slack	5/12/2020 4:15 PM
5	People also don't utilize this as much as I hoped.	5/11/2020 12:54 PM
6	I didn't join	5/11/2020 11:56 AM
7	I did not use it	5/11/2020 11:52 AM

Q7 The overall experience of the workshop was worthwhile

Answered: 129 Skipped: 5

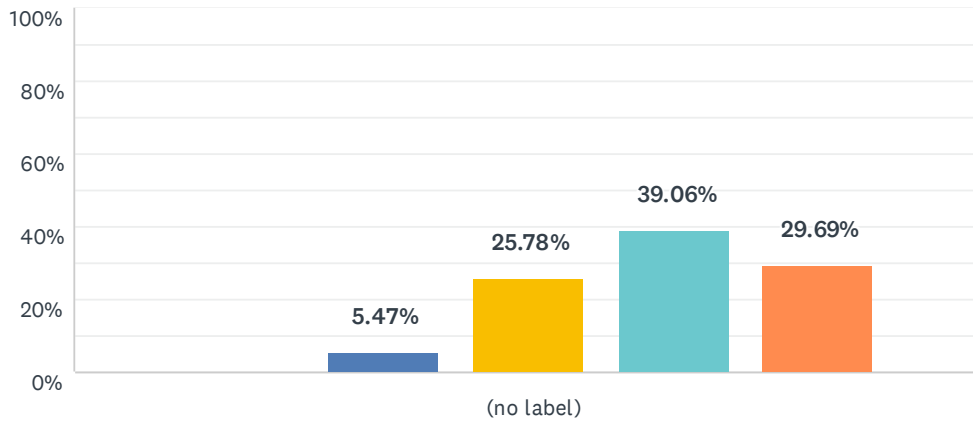


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	2.33% 3	8.53% 11	31.78% 41	57.36% 74	129	4.44

Q8 I was well prepared to benefit from the lectures

Answered: 128 Skipped: 6

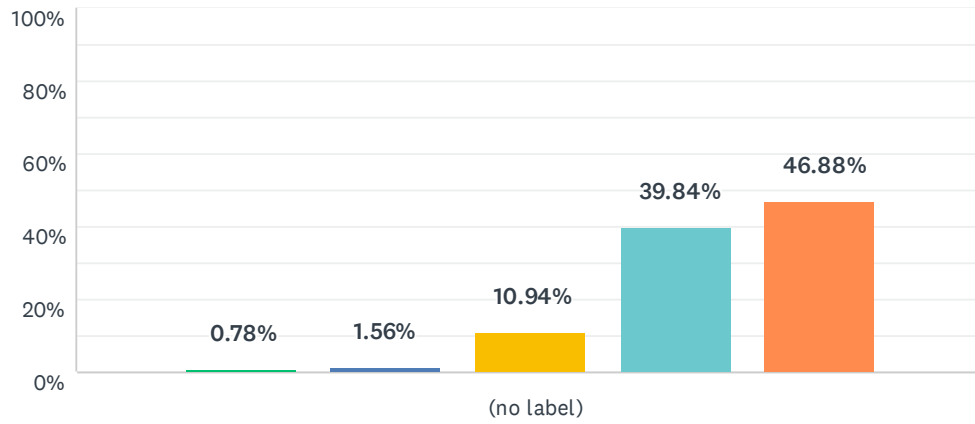


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	5.47% 7	25.78% 33	39.06% 50	29.69% 38	128	3.93

Q9 My interest in the subject matter was increased by the workshop

Answered: 128 Skipped: 6

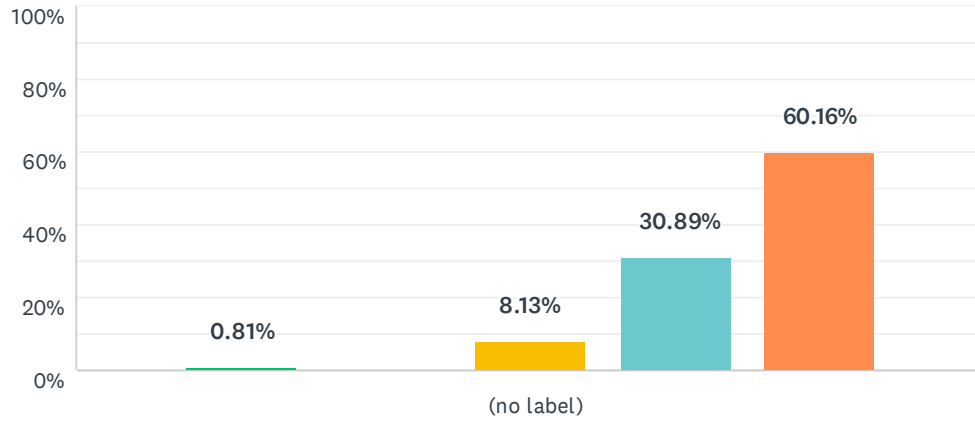


1. Not at all 2 3 4 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.78%	1.56%	10.94%	39.84%	46.88%	128	4.30
	1	2	14	51	60		

Q10 I found the MSRI staff helpful

Answered: 123 Skipped: 11

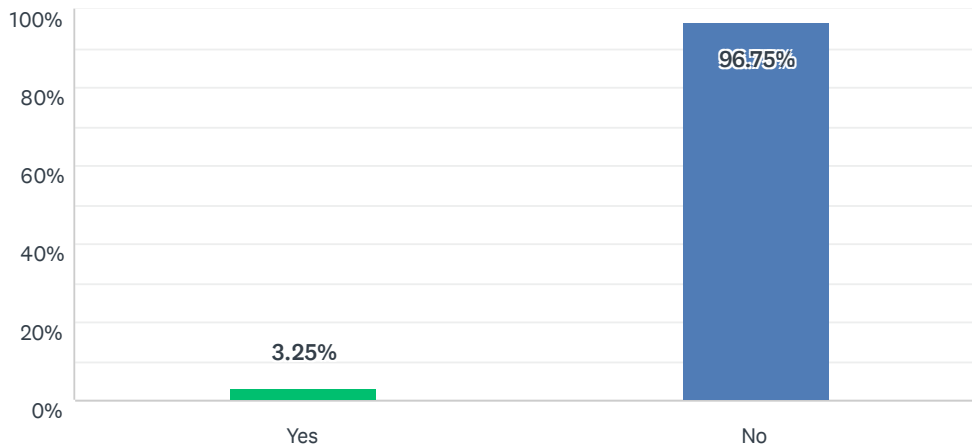


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very

	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.81%	0.00%	8.13%	30.89%	60.16%	123	4.50
	1	0	10	38	74		

Q11 Did you experience any technical difficulties accessing the online workshop?

Answered: 123 Skipped: 11



ANSWER CHOICES	RESPONSES	
Yes	3.25%	4
No	96.75%	119
TOTAL		123

#	IF YES, PLEASE EXPLAIN	DATE
1	On May 4, our local Internet provider (Comcast/Xfinity) had a network outage for 8 hours started around 9:45am. Hence, I missed most of the talks on Monday. Of course, I'm glad that they are available via videos.	5/12/2020 10:29 AM
2	As attendants of the workshop, I a not able to read the questions of the other people which are put in the chat.	5/11/2020 11:52 AM
3	The technical difficulties were on my end, and I was able to resolve them.	5/11/2020 11:39 AM

**Q12 How did having the workshop held online impact your participation?
For instance: did personal circumstances due to the pandemic hamper your participation in any way or was there a barrier to participation due to time zone differences?**

Answered: 123 Skipped: 11

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

#	RESPONSES	DATE
1	Zone difference affect me	6/4/2020 1:31 AM
2	It is challenging to focus for a long time in front of the screen.	5/29/2020 5:02 PM
3	It in fact increased my participation. I was able to listen to lectures that I would probably not have listened to because it would have forced me to spend the entire week at the workshop venue.	5/29/2020 8:06 AM
4	Time zone difference indeed hampered my participation for the lectures scheduled later in the day (California time). Having said that, being able to access the recorded lectures was quite useful.	5/29/2020 2:08 AM
5	The time zone difference was a barrier on few days.	5/28/2020 9:00 AM
6	Actually the online format facilitated my participation. I may not have been able to travel to Berkeley on account of teaching obligations.	5/28/2020 7:48 AM
7	Having it online probably increased my participation. It's far easier to take notes at my desk compared to being cramped into a lecture hall. I'm UK based, so timezones meant it wasn't ideal, but it can't be avoided - recording the talks made this less of an issue.	5/28/2020 1:50 AM
8	Time zone, Personal circumstances such as need to help my children with on line school	5/27/2020 7:23 PM
9	timezone different	5/27/2020 6:24 PM
10	I had no particular issues.	5/27/2020 4:13 PM
11	I had no problems with the workshop being online.	5/27/2020 3:53 PM
12	It was little harder to concentrate for long periods in online lectures.	5/27/2020 3:45 PM
13	There wasn't a problem with participating online. Everything was great!	5/27/2020 3:24 PM
14	Online workshop actually increased chances of my participation. I do not work directly in Optimal Transport field but I am trying to learn. If the workshop was not held online, I probably wouldn't have attended. Online talks reduced the barrier for me to access the talks.	5/27/2020 3:18 PM
15	Face to face interaction is limited.	5/27/2020 3:05 PM
16	I have 4 small kids at home so I could not assist many lectures. Time difference was not that crucial	5/27/2020 3:02 PM
17	Online format is great	5/27/2020 2:50 PM
18	No	5/27/2020 1:58 PM
19	It's actually more convenient to join the meeting without the physical trip.	5/27/2020 1:48 PM
20	online workshop made this event more accessible to me	5/27/2020 1:42 PM
21	not much, I planned to participate anyway.	5/27/2020 1:32 PM
22	easier for me to participate	5/27/2020 1:26 PM
23	no	5/27/2020 1:23 PM
24	yes, I could not attend most lectures since my kids were at home	5/27/2020 1:23 PM
25	I had no problems at all.	5/27/2020 1:23 PM
26	It was more difficult to attend every lecture because of other online meetings :(5/27/2020 1:23 PM
27	No, its was ok.	5/22/2020 3:26 PM
28	The online workshop works efficiently for me, there is no issue or barrier.	5/21/2020 3:59 PM
29	No change	5/18/2020 4:46 PM
30	It was not impacted at all.	5/18/2020 4:23 PM
31	The workshop being online did not really pose any significant issues. Still, I would certainly prefer in-person communication.	5/17/2020 10:42 AM

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

32	It was a little difficult to participate in talks toward the end of the day, since I am on Eastern Time.	5/16/2020 5:57 PM
33	I was fortunate to be in the central time zone.	5/16/2020 2:12 PM
34	There was some barrier to participation due to time zone differences but not essential in my case.	5/16/2020 1:50 PM
35	I was glad that it happened, but I was looking forward to meeting some of the other participants and then having interactions with them and the speakers.	5/16/2020 10:34 AM
36	Completely different than real workshop, like watching youtube videos.	5/16/2020 8:57 AM
37	The fact that videos were posted online made it possible to follow the workshop even when time zone or family restrictions got in the way.	5/16/2020 6:34 AM
38	I live in Europe so all talks were in the evening for me. Since I'm back to living with my family during the pandemic, I had family duties (dinner, dishes etc) that prevented me from attending talks.	5/16/2020 2:59 AM
39	I could not have attended the workshop if it was not online.	5/16/2020 2:25 AM
40	I skipped some of the talks due to time zone differences. The two-hour break really helped me get some naps though.	5/16/2020 2:04 AM
41	No problems at all!	5/16/2020 12:04 AM
42	no problems	5/15/2020 9:17 PM
43	I'm afraid it was too easy to skip the talks in favor of personal responsibilities at home, but that seems unavoidable given the current situation. One issue is that the talks were so spaced out and we weren't interacting between them, which led me to go back to work.	5/15/2020 6:51 PM
44	Due to the time zone difference, it is inconvenient for me to attend the workshop online.	5/15/2020 4:56 PM
45	I would have never joined the workshop if not online	5/15/2020 4:50 PM
46	na	5/15/2020 3:59 PM
47	Everything was fine.	5/15/2020 3:43 PM
48	I would not have been able to attend if it was held in person and so it helped enable me to participate. I'm also in PST (Washington State) and so there was no barrier due to that	5/15/2020 3:33 PM
49	I think the online setting made asking questions a little easier. However I was less inclined to participate in tea times than I would have been had I been physically present. I was also unclear what the format of the tea times were until I participated.	5/15/2020 3:30 PM
50	Nothing negative. In fact, because the workshop was moved online, I was able to participate, since I typically avoid long commute.	5/15/2020 3:08 PM
51	No specially since the talks were recorded I managed to see them the day after	5/15/2020 3:05 PM
52	it was pity there was no chance for participants to meet, discuss and interact with each other in research issues!	5/15/2020 3:03 PM
53	It feels so different compared to being in the workshop face to face. There are more distractions by participating remotely. Hard to concentrate 100% straight for a day, not to mention a week.	5/15/2020 3:00 PM
54	It actually made it easier to participate.	5/15/2020 2:59 PM
55	Being on the US East Cost, the time zone difference was not optimal, but acceptable.	5/15/2020 2:56 PM
56	The time zone works fine for me. Especially, the videos were uploaded online the second day, which made everyone so happy.	5/14/2020 1:48 PM
57	NA, at the same timezone.	5/13/2020 10:05 AM
58	No barriers to participation.	5/12/2020 8:25 PM
59	Online workshop prevents from simultaneous feedbacks and questions, and lose of in person contact for further discussion	5/12/2020 4:19 PM

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

60	It was easier online	5/12/2020 12:23 PM
61	Somehow, compared to the in-person workshop lectures, listening several zoom-based lectures per day was quite tiring and required a lot of efforts to focus on them.	5/12/2020 10:29 AM
62	None. The online participation experience is terrific.	5/12/2020 8:40 AM
63	I think the online aspect in general went well. However, I do find it hard when we can not ask questions directly to the speakers during the talks. Instant feedback is very useful to me.	5/12/2020 8:23 AM
64	to me was really useful because i can see this workshop online, rather than travel outside of my country and go to the workshop	5/12/2020 6:25 AM
65	I couldn't attend the workshop otherwise	5/12/2020 3:57 AM
66	No problem. Overall I do like online workshops.	5/11/2020 11:34 PM
67	A little bit, because of 9 hours difference	5/11/2020 10:45 PM
68	No, Not at all.... I was able to participate in the workshop without any hindering...	5/11/2020 10:13 PM
69	In my case it is time zone difference.	5/11/2020 7:10 PM
70	a barrier due to time zone differences. I am from Asia.	5/11/2020 6:45 PM
71	I would have never participated in the workshop hadn't it been online! I live very far away from Berkley, and even though the time zone differences did place some restrictions, I was very glad for all of the talks that I have still been able to enjoy.	5/11/2020 6:35 PM
72	Not at all	5/11/2020 6:15 PM
73	If I attended in person I would probably ask more questions	5/11/2020 5:43 PM
74	It was great	5/11/2020 3:21 PM
75	due to the time zone difference i sometimes forgot the talks (in the evening for my time zone). but the fact that they were online the next day was really a good thing to catch up.	5/11/2020 3:13 PM
76	Yes. Time zone difference.	5/11/2020 2:36 PM
77	I could attend the workshop because it was held online	5/11/2020 2:07 PM
78	I missed most lectures due to time zone difference. I'm based in California, but currently waiting for US borders to reopen to return. As I'm in Europe, there are only few hours overlaps in the workday, and most of it is taken up by essential work meetings.	5/11/2020 2:03 PM
79	The online version of the workshop is perfect for me.	5/11/2020 1:32 PM
80	Online participation was helpful.	5/11/2020 1:31 PM
81	Having a time difference, my kids at home, made it harder to fully participate. But having the videos online did let me attend a large portion of the talks. But interaction between other participants was very much missing.	5/11/2020 1:15 PM
82	Apart from being able to talk to other participants, having the workshop online was very helpful because I was able to arrange my regular schedule around it more easily.	5/11/2020 1:14 PM
83	It was convenient for me.	5/11/2020 1:11 PM
84	no. doesn't have impact.	5/11/2020 1:10 PM
85	just some problems for the last talks of the day given the time zone differences	5/11/2020 12:59 PM
86	It didn't impact my participation much. But looking at the screen for a long time tires me out. It would be helpful if online workshops span a longer period of time. We don't have travel and hotel costs so that would be doable. I would learn more from each lecture this way.	5/11/2020 12:57 PM
87	no interaction	5/11/2020 12:55 PM
88	Online workshop is very convenient.	5/11/2020 12:55 PM
89	I only participated because it was held online	5/11/2020 12:43 PM
90	I participated to the workshop *because* it was online : I wouldn't have been allowed to travel	5/11/2020 12:34 PM

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

that far in normal times. But being able to attend the talk without traveling was amazing.

91	just missing the person to person interaction	5/11/2020 12:27 PM
92	No, there were no barriers for me to participate in the workshop.	5/11/2020 12:25 PM
93	That the workshop was held online made it possible forme to attend	5/11/2020 12:24 PM
94	I was able to participate online either real time or recorded sessions. I may not have been able to come in person, even without the Covid business.	5/11/2020 12:20 PM
95	Two young children at home made it difficult to participate	5/11/2020 12:19 PM
96	Facilitated.	5/11/2020 12:16 PM
97	I could only access the workshop because it was held online	5/11/2020 12:16 PM
98	Helped participation	5/11/2020 12:11 PM
99	I would not have attended had it not been online	5/11/2020 12:01 PM
100	I was invited a week before my presentation, so it did not affect me much.	5/11/2020 12:01 PM
101	I think the time difference is really a issue, that is why most of us will prefer a actual in person workshop if that is allowed.	5/11/2020 12:01 PM
102	It was nice to be able to watch the lectures on my own time if I could not attend them live.	5/11/2020 11:59 AM
103	This was a good experience, in some way better.	5/11/2020 11:57 AM
104	good	5/11/2020 11:56 AM
105	It gives me opportunity to participate the workshop actually.	5/11/2020 11:55 AM
106	Barrier due to time zone differences	5/11/2020 11:54 AM
107	It was difficult to attend talks due to time zone differences.	5/11/2020 11:53 AM
108	I can not see other participants. And it feels weird	5/11/2020 11:52 AM
109	I like virtual workshops much better, as it helps me to collect more information via print screens or recording rather than just physically listening and missing some parts due to speed of speakers, etc.	5/11/2020 11:46 AM
110	For Europe attending the live late night talks were difficult (after 11 pm talks i.e. 2 pm PST).	5/11/2020 11:44 AM
111	the online format was great	5/11/2020 11:42 AM
112	Would not have joined if it was not online, because I only heard about it from a collaborator on the day before it started.	5/11/2020 11:41 AM
113	time differences were a big issue (9hours)	5/11/2020 11:41 AM
114	Yes; I had more meetings, so I wasn't able to attend as easily and be as present during all the talks as I would have been in person. The breaks also felt shorter than if I were there in person	5/11/2020 11:40 AM
115	The time zone was a minor issue.	5/11/2020 11:39 AM
116	The workshop online actually made it easier for me to attend.	5/11/2020 11:39 AM
117	no	5/11/2020 11:39 AM
118	skipped many presentations	5/11/2020 11:39 AM
119	The participation was made complicated due to time zone differences	5/11/2020 11:39 AM
120	Easier to participate.	5/11/2020 11:38 AM
121	n/a	5/11/2020 11:38 AM
122	There was a barrier with the talks scheduled late during the day.	5/11/2020 11:38 AM
123	I'm in the same timezone as MSRI. The only hindrance was childcare responsibilities.	5/11/2020 11:38 AM

Q13 One important aspect that was missing due to the online format was interaction between participants. Do you have any suggestions on how we can provide this interaction if we hold future workshops online?

Answered: 41 Skipped: 93

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

#	RESPONSES	DATE
1	organize one single slot for questions and discussion (probably in groups by topics...	6/4/2020 1:31 AM
2	One way to encourage people to participate is to have a small 5 minute break in the middle of the talk for questions/chat. The tea times at the end of the talk are sparsely populated.	5/29/2020 8:06 AM
3	Not sure. I would prefer physical interaction between participants.	5/28/2020 9:00 AM
4	Any messaging platform that allows for impromptu video conferencing should help with one-on-one interaction	5/28/2020 7:48 AM
5	I'd push the usage of Slack (or other messaging service). This could be good for interactions, but from what I saw there wasn't much activity on Slack at this workshop.	5/28/2020 1:50 AM
6	Giving an opportunity for participants to ask questions in the middle of presentations. More than anything the interaction with other attendees was limited or nonexistent. I am not sure if there is any substitute to that.	5/27/2020 7:23 PM
7	Yes, it is very important that is why online conferences cannot properly replace the regular ones	5/27/2020 3:02 PM
8	other break out groups. One conf I attended did speed mentoring in 10 minute blocks between senior and junior researchers, which I thought was cool! (you had to sign up for limited slots in advance, which were all booked!)	5/27/2020 1:23 PM
9	I would have likely benefited from in person interaction by feeling more comfortable asking for very vague and general advice. Such as in person, I would asked a speaker where should one get started to read about field.	5/16/2020 2:12 PM
10	Breakaway groups in zoom can also be arranged, so more conversations can happen in breaks. I appreciate the effort to hold this meeting, but the interaction aspect is very hard to replicate online.	5/16/2020 10:34 AM
11	More zoom breakout groups,open problem sessions, I have 8 slack channels to monitor already, I don't need another one.	5/16/2020 8:57 AM
12	I personally find it very hard to interact online with people I haven't met in real life -- I'm not sure what would make things easier for me. Maybe a session et the beginning of the weak where each speaker presents themselves in 5 minutes in an informal way?	5/16/2020 2:59 AM
13	It would be nice if Zoom can implement multiple chat rooms that allow people to freely switch between the rooms.	5/16/2020 2:04 AM
14	The talks were quite spaced out without activities in between. Perhaps specifically pairing people to talk to one another would help?	5/15/2020 6:51 PM
15	Maybe create some ice breakers in existing chats?	5/15/2020 4:50 PM
16	Perhaps make an online ice breaker or provide some method for students to connect with each other.	5/15/2020 3:30 PM
17	Online workshops are more like lectures for missing meeting and discussing between participants, unfortunately.	5/15/2020 3:03 PM
18	Reduce the frequency to 2 talks per day. That's a good scale for people to get most out of it. Or advertise the talks online, and make it super easy to access the videos later. I feel I benefit a lot by going back to the talk videos compared with listening on live.	5/15/2020 3:00 PM
19	If the participants are allow to speak out, instead of typing the answers, during the Q&A session, it will be much stimulating.	5/14/2020 1:48 PM
20	Maybe alignment of groups led by some professors, open to interested participants.	5/12/2020 4:19 PM
21	The fact that the audience could only ask questions by writing in Chat or Q&A part of the zoom system was not good. I wish we could have more direct interaction between the audience and the speakers. I wanted to try virtual tea rooms, but I couldn't. The bad thing about the virtual workshop is that one can put other meetings and seminars easily into one's schedule, which frequently become overwhelming. If one attends an in-person workshop, one cannot participate in the other meetings/seminars, and can focus on the contents of the workshop.	5/12/2020 10:29 AM
22	Perhaps having much more time for chats on either the topic of the workshop or on related	5/11/2020 11:34 PM

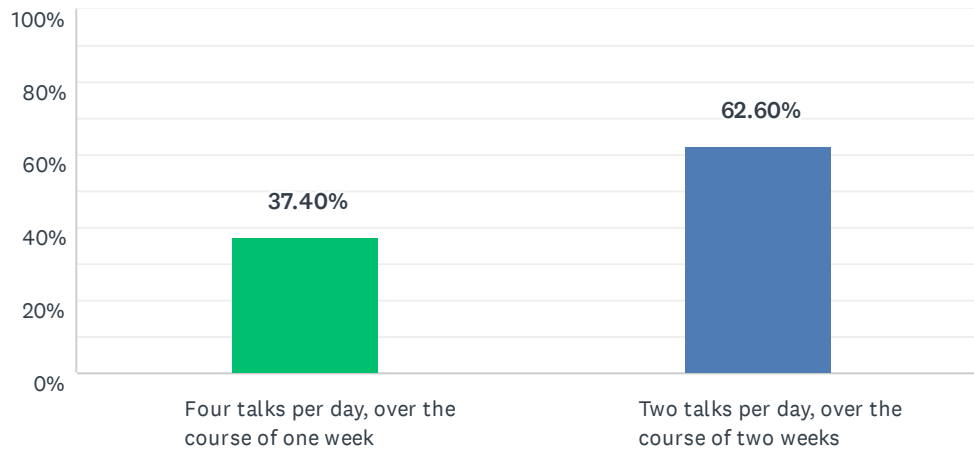
928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

topics. All participants are highly encouraged to take part in those chat by either asking question(s) directed to a certain other participant(s) or anyone in general. Also chats won't be confined to questions but also thoughts and comments pertaining to problems of interests to the various participants. This might entail knowing a bit more about the research background of the attendees including the speakers. In the course of any chat others can easily chime in whether the thought/question was directed toward them or not. Sort of an open discussion forum. As mentioned, sufficient time would be needed to it but I think this would be the closest thing to meeting in person and chatting about various research aspects etc. Anyway, this is my suggestion.

23	Go with 'Go To webinar platform '... Zoom is not that much reliable..	5/11/2020 10:13 PM
24	I have no suggestion.	5/11/2020 7:10 PM
25	Ok, this might sound weird, but it's all I have been able to come up with: somehow, before/after/inbetween the talks, generate a random partition of the participants set (maybe only the ones that are online at the time, or that voluntarily decide to partake on this), with maybe some fixed equivalence class size, (or with equivalence classes size restricted between 2 and some reasonable yet small-ish number, say 5; this actually sounds nicer) and put them in separate chat rooms, so that they can introduce themselves to each other, discuss the talks and etc. I think this could be pretty nice, it seems fun to me, but I guess it could be also perceived as invasive, therefore, it would have to be done somewhat carefully, so as not to be unpleasant to anyone.	5/11/2020 6:35 PM
26	No	5/11/2020 6:15 PM
27	No.	5/11/2020 1:31 PM
28	important; small group chats with members chosen based on interests, which should be collected through a online survey question (like this) before the workshop	5/11/2020 12:55 PM
29	I don't know, I do not feel like interaction between participants is super productive from my limited experience. Q&A with speakers was great and well organized !	5/11/2020 12:34 PM
30	Informal online discussion sessions.	5/11/2020 12:16 PM
31	Breakout chat rooms by topic	5/11/2020 12:01 PM
32	good	5/11/2020 11:56 AM
33	Personal interaction is very unique experience which I don't think is possible to achieve by virtual tools.	5/11/2020 11:55 AM
34	I really liked the interaction format, every one was muted unless the main speaker. Each person could interact via chat however.	5/11/2020 11:46 AM
35	Maybe having a virtual poster session where participants can interact.	5/11/2020 11:44 AM
36	having poster sessions and papers	5/11/2020 11:42 AM
37	n/a I thought it was great. Loved the virtual tea!	5/11/2020 11:40 AM
38	No, because it can't be done.	5/11/2020 11:39 AM
39	do not do it on-line just change dates	5/11/2020 11:39 AM
40	Unfortunately not. I think that the format was nice but the interaction is difficult	5/11/2020 11:39 AM
41	No	5/11/2020 11:38 AM

Q14 In the event that we must hold future workshops online, which of the following would be preferable?

Answered: 123 Skipped: 11



ANSWER CHOICES	RESPONSES	
Four talks per day, over the course of one week	37.40%	46
Two talks per day, over the course of two weeks	62.60%	77
TOTAL		123

#	OTHER (PLEASE SPECIFY)	DATE
1	This would allow folks with children to better manage their time.	5/16/2020 10:34 AM
2	If it's during the academic year then with teaching and other duties 2 is preferable. If it's during the summer then 4 would be fine.	5/15/2020 3:33 PM
3	it is not enough a participant can only speak to organizers...	5/15/2020 3:03 PM
4	then uploading videos would be good	5/13/2020 10:05 AM
5	Four talks per day via zoom are too much.	5/12/2020 10:29 AM
6	So that I could attend other online talks	5/12/2020 3:57 AM
7	Each talk could be up to or more than a couple hours or so to cover quite a bit of relevant materials. Its is not a tutorial but new research materials on a particular topic of relevance to the workshop.	5/11/2020 11:34 PM
8	considering the difference in time zones, I missed the afternoon talks. So I think less talks compatible with more audiences' time would be better.	5/11/2020 11:46 AM
9	do not do it on-line	5/11/2020 11:39 AM
10	two maximum three talks per day to accommodate more time zone	5/11/2020 11:39 AM

Q15 We welcome any additional comments or suggestions you may have to improve the overall online experience for future participants.

Answered: 23 Skipped: 111

928 Hot Topics: Optimal transport and applications to machine learning and statistics: Participant Survey

#	RESPONSES	DATE
1	organize a "tutorial" first (2-3 talks?)	6/4/2020 1:31 AM
2	I would encourage you to keep the divide between organizers and attendees. I have seen a Zoom conference derailed by outsiders trying to disrupt the discussion.	5/28/2020 7:48 AM
3	I'd just like to say that the talk quality was excellent, and the workshop's running and structure was really smooth.	5/28/2020 1:50 AM
4	Perhaps start a bit earlier to accommodate participants in other time zones.	5/27/2020 7:23 PM
5	It's difficult for a lot of us as more and more talks are online. I've been overbooked a few times. So stretching it out and making the talks (with speaker consent) available online (or even just only viewable as a recording to those who register through an embedded portal or something) might help. Enjoyed the workshop a LOT, though!	5/27/2020 1:23 PM
6	Having virtual teas seemed a great idea; I am still surprised it wasn't more popular. Perhaps the problem was with finding a better timing? I.e., some of the teas were held at a rather late hour in Europe. A naive suggestion would be to have them at the local tea hours — say, 5pm CET, then 5pm EDT, etc.	5/17/2020 10:42 AM
7	Make a short presentation of all the speakers and a preview of their talks (30s) so we know what to expect.	5/16/2020 8:57 AM
8	I really appreciate the efforts all organizers and staff put to make this going-on as planned.	5/12/2020 4:19 PM
9	I just want to thank the organizers and MSRI staff for organizing this workshop. The talks were in general of very high quality. Also, the video recording of those talks is essential.	5/12/2020 10:29 AM
10	On the above point 13, it is also highly recommended that the chat participants appear in video during the chat time. This would make the event much more closer to in person get-together.	5/11/2020 11:34 PM
11	I think certificate of participation may be provided....	5/11/2020 10:13 PM
12	I don't have any additional comments.	5/11/2020 7:10 PM
13	Thanks for the organization of such a wonderful workshop	5/11/2020 6:15 PM
14	What is different: usually at a conference, one takes time off to physically be present, and therefore concentrate on the conference. In an online environment it is harder to do so as all other responsibilities and meetings continue in addition to the workshop schedule.	5/11/2020 2:03 PM
15	It'd be nice to know who's in the room. IPAM lets people know about the participants.	5/11/2020 12:57 PM
16	connect the recommended reference material to each of the talks	5/11/2020 12:55 PM
17	It might be better if speakers can share their slides before their talks.	5/11/2020 12:55 PM
18	That was super well organized actually. Thank you !	5/11/2020 12:34 PM
19	I thought the workshop was done very well. Katy Craig in particular did a great job as host of online talks.	5/11/2020 12:20 PM
20	I missed some of the talks due to difference in time zones, however, it seems that something was wrong with link of downloading the recorded talks.	5/11/2020 11:46 AM
21	Try some way to make the in lecture Q&A sessions more interacting!	5/11/2020 11:44 AM
22	Really great. Loved the topic, and the talks were very relevant. Thank you!	5/11/2020 11:40 AM
23	on line workshop does not make any sense	5/11/2020 11:39 AM

Modern Math Workshop 2019
October 30, 2019 – October 31, 2019
Honolulu, HI, USA

Organizers:

Sudipta Dasmohapatra (Duke University)

**Christian Ratsch (University of California, Los Angeles;
Institute of Pure and Applied Mathematics (IPAM))**

Michael Singer (North Carolina State University)

**Ulrica Wilson (Morehouse College; Institute for
Computational and Experimental Research in Mathematics
(ICERM))**

Modern Math Workshop 2019: Final Report
October 30-31, 2019
Honolulu, HI

Description

Goal of Workshop

The Modern Math Workshop (MMW) is one of five programs coordinated through the Mathematical Sciences Institutes Diversity Initiative (MSIDI). With funding from the National Science Foundation, the MSIDI works together to increase the participation of under-represented groups in the mathematical sciences, including women, under-represented racial and ethnic minorities, and persons with disabilities.

MMW is a two-day pre-conference program in conjunction with the national meeting of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS). It reaches a broad audience of underrepresented minorities in the mathematical sciences. MMW goals include:

- Reinvigorate and inspire faculty from minorities serving universities and historically black colleges and universities
- Increase awareness of math-based career paths among underrepresented undergraduates
- Showcase research expositions aimed at underrepresented graduate students and researchers
- Provide mini-courses aimed at underrepresented undergraduates
- Host a networking reception to showcase the contemporary research happening at NSF-funded mathematical sciences institutes around the country

The following NSF Mathematical Sciences Institutes were represented at this workshop: IAS/PCMI, ICERM, IPAM, MSRI, and SAMSI.

Summary of Activities

The workshop took place in Honolulu, Hawai'i on October 30-31, 2019. Being a pre-conference event for SACNAS, it gave people who were already coming to the SACNAS meeting the opportunity to attend the MMW; it also allowed the people attending the Modern Math workshop the chance to stay for the SACNAS meeting.

- **Mini-courses:** Two half-day mini-courses were offered on October 30, running concurrently. They were "An introduction to optimal mass transportation" by Dr. Wilfrid Gangbo and "An introduction to matroid theory" by Dr. Anastasia Chavez. These mini-courses targeted mainly the undergraduate students.
- **Research Talks:** Five speakers gave research talks; "Machine Learning in the Physical Sciences: Applications in Hydrology" by Dr. Kathy Breen (IPAM), "Sparse Learning for Image-on-Scalar Regression with Application to Imaging Genetics Studies" by Dr. Xinyi Li (SAMSI), "The Cheeger Constant of a Jordan Domain Without Necks" by Dr. Robin Neumayer (IAS.PCMI), "Topological Methods for Magnetic Confinement" by Dr.

Gabriel Martins (MSRI) and “Direct Estimation of Appearance Models for Segmentation” by Dr. Marilyn Vazquez (ICERM).

- **Panel Discussion:** The panel consisted of the five speakers who gave research talks and was moderated by Dr. Ulrica Wilson. They spoke on the topic: “I’m In, Now What?!? How to Succeed in Graduate School and Beyond”.
- **Reception:** The NSF math institutes' networking reception immediately followed the Panel Discussion and was sponsored by University of San Francisco Data Institute.
- **Q&A:** The closing session of the workshop was a Q&A with NSF Math Institute representatives.

Broader Impacts

Cultivating diversity and broadening participation of historically underrepresented groups in the mathematical sciences are national goals that are identified by the National Science Foundation as essential components of the innovation engine that drives the Nation’s economy. There is no “one size fits all” to increasing participation from underrepresented groups, so the NSF MSIDI group raises funds to sponsor workshops like the Modern Math Workshop, which aim to address representation.

The broader impacts of the Modern Math Workshop include:

- increasing scientific and networking activities for members of underrepresented minority groups,
- increasing opportunities for mentoring and identification of role models for early career members of underrepresented minority groups, and
- increasing celebration of the successes of mathematical scientists from underrepresented minority groups

Intellectual Merit

Promoting the exchange of ideas is essential for the support of mathematical research and the development of the mathematical community. ICERM will be administering 2- and 4- year post-workshop “impact” surveys for this event, and SAMSI will provide a final analysis of the 4-year data. These coordinated evaluation efforts will be vital to assessing the reach and impact of the MMW.

Organizers

First Name	Last Name	Institution
Sudipta	Dasmohapatra	Duke University
Christian	Ratsch	University of California, Los Angeles
Michael	Singer	MSRI - Mathematical Sciences Research Institute
Ulrica	Wilson	Morehouse College

Speakers

First Name	Last Name	Institution
Katherine	Breen	Institute of Pure and Applied Mathematics (IPAM)
Anastasia	Chavez	University of California, Davis
Wilfrid	Gangbo	University of California, Los Angeles
Xinyi	Li	SAMSI - Statistical and Applied Mathematical Sciences Institute
Gabriel	Martins	California State University, Sacramento
Robin	Neumayer	Northwestern University
Marilyn	Vazquez	Mathematical Biosciences Institute (Ohio State University)

WEDNESDAY, OCTOBER 30TH

12:00 – 1:00	Registration/Check-in	Foyer
1:00 – 2:30	Undergraduate Mini Course Wilfrid Gangbo University of California, Los Angeles An introduction to optimal mass transportation	316B
1:00 – 2:30	Undergraduate Mini Course Anastasia Chavez University of California, Davis An introduction to matroid theory	316C
1:00 – 1:40	Research Talk – IPAM Kathy Breen Baylor University Machine Learning in the Physical Sciences: Applications in Hydrology	316A
1:45 – 2:25	Research Talk – SAMSI Xinyi Li Statistical and Applied Mathematical Sciences Institute Sparse Learning for Image-on-Scalar Regression with Application to Imaging Genetics Studies	316A
2:30 – 2:45	Break	Foyer
2:45 – 4:10	Undergraduate Mini Course Wilfrid Gangbo University of California, Los Angeles An introduction to optimal mass transportation	316B

WEDNESDAY, OCTOBER 30TH

- | | | |
|-------------|--|------|
| 2:45 – 4:10 | Undergraduate Mini Course
Anastasia Chavez
University of California, Davis
An introduction to matroid theory | 316C |
| 2:45 – 3:25 | Research Talk – IAS/PCMI
Robin Neumayer
Northwestern University
The Cheeger Constant of a Jordan Domain Without Necks | 316A |
| 3:30 – 4:10 | Research Talk – MSRI
Gabriel Martins
California State University, Sacramento
Topological Methods for Magnetic Confinement | 316A |
| 4:15 – 5:00 | Panel Discussion
Moderator: Ulrica Wilson
Morehouse College
I'm In, Now What?!?
How to Succeed in Graduate School and Beyond | 316A |
| 5:00 – 6:00 | Modern Math Workshop Reception | 315 |

THURSDAY, OCTOBER 31ST

- | | | |
|---------------|---|-------|
| 9:00 – 9:30 | Coffee and Pastries | Foyer |
| 9:30 - 10:10 | Research Talk – ICERM
Marilyn Vazquez
Mathematical Biosciences Institute
Direct Estimation of Appearance Models for Segmentation | 316A |
| 10:10 - 11:00 | Q&A with Institute Representatives | 316A |

Participants

First Name	Last Name	Institution
Nimish	Adhikari	Tufts University
Sara	Amato	Worcester Polytechnic Institute
Nana	Ankrah	Cornell University
Joshua	Asuncion	University of Hawaii-West Oahu
Mario	Banuelos	California State University, Fresno
Keller	Blackwell	University of South Florida
Katherine	Breen	Institute of Pure and Applied Mathematics (IPAM)
Olga	Bustamante	Arizona State University
Jan Tracy	Camacho	University of California, Davis
Michele	Capovilla-Searle	Case Western Reserve University
Noelani	Cassidy	University of Hawaii at Manoa
Brian	Chau	University of Central Florida
Anastasia	Chavez	University of California, Davis
Alex	Christensen	University of Arizona
Mayleen	Cortez	California State University of Channel Islands
Mark	Curiel	University of Hawaii, Manoa
Kyle	Dahlin	Purdue University
Sudipta	Dasmohapatra	Duke University
Justin	Delos Reyes	University of Hawaii - West Oahu
Carrie	Diaz Eaton	Bates College
Ranthyony	Edmonds	Ohio State University
Summar	Ellis	Spelman College
Esteban	Escobar	California State Polytechnic University
Ricela	Feliciano-Semidei	Northern Illinois University
Alena	Figueroa	University of Hawaii - West Oahu
Gabriel	Flores	Wheaton College
Maria	Franco	Queensborough Community College (CUNY)
Emily	Friedman	Auburn University
Wilfrid	Gangbo	University of California, Los Angeles
Lynette Joyce	Gaoiran	University of Hawaii at West Oahu
Rebecca	Garcia	Sam Houston State University
Xavier	Garrido	University of Hawaii West Oahu
Kayla	Gibson	The University of Iowa
Alison	Gilbert	San Francisco State University
Christa	Gogue	University of Hawai'i - West O'ahu
David	Goldberg	Purdue University
crislian	gutierrez	University of Puerto Rico
Ruth	Haas	University of Hawaii at Manoa
Abigail	Hardin	University of Oklahoma
Sean	Hays	University of South Florida
Leslie	Hogben	AIM - American Institute of Mathematics
Joshua	Hu	University of Hawaii at Manoa
Skylyn	Irby	University of Alabama
Alayt Abraham	Issak	The College of Wooster

Participants

First Name	Last Name	Institution
Tanner	Johnson	University of Hawai - West Oahu
Daniel	Jonas	Colorado State University
Zakiya	Jones	Pomona College
Tolulope	Latunde	Federal University Oye-Ekiti
Alicia	Ledesma Alonso	Grinnell College
Xinyi	Li	SAMSI - Statistical and Applied Mathematical Sciences Institute
Veny	Liu	University of Hawai'i-West O'ahu
Rohan	Lopez	Pomona College
Marissa	Loving	Georgia Institute of Technology
Christina	Lynch	Sonoma State University
Elizabeth Jane	Maluyo	University of Hawaii West Oahu
Michelle	Manes	University of Hawaii at Manoa
Lucy	Martinez	Stockton University
Gabriel	Martins	California State University, Sacramento
JoeAnna	McDonald	University of Hawaii at Manoa
Christian	McRoberts	Iowa State University
Robert	Megginson	University of Michigan
Amaury	Miniño	Florida Atlantic University
Gabriel	Montoya-Vega	George Washington University
Emma	Moore	Western Kentucky University
Anthony	Morales	University of Michigan
Ryan	Moruzzi	Ithaca College
Carlos	Munoz	San Jose State University
Robin	Neumayer	Northwestern University
Ixtaccihuatl	Obregon	University of the Incarnate Word
Stacy	Orozco	Institute of Pure and Applied Mathematics (IPAM)
Jose	Ortiz	Westminster College
Kevin	Palencia Infante	University of Montana
Victoria	Penalver	University of Hawaii West Oahu
Amy	Prager	Cornell University
Anik	Raj	University of Illinois at Chicago
Andres	Ramos	University of Puerto Rico
Christian	Ratsch	University of California, Los Angeles
Robert	Rennie	University of Illinois at Urbana-Champaign
Victoria	Robinson	University of Mississippi
Elisa	Rodriguez	Ursinus College
Gordon	Rojas Kirby	University of California, Santa Barbara
Rachel	Rupnow	Northern Illinois University
Terry Joan	Salaga	University of Hawaii Manoa
Victor	Sanchez	College of the Holy Cross
Erica	Sawyer	California State University, Fresno
Riva	Silver	New Mexico State University
Michael	Singer	MSRI - Mathematical Sciences Research Institute
Patrice	Smith	University of Hawaii at Hilo

Participants

First Name	Last Name	Institution
Bianca	Sosnovski	Queensborough Community College (CUNY)
Elizabeth	Sprangel	Iowa State University
Swati	Sureka	National Science Foundation
Chantelle	Sutton	University of Maryland, Eastern Shore
Cameron	Thomas	Morehouse College
Ana	Tongilava	Sonoma State University
Eduardo	Torres Davila	San Diego State University
David	Uminsky	University of San Francisco
Alexandro	Vasquez	Manhattan College
Marilyn	Vazquez	Mathematical Biosciences Institute (Ohio State University)
Elijah	Vela	New Mexico State University
William	Velez	University of Arizona
Alejandro	Velez-Santiago	University of Puerto Rico
Andrés	Vindas Meléndez	University of Kentucky
Erica	Ward	California State University
Nathaniel	Whitaker	University of Massachusetts Amherst
Esther	Widiasih	UHWO
Sophia	Wiedmann	Iowa State University
Ulrica	Wilson	Morehouse College
Kamuela	Yong	University of Hawaii - West Oahu
Michael	Young	Iowa State University

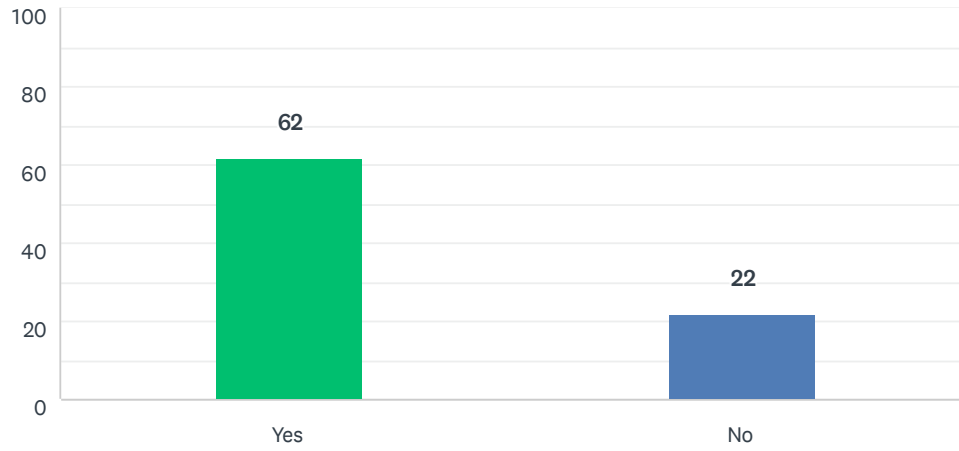
Officially Registered Student Information

Participants		109
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Gender		109
Male	44.04%	48
Female	53.21%	58
Other(Non-binary)	1.83%	2
Declined to state	0.92%	1

Ethnicity*		154
White	24.68%	38
Asian	12.34%	19
Hispanic	27.92%	43
Pacific Islander	5.84%	9
Black	12.99%	20
Native American	1.95%	3
Mixed	12.34%	19
Declined to state	1.95%	3

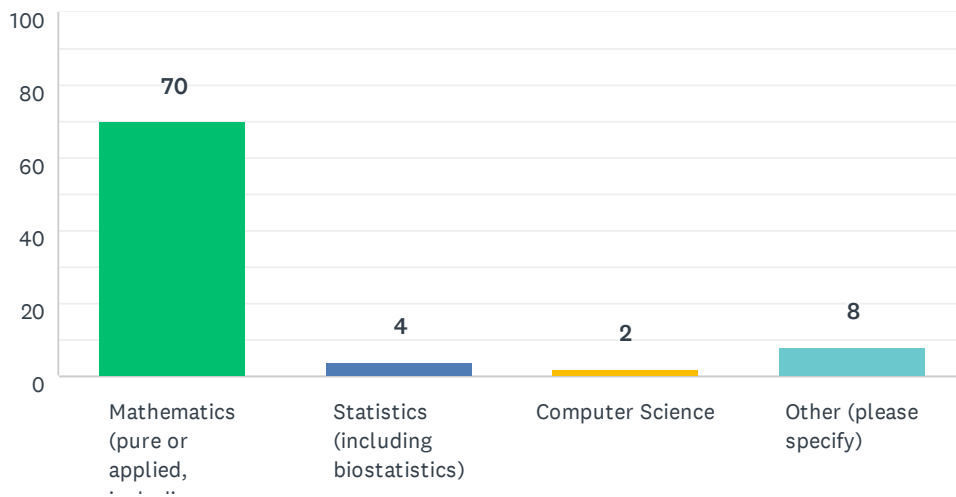
* ethnicity specifications are not exclusive



ANSWER CHOICES	RESPONSES	
Yes	73.81%	62
No	26.19%	22
TOTAL		84

Q2 What is your primary field or discipline? (choose one)

Answered: 84 Skipped: 0

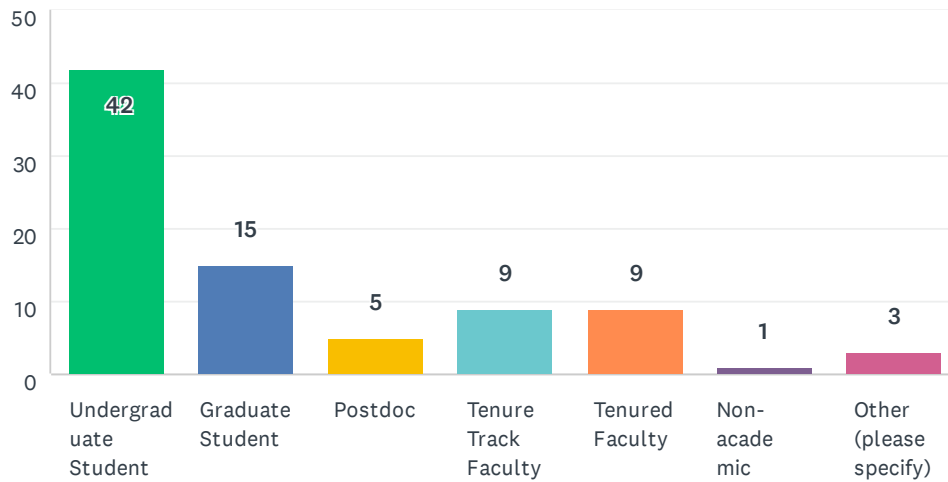


ANSWER CHOICES	RESPONSES	
Mathematics (pure or applied, including biomath)	83.33%	70
Statistics (including biostatistics)	4.76%	4
Computer Science	2.38%	2
Other (please specify)	9.52%	8
TOTAL		84

#	OTHER (PLEASE SPECIFY)	DATE
1	electrical engineering	11/9/2019 12:20 AM
2	Math Education	11/6/2019 5:34 PM
3	Mathematics (math education)	11/5/2019 5:29 PM
4	Social sciences	11/5/2019 7:40 AM
5	Economics	11/5/2019 12:13 AM
6	Astronomy and Math	11/4/2019 9:32 PM
7	Math education	11/4/2019 7:31 PM
8	Mathematics education	11/4/2019 6:50 PM

Q3 Your status or position at the time of the conference:

Answered: 84 Skipped: 0

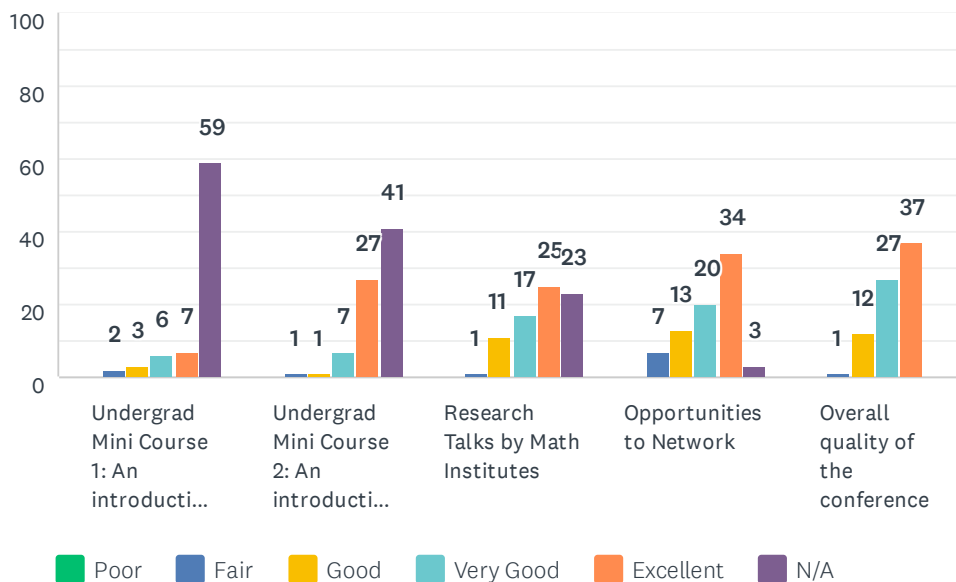


ANSWER CHOICES	RESPONSES	
Undergraduate Student	50.00%	42
Graduate Student	17.86%	15
Postdoc	5.95%	5
Tenure Track Faculty	10.71%	9
Tenured Faculty	10.71%	9
Non-academic researcher	1.19%	1
Other (please specify)	3.57%	3
TOTAL		84

#	OTHER (PLEASE SPECIFY)	DATE
1	tenured faculty and dept. chair	11/6/2019 5:34 PM
2	Emeritus	11/6/2019 11:52 AM
3	Professional (NSF staff)	11/5/2019 7:40 AM

Q4 How would you rate the following sessions or features of the conference? (if you did not attend the session, please select N/A)

Answered: 77 Skipped: 7



	POOR	FAIR	GOOD	VERY GOOD	EXCELLENT	N/A	TOTAL
Undergrad Mini Course 1: An introduction to optimal mass transportation	0.00% 0	2.60% 2	3.90% 3	7.79% 6	9.09% 7	76.62% 59	77
Undergrad Mini Course 2: An introduction to matroid theory	0.00% 0	1.30% 1	1.30% 1	9.09% 7	35.06% 27	53.25% 41	77
Research Talks by Math Institutes	0.00% 0	1.30% 1	14.29% 11	22.08% 17	32.47% 25	29.87% 23	77
Opportunities to Network	0.00% 0	9.09% 7	16.88% 13	25.97% 20	44.16% 34	3.90% 3	77
Overall quality of the conference	0.00% 0	1.30% 1	15.58% 12	35.06% 27	48.05% 37	0.00% 0	77

Modern Math Workshop 2019 Exit Survey

#	COMMENTS	DATE
1	I wished there were more small group and discussions that happened so that we could talk with people from other institutions	11/17/2019 6:39 PM
2	The quality of the conference could improve because sometimes conferences for diversity can be somewhat artificial in how they put people together simply because of a common or similar language or culture.	11/8/2019 3:15 PM
3	As always, this is a great opportunity to meet people with similar interests in research and most importantly, with people sharing the love and passion about math.	11/6/2019 8:40 PM
4	I liked the poster sessions held in past MMWs -they contributed greatly to networking and helped attendees without MMW or SACNAS funding to seek out/secure funds from their home institutions to attend/present at MMW. A few others who are past MMW participants noted the absence of the poster session as well, based on informal conversations I had while at the workshop and reception.	11/6/2019 5:44 PM
5	I was hoping that the research talks would not run concurrently with the mini-courses -- that would have been great. The panel was great, but I also think that ending the MMW with a great plenary lecture by a URM mathematician for the entire group to attend would be a very nice way to end the workshop :D	11/5/2019 5:50 PM
6	I didn't know that faculty would be welcome to attend "undergrad mini courses" - I think I would have liked to do so, but the title made me feel like I wasn't supposed to be there. The talks were very applied & while good were not of that much interest to me. I wish there were more structured networking, because I mostly hung out with people I already knew.	11/5/2019 3:21 PM
7	I wish more time had been allocated for the final panel on Day 1. I also think this would be a good setting for an REUF workshop as a parallel session option as many faculty are there with students.	11/5/2019 12:20 PM
8	The talks were engaging and accessible to a non-specialist audience, and institute faculty were very open with students.	11/5/2019 7:41 AM
9	The networking opportunities are amazing, especially at the reception!	11/5/2019 12:41 AM
10	I enjoyed the overall welcoming environment of the conference. I feel that I've learned a lot about the people who were in attendance and that made me go to their other panels during the rest of SACNAS.	11/4/2019 9:51 PM
11	I thought the graduate students who were selected to speak had very interesting topics and gave great presentations. I, personally, also found the institute panel to have lots of valuable information.	11/4/2019 7:21 PM

Q5 If you attended one of the undergraduate mini-courses listed above, please tell us what you did and did not like about it. We welcome your suggestions for improvement.

Answered: 35 Skipped: 49

Modern Math Workshop 2019 Exit Survey

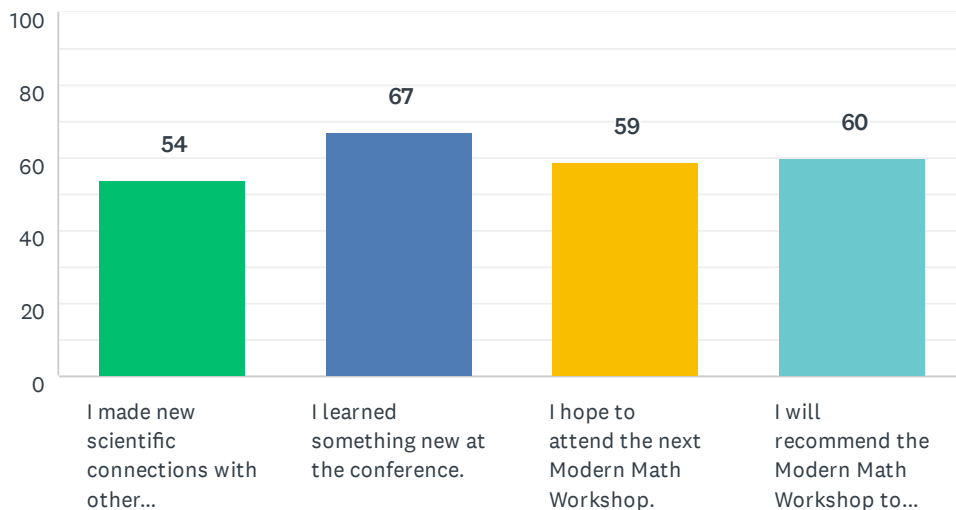
#	RESPONSES	DATE
1	I liked how interactive it was	11/17/2019 6:39 PM
2	The optimal transport problems was a good course and the speaker was very clear. It was a little above my head but I felt like had I recognized some terms I would've followed a little bit better.	11/11/2019 12:31 PM
3	I liked that she made it very interactive.	11/10/2019 8:20 PM
4	I enjoyed the speaker and her passion for the subject! The length was great. I hadn't taken linear algebra so I didn't know much about the background material. That is to be expected at many of math talks though and I felt She helped us along enough so we weren't lost.	11/9/2019 12:21 AM
5	The workshop was excellent	11/8/2019 10:35 PM
6	I enjoyed that we partnered up and actually worked through examples. It definitely helped me to understand the topic better.	11/8/2019 7:02 PM
7	I wish I had a better opportunity to understand how matroids interacted with other fields of math.	11/8/2019 3:15 PM
8	The lecture was great and the professor gave many examples and explanations.	11/7/2019 2:33 PM
9	I liked how engaging the presenter was. We were given time to explore the topic on our own as the presenter walked through the room. This helped with the digestion of the material.	11/7/2019 5:29 AM
10	The material was rather complex and difficult to grasp, but the overall concept was understandable in addition to a few specific terms.	11/7/2019 1:26 AM
11	NA	11/6/2019 8:40 PM
12	I liked the intereaction with the examples and group work although I think 2 breaks instead of 1 would have been better	11/6/2019 3:10 PM
13	I really enjoyed the work and calculations that we did to better understand matorids. I would have liked to see some more structure to the work, as it did feel a bit too unorganized.	11/6/2019 3:04 PM
14	Dr. Chavez did an excellent job with her presentation! I liked how interactive the mini-course was and she really inspired me during the panel discussion.	11/6/2019 1:37 PM
15	It was very informative and easy to follow. I would like for it to be a bit more interactive.	11/6/2019 12:13 PM
16	Well done and clear	11/6/2019 12:01 PM
17	I really enjoyed the energy in the room, partly because of Anastasia's genuine interest to make the material presentable and relatable.	11/6/2019 11:55 AM
18	I enjoyed the hands-on exercises. It allowed us to get to know one another as well as understand the lecture.	11/5/2019 10:49 PM
19	I attended the Introduction to Matroid Theory and I have to say that this was an amazing mini-course. Dr. Chavez balanced activity with lecture and gave a taste of some of the interesting mathematical research currently done using matroids. Everyone enjoyed it (faculty and students alike). Great choice of lecturer.	11/5/2019 5:50 PM
20	I enjoyed everything about the mini-course except that as an undergrad, who hasn't taken many courses, the math was a bit hard to follow. I was lucky enough to have a roommate who is a bit more experienced and was able to clear up some of my doubts. I think maybe stating what the course level is or what pre-requisites would help students better understand the material. That way students can go to whichever minicourse they feel they will understand best.	11/5/2019 10:45 AM
21	Great session, good student involvement, however I would have liked to attend two shorter sessions instead of one long session.	11/5/2019 9:31 AM
22	I wouldn't say I didn't like it but I wish there was some connection between the topic and what I understood. It was interesting however I didn't know how to apply it to what I do know in the scope of my knowledge.	11/5/2019 9:18 AM
23	did not attend	11/5/2019 7:41 AM
24	I liked the topic and the way it was presented. I think the objective of the mini course could have	11/5/2019 7:07 AM

Modern Math Workshop 2019 Exit Survey

	been stated better, it ended with me not knowing why it ended that way.	
25	I really enjoyed that there was audience participation for the a trois theory mini course.	11/5/2019 4:53 AM
26	It would be nice to know the level of math needed for each course.	11/5/2019 12:41 AM
27	Pros: Applicability to my field of research & studies; accessible yet challenging material. Improvement: The second part of the lecture seemed rushed (and we finished the first part quite a bit early, so there could have been better time management).	11/5/2019 12:14 AM
28	I really enjoyed having the opportunity to interact with the material. I feel that working on examples, and working through them with others really helped me see how different people approach problems.	11/4/2019 9:51 PM
29	I was a bit confused about the content of the talk. Maybe making it more understandable to the general audience would be nice.	11/4/2019 9:34 PM
30	It was great	11/4/2019 8:19 PM
31	I attended the introduction to optimal mass transportation. I really enjoyed that it was rigorous at a level that upper level undergrads could understand. I especially enjoyed that we proved a main theorem as the conclusion. However, I wish there were computation examples and concrete application examples in addition to the theory. I feel that this could've easily fit into the time frame if the speaker didn't spend time talking about unnecessary anecdotes.	11/4/2019 8:01 PM
32	Hands-on approach was excellent for developing intuition around the newly introduced mathematical objects quickly.	11/4/2019 7:56 PM
33	I love everything about it. There's not much I would Change	11/4/2019 7:30 PM
34	I thought the mini-course went really well. I enjoyed it a lot.	11/4/2019 6:56 PM
35	I loved how Dr. Chavez made the talk so we could participate and fully understand matroids. he interactive part was great.	11/4/2019 6:50 PM

Q6 Check the boxes of all the statements you agree with:

Answered: 73 Skipped: 11

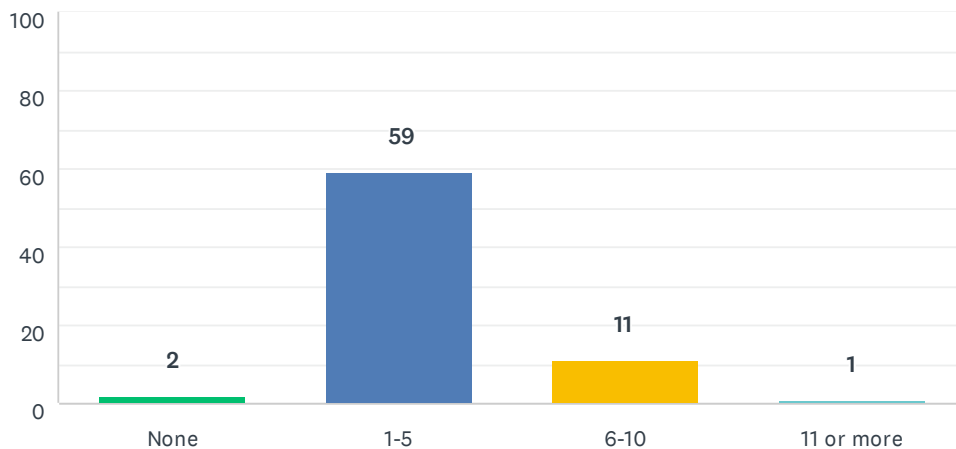


ANSWER CHOICES	RESPONSES	
I made new scientific connections with other participants that may lead to collaborations or other opportunities.	73.97%	54
I learned something new at the conference.	91.78%	67
I hope to attend the next Modern Math Workshop.	80.82%	59
I will recommend the Modern Math Workshop to others.	82.19%	60
Total Respondents: 73		

#	COMMENTS	DATE
1	This is making be respond to at least 1 checkbox, but I don't think any quite apply.	11/8/2019 8:45 AM
2	Loved it!	11/6/2019 8:45 PM
3	I always recommend the MMW to others (students, & faculty).	11/6/2019 5:56 PM
4	Such a great conference -- mathematics is a human endeavor and the inclusivity one felt at this workshop made this a rich and rewarding experience for all.	11/5/2019 5:57 PM

Q7 How many new connections did you make during this conference?

Answered: 73 Skipped: 11

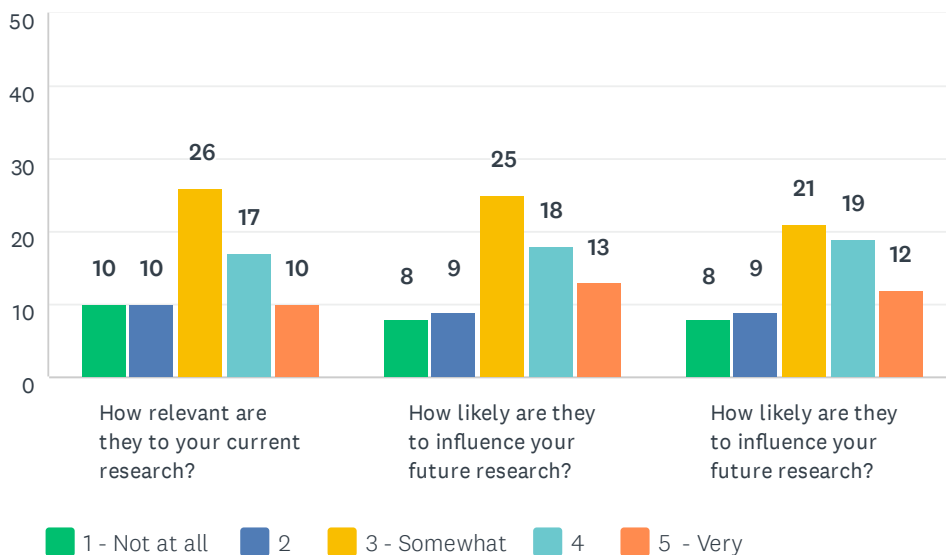


ANSWER CHOICES	RESPONSES
None	2.74% 2
1-5	80.82% 59
6-10	15.07% 11
11 or more	1.37% 1
TOTAL	73

#	COMMENTS	DATE
1	I met up with people I knew prior to the event.	11/6/2019 9:24 PM
2	Met a few undergrads whom I encouraged to apply to MSRI-UP 2020 and introduced to MSRI-UP alumni (from the 2018 & 2019 cohorts). Met/networked/socialized within and outside of MMW/SACNAS with faculty with whom I share other connections but whom I had not met before (e.g. a couple of faculty from Univ. of Hawaii; Dr. Wilfrid Gangbo from UCLA; a female, junior mathematician from a mainland college)	11/6/2019 5:56 PM
3	I'm a very shy person, but I was able to step out of my comfort zone and talk to more people than I initially would have. I hope to attend the next workshop and try to connect with more people.	11/5/2019 10:55 AM

Q8 On a scale of 1 to 5, please answer the following questions concerning the connections that you made during the Modern Math Workshop:

Answered: 73 Skipped: 11

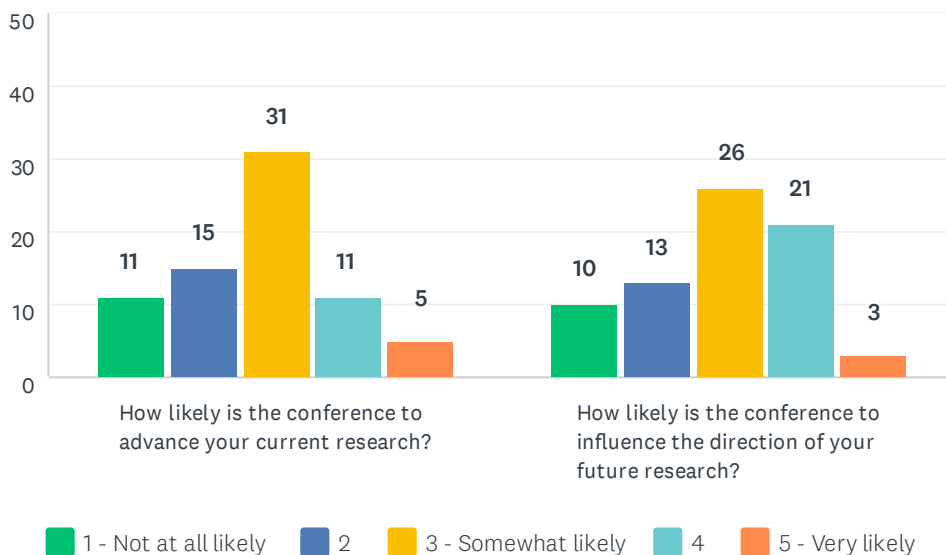


	1 - NOT AT ALL	2	3 - SOMEWHAT	4	5 - VERY	TOTAL	WEIGHTED AVERAGE
How relevant are they to your current research?	13.70% 10	13.70% 10	35.62% 26	23.29% 17	13.70% 10	73	3.10
How likely are they to influence your future research?	10.96% 8	12.33% 9	34.25% 25	24.66% 18	17.81% 13	73	3.26
How likely are they to influence your future research?	11.59% 8	13.04% 9	30.43% 21	27.54% 19	17.39% 12	69	3.26

#	COMMENTS	DATE
1	It was great to hear about the different programs at the Math Institutes that were present. I enjoyed hearing about people's different experiences and I hope I can participate in more programs in the future.	11/11/2019 4:28 PM
2	Aren't the second and third questions identical?	11/7/2019 11:22 AM
3	Questions 2 and 3 in this section are identical. Typo?	11/6/2019 5:56 PM
4	I am retired, so I will not do research	11/6/2019 11:54 AM
5	The last two questions are the same...	11/5/2019 5:57 PM
6	aren't the last two questions identical? I've read them several times...	11/5/2019 3:22 PM
7	I am not a researcher in this field, but they will inform my professional work to a degree.	11/5/2019 7:46 AM

Q9 On a scale of 1 to 5, please answer the following questions concerning the KNOWLEDGE gained during Modern Math Workshop:

Answered: 73 Skipped: 11



	1 - NOT AT ALL LIKELY	2	3 - SOMEWHAT LIKELY	4	5 - VERY LIKELY	TOTAL	WEIGHTED AVERAGE
How likely is the conference to advance your current research?	15.07% 11	20.55% 15	42.47% 31	15.07% 11	6.85% 5	73	2.78
How likely is the conference to influence the direction of your future research?	13.70% 10	17.81% 13	35.62% 26	28.77% 21	4.11% 3	73	2.92

#	COMMENTS	DATE
1	I am retired	11/6/2019 11:54 AM
2	I learned a lot, but it might not be very useful for mathematics education research	11/5/2019 5:33 PM
3	Very applied, not much to take away from the talks. Enjoyable, but I don't see how they could advance anyone's research... too disparate and unfocused.	11/5/2019 3:22 PM
4	I am not a researcher in this field, but they will inform my professional work to a degree.	11/5/2019 7:46 AM

Q10 What aspect(s) of the conference did you like the most?

Answered: 43 Skipped: 41

Modern Math Workshop 2019 Exit Survey

#	RESPONSES	DATE
1	Interactive nature of the workshop	11/11/2019 7:13 PM
2	It was great learning about and getting some encouragement to apply to the different Math programs out there. It was also great meeting other people that were involved with undergraduate research which is something I am trying to learn more about.	11/11/2019 4:28 PM
3	Very causal and comfortable.	11/11/2019 12:33 PM
4	It didn't feel like they were talking at us. they made a really large effort to make it feel like we were included and not seen as lesser than.	11/10/2019 8:22 PM
5	The mellow and comfortable atmosphere and attitude of the speakers.	11/9/2019 12:23 AM
6	The networking opportunities, keynote speakers, and incorporation of Hawaiian culture	11/8/2019 7:07 PM
7	Diversity, opportunity and order.	11/8/2019 6:27 PM
8	It was a nice way to network with people around the country.	11/8/2019 3:17 PM
9	Seeing math people at SACNAS/reconnecting with my minority math community.	11/8/2019 8:45 AM
10	Information for students on future research	11/7/2019 11:22 AM
11	The networking opportunity.	11/7/2019 8:03 AM
12	Networking	11/7/2019 1:28 AM
13	The organization and the general environment were excellent. There were plenty of chances of interacting with other people.	11/6/2019 8:45 PM
14	Networking, informally mentoring students, being exposed again to what the different math institutes have to offer.	11/6/2019 5:56 PM
15	The Matroid Research	11/6/2019 3:12 PM
16	Panel Discussion	11/6/2019 1:39 PM
17	It was great to see so many young people from diverse backgrounds who are studying mathematics.	11/6/2019 12:34 PM
18	So many different people that you could talk to. And they were really willing to help and guide you.	11/6/2019 12:16 PM
19	Gangbo's workshop and panel	11/6/2019 12:03 PM
20	I liked how it was really interactive and allowed us to be hands on.	11/6/2019 12:01 PM
21	I enjoyed the mini-course and the dinner.	11/6/2019 11:57 AM
22	The networking/dinner event	11/5/2019 10:51 PM
23	I loved the mini workshop because it gave everyone a chance to explore the concepts and then to think about deeper applications of these fundamental objects.	11/5/2019 5:57 PM
24	The networking	11/5/2019 5:33 PM
25	Good panel discussion, especially for undergraduates, and good choices of invited speakers, it was nice to hear about their trajectories in their careers	11/5/2019 4:10 PM
26	I enjoyed having options on what I could attend, instead of being forced to attend something that I didn't have an interest in.	11/5/2019 10:55 AM
27	I liked the question and answers; however, some ice breakers would have been nice and maybe workshops directly relating to conducting research for graduate students	11/5/2019 9:45 AM
28	The workshop for Women in STEM by Genentech. I wish their was more companies showcasing their company due to the exposure that it provides for students.	11/5/2019 9:25 AM
29	Research talks by students/early-career researchers	11/5/2019 7:46 AM
30	It was very good organized. The section of questions to the panelist I liked the most because they could share their experiences with all of us.	11/5/2019 5:43 AM

Modern Math Workshop 2019 Exit Survey

31	The networking opportunities	11/5/2019 12:44 AM
32	I enjoyed hearing about the institutes the most. I had never heard of any beyond MSRI.	11/4/2019 11:45 PM
33	I liked the workshop and interacting with the folks in attendance. I also like that there was a great opportunity to interact with faculty and postdocs from different institutions.	11/4/2019 9:54 PM
34	Free ice cream! joke! The valuable connections that we can make.	11/4/2019 9:36 PM
35	Meeting female mathematicians like me	11/4/2019 8:20 PM
36	I enjoyed learning about the different Math Institutes and hearing about the speaker's experiences.	11/4/2019 8:13 PM
37	Networking, minicourse, ice cream during the break - yum!	11/4/2019 8:03 PM
38	Undergraduate mini-courses	11/4/2019 7:57 PM
39	I enjoyed the casual coffee breaks, because after having seen the presentations earlier in the day, at these times I was able to meet the presenters and ask further questions about their research and about their process that may not be as applicable to a wider audience.	11/4/2019 7:36 PM
40	Good overviews of topics I didn't know much about	11/4/2019 7:35 PM
41	I like the receptionist	11/4/2019 7:32 PM
42	I loved meeting people from different institutions and research opportunities.	11/4/2019 6:53 PM
43	panels	11/4/2019 6:49 PM

Q11 What aspect(s) of the conference did you like the least?

Answered: 32 Skipped: 52

Modern Math Workshop 2019 Exit Survey

#	RESPONSES	DATE
1	I felt the breaks in between courses was too short.	11/11/2019 12:33 PM
2	There was nothing I didn't like.	11/10/2019 8:22 PM
3	I wish there had been a longer panel. I also wish there has been more opportunity to encourage mixing in the social afterwards.	11/9/2019 12:23 AM
4	That the poster presentation session on Friday ended after the next section of talks began	11/8/2019 7:07 PM
5	Few days.	11/8/2019 6:27 PM
6	Sometimes, it seemed hard to connect with other people.	11/8/2019 3:17 PM
7	I was very confused which things were open to faculty, there were only a few talks/subjects in what seemed like random areas. The talk length was long, so talks that I decided to commit to, if they were too out of my area to really get much from it was a long 45 minutes.	11/8/2019 8:45 AM
8	Research talks were too technical in some cases for such a brief talk	11/7/2019 11:22 AM
9	I can't think of anything I disliked.	11/7/2019 8:03 AM
10	NA	11/6/2019 8:45 PM
11	I missed the poster session!	11/6/2019 5:56 PM
12	The short period of 2 days	11/6/2019 3:12 PM
13	Food	11/6/2019 1:39 PM
14	The graduate students who attended the research session were exposed to short intros about each of the represented institutes, but my impression is that the undergraduate students who look part in the Q&A with Institute Representatives did not have an opportunity to learn even the names of the represented institutes. It would have been helpful to begin the Q&A with a 1-2 minute introduction of each of the institutes.	11/6/2019 12:34 PM
15	There wasn't much talks on/for computer science majors. The computer science lunch was good though.	11/6/2019 12:16 PM
16	The missed opportunity for more networking.	11/6/2019 11:57 AM
17	The food	11/5/2019 10:51 PM
18	The fact that the research talks ran concurrently with the mini-courses did not give the students the chance to hear them.	11/5/2019 5:57 PM
19	The Q&A with institutes felt awkward to me. I would have preferred that it was a panel or individual tables as it was difficult to pinpoint who was saying what and what institutes were being represented.	11/5/2019 10:55 AM
20	Sitting in talks all day; maybe something interactive since at the rest of the conference we sit in talks. Also the vegetarian options at the networking event the first night were poor	11/5/2019 9:45 AM
21	The fact that we didn't get to explore the environment and surrounding of Hawaii.	11/5/2019 9:25 AM
22	There were relatively few opportunities for small-group discussion, which may have been helpful fora for students seeking advice	11/5/2019 7:46 AM
23	Maybe there was not much variety of topics.	11/5/2019 5:43 AM
24	Some of the talks were inaccessible to undergraduates	11/5/2019 12:44 AM
25	I can't think of any.	11/4/2019 11:45 PM
26	A bit confusing and specialized topic I guess...	11/4/2019 9:36 PM
27	the food was bad	11/4/2019 8:20 PM
28	None!	11/4/2019 8:03 PM
29	My only concern about the workshop was the inability to find any representatives of the workshop, after its completion. I specifically had a concern about logistics of workshop	11/4/2019 7:36 PM

Modern Math Workshop 2019 Exit Survey

	attendance and could not find anyone who could address my question.	
30	Hard to join a group to talk with—some people cliquey	11/4/2019 7:35 PM
31	None I like everything about it	11/4/2019 7:32 PM
32	The q/a sessions were a little unorganized and not incredibly helpful.	11/4/2019 6:53 PM

Q12 How can we improve the quality of the conference? Your suggestions are welcome.

Answered: 27 Skipped: 57

Modern Math Workshop 2019 Exit Survey

#	RESPONSES	DATE
1	All I can think of is that it could have been a little longer? It would have been good to have talks or activities in the morning of the first day as well. That way there would be more variety in the topics for the talks as well.	11/11/2019 4:28 PM
2	Less overlap between when some events end and other begin	11/8/2019 7:07 PM
3	More conferences.	11/8/2019 6:27 PM
4	If the modern math workshop did not interfere with SACNAS.	11/8/2019 3:17 PM
5	I think the mission is not really clear. I'd prefer it was a place to promote a variety work by minority mathematicians and/or was a clear place where you were offering workshops to all levels and types of mathematicians, but that didn't seem to be what it is? I think I was more confused after participating (my first time to participate, but my 3rd time to SACNAS)	11/8/2019 8:45 AM
6	I think the conference has always been very convenient at any stage of the career. Maybe including a mini graduate course would be nice.	11/6/2019 8:45 PM
7	N/A	11/6/2019 5:56 PM
8	1more day	11/6/2019 3:12 PM
9	If I simply missed the opening remarks of the conference, then I apologize for this comment. But it would be great to have some opening remarks aimed at the whole conference audience to welcome everyone and to explain the structure and goals of the workshop.	11/6/2019 12:34 PM
10	The lunch could be more organized, the huge lines in the middle of the halls was chaotic.	11/6/2019 12:16 PM
11	Make a little longer	11/6/2019 12:03 PM
12	We should have a space for group mentoring.	11/6/2019 11:57 AM
13	I would have liked to attend both mini courses	11/5/2019 10:51 PM
14	Having a unifying plenary talk at the end would be a very nice way to end the conference. It should be a talk that is accessible to undergraduate math majors and ideally a talk given by a URM mathematician.	11/5/2019 5:57 PM
15	Provide talks in mathematics education.	11/5/2019 5:33 PM
16	Could make a lightning round of talks (5min or so) for graduate students/early career mathematicians to briefly introduce their work and serve to introduce themselves to each other and let the faculty know a little about themselves	11/5/2019 4:10 PM
17	I would have enjoyed a short presentation on what each institute has to offer, where they are located, whom to contact, etc. in addition to the Q&A.	11/5/2019 10:55 AM
18	More applied math talks and interactive workshop	11/5/2019 9:45 AM
19	Making workshops available for more than one time frame.	11/5/2019 9:25 AM
20	It was a very nice workshop, well-suited to the needs and interests to attendees overall.	11/5/2019 7:46 AM
21	I went to a talk where the audience was separated by undergrad, grad, pos-doc, faculty and then the panelist expert in each category moderate the table(s). Thus I think that everybody has the opportunity to ask.	11/5/2019 5:43 AM
22	Most of the SACNAS participants are undergrads with varying levels of math. It would be nice if the minicourses specified which math would be needed to understand the course and if the other speakers geared their talks to undergrads.	11/5/2019 12:44 AM
23	Have more speakers for the mini talks.	11/4/2019 9:36 PM
24	BETTER PR. Shirts...	11/4/2019 8:20 PM
25	More involvement by organizers to create a social connection between student attendees.	11/4/2019 7:57 PM
26	I really enjoyed the conference and thought that it would have been better if the second day were as long as the first day, or at least longer than two hours. Day 1 had a lot of quality	11/4/2019 7:36 PM

Modern Math Workshop 2019 Exit Survey

research talks by grad (or post doc) students and I think that more of these (for undergrad and grad student audiences) could have been beneficial.

27	Creating more opportunities for meeting new people. I felt that I kept seeing the same people.	11/4/2019 6:53 PM
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Toric Varieties

July 29, 2019 - August 09, 2019

National Center for Theoretical Sciences, Taipei

Organizers:

David Cox (Amherst College)

Henry Schenck (Iowa State University)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL
“Toric Varieties”
July 29 – August 09, 2019

Description

In partnership with the NCTS (National Center for Theoretical Studies), MSRI sponsored a summer graduate workshop on toric varieties in Taipei, Taiwan, from July 29 through August 10, 2019. This workshop marks the first collaboration between MSRI and NCTS. The workshop was truly international in flavor: the 42 registered participants hailed from eleven different countries, including the USA, Taiwan, Canada, China, Cuba, France, Germany, India, Russia, the United Kingdom, and Vietnam. There were also 6 informal local participants.

Toric varieties are algebraic varieties defined by combinatorial data, and there is a wonderful interplay between algebra, combinatorics and geometry involved in their study. Many of the key concepts of abstract algebraic geometry (for example, constructing a variety by gluing affine pieces) have very concrete interpretations in the toric case, making toric varieties an ideal tool for introducing students to abstruse concepts.

Organization Structure

Workshop Organizers

David Cox, Amherst College

Hal Schenck, Iowa State University

NCTS Staff (Taipei)

Jungkai Chen, Director, Mathematics Division

Peggy Lee, Assistant, Mathematics Division

MSRI Staff (Berkeley)

Hélène Barcelo, Deputy Director

Chris Marshall, Program Manager

Tracy Huang, Assistant for Scientific Activities

Local Organizer

Ching-Jui (Ray) Lai, National Cheng Kung University

Teaching Assistants

Kuei-Nuan Lin, Penn State Greater Allegheny

Jen-Chieh Hsiao, National Cheng Kung University

Original Structure of the Workshop

Week 1 (July 29-August 2) 10 main lectures + 1 background lecture

Monday - two lectures on affine toric varieties (Ch 1) [David]

Tuesday - two lectures on projective toric varieties (Ch 2) [Hal]

Wednesday - two lectures on normal toric varieties (Ch 3) [David]

Thursday - two lectures on divisors on toric varieties (Ch 4) [Hal],
plus a background lecture on quotients [David]

Friday - two lectures on homogeneous coordinates and quotient
constructions (Ch 5) [David]

Week 2 (August 5-9) 10 main lectures + 3 background lectures + Fri lectures

Monday - two lectures on line bundles on toric varieties (Ch 6) [Hal], plus a
background lecture on reflexive sheaves and differentials [David]

Tuesday - two lectures on quasi-projective toric varieties and the canonical
sheaf of a toric variety (Ch 7/8) [David], plus a background
lecture on sheaf cohomology [Hal]

Wednesday - two lectures on sheaf cohomology of toric varieties (Ch 9) [Hal]

Thursday - two lectures on toric surfaces (Ch 10) [David], plus a
background lecture on singular and equivariant cohomology and
Chern classes [Hal]

Friday - two lectures on singular and equivariant cohomology of toric
varieties and Riemann-Roch (Ch 12/13) [Hal], plus three afternoon lectures by David, Kuei-
Nuan and Jen-Chieh

Original Daily Schedule

Mornings

9:30-10:30: Hour lecture

10:30-11:00: Coffee/tea break

11:00-12:00: Hour lecture

12:00-1:30 Lunch

Afternoons (except for August 9)

1:30-3:00: Begin problem session

3:00-3:15: Coffee/tea break

3:15-4:15: Continue problem session

4:15-5:20: Student presentations on problems

5:30-6:50: Dinner

Modified Schedule

The schedule given above was modified because of Typhoon Lekima, which arrived on Friday, August 9. NCTS was closed all day on August 9. This necessitated a change in schedule:

- The Thursday afternoon problem session and presentations, and Thursday evening background lecture were cancelled, along with the Friday morning lectures.
- The Friday afternoon lectures were moved to Thursday afternoon.
- The Friday farewell ceremony, originally scheduled for the Friday tea break, was moved to Thursday.

More on the Participants

Participants were assumed to know the first two chapters of *Algebraic Geometry*, by Robin Hartshorne. In fact students had a very wide range of backgrounds. This turned out to be no obstacle, as the problem selection always contained some which were concrete and computational in flavor; stronger students would also help in filling in background during the problem sessions. When lectures touched on subjects (reflexive sheaves, quotients by a group action) not covered in these two chapters, there was a supplemental evening lecture that summarized the material. In addition to the main goal of teaching the students toric geometry (which for us meant not simply listening to lectures, but working lots of problems), we also wanted students to gain experience making presentations in public.

The participants were split between those based in Taiwan and those based in the US (with a couple of exceptions). After hours, the students went to eat at famous restaurants and visited the Taipei night markets together. They also went on sightseeing tours together, including a visit to the coast during the weekend.

The Problem Sessions

About 45 students participated in the problem sessions.

- 10 groups of students, each with 4 or 5 students.
- 5 sets of problems, so groups 1 and 6 would work on problem set 1, groups 2 and 7 would work on problem set 2, etc.
- Each day, five groups would present, chosen so that all five problem sets were presented.

The groups changed every two or three days and included a mix of students from Taiwan and from the US. For some students, presenting was a challenge since English is not their native language. Virtually every student presented at least once during the course of the workshop. This was an act of considerable courage for some students.

The instructors and teaching assistants would circulate among the groups to answer questions. The teaching assistants did an exceptional job.

The US students found the Taiwanese students to be very friendly, and the Taiwanese students were impressed by how serious the US student were about the exercises. The students reported that they found the group work to be extremely beneficial.

Comments about NCTS

The NCTS was an excellent location for the workshop. It was an easy walk to the hotel, and the main lecture room was wonderful – ample blackboards and good projection capability when needed. It took a while to find good space for the group work – it would have been nice to have more rooms equipped for group work. But the space we had worked well for the groups.

The NCTS staff was amazing – very helpful, especially with the last-minute schedule changes caused by the typhoon. They also arranged to interview most of the people involved in the workshop.

The Participants



Name

University

Zeng, Si Min

National Cheng Kung University

Chang, Chin-Chia

National Tsing Hua University

Chou, Tzu-Yang	National Taiwan University
Chang, Chi-Kang	National Center for Theoretical Studies
Chen, Tsung-Fang	National Cheng Kung University
Ke, Zhi-Haung	National Cheng Kung University
Liang, Chia-Tz	National Tsing Hua University
Wang, Shi-Shin	National Taiwan University
Chen, Chen-Tu	National Central University
Su, Shuang	National Tsing Hua University
Hung, Jui-Yun	National Chenchi University
Li, Bo-Jyun	National Chenchi University
Zhang, Zhi Lin	National Central University
Hsu, Shih-Wei	National Central University
Chen, Chen	The Ohio State University
Flatt, Amelie	Freie Universtät Berlin
Hu, Zhengning	University of Missouri
Kansal, Kalyani	Johns Hopkins University
Lamarche, Alicia	University of South Carolina
Li, Shiyue	Yale University
Morishige, Nina	University of British Columbia
Nguyen, Liem	Louisiana State University
Wolfe, Corey	Tulane University
Abdelgalil, Karem	University of Alberta
Afandi, Adam	Colorado State University
Anderson, Reginald	Kansas State University

Cheng, Chi-yu	University of Washington
Cummings, Joseph	University of Kentucky
Deng, Haohua	Washington University - St. Louis
Gotti, Felix	University of California, Berkeley
Heberle, Curtis	Tufts University
Lee, Pui Hang	University of Hawaii
Lefebvre de Saint Germain, Antoine	University of Hong Kong
Loper, Michael	University of Minnesota
Quartin, Jonathan	University of Colorado at Boulder
Robinson, Marcus	University of Utah
Rodriguez, Cristian	University of Massachusetts Amherst
Scholten, Georgy	North Carolina State University
Tseng, Dennis	Harvard University
Wu, Ben	Stony Brook University - SUNY
Xie, Junming	Lehigh University
Reynolds, Will	The University of Edinburgh

Officially Registered Student Information - MSRI sponsored students

Participants		27
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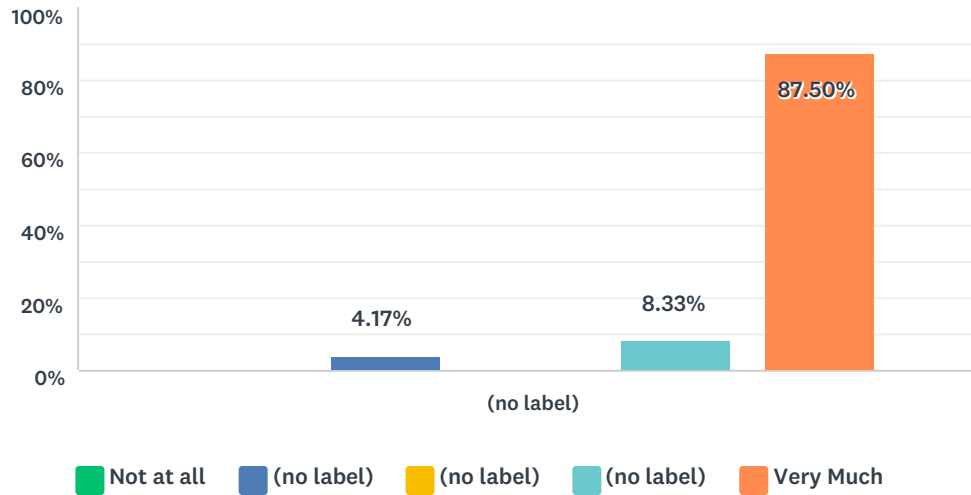
Gender		27
Male	66.67%	18
Female	33.33%	9
Declined to state	0.00%	0

Ethnicity*		31
White	32.26%	10
Asian	38.71%	12
Hispanic	9.68%	3
Pacific Islander	0.00%	0
Black	3.23%	1
Native American	0.00%	0
Mixed	6.45%	2
Declined to state	9.68%	3

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

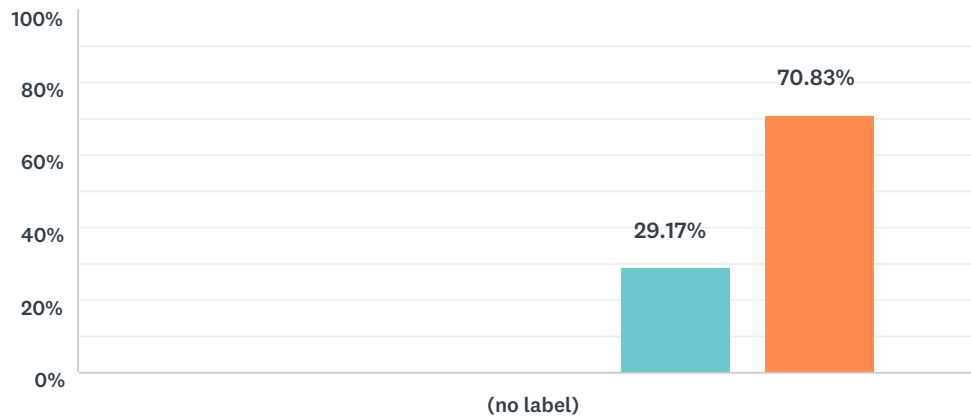
Answered: 24 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.17%	0.00%	8.33%	87.50%	24	4.79
	0	1	0	2	21		

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 24 Skipped: 0

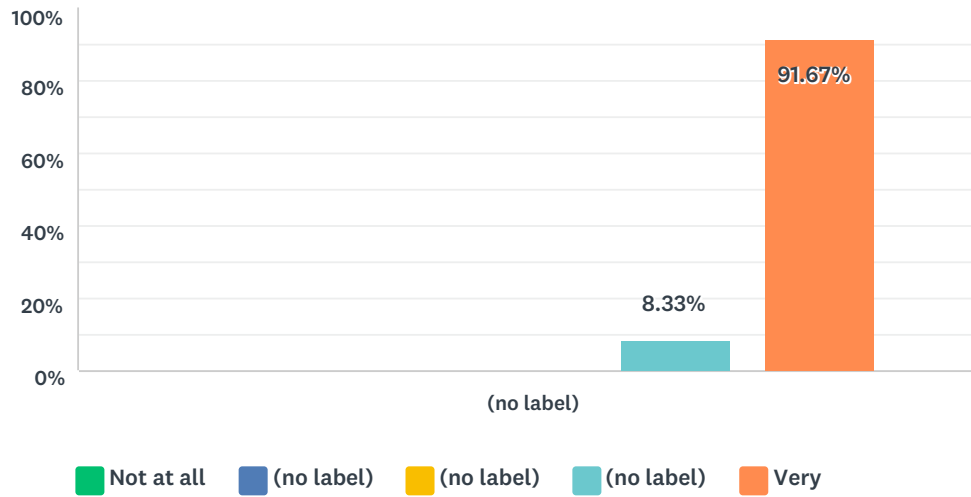


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	29.17%	70.83%	24	4.71
	0	0	0	7	17		

Q3 The school was intellectually stimulating

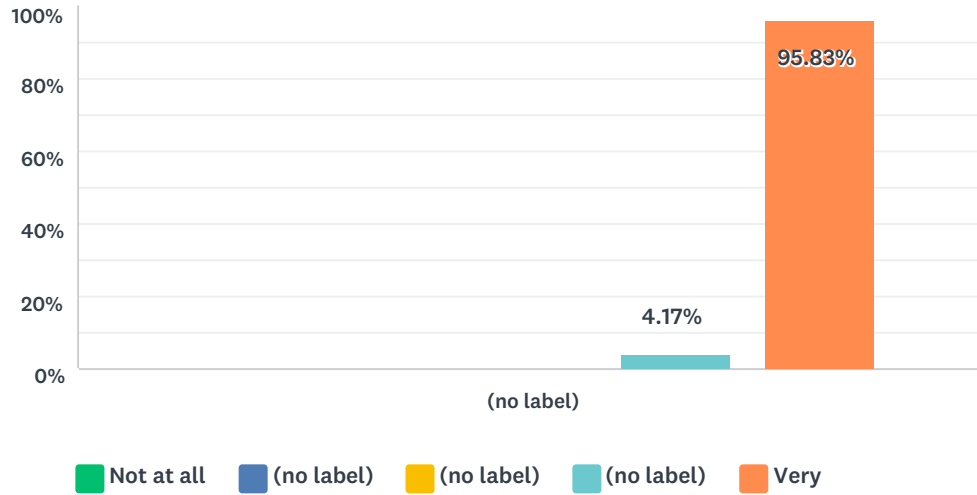
Answered: 24 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	8.33%	91.67%	24	4.92
	0	0	0	2	22		

Q4 The overall experience of the school was worthwhile

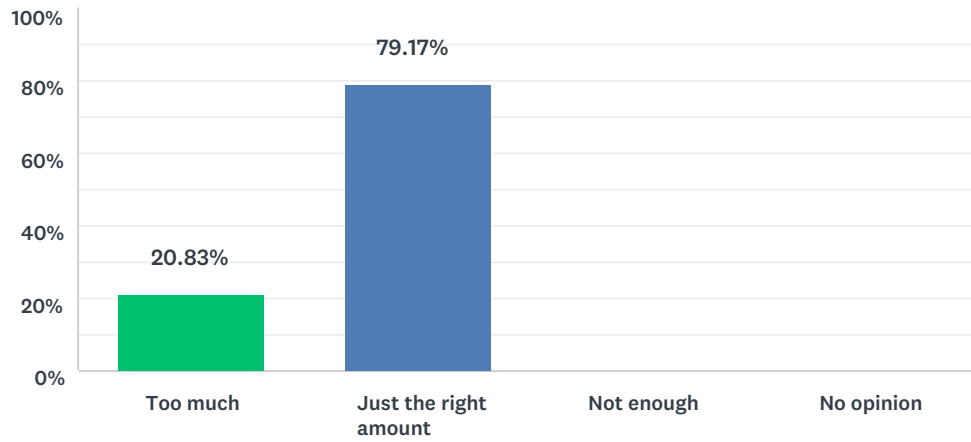
Answered: 24 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	4.17%	95.83%	24	4.96
	0	0	0	1	23		

Q5 The amount of material presented was:

Answered: 24 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	20.83%	5
Just the right amount	79.17%	19
Not enough	0.00%	0
No opinion	0.00%	0
TOTAL		24

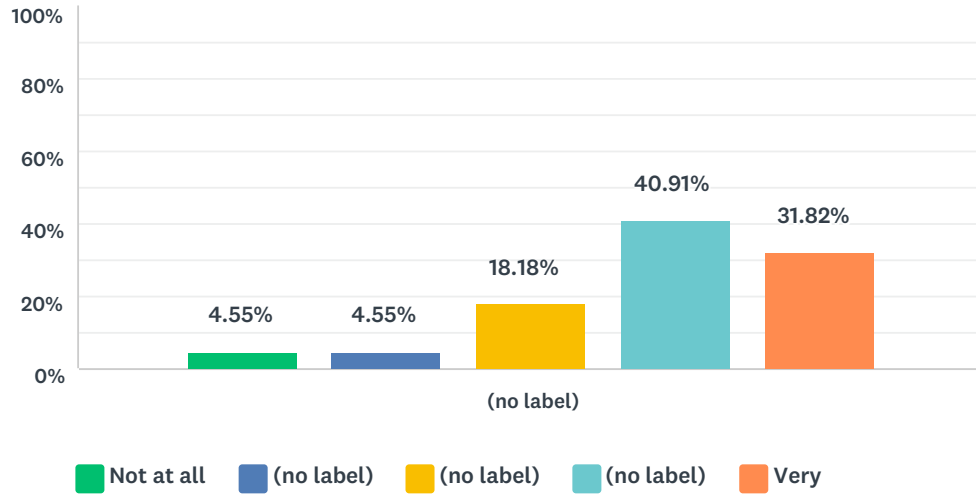
Q6 Additional comments on the topic presentation and organization

Answered: 7 Skipped: 17

#	RESPONSES	DATE
1	This is definitely one of the best organized summer school/conference that I have ever attended. The lectures and in particular the problem sessions are organized in a way that encourage learning and also interaction with my peers and professors.	9/11/2019 11:10 AM
2	The idea of putting group problem-solving and presentation section in the afternoon is super good, but the problem is that it might need more time for the group with assigned questions related to the materials that were failed to cover in class due to lacking of time. It would be better if the problem section can be arranged in a more reasonable way.	8/28/2019 4:25 AM
3	They were both phenomenal lecturers. I have no complaints, and I am very grateful for being able to participate.	8/28/2019 1:03 AM
4	The lectures were very well organized and coherent. They followed the textbook quite closely which allowed us to pre-read, as well as follow-up read for more details and explanations, additional examples, omitted proofs, practice problems, etc. I also liked the fact that the first (and very similar) iteration of the school (2009) had lecture videos available on the MSRI website, and watched these prior to the summer school to gain additional background preparation.	8/27/2019 7:46 AM
5	Great summer school, great lecturers and wonderful location!	8/27/2019 7:33 AM
6	The summer school was organized wonderfully, I had a fantastic time and woke up every morning excited to talk about math with the other participants.	8/27/2019 3:34 AM
7	Group work was extremely valuable. A *lot* of my stress throughout the workshop could have been reduced by clarifying, several months in advance, that the school would just be focusing on chapters 0-9 of the toric varieties book. The pre-reqs list is unrealistic in terms of problems to actually work through to prepare. If you're going to just do chapters 0-9 of your book for the summer school, say it, and say it far out enough in advance so that we can all follow.	8/27/2019 3:25 AM

Q7 I was well prepared to benefit from the school

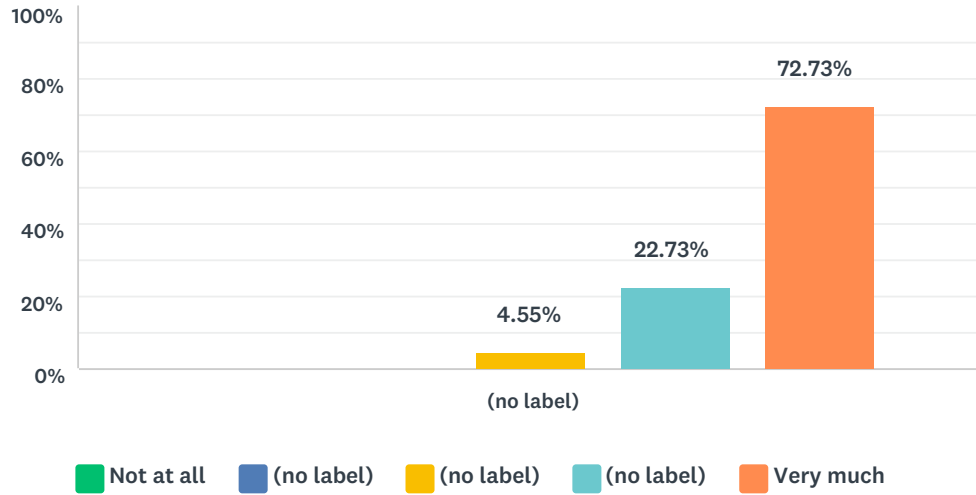
Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	4.55%	4.55%	18.18%	40.91%	31.82%	22	3.91
	1	1	4	9	7		

Q8 My interest in the subject matter was increased by the school

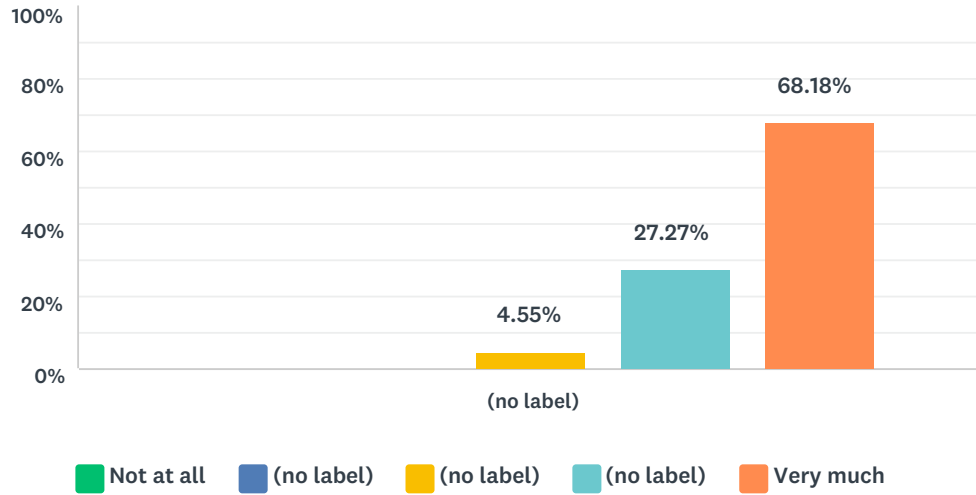
Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.55%	22.73%	72.73%		
	0	0	1	5	16	22	4.68

Q9 The school helped me meet people with similar scientific interests

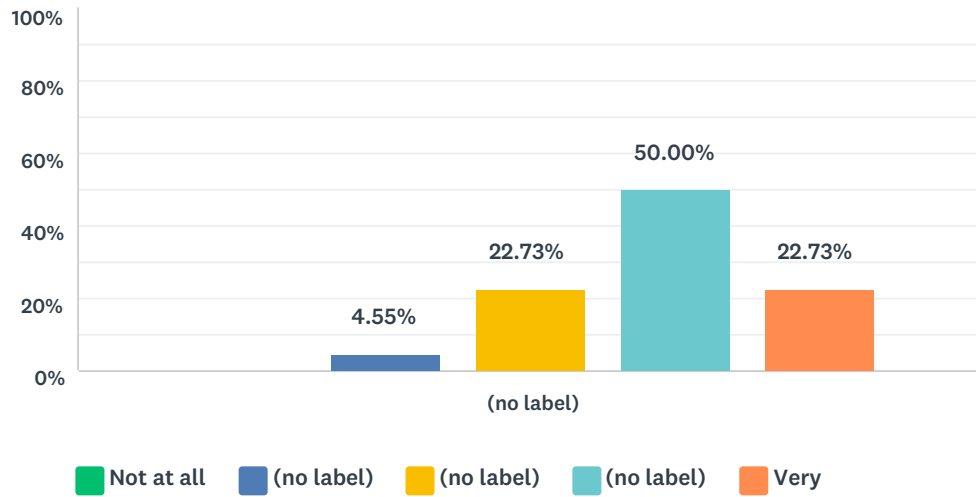
Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.55%	27.27%	68.18%	22	4.64
	0	0	1	6	15		

Q10 It is likely that I will work in the area of the school subject in the future

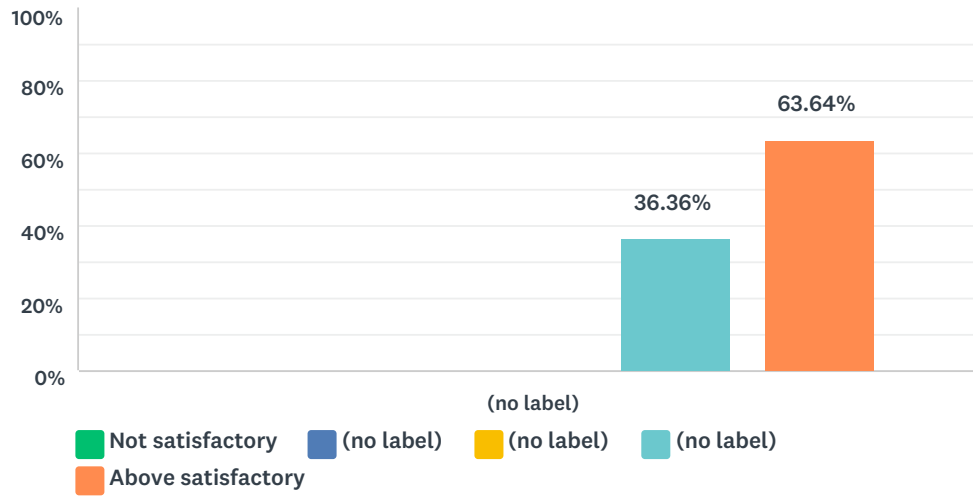
Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.55%	22.73%	50.00%	22.73%	22	3.91
	0	1	5	11	5		

Q11 How would you evaluate your interaction with other participants?

Answered: 22 Skipped: 2



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	0.00% 0	36.36% 8	63.64% 14	22	4.64

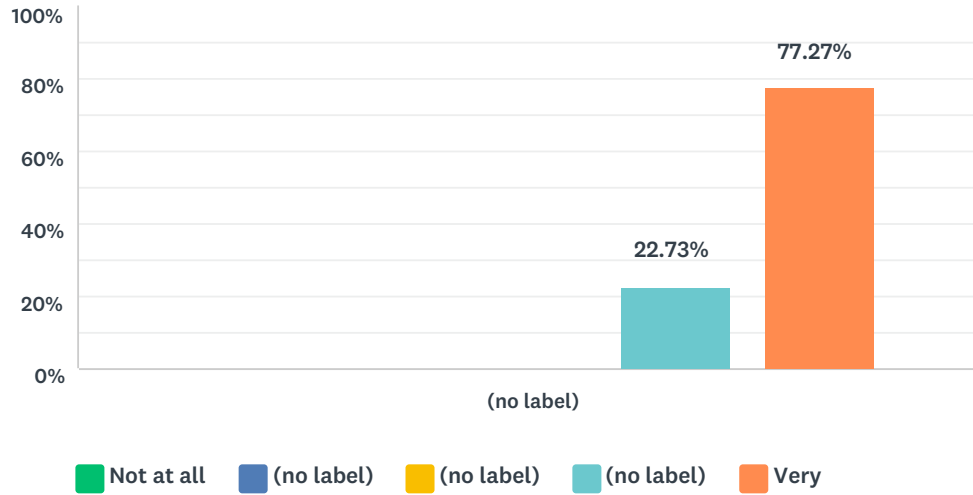
Q12 Additional comments on your personal assessment

Answered: 2 Skipped: 22

#	RESPONSES	DATE
1	The participants are all very friendly and easy to work with and I have a good time working with them in this summer school.	9/11/2019 11:19 AM
2	I gained a lot from this school, both in terms of knowledge and in forming connections. I think the mandatory problem sessions in small groups was instrumental for both of these	8/27/2019 7:48 AM

Q13 I found the onsite staff helpful

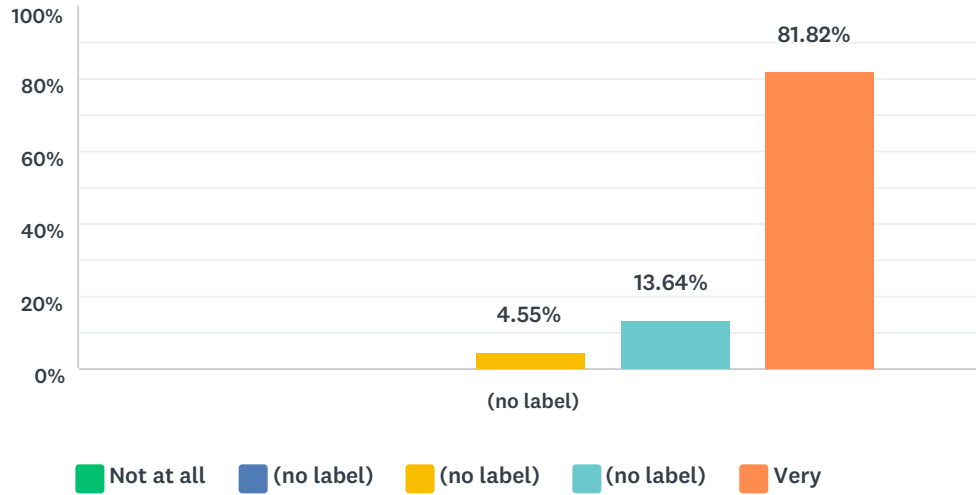
Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	22.73%	77.27%	22	4.77
	0	0	0	5	17		

Q14 The physical facilities were conducive for such a school

Answered: 22 Skipped: 2



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.55%	13.64%	81.82%	22	4.77
	0	0	1	3	18		

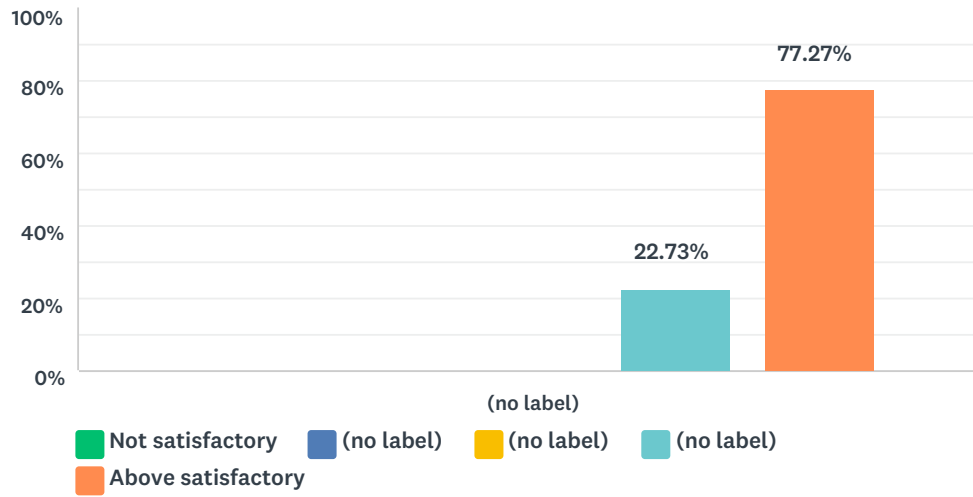
Q15 Additional comments on the venue

Answered: 6 Skipped: 18

#	RESPONSES	DATE
1	The accommodation and class room for the summer school are well arranged, the local organizers are also very friendly and make the event an enjoyable experience beyond my expectations.	9/11/2019 11:28 AM
2	The venue was fine. However Taiwan in August is unbelievably hot and humid. And prone to typhoons and earthquakes both of which we experienced.	8/27/2019 7:51 AM
3	The staff at NTU were AMAZING!	8/27/2019 4:13 AM
4	NCTS was an amazing location for the school. The facilities were very nice and Taipei presented many opportunities for fun outside of the classroom. The onsite staff went above and beyond accommodating our requests.	8/27/2019 4:02 AM
5	NTU was very helpful in every possible way, and I appreciate that our dorms/hotels were booked for us ahead of time. They also gave us instructions in mandarin and English on how to get to the hotel from Taipei Main Station via taxi, so that there'd be no language barrier issues with taxi drivers.	8/27/2019 3:36 AM
6	The 'squat toilets' were a very minor inconvenience.	8/27/2019 3:28 AM

Q16 The summer school accommodation

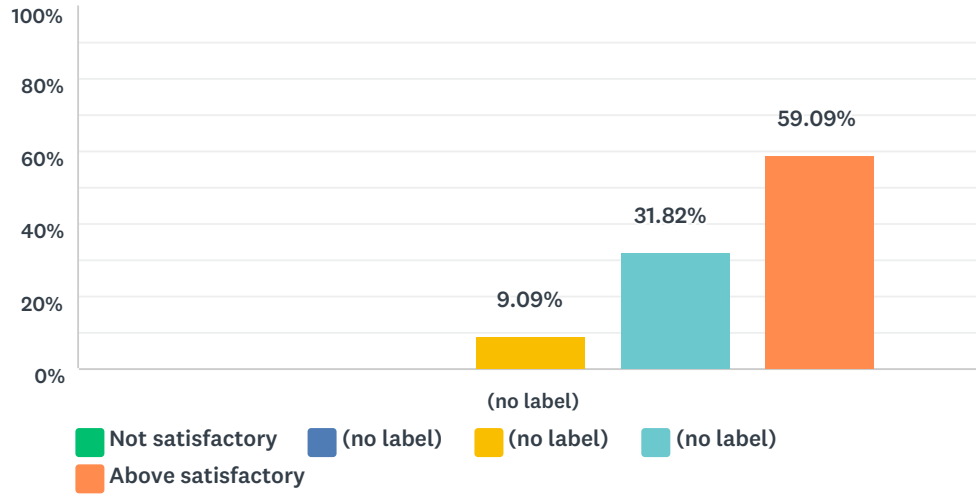
Answered: 22 Skipped: 2



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	0.00% 0	22.73% 5	77.27% 17	22	4.77

Q17 The food provided

Answered: 22 Skipped: 2



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	9.09% 2	31.82% 7	59.09% 13	22	4.50

Q18 Additional comments on accommodation and food

Answered: 4 Skipped: 20

#	RESPONSES	DATE
1	Already included in previous comment.	9/11/2019 11:29 AM
2	The per diem did only barely cover the hotel, and we definitely did not receive enough to buy a meal a day (~\$10) for two weeks.	8/28/2019 1:05 AM
3	I appreciated the accommodation arrangement consisting of single rooms. The food was very good.	8/27/2019 7:52 AM
4	The food was satisfying, the accommodations where very nice.	8/27/2019 3:37 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 20

#	RESPONSES	DATE
1	Get yourself well-prepared beforehand if you want to attend and learn more from the summer school.	8/28/2019 4:28 AM
2	The toilets should have toilet paper.	8/27/2019 1:30 PM
3	I think this is one of the best summer schools I have ever attended. Part of this was due to the excellent lecturers who were very engaged and interested in our learning the material. The TA Lin was also very good in organizing the afternoon small group work. It was quite hard work, but I think it was these daily problem solving sessions, and their particular format, that were crucial in reinforcing my understanding of the material and made a big difference to my overall progress at the school. I feel very fortunate to have experienced this school.	8/27/2019 8:06 AM
4	My only comment is that I had an outstanding time in Taipei in terms of both the math involved and the city itself.	8/27/2019 3:37 AM

Polynomial Method

July 08, 2019 - July 19, 2019

MSRI, Berkeley CA, USA

Organizers:

Adam Sheffer (Bernard M. Baruch College, CUNY)

Joshua Zahl (University of British Columbia)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL “Polynomial Method” July 08 – 19, 2019

Organizers

- Adam Sheffer (Bernard M. Baruch College, CUNY)
- Joshua Zahl (University of British Columbia)

Description

In the past eight years, a number of longstanding open problems in combinatorics were resolved using a new set of algebraic techniques. In this summer school, new techniques as well as some exciting recent developments were discussed.

Highlights of the School

The summer school brought together students with a diverse range of backgrounds. Several students expressed an interest in using polynomial method techniques in their research, and our lectures equipped them with the tools to do this.

The afternoons were dedicated to solving exercises. Some excited students would go to MSRI early in the mornings to do more work on the exercises. A lot before the starting time of the program. Many of the exercises came from Adam Sheffer’s book on the polynomial method. Several students caught issues in the book and also came up with original new exercises for it. Their names are now in the acknowledgements of the current version of the book (<http://faculty.baruch.cuny.edu/ASheffer/000book.pdf>).

Finally, the summer school provided an opportunity for graduate students to meet their future peers. They opened their own Facebook group, and each time some of them met up after the program, such as in a conference, they uploaded a picture of this to the group.

Organizers		
First Name	Last Name	Institution
Adam	Scheffer	Bernard M. Baruch College, CUNY
Joshua	Zahl	University of British Columbia
Speakers		
First Name	Last Name	Institution
Marina	Iliopoulou	University of Kent
Arie	Levit	California Institute of Technology
Adam	Scheffer	Bernard M. Baruch College, CUNY
Joshua	Zahl	University of British Columbia
Teaching Assistants		
First Name	Last Name	Institution
Gil	Goffer	Weizmann Institute of Science
Subhadip	Dey	University of California, Davis

Mathematical Sciences Research Institute

Polynomial Method

July 8 - July 19, 2019

Monday, July 8, 2019

9:00 AM - 9:15 AM	Simons Auditorium		Introduction to MSRI
9:15 AM - 10:15 AM	Simons Auditorium	Joshual Zahl	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Joshual Zahl	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Tuesday, July 9, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Adam Sheffer	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Adam Sheffer	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Wednesday, July 10, 2019

9:00 AM - 10:00 AM	Simons Auditorium	Adam Sheffer	Lecture
10:00 AM - 10:30 AM	Atrium		Break
10:30 AM - 11:30 AM	Simons Auditorium	Adam Sheffer	Lecture
11:30 AM - 2:00 PM	Tilden Park		BBQ Lunch

Thursday, July 11, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Joshual Zahl	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Joshual Zahl	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Friday, July 12, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Joshual Zahl	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Joshual Zahl	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Monday, July 15, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Adam Sheffer	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Adam Sheffer	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Tuesday, July 16, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Adam Sheffer	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Adam Sheffer	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Cosmin Pohoata	Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Wednesday, July 17, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Joshual Zahl	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Joshual Zahl	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch

Thursday, July 18, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Adam Sheffer	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Adam Sheffer	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Marina Iliopoulou	Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session

Friday, July 19, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Adam Sheffer	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Adam Sheffer	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Session



Participants

First Name	Last Name	Institution
Komal	Agrawal	University of Georgia
Maricela	Best Mckay	Portland State University
Benjamin	Bruce	University of Wisconsin-Madison
Wenjun	Cai	University of Chicago
Alan	Chang	University of Chicago
Ana	Chavez Caliz	Pennsylvania State University
Hung	Chu	Washington and Lee University
Jeshu	Dastidar	San Francisco State University
Dheer Noal	Desai	University of Delaware
Daniel	Di Benedetto	University of British Columbia
Austin	Dukes	University of South Florida
Marina	Iliopoulou	University of Kent
Jieying	Jin	Northeastern University
Hongki	Jung	Indiana University
Kyung-sung	Lee	Seoul National University
Brett	Leroux	University of California, Davis
David	Lovitz	Portland State University
Sayan	Mukherjee	University of Illinois, Chicago
Benjamin	Nassau	University of Delaware
Joanna	Niezen	University of Victoria
JD	Nir	University of Nebraska
Kazuhiro	Nomoto	University of Waterloo
Jason	O'Neill	University of California, San Diego
Vy	Ong	Augusta University
Yue	Pan	Washington and Lee University
Jonathan	Passant	University of Rochester
Rachel	Perrier	Washington State University
Matthew	Plante	University of Connecticut
George	Santellano	University of Pennsylvania
Michail	Sarantis	Georgia Institute of Technology
Sam	Spiro	University of California, San Diego
Jonathan	Tidor	Massachusetts Institute of Technology
Rongrong	Wang	Augusta University
Xiaofan	Yuan	Georgia Institute of Technology
Xingyu	Zhu	Georgia Institute of Technology

Officially Registered Student Information

Participants		34
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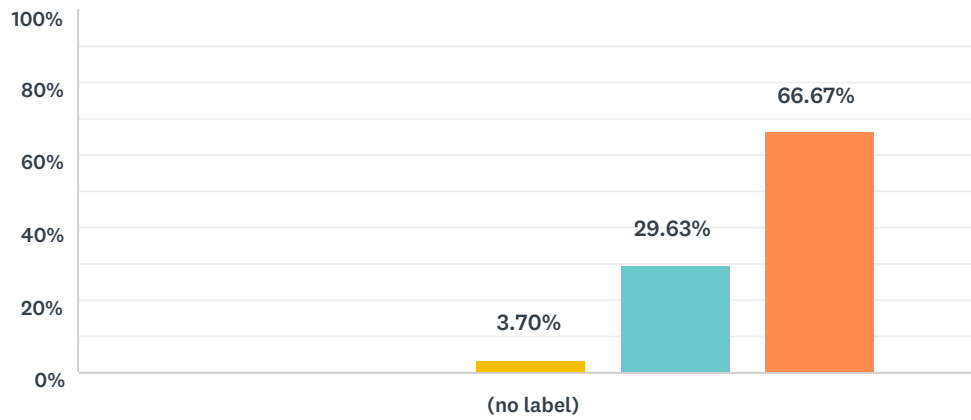
Gender		34
Male	70.59%	24
Female	29.41%	10
Declined to state	0.00%	0

Ethnicity*		36
White	41.67%	15
Asian	44.44%	16
Hispanic	8.33%	3
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	2.78%	1
Declined to state	2.78%	1

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 27 Skipped: 0

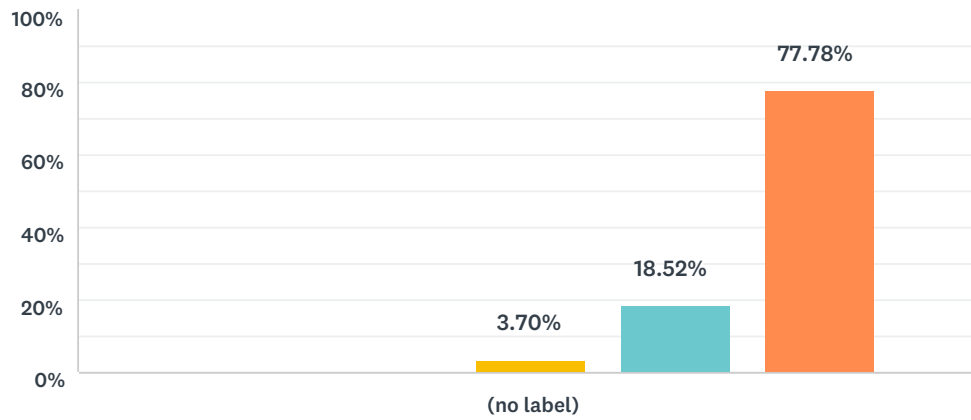


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.70%	29.63%	66.67%	27	4.63
	0	0	1	8	18		

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 27 Skipped: 0

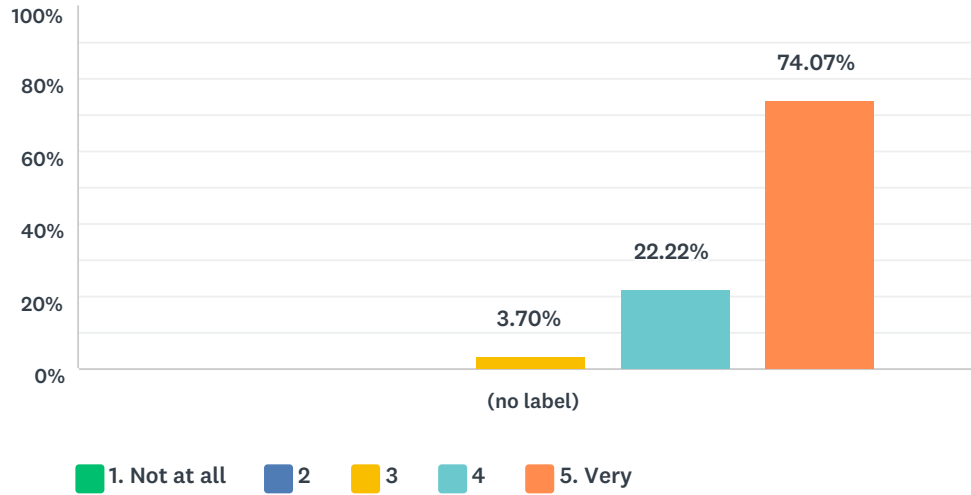


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.70%	18.52%	77.78%	27	4.74
	0	0	1	5	21		

Q3 The school was intellectually stimulating

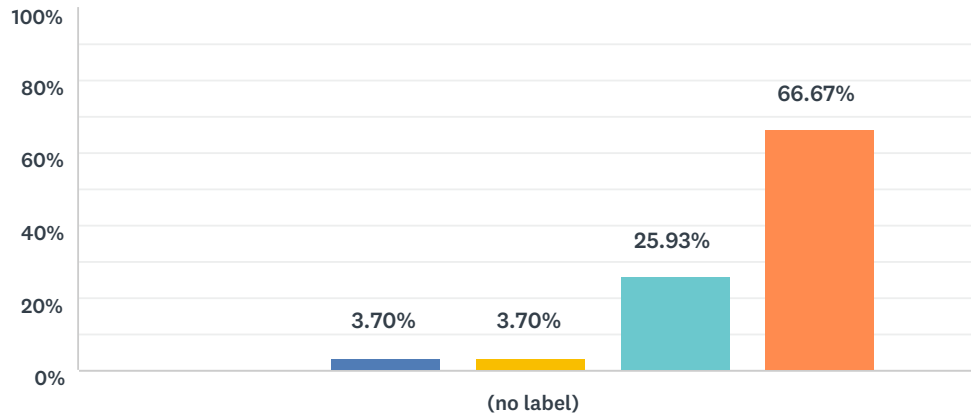
Answered: 27 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.70%	22.22%	74.07%		
	0	0	1	6	20	27	4.70

Q4 My fellow students were appropriately selected to make the event interesting.

Answered: 27 Skipped: 0

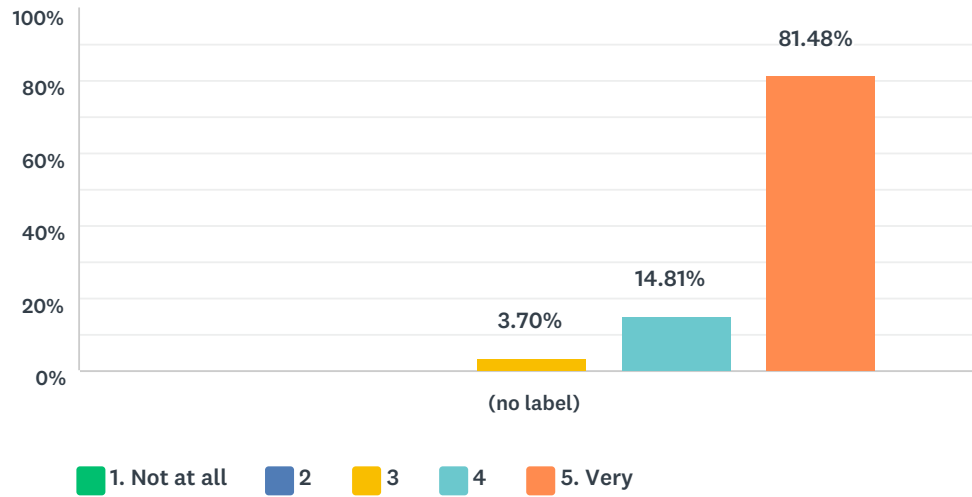


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.70%	3.70%	25.93%	66.67%	27	4.56
	0	1	1	7	18		

Q5 The overall experience of the school was worthwhile

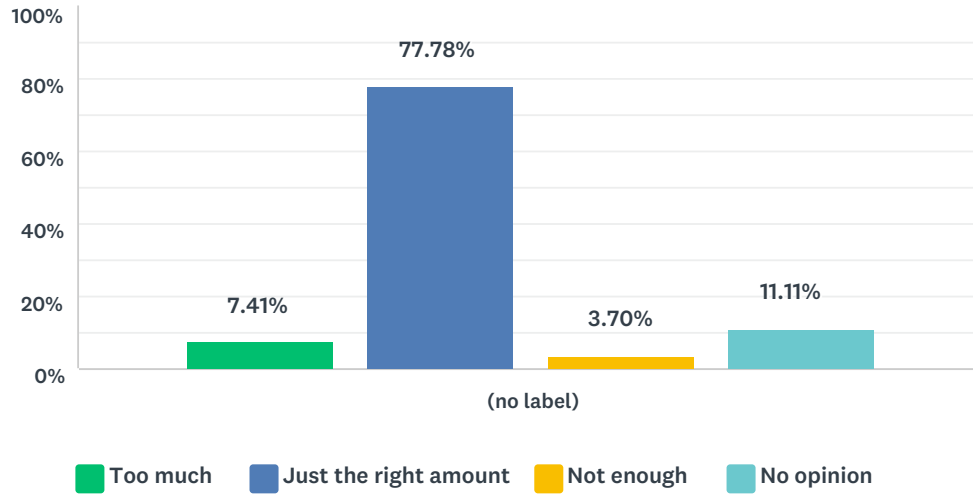
Answered: 27 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	3.70% 1	14.81% 4	81.48% 22	27	4.78

Q6 The amount of material presented was

Answered: 27 Skipped: 0



	TOO MUCH	JUST THE RIGHT AMOUNT	NOT ENOUGH	NO OPINION	TOTAL	WEIGHTED AVERAGE
(no label)	7.41%	77.78%	3.70%	11.11%	27	2.19
	2	21	1	3		

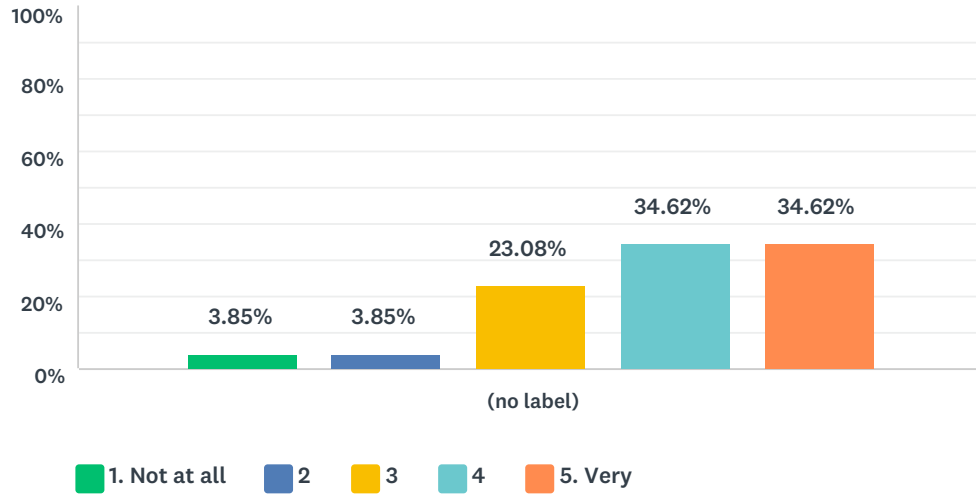
Q7 Additional comments on the topic presentation and organization

Answered: 12 Skipped: 15

#	RESPONSES	DATE
1	Many of the topics were quite new to me, and I feel like the lecturers did a very good job on starting from ground level and building up to more difficult stuff.	8/9/2019 8:13 AM
2	Thank you very much	8/3/2019 4:56 AM
3	Thank you very much for this wonderful summer school! I enjoyed it.	8/2/2019 5:52 PM
4	Learned a lot, and met good people in the area. Thank you, I feel inspired to work.	8/2/2019 2:39 AM
5	Thank you for the exposition!	7/24/2019 8:56 AM
6	I thought the amount of material presented was at an excellent pace. My only complaint in this area was Wednesday and Thursday of the second week - the Restriction Problem. This being alien to a number of students and very difficult to pick up on if we didn't have any familiarity, I would have appreciated more freedom those days - if Josh had said at the very start "For those of you who this is unfamiliar, you're better off doing exercises on other topics instead," I feel I would've benefited. Aside from that, everything was well plotted, not overstuffed, and not so slow as to be dull.	7/21/2019 6:08 AM
7	The topic presentation and pace seemed ideal for the audience present. The choice of emphasis and pace were frustrating to me as I am familiar with the area and so I wished to see less mainstream ideas and results.	7/20/2019 1:19 PM
8	Thanks Josh, Adam and MSRI !	7/20/2019 3:06 AM
9	I really enjoyed the exercises that we worked on with our fellow students, and overall I had a great time!	7/20/2019 12:55 AM
10	I think MSRI is a perfect place to do math. I really enjoyed this.	7/19/2019 4:01 PM
11	I loved the problem sessions, which gave the students opportunities to discuss and share the ideas and solutions.	7/19/2019 2:20 PM
12	Problem sessions were poorly organized, compared to lecture. Lectures running a little long is okay, but cutting out break time makes it tough to really pay attention during the second lecture. The four lecture day (7/18) was brutal; I believe only a small fraction of students were able to follow anything in the afternoon. Overall, I found the school very well put together, these small notes aside.	7/19/2019 11:06 AM

Q8 I was well prepared to benefit from the school

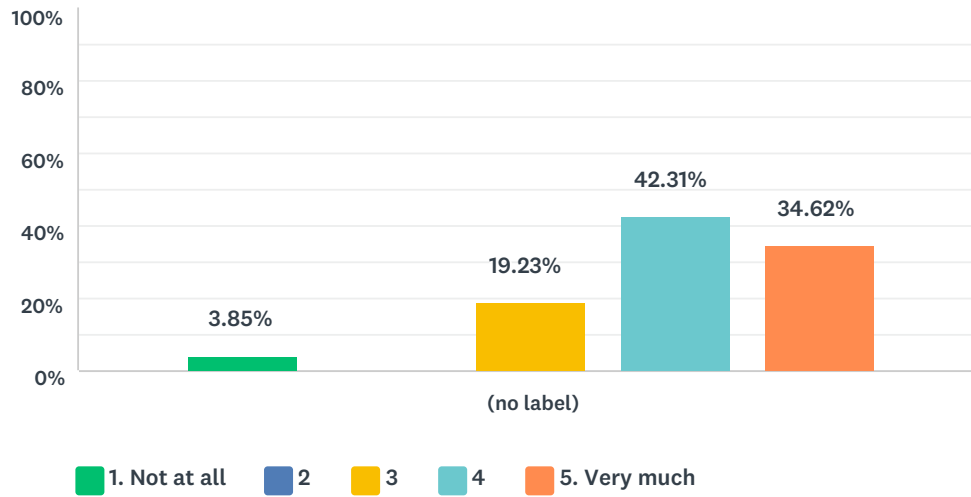
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.85%	3.85%	23.08%	34.62%	34.62%	26	3.92
	1	1	6	9	9		

Q9 My interest in the subject matter was increased by the school

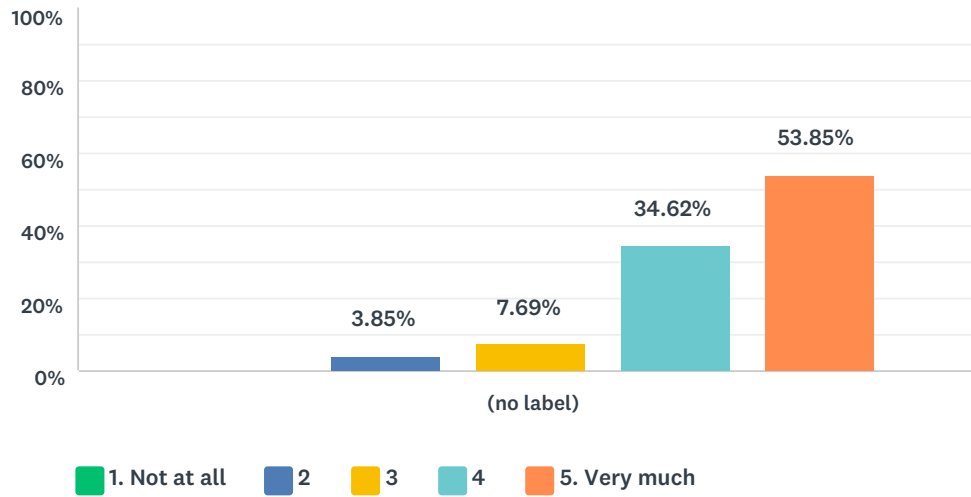
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	3.85%	0.00%	19.23%	42.31%	34.62%	26	4.04
	1	0	5	11	9		

Q10 The school helped me meet people with similar scientific interests

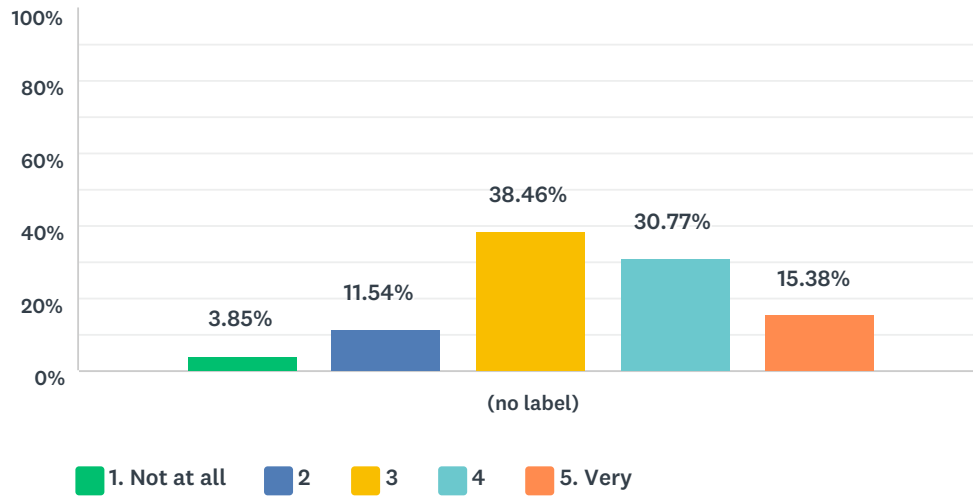
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.85%	7.69%	34.62%	53.85%	26	4.38
	0	1	2	9	14		

Q11 It is likely that I will work in the area of the school subject in the future

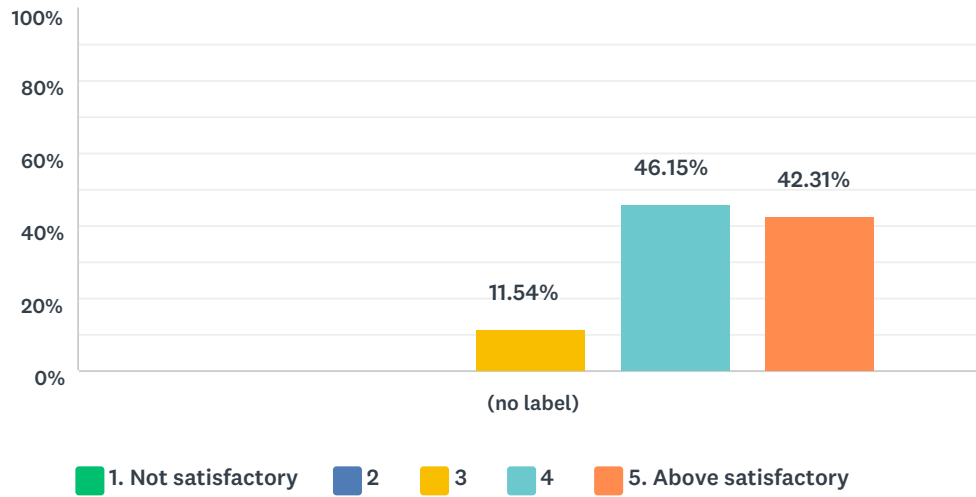
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.85%	11.54%	38.46%	30.77%	15.38%	26	3.42
	1	3	10	8	4		

Q12 How would you evaluate your interaction with other participants?

Answered: 26 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	11.54%	46.15%	42.31%	26	4.31
	0	0	3	12	11		

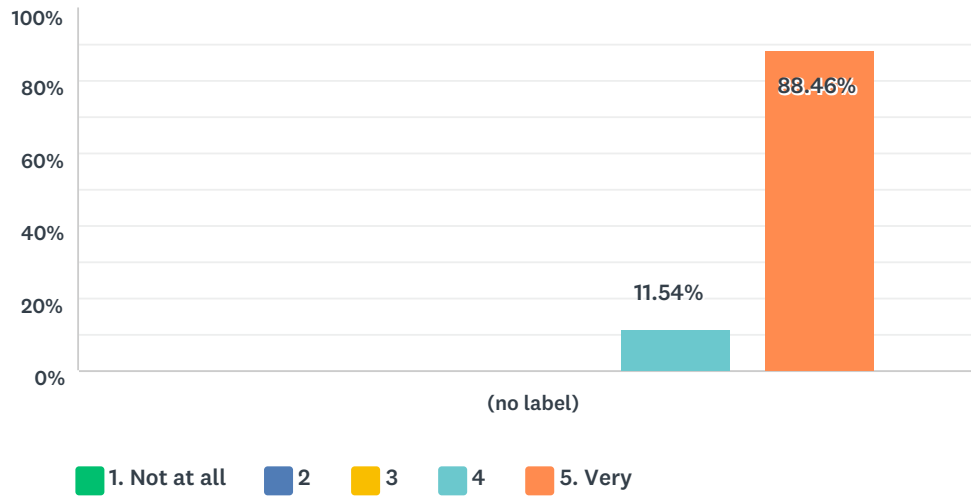
Q13 Additional comments on personal assessment

Answered: 8 Skipped: 19

#	RESPONSES	DATE
1	Meeting a lot of new and old peers who work on/are interested in similar research problems as me was very stimulating.	8/9/2019 8:14 AM
2	Very good, glad to have met some of the people I did	8/2/2019 2:40 AM
3	N/A.	7/24/2019 8:57 AM
4	I think it would have been helpful to have a few more optional prerequisite topics listed to help have a bit more useful background knowledge going into the class.	7/21/2019 9:13 AM
5	I'm very excited to see how the polynomial method translates to my personal research. We all got along great - which also caused us to spend lots of time playing games with our time off rather than doing problems. We certainly got a lot of work done and almost always collaborated in groups of 2 to ~6 while working exercises. Most were answered by the end of the 2 weeks, so this isn't really a complaint.	7/21/2019 6:14 AM
6	It was frustrating not to have more graduate students from the area, as the time would have allowed us to work on some interesting open problems and likely build good relationships going forward. As it was, more time was spent explaining the ideas to people unfamiliar with the area.	7/20/2019 1:22 PM
7	I tried to make interaction with my background (harmonic analysis) and next time I will broaden my background and interact again	7/20/2019 3:09 AM
8	I could have prepared more. I could have spent more time on problems. But playing games was more fun and, ultimately I think, more worth it.	7/19/2019 4:26 PM

Q14 I found the MSRI staff helpful

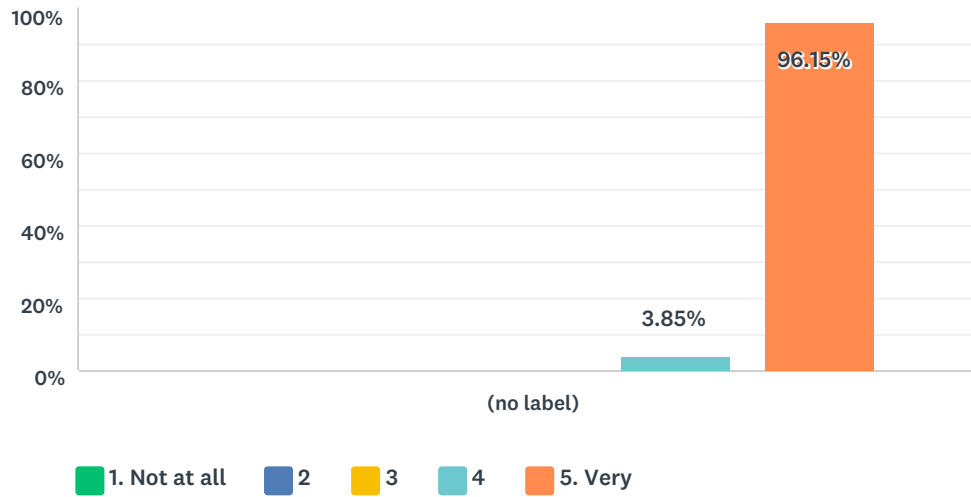
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	11.54%	88.46%		
	0	0	0	3	23	26	4.88

Q15 The MSRI facilities were conducive for such a school

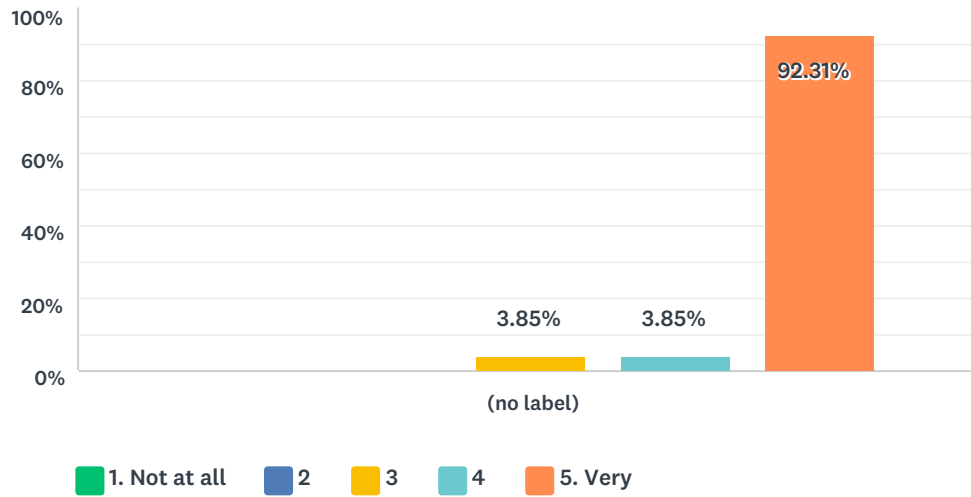
Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	3.85%	96.15%	26	4.96
	0	0	0	1	25		

Q16 The MSRI computer facilities were adequate for such a school

Answered: 26 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.85%	3.85%	92.31%		
	0	0	1	1	24	26	4.88

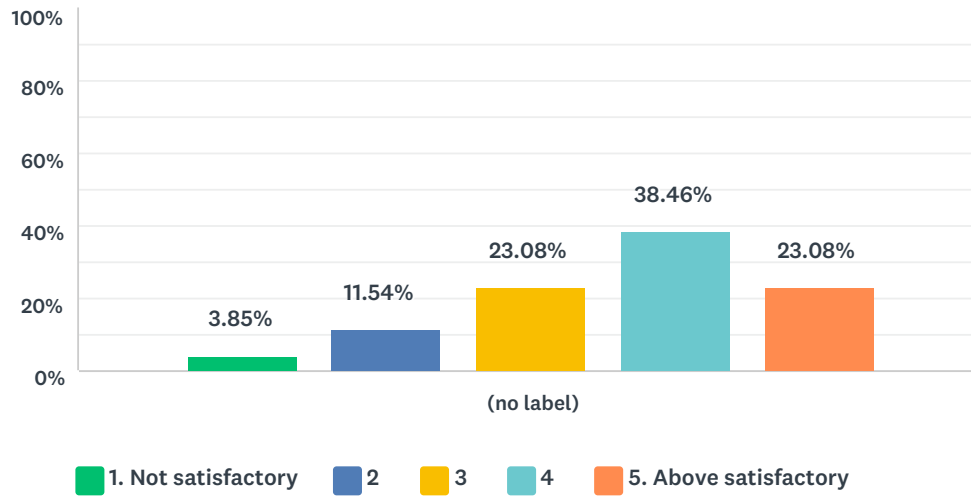
Q17 Additional comments on the MSRI venue

Answered: 7 Skipped: 20

#	RESPONSES	DATE
1	The location is superb. Daily treks downhill were something to look forward to!	8/9/2019 8:15 AM
2	It's a wonderful place with an amazing view!	7/24/2019 8:57 AM
3	I loved the environment at MSRI. Everyone was extremely nice and helpful and it was a great place to work.	7/21/2019 9:14 AM
4	MSRI made for an excellent venue for the summer school - both having Berkeley to explore and the actual building during the day engendered collaboration and hard work. While I'm glad we had the library, I think that particular resource is more suited to longer term programs than ours. I would also like to shout out MSRI's administrative staff and kitchen staff - both went absolutely above and beyond helping everybody out with otherwise complicated matters like reimbursement or navigating difficult dietary restrictions. The fact that they're all incredibly kind is a bonus - pay these people more!	7/21/2019 6:56 AM
5	The lunches provided were excellent, the caterers did an excellent job.	7/20/2019 1:23 PM
6	Thank you very much!	7/20/2019 3:10 AM
7	Food and the servers were incredible. Rest of the staff was very welcoming.	7/19/2019 4:27 PM

Q18 How did you find the summer school accommodations?

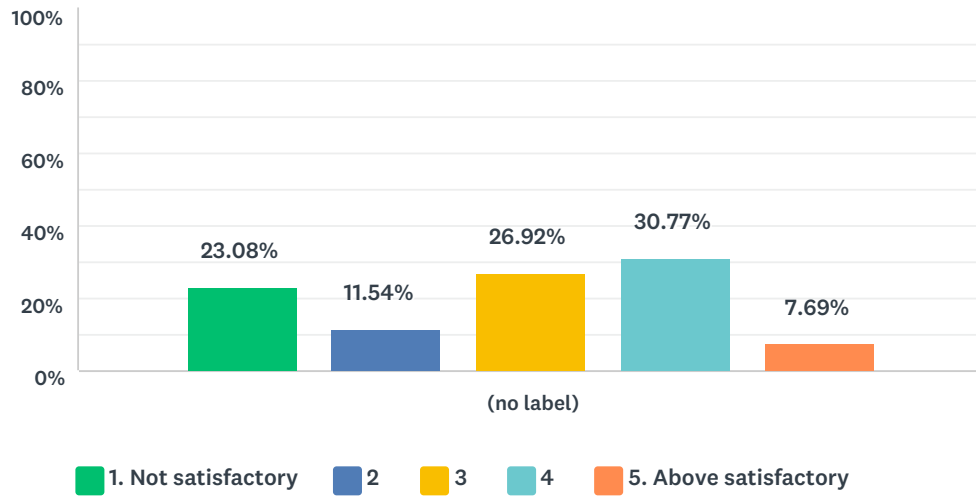
Answered: 26 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	3.85%	11.54%	23.08%	38.46%	23.08%	26	3.65
	1	3	6	10	6		

Q19 How did you find the food at the dormitories?

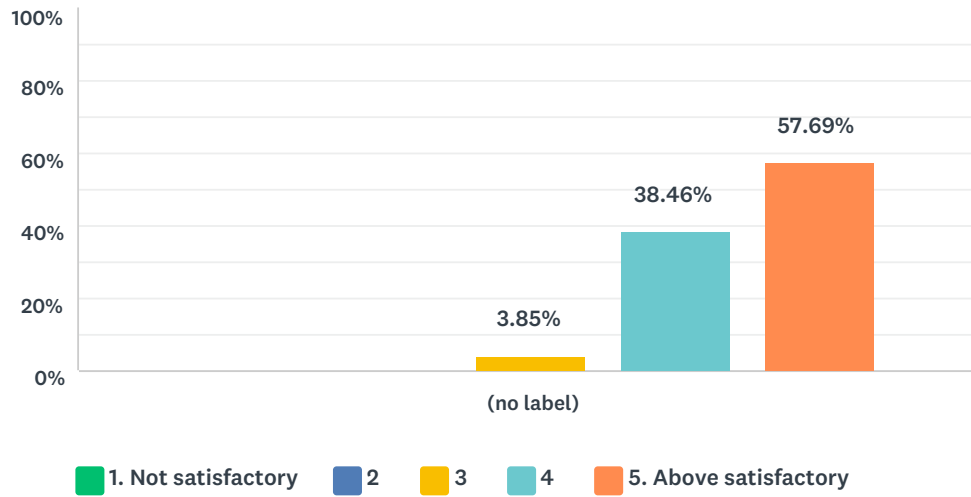
Answered: 26 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	23.08%	11.54%	26.92%	30.77%	7.69%	26	2.88
	6	3	7	8	2		

Q20 How did you find the food provided by MSRI?

Answered: 26 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.85%	38.46%	57.69%	26	4.54
	0	0	1	10	15		

Q21 Additional comments on accommodation and food

Answered: 10 Skipped: 17

#	RESPONSES	DATE
1	The cafeteria food was very average, and repetitive in a lot of cases. Many a times they would run out of supplies such as milk, and it would take until the next day to get refilled... Accommodation was great though!	8/9/2019 8:17 AM
2	Good staff which looked out for everybody to get food.	8/2/2019 2:41 AM
3	The beds in the dorms were very hard and made sleeping difficult.	7/24/2019 8:58 AM
4	The food at MSRI was fantastic!	7/21/2019 9:14 AM
5	We were warned about the hard mattresses, but not about the pitiful pillows. Beyond that, the dorms were serviceable. The dining hall food was pretty unfortunate (except the occasional pastry), though dining options around Berkeley were good. I would like to reiterate that the MSRI kitchen staff was tremendous - see previous box.	7/21/2019 7:48 AM
6	The food at crossroads, particularly for dinner, was quite poor. This was improved once we found that we could visit the other dining locations (typically café 3), where there were fewer large groups of younger children/teens and an overall quieter atmosphere. The food at MRSI was excellent, I think every lunch we had was excellent.	7/20/2019 1:27 PM
7	Crossroads is too crowded	7/20/2019 3:10 AM
8	It appears that we were also able to eat at Cafe 3 during our stay here. It would have been nice to have known this flexibility in our dining options before the start of the program.	7/20/2019 1:26 AM
9	I found sleeping in the dorms rather difficult, which diminished my overall experience in the school. One particular cause was an odd humming sound prevalent throughout the building, though I have no idea what one could do about this.	7/20/2019 12:58 AM
10	Dining hall food was bad verging on inedible. Room met bare minimum standards. Bed was incredibly uncomfortable.	7/19/2019 4:29 PM

Q22 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 8 Skipped: 19

#	RESPONSES	DATE
1	I selected "right amount" for the question regarding the material taught by the summer school, but maybe the summer school can be a little more intense. Eg. less rest time, possibly assigning homework, etc. Overall very good experience, thank you all :)	8/2/2019 5:57 PM
2	Beds could be softer for the dorms, writing on chalk board could be neater, one could know how many swipes they have left on their food cart or if it is unlimited.	8/2/2019 2:43 AM
3	Thank you for the opportunity!	7/24/2019 8:58 AM
4	Honestly, I'm very pleased with almost all of it - the pace of lectures, the unstructured free time, the problem sets, the different groups that worked together, the venue, etc. All were really excellent. The only thought that occurred to me (beyond what I've already said in other comment boxes) is that it would be nice to have a session all about brainstorming applying polynomial method to our current research, if only because the field is so new. This is just a passing thought though - everything was wonderful. Thanks so much!	7/21/2019 8:02 AM
5	Could you make the lights in Simons Hall more brighter? All in all, the program was very nice.	7/20/2019 3:12 AM
6	I think a slightly better schedule would involve: Second AM session: Lecture First PM session: Lecture Second PM session: Problems (loosely work on/ write up solutions in the evening) First AM session: Go over answers; broader comments So essentially shift the schedule by one session so that when discussing problems we are all fresh and don't have one foot out of the door. This would also be a good warm-up to lecture some days. Also, the cookies at lunch were really good!	7/20/2019 1:30 AM
7	While it eventually evolved naturally, I would have liked MSRI to provide some social infrastructure. We tried to set up communication channels to arrange for social activities outside of class but it was difficult without a central authority.	7/19/2019 4:33 PM
8	This summer school is awesome. I highly appreciate MSRI for this event and welcome any future opportunities for learning and contributions.	7/19/2019 10:31 AM

Representation stability

June 24, 2019 - July 05, 2019

MSRI, Berkeley CA, USA

Organizers:

Thomas Church (Stanford University)

Andrew Snowden (University of Michigan)

Jenny Wilson (University of Michigan)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL

“Representation stability”

June 24 – July 05, 2019

Organizers

- Thomas Church (Stanford University)
- Andrew Snowden (University of Michigan)
- Jenny Wilson (University of Michigan)

Description

This summer school will give an introduction to representation stability, the study of algebraic structural properties and stability phenomena exhibited by sequences of representations of finite or classical groups -- including sequences arising in connection to hyperplane arrangements, configuration spaces, mapping class groups, arithmetic groups, classical representation theory, Deligne categories, and twisted commutative algebras. Representation stability incorporates tools from commutative algebra, category theory, representation theory, algebraic combinatorics, algebraic geometry, and algebraic topology. This workshop will assume minimal prerequisites, and students in varied disciplines are encouraged to apply.

Highlights of the School

The school took place over two weeks. During that time, there were two two-week lecture series, by Peter Patzt and Andrew Snowden, one one-week lecture series, by Andy Putman, and some other talks by Jenny Wilson and John Wiltshire-Gordon. There were typically three lectures each day, with problem sessions immediately following each lecture featuring problems directly relevant to the lecture. In addition, the two TA's (Megan Maguire and John Wiltshire-Gordon) gave several review sessions on background material. The review sessions and lectures were designed to appeal to students with a broad spectrum of backgrounds, and incorporated exercises with a wide range of difficulty levels.

From the perspective of the organizers, the lectures appeared to be prepared and delivered well. The students' survey responses show that they feel similarly: they rated the clarity and organization of the lectures at 4.67 out of 5. The lectures were well-attended, and students asked numerous questions during them, which speaks to the friendly atmosphere of the summer school.

The problem sessions seemed to be a hit as well. For the most part, the students broke into small groups and worked together on the problems. The groups were lively and engaged with the material. The faculty and TA's went from group to group, checking on their progress and answering any questions that came up. The students seemed to have an especially good rapport with the TA's, and interacted with them almost constantly. (The students' high esteem of the TA's is attested in their survey response, where they rated the TA's helpfulness at 4.63 out of 5.)

During the second week the lecturers and TAs held a Q&A session, to give students an open opportunity to ask questions about math or professional development to a panel of math faculty. The students showed particular interest in asking about the faculty members' motivation and experiences with their careers in math research, and asking about how to overcome various obstacles (mathematical, logistical, and psychological) commonly faced by math graduate students.

While the planned activities discussed above went as well as could be hoped for, the TA's review sessions stole the show. John in particular explains basic mathematical concepts with an amazing energy and creativity, and the students were captivated by his lectures. Since these sessions were informal (and not recorded), the students also felt more freedom to speak up, so there was a great deal of interaction; in fact, at times the sessions were more of a dialogue between the TA and the audience instead of a traditional lecture.

Some additional excerpts from the student surveys:

"It was a great experience with a good mix of people."

"The amount of material presented was too much for me to do all of, but it was just the right amount in that there were always a few problems that I could feel pretty good about engaging with, which I appreciated! Thanks again to everyone at MSRI, too, for making it an absolute pleasure to be there."

"there were certainly peers and activities at many different levels of knowledge, and a great positive atmosphere, so I think everyone got something worthwhile out of it."

"At one point, I got some positive feedback from a TA, telling me he was impressed by my work. This offhand comment was actually really motivating. It was nice to know that someone who works in the field thinks my work is good, which made me want to keep working on more problems."

"I appreciated the broad range of materials and exercises, so that people from various backgrounds still had enough to do that was accessible."

"everyone was fantastic and the venue was way beyond what I could have imagined."

"Everyone at MSRI was very friendly and kind."

"It has been a great experience."

"It was a great experience!"

"It was an excellent experience, and I definitely left much more excited about mathematics in general than when I arrived. Please keep running these summer schools! They are very worthwhile."

"I had a fantastic time at MSRI and this workshop really made me passionate about math again. I love the format of lectures following by problem sessions, and I learned a lot from doing the problems and collaborating with other students. Please organize more of these workshops!"

Organizers

First Name	Last Name	Institution
Thomas	Church	Stanford University
Andrew	Snowden	University of Michigan
Jenny	Wilson	University of Michigan

Speakers

First Name	Last Name	Institution
Peter	Patz	Purdue University
Andrew	Snowden	University of Michigan
Jenny	Wilson	University of Michigan
John	Wiltshire-Gordon	University of Wisconsin-Madison

Teaching Assistants

First Name	Last Name	Institution
John	Wiltshire-Gordon	University of Wisconsin-Madison
Megan	Maguire	University of California, Irvine

Mathematical Sciences Research Institute

Representation Stability

June 24, 2019 - July 05, 2019

Monday, June 24, 2019			
8:40 AM - 9:00 AM	Simons Auditorium		Introduction to MSRI
9:00 AM - 9:45 AM	Simons Auditorium		Putman Lectures Series (Talk #1)
9:45 AM - 10:30 AM	Simons Auditorium		Putman Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Snowden Lecture Series (Talk #1)
11:30 AM - 12:15 PM	Simons Auditorium		Snowden Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Background module: Category theory
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session
Tuesday, June 25, 2019			
9:00 AM - 9:45 AM	Simons Auditorium		Snowden Lectures Series (Talk #2)
9:45 AM - 10:30 AM	Simons Auditorium		Snowden Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Patz Lecture Series (Talk #1)
11:30 AM - 12:15 PM	Simons Auditorium		Patz Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Putman Lectures Series (Talk #2)
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session
Wednesday, June 26, 2019			
9:00 AM - 9:45 AM	Simons Auditorium		Patz Lectures Series (Talk #2)
9:45 AM - 10:30 AM	Simons Auditorium		Putman Problem Session
10:30 AM - 11:30 AM	Simons Auditorium		Background module: Homological algebra
11:30 AM - 2:00 PM	Tilden Park		BBQ Lunch
2:00 PM - 2:45 PM	Simons Auditorium		Putman Lectures Series (Talk #3)
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session
Thursday, June 27, 2019			
9:00 AM - 9:45 AM	Simons Auditorium		Putman Lectures Series (Talk #4)
9:45 AM - 10:30 AM	Simons Auditorium		Putman Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Snowden Lecture Series (Talk #3)
11:30 AM - 12:15 PM	Simons Auditorium		Snowden Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Patz Lecture Series (Talk #3)
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session
Friday, June 28, 2019			
9:00 AM - 9:45 AM	Simons Auditorium		Patz Lectures Series (Talk #4)
9:45 AM - 10:30 AM	Simons Auditorium		Patz Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Snowden Lecture Series (Talk #4)
11:30 AM - 12:15 PM	Simons Auditorium		Snowden Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Putman Lecture Series (Talk #5)
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session

Monday, July 1, 2019

9:00 AM - 9:45 AM	Simons Auditorium		Snowden Lectures Series (Talk #5)
9:45 AM - 10:30 AM	Simons Auditorium		Snowden Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Patz Lecture Series (Talk #5)
11:30 AM - 12:15 PM	Simons Auditorium		Patz Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Lecture Series
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session

Tuesday, July 2, 2019

9:00 AM - 9:45 AM	Simons Auditorium		Patz Lectures Series (Talk #6)
9:45 AM - 10:30 AM	Simons Auditorium		Patz Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Snowden Lecture Series (Talk #6)
11:30 AM - 12:15 PM	Simons Auditorium		Snowden Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session

Wednesday, July 3, 2019

9:00 AM - 9:45 AM	Simons Auditorium		Snowden Lectures Series (Talk #7)
9:45 AM - 10:30 AM	Simons Auditorium		Snowden Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Lecture Series
11:30 AM - 12:15 PM	Simons Auditorium		Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:30 PM	Simons Auditorium		Patz Lectures (Talk #7)
2:30 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session

Thursday, July 4, 2019

Independence Day
MSRI Closed

Friday, July 5, 2019

9:00 AM - 9:45 AM	Simons Auditorium		Snowden Lectures Series (Talk #8)
9:45 AM - 10:30 AM	Simons Auditorium		Snowden Problem Session
10:30 AM - 10:45 AM	Atrium		Short Break
10:45 AM - 11:30 AM	Simons Auditorium		Patz Lecture Series (Talk #8)
11:30 AM - 12:15 PM	Simons Auditorium		Patz Problem Session
12:15 PM - 1:45 PM	Atrium		Lunch
1:45 PM - 2:45 PM	Simons Auditorium		Wilson Lectures (Talk #2)
2:45 PM - 3:15 PM	Simons Auditorium		Problem Session
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Problem Session



Participants		
First Name	Last Name	Institution
Olakunle	Abawonse	Binghamton University (SUNY)
Noel	Bourne	Howard University
Ka Yue	CHEUK	University at Buffalo (SUNY)
René	Corbet	Technische Universität Graz
Patrick	Durkin	University of Oregon
Christian	Gaetz	Massachusetts Institute of Technology
Karthik	Ganapathy	University of Michigan
Zachary	Himes	Purdue University
Peter	Huston	Ohio State University
Jasim	Ismaeel	University of Missouri
Erich	Jauch	Iowa State University
Sam	Jeralds	University of North Carolina
Eric	Jovinelly	University of Notre Dame
Hayden	Julius	Kent State University
Arun	Kannan	University of Virginia
O'Neill	Kingston	Iowa State University
Anthony	Kling	University of Arizona
Stark	Ledbetter	University of Washington
Tianyue	Liu	University of Pennsylvania
Derek	Lowenberg	University of California, Riverside
Samantha	Miller-Brown	Lehigh University
Dinushi	Munasinghe	University of Toronto
Csaba	Nagy	The University of Melbourne
Gabriel	Necoechea	Kansas State University
Daniel	Plummer	Howard University
Kevin	Pomorski	Ohio University
Greyson	Potter	Boston University
Nicholas	Russoniello	Lehigh University
Cecily	Santiago	University of Minnesota Twin Cities
Bridget	Schreiner	University of Notre Dame
Jiayi	Shen	University of California, Irvine
Porter	Summers	Southern Illinois University
Alexander	Sutherland	University of California, Irvine
Shichen	Tang	University of California, Irvine
Ashwin	Trisal	University of California, Santa Barbara
Frederick	Vu	University of California, Los Angeles
Ilan	Weinschelbaum	University of Oregon
Menake	Wijerathne	Southern Illinois University
Adam	Wood	University of Iowa
Huanhuan	Yu	University of North Carolina
Claudia	Yun	Brown University
Victor	Zhang	California Institute of Technology

Officially Registered Student Information

Participants		42
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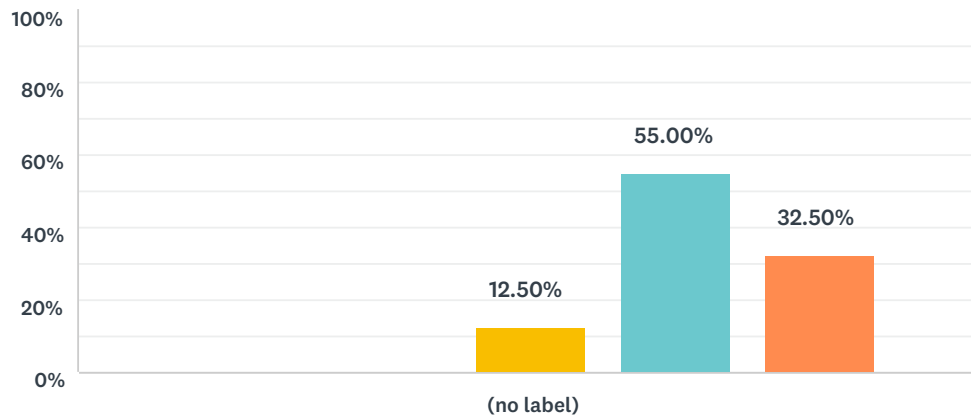
Gender		42
Male	80.95%	34
Female	16.67%	7
Declined to state	2.38%	1

Ethnicity*		52
White	44.23%	23
Asian	28.85%	15
Hispanic	3.85%	2
Pacific Islander	0.00%	0
Black	5.77%	3
Native American	1.92%	1
Mixed	9.62%	5
Declined to state	5.77%	3

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 40 Skipped: 0

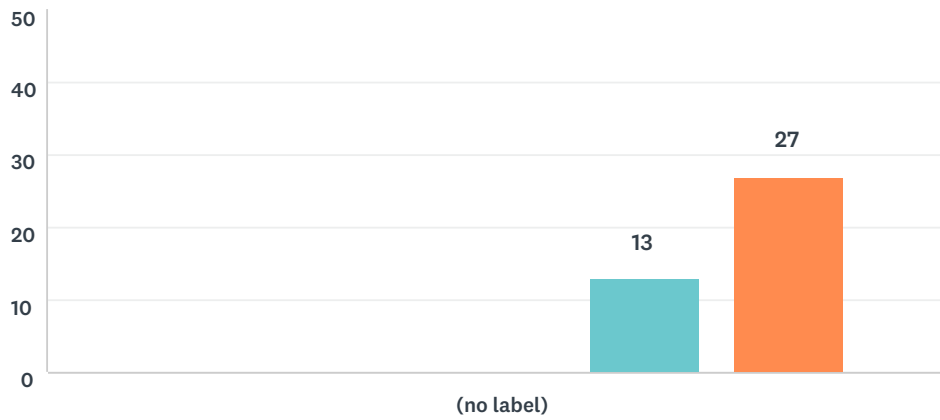


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	12.50% 5	55.00% 22	32.50% 13	40	4.20

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 40 Skipped: 0

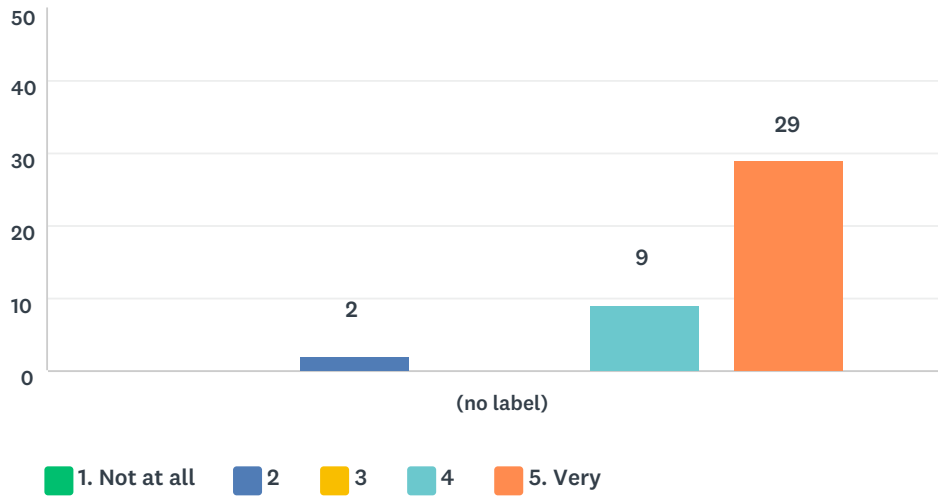


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	32.50%	67.50%	40	4.67
	0	0	0	13	27		

Q3 The Teaching Assistants were helpful

Answered: 40 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.00%	0.00%	22.50%	72.50%	40	4.63
	0	2	0	9	29		

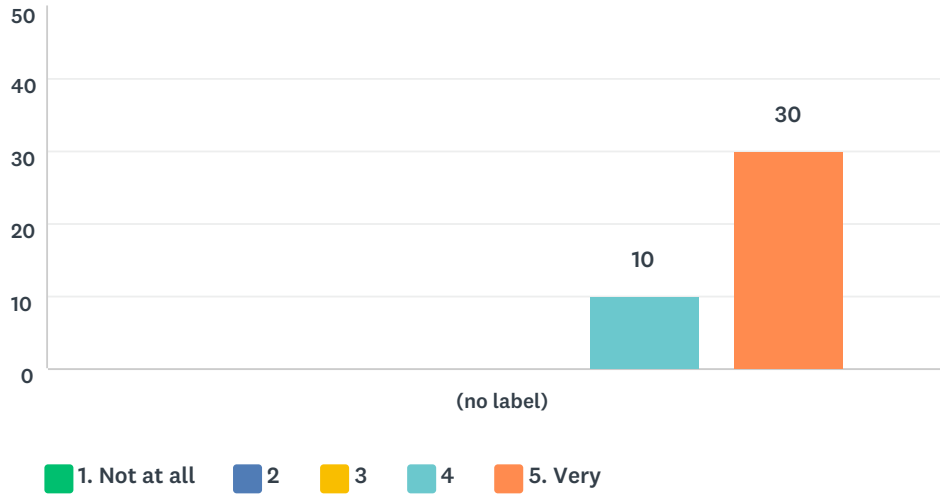
#	PLEASE PROVIDE SOME COMMENTS ON THE TAS.	DATE
1	TAs are great! Please invite them back later.	7/17/2019 4:03 PM
2	John and Megan were great!	7/16/2019 10:14 AM
3	They were extremely knowledgeable about the subject matter. Furthermore, they were very personable and great to talk to about matters outside of math.	7/16/2019 3:37 AM
4	Only really interacted with John, but having his perspective around was great.	7/16/2019 3:26 AM
5	I mostly interacted with John. He was helpful, intellectually provocative, and provided a lot of interesting ideas of his own to play with.	7/9/2019 7:48 AM
6	John and Megan are fantastic explainers of all things algebraic. I particularly appreciated their willingness to meet us wherever we were. The "mini-courses" were also excellent.	7/9/2019 2:04 AM
7	I did not get much chances to talk to Megan, but John is very good at explaining the rationales behind ideas in simple ways. He helped me a lot	7/9/2019 12:19 AM
8	Both TAs were very active and focused on the success of all of us. I feel they were paramount to the success of the course.	7/8/2019 1:40 PM
9	Both TA's were immensely intelligent in a wide range of topics.	7/8/2019 7:07 AM
10	Sometimes there were some issues with either assuming we know way less than we do, or assuming we know way more than we do. But this more or less worked itself out over time, as the TA's got to know us better and knew what we did/didn't know.	7/8/2019 7:02 AM
11	The TAs were not really facilitating. Lingering around at the same group would often hinder discussion among the group. This is nothing to do with if they knew how to do the problem or not. However, the TAs were always available and willing to answer questions to the best of their ability.	7/8/2019 6:49 AM
12	The offshoot sessions were conceptually great but lacked any real information.	7/8/2019 5:42 AM
13	John and Megan were awesome and very helpful.	7/8/2019 5:03 AM
14	Both the TAs were very kind and great at explaining everything	7/8/2019 4:18 AM
15	John did an excellent job providing background and intuition on a variety of topics. Megan was helpful 1-on-1 throughout the program. The two TAs complemented each other nicely.	7/8/2019 4:15 AM

MSRI 850 SGS: Representation stability - Participant Survey

16	John was very much helpful.	7/8/2019 4:05 AM
17	The teaching assistants were very helpful and clearly wanted to help and guide the students' understand of the material.	7/8/2019 3:59 AM
18	I learned more from John than from all of the faculty combined. His background talks completely changed the way I thought about previously intimidating topics, such as category theory. He also made me feel comfortable learning, especially in the first few days, when I wasn't sure my background was sufficient to be in the program.	7/8/2019 3:58 AM

Q4 The school was intellectually stimulating

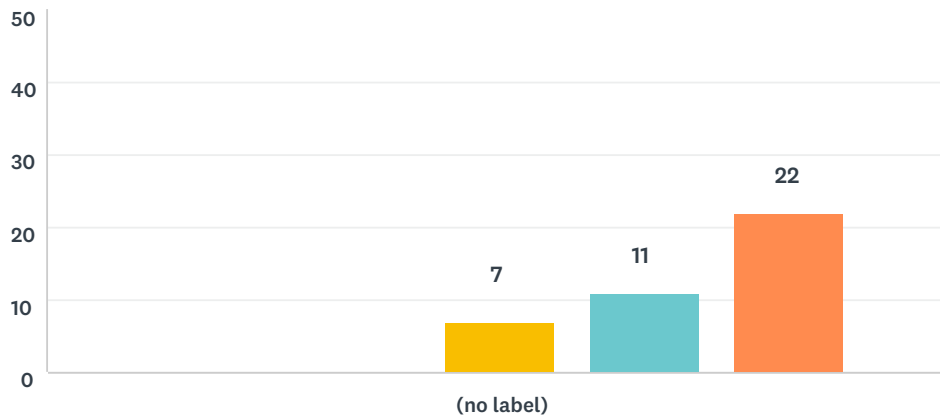
Answered: 40 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	25.00%	75.00%	40	4.75
	0	0	0	10	30		

Q5 My fellow students were appropriately selected to make the event interesting.

Answered: 40 Skipped: 0

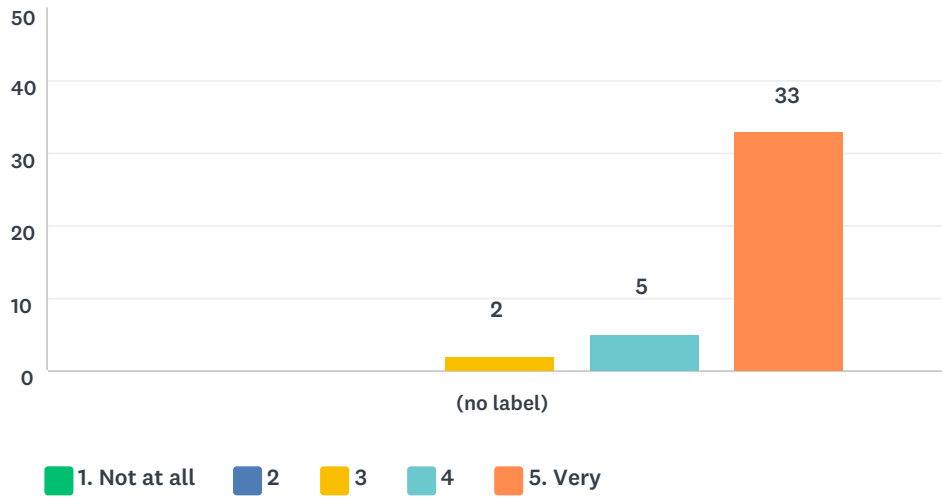


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	17.50%	27.50%	55.00%	40	4.38
	0	0	7	11	22		

Q6 The overall experience of the school was worthwhile

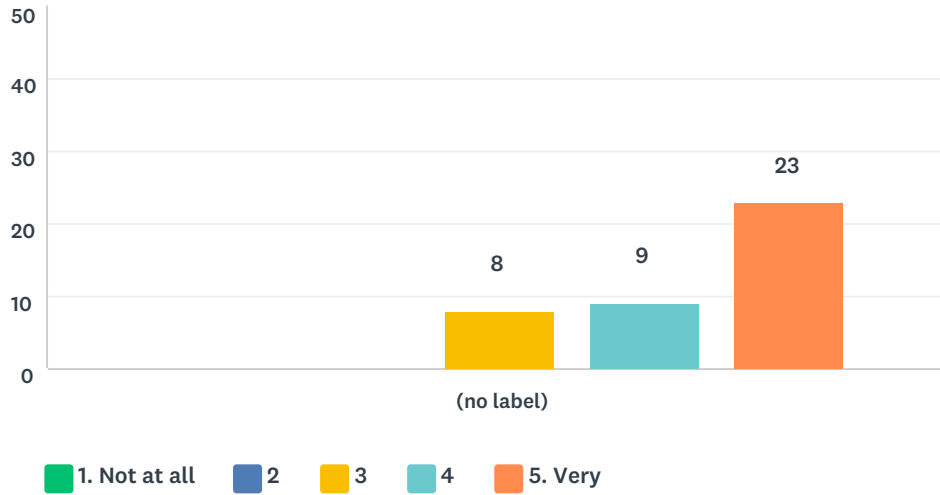
Answered: 40 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	5.00% 2	12.50% 5	82.50% 33	40	4.78

Q7 The Problem Sessions were productive

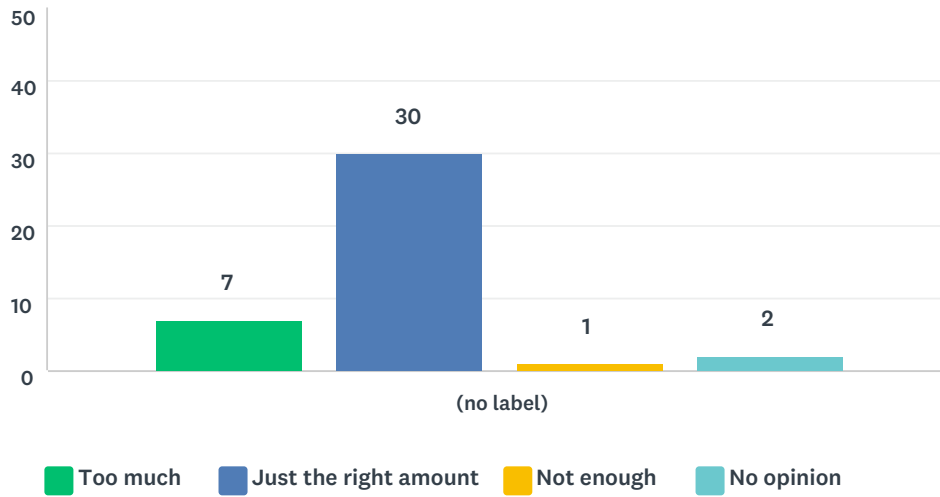
Answered: 40 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	20.00%	22.50%	57.50%	40	4.38
	0	0	8	9	23		

Q8 The amount of material presented was

Answered: 40 Skipped: 0



	TOO MUCH	JUST THE RIGHT AMOUNT	NOT ENOUGH	NO OPINION	TOTAL	WEIGHTED AVERAGE
(no label)	17.50%	75.00%	2.50%	5.00%	40	1.95
	7	30	1	2		

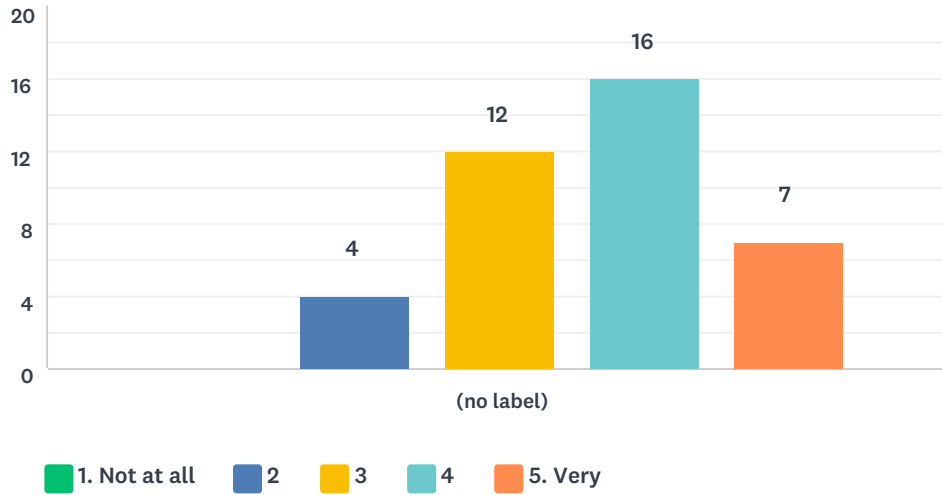
Q9 Additional comments on the topic presentation and organization

Answered: 9 Skipped: 31

#	RESPONSES	DATE
1	Sorry I took so long to fill this out!	8/1/2019 8:30 AM
2	The amount of material presented was too much for me to do all of, but it was just the right amount in that there were always a few problems that I could feel pretty good about engaging with, which I appreciated! Thanks again to everyone at MSRI, too, for making it an absolute pleasure to be there.	7/9/2019 2:04 AM
3	If during the problem session we can go over some homework problems it would be great	7/9/2019 12:19 AM
4	While I felt the topics connected well, but that wasn't entirely clear until the second week of the course.I think that some of the presenters were more prepared than others.	7/8/2019 1:40 PM
5	No additional comments	7/8/2019 7:02 AM
6	There was too much material, but I think that is just the nature of such an endeavor. I look forward to pouring through all of this more in the coming weeks.	7/8/2019 5:03 AM
7	It was my first summer school and it is one of my best experiences so far.	7/8/2019 4:45 AM
8	An in class exercise will be much preferable, so the lecturer get to know that everyone is following, instead of just handing out the problems .	7/8/2019 4:05 AM
9	I liked how the topics tied together but also presented slightly different views of Representation Stability.	7/8/2019 3:59 AM

Q10 I was well prepared to benefit from the school

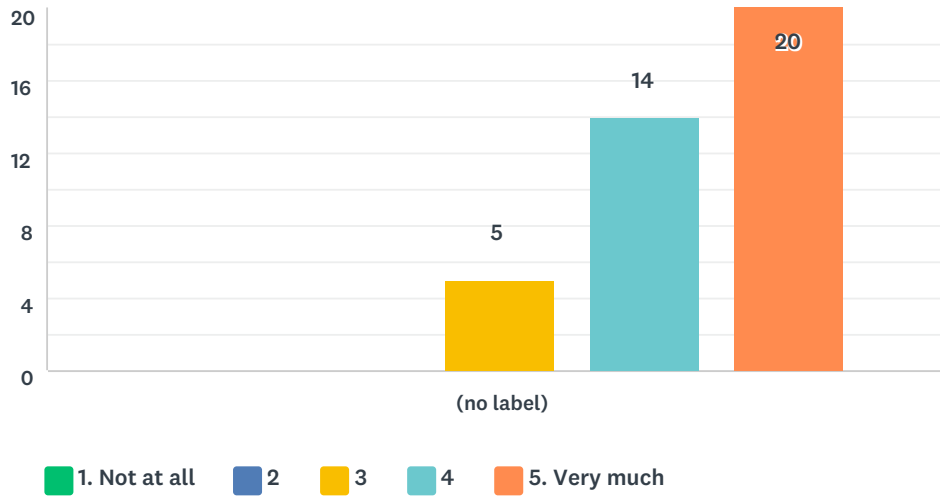
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	10.26%	30.77%	41.03%	17.95%	39	3.67
	0	4	12	16	7		

Q11 My interest in the subject matter was increased by the school

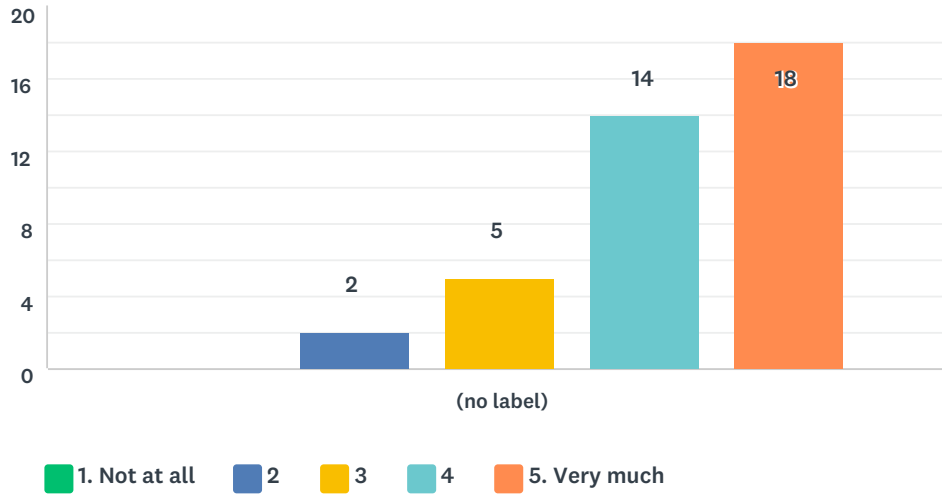
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	12.82%	35.90%	51.28%	39	4.38
	0	0	5	14	20		

Q12 The school helped me meet people with similar scientific interests

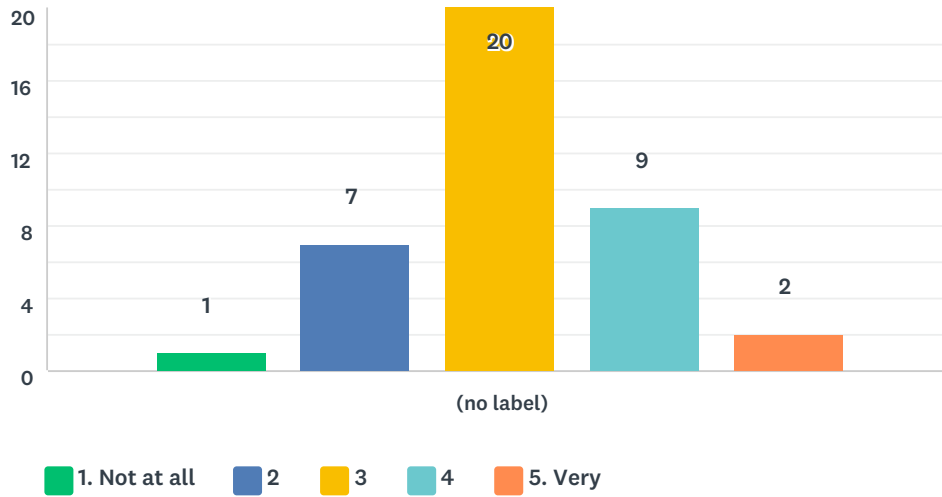
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.13%	12.82%	35.90%	46.15%	39	4.23
	0	2	5	14	18		

Q13 It is likely that I will work in the area of the school subject in the future

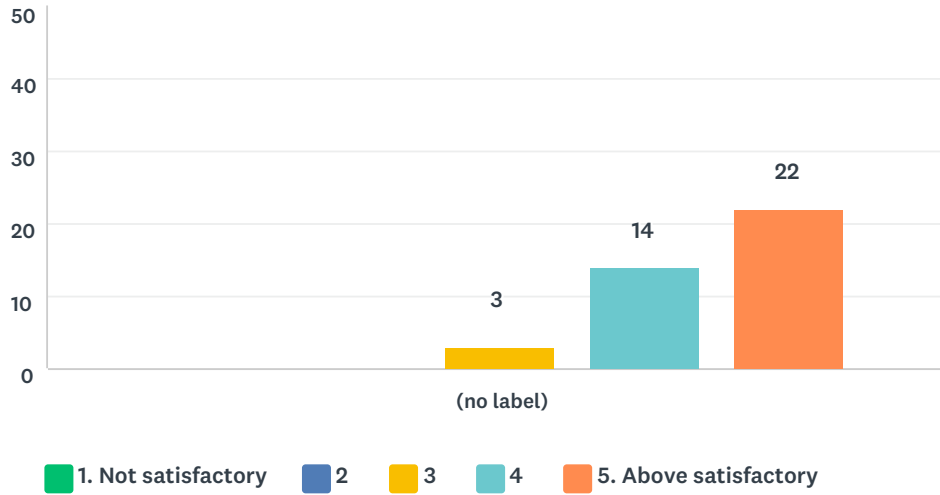
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	2.56%	17.95%	51.28%	23.08%	5.13%	39	3.10
	1	7	20	9	2		

Q14 How would you evaluate your interaction with other participants?

Answered: 39 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	7.69%	35.90%	56.41%	39	4.49
	0	0	3	14	22		

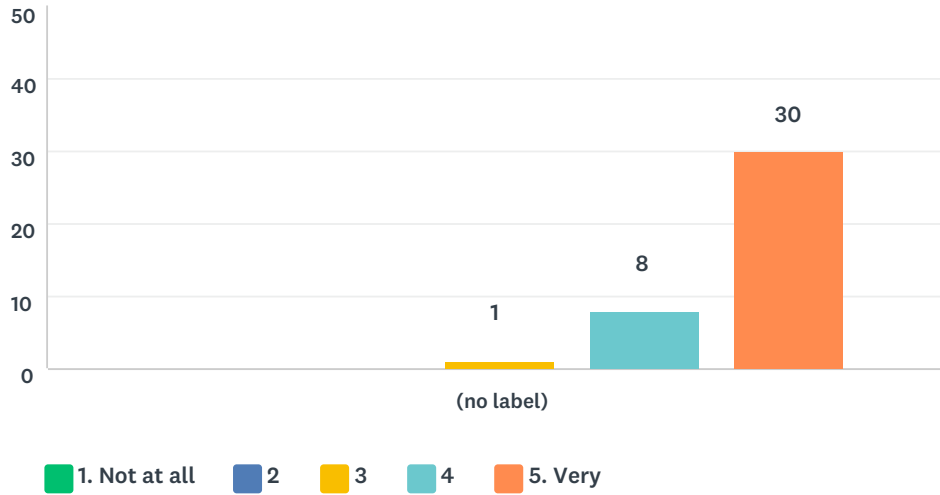
Q15 Additional comments on personal assessment

Answered: 11 Skipped: 29

#	RESPONSES	DATE
1	It seemed that a large portion of the students knew very little about the background topics, and I imagine they didn't get very far with the material presented. But there were certainly peers and activities at many different levels of knowledge, and a great positive atmosphere, so I think everyone got something worthwhile out of it.	7/9/2019 7:51 AM
2	Considering that the point of the school was to learn as much as possible, including background material not already accounted for, I feel like I had a pretty accurate expectation of what it would be like before arrival and was able to get a lot out of it. It was a little farther from my own research area than I expected, but that's not to say that I can't imagine ever using any of the techniques, especially because the presenters did such a good job of showcasing a wide variety of them.	7/9/2019 2:06 AM
3	I felt I was somewhat prepared, but I definitely could have prepared better.	7/8/2019 1:41 PM
4	It was a great experience with a good mix of people.	7/8/2019 7:30 AM
5	At one point, I got some positive feedback from a TA, telling me he was impressed by my work. This offhand comment was actually really motivating. It was nice to know that someone who works in the field thinks my work is good, which made me want to keep working on more problems.	7/8/2019 7:04 AM
6	I met many wonderful people!	7/8/2019 6:50 AM
7	I felt generally unprepared to check important details about the material. But, coming away from the school, I have a much better high-level understanding of how the subject is supposed to work.	7/8/2019 5:43 AM
8	Some students were not very keen on working with others, and many were not very prepared for the pace of presentation of the material and/or lacked basic prerequisite knowledge.	7/8/2019 5:04 AM
9	Some topics I was not adequately prepared for, but most of the time, the material was at the correct level. I think that many of my peers completed the problems more quickly than I did.	7/8/2019 4:00 AM
10	I appreciated the broad range of materials and exercises, so that people from various backgrounds still had enough to do that was accessible. I felt that some of the talks/exercises were not accessible to me, but I never ran out of material/exercises to think about.	7/8/2019 4:00 AM
11	The participants came from various different backgrounds and were of different interests. That made it necessary to choose the right persons to talk to. On the other hand, it made interesting conversations on broader aspects possible.	7/8/2019 3:56 AM

Q16 I found the MSRI staff helpful

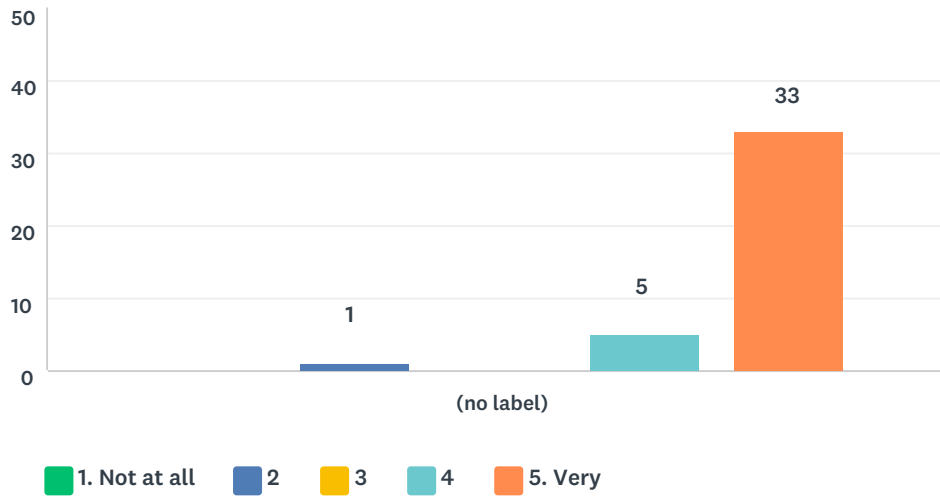
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	2.56%	20.51%	76.92%	39	4.74
	0	0	1	8	30		

Q17 The MSRI facilities were conducive for such a school

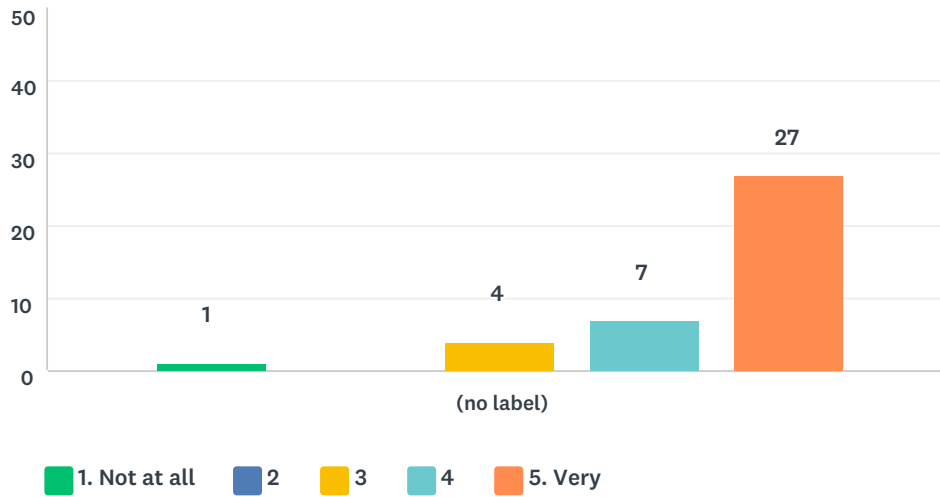
Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.56%	0.00%	12.82%	84.62%		
	0	1	0	5	33	39	4.79

Q18 The MSRI computer facilities were adequate for such a school

Answered: 39 Skipped: 1



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	2.56%	0.00%	10.26%	17.95%	69.23%	39	4.51
	1	0	4	7	27		

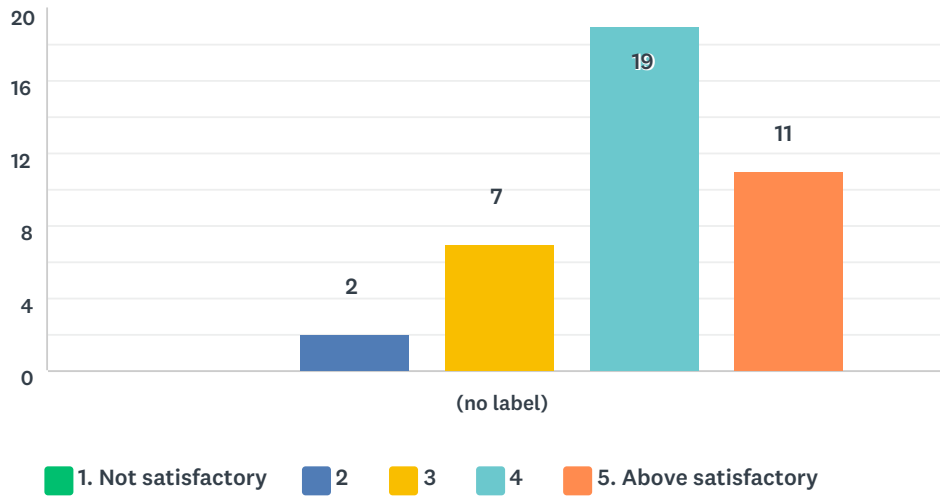
Q19 Additional comments on the MSRI venue

Answered: 10 Skipped: 30

#	RESPONSES	DATE
1	Love the view!	8/6/2019 5:45 AM
2	Would have loved more blackboards somewhere.	7/16/2019 3:27 AM
3	Oops, I gave MSRI staff a shoutout in the comments on the first page because I didn't realize how many pages there were. Happy to do so again, though: everyone was fantastic and the venue was way beyond what I could have imagined. I must add that Linda was not just extremely helpful but a pleasure to be around, and everyone in the office was super great too (and had good hiking recommendations).	7/9/2019 2:09 AM
4	It's a great place, but lunch usually run out very fast	7/9/2019 12:21 AM
5	I felt the venue was very conducive to my studies, and very accommodating of all of us. Everyone at MSRI was very friendly and kind.	7/8/2019 1:44 PM
6	A bit hard to get to, but the view was well worth it.	7/8/2019 7:31 AM
7	What a fantastic view from up there!	7/8/2019 7:04 AM
8	The MSRI venue is very nice and I really appreciated the hard work of the staff there. The walk to and from school school is very beautiful.	7/8/2019 4:02 AM
9	Loved the view! The commute from the dorms to MSRI was a bit far (10-minute walk plus shuttle).	7/8/2019 4:01 AM
10	Awesome and stimulating atmosphere!	7/8/2019 3:56 AM

Q20 How did you find the summer school accommodations?

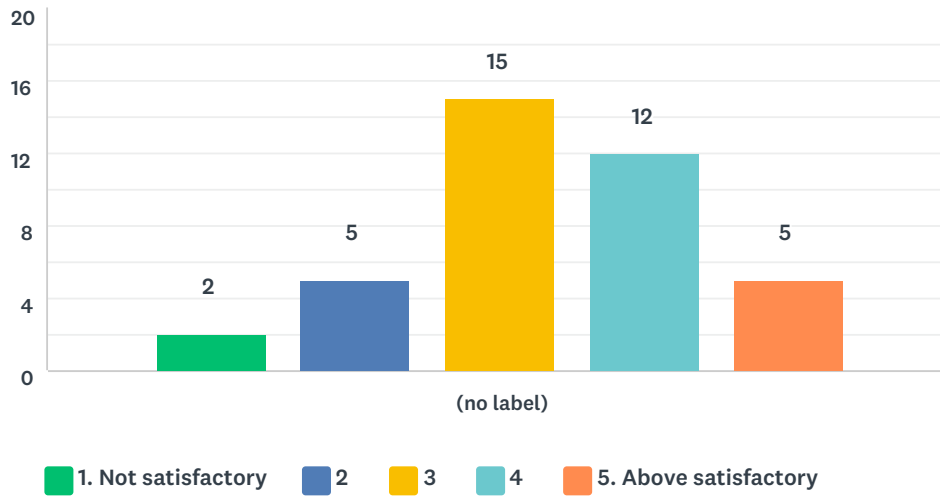
Answered: 39 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.13%	17.95%	48.72%	28.21%	39	4.00
	0	2	7	19	11		

Q21 How did you find the food at the dormitories?

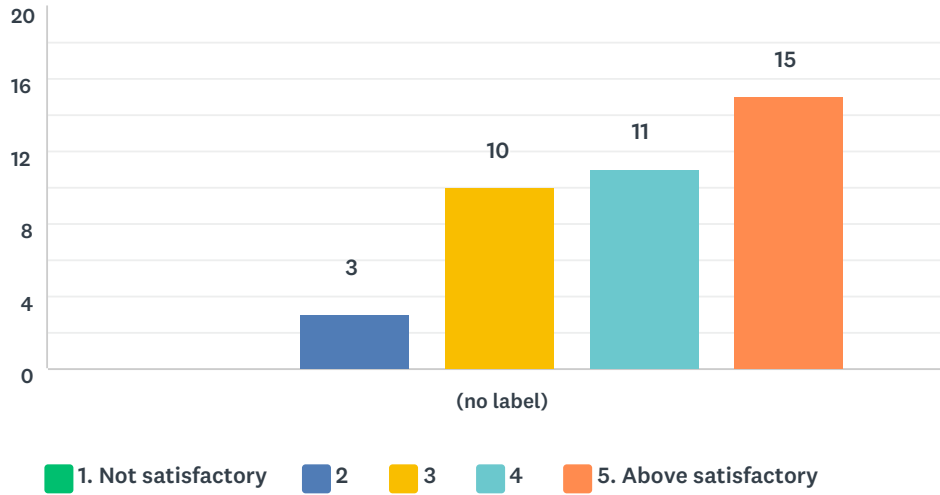
Answered: 39 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	5.13%	12.82%	38.46%	30.77%	12.82%	39	3.33
	2	5	15	12	5		

Q22 How did you find the food provided by MSRI?

Answered: 39 Skipped: 1



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	7.69%	25.64%	28.21%	38.46%	39	3.97
	0	3	10	11	15		

Q23 Additional comments on accommodation and food

Answered: 15 Skipped: 25

#	RESPONSES	DATE
1	The barbeque lunch was terrible	7/17/2019 4:05 PM
2	MSRI needs to offer more vegetarian options with proper protein.	7/16/2019 10:16 AM
3	On July 4, there was no session at MSRI and consequently no lunch at MSRI, but the dormitory meal pass did not cover lunch for that day. (At least, I was not allowed in for lunch.) This was only a minor inconvenience, but I feel it is worth mentioning.	7/16/2019 4:33 AM
4	More food for lunch would be good.	7/11/2019 2:17 PM
5	Excellent across the board, though the quality and quantity of the dorm food does mean I should probably eat nothing but light salads for a couple of weeks.	7/9/2019 2:11 AM
6	In the first few days the food was amazing, but then something happened, and the food quality at the dormitories went down as various regions of the dining hall was shut done.	7/9/2019 12:23 AM
7	The dorms are a bit uncomfortable, but not unreasonable. While I didn't have a particular problem with the food, I heard many of the vegan/vegetarian participants complain that tofu was essentially the only option.	7/8/2019 1:46 PM
8	Beds were stiff. Too much tofu in food served at MSRI.	7/8/2019 11:10 AM
9	The sheets didn't fit the bed and so came off regularly, and the pillow was plastic covered (which I understand is better for sanitary reasons, but had I known I would have brought my own). We were advised to bring a mattress pad, but this email reached me after I had already left home, and as most people flew in I don't know if it would be possible to bring a mattress pad as was advised. Bringing sheets and a pillow is more doable, in my opinion, and definitely would have helped.	7/8/2019 7:35 AM
10	The food provided by MSRI itself was great. But the food at the dorms was pretty bad. And the bedding was terrible - very hard mattresses, and the sheets were too small and never stayed on (plus they were basically glorified paper, very scratchy and uncomfortable)	7/8/2019 7:06 AM
11	The MSRI food was quite good! The dormitories were uninspiring, far-removed, and uncomfortable.	7/8/2019 5:45 AM
12	The mattresses and bed linen were of very low quality. The food at the dormitories was on par with typical college dining halls, but compared to cheap groceries at any typical city in Europe, the food was of low quality. The MSRI food was much better, though they often ran low on snacks.	7/8/2019 5:09 AM
13	The accommodations in the dorm were great. I was impressed by the food provided by MSRI and thought that the afternoon teas were especially impressive. I think that you don't need to provide hot lunch everyday, but could probably provide a more simple, sandwich lunch. That might make things easier. The rule about food and water in the lecture hall is a good idea; the lecture hall was always very clean.	7/8/2019 4:04 AM
14	A better mattress would help a lot. Sometimes, it felt like the food at MSRI was running out. The day with the bacon mac and cheese as the only protein option wasn't great. I prefer to eat a bit healthier than that.	7/8/2019 4:02 AM
15	For 2 weeks only, accommodation and food were good for not losing the focus on maths. For a longer amount of time it would have been more difficult to deal with it	7/8/2019 3:59 AM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 8 Skipped: 32

#	RESPONSES	DATE
1	I had a fantastic time at MSRI and this workshop really made me passionate about math again. I love the format of lectures following by problem sessions, and I learned a lot from doing the problems and collaborating with other students. Please organize more of these workshops!	8/6/2019 5:47 AM
2	This is extremely tangential: I don't know if this is how it was supposed to work, but when some of us went to the botanical garden we asked the person at the desk whether as MSRI participants we counted as Berkeley-affiliated for the purposes of free admission and she said "sure, why not!" and let us in. It's a really great botanical garden! If that is how it's supposed to work and MSRI program people can always get in for free, I suggest officially encouraging them to do so. I think that's the most serious suggestion that I have, it is hard to think of ways to improve it otherwise.	7/9/2019 2:20 AM
3	It has been a great experience. There is hardly anything for me to complain about.	7/9/2019 12:24 AM
4	On weekends a more general "two meals per day" would have been preferable as I know very few people woke up in time to get breakfast. That said, I am very grateful for all that was provided to me, and think it is perfectly reasonable to expect us to feed ourselves on weekends (it just may be better in terms of unused-but-paid-for meals on the MSRI's behalf.)	7/8/2019 7:38 AM
5	It was a great experience! Being in the later part of my PhD, I do think I benefited more than I would have in an earlier part of my Graduate School. It seemed to me that the majority of the lectures were aimed at students who were quite familiar with a lot of nontrivial background material. I enjoyed this, but I realize that if I had come even a year or two earlier, I wouldn't have gotten as much out of the experience.	7/8/2019 7:09 AM
6	It will be nice if there is some final day (or last few days) projects (in group randomly chosen by MSRI) and presented on the final day by the group members; in this way everyone is involved irrespective of there level with the materials.	7/8/2019 4:15 AM
7	Random comments: I didn't appreciate the mandatory hike with elevation changes. FYI, I went well over my allotted travel reimbursement amount. Overall comments: It was an excellent experience, and I definitely left much more excited about mathematics in general than when I arrived. Please keep running these summer schools! They are very worthwhile.	7/8/2019 4:06 AM
8	I suppose that keeping the high standards up would give future participants a good experience, too	7/8/2019 4:01 AM

Random and arithmetic structures in topology

June 10, 2019 - June 21, 2019

MSRI, Berkeley CA, USA

Organizers:

Alexander Furman (University of Illinois at Chicago)

Tsachik Gelander (Weizmann Institute of Science)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL
“Random and arithmetic structures in topology”
June 10 – 21, 2019

Organizers

- Alexander Furman (University of Illinois at Chicago)
- Tsachik Gelander (Weizmann Institute of Science)

Description

The study of locally symmetric manifolds, such as closed hyperbolic manifolds, involves geometry of the corresponding symmetric space, topology of towers of its finite covers, and number-theoretic aspects that are relevant to possible constructions. The workshop provided an introduction to these and closely related topics such as lattices, invariant random subgroups, and homological methods.

Highlights of the School

The summer school consisted of mini courses by Alexander Furman, Arie Levit, and Clara Loh. Each afternoon was devoted to Discussion and Problem sessions, led by the Teaching Assistants Sudhadip Dey and Gil Goffer.

Organizers		
First Name	Last Name	Institution
Alexander	Furman	University of Illinois at Chicago
Tsachik	Gelander	Weizmann Institute of Science
Speakers		
First Name	Last Name	Institution
Alexander	Furman	University of Illinois at Chicago
Arie	Levit	Yale University
Clara	Löh	Universität Regensburg
Teaching Assistants		
First Name	Last Name	Institution
Gil	Goffer	Weizmann Institute of Science
Subhadip	Dey	University of California, Davis

Mathematical Sciences Research Institute

Random and Arithmetic Structures in Topology

June 10 - June 21, 2019

Monday, June 10, 2019

9:00 AM - 9:15 AM	Simons Auditorium		Introduction to MSRI
9:15 AM - 10:15 AM	Simons Auditorium	Alexander Furman	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Arie Levit	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Tuesday, June 11, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Arie Levit	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Alexander Furman	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Wednesday, June 12, 2019

9:00 AM - 10:00 AM	Simons Auditorium	Alexander Furman	Lecture
10:00 AM - 10:30 AM	Atrium		Coffee Break
10:30 AM - 11:30 AM	Simons Auditorium	Arie Levit	Lecture
11:30 AM - 2:00 PM	Tilden Park		BBQ Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Thursday, June 13, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Arie Levit	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Alexander Furman	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Friday, June 14, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Alexander Furman	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Arie Levit	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Monday, June 17, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Clara Löh	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Alexander Furman	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Tuesday, June 18, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Alexander Furman	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Clara Löh	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Wednesday, June 19, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Clara Löh	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Alexander Furman	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Thursday, June 20, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Alexander Furman	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Clara Löh	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion

Friday, June 21, 2019

9:00 AM - 10:15 AM	Simons Auditorium	Clara Löh	Lecture
10:15 AM - 10:45 AM	Atrium		Coffee Break
10:45 AM - 12:00 PM	Simons Auditorium	Alexander Furman	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion
3:15 PM - 3:45 PM	Atrium		Tea
3:45 PM - 5:00 PM	Simons Auditorium		Discussion



Participants

First Name	Last Name	Institution
Jose	Aranda Cuevas	University of Iowa
Nic	Brody	University of California, Berkeley
Matthew	Cavallo	Howard University
Samuel	Dodds	University of Illinois, Chicago
Lina	Fajardo Gomez	University of South Florida
Carmen	Galaz-García	University of California, Santa Barbara
Jiawei	Han	Vanderbilt University
Yanlong	Hao	University of Illinois at Chicago
Hayden	Houser	Tulane University
Justin	Katz	Purdue university
Sayantana	Khan	University of Michigan
Benjamin	Krakoff	University of Michigan
Khanh	Le	Temple University
Beibei	Liu	University of California, Davis
Joseph	Melby	Michigan State University
Michael	Montoro	University at Buffalo (SUNY)
Kieran	O'Reilly	CUNY, Graduate Center
Rebekah	Palmer	Temple University
Lam	Pham	Yale University
David	Polletta	Arizona State University
Samuel	Restoy Berganza	National Autonomous University of Mexico (UNAM)
Cameron	Rudd	University of Illinois at Urbana-Champaign
Nathaniel	Sagman	California Institute of Technology
Eduard	Schesler	Universität Bielefeld
Connor	Sell	Rice University
Dominic	Tate	University of Sydney
François	Thilmany	University of California, San Diego
Tian	Wang	University of Illinois at Chicago
Shuai	Wei	Beijing Institute of Technology
Liyang	Yang	California Institute of Technology

Officially Registered Student Information

Participants		30
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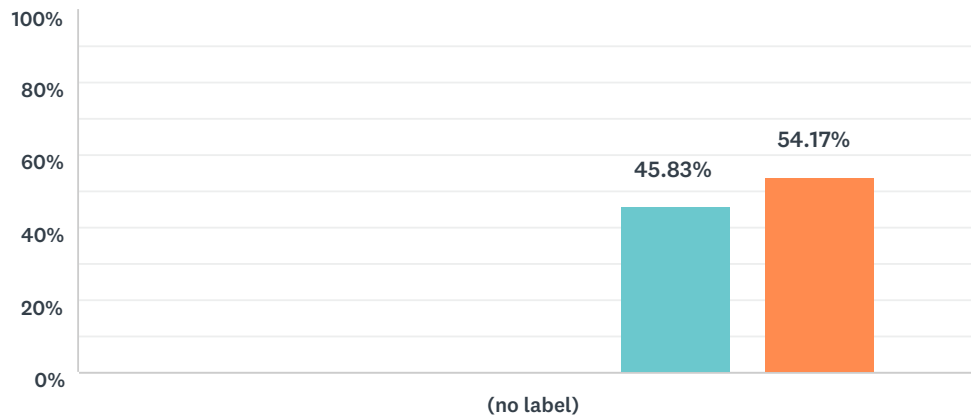
Gender		30
Male	80.00%	24
Female	20.00%	6
Declined to state	0.00%	0

Ethnicity*		34
White	52.94%	18
Asian	26.47%	9
Hispanic	11.76%	4
Pacific Islander	0.00%	0
Black	2.94%	1
Native American	0.00%	0
Mixed	5.88%	2
Declined to state	0.00%	0

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 24 Skipped: 0

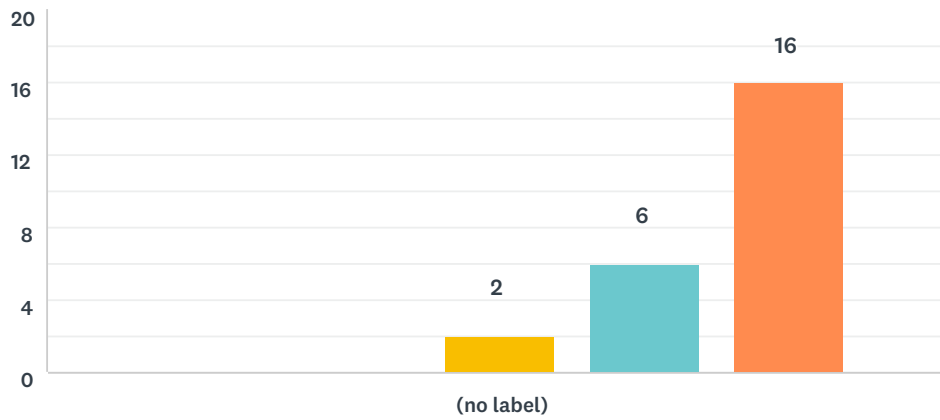


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	45.83%	54.17%	24	4.54
	0	0	0	11	13		

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 24 Skipped: 0

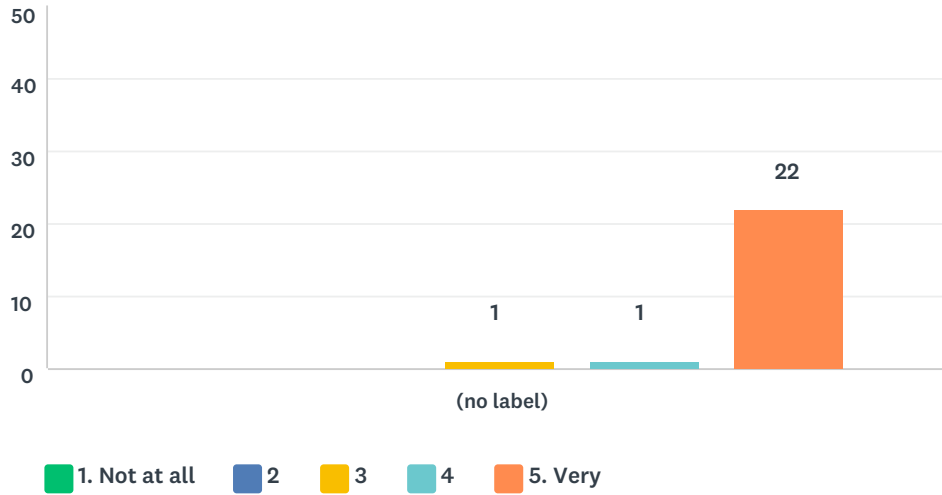


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	8.33%	25.00%	66.67%	24	4.58
	0	0	2	6	16		

Q3 The school was intellectually stimulating

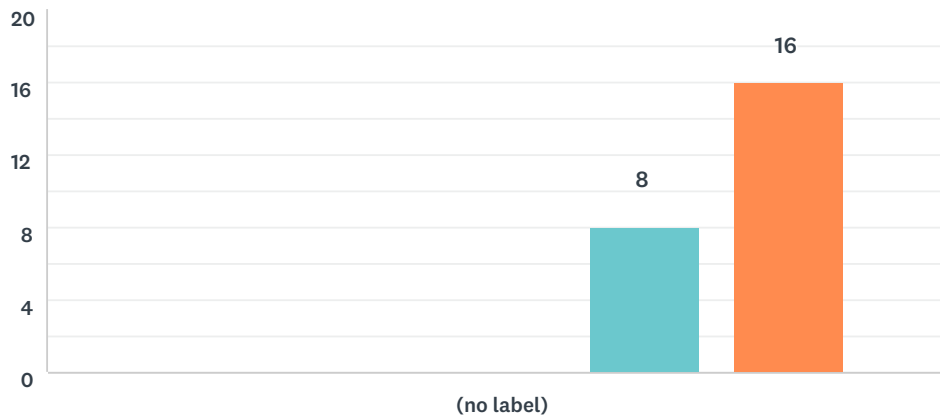
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.17%	4.17%	91.67%	24	4.88
	0	0	1	1	22		

Q4 My fellow students were appropriately selected to make the event interesting.

Answered: 24 Skipped: 0

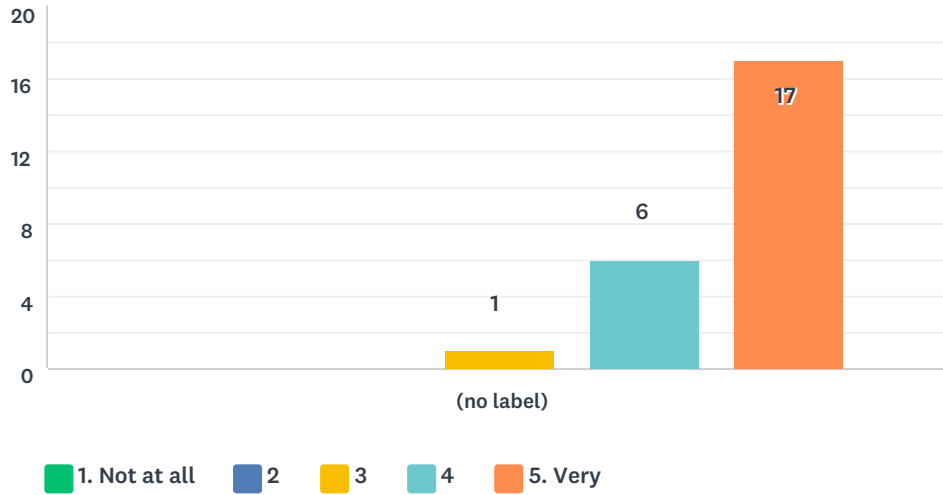


■ 1. Not at all
 ■ 2
 ■ 3
 ■ 4
 ■ 5. Very much

	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	33.33%	66.67%	24	4.67
	0	0	0	8	16		

Q5 The overall experience of the school was worthwhile

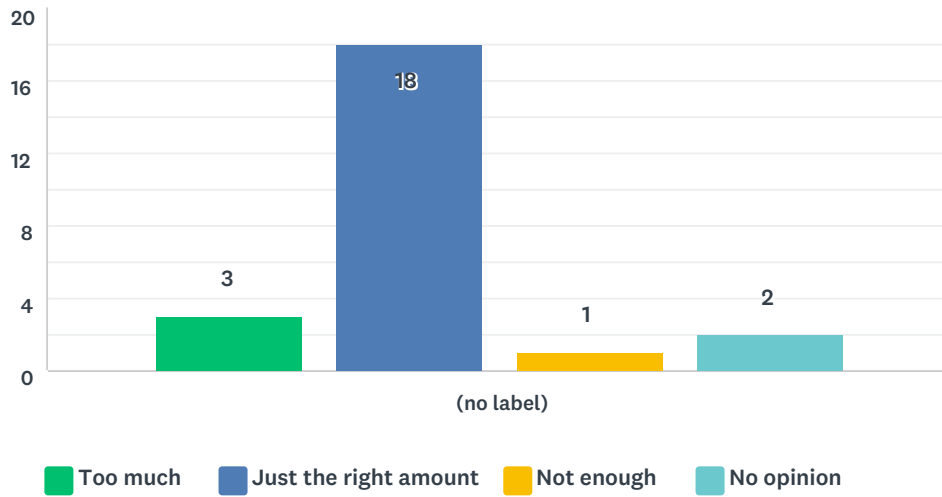
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.17%	25.00%	70.83%	24	4.67
	0	0	1	6	17		

Q6 The amount of material presented was

Answered: 24 Skipped: 0



	TOO MUCH	JUST THE RIGHT AMOUNT	NOT ENOUGH	NO OPINION	TOTAL	WEIGHTED AVERAGE
(no label)	12.50%	75.00%	4.17%	8.33%	24	2.08
	3	18	1	2		

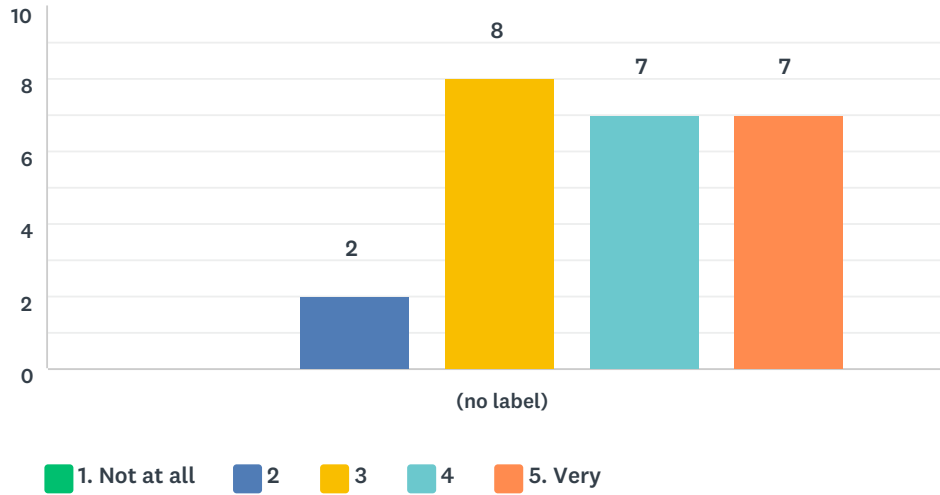
Q7 Additional comments on the topic presentation and organization

Answered: 4 Skipped: 20

#	RESPONSES	DATE
1	I enjoyed my time at the msri	8/1/2019 11:06 PM
2	MSRI is a wonderful institution, and the program was excellent.	7/16/2019 3:58 AM
3	Prof. Clara Loh was extremely well organized, thank you!	7/8/2019 5:05 AM
4	Really liked the organization of the event and talks. Congrats and thanks to the speakers and organizers for being able to make an event like this.	7/3/2019 4:12 AM

Q8 I was well prepared to benefit from the school

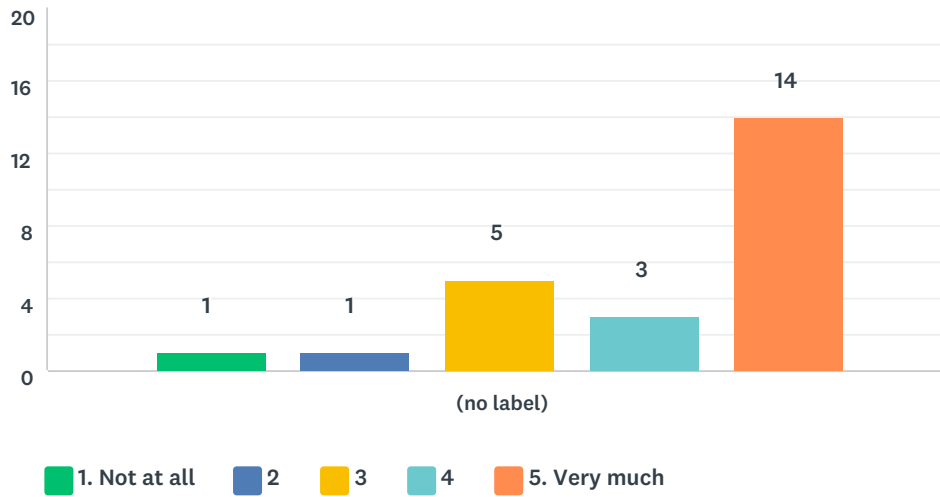
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	8.33%	33.33%	29.17%	29.17%	24	3.79
	0	2	8	7	7		

Q9 My interest in the subject matter was increased by the school

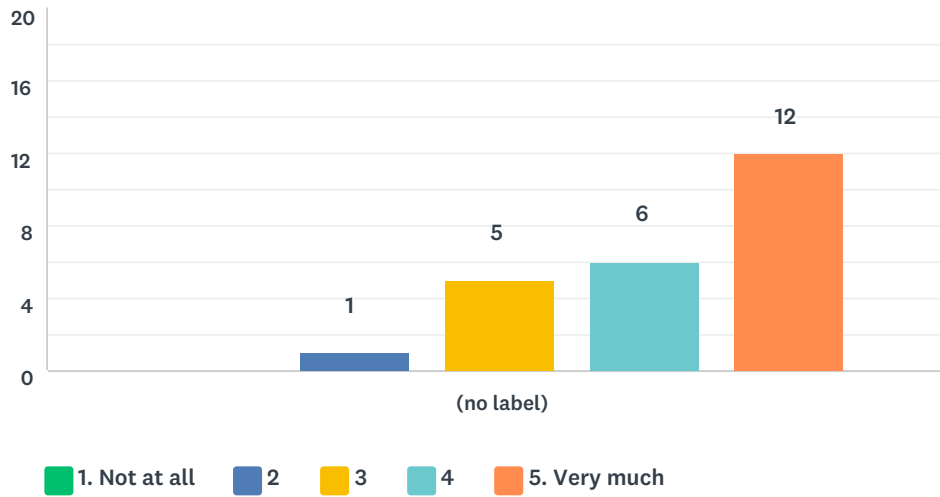
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	4.17%	4.17%	20.83%	12.50%	58.33%	24	4.17
	1	1	5	3	14		

Q10 The school helped me meet people with similar scientific interests

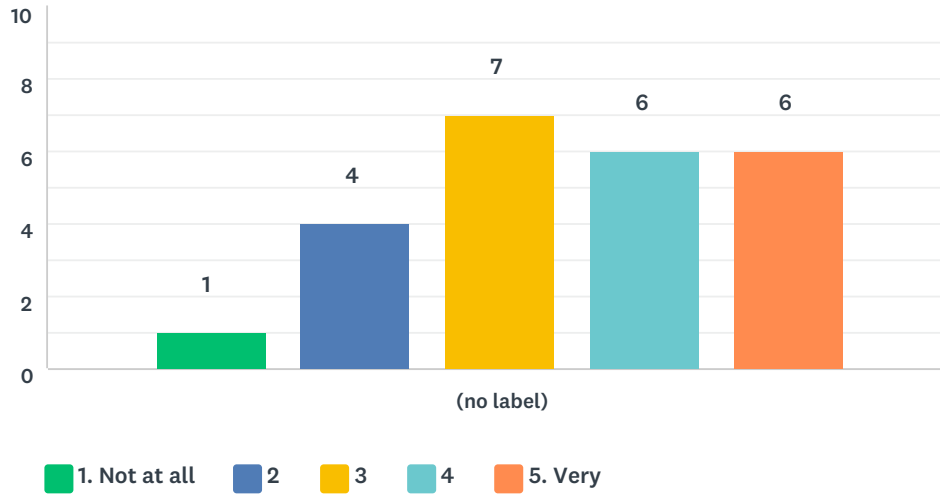
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.17%	20.83%	25.00%	50.00%	24	4.21
	0	1	5	6	12		

Q11 It is likely that I will work in the area of the school subject in the future

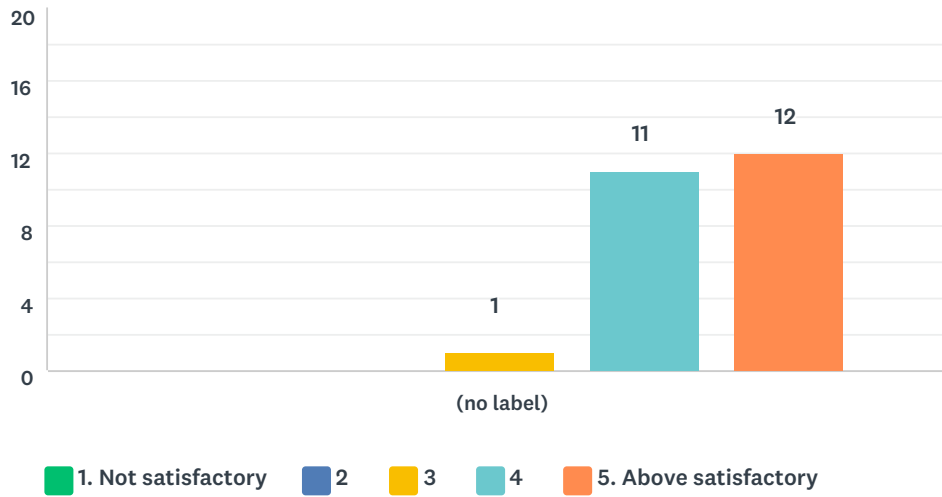
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	4.17%	16.67%	29.17%	25.00%	25.00%	24	3.50
	1	4	7	6	6		

Q12 How would you evaluate your interaction with other participants?

Answered: 24 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.17%	45.83%	50.00%	24	4.46
	0	0	1	11	12		

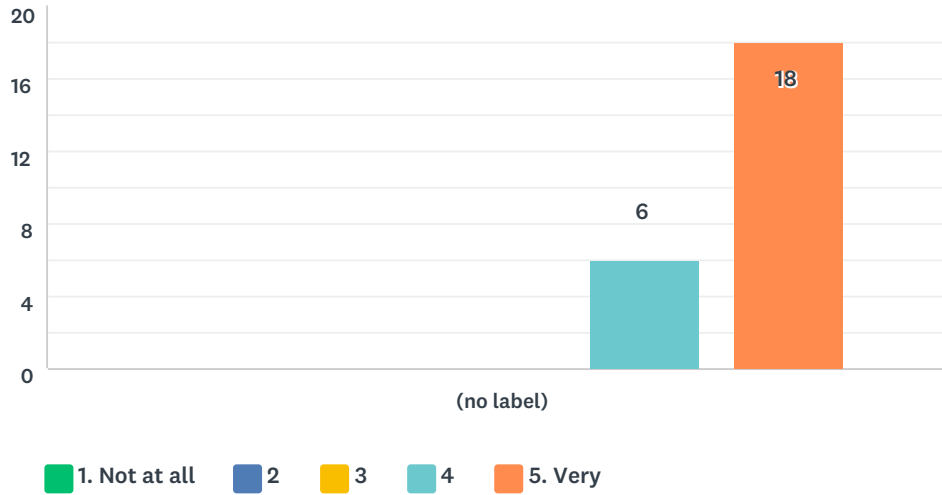
Q13 Additional comments on personal assessment

Answered: 2 Skipped: 22

#	RESPONSES	DATE
1	We had a really exceptional group of students during my summer course and I very much enjoyed working with them	8/15/2019 12:43 AM
2	I really liked all of the students I met!	7/16/2019 4:01 AM

Q14 I found the MSRI staff helpful

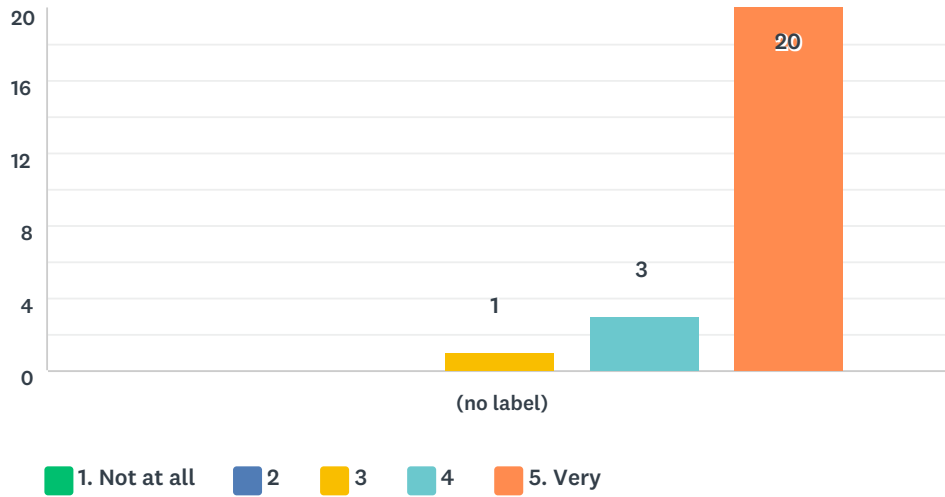
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	0.00% 0	25.00% 6	75.00% 18	24	4.75

Q15 The MSRI facilities were conducive for such a school

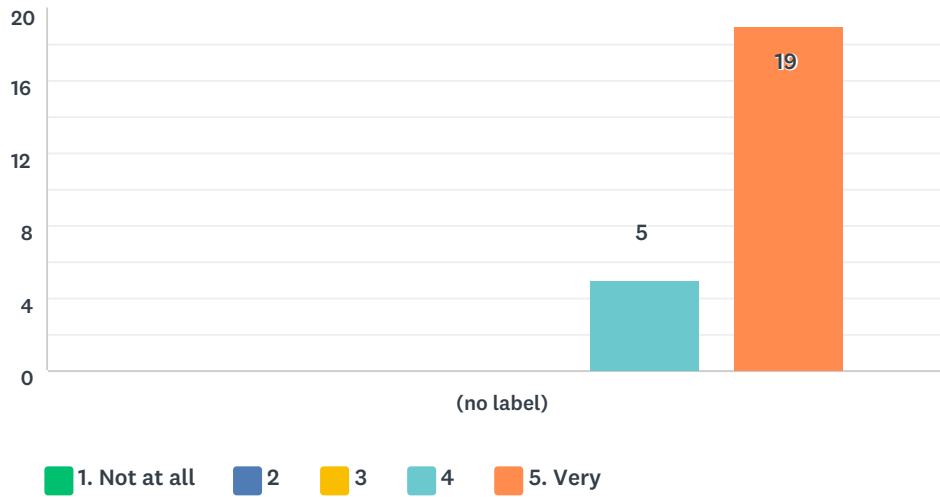
Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.17%	12.50%	83.33%	24	4.79
	0	0	1	3	20		

Q16 The MSRI computer facilities were adequate for such a school

Answered: 24 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	20.83%	79.17%		
	0	0	0	5	19	24	4.79

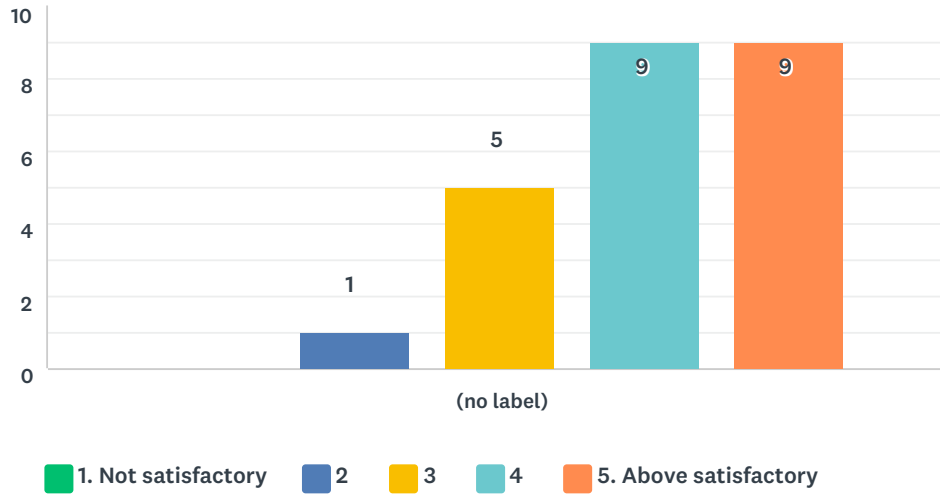
Q17 Additional comments on the MSRI venue

Answered: 2 Skipped: 22

#	RESPONSES	DATE
1	It was amazing!	8/15/2019 12:43 AM
2	All was on point.	7/3/2019 4:16 AM

Q18 How did you find the summer school accommodations?

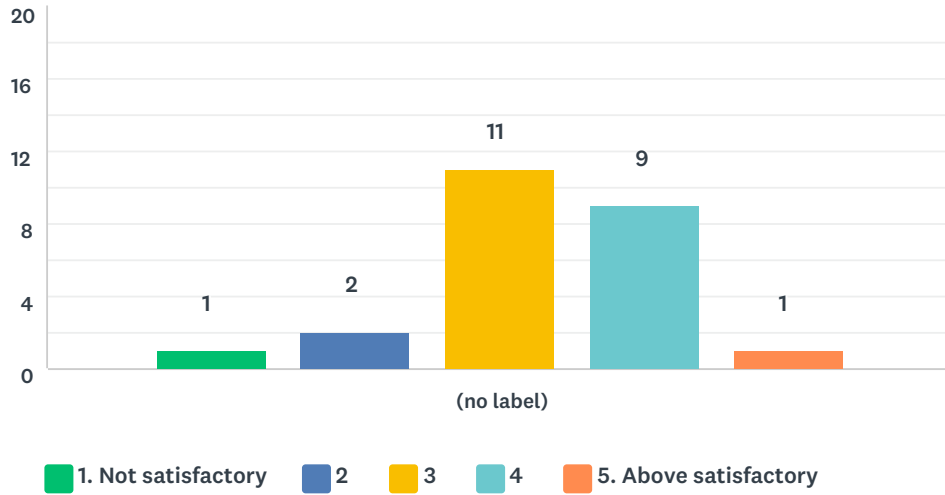
Answered: 24 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.17%	20.83%	37.50%	37.50%	24	4.08
	0	1	5	9	9		

Q19 How did you find the food at the dormitories?

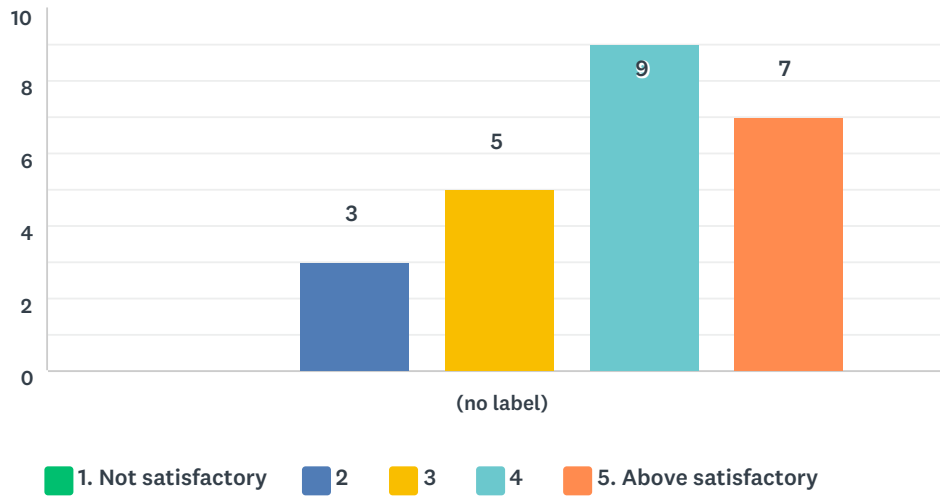
Answered: 24 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	4.17%	8.33%	45.83%	37.50%	4.17%	24	3.29
	1	2	11	9	1		

Q20 How did you find the food provided by MSRI?

Answered: 24 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	12.50%	20.83%	37.50%	29.17%	24	3.83
	0	3	5	9	7		

Q21 Additional comments on accommodation and food

Answered: 7 Skipped: 17

#	RESPONSES	DATE
1	Food provided by MSRI was very good, but occasionally there was not enough for everyone to have a complete meal's worth.	8/2/2019 8:45 AM
2	I did not stay in the dorm or eat at the cafeteria	7/16/2019 4:04 AM
3	Given the current environmental problems, It would be better if less plastic was used during lunch. In particular not having small water bottles. There is a really good water fountain at MSRI and you can even borrow a mug! Even the biodegradable utensils need to be processed, so having non-disposable utensils would also be great.	7/8/2019 5:09 AM
4	The dorm food was (as expected) not very satisfactory, but there was a reasonable variety. The food provided by MSRI was hit or miss. The lunches were not served consistently; some days I was not able to get a side item since I was at the back of the line. There was a single entree option, which was not ideal when many of us do not like tilapia, etc. The cookies were amazing though.	7/5/2019 11:20 PM
5	Portions during lunch at MSRI were sometimes very small	7/3/2019 12:55 PM
6	The pillow case seemed to be made out of plastic. It was uncomfortable sleeping at night with such pillow.	7/3/2019 7:58 AM
7	More cookies day! :)	7/3/2019 4:17 AM

Q22 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 1 Skipped: 23

#	RESPONSES	DATE
1	Thank you so much for organizing this!! It was a really great experience.	7/8/2019 5:09 AM

**Recent topics on well-posedness and
stability of incompressible fluid and
related topics**

July 22, 2019 - August 02, 2019

MSRI, Berkeley CA, USA

Organizers:

Yoshikazu Giga (University of Tokyo)

Maria Schonbek (University of California, Santa Cruz)

Tsuyoshi Yoneda (University of Tokyo)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL
“Recent topics on well-posedness and stability of incompressible fluid
and related topics”
July 22 – August 2, 2019

Organizers

- Yoshikazu Giga (University of Tokyo)
- Maria Schonbek (University of California, Santa Cruz)
- Tsuyoshi Yoneda (University of Tokyo)

Description

The purpose of the workshop is to introduce graduate students to fundamental results on the Navier-Stokes and the Euler equations, with special emphasis on the solvability of its initial value problem with rough initial data as well as the large time behavior of a solution. These topics have long research history. However, recent studies clarify the problems from a broad point of view, not only from analysis but also from detailed studies of orbit of the flow.

Highlights of the School

The summer school on “Recent topics on well-posedness and stability of incompressible fluid and related topics” was very interesting and well integrated. The three lecturers were extremely well organized. The topics that they chose gave a very good introduction to students. Not only they gave a wonderful presentation of their research but also a general background to several areas in Nonlinear partial differential equations and functional analysis. This should be very useful for the students.

In this background information Professor Gallagher presented Besov spaces in a very clear and helpful way. Professor Yoneda in his research had many applications of inequalities for the Riesz Transform. Professor Brandolese showed different applications to decay problems using Fourier methods.

The students seemed to work hard on the problem sessions, which I believe were very helpful.

The student presentations were well organized and allowed them to see what their colleagues were doing. Hopefully this will lead to further work.

Organizers		
First Name	Last Name	Institution
Yoshikazu	Giga	University of Tokyo
Maria	Schonbek	University of California, Santa Cruz
Tsuyoshi	Yoneda	University of Tokyo
Speakers		
First Name	Last Name	Institution
Lorenzo	Brandolese	Universite Lyon 1
Isabelle	Gallagher	École Normale Supérieure
Tsuyoshi	Yoneda	University of Tokyo
Teaching Assistants		
First Name	Last Name	Institution
Patrick	Heslin	University of Notre Dame
Trevor	Leslie	University of Wisconsin-Madison

Mathematical Sciences Research Institute

Recent Topics On Well-Posedness And Stability Of Incompressible Fluid And Related Topics

July 22 - August 2, 2019

Monday, July 22, 2019

9:15 AM - 9:30 AM	Simons Auditorium		Introduction to MSRI
9:30 AM - 10:30 AM	Simons Auditorium	Isabelle Gallagher	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Isabelle Gallagher	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		Problem and Discussion Session
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium		Problem and Discussion Session

Tuesday, July 23, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Tsuyoshi Yoneda	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Isabelle Gallagher	Lecture
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Wednesday, July 24, 2019

9:15 AM - 10:15 AM	Simons Auditorium	Isabelle Gallagher	Lecture
10:15 AM - 10:30 AM	Atrium		Break
10:30 AM - 11:30 AM	Simons Auditorium	Isabelle Gallagher	Lecture
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Thursday, July 25, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Isabelle Gallagher	Lecture
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9:30 AM - 10:30 AM	Simons Auditorium	Lorenzo Brandolese	Lecture
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Monday, July 29, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Tsuyoshi Yoneda	Lecture
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Tuesday, July 30, 2019

9:30 AM - 10:30 AM	Simons Auditorium	Lorenzo Brandolese	Lecture
10:30 AM - 11:00 AM	Atrium		Break
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3:30 PM - 4:30 PM	Simons Auditorium		Problem and Discussion Session



Participants

First Name	Last Name	Institution
Andrea	Argenziano	Università di Palermo
Braden	Balentine	University of Colorado
Shalmali	Bandyopadhyay	University of North Carolina
Berlinda	Batista	Howard University
Yunbai	Cao	University of Wisconsin-Madison
Elizabeth	Carlson	University of Nebraska
Brian	Choi	Boston University
Timothy	Collier	University of Sydney
Xin	Dong	University of Maryland
Alexander	Dunlap	Stanford University
Daniel	Erickson	Oregon State University
Ken	Furukawa	The University of Tokyo
Elena	Giorgi	Columbia University
Zhongyang	Gu	University of Tokyo
Yiran	Hu	University of Texas, Austin
Xin	Hu	University of Tokyo
Malick	Kebe	Howard university
Ramsha	Khan	McMaster University
Junichi	Koganemaru	Carnegie Mellon University
Anuj	Kumar	Indiana University
Bai	Lin	University of Rochester
Han	Liu	University of Illinois at Chicago
Xuezhu	Lu	Southeast university
Pritpal	Matharu	McMaster University
Forrest	Miller	Carnegie Mellon University
Evan	Miller	University of Toronto
Ryan Chris	Moreno-Vasquez	University of California, Davis
Kengo	Nakai	University of Tokyo
Stavros	Papathanasiou	University of Maryland
Jaemin	Park	Georgia Institute of Technology
Dayton	Preissl	University of Victoria
Calum	Rickard	University of Southern California
Cesar Alberto	Rosales-Alcantar	Universidad Nacional Autónoma de México
Ravi	Shankar	University of Washington
Jia	Shi	Princeton University
Jingyang	Shu	University of California, Davis
Adebowale	Sijuwade	Washington State University
Hui	Sun	Florida State University
Albany	Thompson	University of Colorado
Lauren	White	Kansas State University
Zachary	Wickham	University of Southern California
Andre	Wilke	Universität Bielefeld
Zhuolun	Yang	Rutgers University

Officially Registered Student Information

Participants		43
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Gender		43
Male	69.77%	30
Female	23.26%	10
Declined to state	6.98%	3

Ethnicity*		43
White	34.88%	15
Asian	44.19%	19
Hispanic	2.33%	1
Pacific Islander	2.33%	1
Black	6.98%	3
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	9.30%	4

* ethnicity specifications are not exclusive

Mathematical Sciences Research Institute

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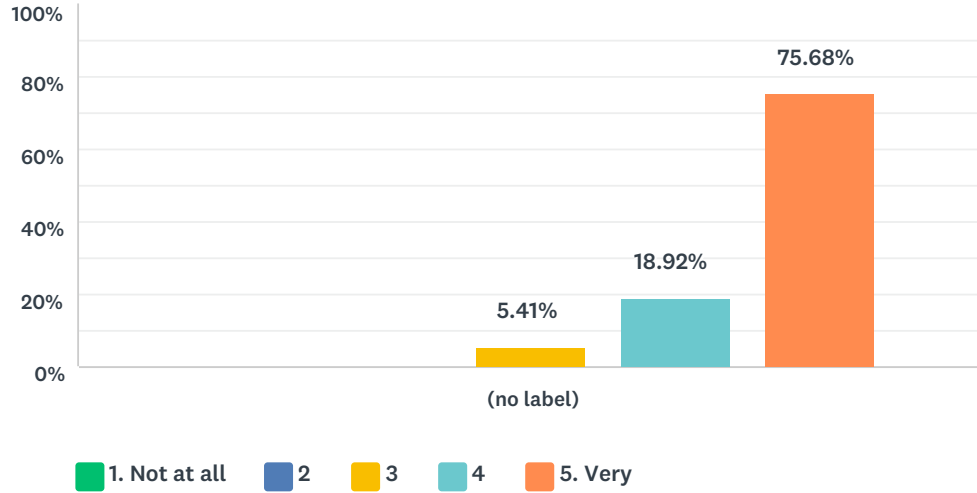
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Q3 The school was intellectually stimulating

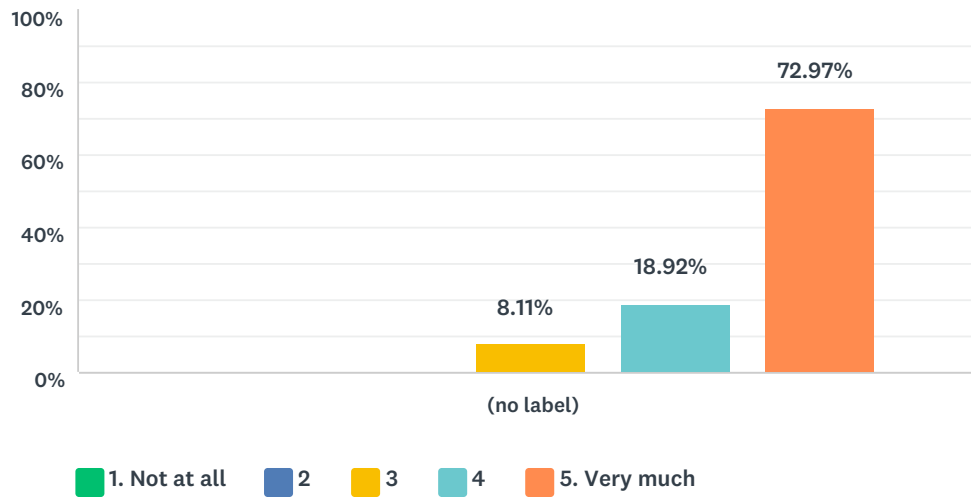
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	5.41% 2	18.92% 7	75.68% 28	37	4.70

Q4 My fellow students were appropriately selected to make the event interesting.

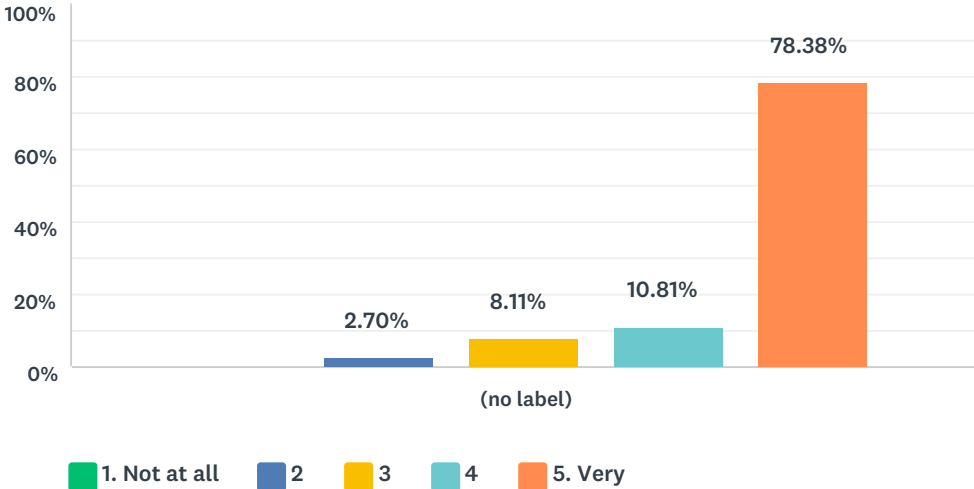
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	8.11%	18.92%	72.97%	37	4.65
	0	0	3	7	27		

Q5 The overall experience of the school was worthwhile

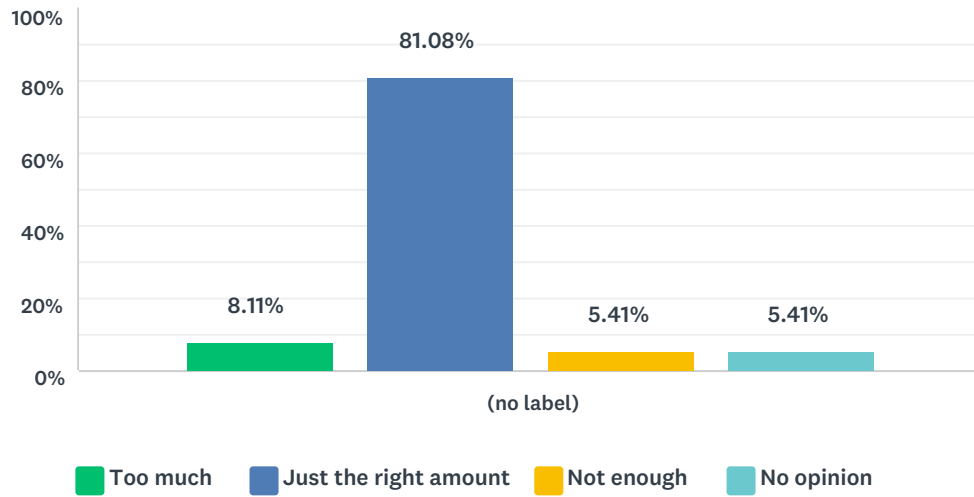
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.70%	8.11%	10.81%	78.38%	37	4.65
	0	1	3	4	29		

Q6 The amount of material presented was

Answered: 37 Skipped: 0



	TOO MUCH	JUST THE RIGHT AMOUNT	NOT ENOUGH	NO OPINION	TOTAL	WEIGHTED AVERAGE
(no label)	8.11%	81.08%	5.41%	5.41%	37	2.08
	3	30	2	2		

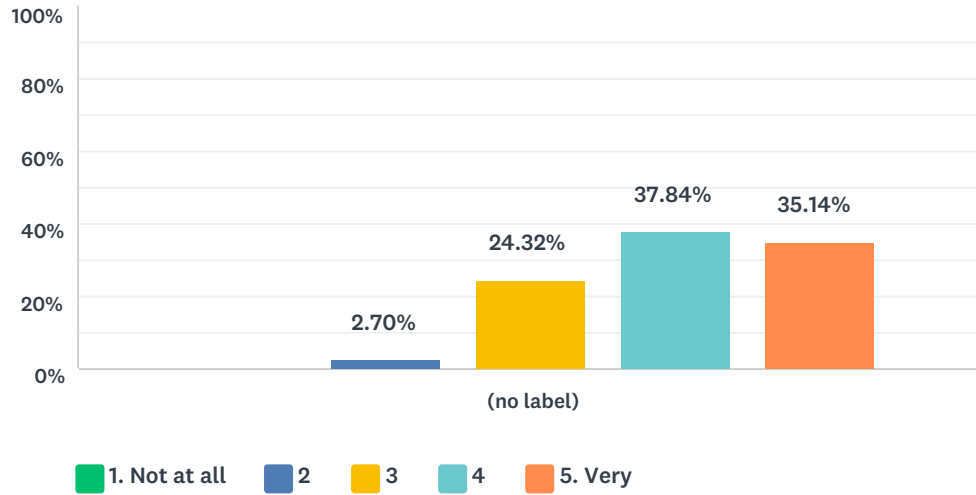
Q7 Additional comments on the topic presentation and organization

Answered: 10 Skipped: 27

#	RESPONSES	DATE
1	Aside from the fact that professor Giga could not make it, all was very good.	8/24/2019 1:25 AM
2	The problem session were a real annoyance. After the first few days, the problems were hard enough and coming so quickly that the sessions more or less turned into lectures...but just very technical and boring. I attended a past MSRI where we broke into groups and presented research papers...this was a better use of time for me.	8/14/2019 2:48 AM
3	Excellent organization and event!!! I want more	8/9/2019 3:30 AM
4	It may be better to spend one or two more lectures introducing current trends in the field.	8/8/2019 4:16 AM
5	A great summer school. Nice to see presenters introducing work that they were closely related to/involved in. I particularly enjoyed Prof Gallagher's talks for making clearer the foundation of Besov spaces and Prof Yoneda, motivating some physical understanding via the vorticity equation and lagrangian flow. The asymptotic decays of Prof Brandolese was also a perspective that I had not previously considered. The student talks were a good overview to see some ideas of future work/collaboration. The TAs did well and were accomodating for various questions. The length of days seemed appropriate.	8/3/2019 2:46 PM
6	Would have been nice to have some more broader talks.	8/3/2019 5:30 AM
7	It's a great experience taking the summer school in MSRI. Hope to have chances to come back in the future.	8/2/2019 3:58 PM
8	Question 4 is a bit odd....	8/2/2019 1:20 PM
9	The opportunity to discuss open problems in the field with the lecturers was extremely valuable, and may lead to new results and collaborations.	8/2/2019 11:15 AM
10	I would like to thank the organizers for their efforts. Many thanks to the MSRI and its staffs.	8/2/2019 8:37 AM

Q8 I was well prepared to benefit from the school

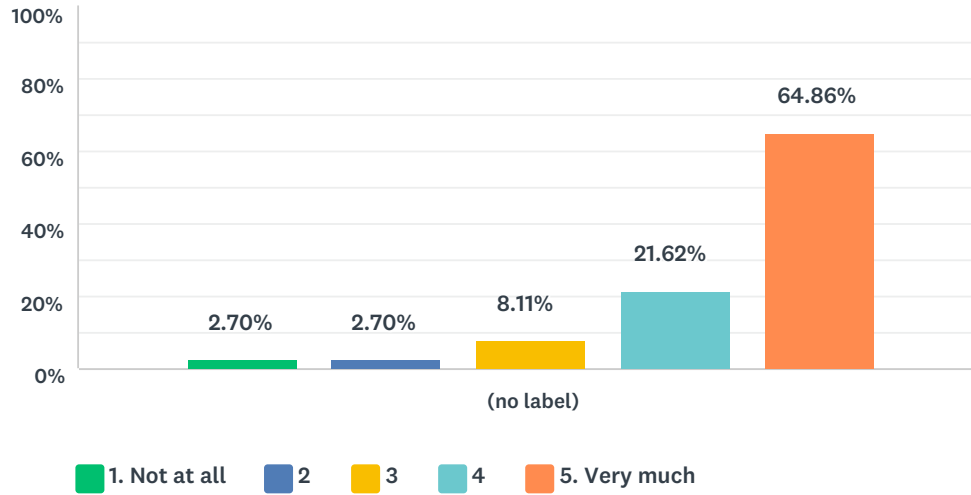
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.70%	24.32%	37.84%	35.14%	37	4.05
	0	1	9	14	13		

Q9 My interest in the subject matter was increased by the school

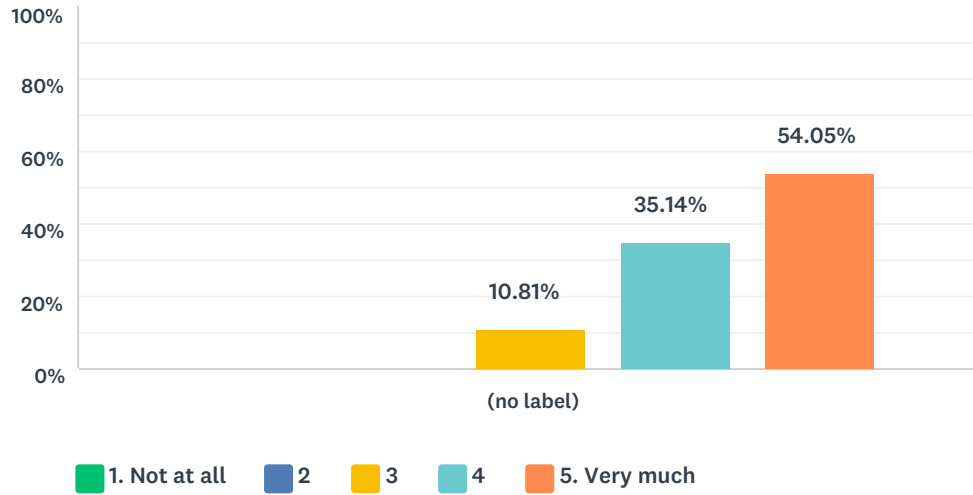
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	2.70%	2.70%	8.11%	21.62%	64.86%	37	4.43
	1	1	3	8	24		

Q10 The school helped me meet people with similar scientific interests

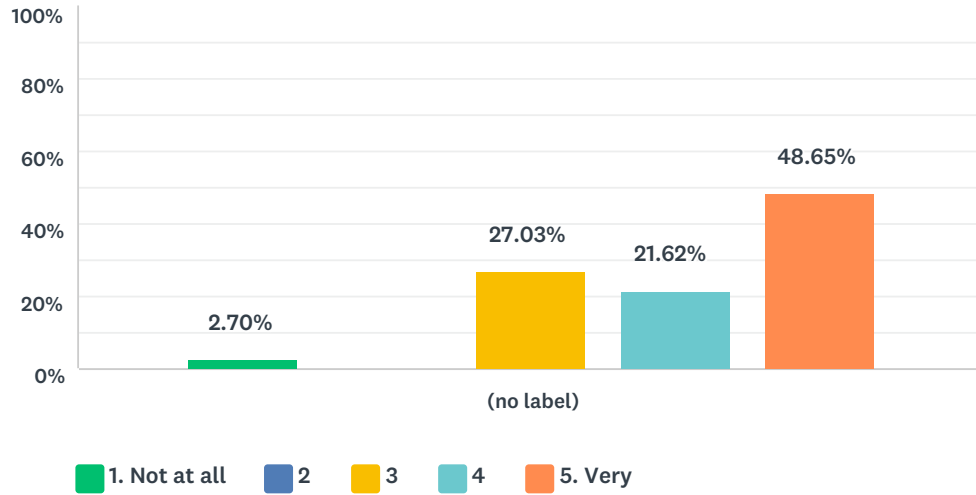
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	10.81%	35.14%	54.05%	37	4.43
	0	0	4	13	20		

Q11 It is likely that I will work in the area of the school subject in the future

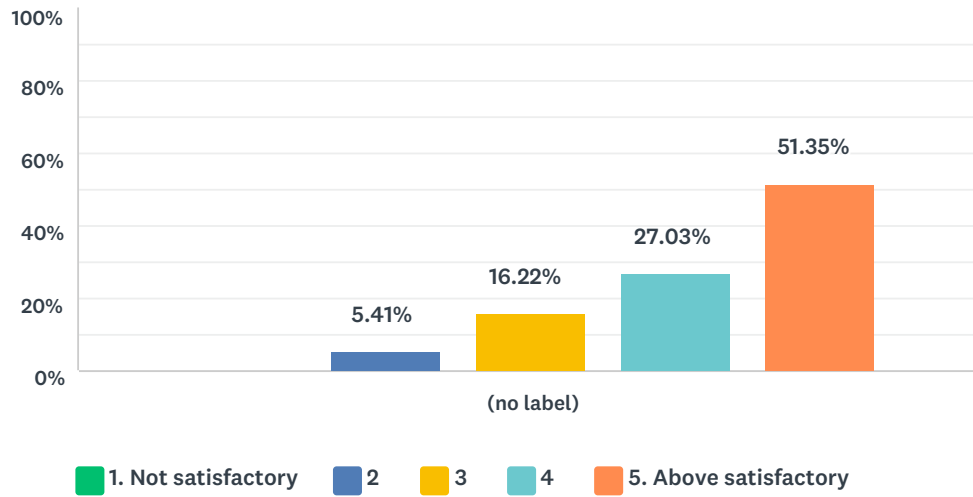
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	2.70%	0.00%	27.03%	21.62%	48.65%	37	4.14
	1	0	10	8	18		

Q12 How would you evaluate your interaction with other participants?

Answered: 37 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.41%	16.22%	27.03%	51.35%	37	4.24
	0	2	6	10	19		

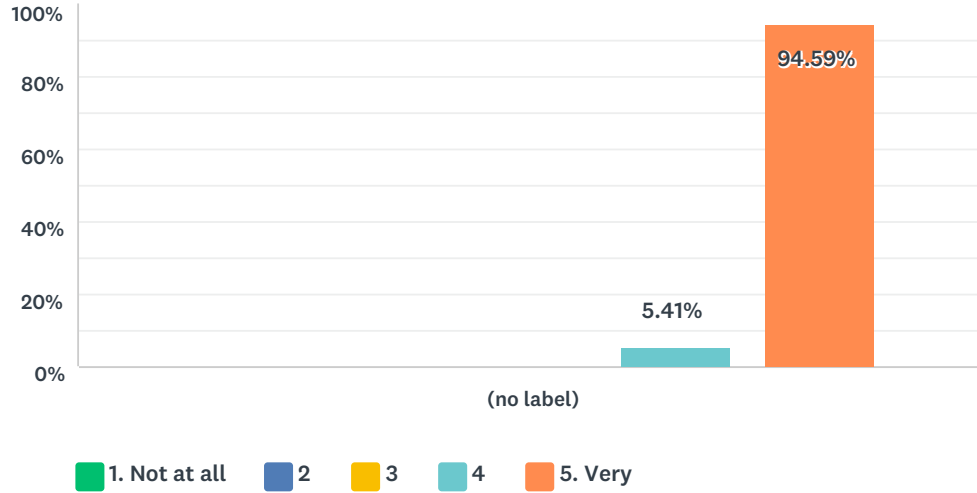
Q13 Additional comments on personal assessment

Answered: 3 Skipped: 34

#	RESPONSES	DATE
1	Most of them were excited about the topics, and the discussions over that was exciting	8/9/2019 3:31 AM
2	I have much more to learn...	8/3/2019 2:47 PM
3	Very friendly and very intelligent.	8/2/2019 3:59 PM

Q14 I found the MSRI staff helpful

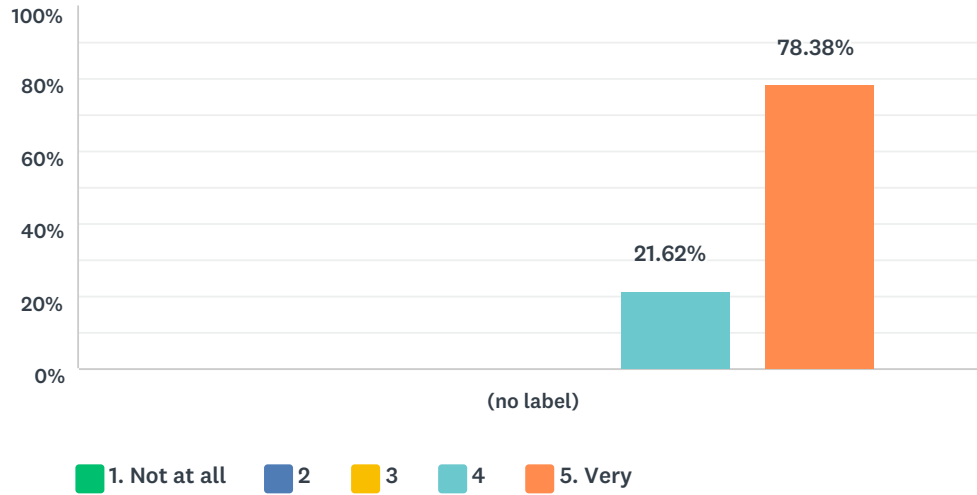
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	5.41%	94.59%	37	4.95
	0	0	0	2	35		

Q15 The MSRI facilities were conducive for such a school

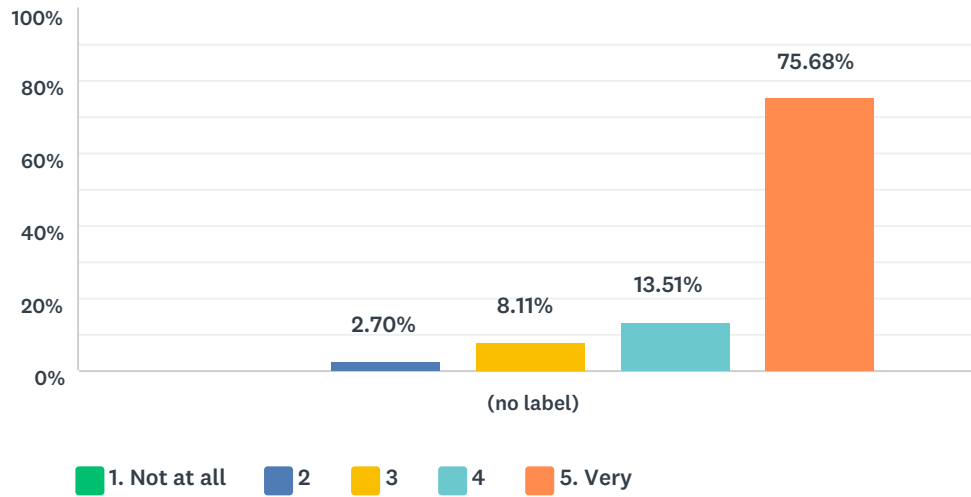
Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	21.62%	78.38%	37	4.78
	0	0	0	8	29		

Q16 The MSRI computer facilities were adequate for such a school

Answered: 37 Skipped: 0



	1. NOT AT ALL	2	3	4	5. VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	2.70%	8.11%	13.51%	75.68%		
	0	1	3	5	28	37	4.62

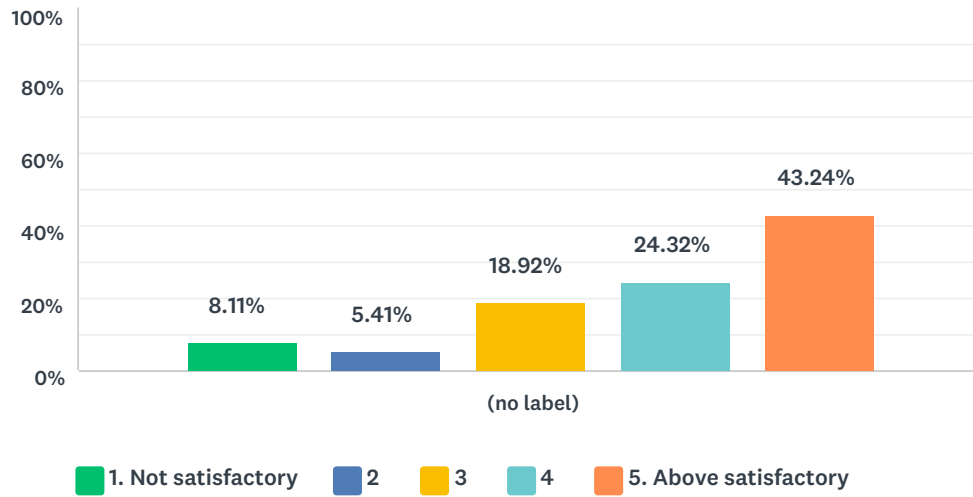
Q17 Additional comments on the MSRI venue

Answered: 7 Skipped: 30

#	RESPONSES	DATE
1	The Staff was very professional	8/30/2019 9:42 AM
2	The MSRI computer facilities were pretty good but there was not enough time to use them.	8/9/2019 5:03 AM
3	Nothing to say, excellent job	8/9/2019 3:31 AM
4	I would say, more independent work areas in which you have have a beverage or food would be nice. The work areas (at least the ones I was aware of) were either pretty open or prohibited having food and drink. My ideal work space is private, with snacks and coffee :-).	8/5/2019 3:30 AM
5	Venue was convenient with great views (particularly on the few days lacking fog), food and reasonable quiet/not excessive business. The venue seemed appropriate for the size of the group. Computing facilities/scanner/printer worked without issue. Admin was effective in sorting the reimbursements and generally running the event in a timely manner.	8/3/2019 2:47 PM
6	Very friendly and nice.	8/2/2019 3:59 PM
7	The lunches and snacks were excellent. Much thanks to the staff for creating such a conducive environment for learning and research. The venue is secluded with gorgeous views of the bay.	8/2/2019 11:19 AM

Q18 How did you find the summer school accommodations?

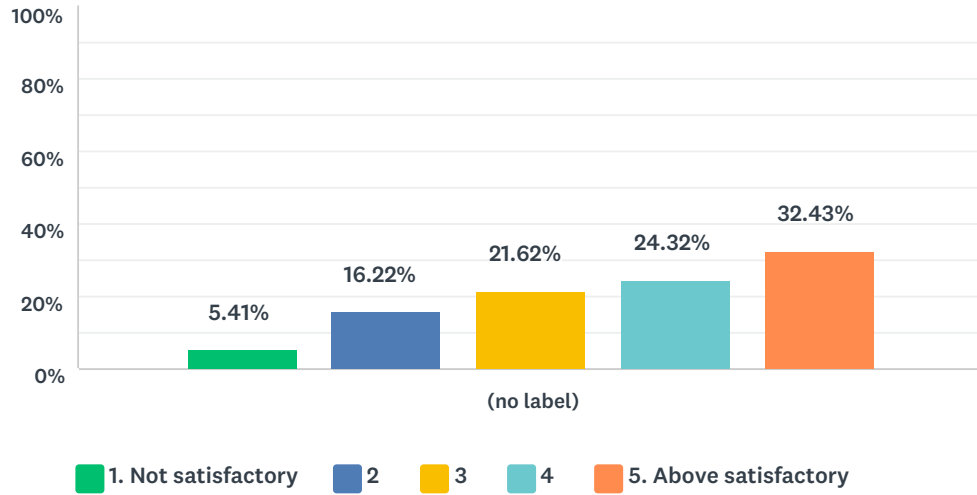
Answered: 37 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	8.11% 3	5.41% 2	18.92% 7	24.32% 9	43.24% 16	37	3.89

Q19 How did you find the food at the dormitories?

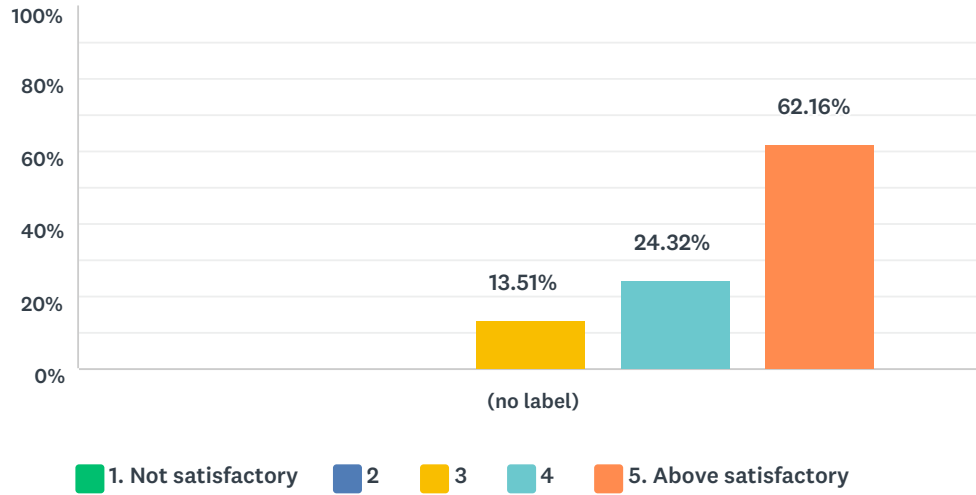
Answered: 37 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	5.41%	16.22%	21.62%	24.32%	32.43%	37	3.62
	2	6	8	9	12		

Q20 How did you find the food provided by MSRI?

Answered: 37 Skipped: 0



	1. NOT SATISFACTORY	2	3	4	5. ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	13.51%	24.32%	62.16%	37	4.49
	0	0	5	9	23		

Q21 Additional comments on accommodation and food

Answered: 16 Skipped: 21

#	RESPONSES	DATE
1	The accommodation was wonderful. The food was superb and the servers were very friendly.	8/30/2019 9:43 AM
2	The dorm was a terrible experience. I have chronic back pain and insomnia, so forcing me into bunk beds with a loud roommate was really unfortunate. I hardly slept, was in pain, and dreaded the times in my room. Surely making us bunk together isn't necessary? This happened in a past MSRI in Italy as well and as fun as it was, because of the roommate situation I spent two weeks basically sleeping 1-2 hours a night at most. It is hard to do math when tired. As well, the dorm food was just terrible. Really really bad. I attended a nonlinear dispersive PDE MSRI in Italy and every meal there, breakfast, lunch, and dinner, was catered and fantastic. Seems like the MSRI in Berkeley should have been cheaper for you all so I am not why we were given such bad food. I stopped eating there after a few days, having to spend my own money on food to avoid stomach aches. The lunch catering at MSRI was great and so were the servers. As well, we shared the dorms and dining hall with huge groups of children that were there for some sort of summer camp. If you left too late, it was almost impossible to get food due to swarms of small children. And they were often very loud in the courtyard until late at night. We are graduate students, not undergrads...why make us experience this? I think you can do better on lodging and food because for me, they significantly detracted from the experience.	8/14/2019 2:55 AM
3	I want to say that the food was delicious	8/9/2019 3:32 AM
4	The beds at the dormitory should be burnt.	8/5/2019 3:31 AM
5	Food and accomodation was very convenient and made for a comfortable stay. The dorm arrangement worked out well for me. It would have saved some hassle to have ~\$5 credit for the washing machines as the attaining of the (fifteen) quarters is not so straightfoward.	8/3/2019 2:48 PM
6	Limiting the plant-based options to people who declared themselves to be "vegetarians" was rather oppressive, and stifles people's efforts to be more sustainable by eating less meat even if they do not identify as "vegetarians." Also just because you do not eat meat does not mean that you need to consume a large amount of tofu at every meal. There are many healthy plant-based meals that do not involve tofu.	8/3/2019 5:33 AM
7	Overall satisfied since it's all given us for free.	8/2/2019 4:00 PM
8	Everything was great except the beds, but we were forewarned about them.	8/2/2019 1:22 PM
9	There were many youth programs located in the same dormitory block as the MSRI participants. The noise from the children made woking and sleeping in the dorms difficult on many occasions.	8/2/2019 12:19 PM
10	The sleeping arrangements (bed, bedding/sheets) really could use improvement but it is not a fault of MSRI: more so of the Berkeley dormitories.	8/2/2019 11:58 AM
11	The lunch and caterers at MSRI were excellent.	8/2/2019 11:25 AM
12	The food at MSRI was excellent. The food at the dorms was pretty good for dorm food. One suggestion: there often wasn't enough chips/pita at the afternoon coffee break compared to the amount of hummus and guacamole. The guacamole was really good, so it was a shame to leave some uneaten for lack of dipping materials. The food in general was really incredible at MSRI, and the staff were supper friendly and helpful.	8/2/2019 11:23 AM
13	Lunch was great!	8/2/2019 10:49 AM
14	Could be better if provide single rooms	8/2/2019 9:00 AM
15	Everything was nice. No complaints.	8/2/2019 8:39 AM
16	It might be beneficial to mention the meal cards work at multiple food halls to allow students to vary their experience.	8/2/2019 8:39 AM

#2: MSRI Response - the students do have the option to pay extra for a single room. We will make sure this is more clear in the future.

Q22 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 8 Skipped: 29

#	RESPONSES	DATE
1	This was a wonderful experience. The respect for time was very much appreciated.	8/30/2019 9:44 AM
2	Stop forcing people to bunk together and do better on the food. The dorm dining hall is a terrible option.	8/14/2019 2:55 AM
3	break is kind of long, and I prefer to have my own bedroom. Anything else is perfect. Thanks a lot for inviting us!	8/3/2019 2:04 AM
4	Very good! Great experience!	8/2/2019 4:00 PM
5	I found the student presentations extremely interesting and stimulating. However there was a strong time restriction on talk lengths because of the amount of speakers and time allocated for the presentations. Therefore I think it could be beneficial to allocate more time for the presentations: perhaps 2 hours on the afternoon they were conducted without, in my opinion, the not as beneficial problem solving session that same day. The problem solving sessions however were useful overall, so I am just commenting on the one on the same day as the presentations.	8/2/2019 12:02 PM
6	The student presentations information was slightly disorganized. We did not know when or how long we were presenting for until last minute. However, the overall experience was great.	8/2/2019 11:27 AM
7	Perhaps give more time for student presentations. I felt those two hours were the most I got out of the summer school. Maybe take up 4 hours, two each week instead of one hour each week.	8/2/2019 10:50 AM
8	It would be fun to have a group event on Sunday like a trip to the rose garden. Also make it clear the fire trail takes over an hour and people who are interested should bring water. (Could include this on the map provided.)	8/2/2019 8:42 AM

Mathematics of Machine Learning

July 29, 2019 - August 09, 2019

University of Washington, Seattle

Organizers:

Sebastien Bubeck (Microsoft Research)

Anna Karlin (University of Washington)

Adith Swaminathan (Microsoft Research)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL

“Mathematics of Machine Learning”

July 29 – August 09, 2019

Organizers

- Sebastien Bubeck (Microsoft Research)
- Anna Karlin (University of Washington)
- Adith Swaminathan (Microsoft Research)

Description

Learning theory is a rich field at the intersection of statistics, probability, computer science, and optimization. Over the last decades the statistical learning approach has been successfully applied to many problems of great interest, such as bioinformatics, computer vision, speech processing, robotics, and information retrieval. These impressive successes relied crucially on the mathematical foundation of statistical learning.

Recently, deep neural networks have demonstrated stunning empirical results across many applications like vision, natural language processing, and reinforcement learning. The field is now booming with new mathematical problems, and in particular, the challenge of providing theoretical foundations for deep learning techniques is still largely open. On the other hand, learning theory already has a rich history, with many beautiful connections to various areas of mathematics (e.g., probability theory, high dimensional geometry, game theory). The purpose of the summer school was to introduce graduate students (and advanced undergraduates) to these foundational results, as well as to expose them to the new and exciting modern challenges that arise in deep learning and reinforcement learning.

Highlights of the School

The summer school (<http://mathofml.cs.washington.edu/msri.html>) was a great success, thanks to support from MSRI in Berkeley, University of Washington (UW), as well as Microsoft Research (MSR). The student body was a cohort of 45 PhD students in Math and Applied Math from graduate programs worldwide (see [Appendix A](#) for a complete list). MSRI chose the non-local students, and they did an amazing job in terms of diversity, talent and drive to learn machine learning. The lectures were also open to others in the UW/MSR community. Many people watched the Youtube livestream (videos are archived here <https://www.youtube.com/playlist?list=PLTPQEx-31JXhguCush5J7OGnEORofoCW9>; viewed by over 4300 people).

There were five courses on Statistical Learning, Convex Optimization, Bandits, Reinforcement Learning, and Deep Learning spread over two weeks. Each course had five hours of lectures, and three hands-on problem-solving sessions (see [Appendix B](#) for the list of lecturers and Teaching

Assistants). Each lecturer nominated a graduate student TA for their problem session. These problem sessions were consistently applauded in students' feedback: e.g. *"The selection and ordering of the speaker series was excellent. The problem sessions were very useful to me -- I don't know if I would have followed later talks in the series as well had I not worked through the exercises"*. Another student shared that, *"I loved having no more than 3 hours of lecture a day and how spaced out the lectures were. This allowed me to not zone out during lectures. The setting was also perfect to allow all participants to mingle and form potential long lasting collaborations"*. (all the students' feedback is available here

<https://forms.office.com/Pages/AnalysisPage.aspx?id=v4j5cvGGr0GRqy180BHbR8Vg3Qlwn8FBtMIU1MeFrIFUNjU5SjUzN0JOSFFDR0MyOVpRNU1ESDZHOC4u&AnalyzerToken=oYFlMZZGmrQzpxnJNeU7ArISd2XKp9D8>).

In addition to a packed schedule of lectures and problem sessions, the students also spent one day at MSR. They heard talks by a variety of researchers/visiting researchers/interns/AI residents, and had lunch with some of them. The feedback for this trip was overwhelmingly positive, and a recurring comment was that it would have been nice to spend more time at MSR.

We aimed to introduce students to the excitement and challenging open problems in machine learning research. Based on students' feedback we feel we succeeded. For instance, one student wrote that *"Overall I definitely plan to shift my research in directions I was introduced to here and I hope to continue working with some of the people I met here!"* and another student said that, *"I was happy with the content on Reinforcement learning and deep learning - it seems like there are actually many interesting problems to be studied and understood there"*.

As organizers, we are very happy with the final outcome which can be summarized by the following feedback: *"the lectures given in the summer school were very insightful, and you cannot find such good material anywhere"*. There is clear demand for such summer schools: *"I thought the summer school was great, and I really hope it continues to be run in the future"*.

Appendix A. List of students and their affiliations

University of British Columbia	Rebeca	Cardim Falcao
University of California, Los Angeles	Fei	Feng
Cornell University	Elizabeth	Greco
Arizona State University	Sandra Nguemto	Guiawa
University of California, Berkeley	Yanhe	Huang
Arizona State University	Danielle	Brager
University of Oregon	Helen	Jenne
University at Buffalo - SUNY	Megan	Johnson
University of Oklahoma	Wenwen	Li
Portland State University	Anastasia	Adriano
Pennsylvania State University	Caitlin	Lienkaemper

University of Hong Kong	Huan	Miao
University of Michigan	Karina	Aponte
Centro de Investigacion y de Estudios Avanzados del IPN	Mariana	Perez Rojas
University of Utah	Ryeongkyung	Yoon
University of Kansas	Jinjin	Zhang
City University of New York, Graduate Center	Tai-Danae	Bradley
Brigham Young University	Rebecca	Jones
North Dakota State University	Shantanu	Awasthi
University of Maryland	Zeyad	Emam
University of California, Berkeley	Milind	Hegde
San Francisco State University	Oliver	Knitter
Kansas State University	Kapila	Kottegoda
Texas A&M University	Bolong	Ma
The Ohio State University	Matthew	Osborne
University of Alberta	Matthew	Pietrosanu
Istituto Nazionale di Alta Matematica (INdAM)	Manfredi Federico	Pivetta
University of Iowa	Hassan	Rafique
University of Minnesota	Yunpeng	Shi
Baylor University	Chong	Sun
Washington University - St. Louis	Cezareo	Rodriguez
University of California, Riverside	Isaac	Tate
Washington State University	Konstantinos	Tsampourakis
Stanford University	Yang	Liu
Tsinghua University	Daogao	Liu
University of Washington	Ashwin	Tarikere Ashok Kumar Nag
University of Washington	Yizhe	Zhu
University of Washington	Nicolas	Courts
University of Washington	Angel	Burr
University of Washington	Charles	Godfrey
Princeton	Maryam	Bahrani
University of Arizona	Rachel	Oliver
University of Washington	Jennifer	Rogers
US Government	Dimitrije	Kostic

Appendix B. Lecturers and Teaching Assistants

Lecturers			
Microsoft Research	Robert	Schapire	Statistical Learning

Microsoft Research	Sebastien	Bubeck	Convex Optimization
University of Washington	Kevin	Jamieson	Bandits
Stanford University	Emma	Brunskill	Reinforcement Learning
NYU	Joan	Bruna	Deep Learning
Teaching Assistants			
Princeton	Samy	Jelassi	Deep Learning
Princeton	Seyed Sobhan Mir	Yoosefi	Statistical Learning
Stanford	Andrea	Zanette	Reinforcement Learning
University of Washington	Ruoqi	Shen	Convex Optimization
University of Washington (TA)	Lalit	Jain	Bandits

Organizers

First Name	Last Name	Institution
Sebastien	Bubeck	Microsoft Research
Anna	Karlin	University of Washington
Adith	Swaminathan	Microsoft Research

Mathematical Sciences Research Institute

Mathematics Of Machine Learning

July 29 - August 9, 2019

Monday, July 29, 2019			
8:00 AM - 8:30 AM			Coffee and Bade pick-up (Zillow Commons)
8:30 AM - 8:45 AM			Welcome
9:00 AM - 10:00 AM		Robert Schapire	Statistical Learning
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Sebastien Bubeck	Convex Optimization
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Robert Schapire	Statistical Learning
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session
Tuesday, July 30, 2019			
9:00 AM - 10:00 AM		Robert Schapire	Statistical Learning
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Sebastien Bubeck	Convex Optimization
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Robert Schapire	Statistical Learning
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session
Wednesday, July 31, 2019			
9:00 AM - 10:00 AM		Kevin Jamieson	Bandits
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Robert Schapire	Statistical Learning
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Kevin Jamieson	Bandits
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session
Thursday, August 1, 2019			
9:00 AM - 10:00 AM		Kevin Jamieson	Bandits
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Sebastien Bubeck	Convex Optimization
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Kevin Jamieson	Bandits
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session
Friday, August 2, 2019			
9:00 AM - 10:00 AM		Kevin Jamieson	Bandits
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Sebastien Bubeck	Convex Optimization
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Sebastien Bubeck	Convex Optimization
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session

Monday, August 5, 2019

9:00 AM - 10:00 AM		Joan Bruna	Deep Learning
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Emma Brunskill	Reinforcement Learning
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM		Emma Brunskill	Reinforcement Learning

Tuesday, August 6, 2019

9:00 AM - 10:00 AM		Emma Brunskill	Reinforcement Learning
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Joan Bruna	Deep Learning
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Emma Brunskill	Reinforcement Learning
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session

Wednesday, August 7, 2019

9:00 AM - 10:00 AM		Emma Brunskill	Reinforcement Learning
10:00 AM - 10:30 AM			Coffee Break
10:30 AM - 11:30 AM		Joan Bruna	Deep Learning
11:30 AM - 12:30 PM			Problem Session
12:30 PM - 2:00 PM			Lunch
2:00 PM - 3:00 PM		Joan Bruna	Deep Learning
3:00 PM - 3:30 PM			Coffee Break
3:30 PM - 4:30 PM			Problem Session

Thursday, August 8, 2019

All Day			Field Trip to Microsoft Research Redmond
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Friday, August 9, 2019

9:00 AM - 12:00 PM			Student presentations and wrap-up
12:30 PM - 2:00 PM			Lunch



Participants

First Name	Last Name	Institution
Anastasia	Adriano	Portland State University
Karina	Aponte	University of Michigan
SHANTANU	AWASTHI	North Dakota State University
Tai-Danae	Bradley	CUNY, Graduate Center
Danielle	Brager	Arizona State University
Zeyad	Emam	University of Maryland
Rebeca	Falcao	University of British Columbia
Fei	Feng	University of California, Los Angeles
Elizabeth	Greco	Cornell University
Milind	Hegde	University of California, Berkeley
Yanhe	Huang	University of California, Berkeley
Helen	Jenne	University of Oregon
Megan	Johnson	University at Buffalo (SUNY)
Rebecca	Jones	Brigham Young University
Oliver	Knitter	San Francisco State University
Dimitrije	Kostic	United States Government
Kapila	Kottegoda	Kansas State University
Wenwen	Li	University of Oklahoma
Caitlin	Lienkaemper	Pennsylvania State University
Bolong	Ma	Texas A&M University
Huan	Miao	The department of Mathematics
Sandra	Nguemto Guiawa	Oregon State University
Rachel	Oliver	University of Arizona
Matthew	Osborne	The Ohio State University
Mariana	Perez Rojas	Centro de Investigacion y Estudios Avanzados
Matthew	Pietrosanu	University of Alberta
Manfredi Fede	Pivetta	Università di Pavia
Hassan	Rafique	University of Iowa
Cezareo	Rodriguez	Washington University
Yunpeng	Shi	University of Minnesota, Twin Cities
Chong	Sun	Baylor University
Isaac	Tate	University of California, Riverside
Konstantinos	Tsampourakis	Washington State University
Ryeongkyung	Yoon	University of Utah
Jinjin	Zhang	University of Kansas

Officially Registered Student Information

Participants		35
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Gender		35
Male	45.71%	16
Female	54.29%	19
Declined to state	0.00%	0

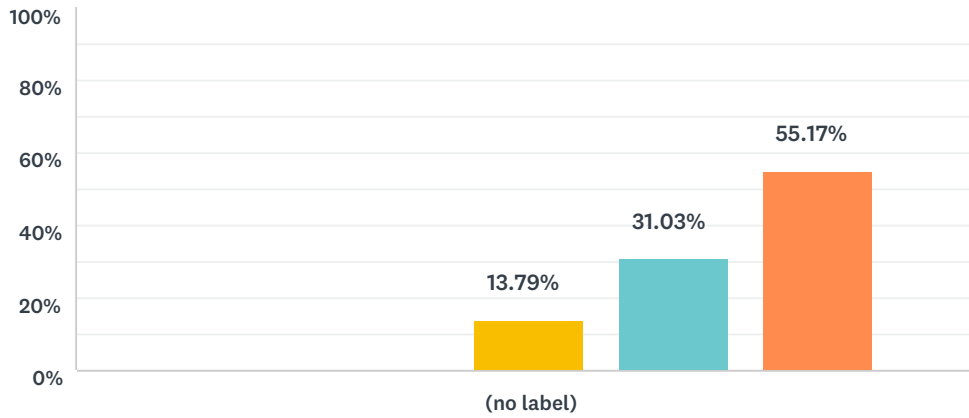
Ethnicity*		43
White	30.23%	13
Asian	37.21%	16
Hispanic	9.30%	4
Pacific Islander	0.00%	0
Black	9.30%	4
Native American	0.00%	0
Mixed	9.30%	4
Declined to state	4.65%	2

* ethnicity specifications are not exclusive

29 responses out of 35 participants = 83% response rate

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 29 Skipped: 0

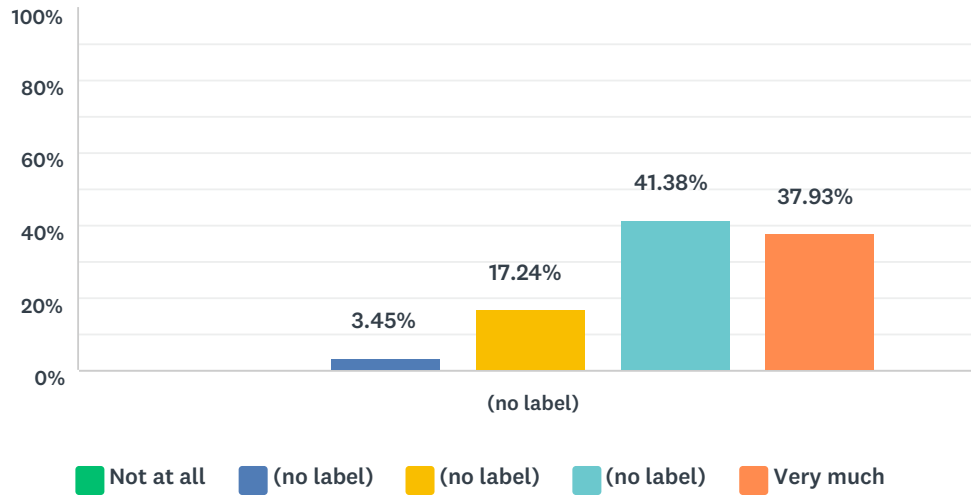


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very Much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	13.79%	31.03%	55.17%	29	4.41
	0	0	4	9	16		

Q2 The faculty speakers were generally clear and well organized in their presentation

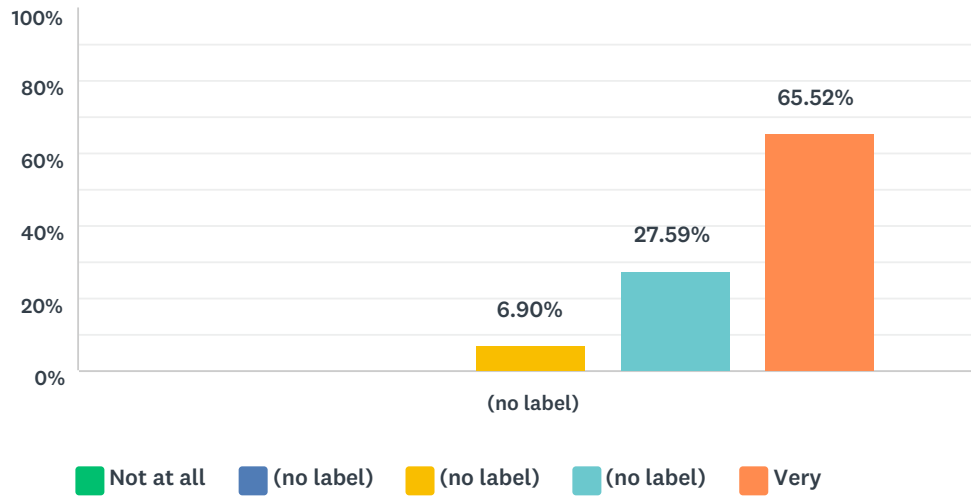
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	3.45%	17.24%	41.38%	37.93%	29	4.14
	0	1	5	12	11		

Q3 The school was intellectually stimulating

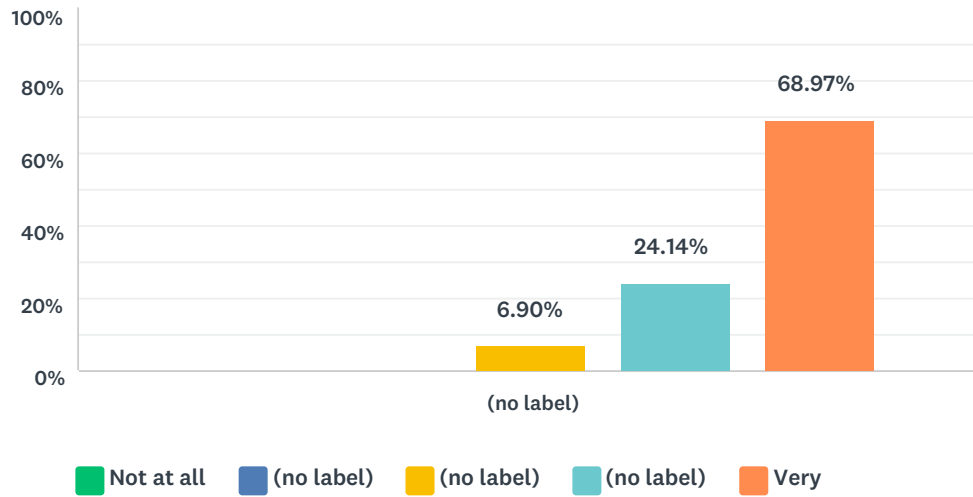
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.90%	27.59%	65.52%	29	4.59
	0	0	2	8	19		

Q4 The overall experience of the school was worthwhile

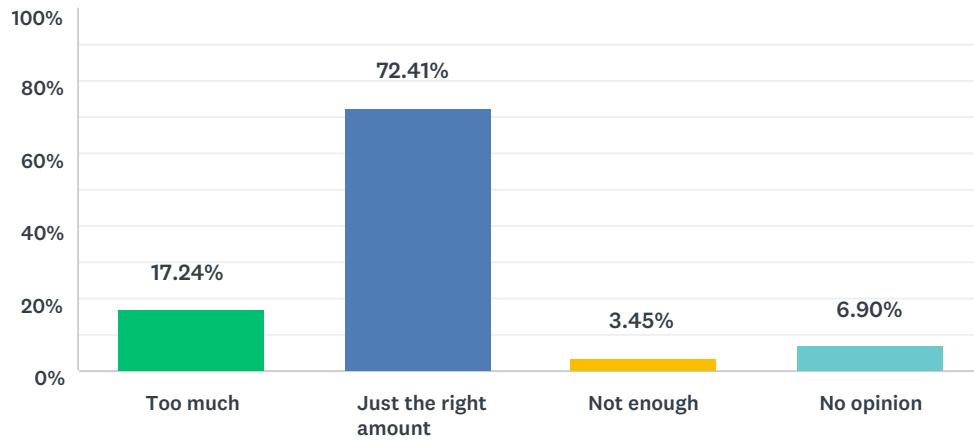
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	6.90%	24.14%	68.97%	29	4.62
	0	0	2	7	20		

Q5 The amount of material presented was:

Answered: 29 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	17.24%	5
Just the right amount	72.41%	21
Not enough	3.45%	1
No opinion	6.90%	2
TOTAL		29

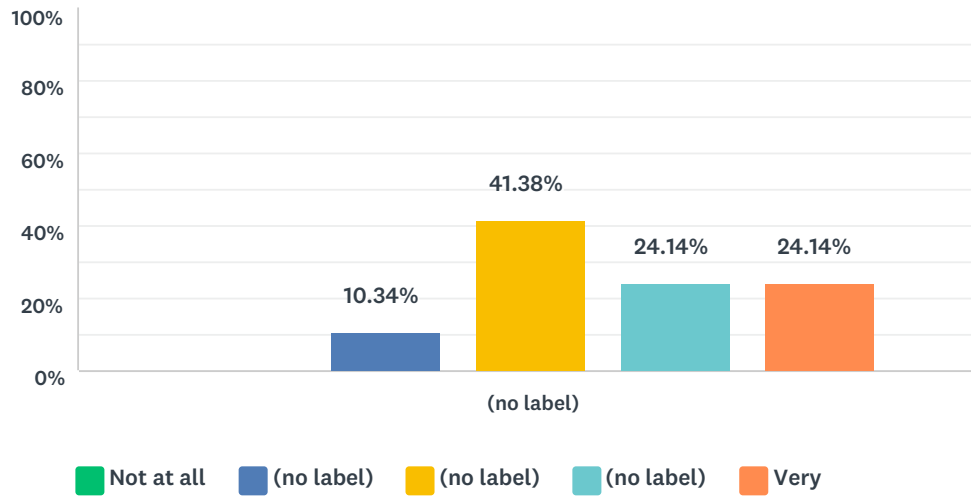
Q6 Additional comments on the topic presentation and organization

Answered: 8 Skipped: 21

#	RESPONSES	DATE
1	This summer school is so great. I definitely learned a lot from it. This is a very beneficial activity.	9/11/2019 11:31 AM
2	Very well organized. A little too much information in my opinion, but overall it was an excellent experience.	9/2/2019 4:12 AM
3	The working sessions were short and a bit rushed. In the future, I'd suggest leaving that for students to do on their own time. With the limited time in the daily programming, it lost some of the value it could have had.	8/29/2019 11:04 AM
4	I would have enjoyed slightly less material presented more slowly. At times it was tough to follow lectures while taking notes.	8/27/2019 5:21 AM
5	Some of the speakers did a better job than others, I thought. Rob Schapire's lectures were outstanding; Emma Brunskill, Kevin Jamieson, and Joan Bruna were very knowledgeable and gave thorough lectures but I sometimes had difficulty following their details. I had the most difficulty following Sebastien Bubeck's lectures and, independently of that, I had the least prior interest in his topic. I would have liked the five lecture series to be run serially; that is, we do all five lectures on one topic before moving on to the next. I realize, however, that this arrangement gave the lecturers some time to catch their breath.	8/27/2019 4:20 AM
6	The open problems session will be more useful if TAs actually solved the questions step by step. Not all questions, but some. This way will be easier for students of other fields to actually get to learn how to solve theoretical problems in this field. Also, some of the questions weren't that much related to the lectures. I also think the school should have some coding session. Code is essential to this field, to see the theory working. It gives a deeper understanding.	8/27/2019 3:44 AM
7	This Summer School was possibly the best pedagogical experience I've ever been involved in. Thank you for all your work in putting this together!	8/27/2019 3:35 AM
8	I think the order of the courses was good. The deep learning class went a little too fast.	8/27/2019 3:32 AM

Q7 I was well prepared to benefit from the school

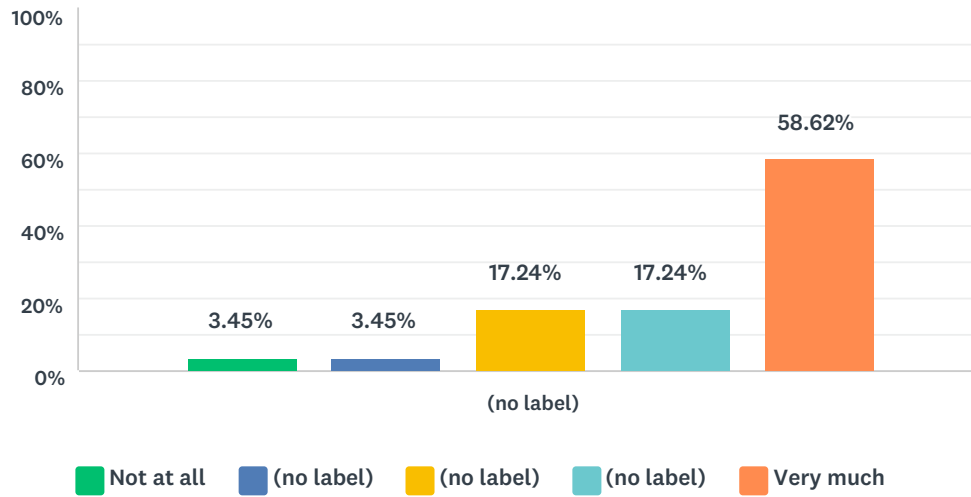
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	10.34%	41.38%	24.14%	24.14%	29	3.62
	0	3	12	7	7		

Q8 My interest in the subject matter was increased by the school

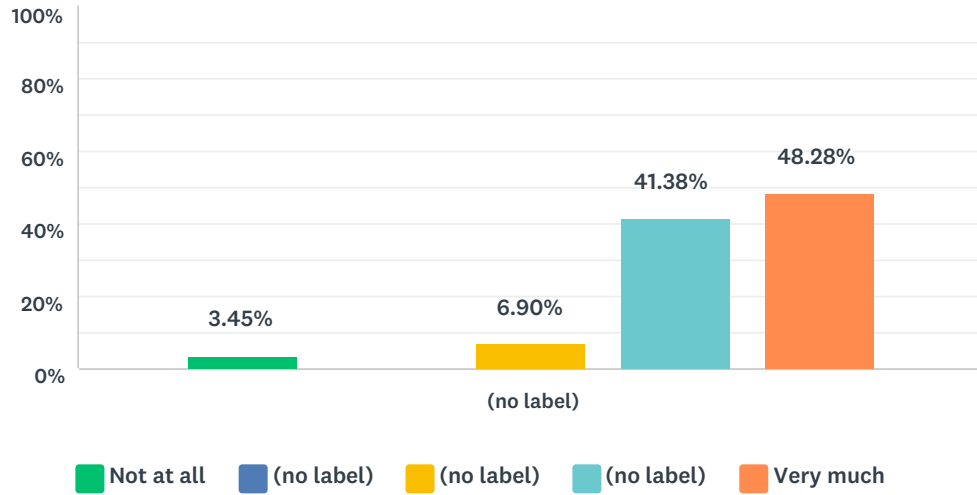
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	3.45%	3.45%	17.24%	17.24%	58.62%	29	4.24
	1	1	5	5	17		

Q9 The school helped me meet people with similar scientific interests

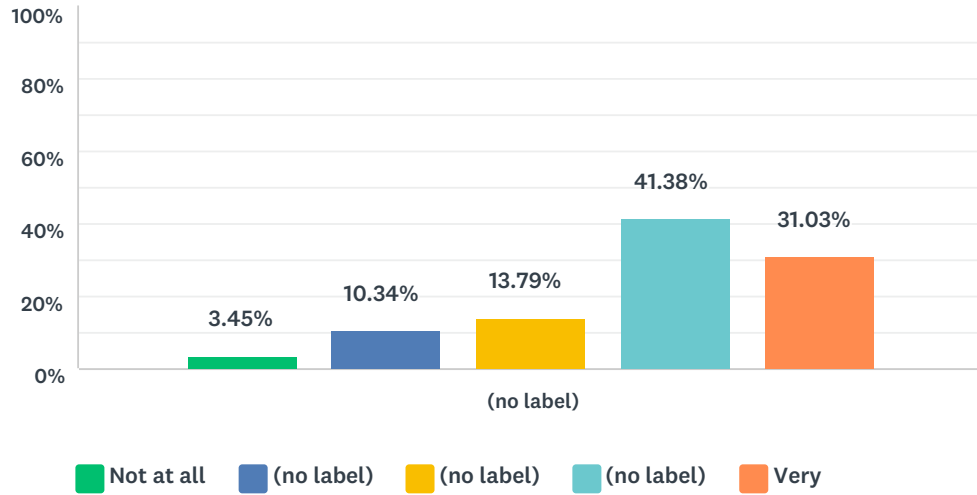
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	3.45%	0.00%	6.90%	41.38%	48.28%	29	4.31
	1	0	2	12	14		

Q10 It is likely that I will work in the area of the school subject in the future

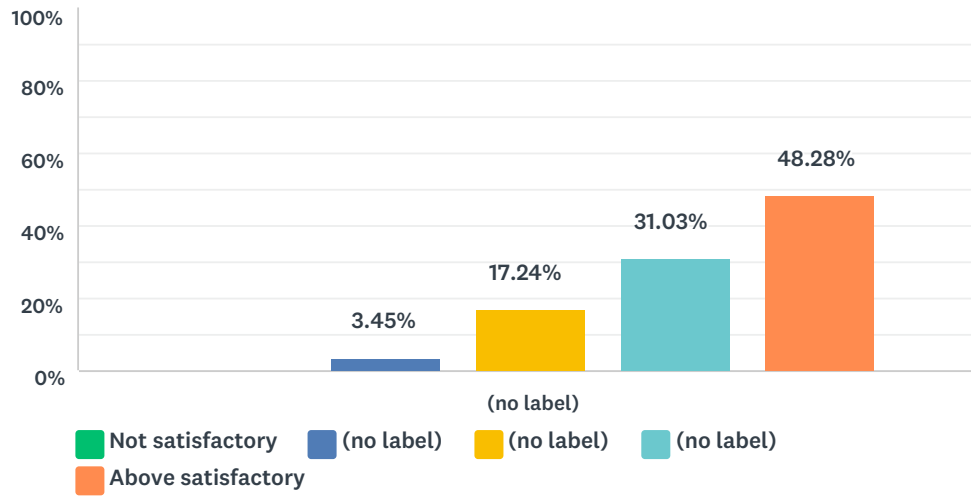
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.45%	10.34%	13.79%	41.38%	31.03%	29	3.86
	1	3	4	12	9		

Q11 How would you evaluate your interaction with other participants?

Answered: 29 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	3.45% 1	17.24% 5	31.03% 9	48.28% 14	29	4.24

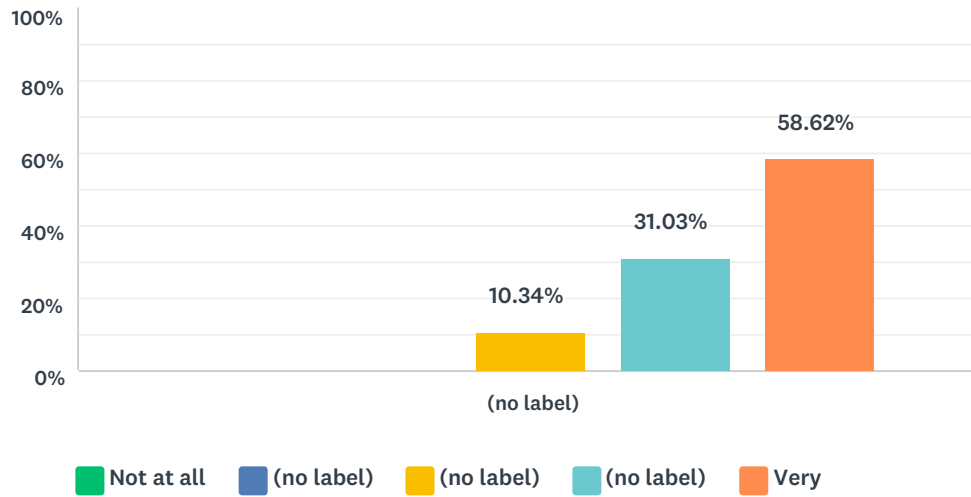
Q12 Additional comments on your personal assessment

Answered: 3 Skipped: 26

#	RESPONSES	DATE
1	I felt the description of the program from the beginning was unclear. I (and numerous other participants I talked to) thought the summer school would have more application, such as the DLRL summer school. Overall, this made the event somewhat disappointing and underwhelming.	9/12/2019 4:48 AM
2	I met a bunch of great researchers. It is a wonderful experience and helped me with future working direction/.	9/11/2019 11:32 AM
3	I would have liked that the field trip to Microsoft had been more of getting to know the people there and less formal.	9/2/2019 4:18 AM

Q13 I found the onsite staff helpful

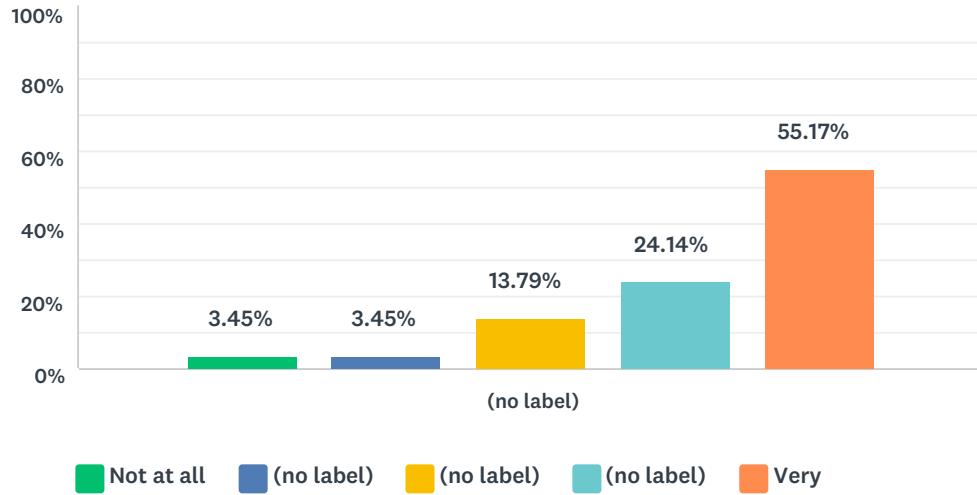
Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	10.34%	31.03%	58.62%	29	4.48
	0	0	3	9	17		

Q14 The physical facilities were conducive for such a school

Answered: 29 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	3.45%	3.45%	13.79%	24.14%	55.17%	29	4.24
	1	1	4	7	16		

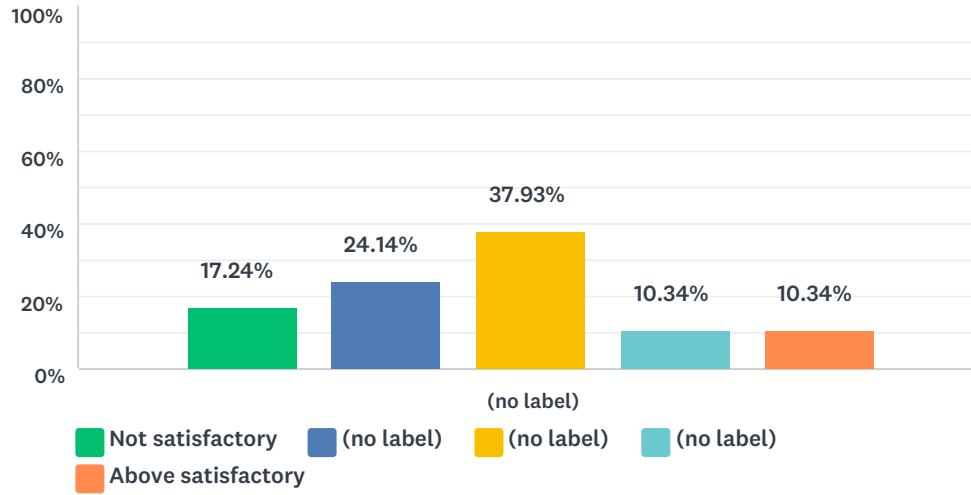
Q15 Additional comments on the venue

Answered: 7 Skipped: 22

#	RESPONSES	DATE
1	Great facilities for the program events, although the on-campus housing accommodations were the worst I've ever been in.	9/12/2019 4:49 AM
2	It is great.	9/11/2019 11:32 AM
3	The University of Washington dining hall is not accommodating to people with dietary restrictions.	9/8/2019 1:04 PM
4	Very nice building.	9/2/2019 4:19 AM
5	The dorm had no in room wi-fi making it difficult to have reliable internet, which I think is critical to following up on the material presented in the course. Also dining halls closed at 7 and our classes ended at 5ish making it slightly difficult to enjoy the city of Seattle and eat dinner during the week.	8/27/2019 5:24 AM
6	The dormitories were the only "bad thing" I would say.	8/27/2019 3:37 AM
7	The temperature in the lecture room and problem session room was very cold.	8/27/2019 3:33 AM

Q16 The summer school accommodation

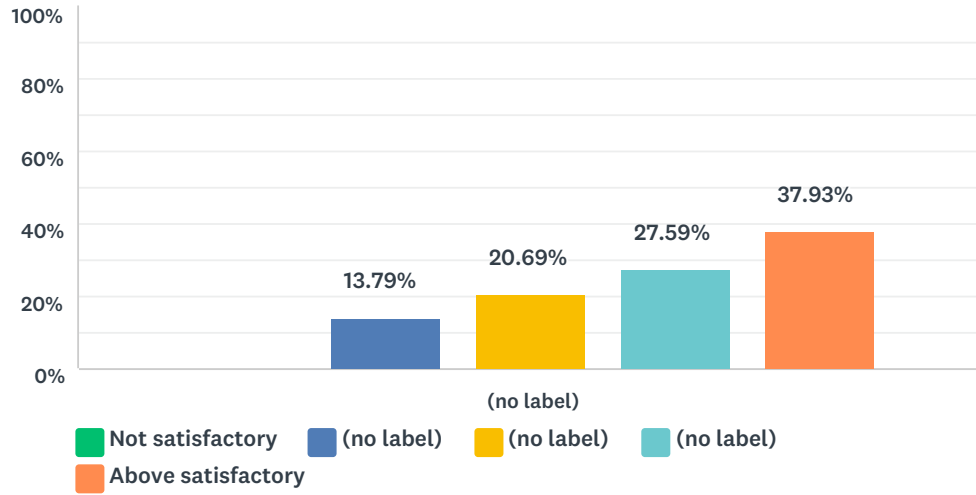
Answered: 29 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	17.24%	24.14%	37.93%	10.34%	10.34%	29	2.72
	5	7	11	3	3		

Q17 The food provided

Answered: 29 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	13.79% 4	20.69% 6	27.59% 8	37.93% 11	29	3.90

Q18 Additional comments on accommodation and food

Answered: 10 Skipped: 19

#	RESPONSES	DATE
1	I didn't use the accommodations, but stayed with family instead.	9/12/2019 7:38 AM
2	Appreciated the flexibility offered by the meal cards. I might have preferred a reimbursement by cheque though.	9/12/2019 4:49 AM
3	It is very healthy and convenient.	9/11/2019 11:33 AM
4	The accommodation is lacking maintenance.	9/2/2019 4:21 AM
5	My goodness, I don't even know where to begin. The accommodations were so highly inappropriate that they were not designed to house any adult, let alone a group of professionals. It was a horrible reflection on the school, and on the MSRI program. In the future, the host should have a representative go and physically look at the accommodations that they book for students. We were squeezed two to a room into a former dorm the size of a regular walk-in closet; Twin beds with hard mattresses and a wire clothing rack reminiscent of the soviet era. On top of that, we were 6-8 people in a pod all sharing one bathroom with two stalls and one shower. The shower head was at my shoulders-- and I am only 5'4. There was no air conditioning, and no WiFi. How do you invite a bunch of machine learning students to stay in a place with no WiFi? It disrupted our ability to work on school work, program exercises, or our jobs- which we all took time away from to attend the conference. On the topic of "adult" accommodations, since this housing was clearly designed for children, we shared the building with several noisy and rowdy groups of kids camps. They were constantly running and screaming, and broke the elevator twice while we were there by jumping up and down. The water fountain on our floor was also broken, in addition to all the above issues. Given these circumstances, all the students with friends or family in the area were very quick to leave. I honestly considered sleeping in my car, which would have been a dramatic improvement over the housing. Overall, I cannot believe that a school with a reputation such as UW would ever think it is appropriate to host graduate professionals in such an environment. The food was fine. It was exactly what you would expect on a college campus; the same hotel-like eggs-from-a-powder breakfast every morning and fast food for dinner. The biggest issues were the restrictive dining hours which intersected with the program (7-9am and 5-7pm)- however these isn't much to be done about that.	8/29/2019 11:20 AM
6	Dorms were horrible. No wifi for a computing oriented program? Dinning hall was okay but way over priced.	8/27/2019 6:19 AM
7	The dorms were subpar. We had not hot water for 80% of the summer school. There was also no in building wi-fi, while they provide ethernet ports, many laptops (including my own) do not have ethernet connectivity.	8/27/2019 5:25 AM
8	I stayed off-campus, so I have no comment on the accommodations provided. However, for what it's worth, what I heard about the dorms where the on-campus students stayed was unanimously bad.	8/27/2019 4:22 AM
9	No WiFi connection in the dorm, which is inconvenient.	8/27/2019 3:39 AM
10	The dining hall had very limited options on the weekend. People with severe food restrictions sometimes couldn't eat much or any of the catered lunches. Some people had problems with a lack of hot water in the dorms.	8/27/2019 3:35 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 26

#	RESPONSES	DATE
1	Get more informative descriptions of the summer school so applicants know what they're applying for without having to make any assumptions. I also found the Microsoft field trip quite disappointing. We were on the Microsoft campus and didn't get so much as a tour. We hardly even left the foyer and dining areas. Why not just invite some speakers from Microsoft to the UW campus and save us all the commute and a day of having no choice as to what lectures we attend?	9/12/2019 4:52 AM
2	Provide lecture notes beforehand; the listed prerequisites weren't sufficient for keeping up with the lectures	8/27/2019 4:37 AM
3	The problem sessions were kind of frustrating for me. I would have preferred to get problem sets at the end of the day, and have an evening to try to work on them with other students or by myself. Having the TA give us 10 minutes or so to try to figure out the problems made the session feel like a qualifying exam. I didn't get much out of them. On the whole though, this program was very well done. I came away with a much greater interest in bandit problems in particular, and that's something I plan to work on in the future.	8/27/2019 4:24 AM

Commutative Algebra and its Interaction with Algebraic Geometry

June 03, 2019 - June 14, 2019

Center for Mathematics, University of Notre
Dame

Organizers:

Craig Huneke (University of Virginia,

Sonja Mapes (University of Notre Dame)

Claudia Polini (University of Notre Dame)

Claudiu Raicu (University of Notre Dame)

REPORT ON THE MSRI SUMMER GRADUATE SCHOOL

Commutative Algebra and its Interaction with Algebraic Geometry

June 03–14, 2019

Organizing Committee:

Craig Huneke (University of Virginia),
Sonja Mapes (University of Notre Dame),
Juan Migliore (University of Notre Dame),
Claudia Polini (University of Notre Dame),
Claudiu Raicu (University of Notre Dame).

Lecturers:

Mark Johnson (University of Arkansas),
Linquan Ma (University of Utah),
Claudia Polini (University of Notre Dame),
Javid Validashti (DePaul University).

Macaulay2 coordinators:

Sonja Mapes (University of Notre Dame),
Claudiu Raicu (University of Notre Dame),
Gregory Smith (Queen's University, Canada).

Teaching Assistants:

Youngsu Kim (University of Arkansas) [unofficial helper]
Paolo Mantero (University of Arkansas)
Jonathan Montaña (Kansas University)
Vivek Mukundan (University of Virginia)
Lan Nguyen (Vietnam National University)
Thomas Polstra (University of Utah)
Alessio Sammartano (Purdue University)
Ilya Smirnov (University of Michigan)
Kevin Tucker (University at Illinois at Chicago) [unofficial helper]
Yu Xie (Widener University).

Colloquium Speakers

Robin Hartshorne (University of California, Berkeley)
Uwe Nagel (University of Kentucky)

The MSRI Summer School consisted of four minicourses (5 lectures each) on fundamental topics in commutative algebra, three colloquium-style lectures, and a panel discussion. In addition, each course was complemented and supported by problem sessions and Macaulay2 workshops. These activities gave the students plenty of opportunities to engage with the

material and therefore obtain a deeper understanding of it. In addition the Macaulay2 sessions allowed them to learn powerful computational methods. Collaborations among students were also encouraged during the homework sessions. Several dinners and social events were organized to maximize the possibility of making productive new contacts and connections.

The first week of the school featured a course on linkage and residual intersections taught by Mark Johnson and one on characteristic p -methods and applications taught by Linquan Ma. The courses in the second week were: *Defining equations of blowup algebras* taught by Claudia Polini and *Multiplicity theory* taught by Javid Validashti.

Linkage is a method for classifying ideals in local rings. Residual intersections is a generalization of linkage to the case where the two linked ideals need not have the same codimension. Residual intersections are ubiquitous: they play an important role in the study of blowups, branch and multiple point loci, secant varieties, and Gauss images; they appear naturally in intersection theory; and they have close connections with integral closures of ideals. Mark Johnson's lectures started with the modern treatment of linkage theory as developed by Peskine and Szpiro in the 70's and finished with the theory of residual intersections developed by Huneke and Ulrich in the 90's.

The action of Frobenius on a ring of positive characteristic has a long history of being used to characterize the singularities of the associated varieties. Work of Kunz shows that a Noetherian ring R of prime characteristic is regular if and only if the Frobenius map on R is flat. The Frobenius map was also applied to several important questions, for example the study of cohomological dimension and the study of invariant rings of group actions in positive characteristic. The development of tight closure theory added tremendously to our understanding of singularities via the Frobenius map. A number of classes of singularities were formally introduced, which include F -regular, F -rational, F -pure and F -injective singularities. Linquan Ma, in his course, gave an introduction on these ' F -singularities', with a focus on the connection with Frobenius actions on local cohomology modules.

The Rees ring and the special fiber ring of an ideal arise in the process of blowing up a variety along a subvariety. Rees rings and special fiber rings also describe the graphs and the images of rational maps between projective spaces, respectively. A difficult open problem in commutative algebra, algebraic geometry, elimination theory, and geometric modeling is to determine explicitly the equations defining graphs and images of rational maps. Historically the pathway to study the Rees ring is via the symmetric algebra. There is a natural surjection from the latter to the former and computing the defining equations of the Rees ring is equivalent to determining the kernel of this surjection. The advantage of this approach is that the equations of the symmetric algebra of an ideal are readily available. Hence the first case to consider is when the two rings are isomorphic. In this case the ideal is called of linear type. These and many other techniques were shown in Polini's course.

Numerical conditions for the integral dependence of ideals and modules have a wealth of applications, not the least of which is in equisingularity theory. The first numerical criterion for integral dependence of 0-dimensional ideals was proved by Rees in 1961 and used the Hilbert-Samuel multiplicity. After that, there was a long history of generalized criteria for integral dependence of ideals and modules that still require some remnants of finite length assumptions. The case of arbitrary ideals was first treated by Gaffney and Gassler in the analytic setting and by Flenner and Manaresi for abstract Noetherian rings. Since the Hilbert-Samuel multiplicity is no longer defined for non 0-dimensional ideals, other notions of multiplicities needed to be defined. Javid Validashti in his course explained the several possible choices and showed their advantages and disadvantages.

Robin Hartshorne gave two colloquium talks. The first one was about Gorenstein linkage, a variation of linkage, that fitted very well with the course delivered by Mark Johnson. The second one was about the long standing question of whether every irreducible curve in \mathbb{P}^3 is the intersection of two surfaces. Uwe Nagel delivered a general talk on *Interpolation and Unexpected Curves*.

The program was a great success. We had many more applications than we would expect. We had to be very selective and choose less than half of the excellent students that applied. Students came from all over the world and from very different schools. They formed clusters, discussed together, worked together, and asked many questions. We were lucky to have so many senior mathematicians attend the school that most students could get personal attention.

In the afternoon sessions, the students were divided into three groups so that each group would not have more than 25 students. In each room there were at least 4/5 senior mathematicians leading each problem session. The large numbers of teaching assistants ensured that each group was properly guided. Each group worked through three problem sessions (each 90 minutes long): one on the first lecture of the day, one on the second, and the third one on Macaulay 2 exercises. At the end of each problem session, the students presented their solutions at the board. The exercises were of increasing difficulty, starting from computational problems to theoretical ones that were used to strengthen the students' understanding. The students were encouraged to work together to create collaborations that can be useful for their future careers.

We had a panel discussion that focussed on how to find collaborators, how to apply for jobs, how to find alternative career paths to academia, and how to apply for grants. Questions were plentiful. The panel members were David Eisenbud, Kevin Tucker, Claudia Polini, Sonja Mapes, and Alessio Sammartano.

During the breaks and the morning breakfasts we would all meet in the common lounge to discuss. The organized activities created a sense of community. The response of the students was overwhelming. They worked very hard for both weeks.

Mathematical Sciences Research Institute

Commutative Algebra And Its Interaction With Algebraic Geometry

June 3, 2019 - June 14, 2019

Monday, June 3, 2019			
8:30 AM - 10:00 AM			Registration/Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work
Tuesday, June 4, 2019			
8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work
Wednesday, June 5, 2019			
8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work
Thursday, June 6, 2019			
8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work
Friday, June 7, 2019			
8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM		Robin Hartshorne	Colloquium
6:00 PM - 7:00 PM			Reception

Monday, June 10, 2019

8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work

Tuesday, June 11, 2019

8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work

Wednesday, June 12, 2019

8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 2:00 PM			Lunch Break
2:00 PM - 3:15 PM			Group Work
3:15 PM - 3:30 PM			Coffee Break
3:30 PM - 4:45 PM			Group Work
4:45 PM - 5:00 PM			Coffee Break
5:00 PM - 6:00 PM			Group Work

Thursday, June 13, 2019

8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 1:15 PM			Lunch Break
1:15 PM - 2:15 PM			Group Work
2:15 PM - 2:30 PM			Coffee Break
2:30 PM - 3:30 PM			Group Work
3:30 PM - 3:45 PM			Coffee Break
3:45 PM - 5:00 PM			Group Work
5:00 PM - 6:00 PM			Panel Discussion

Friday, June 4, 2019

8:30 AM - 10:00 AM			Continental Breakfast
10:00 AM - 11:00 AM			Lecture
11:00 AM - 11:30 AM			Coffee Break
11:30 AM - 12:30 PM			Lecture
12:30 PM - 1:15 PM			Lunch Break
1:15 PM - 2:15 PM			Group Work
2:15 PM - 2:30 PM			Coffee Break
2:30 PM - 3:30 PM			Group Work
3:30 PM - 3:45 PM			Coffee Break
3:45 PM - 5:00 PM			Group Work
5:00 PM - 6:00 PM		Uwe Nagel	Colloquium - Interpolation and Unexpected Curves
6:00 PM - 7:00 PM			BBQ Picnic



Participants

First Name	Last Name	Institution
Sankhaneel	Bisui	Tulane University
Xiaojiang	Cheng	Washington University
Alessandra	Costantini	Purdue University
Martino	Fassina	University of Illinois at Urbana-Champaign
Lily	Friedberg	Harvey Mudd College
Jong In	Han	KAIST
Lauren	Heller	University of California, Berkeley
Hang	Huang	University of Wisconsin-Madison
Lena	Ji	Princeton University
Uyen	Le	West Virginia University
Li	Li	Humboldt-Universität
Sarasij	Maitra	University of Virginia
Michael	Marmorstein	North Dakota State University
Adolfo	Martin	University of Nebraska
Fanjun	Meng	Northwestern University
Roberto	Nunez	University of Missouri
McCleary	Philbin	University of Minnesota, Twin Cities
Giovan Battista	Pignatti Morano di Custoza	CUNY, Graduate Center
Nandagopal	Ramachandran	University of California, San Diego
Ritvik	Ramkumar	University of California, Berkeley
Nicholas	Rekuski	Michigan State University
Kalila	Sawyer	University of Kentucky
Lisa	Seccia	Università di Genova
Prashanth	Sridhar	University of Kansas
Ergun	Suer	University of Oklahoma
Libby	Taylor	Stanford University
Elena	Tielker	Universität Bielefeld

Officially Registered Student Information

Participants		27
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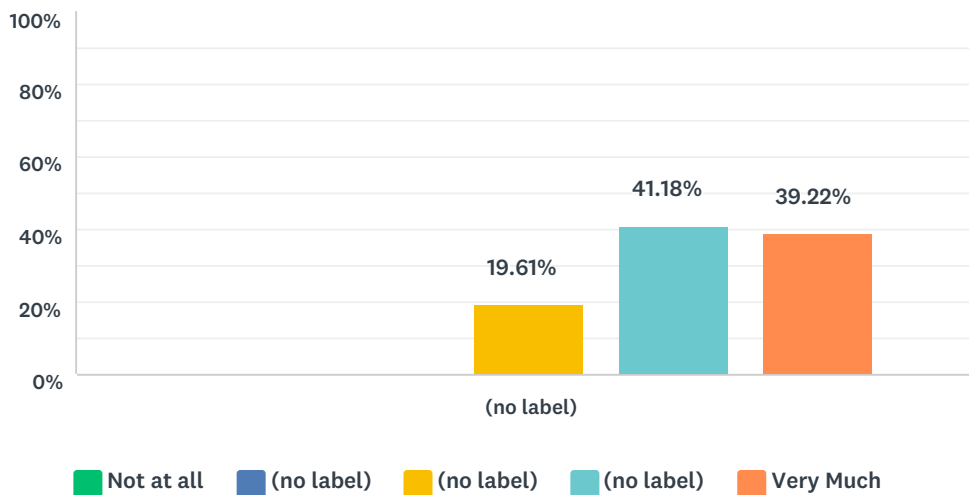
Gender		27
Male	59.26%	16
Female	40.74%	11
Declined to state	0.00%	0

Ethnicity*		27
White	37.04%	10
Asian	40.74%	11
Hispanic	7.41%	2
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	14.81%	4

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

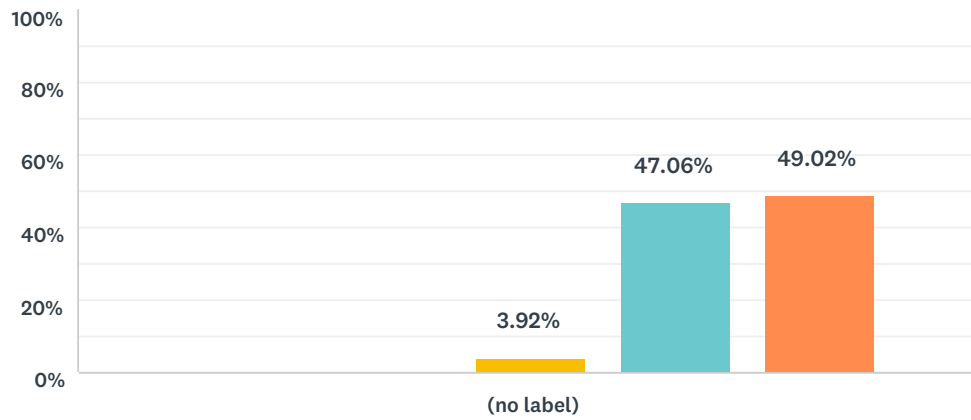
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	19.61% 10	41.18% 21	39.22% 20	51	4.20

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 51 Skipped: 0

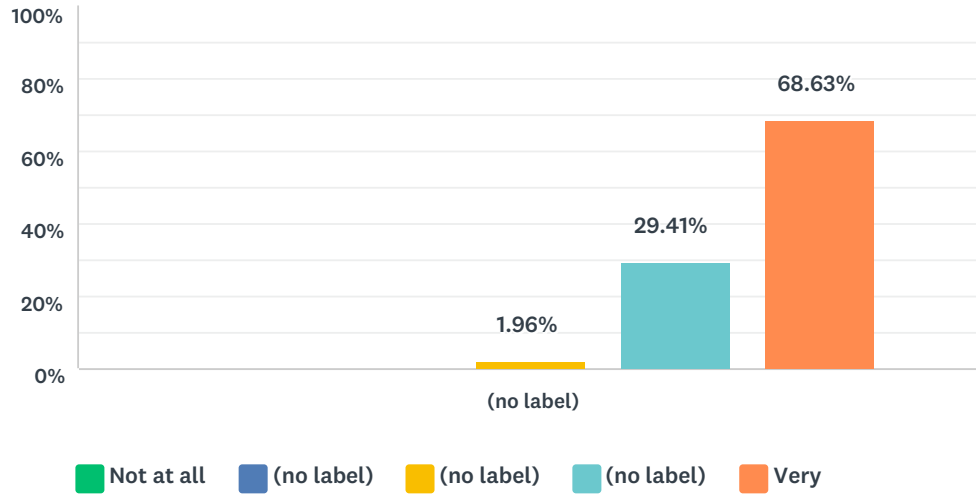


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.92%	47.06%	49.02%	51	4.45
	0	0	2	24	25		

Q3 The school was intellectually stimulating

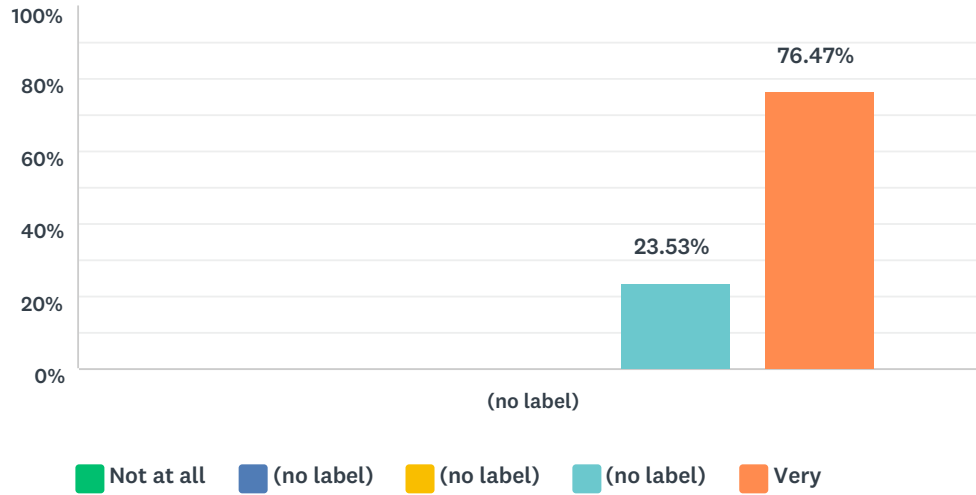
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	1.96%	29.41%	68.63%	51	4.67
	0	0	1	15	35		

Q4 The overall experience of the school was worthwhile

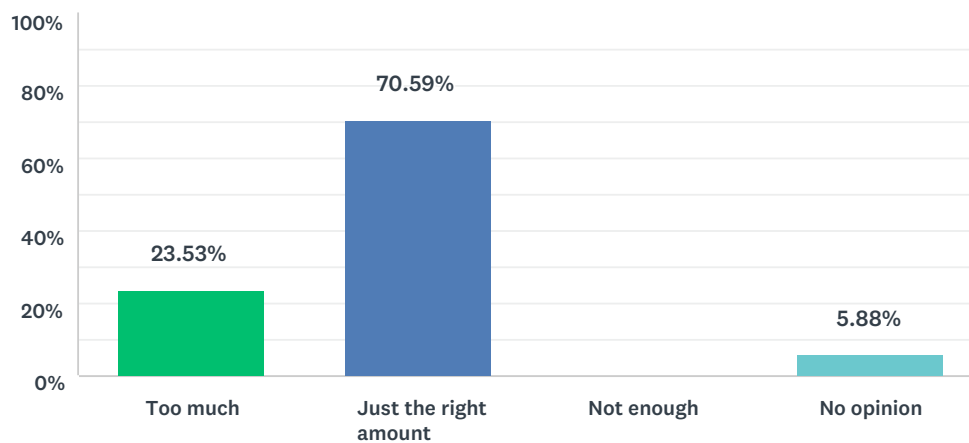
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	23.53%	76.47%	51	4.76
	0	0	0	12	39		

Q5 The amount of material presented was:

Answered: 51 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	23.53%	12
Just the right amount	70.59%	36
Not enough	0.00%	0
No opinion	5.88%	3
TOTAL		51

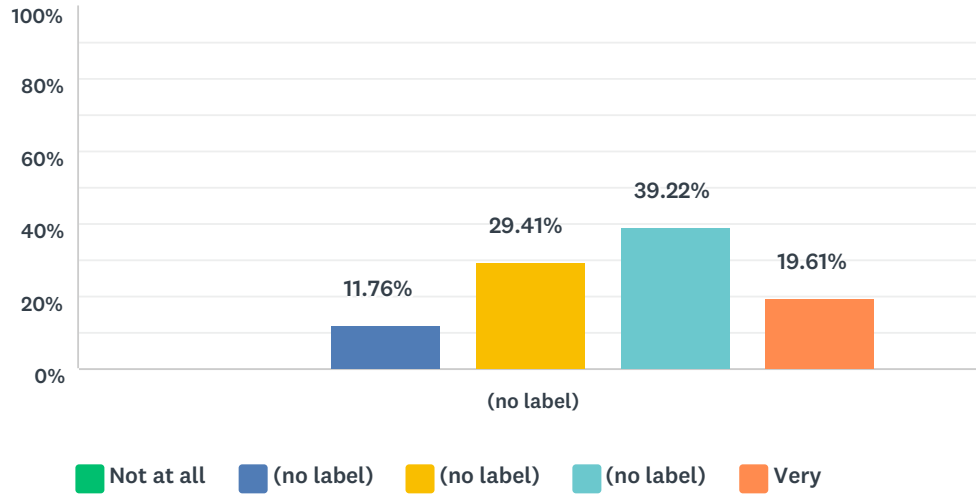
Q6 Additional comments on the topic presentation and organization

Answered: 11 Skipped: 40

#	RESPONSES	DATE
1	I appreciated the problem sessions a lot. The lectures were engaging but sometimes the speaker was too eager to get quickly to the results connected with their research.	9/12/2019 12:22 PM
2	I'm really grateful for my time at MSRI and the perspective I gained. Some topics moved a little quickly for me, especially the more geometric talks.	8/22/2019 7:36 AM
3	The linkage lectures could have been better motivated, but in general the speakers were good. On a few occasions during the afternoon I had TAs give me unsolicited and unhelpful advice for solving a problem because they assumed I was more confused than I actually was.	6/21/2019 9:21 AM
4	None	6/17/2019 10:29 PM
5	I didn't like how the talks kept starting late and also went overtime (overtime even when starting late is taken into account).	6/16/2019 12:05 PM
6	The Macaulay2 exercises in the afternoon were extremely helpful in digesting the lectures.	6/16/2019 1:10 AM
7	The presenters and helpers did a fantastic job of communicating how the techniques presented fit into the literature and into the modern view. I especially appreciated that themes and even specific results from the first week (characteristic p and linkage) were referred to often in the second week (multiplicities and blowup algebras).	6/15/2019 6:23 AM
8	very good experience	6/14/2019 1:02 PM
9	If references are cited, then it will help a lot. Also, it will be very helpful to have solutions to problems posted at the end of the summer school. A lot of problems were left undone and we did not have time to go over them even on a one on one basis with the teaching instructors.	6/14/2019 10:21 AM
10	I am so glad I attended this workshop. It would be nice if all the presenters made their notes available (or at least provided a bibliography for the relevant topics).	6/14/2019 10:07 AM
11	Effective use and balance of slides and board work. The tutorial problems were intellectually stimulating and helped in deeper understanding of the subject. The division of lecture and tutorial hours was apt as well.	6/14/2019 7:51 AM

Q7 I was well prepared to benefit from the school

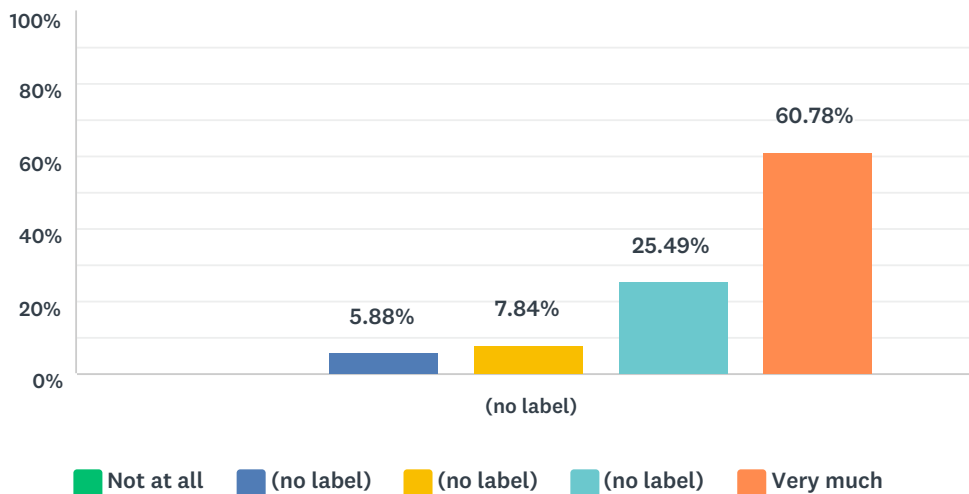
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	11.76%	29.41%	39.22%	19.61%	51	3.67
	0	6	15	20	10		

Q8 My interest in the subject matter was increased by the school

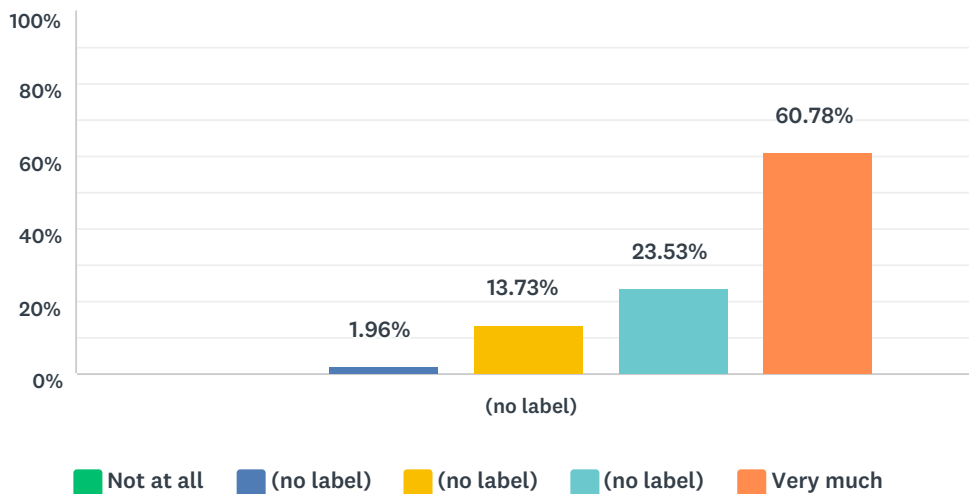
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	5.88%	7.84%	25.49%	60.78%	51	4.41
	0	3	4	13	31		

Q9 The school helped me meet people with similar scientific interests

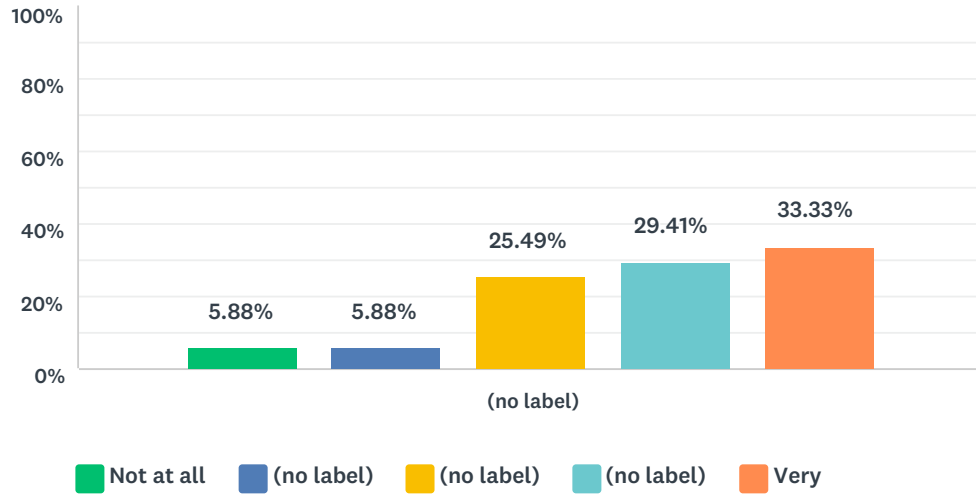
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.96%	13.73%	23.53%	60.78%	51	4.43
	0	1	7	12	31		

Q10 It is likely that I will work in the area of the school subject in the future

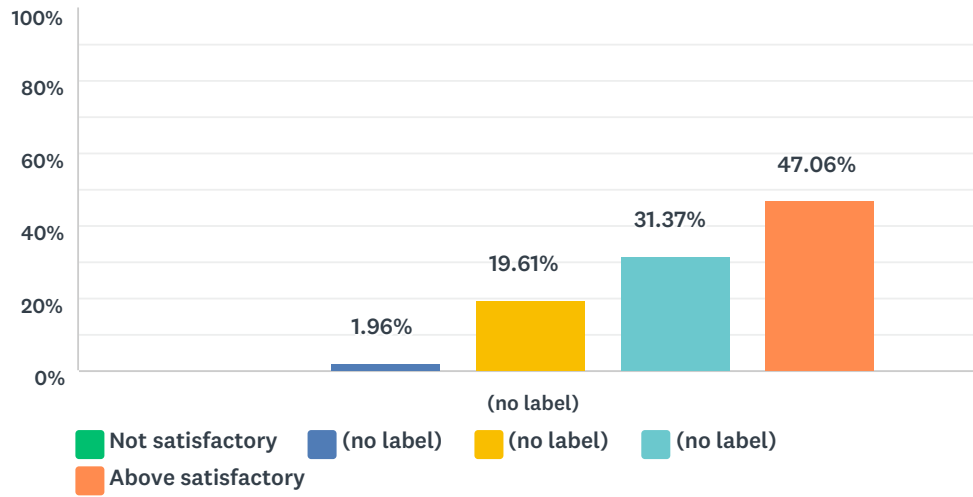
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	5.88%	5.88%	25.49%	29.41%	33.33%	51	3.78
	3	3	13	15	17		

Q11 How would you evaluate your interaction with other participants?

Answered: 51 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	1.96% 1	19.61% 10	31.37% 16	47.06% 24	51	4.24

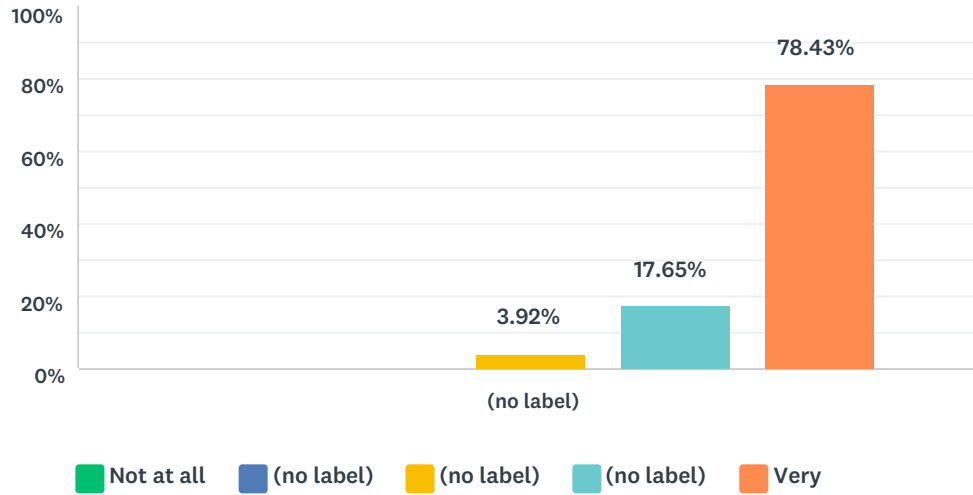
Q12 Additional comments on your personal assessment

Answered: 6 Skipped: 45

#	RESPONSES	DATE
1	I do wish I was more prepared going into the conference but still got a lot out of it.	8/22/2019 7:38 AM
2	The problem solving sessions were very helpful in understanding the lecture material. The questions were the correct difficulty level to illustrate the examples in the lecture	6/26/2019 10:50 AM
3	None	6/17/2019 10:30 PM
4	I appreciated the opportunities created to interact socially with other participants, though I wish there was a central way to communicate with other participants, for instance via a mailing list.	6/16/2019 1:11 AM
5	I felt that the techniques covered were general enough that I can apply specific ideas to my own research, even though aspects of it are a bit removed from the specific topics presented.	6/15/2019 6:25 AM
6	I am mainly interested in complex geometry. But this is a great opportunity to know how people study geometry by algebra	6/14/2019 1:04 PM

Q13 I found the onsite staff helpful

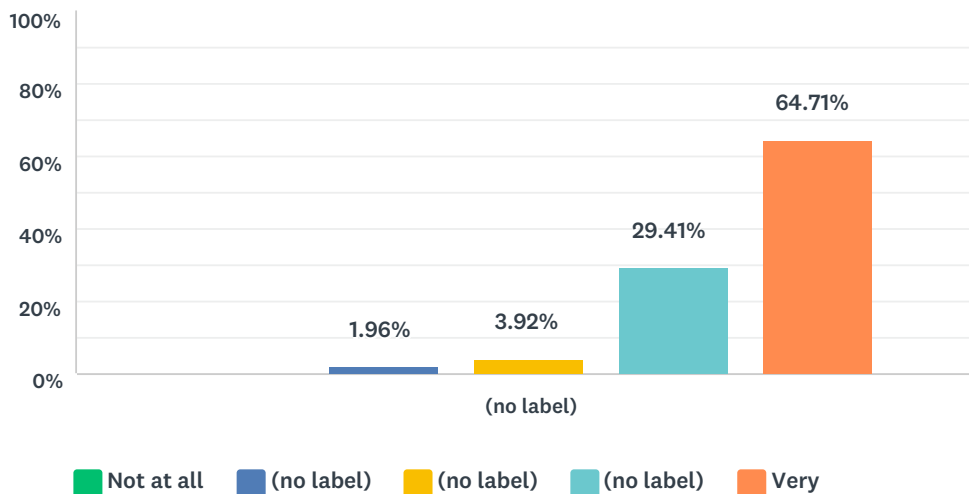
Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	3.92%	17.65%	78.43%	51	4.75
	0	0	2	9	40		

Q14 The physical facilities were conducive for such a school

Answered: 51 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	1.96%	3.92%	29.41%	64.71%	51	4.57
	0	1	2	15	33		

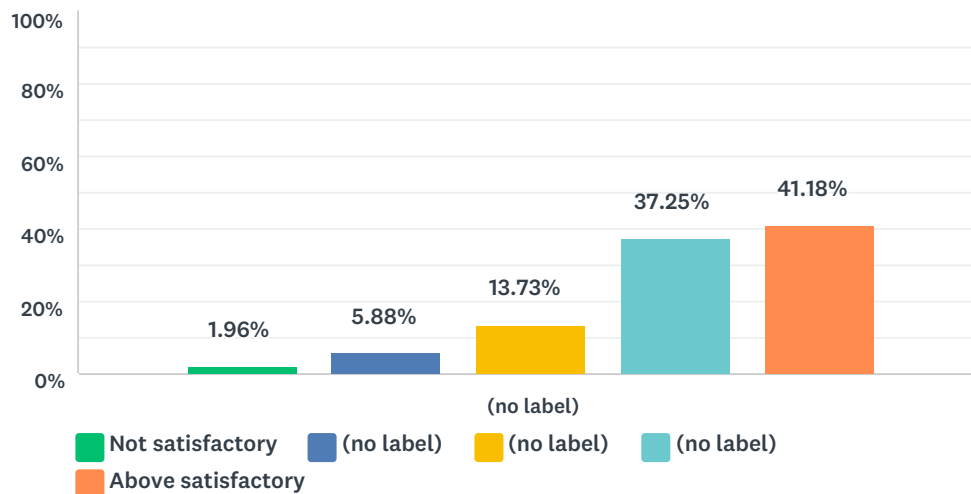
Q15 Additional comments on the venue

Answered: 7 Skipped: 44

#	RESPONSES	DATE
1	Very welcoming, always available for questions or concerns, very good quality food	8/23/2019 3:18 PM
2	Hard to print documents or use the wellness facilities at Notre Dame.	8/22/2019 7:39 AM
3	None	6/17/2019 10:31 PM
4	Organizers and staff did a tremendous job, and were incredibly attentive and supportive towards participants' needs	6/15/2019 10:12 AM
5	The location was great, and the staff at Notre Dame were absolutely wonderful.	6/15/2019 6:26 AM
6	All the facilities and services are excellent	6/14/2019 1:05 PM
7	It would be nice if participants had access to the Notre Dame fitness center, but the small dorm gym was mostly sufficient.	6/14/2019 10:09 AM

Q16 The summer school accommodation

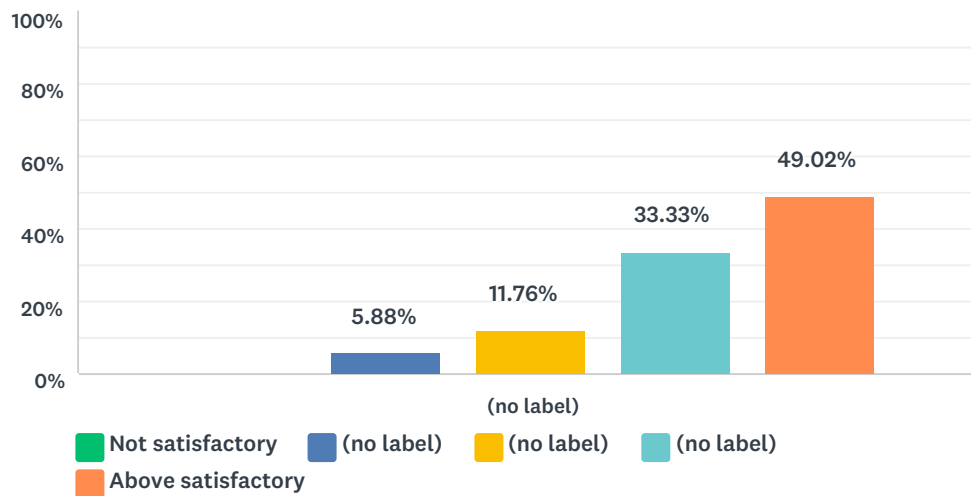
Answered: 51 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	1.96%	5.88%	13.73%	37.25%	41.18%	51	4.10
	1	3	7	19	21		

Q17 The food provided

Answered: 51 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	5.88% 3	11.76% 6	33.33% 17	49.02% 25	51	4.25

Q18 Additional comments on accommodation and food

Answered: 11 Skipped: 40

#	RESPONSES	DATE
1	I am a Purdue student, so my accommodations were at the hotel, not the dorm. The dorm did not sound very nice. The hotel was awesome.	9/11/2019 9:25 AM
2	The food was great, but there was not enough meat, most of the dishes were vegetable.	8/23/2019 12:17 PM
3	FOOD WAS AMAZING.	6/28/2019 11:00 AM
4	The food was amazing!	6/26/2019 10:50 AM
5	The snacks were excellent. I wish there had been more space for preparing/storing food in the dormitory, so that we were not expected to eat out every day.	6/21/2019 9:22 AM
6	None	6/17/2019 10:31 PM
7	Even difficult food intolerances were taken into account. Thank you!	6/15/2019 8:40 AM
8	Hotel accommodations were very cramped when 3 to a room	6/15/2019 6:17 AM
9	The dorm sleeping situation was disappointing. The air conditioner control was locked (so we could not change the temperature) and one of the blankets was literally a large piece of felt. If I had known this beforehand, I would have brought my own bedding to the dorm. Also, it is difficult to get food near campus after 6:00 PM or during the weekend.	6/14/2019 6:23 PM
10	Very good	6/14/2019 1:05 PM
11	The breakfasts were consistently very well prepared.	6/14/2019 10:12 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 7 Skipped: 44

#	RESPONSES	DATE
1	I think the group work would have been more productive if we had received the questions a bit in advance so that we could look at them individually before meeting. There should also have been time in the schedule reserved for announcements so that we weren't constantly delayed.	6/21/2019 9:22 AM
2	None	6/17/2019 10:31 PM
3	It would be really great if you could encourage the professors/TAs to upload the notes as quickly as possible, and also upload solution manuals(or just hints) for all the problems given during group work.	6/16/2019 5:29 AM
4	It's clear that students have different levels of preparation. I just finished my first year and did not have the time to go through all of the suggested chapters in the prerequisite material. I would have greatly appreciated a list of key terms the participants were assumed to know already. That would have made my preparation much more effective, and I probably would have understood much more of the lectures.	6/15/2019 8:43 AM
5	Could we get solutions to the problem sets at the end of the school?	6/15/2019 2:21 AM
6	Many students (myself included) were very annoyed at the fact that most of the lectures went significantly overtime. This led to the afternoon working sessions being cut short, which was very frustrating, as I learned more from the problem sessions than I did from the lectures themselves.	6/15/2019 1:11 AM
7	Again, a bibliography would be very nice for the talks. Most of the time names of authors were given, but the actual papers never named. It would be nice to have at least an initial list of essential sources for those that are interested in pursuing the topics further. Also, it might be helpful to emphasize the prerequisites more - it was clear that a decent portion of the participants were not prepared for the problem sessions.	6/14/2019 10:17 AM

H-Principle

July 29, 2019 - August 09, 2019

NdAM, Cortona, Italy

Organizers:

Emmy Murphy (Northwestern University)

Takashi Tsuboi (University of Tokyo)

Report on
the MSRI Summer Graduate School “ h -principles”
July 29 – August 9, 2019
The Palazzone of the Scuola Matematica Interuniversitaria,
Cortona, Italy

The summer school took place at the Palazzone, covering two lectures a day, together with TA and problem sessions. The lodging, lecture room, and eating area are all in the same building, which made it very easy for the students to discuss math with each other, the lecturers, and the TAs in a casual way during off hours. The goal of the summer graduate school was to introduce graduate students to the theory of h -principles. The structure of the school was centered around four courses: an introductory course covering the “classical” theory in smooth topology, and three courses focused on more recent developments of the theory: fluid dynamics, symplectic and contact geometry, and foliation theory.

During the first week the two topics were Emmy Murphy’s introductory course, and Phil Isett’s course on fluid mechanics. These two topics mirrored each other nicely, particularly as Emmy’s course covered the more topological/geometric version of convex integration for open relations, whereas Phil’s course covered a more analytic/numerical approach to the same topic, which is useful for the specific case of the Euler equation. Emmy’s course was focused around the theme of formal vs. holonomic solutions to partial differential relations (as in Gromov/Eliashberg/Mishachev), and developing various tools to connect these: holonomic approximation, convex integration, and wrinkled embeddings. Phil’s course was focused on the idea of iteration of solutions at different length/time scales, and how ideal bounds shift to these scales.

Throughout the week there were approximately 15 problems given for each of the two courses. This prompted a lot of discussion among the students, TAs, and lecturers. The problems ranged from small lemmas left unproven in the lectures suitable for beginning students to large-ranging difficult questions about how to extend the theory to novel situations, to interesting asides with the flavor of “recreational mathematics”. Andy Ma gave a number of short informal lectures on the problem sets of the Euler equations which were an excellent supplement to Phil’s course.

The weekend left participants with unstructured time to explore the area. A large group of the students took a weekend trip to Florence. Other explored the area closer to Cortona, or took a trip to Rome.

The second week followed essentially the same structure as the first week, now covering Takashi Tsuboi’s course on foliation theory and Emmy’s course on contact and symplectic geometry. The first lectures began with the introductory basics of symplectic/contact geometry by Emmy and foliations by Takashi giving the students a chance to familiarize themselves with the basics of these geometries before applying the h -principle theory to

them. The concepts were additionally explained in more detail after the lectures. As the week went on, the lectures turned to the theory of h-principles on symplectic/contact structures by and foliations. Similar to the previous week, the session on the morning of the last day was devoted to exercises where the lectures answers questions by the participants.

We think the lectures and the organization of the school were very successful. The close-knit space of the Palazzone, including lunches and coffees, as well as the dinners provided at the nearby hotel, did very well to support discussion among the participants and build a sense of camaraderie.

Also, a set of notes for Emmy's two courses are currently being completed by Apurva Nakade and Javier Martínez-Aguinaga, complete with very well-done figures (≈ 50 pages). These are in the final editing stages and can be sent on request, we would be happy to hear if MSRI has any publishing recommendations!

a) Full list of attendants to the summer school (their names and institutions)

Rima Chatterjee	Louisiana State University
Mita Banik	University of California, Santa Cruz
Soham Chanda	Rutgers University
Apurva Nakade	Johns Hopkins University
Oliver Waite	University of Vermont
Pedro Valentin De Jesus	University of Iowa
Carlos Osco Huaricapcha	San Francisco State University
Omar Melikechi	Duke University
Yijin Gao	Iowa State University
Jose Lopez-Garcia	Iowa State University
Elijah Fender	University of California, Santa Cruz
Che Hung Huang	Purdue University
Jens Reinhold	Stanford University
Christopher Kuo	University of California, Berkeley
Steven Gilmore	North Carolina State University
Daniele Cannarsa	Université Pierre et Marie Curie-Université Paris Diderot
Álvaro del Pino Gómez	Universiteit Utrecht
Thomas Dumont	Université de Bretagne Sud
Cyril Falcon	Université Paris-Sud
Eduardo Fernández Fuertes	ICMAT, Madrid
Alessandro Gubbiotti	Roma, La Sapienza
Francisco Javier Martínez-Aguinaga	ICMAT, Madrid
Lukas Nakamura	Ludwig-Maximilian University of Munich
Eric Stenhede	University of Pisa
Guillermo Sánchez	ICMAT, Madrid

b) List of lecturers, organizers, and TAs (please specify: first name, last name, institution, and role(s))

Phil Isett	California Institute of Technology	lecturer
Andy Ma	UT Austin	TA
Emmy Murphy	Northwestern University	organizer, lecturer
Giorgio Patrizio	Università degli Studi di Firenze	organizer
Nicoletta Tardini	University of Torino	TA
Takashi Tsuboi	The University of Tokyo	organizer, lecturer

c) schedule (with titles and abstracts or a program)

Course Plan

Part I: Introductory h -principles (Emmy Murphy) Intro to the h -principle and philosophy, Smale-Hirsch immersion theory, jet spaces, holonomic approximation, convex integration for ample open differential relations, the Nash-Kuiper embedding theorem, and other applications.

Part II: Fluid mechanics and the Euler equations (Phil Isett) Intro to the incompressible Euler equations and weak solutions; proof of energy conservation for weak solutions with sharp regularity; partial results towards Onsager with Main Lemma and numerology; nonstationary phase lemma; proof of full Onsager conjecture by convex integration and gluing approximation.

Part III: Contact and symplectic h -principles (Emmy Murphy) Basics of symplectic geometry and Hamiltonian mechanics, neighborhood theorems, isosymplectic embeddings, overtwisted contact structures, modern results.

Part IV: h -principles in foliation theory (Takashi Tsuboi) The h -principle for $\text{Diff } V$ invariant differential relations and the h -principle for submersions and the theorem of Phillips, definition of foliations of manifolds, examples, basic notions, the Bott vanishing theorem, definition of Haefliger's I structures and Haefliger's theorem on foliations of open manifolds, the theorem of Thurston on the classification of foliations of codimension greater than one.

Schedule

9:00 – 10:30	Lecture I
10:30 – 11:00	Coffee
11:00 – 12:30	Lecture II
12:30 – 3:00	Lunch
3:00 – 4:30	Problem session
4:30 – 5:00	Coffee
5:00 – 7:00	Problem session (cont)
8:00	Dinner

Participants

First Name	Last Name	Institution
Soham	Chanda	Rutgers University
Rima	Chatterjee	Louisiana State University
Elijah	Fender	University of California, Santa Cruz
Steven	Gilmore	North Carolina State University
Che Hung	Huang	Purdue University
Christopher	Kuo	University of California, Berkeley
Jose	Lopez	Iowa State University
Omar	Melikechi	Duke University
Apurva	Nakade	Johns Hopkins University
Carlos	Osco Huarica	San Francisco State University
Pedro	Valentin	The University of Iowa
Oliver	Waite	University of Vermont

Officially Registered Student Information

Participants		12
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Gender		12
Male	91.67%	11
Female	8.33%	1
Declined to state	0.00%	0

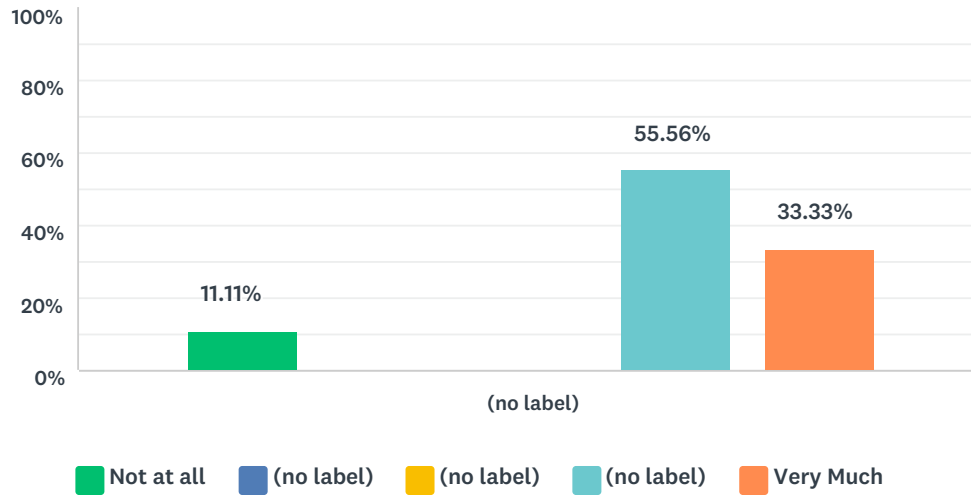
Ethnicity*		12
White	33.33%	4
Asian	41.67%	5
Hispanic	25.00%	3
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	0.00%	0

* ethnicity specifications are not exclusive

9 responses out of 12 participants = 75% response rate

Q1 The various topics within the summer school integrated into a coherent picture

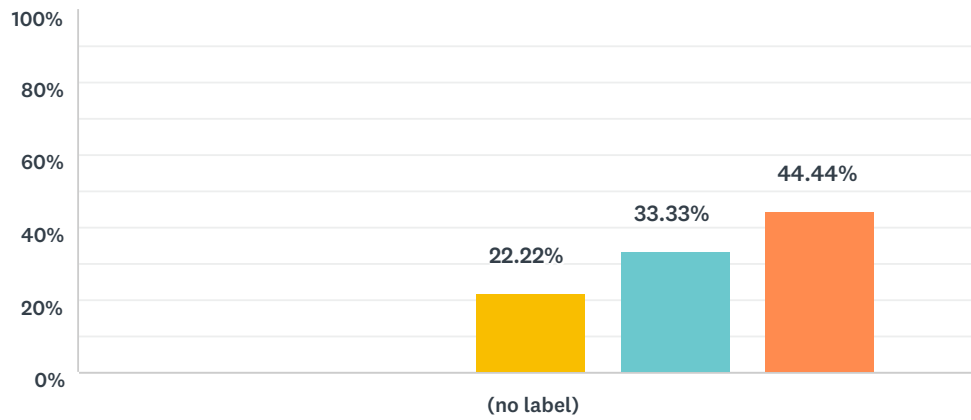
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	11.11%	0.00%	0.00%	55.56%	33.33%	9	4.00
	1	0	0	5	3		

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 9 Skipped: 0

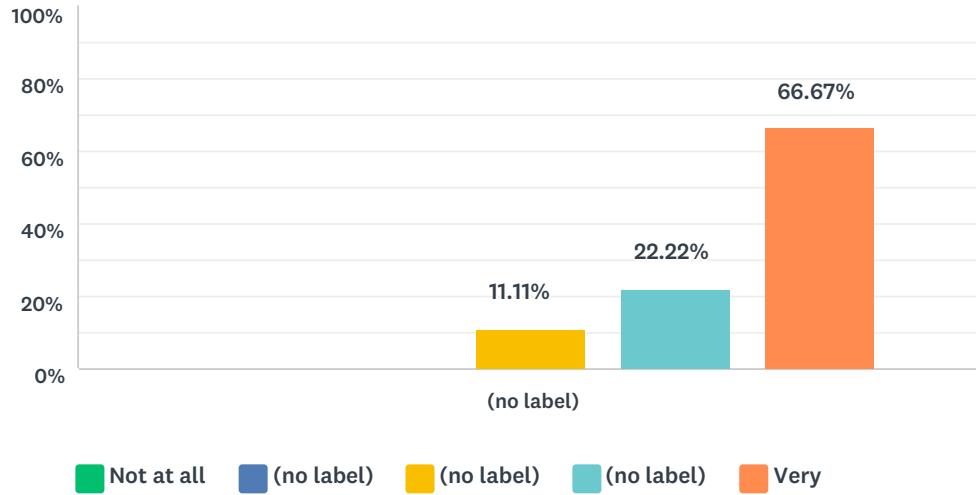


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	22.22%	33.33%	44.44%	9	4.22
	0	0	2	3	4		

Q3 The school was intellectually stimulating

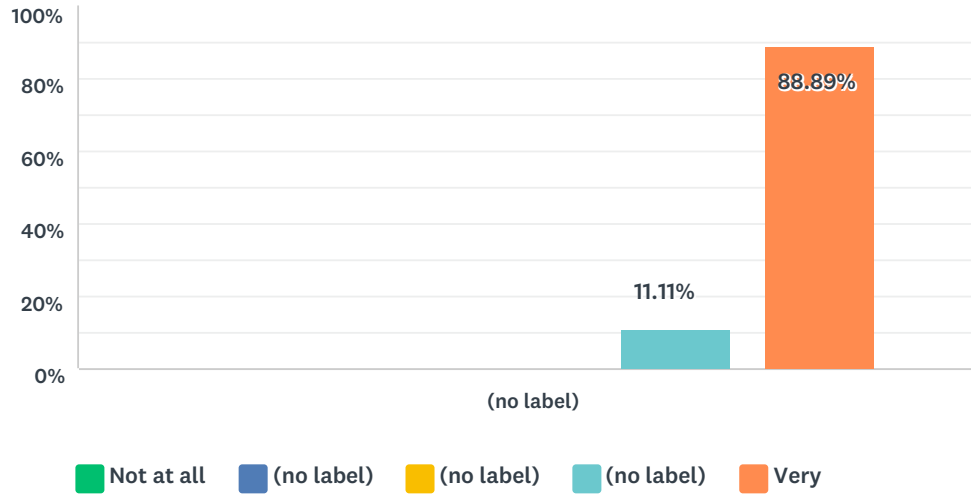
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	11.11%	22.22%	66.67%	9	4.56
	0	0	1	2	6		

Q4 The overall experience of the school was worthwhile

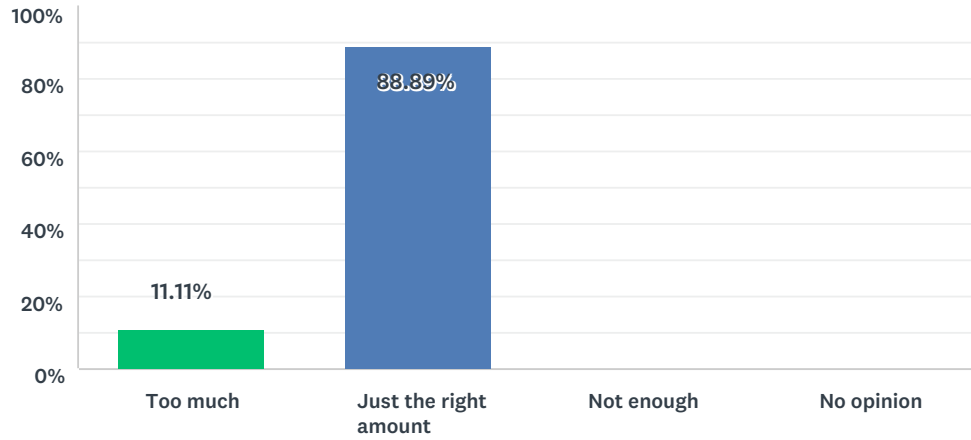
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	11.11%	88.89%	9	4.89
	0	0	0	1	8		

Q5 The amount of material presented was:

Answered: 9 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	11.11%	1
Just the right amount	88.89%	8
Not enough	0.00%	0
No opinion	0.00%	0
TOTAL		9

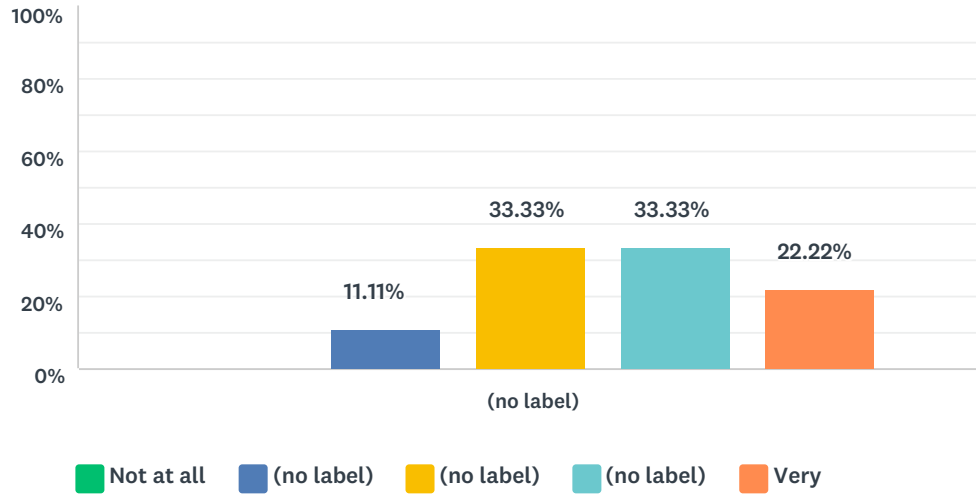
Q6 Additional comments on the topic presentation and organization

Answered: 5 Skipped: 4

#	RESPONSES	DATE
1	The summer school was great and inspiring. I would love to participate again!	9/12/2019 6:55 AM
2	Emmy was really great. Phil included too many details and did not motivate the work. Takashi was a little unorganized.	9/5/2019 4:19 AM
3	Emmy Murphy did a great job with the organization and gave good presentations. She basically made the entire conference useful.	8/29/2019 2:32 AM
4	Our TA (Andy) was extremely helpful. He played a big role in the understanding of the material after lectures.	8/27/2019 5:17 AM
5	This is likely my own fault, but I expected the material to be more entry-level than it was, which made it more difficult to follow at some points.	8/27/2019 3:38 AM

Q7 I was well prepared to benefit from the school

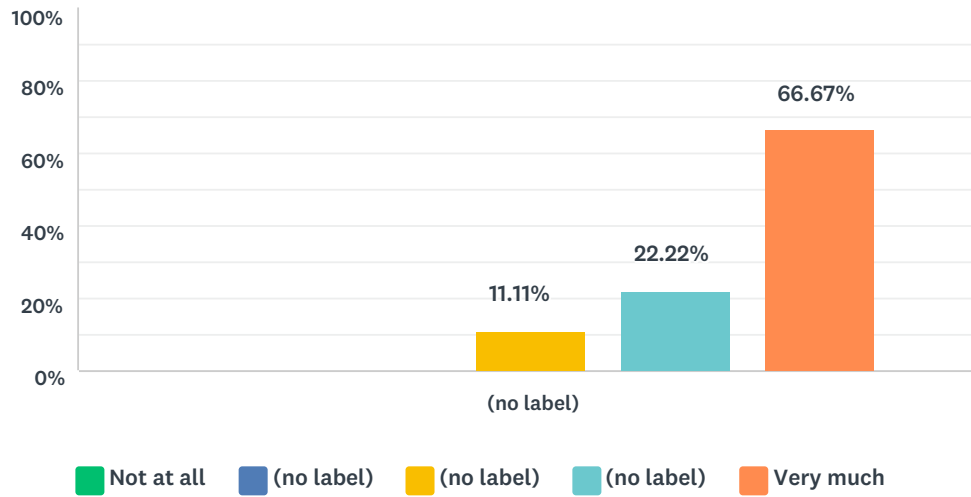
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	11.11%	33.33%	33.33%	22.22%	9	3.67
	0	1	3	3	2		

Q8 My interest in the subject matter was increased by the school

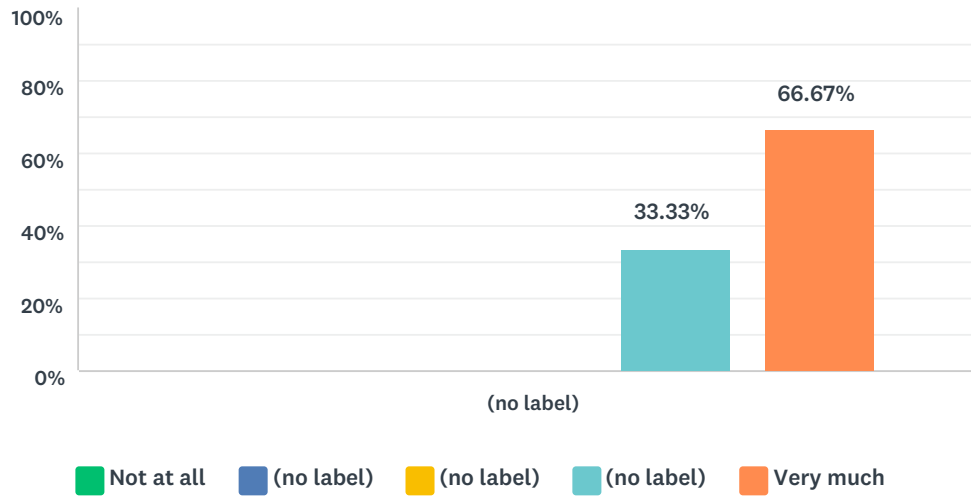
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	11.11%	22.22%	66.67%	9	4.56
	0	0	1	2	6		

Q9 The school helped me meet people with similar scientific interests

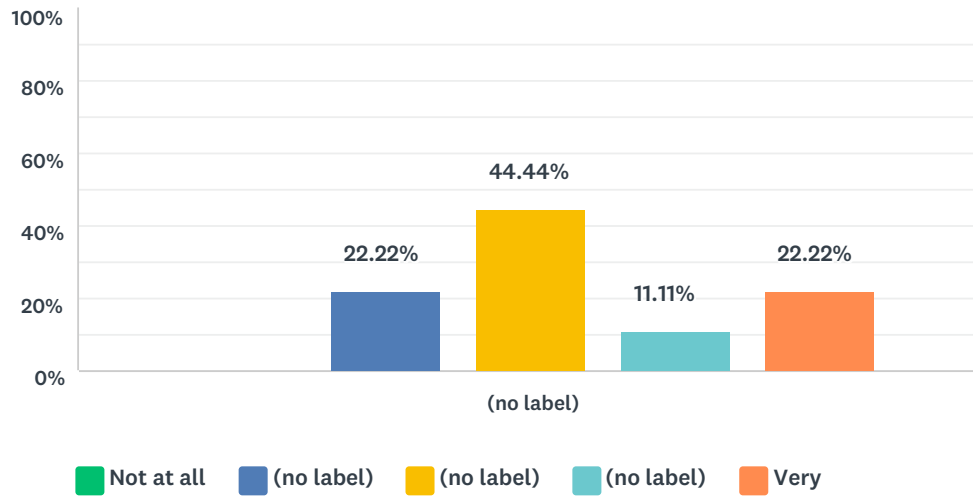
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	33.33%	66.67%	9	4.67
	0	0	0	3	6		

Q10 It is likely that I will work in the area of the school subject in the future

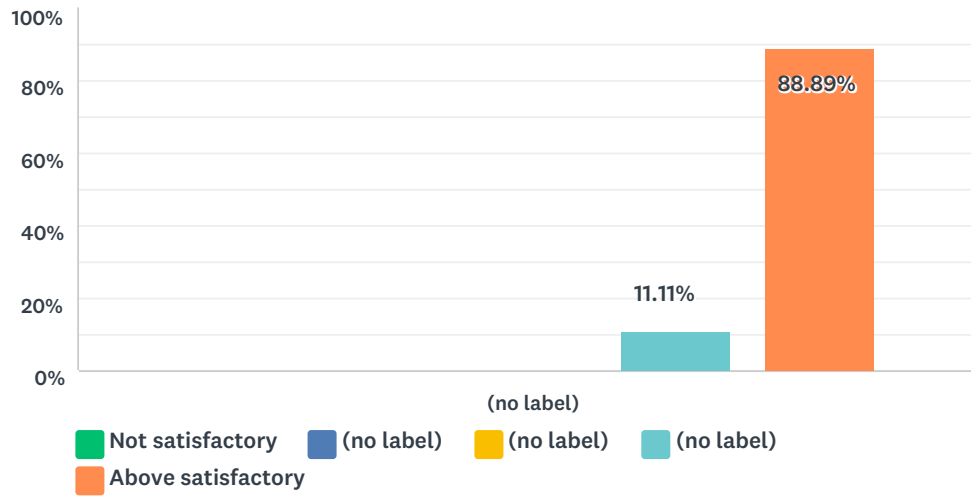
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	22.22%	44.44%	11.11%	22.22%	9	3.33
	0	2	4	1	2		

Q11 How would you evaluate your interaction with other participants?

Answered: 9 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	0.00% 0	11.11% 1	88.89% 8	9	4.89

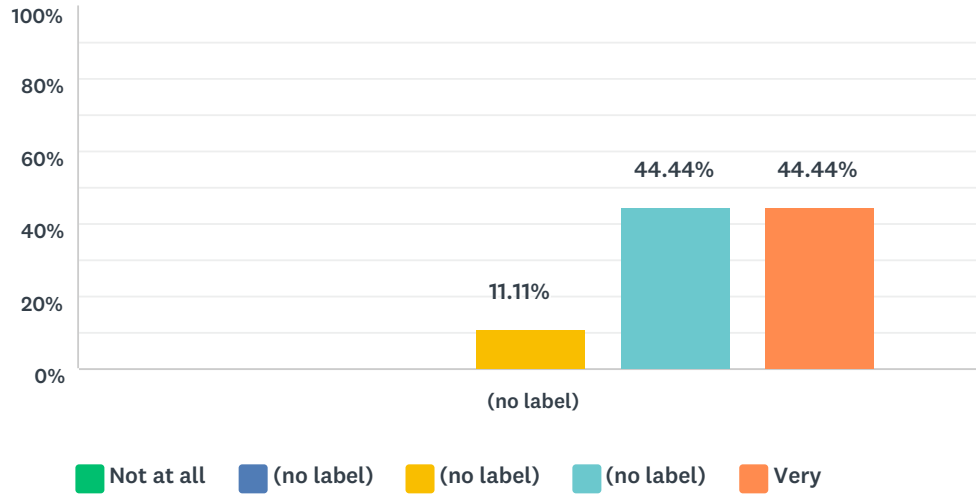
Q12 Additional comments on your personal assessment

Answered: 4 Skipped: 5

#	RESPONSES	DATE
1	The participants were amazing.	9/5/2019 4:22 AM
2	The mix of candidates turned to be very good, almost by accident. It was great to have participants from different countries and different cultures.	8/29/2019 2:33 AM
3	The course was very challenging but the help available during school (instructors and peers) was very useful.	8/27/2019 5:19 AM
4	Thanks for these summer schools!	8/27/2019 3:58 AM

Q13 I found the onsite staff helpful

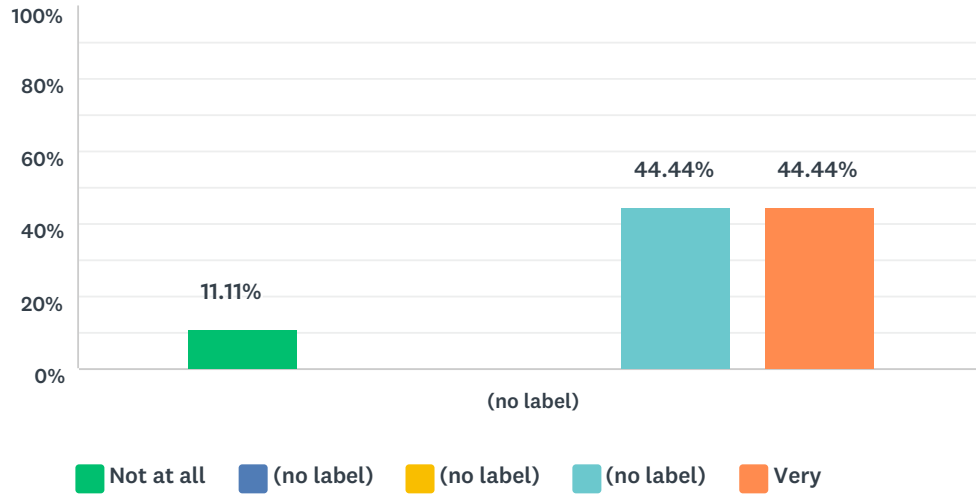
Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	11.11%	44.44%	44.44%	9	4.33
	0	0	1	4	4		

Q14 The physical facilities were conducive for such a school

Answered: 9 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	11.11%	0.00%	0.00%	44.44%	44.44%	9	4.11
	1	0	0	4	4		

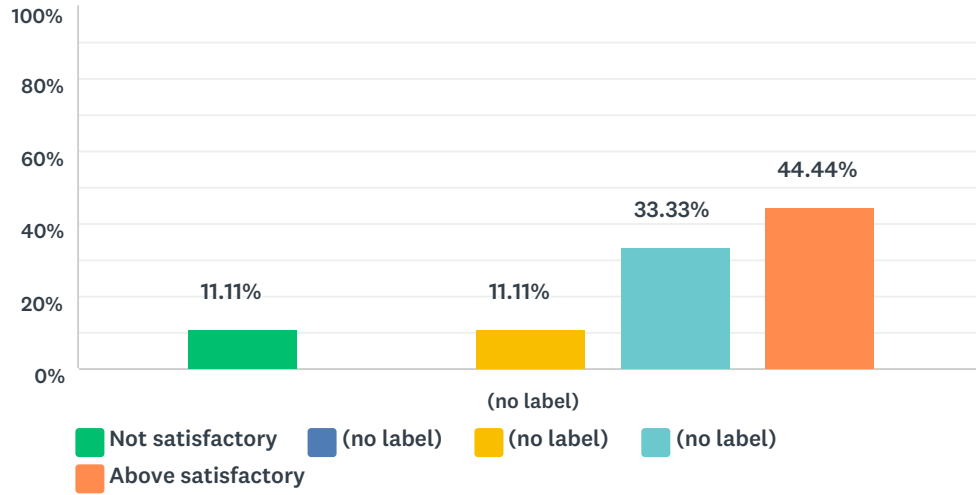
Q15 Additional comments on the venue

Answered: 2 Skipped: 7

#	RESPONSES	DATE
1	Everything was nice. No complaint.	9/12/2019 6:56 AM
2	There is no air-conditioning or fans in the rooms, there is no laundry available nearby, the directions to get to the conference were extremely confusing. I think this location needs a lot of improvement and is not suited for a serious conference.	8/29/2019 2:34 AM

Q16 The summer school accommodation

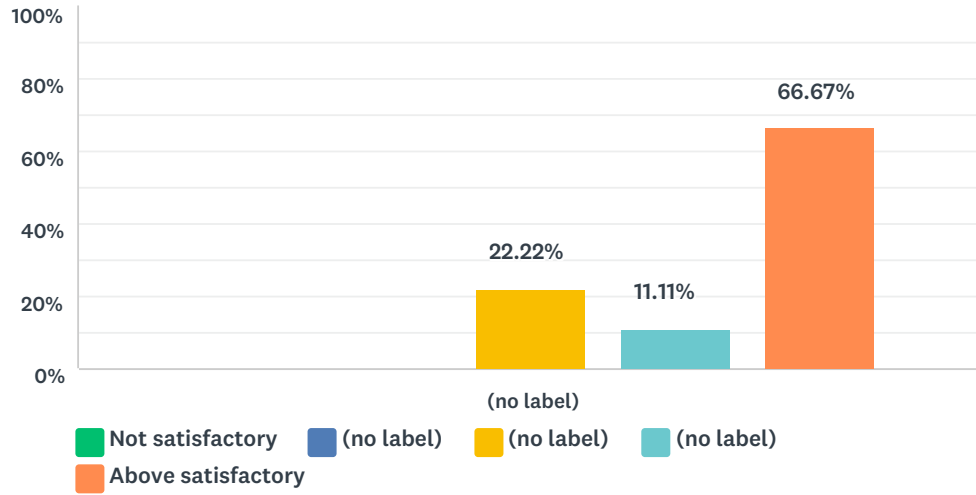
Answered: 9 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	11.11% 1	0.00% 0	11.11% 1	33.33% 3	44.44% 4	9	4.00

Q17 The food provided

Answered: 9 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	22.22% 2	11.11% 1	66.67% 6	9	4.44

Q18 Additional comments on accommodation and food

Answered: 5 Skipped: 4

#	RESPONSES	DATE
1	Food and accommodation were awesome.	9/12/2019 6:57 AM
2	The rooms didn't have fan or ac and the summer heat did bother me a bit.	9/11/2019 10:22 PM
3	The breakfast was atrocious. Only carbs - no protein. The rest of the food was pretty good. Lots and lots of rules in the castle. No A/C was difficult and the venue in general was not accommodating to people with disabilities. Pretty far from Cortona.	9/5/2019 4:24 AM
4	See previous comments. It would better to have this near a university, or a slightly more accessible town.	8/29/2019 2:35 AM
5	Being some distance for a grocery it was harder to supplement the provided food.	8/27/2019 3:39 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 6

#	RESPONSES	DATE
1	Better breakfast, laundry service and air conditioning.	9/5/2019 4:25 AM
2	I would like to shout out to Emmy Murphy for all her effort, (and many of the behind the scene organizers). This conference would have been a total disaster had it not been for her amazing lectures. The amount of work she put in these lectures, despite being an active researcher, is very remarkable.	8/29/2019 2:37 AM
3	Thanks a lot for these summer schools! We received our daily schedule on the first day of the summer school, I would suggest to send it several days before through email.	8/27/2019 4:03 AM

**Séminaire de Mathématiques
Supérieures 2019: Current trends in
Symplectic Topology**

July 01, 2019 - July 13, 2019

Montreal, Canada

Organizers:

Octav Cornea (Université de Montréal)

Yakov Eliashberg (Stanford University)

Michael Hutchings (University of California, Berkeley)

Egor Shelukhin (Université de Montréal)

SMS 2019: Director's report

The 58th *Séminaire de Mathématiques Supérieures* on *Current trends in symplectic topology* was held in Montréal on July 1 – July 12, 2019. The summer school was organized by **Octav Cornea** (Université de Montréal), **Yakov Eliashberg** (Stanford University), **Michael Hutchings** (UC Berkeley) and **Egor Shelukhin** (Université de Montréal).

This was one of the largest schools in the field in the past decade. It brought together young mathematicians and world leading researchers in various aspects of symplectic topology. The event was a huge success, featuring a diverse group of more than 100 participants from 15 countries. The scientific program contained 12 minicourses (typically 3 hours each), complemented by innovative Tips and Tricks exercise sessions, a distinguished open question panel and young researcher talks. A large variety of cutting-edge research topics have been covered, including Hamiltonian dynamics, persistence modules, arboreal singularities, Weinstein domains and quantum Steenrod operations.

I would like to thank the organizers for putting together such an outstanding summer school, as well as **Sakina Benhima** from the CRM for her indispensable help with administrative and logistical matters.

As in past years, this edition of the *SMS* was only possible with the cooperation of our main partners the **CRM**, **Fields Institute**, **PIMS** and **MSRI**, as well as with support from the **ISM**, the **University of Montréal** and the **CMS**. This year, the *SMS* benefited also from the support of **NSF**, **CIRGET** and **Courtois Foundation**. I thank all these institutions for their contributions. I also thank past *SMS* director, **Octav Cornea**, as well as members of the *SMS* steering board for their work and support.

Attached you will find a detailed scientific, organizational and budgetary report. I thank again the organizers for taking the time to prepare this document.

Best regards,



Iosif Polterovich
Director, Séminaire de Mathématiques Supérieures
iossif@dms.umontreal.ca

September 3, 2019

Report
Séminaire des mathématiques supérieures
Current trends in symplectic topology
July 1 - July 12, 2019

1 Organizers

Octav Cornea (Université de Montréal),
Yakov Eliashberg (Stanford University),
Michael Hutchings (UC Berkeley),
Egor Shelukhin (Université de Montréal).

2 Invited speakers

2.1 Minicourse lecturers

Mohammed Abouzaid (Columbia University)
Floer Homotopy theory

Tobias Ekholm (University of Uppsala)
Skeins on Branes

Yakov Eliashberg (Stanford University)
Arborealization

Viktor Ginzburg (University of California Santa Cruz)
Periodic orbits of Hamiltonian systems : from the Conley conjecture to pseudo-rotations

Nancy Hingston (College of New Jersey)
Loop products, closed geodesics and self-intersections

Michael Hutchings (University of California, Berkeley)
Embedded contact homology and dynamics

François Lalonde (Université de Montréal)
Geometry of the Poisson bracket

Dusa McDuff (Barnard College, Columbia University)
Symplectic embedding problem

Emmy Murphy (Northwestern University)
Arboreal singularities from Legendrian viewpoint

Yaron Ostrover (Tel Aviv University)
Symplectic Measurements

John Pardon (Princeton University)
Structural results in wrapped Floer theory

Paul Seidel (MIT)
Quantum Steenrod Operations

Michael Usher (University of Georgia, Athens)
Persistence modules in symplectic topology

2.2 Open problems panel

Paul Biran (ETH, Zürich)
Helmut Hofer (IAS, Princeton)
Leonid Polterovich (Tel Aviv University).

2.3 Young researcher talks speakers

Jeffrey Stephen Hicks (UC Berkeley)
Tropical Lagrangians in Mirror Symmetry

Yusuf Baris Kartal (MIT)
Distinguishing Liouville manifolds via the dynamics of Fukaya categories

Noémie Legout (ShanghaiTech University)
On product structures on the Floer homology of Lagrangian cobordisms

Vukašin Stojisavljević (Tel-Aviv University)
Symplectic Banach-Mazur distance and persistence barcodes

Shira Tanny (Tel-Aviv University)
The Poisson bracket conjecture in dimension 2

Nicholas Wilkins (MIT)
Steenrod squares for quantum cohomology, and other symplectic invariants

2.4 Tips and tricks session speakers

Baptiste Chantraine (Université de Nantes)

Augmentations : why do we need them and what are they good for ?

François Charette (Marianopolis College)

Floer homology with non abelian coefficients

Clément Hyvrier (Cégep de Saint Laurent)

Tips and tricks on the index formula for punctured pseudo-holomorphic disks with strip-like ends, and Lagrangian boundary conditions

Yu Pan (MIT)

The duality of linearized Legendrian contact homology

3 Summary

Perhaps the largest school in symplectic topology since 2011, this event brought together students and internationally renowned experts in algebraic, topological, and dynamical aspects of symplectic topology.

The area of symplectic topology has been born from the work of Poincaré on the three-body problem, as well as Darboux's work on classical diffeomorphism groups. Recent years, since the SMS 2004 that was dedicated to symplectic topology, have seen remarkable progress in several branches of the field. The school consisted of twelve minicourses focusing on various aspects of the modern theory, including interaction with :

Hamiltonian dynamics, Weinstein domains, arboreal singularities, persistence modules, relative enumerative geometry, Steenrod operations, symplectic packing, closed geodesics, Seiberg-Witten equations, symplectic capacities, the Poisson bracket, and Floer homotopy theory.

The minicourses were typically 3 hours long. The minicourses were complemented by Tips and Tricks (exercise) sessions, an open question panel, and young researcher talks.

The Tips and Tricks sessions, which were particularly well received by students, were given by young but relatively established researchers. They were concerned with aspects of the subject that do not appear as such in the literature but are of significant importance for students of the subject.

The open question panel, run by the distinguished scientists **Paul Biran**, **Helmut Hofer**, and **Leonid Polterovich**, has collected and presented over a dozen of open questions pertinent for the field today. These questions have already stimulated new developments in the field.

The young researcher talks were given by finishing graduate students who presented results related to their Ph.D. theses.

4 Record of activities

The first week had an overall direction of dynamics, in terms of the minicourses. Accordingly, it started on Monday with the minicourse of **Viktor Ginzburg** on questions of periodic orbits of Hamiltonian dynamical systems, related to the Conley conjecture,

and to the central notion of Hamiltonian pseudo-rotations. This minicourse was followed by that of **Michael Hutchings**, who has described relation of the so-called embedded contact homology theory and recent striking results in the dynamics of Reeb flows and Hamiltonian diffeomorphisms, in part due to Kei Irie. A further minicourse of **Yaron Ostrover** related numerical invariant in symplectic topology, called symplectic capacities, obtained from Reeb flow dynamics and by other means, to notions of convexity in linear symplectic spaces. A particular emphasis was given to an influential conjecture of Viterbo and its relation to a century-old question in convex geometry called the Mahler conjecture. An exciting recent development due to Pazit Haim-Kislev was explained. Furthermore, the minicourse of **Nancy Hingston** was focused on questions of existence of closed geodesics in Riemannian manifolds, and the topology of the free loop space. These questions can be interpreted as the study of the dynamics of the Reeb flows on suitable contact hypersurfaces in cotangent bundles. The minicourse of **Emmy Murphy** dealt with the topological and combinatorial background necessary to study sheaves supported on skeleta with arboreal singularities, a recent notion that has had a strong impact in the field. Finally, the minicourse of **François Lalonde** described recent results related to the rigidity aspects of the Poisson bracket.

The first week also featured 3 Tips and Tricks sessions, and 2 young researcher talks. In the first Tips and Tricks session, **Baptiste Chantraine** described notions related to Legendrian submanifolds and a powerful invariant thereof, called Legendrian contact homology, focusing in particular on the notion of augmentations. The second Tips and Tricks session, given by **François Charette**, described an argument related to the definition Lagrangian Floer homology, that works with local coefficients. This is a very useful argument to know that is not usually stressed sufficiently in the literature. The final Tips and Tricks session, given by **Yu Pan**, described duality in Legendrian contact homology, and was particularly well-received. In the first young researcher talk **Shira Tanny** has explained a solution, co-authored with Buhovsky and Logunov, to a conjecture of Polterovich on the rigidity of Poisson brackets in dimension two. This talk was connected to the minicourse of Lalonde. In the second young researcher talk, **Vukašin Stojisavljević** related the notion of barcodes, Floer homology, and closed geodesics.

Finally, during the first week two sessions of the open problem panel were held. **Paul Biran**, **Helmut Hofer** and **Leonid Polterovich** have collected and carefully curated a list of important open questions, authored by leading mathematicians in the field : themselves, as well as Mohammed Abouzaid, Octav Cornea, Yakov Eliashberg, Michael Entov, Joel Fish, Kenji Fukaya, Viktor Ginzburg, Nancy Hingston, François Lalonde, Emmy Murphy, and others. The questions were presented by their authors, or by members of the open problem panel on their behalf. Some open questions served to enliven the minicourses, presenting them in a more research-oriented context.

The second week had a more algebraic and topological flavor. In the first minicourse, **Michael Usher** has introduced the audience to notions of persistent homology and their relations to questions of symplectic embeddings and Lagrangian intersections. The second minicourse, given by **Dusa McDuff**, presented in both depth and detail the subject of symplectic embeddings of domains, ranging from classical results, such as those of Mikhail Gromov, to very recent ones due to herself and Kyler Siegel, passing via many exciting results in the subject, most of which she had an important impact on. **Paul Seidel** gave the third minicourse that focused on the quantum Steenrod operations, a notion initially due to Fukaya, that has seen recent development in the work of Wilkins.

Seidel discussed exciting recent results, partially joint with Wilkins, on the enumerative geometry aspects of these invariants. In his minicourse, **John Pardon** has described his work, of great recent interest, with Ganatra and Shende, on the calculations of wrapped Fukaya categories of Weinstein domains in terms of certain sheaves over their skeleta. In the fifth minicourse, **Mohammed Abouzaid** has presented notions related to his ongoing work with Blumberg and Kragh related to bringing to fruition old ideas of Cohen, Jones, and Segal on a homotopy type upgrading the Floer homology theory, that is expected to yield very interesting new results in the field. In his minicourse, **Tobias Ekholm** has described his work with Shende on enumerating holomorphic disks with boundary on a Lagrangian submanifold, by taking into account the homotopy type of their boundaries in the Skein module, making connection with classical knot theory. Finally, in the last minicourse, **Yakov Eliashberg** has described fundamental new results with Alvarez-Gavela, Nadler, and partially Starkston and Pardon, on the classification of Weinstein manifolds admitting an arboreal skeleton. In particular, he presented a simple topological criterion in the case when the arboreal skeleton satisfies a natural positivity property.

During the second week there were 4 young researcher talks and 1 Tips and Tricks session. **Noémie Legout** has described results on algebraic structures on Legendrian contact homology. **Nicholas Wilkins** has described his results on the definition of the quantum Steenrod squares, as well as on their algebraic properties, such as the quantum Cartan and Adem relation, as well as interactions with Hamiltonian Floer theory. **Yusuf Baris Kartal** described surprising results on non-equivalence of certain pairs of Weinstein domains with identical more classical symplectic invariants, such as symplectic homology, making use of very sophisticated algebraic techniques. **Jeffrey Stephen Hicks** talked about his new constructions of Lagrangian submanifolds in the setting of mirror symmetry, that were motivated by non-Archimedean geometry. For the Tips and Tricks session, **Clément Hyvrier** discussed index calculations for solutions of the Floer equation.

5 Organization

The school featured about 120 participants (including the speakers, open problem panel, and the local participants) from 15 countries. The speakers and open problem panel featured some of the world leading researchers, including 14 ICM speakers, out of which 3 plenary. The non-local junior participants were selected mainly on the basis of the relevance of their research background to the topic of the school. A vast majority of non-local junior participants received financial support that allowed to cover accommodation for the duration of the school. There were at least 18 women among the participants, including 3 main speakers, 2 junior speakers, and one Tips and Tricks speaker.

The school was widely advertised through professional mailing lists and the CRM information network, as well as a widely distributed poster, and a dedicated website maintained by the CRM. The participants were selected out of about 150 applications that were submitted through MathJobs. In addition to housing, the school supported in part the travel expenses for some of the students and, in particular, about ten special grants were offered in support of women participants.

Finally, the school was videotaped in its entirety, and the videos will be available on the CRM website <http://www.crm.umontreal.ca/sms/2019/>.

HORAIRE / *PROGRAM*

ÉCOLE D'ÉTÉ SMS 2019

TENDANCES ACTUELLES EN TOPOLOGIE SYMPLECTIQUE

1 au 12 juillet 2019

SMS 2019 SUMMER SCHOOL

CURRENT TRENDS IN SYMPLECTIC TOPOLOGY

July 1–12, 2019

Le lundi 1 juillet 2019 / Monday, July 1, 2019

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Viktor L. Ginzburg (University of California, Santa Cruz)
“Periodic orbits of Hamiltonian systems: from the Conley conjecture to pseudo-rotations I”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Michael Hutchings (UC Berkeley)
“Embedded contact homology and dynamics I”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Yaron Ostrover (Tel Aviv University)
“Symplectic Measurements I”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 Nancy Hingston (The College of New Jersey)
“Loop products, closed geodesics and self-intersections I”

16:15–17:15 Baptiste Chantraine (Université de Nantes)
“Tips and tricks I”

Le mardi 2 juillet 2019 / Tuesday, July 2, 2019

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Michael Hutchings (UC Berkeley)
“Embedded contact homology and dynamics II”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Emmy Murphy (Northwestern University)
“Arboreal singularities from Legendrian viewpoint I”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 François Lalonde (Université de Montréal)
“Geometry of the Poisson bracket I”

14:30–14:50 Pause-café / *Coffee break*

14:50–15:20 Shira Tanny (Tel-Aviv University)
“Short research talks I”

15:30–16:00 Vukašin Stojisavljevic (Tel-Aviv University)
“Short research talks II”

16:15–17:30 Open Problems / *Open Problems*

17:45– Cocktail de bienvenue / *Welcoming reception*

Le mercredi 3 juillet 2019 / Wednesday, July 3, 2019

08:00–08:30 Café croissants / *Coffee & Croissants*

08:30–09:30 Yaron Ostrover (Tel Aviv University)
“Symplectic Measurements II”

09:45–10:45 Emmy Murphy (Northwestern University)
“Arboreal singularities from Legendrian viewpoint II”

10:45–11:00 Pause-café / *Coffee break*

11:00–12:00 Viktor L. Ginzburg (University of California, Santa Cruz)
“Periodic orbits of Hamiltonian systems: from the Conley conjecture to pseudo-rotations II”

12:00–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 François Charette (Marianopolis College)
“Tips and Tricks II”

Le jeudi 4 juillet 2019 / Thursday, July 4, 2019

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Emmy Murphy (Northwestern University)
“Arboreal singularities from Legendrian viewpoint III”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Nancy Hingston (The College of New Jersey)
“Loop products, closed geodesics and self-intersections II”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Michael Hutchings (UC Berkeley)
“Embedded contact homology and dynamics III”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 François Lalonde (Université de Montréal)
“Geometry of the Poisson bracket II”

16:15–17:30 Open Problems / *Open Problems*

Le vendredi 5 juillet 2019 / *Friday, July 5, 2019*

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Nancy Hingston (The College of New Jersey)
“Loop products, closed geodesics and self-intersections III”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 François Lalonde (Université de Montréal)
“Geometry of the Poisson bracket III”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Yaron Ostrover (Tel Aviv University)
“Symplectic Measurements III”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 Viktor L. Ginzburg (University of California, Santa Cruz)
“Periodic orbits of Hamiltonian systems: from the Conley conjecture to pseudo-rotations III”

16:15–17:15 Yu Pan (Massachusetts Institute of Technology)
“Tips and Tricks III”

Le lundi 8 juillet 2019 / *Monday, July 8, 2019*

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Michael Usher (University of Georgia)
“Persistence modules in symplectic topology I”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Dusa McDuff (Columbia University)
“Symplectic embedding problem I”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Paul Seidel (MIT)
“Quantum Steenrod Operations I”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 John Pardon (Princeton University)
“Structural results in wrapped Floer theory I”

16:10–16:40 Noémie Legout (ShanghaiTech University)
“Short research talks III”

16:45–17:15 Nicholas Wilkins (MIT)
“Short research talks IV”

Le mardi 9 juillet 2019 / Tuesday, July 9, 2019

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Mohammed Abouzaid (Columbia University)
“Floer Homotopy theory I”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Tobias Ekholm (Uppsala University)
“Skeins on Branes I”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Michael Usher (University of Georgia)
“Persistence modules in symplectic topology II”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 John Pardon (Princeton University)
“Structural results in wrapped Floer theory II”

16:15–17:15 Paul Seidel (MIT)
“Quantum Steenrod Operations II”

17:30– Cocktail / *Reception*

Le mercredi 10 juillet 2019 / Wednesday, July 10, 2019

08:00–08:30 Café croissants / *Coffee & Croissants*

08:30–09:30 Mohammed Abouzaid (Columbia University)
“Floer Homotopy theory II”

09:45–10:45 Tobias Ekholm (Uppsala University)
“Skeins on Branes II”

10:45–11:00 Pause-café / *Coffee break*

11:00–12:00 Yakov Eliashberg (Stanford University)
“Arborealization I”

12:00–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Clément Hyvrier (Cégep de Saint Laurent)
“Tips and tricks IV”

Le jeudi 11 juillet 2019 / Thursday, July 11, 2019

08:30–09:00 Café croissants / *Coffee & Croissants*

09:00–10:00 Dusa McDuff (Columbia University)
“Symplectic embedding problem II”

10:00–10:30 Pause-café / *Coffee break*

10:30–11:30 Paul Seidel (MIT)
“Quantum Steenrod Operations III”

11:30–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Yakov Eliashberg (Stanford University)
“Arborealization II”

14:30–15:00 Pause-café / *Coffee break*

15:00–16:00 Tobias Ekholm (Uppsala University)
“Skeins on Branes III”

16:10–16:40 Yusuf Baris Kartal (MIT)
“Short research talks V”

16:45–17:15 Jeffrey Stephen Hicks (UC Berkeley)
“Short research talks VI”

Le vendredi 12 juillet 2019 / *Friday, July 12, 2019*

08:00–08:30 Café croissants / *Coffee & Croissants*

08:30–09:30 Yakov Eliashberg (Stanford University)
“Arborealization III”

09:45–10:45 Michael Usher (University of Georgia)
“Persistence modules in symplectic topology III”

10:45–11:00 Pause-café / *Coffee break*

11:00–12:00 John Pardon (Princeton University)
“Structural results in wrapped Floer theory III”

12:00–13:30 Pause-déjeuner / *Lunch break*

13:30–14:30 Dusa McDuff (Columbia University)
“Symplectic embedding problem III”

Participants

First Name	Last Name	Institution
Shaoyun	Bai	Princeton University
Fraser	Binns	Boston College
Johnathan	Bush	Colorado State University
Orsola	Capovilla-Searle	Duke University
Julian	Chaidez	University of California, Berkeley
Dahye	Cho	State University of New York, Stony Brook
Austin	Christian	University of California, Los Angeles
Erman	Cineli	University of California, Santa Cruz
Jesse	Cohen	University of Oregon
Frederik	De Keersmaecker	Cornell University
Yash	Deshmukh	Columbia University
Leo	Digiosia	Rice University
Jack	Ding	University of Toronto
Mohamed	El Alami	State University of New York, Stony Brook
Roderic	Guigo Corominas	Boston University
Thomas	Harris	University of Arizona
Daniel	Irvine	University of Michigan
Darryl	Johnson	Northeastern University
Lea	Kenigsberg	Columbia University
Thomas	Melistas	University of Georgia
Kai	Nakamura	University of Texas, Austin
Stanislav	Opanasenko	Memorial University of Newfoundland
Ignacio	Otero	Centro de Investigacion y Estudios Avanzados
John Gabriel	Pelias	University of California, Santa Cruz
Richard	Shumate	University of Arkansas
John	Snadden	Northwestern University
Mohan	Swaminathan	Princeton University
Randy	Van Why	Northwestern University
Alfredo	Vargas	Bryn Mawr College
Xiaohan	Yan	University of California, Berkeley
Yuxuan	Yang	Harvard University

Officially Registered Student Information

Participants		31
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Gender		31
Male	90.32%	28
Female	9.68%	3
Declined to state	0.00%	0

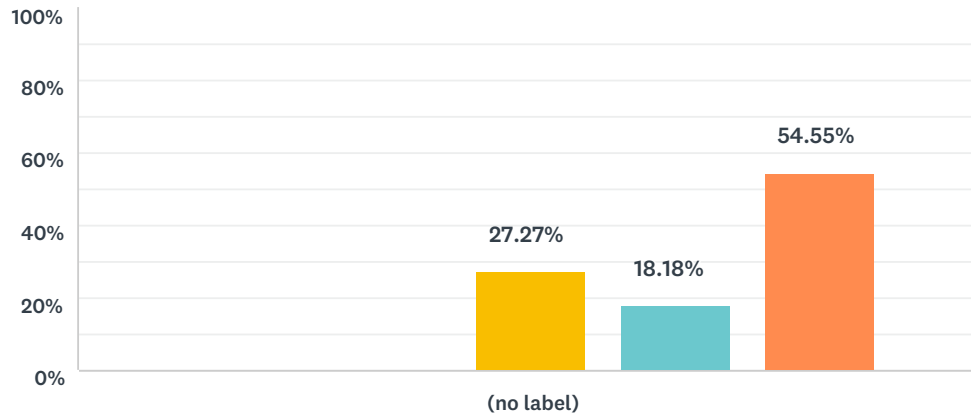
Ethnicity*		37
White	45.95%	17
Asian	27.03%	10
Hispanic	13.51%	5
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	2.70%	1
Mixed	8.11%	3
Declined to state	2.70%	1

* ethnicity specifications are not exclusive

22 responses out of 31 participants = 71% response rate

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 22 Skipped: 0

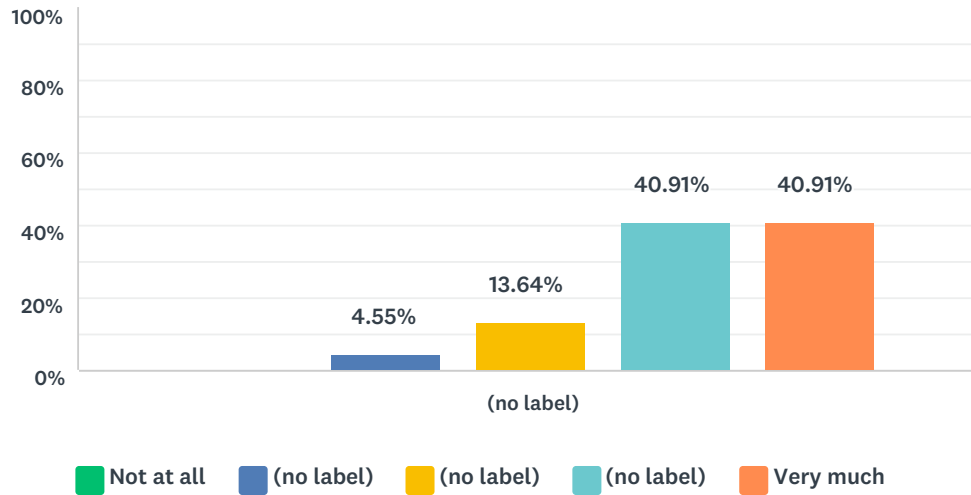


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very Much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	27.27% 6	18.18% 4	54.55% 12	22	4.27

Q2 The faculty speakers were generally clear and well organized in their presentation

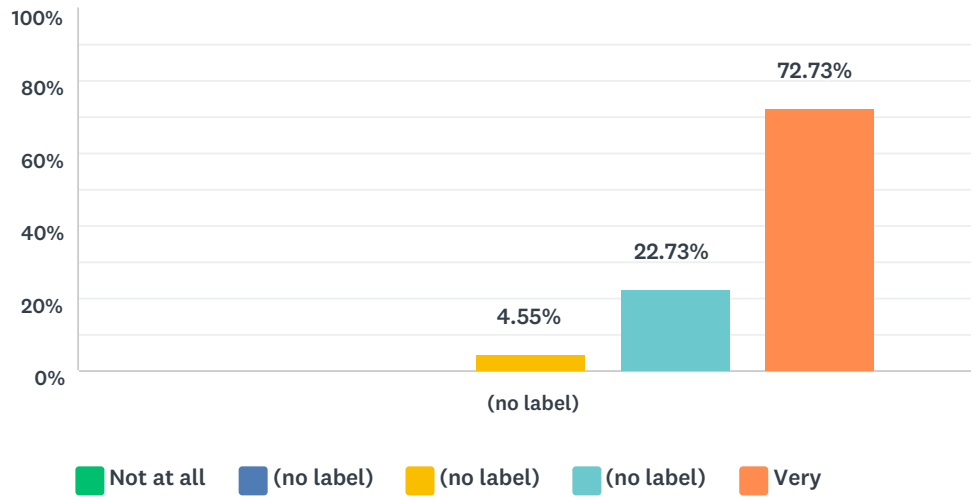
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.55%	13.64%	40.91%	40.91%	22	4.18
	0	1	3	9	9		

Q3 The school was intellectually stimulating

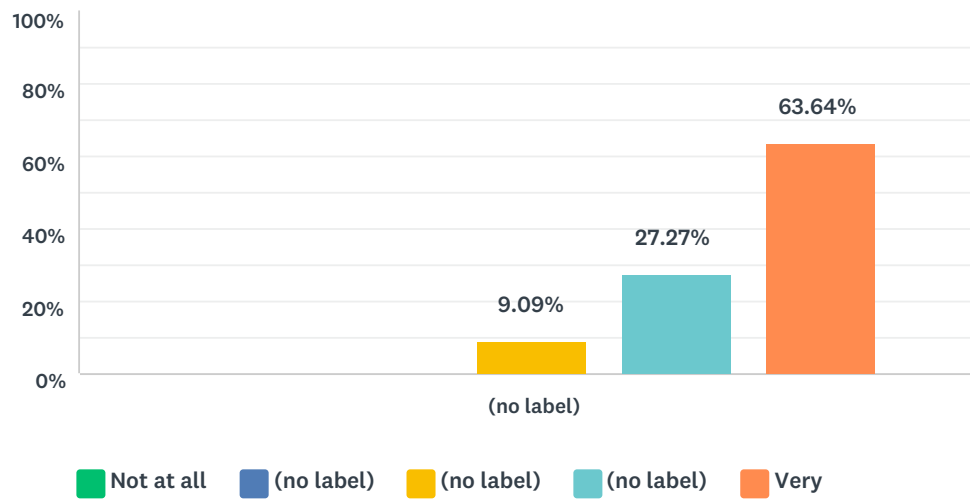
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	4.55%	22.73%	72.73%	22	4.68
	0	0	1	5	16		

Q4 The overall experience of the school was worthwhile

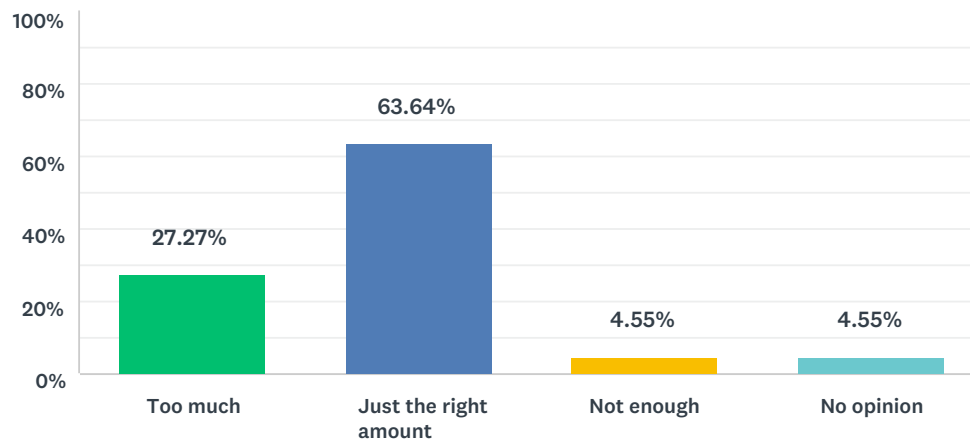
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.09%	27.27%	63.64%	22	4.55
	0	0	2	6	14		

Q5 The amount of material presented was:

Answered: 22 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	27.27%	6
Just the right amount	63.64%	14
Not enough	4.55%	1
No opinion	4.55%	1
TOTAL		22

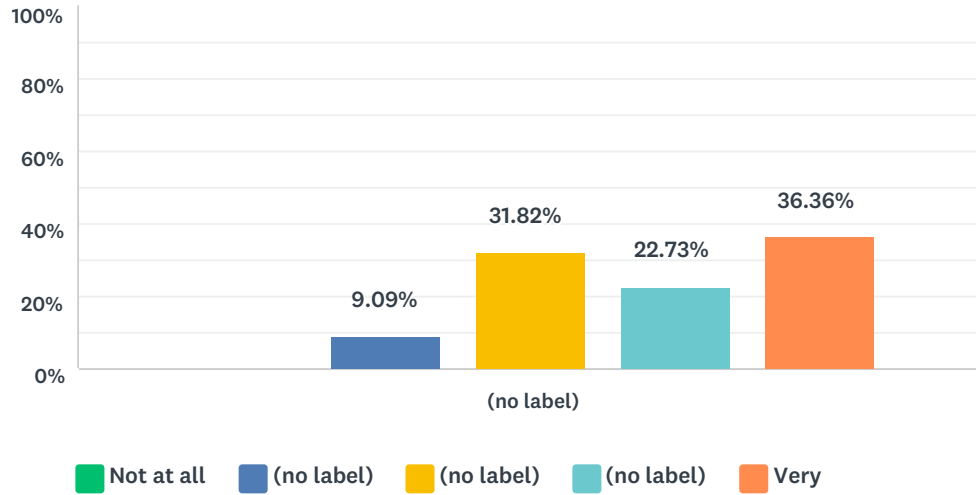
Q6 Additional comments on the topic presentation and organization

Answered: 4 Skipped: 18

#	RESPONSES	DATE
1	In the first week, the talks were directed at graduate students. In the second week, the talks were mostly just for experts.	9/17/2019 6:27 AM
2	I would have liked to have seen some of the faculty speakers keep more strictly to the guideline of presenting an "introduction and guideline to students and young researchers", rather than regarding the experts in the room as their baseline. I was able to follow the majority of the lectures but there were a few that I felt did not do enough to lay enough foundation to really get much out of them.	9/11/2019 11:54 AM
3	Well organized. Though a bit hectic at times, due to long series of lectures.	8/28/2019 12:57 AM
4	It was a great summer school. I had an big opportunity to meet together and talk about our research and communicate with other people and learned about various directions of symplectic geometry/topology, which broaden my point of view a lot.	8/27/2019 11:29 PM

Q7 I was well prepared to benefit from the school

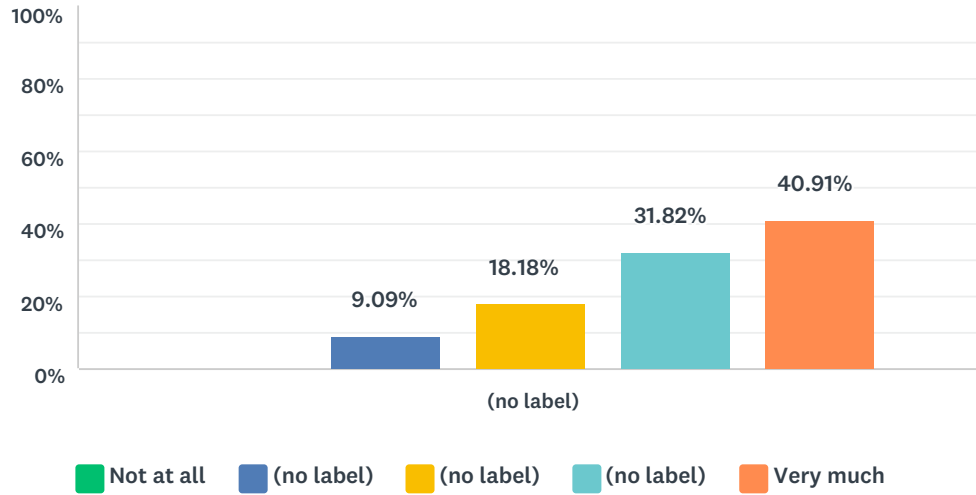
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	9.09%	31.82%	22.73%	36.36%	22	3.86
	0	2	7	5	8		

Q8 My interest in the subject matter was increased by the school

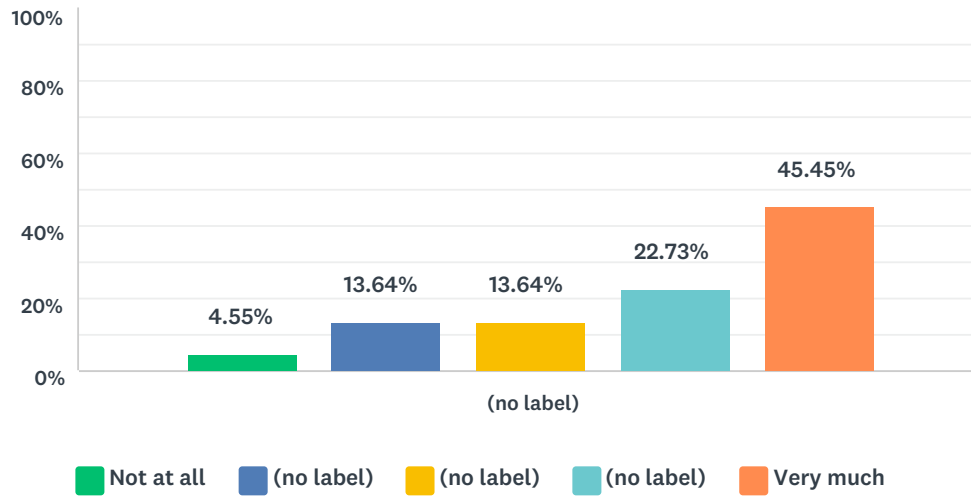
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	9.09%	18.18%	31.82%	40.91%	22	4.05
	0	2	4	7	9		

Q9 The school helped me meet people with similar scientific interests

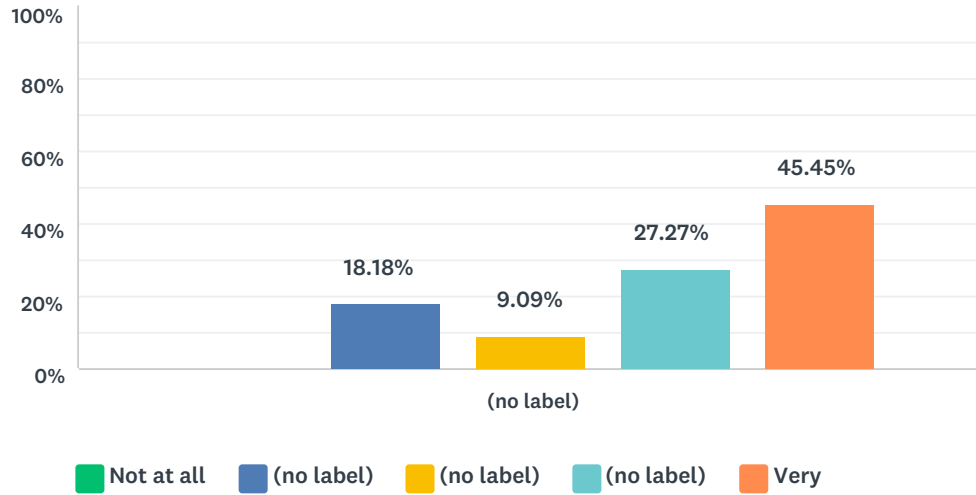
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	4.55%	13.64%	13.64%	22.73%	45.45%	22	3.91
	1	3	3	5	10		

Q10 It is likely that I will work in the area of the school subject in the future

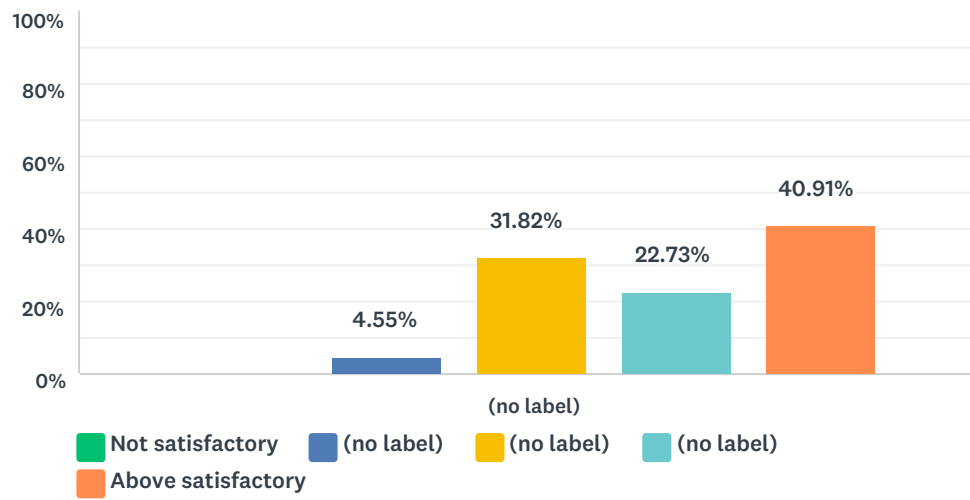
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	18.18%	9.09%	27.27%	45.45%	22	4.00
	0	4	2	6	10		

Q11 How would you evaluate your interaction with other participants?

Answered: 22 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	4.55% 1	31.82% 7	22.73% 5	40.91% 9	22	4.00

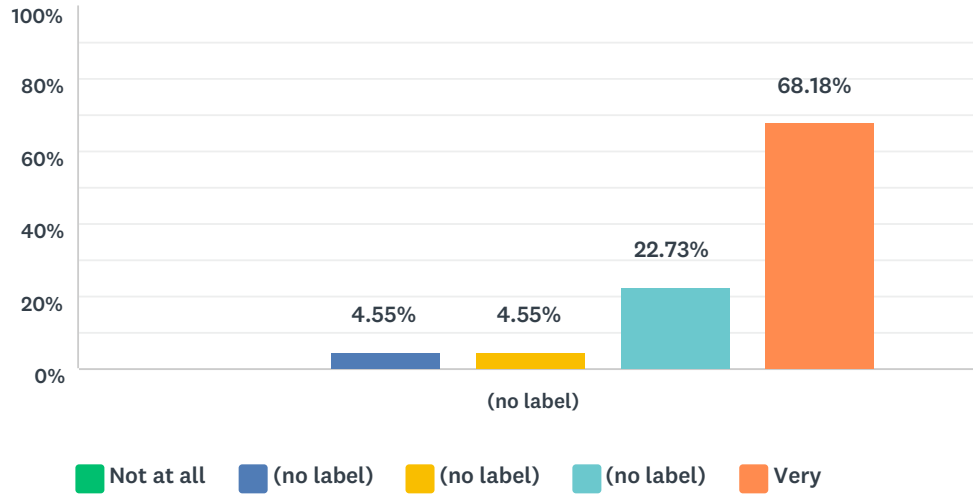
Q12 Additional comments on your personal assessment

Answered: 1 Skipped: 21

#	RESPONSES	DATE
1	I am not doing research in the area, just an enthusiast, but I received some useful ideas for me and enjoyed the school.	8/27/2019 3:31 AM

Q13 I found the onsite staff helpful

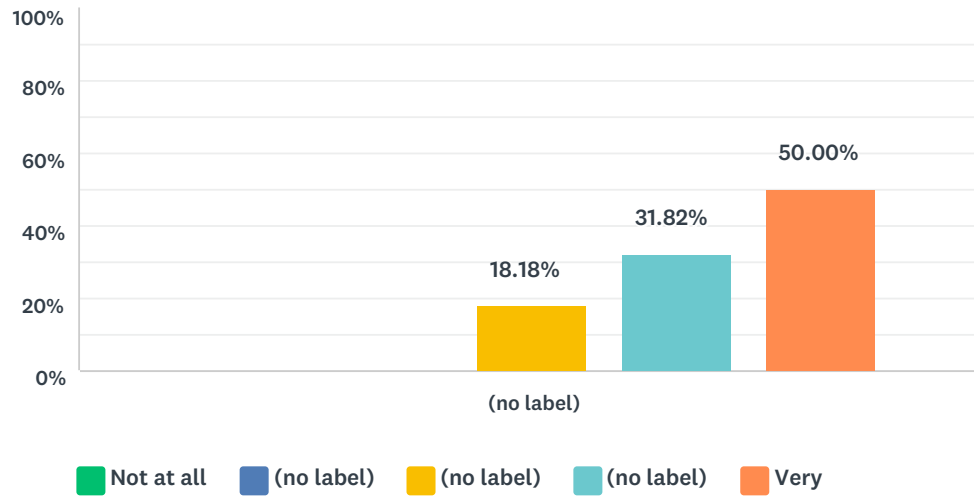
Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	4.55%	4.55%	22.73%	68.18%	22	4.55
	0	1	1	5	15		

Q14 The physical facilities were conducive for such a school

Answered: 22 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	18.18%	31.82%	50.00%	22	4.32
	0	0	4	7	11		

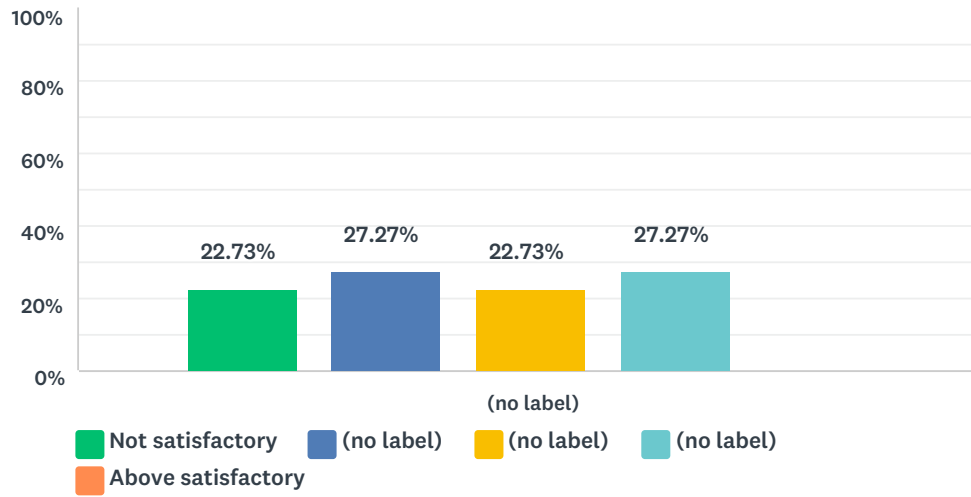
Q15 Additional comments on the venue

Answered: 3 Skipped: 19

#	RESPONSES	DATE
1	The CRM staff and facilities were great. The dorm staff were not so helpful, and the dorm facilities were rather spartan.	9/4/2019 1:51 AM
2	The conference Hall sometimes gets too cold.	8/28/2019 12:58 AM
3	The housing at ZUM hotel was not very good.	8/27/2019 11:06 AM

Q16 The summer school accommodation

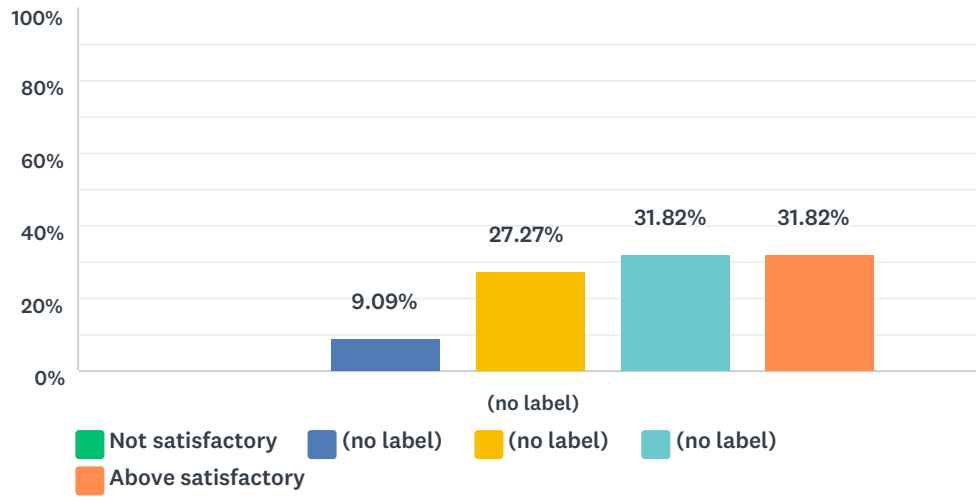
Answered: 22 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	22.73%	27.27%	22.73%	27.27%	0.00%	22	2.55
	5	6	5	6	0		

Q17 The food provided

Answered: 22 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	9.09% 2	27.27% 6	31.82% 7	31.82% 7	22	3.86

Q18 Additional comments on accommodation and food

Answered: 5 Skipped: 17

#	RESPONSES	DATE
1	The accommodation at the Zum hotel was probably the worst housing experience I have ever had. The hotel did not have air conditioning and it was July with temperatures pushing 90F. There was no Internet in the hotel.	9/12/2019 3:40 AM
2	Zum Hotel, to be blunt, borders on being a death trap. There is no air conditioning of any kind in any of the rooms aside from the lobby, unless you count a small and essentially useless electric fan which does nothing to combat the 90+ degree Montreal summer weather, thereby placing guests with certain medical conditions at high risk of heat stroke. Together with the lack of wi-fi (again available only in or adjacent to the lobby), this makes it essentially impossible to get any work done in the rooms. Additionally, the bathroom and shower facilities (a single toilet stall and two shower stalls crammed into a tiny room to serve an entire floor) are entirely inadequate and quite probably not up to code.	9/11/2019 12:06 PM
3	The ZUM hotel was quite bad. None of the participants that I spoke to enjoyed the accommodations.	8/27/2019 11:07 AM
4	Although the accommodation was good, the last year "H-principle" summer school was accommodated on a much more superior level. The idea of hosting the school in the middle of nowhere in the National park, where the only thing students could do is to communicate with each other was perfect.	8/27/2019 3:47 AM
5	The provided housing wasn't very good, but I don't think there would be any other options near the university.	8/27/2019 3:27 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 0 Skipped: 22

#	RESPONSES	DATE
	There are no responses.	

Geometric Group Theory

July 01, 2019 - July 12, 2019

Oaxaca, Mexico

Organizers:

Rita Jiménez Rolland (Instituto de Matemáticas, UNAM-Oaxaca)

Pierre Py (Instituto de Matemáticas, UNAM-Ciudad Universitaria)

MSRI SUMMER GRADUATE SCHOOL

“Geometric Group Theory”

Final report

July 01 – 12, 2019

Goals of the workshop

The two-week graduate summer school in geometric group theory that took place in Oaxaca in July 2019 was centered around geometric group theory in a broad sense. The field of geometric group theory was born in the 80s and has witnessed since then a tremendous development, leading to connections with many areas of mathematics: low dimensional topology, dynamical systems, number theory, logic... This workshop included four mini-courses which were centered either on geometric group theory by itself or on interactions with low dimensional topology and dynamics. The main objectives of the workshop were the following:

1. Introduce graduate students to specific core topics and recent developments in geometric group theory. In particular, include aspects of geometric group theory that are not well-represented in Mexico.
2. Give graduate students an opportunity to practice speaking skills in mathematics in a safe environment. This is why we included more than 20 students presentations (of 30 min each).
3. Connect Mexican, South and Central American students with their American and Canadian counterparts in an environment that encourages discussion and collaboration.

Organization of the workshop

The summer school started with an introductory talk, given by Pierre Py. This talk gave the students a panorama of geometric group theory and an overview of the topics that were going to be covered in the courses during the two weeks and of the way they are interrelated. Besides this introductory lecture, each day was organized as follows. There were two lectures from the mini-courses each day, two problems sessions and two to four presentations by students (except on Wednesdays, when the afternoon was free.)

Week 1: This first week covered the following topics: group actions on Hilbert spaces, property T, Haagerup property, orderable groups and dynamics in dimension 1.

Talia Fernós gave a mini-course on *Group actions on Hilbert spaces: property T and Haagerup property*. This mini-course considered the study of group actions on Hilbert spaces and gave an introduction to property T, which was introduced by Kazhdan in 1967, and related developments, including the reformulation of property T in terms of affine isometric actions on Hilbert spaces, the appearance of Haagerup’s property (a strong negation of property T) and recent variations on property T by Lafforgue. *Andrés Navas* gave a mini-course on *Orderable groups and dynamics in dimension 1*. In this mini-course orderable groups were studied emphasizing the connections to low-dimensional topology and the characterization of orderable groups in terms of

actions on the real line by homeomorphisms. Several questions and open problems on this topic were raised and some connected the topics of the two mini-courses of the week. For instance, the existence of property T groups which are orderable or even the existence of higher rank lattices which are orderable are open questions.

Week 2: During the second week the speakers coordinated their mini-courses to present an introduction to the study of the geometry and topology of mapping class groups and free groups automorphisms, combined with some of their recent results on growth of groups and hyperbolic extensions. Mapping class groups and groups of outer automorphisms of free groups are emblematic examples studied in geometric group theory. One guiding line was to compare them with arithmetic groups, more concretely with the groups $SL(n, \mathbb{Z})$. The topics presented this week allowed to simultaneously introduce students to these important examples and to expose them to many general notions of geometric group theory.

Jing Tao gave a mini-course on *Geometry and topology of mapping class groups*. Topics included basic properties of mapping class groups (definition, notion of Dehn twists, generating sets, presentations, residual finiteness...) as well as a description of important spaces on which these groups act, most notably the Teichmüller space and the curve complex. *Spencer Dowdall* presented a mini-course on *Geometry and topology of free group automorphisms: hyperbolic extensions* which gave an introduction to hyperbolic groups and hyperbolic extensions of free groups. This mini-course included basic notions such as Gromov hyperbolic spaces, group extensions and group cohomology, as well as a description of fundamental properties of the (outer) automorphism group of a free group and outer space.

During the two weeks the lecturers presented the basic definitions and fundamental results, worked out with the students some simple examples and discussed as well important questions in current research. Some (partial) notes for the mini-courses are available at :

<http://irma.math.unistra.fr/~py/msricmo19.html>.

Problem sessions. The problem sessions were mainly run by the lecturers and teaching assistants. But the organizers also participated actively in many of these sessions. We had two teaching assistants. *Gonzalo Ruiz* is working for his Ph. D. on topics related to the courses of the first week, whereas *Justin Lannier* is working on topics related to the courses of the second week. Hence their respective fields of expertise covered roughly the topics of the four courses. Moreover, the two teaching assistants participated actively in the problem sessions of both weeks.

The activities during the problem sessions were varied. Some examples and problems were assigned to the students who generally were working in small groups on the problems to reinforce their understanding of the material. They discussed potential solutions and reviewed the notions covered in the mini-courses. Some of them were working completely on they own, by groups of 4 or 5 students, and some of them were interacting with the teaching assistants and lecturers during the problem sessions. This was complemented by optional 10 minutes mini-talks on topics and questions raised by the students that were presented by the leads. We actually encouraged students to submit before the problem sessions some requests for mini-talks covering some specific topics that they wanted to understand better.

Students talks. There were a total of 23 lectures by students during the two weeks. Each of these lasted 30 minutes. The topics of these talks were suggested by each of the lecturers and reinforced the main topics of the summer school and were a good exercise for students to learn how to communicate mathematics and how to navigate through the literature. Some examples of the topics covered in the student talks are:

1. Amenability (for a discrete group): definition in terms of an invariant mean, definition in terms of Folner sequences, definition in terms of almost invariant vectors in the regular representation, examples, proof of some of the equivalences.
2. The Kirby torus trick following: <https://pi.math.cornell.edu/~hatcher/Papers/TorusTrick.pdf>
3. The Whitehead algorithm to determine when a set of elements of a free group is part of a basis, following Stallings's paper « Whitehead graphs on handlebodies ».

See the Schedule posted in https://www.msri.org/summer_schools/909 for other titles of the student presentations.

The last day of the summer school *Justin Lannier* organized a *Geometric group theory pictograph game* which was highly attended and turned out to be a fun activity with the new words and notions learned during the two weeks.

Accomplishments and highlights of the workshop

From an academic point of view, from the feedback that we received from the participants and what we observed during the two weeks, we believe that the summer school was successful. The students learnt a lot from each of the mini-courses and the problem sessions; there was a lot of interactions between students, teaching assistants and lecturers, and many research problems were presented.

In terms of training the graduate students, we also think that the school was productive. The problem sessions, the informal talks during the coffee breaks and the students presentations gave the participants the opportunity to communicate about the subject in a wide variety of modalities. The friendly ambience of the summer school allowed students to receive constructive feedback from speakers as well as from other students, and to get strength and confidence in communicating mathematics.

The 30 minutes talks were a particular challenge for Latin American students since all the presentations were in English. For a lot of them, this was the first time ever giving an English talk. We were delighted to observe that some of the students coming from American institutions helped some of the Mexican students to prepare their talks in English. We believe that the interaction between Latin American students and students coming from the United States and Canada based institutions was very fruitful. In particular, we noticed that among the graduate students coming from institutions based in the United States and Canada, several were of Latin American origin. We believe that these students played a key role in bringing together the students that attended the summer school. A lot of the study groups were mixed and almost all the students went on a touristic tour together on the Saturday between the two weeks of the conference.

We should also mention that students and professors from local institutions in Oaxaca benefited from the activities of the summer school and were exposed to topics in geometric group theory that are not well-represented in the country.

Organizers

First Name	Last Name	Institution
Rita	Jiménez Rolland	Instituto de Matemáticas, UNAM-Oaxaca
Pierre	Py	Instituto de Matemáticas, UNAM-Oaxaca

Speakers

First Name	Last Name	Institution
Spencer	Dowdall	Vanderbilt University
Talia	Fernós	University of North Carolina
Andrés Navas	Flores	University of Santiago de Chile
Pierre	Py	Instituto de Matemáticas, UNAM-Oaxaca
Jing	Tao	University of Oklahoma

Teaching Assistant

First Name	Last Name	Institution
Justin	Lanier	Georgia Institute of Technology
Gonzalo	Ruiz	Instituto de Matemáticas, UNAM-Oaxaca

Mathematical Sciences Research Institute

Geometric Group Theory

July 1, 2019 - July 12, 2019

Monday, July 1, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM			Introductory Talk
10:15 AM - 11:30 AM		Talia Fernos	Group actions on Hilbert spaces: property T and Haagerup property
11:30 AM - 12:00 PM			Coffee Break
12:00 PM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Andrés Navas Flores	Orderable groups and dynamics in dimension 1
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Sergio Zamora (Amenability) - Arturo Sánchez (Hölder's theorem)
7:00 PM - 8:00 PM			Dinner
Tuesday, July 2, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:00 AM		Andrés Navas Flores	Orderable groups and dynamics in dimension 1
10:15 AM - 11:30 AM			Problem Session
11:30 AM - 12:00 PM			Coffee Break
12:00 PM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Talia Fernos	Group actions on Hilbert spaces: property T and Haagerup property
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Daniel Cardenas (orders in abelian groups) - Supun Samarakoon (growth of groups)
7:00 PM - 8:00 PM			Dinner
Wednesday, July 3, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Talia Fernos	Group actions on Hilbert spaces: property T and Haagerup property
10:15 AM - 10:45 AM			Coffee Break
10:45 AM - 12:00 PM		Andrés Navas Flores	Orderable groups and dynamics in dimension 1
12:00 PM - 12:30 PM			Group Photo
12:30 PM - 1:30 PM			Lunch
1:30 PM - 7:00 PM			Free Afternoon
7:00 PM - 8:00 PM			Dinner
Thursday, July 4, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Andrés Navas Flores	Orderable groups and dynamics in dimension 1
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Talia Fernos	Group actions on Hilbert spaces: property T and Haagerup property
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Leydi Hernández (Orders on surface groups) - Dylan Dairey (SL(3) has T)
7:00 PM - 8:00 PM			Dinner
Friday, July 5, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Talia Fernos	Group actions on Hilbert spaces: property T and Haagerup property
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Andrés Navas Flores	Orderable groups and dynamics in dimension 1
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Braid Groups (Briseida Trejo and Ernesto Vazquez)
7:00 PM - 8:00 PM			Dinner

Monday, July 8, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Jing Tao	Geometry and topology of mapping class groups
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Spencer Dowdall	Geometry and topology of free group automorphisms: hyperbolic extensions
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Chaitanya Tappu (Kirby torus trick) - Arora Shivam (Basics of hyperbolic groups I)
7:00 PM - 8:00 PM			Dinner
Tuesday, July 9, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Spencer Dowdall	Geometry and topology of free group automorphisms: hyperbolic extensions
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Jing Tao	Geometry and topology of mapping class groups
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Mark Fincher (Bass-Serre theory)
7:00 PM - 8:00 PM			Dinner
Wednesday, July 10, 2019			
8:00 AM - 9:00 AM			Continental Breakfast
9:00 AM - 10:15 AM		Jing Tao	Geometry and topology of mapping class groups
10:15 AM - 10:45 AM			Coffee Break
10:45 AM - 12:00 PM		Spencer Dowdall	Geometry and topology of free group automorphisms: hyperbolic extensions
12:00 PM - 1:30 PM			Lunch
1:30 PM - 7:00 PM			Free afternoon
7:00 PM - 8:00 PM			Dinner
Thursday, July 11, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Spencer Dowdall	Geometry and topology of free group automorphisms: hyperbolic extensions
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Students talks: Anindya Chanda (Definition and basic properties of train track representatives for free group automorphisms)
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Jing Tao	Geometry and topology of mapping class groups
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Student talks / Discussion time: Jesús Hernandez Serda (Ping-pong and Dehn twists)
7:00 PM - 8:00 PM			Dinner
Friday, July 12, 2019			
8:00 AM - 9:00 AM			Breakfast
9:00 AM - 10:15 AM		Jing Tao	Geometry and topology of mapping class groups
10:30 AM - 11:30 AM			Problem Session
11:30 AM - 11:15 AM			Coffee Break
11:45 AM - 1:00 PM			Problem Session
1:15 PM - 2:45 PM			Lunch
3:00 PM - 4:15 PM		Spencer Dowdall	Geometry and topology of free group automorphisms: hyperbolic extensions
4:15 PM - 4:30 PM			Coffee Break
4:30 PM - 5:30 PM			Problem Session
5:45 PM - 7:00 PM			Discussion time
7:00 PM - 8:00 PM			Dinner



Participants

First Name	Last Name	Institution
Dylan	Airey	Princeton University
Jonathan	Alcaraz	University of California, Riverside
Shivam	Arora	Memorial University of Newfoundland
Anindya	Chanda	Florida State University
Gary	DeClerk	University of Nebraska
Rebecca	Eastham	University of Wisconsin-Madison
Mark	Fincher	University of Pittsburgh
Worapan	Homsomboon	Oregon State University
Jacob	Landgraf	University of Notre Dame
Christopher	Loa	University of Illinois at Urbana-Champaign
Laura	Lopez Cruz	University of Puerto Rico
Anthony	Martino	University of Oklahoma
Braulio	Molina Gonzalez	Florida State University
Supun	Samarakoon	Texas A & M University
Levi	Sledd	Vanderbilt University
Chaitanya	Tappu	Cornell University
Caitlin	Waddle	San Francisco State University
Sergio	Zamora	Pennsylvania State University

Officially Registered Student Information

Participants		18
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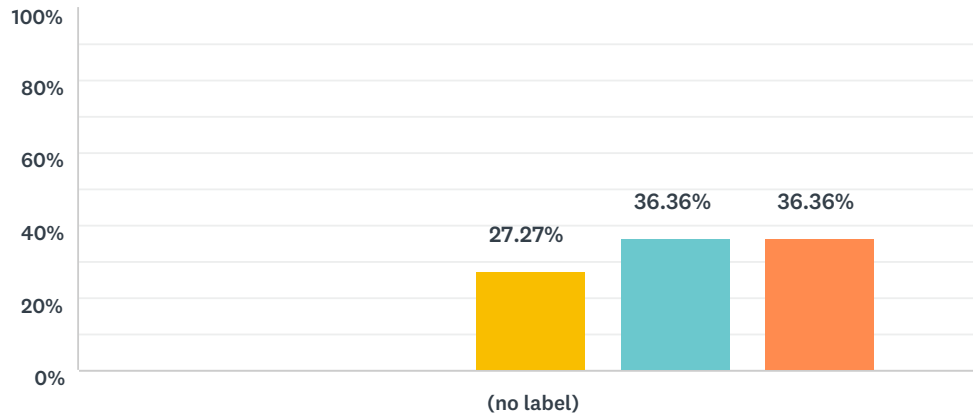
Gender		18
Male	83.33%	15
Female	16.67%	3
Declined to state	0.00%	0

Ethnicity*		18
White	44.44%	8
Asian	22.22%	4
Hispanic	27.78%	5
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	5.56%	1

* ethnicity specifications are not exclusive

Q1 The various topics within the summer school integrated into a coherent picture

Answered: 11 Skipped: 0

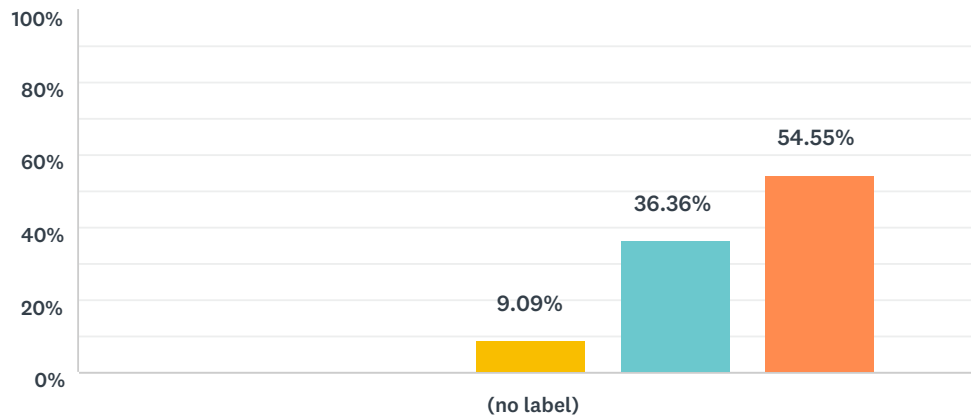


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very Much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	27.27% 3	36.36% 4	36.36% 4	11	4.09

Q2 The faculty speakers were generally clear and well organized in their presentation

Answered: 11 Skipped: 0

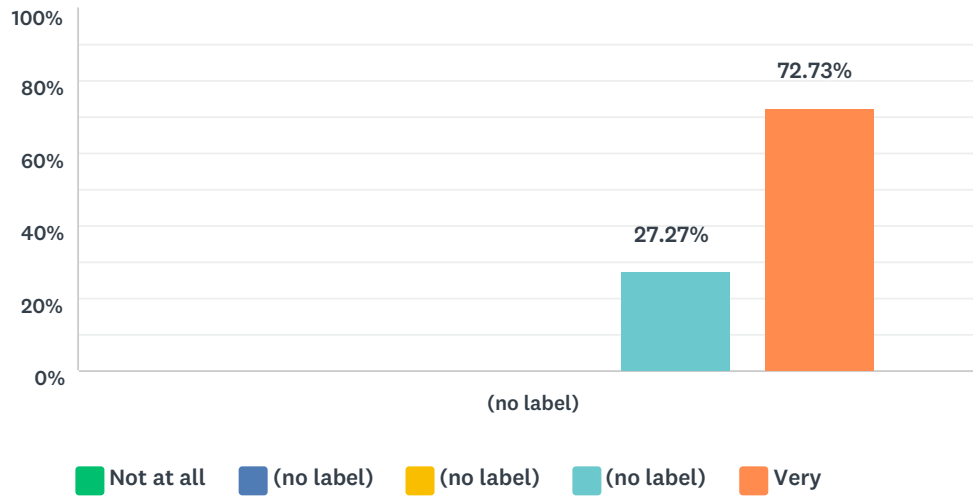


■ Not at all
 ■ (no label)
 ■ (no label)
 ■ (no label)
 ■ Very much

	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.09%	36.36%	54.55%	11	4.45
	0	0	1	4	6		

Q3 The school was intellectually stimulating

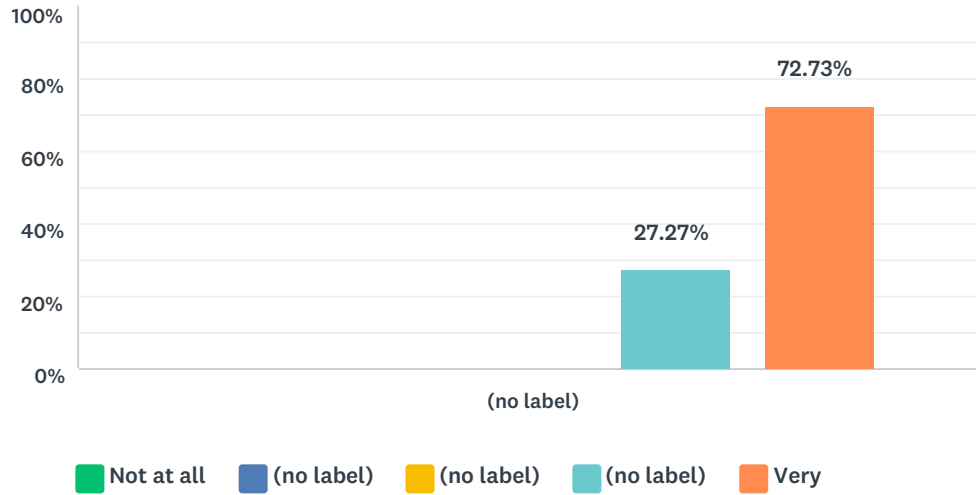
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	27.27%	72.73%	11	4.73
	0	0	0	3	8		

Q4 The overall experience of the school was worthwhile

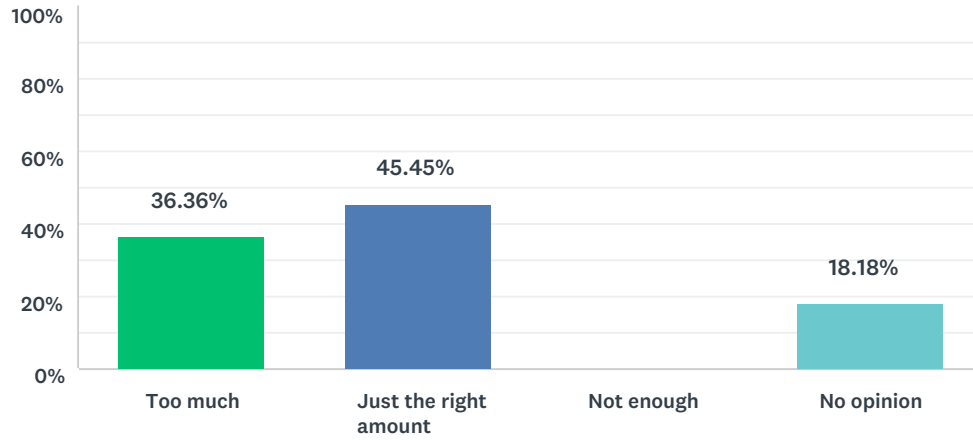
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	27.27%	72.73%	11	4.73
	0	0	0	3	8		

Q5 The amount of material presented was:

Answered: 11 Skipped: 0



ANSWER CHOICES	RESPONSES	
Too much	36.36%	4
Just the right amount	45.45%	5
Not enough	0.00%	0
No opinion	18.18%	2
TOTAL		11

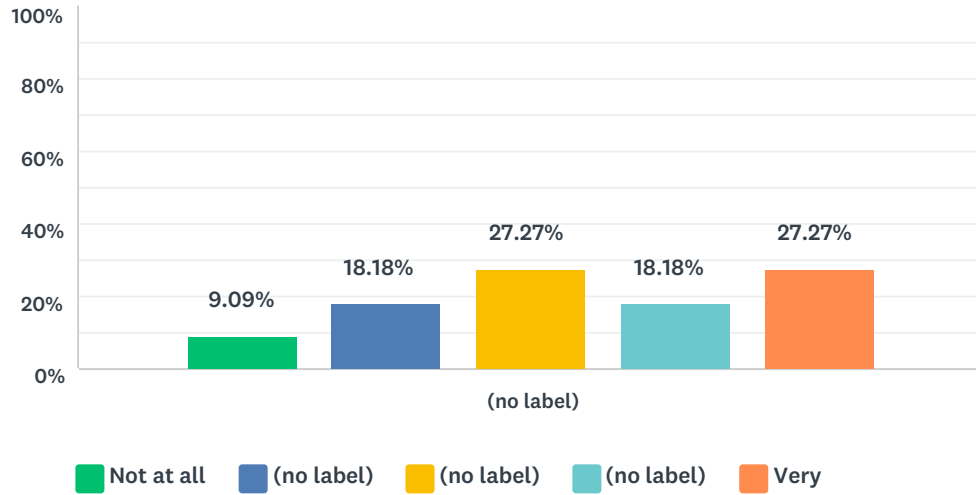
Q6 Additional comments on the topic presentation and organization

Answered: 2 Skipped: 9

#	RESPONSES	DATE
1	There were too many breaks. The problem sessions could have been more intensive in order for me to make the most benefit of the summer school.	8/27/2019 11:05 PM
2	I wish that I had a stronger background going in - I really was not prepared.	8/27/2019 9:46 AM

Q7 I was well prepared to benefit from the school

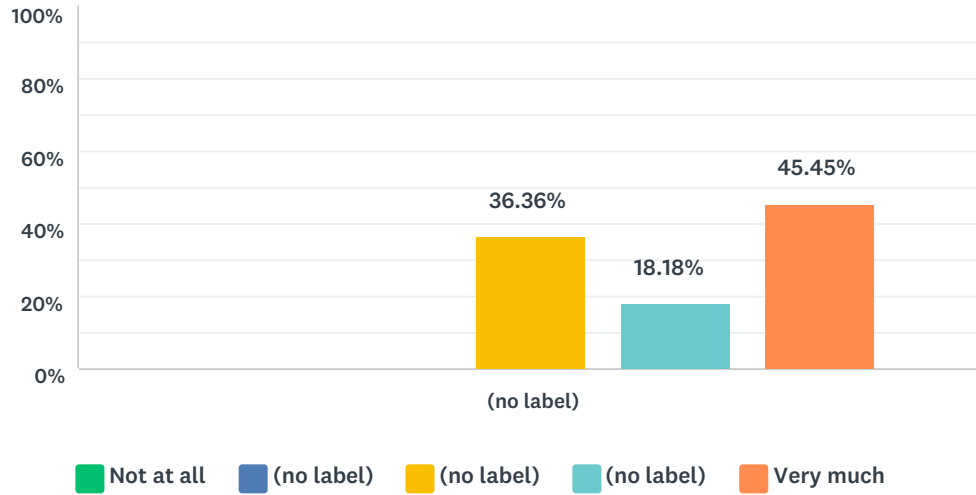
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	9.09%	18.18%	27.27%	18.18%	27.27%	11	3.36
	1	2	3	2	3		

Q8 My interest in the subject matter was increased by the school

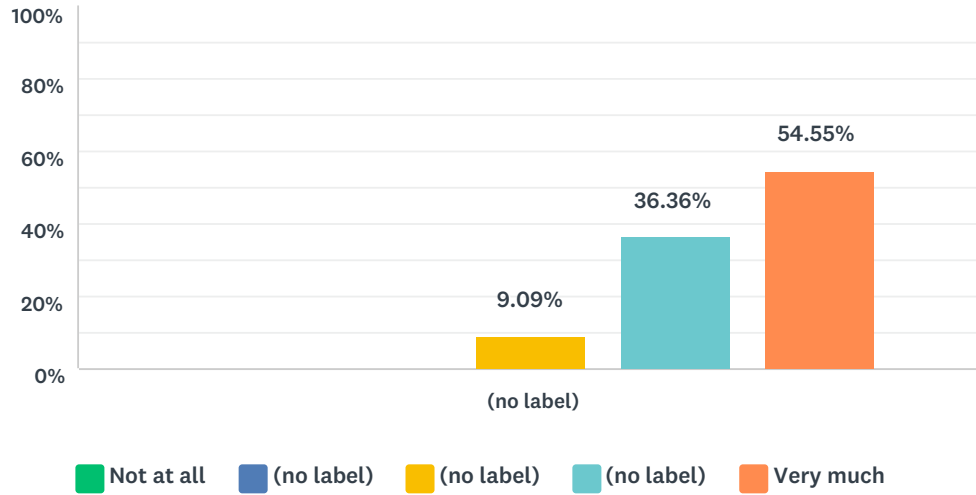
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	36.36%	18.18%	45.45%	11	4.09
	0	0	4	2	5		

Q9 The school helped me meet people with similar scientific interests

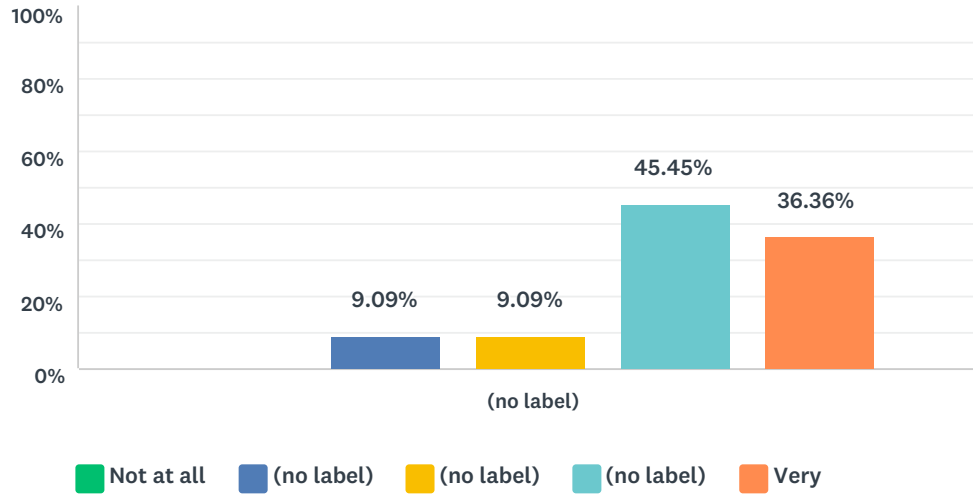
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY MUCH	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	9.09%	36.36%	54.55%	11	4.45
	0	0	1	4	6		

Q10 It is likely that I will work in the area of the school subject in the future

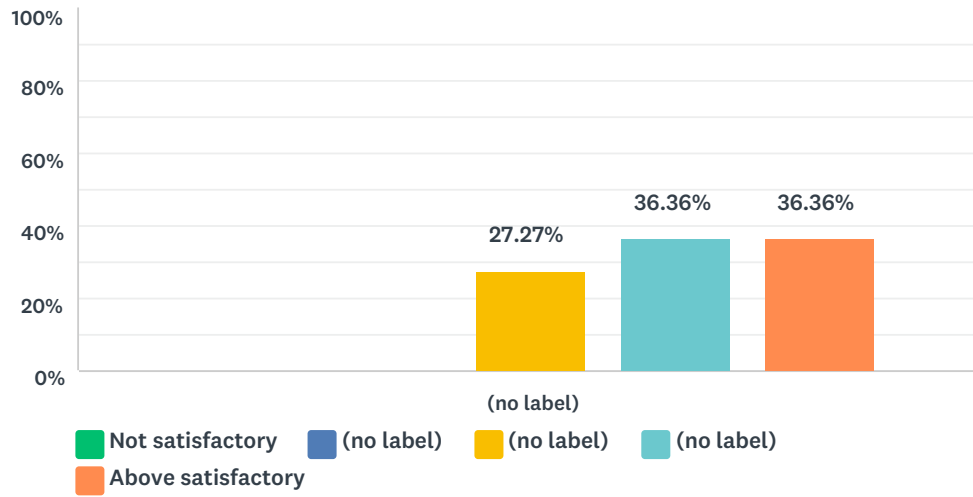
Answered: 11 Skipped: 0



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	9.09%	9.09%	45.45%	36.36%	11	4.09
	0	1	1	5	4		

Q11 How would you evaluate your interaction with other participants?

Answered: 11 Skipped: 0



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	27.27% 3	36.36% 4	36.36% 4	11	4.09

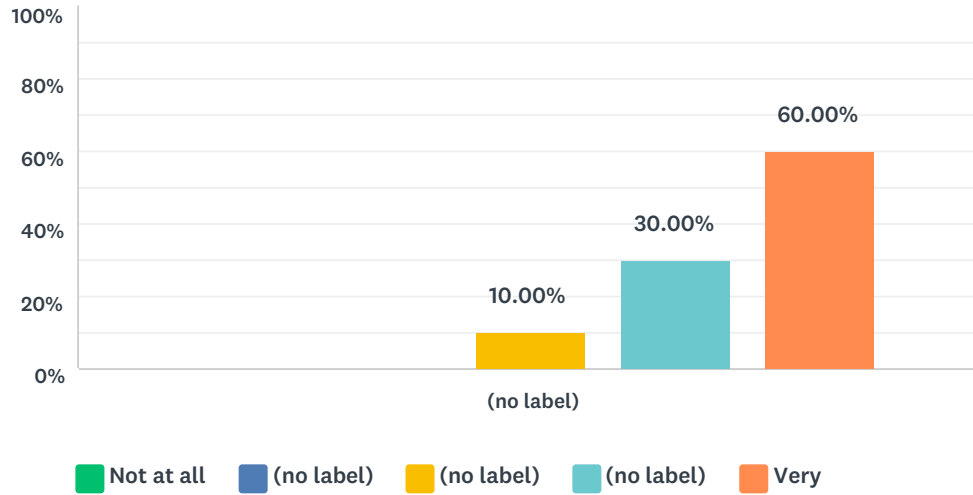
Q12 Additional comments on your personal assessment

Answered: 0 Skipped: 11

#	RESPONSES	DATE
	There are no responses.	

Q13 I found the onsite staff helpful

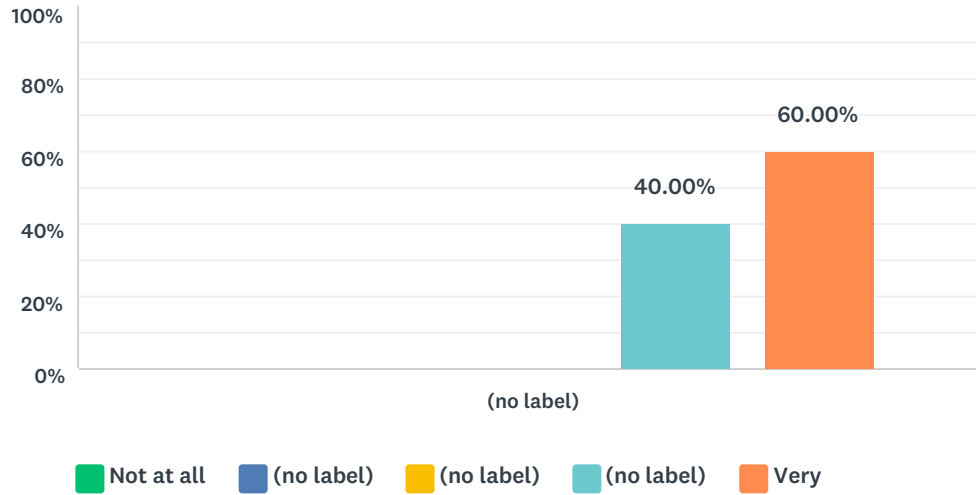
Answered: 10 Skipped: 1



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	10.00%	30.00%	60.00%	10	4.50
	0	0	1	3	6		

Q14 The physical facilities were conducive for such a school

Answered: 10 Skipped: 1



	NOT AT ALL	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00%	0.00%	0.00%	40.00%	60.00%	10	4.60
	0	0	0	4	6		

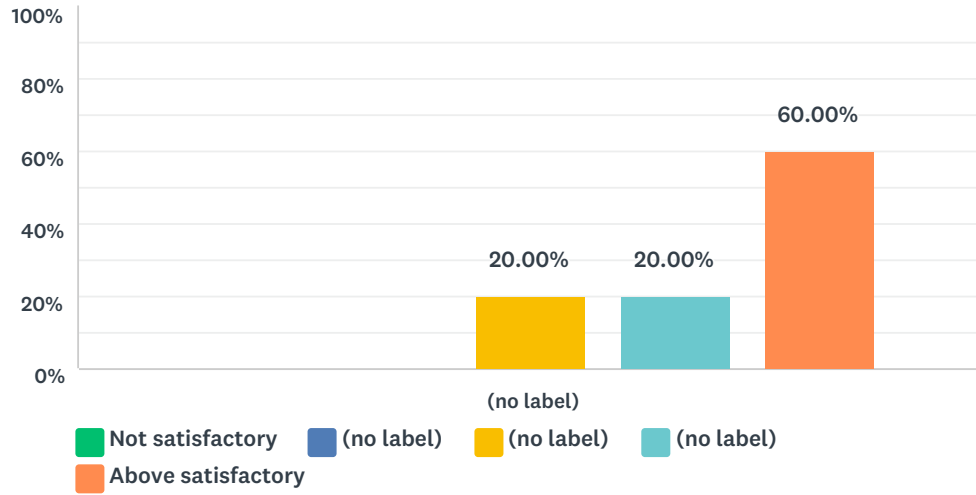
Q15 Additional comments on the venue

Answered: 3 Skipped: 8

#	RESPONSES	DATE
1	Lunch and dinner breaks were excessively long. I feel the food served could have been healthier and filling rather than exorbitantly exotic.	8/27/2019 11:07 PM
2	It was a bummer that the windows had to be closed - it was really hard to spend so many hours in a windowless room in such a beautiful place.	8/27/2019 9:47 AM
3	lovely	8/27/2019 5:11 AM

Q16 The summer school accommodation

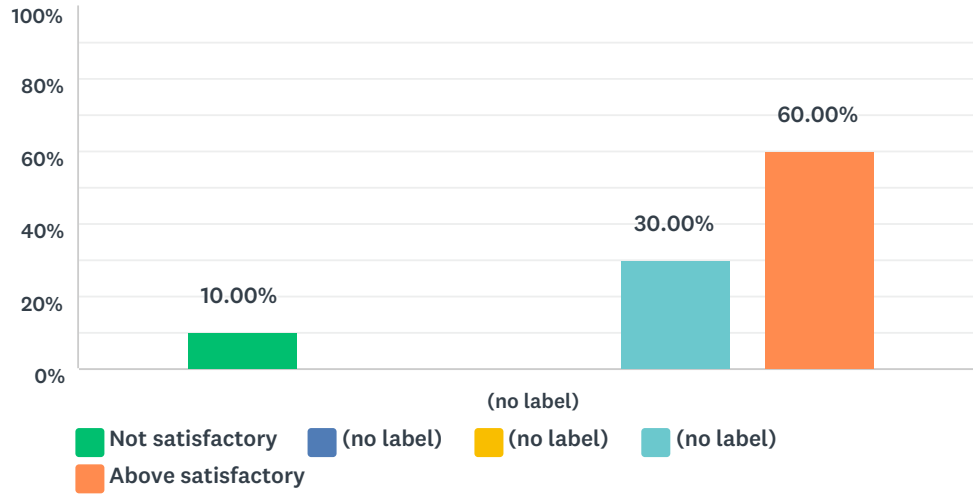
Answered: 10 Skipped: 1



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	0.00% 0	20.00% 2	20.00% 2	60.00% 6	10	4.40

Q17 The food provided

Answered: 10 Skipped: 1



	NOT SATISFACTORY	(NO LABEL)	(NO LABEL)	(NO LABEL)	ABOVE SATISFACTORY	TOTAL	WEIGHTED AVERAGE
(no label)	10.00% 1	0.00% 0	0.00% 0	30.00% 3	60.00% 6	10	4.30

Q18 Additional comments on accommodation and food

Answered: 3 Skipped: 8

#	RESPONSES	DATE
1	The dishes served were exotic rather than regular healthy food. I definitely gained a lot of weight during the school	8/27/2019 11:08 PM
2	It was incredible - I loved everything.	8/27/2019 9:47 AM
3	again, lovely	8/27/2019 5:11 AM

Q19 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 8

#	RESPONSES	DATE
1	I am not very well-prepared, so this is just my personal comment. I think the pace and amount of materia is too over-whelming. There are 4 subjects throughout 2 weeks. The total number of hours for each subject is just about 5 hours with disproportionately amount of materials. Perhaps increases numbers of hours will help. Student talks are good, but I think there are too many. Maybe use those hours from student talks for lecturing.	9/11/2019 2:39 PM
2	This summer school was not for beginners, but it was very very helpful for a student with basic understanding on these topics. The best part is one can interact with others, work together, discuss the topics and these are always extremely helpful to grow a clear idea on a topic. I would definitely want to attend another workshops or summer schools arranged by MSRI.	8/27/2019 4:01 PM
3	My biggest comment is that the lectures seemed pitched beyond the preparation of almost all participants. Very few people asked questions, commented, or in any way participated in the lectures, and when I spoke with other participants most of us were lost by the 2nd or 3rd day of all but one of the courses (Dr. Flores). The professors made very little effort to assess the background of attendees or tailor their lectures accordingly. The most valuable aspect of the program to me seemed to be the opportunity for individual students to prepare and present a talk, though many of those were inaccessible to the audience as well. Finally, I found the experience of being only one woman from the U.S. to be disappointing, I was hoping to meet other female graduate students from around the country. I was able to meet some women students from Mexico, which was wonderful. I really appreciated the participation and inclusion of the Mexican students.	8/27/2019 9:52 AM