MSRI
Mathematical Sciences Research Institute

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Annual Report on the Mathematical Sciences Research Institute 2016–2017 activities supported by NSF Grant DMS-1440140 June 1, 2016 to May 31, 2017

July 2017

Mathematical Sciences Research Institute
Annual Report, 2016-2017

PROGRAM REPORTS

WORKSHOP REPORTS

SUMMER GRADUATE SCHOOLS

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, 2016 to May 31st, 2017.

1.1 New Developments

The year 2016–17 was an exciting one. In fall 2016, we held a jumbo program: *Geometric Group Theory*, with lead organizer Mark Feighn (Rutgers). In Spring 2017, we held two programs: *Analytic Number Theory*, led by Terence Tao (UCLA), and *Harmonic Analysis*, led by Michael Christ (Berkeley) and Michael Lacey (Georgia Tech). All three programs were very popular, and their workshops well attended. All programs had stellar researchers with four of them awarded funding by the Clay Mathematics Institute: Manjul Bhargava, Rodney Heath-Brown, Karen Vogtmann, and Alexander Volberg.

Manjul Bhargava and Terry Tao need no introduction, as their pioneering work in several areas of number theory and harmonic analysis yielded breakthroughs that didn't seem possible ten years ago. Their Fields Medals (2014, 2016), Infosys, Fermat, Cole, Salem, Polya, and Breakthrough prizes (and many other awards) simply confirm what everyone knows: they are exceptional researchers producing extraordinary mathematics. Prof. Tao mentored a postdoc, Ayla Gafni, whose experience at MSRI was exceptionally productive. As she mentions in her end of semester report (see section 3), prior to her PD fellowship at MSRI she did not have many collaborators. She now lists 11 collaborators and six projects started here which are in various stages of completion.

Professor Heath-Brown has been an inspiration and mentor in the field of Analytical Number Theory for more than 30 years. He has over 150 publications featuring breakthroughs and contributions ranging from his work on Riemann Zeta-Functions to topics in sieve theory. He received the Hardy-Ramanujan Society Prize on two occasions and became an Honorary Fellow of that Society in 2004. He received the Junior and Senior Berwick Prize from the London Mathematical Society as well as its Polya Prize, and in 1993 was elected Fellow of the British Royal Society. Naser Talebizadeh Sardari was mentored by Prof. Heath-Brown and reports (section 3) a productive time at MSRI with 3 projects, one with his mentor which is soon to be published.

Karen Vogtmann is incontestably a leader in the field of geometric group theory. Originally trained at the University of California, Berkeley, she has held positions at the University of Michigan, Brandeis University, Columbia University, and Cornell University where, since 2011, she is a Goldwin Smith Professor of Mathematics. Since 2013, she is also a Professor at the University of Warwick. She has served on several Scientific Advisory Boards, Editorial Boards, and is currently Chairman for the Board of Trustees of the American Mathematical Society. She has been a lead organizer for many conferences, workshops, and programs throughout her career, including an earlier program in geometric group theory held at MSRI in Fall 2007. She was recently (2014) awarded a Humboldt Research prize, and a Royal Society Wolfson Research Award for outstanding scientists. In 2012, Professor Vogtmann was elected Fellow of the American Mathematical Society. Prof. Vogtmann was instrumental in the success of the Geometric Group Theory program. She had written the program proposal and while at MSRI

took on a mentoring role for all of the junior members (PDs, graduate students, and early career members). She was the driving force behind most of the scientific activities that semester.

Alexander Volberg is an internationally recognized researcher with a broad expertise in analysis, who received, in 1988, the prestigious Prix Salem. A few years later, he was one of the invited speakers at the Kyoto's International Congress of Mathematicians. More recently, he received (2005) the Lars Onsager Medal from the Norwegian University of Science and Technology as well as a Humboldt Research Award (2011). His collaborations with numerous mathematicians from around the world resulted in more than 140 research articles. He has been an excellent mentor to several graduate students who have gone on to distinguish careers, including Stefanie Petermichl, who was the first woman to be awarded the Salem Prize for young analysts in 2005. While at MSRI, Prof. Volberg mentored Shaoming Guo who reports (section 3) a beneficial experience which significantly broadened his research interest. He lists 3 projects that were developed during his fellowship here, with one already posted on the arXiv.

Other luminaries, aside from the organizers listed in the program reports, were Ruth Charney (Brandeis University), Koji Fujiwara (Kyoto University), Howard Masur (University of Chicago), Kasra Rafi (University of Toronto), Zlil Sela (Hebrew University), and Alain Valette (Universite de Neuchatel), who were in residence during the fall 2016. Tim Browning (University of Bristol), Tamar Ziegler (Hebrew Univeristy of Jerusalem), Guy David (Universite de Paris sud), Ciprian Demeter (Indiana University), Jill Pipher (Brown University), Elias Stein (Princeton University), and Tatiana Toro (University of Washington), were at MSRI in the spring 2017.

In all, MSRI awarded twenty (20) researchers the distinguished Eisenbud and Simons Professorships.

The organizers report striking results (see the Appendix for more details). Here is a small sample that gives a glimpse into the effervescent research activities that took place throughout the year.

Fall 2016, Geometric Group Theory. A striking development for this program was the emergence of new probabilistic methods. Random walk techniques can be used to find elements of a given group with particularly desirable properties. This method generalizes the classical *Drunkard's Walk* on the integers that randomly adds or subtracts 1 with equal chance. In group theory the integers are replaced by the elements of the group, one "walks" by applying group generators and their inverses, and probabilistic methods can be used to describe the properties of a typical path. In interesting cases these paths get closer and closer to a point in a standard "space at infinity," a space classically studied in geometric group theory. One of the fundamental problems in topology is the classification of manifolds (say homotopy equivalent to a given manifold). This classification problem can be solved under the condition that a certain conjecture about the fundamental group of the manifold is true. This conjecture is called the Farrell-Jones conjecture, and the **Novikov conjecture** is a slightly weaker version. These conjectures are known to be true for many classes of groups, but the group Out(F_n) of symmetries of a free group resisted all efforts. This is a naturally arising group basic to the theory of automorphism groups in general, and with many connections to other areas of mathematics. A breakthrough was achieved during that program, when the **Novikov conjecture** was established for *Out(F_n)* (Bestvina, Bromberg, Fujiwara, and Sisto). Another breakthrough result was obtained by one of the Postdoctoral fellows, David Hume, who showed that Baumslag-Solitar groups do not

coarsely embed in any hyperbolic group. This was a longstanding question in the subject of coarse embeddings and the proof is rather ingenious, making use of the notion of ``separation profile" introduced by Benjamini, Schramm and Timar. Another interesting result came about from a talk from Soroko (a graduate student at the time) that sparked a collaboration with Kropholler (a Postdoc) and Leary (a Research member). The three of them discovered that there are uncountably many quasi-isometry types of groups of type FP. A

Spring 2017, Analytic Number Theory and Harmonic Analysis programs. Almost all of the leading experts in the recent breakthroughs on large gaps between primes were present at MSRI. This led to a collaboration between Ford, Konyagin, Maynard, Pomerance, and Tao producing for the first time nontrivial large gaps in certain sparse subsets of the primes, such as primes of the form n^2+1. These gaps were obtained by modifying the usual Erdös-Rankin sieving strategy to eliminate the reliance on bounds on the density of smooth numbers (which is a tool that cannot be applied in these more general settings).

David, Gafni, Malik, Pierce, Prabhu, and Turnage-Butterbaugh started a collaboration on the behavior of “champion primes” on elliptic curves, a project that required expertise from multiple areas in analytic number theory and was only possible thanks to the presence of the collaborators (who, incidentally, are all female) at MSRI.

As a consequence of Matomäki, Radziwiłł, and Tao being in residence at the same time, a number of research objectives were achieved. Those include new correlation estimates on divisor functions and on the von Mangoldt function for most shifts in a short range, and new results on the local uniformity of the Liouville and Möbius functions in short intervals, a topic of importance for its potential application to the Chowla conjecture.

A few years back, Munshi announced a program to establish sub-convex bounds for symmetric square L-functions in the level aspect. This presents formidable technical difficulties for which Munshi has made substantial progress while at MSRI. During that time, he also began a collaboration with Nelson. As a consequence, Nelson realized that he could deduce from Munshi's result (combined with several of his own ideas) corresponding sub convex estimates for certain triple product L-functions. The work of Munshi and Nelson would have the spectacular consequence of obtaining strong rates of convergence in the Quantum Unique Ergodicity problem for holomorphic forms in the level aspect, which seemed until recently a distant hope.

The Spring semester was fortuitously timed to advance polynomial and multilinear approaches to Fourier restriction theorems, two powerful techniques which have emerged as especially promising over the last few years. Two particularly striking results in this vein were: The resolution of the cone restriction conjecture in dimension five by one of the postdocs, Yumeng Ou, in collaboration with graduate student Hong Wang; and work of the postdocs Jonathan Hickman and Marina Iliopoulou, in collaboration with L. Guth, establishing sharp estimates for certain oscillatory integral operators. In another vein, D. Müller, F. Ricci, and J. Wright found new life in the original, measure theoretic, motivation for studying Fourier restriction operators, and proved bounds for the composition of maximal operators with Fourier restriction operators; these bounds allow one to understand the restriction of $\hat{f}$ to a surface in a pointwise, rather than operator theoretic, sense.

J. Zahl announced breakthrough work, joint with N. Katz, on the closely related Kakeya

problem. The authors have obtained an improved lower bound on the Hausdorff dimension of a Kakeya set in dimension three, the first new bound in roughly two decades, in part by using sum-product estimates. While polynomial partitioning is not used in their analysis, one senses it lurking in certain algebraic sets that arise there. There were also significant breakthroughs in the theory of weights, and in elliptic and parabolic partial differential equations. T. Hytönen, S. Petermichl and A. Volberg proved the first optimal weighted norm estimate with matrix weight (i.e., a weighted L^2 bound, with linear growth in terms of the A_2 characteristic of the weight) for a singular operator, in this case, the dyadic square function.

The Spring semester was particularly fruitful thanks to the Scientific Advisory Committee judicious pairing of the two programs. For many participants, the concurrent programs provided a bonus in stimulus and an enhanced understanding of contemporary issues in their field. In particular, many new interactions were created among the junior participants of the two programs. We hope that this will help to stimulate more interactions between these two fields yielding interesting and unexpected results in the near future. The programs were enormously productive from a research standpoint, facilitating new results in a variety of subfields of harmonic analysis and analytic number theory as well as generating ideas for future directions. A particular strength of both programs was the large number of collaborations, both old and new, that it facilitated; many of these collaborations brought together junior and senior researchers. The analytic number theory program organizers give a partial list of over 30 results that were obtained during the program, while the harmonic analysis organizers list 57 concrete research advances attained or initiated during the spring. Many more projects are at earlier stages of development, so the impact of the semester will be realized with the coming months and years.

This year, the MSRI's annual ***Hot Topics workshop*** was on*: Galois Theory of Periods and Applications*. Periods are integrals of algebraic differential forms over algebraically-defined domains and are ubiquitous in mathematics and physics. A deep idea, originating with Grothendieck, is that there should be a Galois theory of periods. This general principle provides a unifying approach to several problems in the theory of motives, quantum groups and geometric group theory. This workshop brought together leading experts around this subject and covered topics such as the theory of multiple zeta values, modular forms, and motivic fundamental groups.

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 2016–17, of the support for program members (long-term visitors) 52% came from the NSF, 8% from the NSA, and 40% from private funds. Of the support for workshop participants (short term visitors) 72% came from the NSF, 9% from the NSA and 19% 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-four (34) Postdoctoral Fellows participated in our three scientific programs and in the complementary program. Of those, twenty (20) were funded by this NSF Grant. Maria Nastasescu was the Berlekamp postdoctoral Fellow; Michael Cantrell the Gamelin Fellow; Max Engelstein the Huneke Fellow; David Hume the McDuff Fellow; Marina Iliopoulou the Strauch Fellow; Naser Talebizadeh Sardari the Uhlenbeck Fellow; and Jenya Sapir and Julia

Brades the Viterbi Fellows. As in the past years, there was a consensus among them that the wealth of connections they were able to establish with the top researchers in their field and with fellow postdocs was extremely beneficial, as was the possibility of learning directly from the leaders of their fields. These connections are already playing an important role in their professional development. It was noted by several of the senior participants that the environment at MSRI was particularly advantageous for the postdoctoral members of the program. As Andreas Seeger, one of the Harmonic Analysis research members, puts it: the postdocs were "just exploding" during the semester. This success can be seen in the Research Developments and Breakthroughs sections of the program's reports (Appendix 11) where more than half of the collaborations, many on major new results, involve researchers within 10 years of their Ph.D. The intensity of this research activity (and proximity to the job market) could have led to a destructively competitive environment, but the postdocs seemed to get along very well, both research-wise and socially. The Fall postdocs also established relations with the numerous postdocs at Lawrence Berkeley Lab while the spring ones found a local restaurant where 15-20 would regularly gather. For details, please see Section 3 and the Appendix.

Collaborative Diversity Initiative. The *Diversity Initiative* 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 the eight NSF-funded US mathematical sciences institutes (AIM, ICERM, IMA, IPAM, MBI, MSRI, NIMBioS, and SAMSI). MSRI is the institute administering the grant. During the 2016–17 year, two events were supported by the Initiative: *Modern Math Workshop*, held in October 2016 at the Long Beach Convention Center in Long Beach, California. It was organized by IPAM and attracted 118 participants. The second workshop was the *Blackwell-Tapia Conference and Award Ceremony*, also held in October 2016 at the University of Tennessee. It was organized by NIMBioS and attracted 107 participants.

Complete reports can be found in the final report of our NSF grant DMS-0932078, as well as in IPAM (for the MMW) and NIMBioS (B-T conference) annual (2016-17) reports.

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 *Observing for Access, Power, and Participation in Mathematics Classrooms as a Strategy to Improve Mathematics Teaching and Learning.* There were about 116 attendees, all very engaged in the discussions. It was funded through grants from Math for America and from the NSF Division of Education and thus reported to them directly.

Public Understanding of Mathematics.

National Math Festival. The 2017 National Math Festival brought 20,000 children and adults of all ages who enjoyed more than 90 events including lectures, demos, puzzles, games, films, mathletic competitions, and other hands-on, interactive activities. It was held on Saturday, April 22 in the Convention Center in Washington, DC. The Festival featured 30 presenting mathematicians, scientists, and educators, who collectively brought 37 presentations. Most lectures were offered twice in order to allow for easy access; and 20 of them were videotaped. These videos are being gradually released at the nationalmathfestival.org web site. This was an extraordinary event, and the full report can be found in the Appendix.

Mathical. Books for Kids from Tots to Teens. MSRI, in partnership with the National Council of Teachers of Mathematics (NCTM) and the National Council of Teachers of English (NCTE) with support from the Firedoll Foundation, continued the Mathical Book Prize, which cultivates a love of mathematics in the everyday world. Each year's winners and honor books join a selective and ever-growing list of new and previously published fiction and nonfiction titles for kids of all ages. These titles are as varied as the intersection between literature and mathematics, encompassing picture books, novels, poetry collections, puzzle books, biographies, and more. The prize seeks to expand the public understanding and enjoyment of mathematics through highlighting titles that will inspire young people of all ages to see the world in new ways. A national committee of mathematicians, librarians, educators, and distinguished authors selects each year's winners. 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.

The 2017 Mathical Prize winners (published in 2016) are: Pre-K, ONE Very Big Bear, by Alice Brière-Haquet (author) and Olivier Philipponneau and Raphaële Enjary (illustrators); Grades K-2, Absolutely One Thing: Featuring Charlie and Lola, by Lauren Child; Grades 3-5, Which One Doesn't Belong? A Shapes Book, by Christopher Danielson; Grades 6-8, Mind-Boggling Numbers, by Michael J. Rosen (author) and Julia Patton (illustrator); and Grades 9-12, Genius: The Game, by Leopoldo Gout. An additional four honor books were also selected by the committee.

Numberphile. Since January 2014, MSRI has supported Brady Haran's "Numberphile" channel on YouTube. MSRI has contributed both support and connections to some of the world's great mathematicians — we recommend the charming piece by Terry Tao on how he came to love mathematics, and the interesting interview with Robbert Dijkgraaf on Math vs Physics
— and with young mathematicians such as Holly Krieger, a postdoc in arithmetic dynamics at MIT who was at MSRI for a semester. We were amazed by the result on primes and iterated functions that she explains in her video. These and other treats can be found at http://www.numberphile.com/. This year Numberphile has uploaded 64 videos, taking the all-time total number of videos to 453. It has accumulated a further 75.7 million videos views, taking the total to 282 million. In addition, a further 17 supplemental videos were uploaded to the "extras channel" called Numberphile2. It is an unprecedented way to share mathematics with millions of people from all generations.

Chicago Mercantile Exchange Prize. The 11th annual CME Group-MSRI Prize in Innovative Quantitative Applications was awarded to Robert B. Wilson, on February 2, 2017 in Chicago.

Dr. Wilson's research and teaching are on market design, pricing, negotiation, and related topics concerning industrial organization and information economics. He is an expert on game theory and its applications. Dr. Wilson has been a major contributor to auction designs and competitive bidding strategies in the oil, communication, and power industries, and to the design of innovative pricing schemes. His work on pricing of priority service for electric power has been implemented in the utility industry. His book on Nonlinear Pricing (Oxford Press, 1993) is an encyclopedic analysis of tariff design and related topics for public utilities, including power, communications, and transport; it won the 1995 Leo Melamed Prize, awarded biannually by the University of Chicago for "outstanding scholarship by a business professor." His work on game theory includes wage bargaining and strikes, and in legal contexts, settlement negotiations. He has authored some of the basic studies of reputational effects in predatory pricing, price wars, and other competitive battles. The annual CME Group-MSRI 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. Read more about the prize at, https://www.msri.org/general_events/22295.

These are sample of activities that MSRI organizes each year in its effort to reach out to the general population and share with them what mathematics is all about.

1.2 Summary of Demographic Data for 2016–17 Activities

During the academic year 2016–17, MSRI hosted 250 program members (of which, 34 were Postdoctoral Fellows) and 1452 workshop participants.

The Postdoctoral program was particularly successful and is described in detail in Section 3. Of the Fellows, 35% were female, 32% were U.S. Citizens or Permanent Residents, and 77% listed a U.S. university as their home institution. Of those institutions, 31% are located in the Northeast, 23% in the West, 35% in the Midwest, and the remaining 11% in the South.

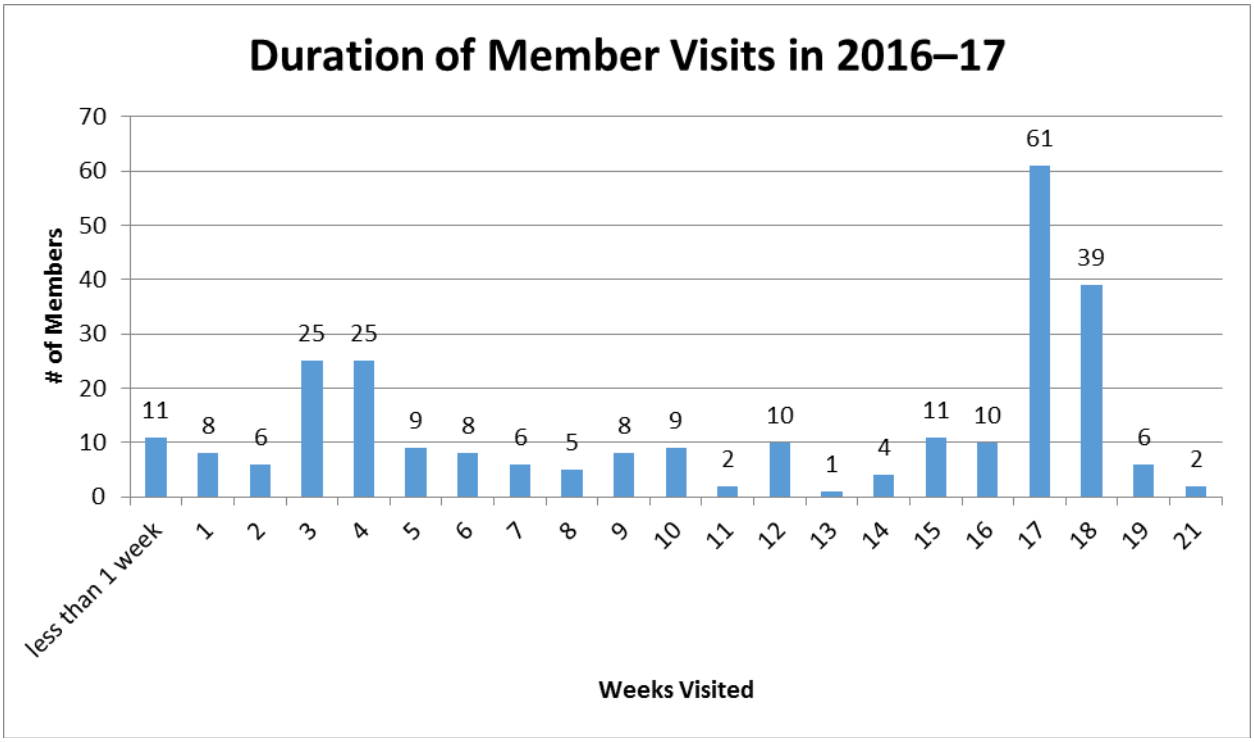
MSRI had a total of 250 long-term members. Members spent an average of 81 days (2.7 months) at MSRI, with peak attendance in September for the fall semester and March for the spring semester. Of the members, 25% were female, 48% reported being U.S. Citizens or Permanent Residents and 52% listed a U.S. university as their home institution. Of those institutions, 33% are located in the Midwest, 20% in the West, 30% in the Northeast, and 17% in the South. Of the members, 70% had received a Ph.D degree during the year 2000 or later, 24% received one between 1981 and 1999, and the remaining 6% had received a Ph.D. in 1980 or earlier. Detailed demographic data can be found in Section 2.

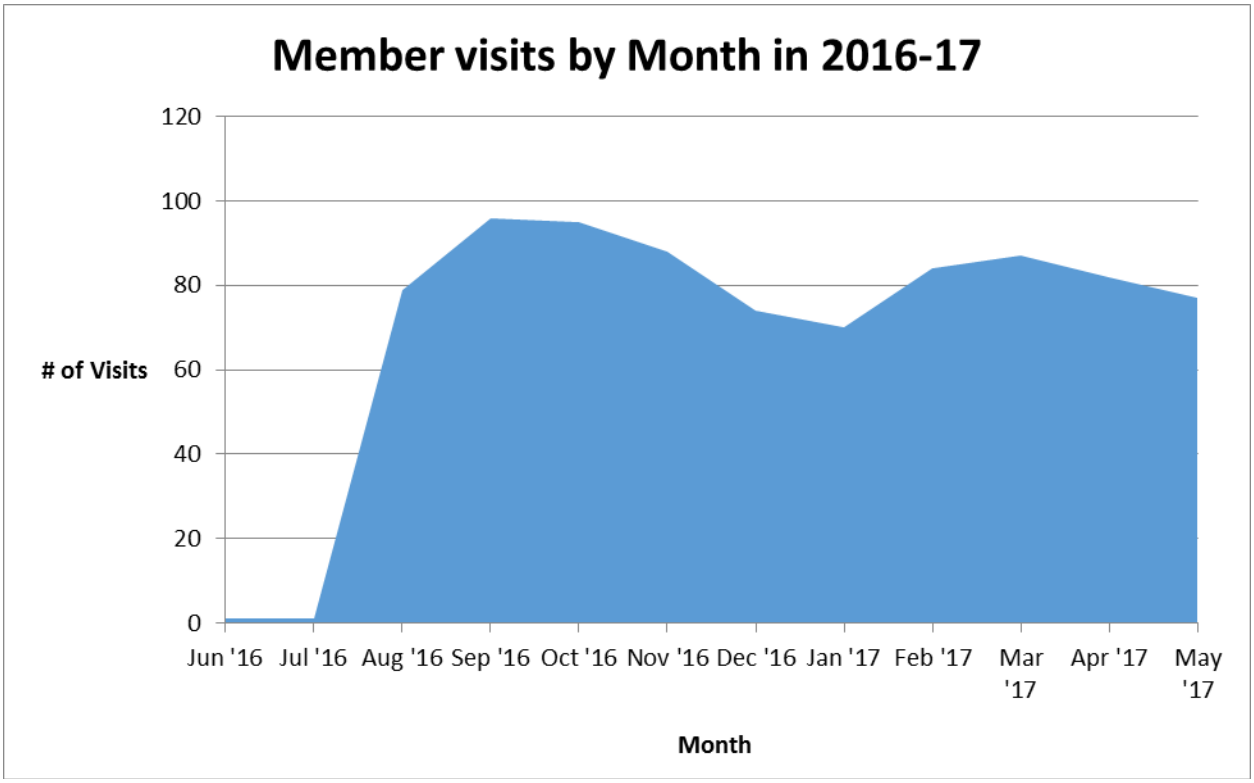
In the 2016–17 workshops, MSRI hosted 1452 visitors (some visitors attended multiple events). Of the workshop participants, 32% were female, 47% were U.S. Citizens or Permanent Residents, of which 9% reported being a member of an under-represented minority. In addition, 60% of the 1452 participants came 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 2016	Fall 2016	Spring 2017	2016–17	2004–17
Total Member Days	54	9,775	11,792	**21,621**	**231,815**
Total # of Member Visits	1	122	143	**266**	**3,189**
Avg # of Days per Member Visit	54.00	80.12	82.46	**81.28**	**72.69**
Avg # of Months per Member Visit	1.80	2.67	2.75	**2.71**	**2.42**
All female program members	**Summer 2016**	**Fall 2016**	**Spring 2017**	**2016–17**	**2009–17**
Total Member Days	0	2,782	3,156	**5,938**	**36,280**
Total # of Member Visits	0	31	36	**67**	**485**
Avg # of Days per Member Visit	0.00	89.74	87.67	**88.63**	**74.80**
Avg # of Months per Member Visit	0.00	2.99	2.92	**2.95**	**2.49**

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





1.3 Scientific Programs and their Associated Workshops

There were three major, one complementary and one research programs that took place at MSRI during the 2016–17 year, as well as 11 programmatic workshops.

Note: Full descriptions of each activity can be found the the Appendix, Section 11 of this Annual Report. In the lists of organizers of each activity below, an asterisk (*) denotes lead organizer(s).

Program 1: Geometric Group Theory
August 15, 2016 - December 16, 2016
*Organizers: Ian Agol (University of California, Berkeley), Mladen Bestvina (University of Utah), Cornelia Drutu (University of Oxford), *Mark Feighn (Rutgers University), Michah Sageev (Technion---Israel Institute of Technology), Karen Vogtmann (University of Warwick)*

Workshop 1: Connections for Women: Geometric Group Theory
August 17, 2016 - August 19, 2016
*Organizers: *Ruth Charney (Brandeis University), Indira Chatterji (Université Nice Sophia-Antipolis), Mark Feighn (Rutgers University), Talia Fernós (University of North Carolina)*

Workshop 2: Introductory Workshop: Geometric Group Theory
August 22, 2016 - August 26, 2016
*Organizers: Martin Bridson (University of Oxford), Benson Farb (University of Chicago), *Zlil Sela (Hebrew University), Karen Vogtmann (University of Warwick)*

Workshop 3: Groups acting on CAT(0) spaces
September 27, 2016 - September 30, 2016
*Organizers: Ian Agol (University of California, Berkeley), Pierre-Emmanuel Caprace (Université Catholique de Louvain), Koji Fujiwara (Kyoto University), Alessandra Iozzi (ETH Zürich), * Michah Sageev (Technion---Israel Institute of Technology)*

Workshop 4: Geometry of mapping class groups and Out (Fn)
October 25, 2016 - October 28, 2016
*Organizers: Yael Algom-Kfir (University of Haifa), *Mladen Bestvina (University of Utah), Richard Canary (University of Michigan), Gilbert Levitt (Université de Caen)*

Workshop 5: Amenability, coarse embeddability and fixed point properties
December 06, 2016 - December 09, 2016
*Organizers: Goulnara Arzhantseva (University of Vienna), *Cornelia Drutu (University of Oxford), Graham Niblo (University of Southampton), Piotr Nowak (Polish Academy of Sciences)*

Program 2: Analytic Number Theory
January 17, 2017 - May 26, 2017
*Organizers: Chantal David (Concordia University), Andrew Granville (Université de Montréal), Emmanuel Kowalski (ETH Zuerich), Philippe Michel (École Polytechnique Fédérale de Lausanne (EPFL)), Kannan Soundararajan (Stanford University), *Terence Tao (University of California, Los Angeles)*

Workshop 1: Connections for Women: Analytic Number Theory
February 02, 2017 - February 03, 2017
**Chantal David (Concordia University), Kaisa Matomäki (University of Turku), Lillian Pierce (Duke University), Kannan Soundararajan (Stanford University), Terence Tao (University of California, Los Angeles)*

Workshop 2: Introductory Workshop: Analytic Number Theory
February 06, 2017 - February 10, 2017
*Andrew Granville (Université de Montréal), *Emmanuel Kowalski (ETH Zuerich), Kaisa Matomäki (University of Turku), Philippe Michel (École Polytechnique Fédérale de Lausanne (EPFL))*

Workshop 3: Recent developments in Analytic Number Theory
May 01, 2017 - May 05, 2017
*Tim Browning (University of Bristol), Chantal David (Concordia University), Kannan Soundararajan (Stanford University), *Terence Tao (University of California, Los Angeles)*

Program 3: Harmonic Analysis
January 17, 2017 to May 26, 2017
**Michael Christ (University of California, Berkeley), Allan Greenleaf (University of Rochester), Steven Hofmann (University of Missouri), *Michael Lacey (Georgia Institute of Technology), Svitlana Mayboroda (University of Minnesota, Twin Cities), Betsy Stovall (University of Wisconsin-Madison), Brian Street (University of Wisconsin-Madison)*

Workshop 1: Connections for Women: Harmonic Analysis
January 19, 2017 - January 20, 2017
*Svitlana Mayboroda (University of Minnesota, Twin Cities), *Betsy Stovall (University of Wisconsin-Madison)*

Workshop 2: Introductory Workshop: Harmonic Analysis
January 23, 2017 - January 27, 2017
*Allan Greenleaf (University of Rochester), *Michael Lacey (Georgia Institute of Technology), Svitlana Mayboroda (University of Minnesota, Twin Cities), Betsy Stovall (University of Wisconsin-Madison), Brian Street (University of Wisconsin-Madison)*

Workshop 3: Recent Developments in Harmonic Analysis
May 15, 2017 - May 19, 2017
*Michael Christ (University of California, Berkeley), Steven Hofmann (University of Missouri), *Michael Lacey (Georgia Institute of Technology), Betsy Stovall (University of Wisconsin-Madison), Brian Street (University of Wisconsin-Madison)*

Program 4: Complementary Program (2016–17)
August 15, 2016 to July 31, 2017

MSRI had a small Complementary Program comprised of one postdoctoral fellow, Mina Bigdeli (Institute for Research in Fundamental Sciences) and the following researchers: Catalin Badea (Université de Lille I (Sciences et Techniques de Lille Flandres Artois)), Valerio Capraro (Middlesex University London), Komla Domelevo (Institut de Mathématiques de Toulouse), Jeremy Gray (University of Warwick), Susana Gutierrez (University of Birmingham), Joseph Harris (Harvard University), Dominique Hulin (Université de Paris XI), Abdul Jarrah (American University of Sharjah), Francoise Point (Université de Mons-Hainaut), Alexander Postnikov (Massachusetts Institute of Technology), Sebastien Roch (University of Wisconsin-Madison), and Bernd Ulrich (Purdue University).

Program 5: Summer Research Program 2016
June 06, 2016 to August 05, 2016

MSRI had a small Summer Research Program comprised of ten researchers, Christine Breiner (Fordham University), Stefan Catoiu (DePaul University), Rob Kusner (University of Massachusetts, Amherst), Wöden Kusner (Technische Universität Graz), Grigory Mikhalkin (Université de Genève), Irena Peeva (Cornell University), Yanir Rubinstein (University of Maryland), Catherine Searle (Wichita State University), Rosa Sena-Dias (Instituto Superior Técnico), and John Villavert (University of Texas Rio Grande Valley).

1.4 Scientific Activities Directed at Underrepresented Groups in Mathematics

Connections for Women Workshops
During the 2016–17 academic year, MSRI hosted three Connections for Women workhops, one for each scientific program. The goal of these workshops was to facilitate networks among women and members of underrepresented minorities. For more information regarding each workshop, please refer to Section 1.3 above.

Undergraduate Program: MSRI-UP 2016: Sandpile Groups
June 11, 2016 - July 24, 2016
*Federico Ardila (San Francisco State University), Duane Cooper (Morehouse College), Maria Mercedes Franco (Queensborough Community College (CUNY)), Herbert Medina (Loyola Marymount University), *Suzanne Weekes (Worcester Polytechnic Institute)*

Please note: MSRI-UP is funded by an independent NSF grant, DMS-1156499. The report was filed independently to the NSF in February 2017, thus there is no report attached in Section 11.Appendix.

***NSF Mathematics Institutes' Modern Math Workshop at SACNAS**
NSF supplemental grant DMS 1126721
Location: Los Angeles, California
October 12, 2016 to October 13, 2016
Organized by IPAM

***Ninth Bi-Annual Blackwell-Tapia Conference 2016**
NSF supplemental grant DMS 1126721
Location: Knoxville, Tennessee
October 28, 2016 to October 29, 2016
Organized by NIMBioS/ICERM

**Please note: The report of this activity is included in each respective institute's annual report, thus there is no report attached in Section 11. Appendix.*

1.5 Summer Graduate Schools (Summer 2016)

SGS 1: Séminaire de Mathématiques Supérieures 2016: Dynamics of Biological Systems
May 30, 2016 - June 11, 2016
Location: University of Alberta, Canada
Organizers: Thomas Hillen (University of Alberta), Mark Lewis (University of Alberta), Yingfei Yi (University of Alberta)

SGS 2: Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets
June 13, 2016 - June 24, 2016
*Organizers: *Steven Hofmann (University of Missouri), Jose Maria Martell (Instituto de Ciencias Matematicas (ICMAT))*

SGS 3: Mixed Integer Nonlinear Programming: Theory, algorithms and applications
June 20, 2016 - July 1, 2016
Location: Seville, Spain
Organizers: Francisco Castro (University of Sevilla), Elena Fernandez (Universitat Politecnica de Catalunya), Justo Puerto (University of Sevilla)

SGS 4: An Introduction to Character Theory and the McKay Conjecture
July 11, 2016 - July 22, 2016
Organizers: Robert Guralnick (University of Southern California), Pham Tiep (University of Arizona)

SGS 5: Electronic Structure Theory
July 18, 2016 - July 29, 2016
*Organizers: *Lin Lin (University of California, Berkeley), Jianfeng Lu (Duke University), James Sethian (University of California, Berkeley)*

SGS 6: Chip Firing and Tropical Curves
July 25, 2016 - August 05, 2016
*Organizers: *Matthew Baker (Georgia Institute of Technology), David Jensen (University of Kentucky), Sam Payne (Yale University)*

1.6 Other Scientific Workshops

Workshop 1: Math Circle – Mentorship and Partnership Program
September 15, 2016 – September 1, 2016
Location: University of Colorado, Denver
**Diana White (MSRI - Mathematical Sciences Research Institute), Brandy Wiegers (Central Washington University)*

Workshop 2: Circle on the Road
October 28, 2016 - October 30, 2016
Location: Courant Institute of Mathematical Sciences, New York
*Selin Kalayciglu (The Center for Mathematical Talent), Berna Ok (The Center for Mathematical Talent), *Diana White (MSRI - Mathematical Sciences Research Institute), Brandy Wiegers (Central Washington University)*

Workshop 3: Insect Navigation
December 06, 2016 - December 09, 2016
Location: Janelia Research Campus of Howard Huges Medical Institute, Ashburn, Virgina
Organizers: Larry Abbott (Columbia University), David Eisenbud (MSRI - Mathematical Sciences Research Institute), Mimi Koehl (University of California, Berkeley)

Workshop 4: Bay Area Differential Geometry Seminar (BADGS) Winter 2016
December 03, 2016
Orgnizers: David Bao (San Francisco State University), Joel Hass (University of California, Davis), David Hoffman (Stanford University), Rafe Mazzeo (Stanford University), Richard Montgomery (University of California, Santa Cruz)

Workshop 5: Bay Area Differential Geometry Seminar (BADGS) Spring 2017
February 25, 2017
Orgnizers: David Bao (San Francisco State University), Joel Hass (University of California, Davis), David Hoffman (Stanford University), Rafe Mazzeo (Stanford University), Richard Montgomery (University of California, Santa Cruz)

Workshop 6: Bay Area Differential Geometry Seminar (BADGS) Spring 2017
Location: UC Davis
April 15, 2017
Organizers: David Bao (San Francisco State University), Joel Hass (University of California, Davis), David Hoffman (Stanford University), Rafe Mazzeo (Stanford University), Richard Montgomery (University of California, Santa Cruz)

Workshop 7: Hot Topics: Galois Theory of Periods and Applications
March 27, 2017 - March 31, 2017
*Organizers: *Francis Brown (University of Oxford), Clément Dupont (Université de Montpellier), Richard Hain (Duke University), Vadim Vologodsky (University of Oregon)*

Workshop 8: A View Towards Algebraic Geometry, in honor of David Eisenbud's birthday
May 1, 2017 – May 5, 2017
Location: Harbor View Hotel, Martha's Vineyard
Organizers: Daniel Erman (University of Wisconsin), Mircea Mustaţă (University of Michigan), Claudiu Raicu (University of Notre Dame), Gregory G. Smith (Queen's University)

Please note: With the exception of Workshop 7: Hot Topics, all other seven workshops in section 1.6 were not funded by DMS-1440140 thus there is no report attached in Section 11. Appendix. For more information about these workshops, please visit our website at www.msri.org.

1.7 Education & Outreach Activities

Workshop 1: Critical Issues in Mathematics Education (CIME) 2017: Observing for Access, Power, and Participation in Mathematics Classrooms as a Strategy to Improve Mathematics Teaching and Learning
NSF independent grants DLR-1461358 and DLR-1738702
March 15, 2017 - March 17, 2017
*Organizers: Michael Driskill (Math for America), Esther Enright (Boise State University), Rochelle Gutierrez (University of Illinois), *Jodie Novak (University of Northern Colorado), *Miriam Sherin (Northwestern University), Joi Spencer (University of San Diego), Elizabeth van Es (University of California, Irvine)*

Please note: CIME was funded by independent NSF grants. The report was filed independently to the NSF, thus there is no report attached in Section 11. Appendix. For more information about CIME workshops, please visit our website at www.msri.org.

Workshop 2: National Math Festival 2017
NSF supplemental grant DMS-1733966
April 22, 2017
Organizers: Mathematical Sciences Research Institute, Insitute for Advanced Study, National Museum of Mathematics

1.8 Program Consultants List in 2016–17

Consultant Name(s)	Consultant Disciplinary Specialty	Consultant Employer	Activity Title
Larry Abbott	Math Biology	Columbia University	Neuroscience meeting
Dave Auckly	Algebraic Geometry	Kansas State University	Navajo Math Circles
John Ewing	Math, Education	Math for America	Critical Issues in Math Education workshop
Ben Green	Analysis, Combinatorics, Number Theory	Oxford University	Speaker at BOT meeting
Sanford Grossman	Econ, Neuroscience	self	Neuroscience meeting
Steven Kaliszewski	Operator algebra	Arizona State University	Summer Graduate Schools
Robert Klein	Mathematics education	Ohio University	Navajo Math Circles
Mimi Koehl	Biology	UC Berkeley	Insect Navigation
Jane Long	Education	Stephen F. Austin State University	National Association of Math Circles
William Macallum	Education	University of Arizona	Educational workshops
Rafe Mazzeo	Differential geometry	Stanford University	Differential geometry seminar
Robert Megginson	Fuctional analysis	University of Michigan	Critical Issues in Math Education
Paul Milgrom	Economics	Stanford University	Economics program
Andrei Okounkov	Mathematical physics	Columbia University	Speaker at BOT meeting
Hugo Rossi	Complex analysis	University of Utah	Navajo Math Circles
Alvin Roth	Economics	Stanford University	Economics program
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	Bay Area Circle for Teachers
Hugo Sonnenschein	Economics	University of Chicago	MSRI-CME Group Prize
Sam Vandervelde	Number theory	St. Lawrence University	Math Circles
Hal Varian	Economics	UC Berkeley and Google	Economics program
Diana White	Commutative algebra	University of Colorado, Denver	National Association of Math Circles
Brandy Wiegers	Numerical analysis	Central Washington University	National Association of Math Circles
Hugh Woodin	Logic	Havard University	Decidability, definability and computability in number theory
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, GFAA, GTC, GRTA, EGN and CP
Scientific Advisory Committee (SAC) & Board of Trustees (BOT)	See Section 10: Committee Membership		Geometric Functional Analysis and Applications (GFAA) Geometric and Topological Combinatorics (GTC) Group Representation Theory and Applications (GRTA) Enumerative Geometry Beyond Numbers (EGN) Complementary Program (CP) Summer Graduate Schools

2. Program and Workshop Data

2.1 Program Members List

(See e-mail attachment)

2.2 Program Members Summary

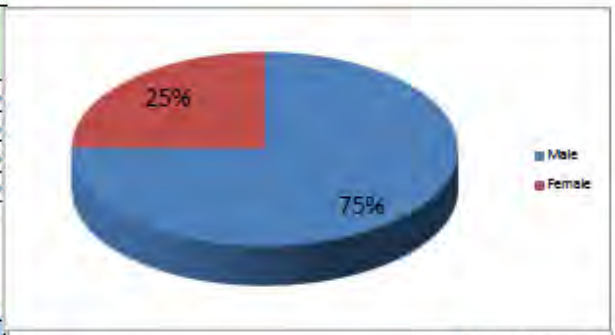
Programs	# of Members	# of Citizens & Perm. Res.	# of Female	%	# of Minorities[1]	%	US Home Institution	%
Geometric Group Theory	107	57	27	*25.2%*	4	*7.0%*	57	53.3%
Analytic Number Theory	57	22	13	*22.8%*	1	*4.5%*	24	42.1%
Harmonic Analysis	73	37	18	*24.7%*	6	*16.2%*	43	58.9%
Complementary Program (2016-17)	13	5	4	*30.8%*	0	*0.0%*	5	38.5%
Total # of Distinct Members	**250**	**121**	**62**	***24.8%***	**11**	***9.1%***	**129**	***51.6%***

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

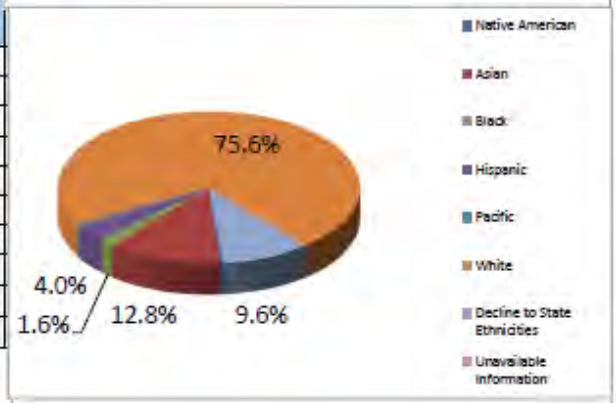
2.3 Program Members Demographic Data

2016–17 Program Members Demographic Summary

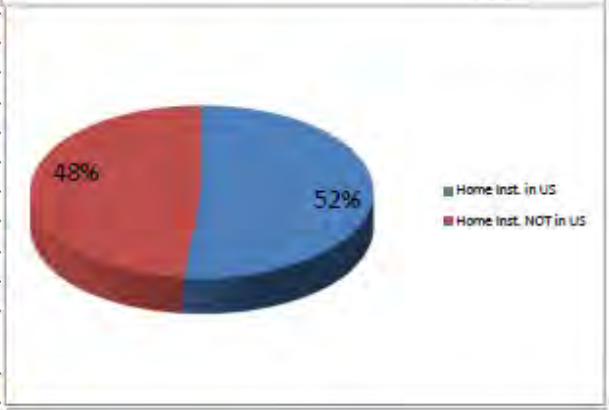
Gender	#	% (No Decl.)*	%
# of Distinct Members	250		100.0%
Male	187	75.10%	74.8%
Female	62	24.90%	24.8%
Decline to State Gender	1		0.4%



Ethnicities	#	% (No Decl.)*	%
Native American	1	0.42%	0.4%
Asian	32	13.50%	12.8%
Black	4	1.69%	1.6%
Hispanic	10	4.22%	4.0%
Pacific	1	0.42%	0.4%
White	189	79.75%	75.6%
Decline to State Ethnicities	24		9.6%
Unavailable Information	0		0.0%
Minorities	11		9.1%

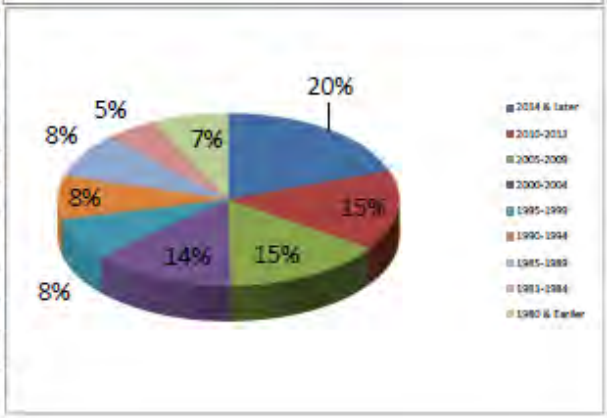


Citizenships	#		%
US Citizen & Perm. Residents	121		48.4%
Foreign	129		51.6%
Unavailable information	0		0.0%
# of Distinct Members	250		100.0%
US Citizen	106		42.4%
Perm Residents	15		6.0%
Home Inst. in US	129		51.60%



Year of Ph.D	#		%
Program Associates (GS)	45		18.0%
2014 & Later	40		16.0%
2010-2013	31		12.4%
2005-2009	31		12.4%
2000-2004	28		11.2%
1995-1999	16		6.4%
1990-1994	17		6.8%
1985-1989	17		6.8%
1981-1984	10		4.0%
1980 & Earlier	15		6.0%
Unavailable Info.	0		0.0%
Total # of Distinct Members	250		100.0%

**Statistic Calculation based on all participants that did not decline.*



Programs

Geometric Group Theory

Analytic Number Theory

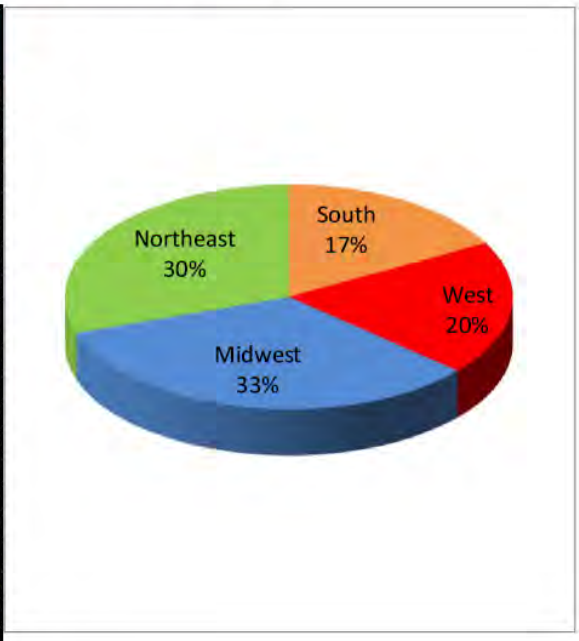
Harmonic Analysis

Complementary Program (2016-17)

2016–17 Program Members Home Institution Classified by States

**Regions based on US Census classification*

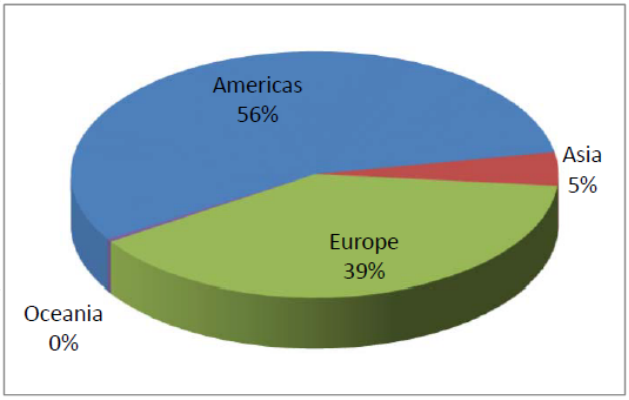
State	#	%	2010 Census Population
South	**22**	**17.1%**	**37.1%**
AL	-	0.0%	1.5%
AR	2	1.6%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	1	0.8%	6.1%
GA	2	1.6%	3.1%
KY	-	0.0%	1.4%
LA	1	0.8%	1.5%
MD	2	1.6%	1.9%
MS	-	0.0%	1.0%
NC	3	2.3%	3.1%
OK	3	2.3%	1.2%
SC	1	0.8%	1.5%
TN	1	0.8%	2.1%
TX	5	3.9%	8.1%
VA	1	0.8%	2.6%
WV	-	0.0%	0.6%
West	**25**	**19.4%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	1	0.8%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	16	12.4%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	6	4.7%	0.9%
WA	2	1.6%	2.2%
WY	-	0.0%	0.2%
Midwest	**43**	**33.3%**	**21.7%**
IL	13	10.1%	4.2%
IN	4	3.1%	2.1%
IA	-	0.0%	1.0%
KS	1	0.8%	0.9%
MI	3	2.3%	3.2%
MN	4	3.1%	1.7%
MO	2	1.6%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	5	3.9%	3.7%
SD	-	0.0%	0.3%
WI	11	8.5%	1.8%
Northeast	**39**	**30.2%**	**17.9%**
CT	4	3.1%	1.2%
ME	-	0.0%	0.4%
MA	10	7.8%	2.1%
NH	1	0.8%	0.4%
NJ	5	3.9%	2.8%
NY	10	7.8%	6.3%
PA	1	0.8%	4.1%
RI	8	6.2%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**129**	**100%**	**100%**



2016–17 Program Members Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**140**
	North America	Canada	11
		United States	129
Asia			**11**
	East Asia	Japan	1
		Republic of Korea	1
	Western Asia	Israel	5
		United Arab Emirates	1
	Southern Asia	India	2
	Southeastern Asia	Thailand	1
Europe			**98**
	Northern Europe	Finland	4
	Southern Europe	Spain	6
		Portugal	0
	Western Europe	Austria	1
		Belgium	1
		France	26
		Germany	11
		Sweden	2
		Switzerland	11
		United Kingdom	32
	Eastern Europe	Poland	2
		Russia	2
Oceania			**1**
	Australia and New Zealand	Australia	1
Grand Total			**250**



2.4 Workshop Participant List

(See e-mail attachment)

2.5 Workshop Participant Summary*

Workshops	# of Participants	# of Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%	US Home Institution	%
12 Scientific Workshops									
Connections for Women: Harmonic Analysis	65	30	*46.2%*	38	*58.5%*	3	*10.0%*	44	67.7%
Introductory Workshop: Harmonic Analysis	124	57	*46.0%*	41	*33.1%*	6	*10.5%*	85	68.5%
Recent Developments in Harmonic Analysis	106	41	*38.7%*	28	*26.4%*	2	*4.9%*	64	60.4%
Groups acting on CAT(0) spaces	140	72	*51.4%*	28	*20.0%*	4	*5.6%*	80	57.1%
Introductory Workshop: Analytic Number Theory	138	44	*31.9%*	37	*26.8%*	2	*4.5%*	52	37.7%
Connections for Women: Analytic Number Theory	70	28	*40.0%*	36	*51.4%*	3	*10.7%*	36	51.4%
Amenability, coarse embeddability and fixed point properties	95	38	*40.0%*	22	*23.2%*	0	*0.0%*	50	52.6%
Geometry of mapping class groups and Out(Fn)	145	72	*49.7%*	29	*20.0%*	4	*5.6%*	88	60.7%
Hot Topics: Galois Theory of Periods and Applications	75	24	*32.0%*	10	*13.3%*	2	*8.3%*	31	41.3%
Recent developments in Analytic Number Theory	138	52	*37.7%*	32	*23.2%*	2	*3.8%*	71	51.4%
Connections for Women: Geometric Group Theory	92	53	*57.6%*	46	*50.0%*	7	*13.2%*	65	70.7%
Introductory Workshop: Geometric Group Theory	148	83	*56.1%*	44	*29.7%*	5	*6.0%*	93	62.8%
All 12 Workshops Total	**1,336**	**594**	***44.5%***	**391**	***29.3%***	**40**	***6.7%***	**759**	***56.8%***
1 Education & Outreach Workshop[2]									
Critical Issues in Mathematics Education 2017: Observing for Access, Power, and Participation in Mathematics Classrooms as a Strategy to Improve Mathematics Teaching and Learning	**116**	**112**	***96.6%***	**71**	***61.2%***	**32**	***28.6%***	**113**	***97.4%***
All 13 Workshops Total	**1,452**	**706**	***48.6%***	**462**	***31.8%***	**72**	***10.2%***	**872**	***60.1%***

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

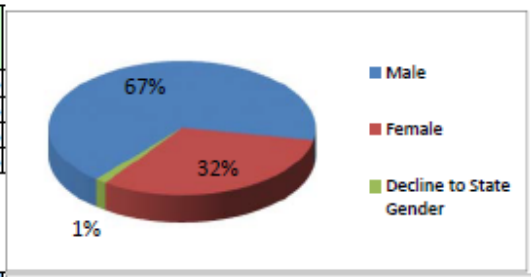
[2] *Demographics for the National Math Festival can be found in the National Math Festival report in the appendix.*

*Note that the overall workshop data in section 2.5 is not distinct as some participants attended multiple workshops, but the statistics of individual workshop found in Section 11, Appendix, were calculatued on distinct participant data.

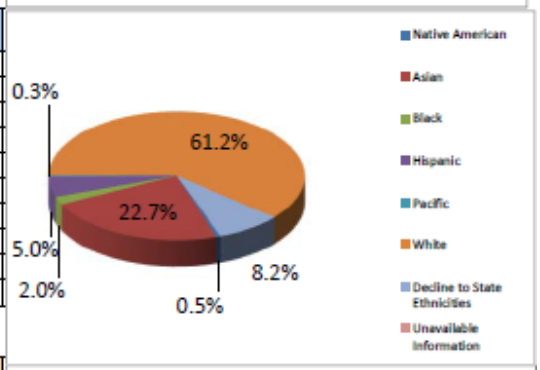
2.6 Workshop Participant Demographic Data

2016–17 Workshop Participants Demographic Summary

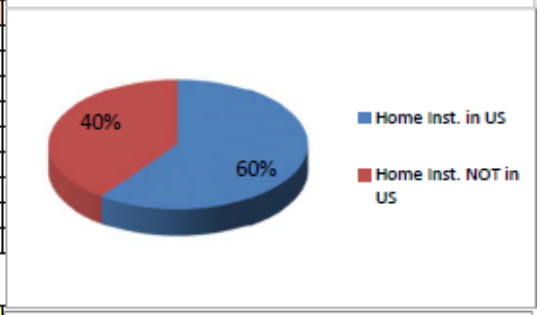
Gender	#	% (No Decl.)*	%
# of Participants	1452		100.0%
Male	970	67.74%	66.8%
Female	462	32.26%	31.8%
Decline to State Gender	20		1.4%



Ethnicities	#	% (No Decl.)*	%
Native American	8	0.57%	0.5%
Asian	348	24.79%	22.7%
Black	30	2.14%	2.0%
Hispanic	77	5.48%	5.0%
Pacific	5	0.36%	0.3%
White	936	66.67%	61.2%
Decline to State Ethnicities	126		8.2%
Unavailable Information	0		0.0%
Minorities	72		10.2%

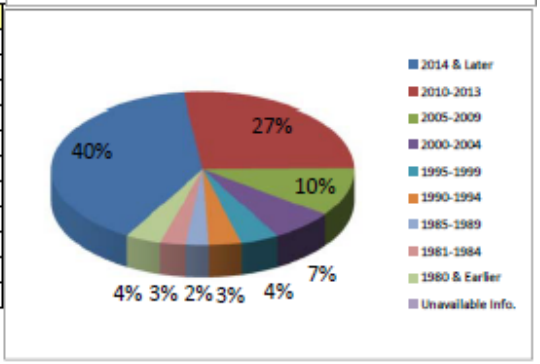


Citizenships	#		%
US Citizen & Perm. Residents	706		48.6%
Foreign	740		51.0%
Unavailable information	6		0.4%
# of Participants	1452		100.0%
US Citizen	630		43.4%
Perm Residents	76		5.2%
Home Inst. in US	872		60.06%



Year of Highest Degree	#		%
2014 & Later	576		39.7%
2010-2013	389		26.8%
2005-2009	149		10.3%
2000-2004	98		6.7%
1995-1999	59		4.1%
1990-1994	51		3.5%
1985-1989	35		2.4%
1981-1984	40		2.8%
1980 & Earlier	55		3.8%
Unavailable Info.	0		0.0%
Total # Participants	1452		100.0%

**Statistic Calculation based on all participants that did not decline.*



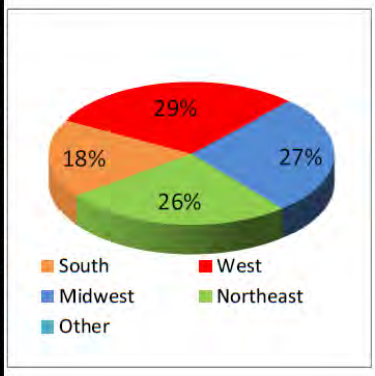
2016–17 Workshops

Connections for Women: Harmonic Analysis
Introductory Workshop: Harmonic Analysis
Recent Developments in Harmonic Analysis
Groups acting on CAT(0) spaces
Introductory Workshop: Analytic Number Theory
Connections for Women: Analytic Number Theory
Amenability, coarse embeddability and fixed point properties
Geometry of mapping class groups and Out(Fn)
Hot Topics: Galois Theory of Periods and Applications
Recent developments in Analytic Number Theory
Connections for Women: Geometric Group Theory
Introductory Workshop: Geometric Group Theory
Critical Issues in Mathematics Education 2017: Observing for Access, Power, and Participation in Mathematics Classrooms as a Strategy to Improve Mathematics Teaching and Learning

2016–17 Workshop Participants Home Institution Classified by States

**Regions based on US Census classification*

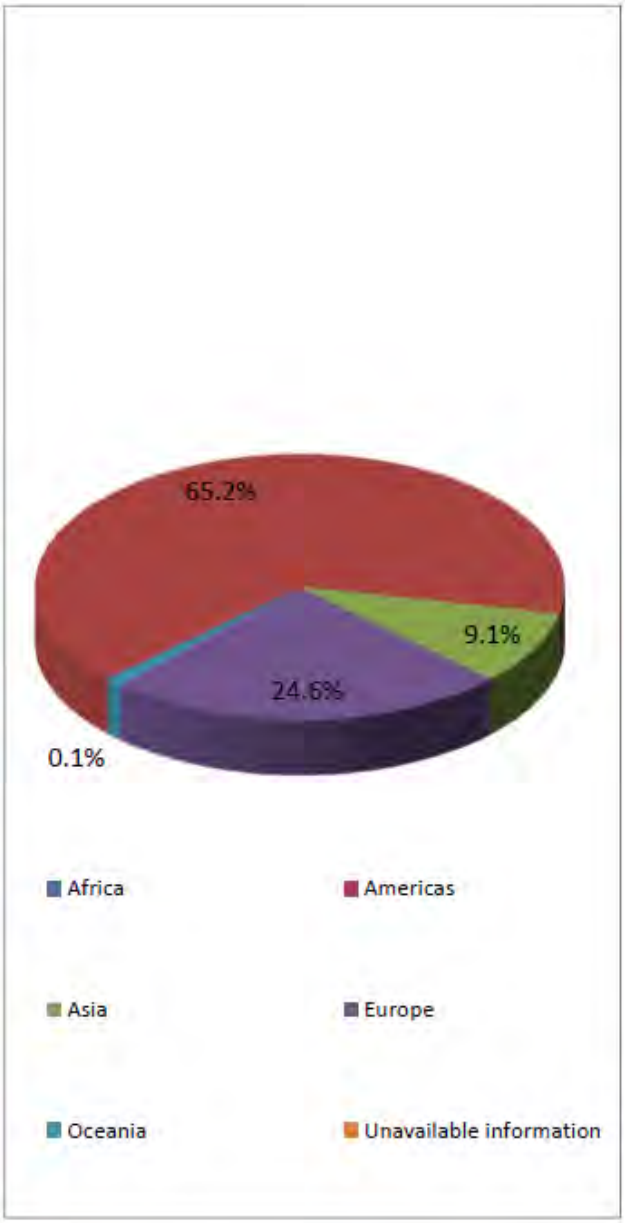
State	#	%	2010 Census Population
South	**155**	**17.8%**	**37.1%**
AL	-	0.0%	1.5%
AR	5	0.6%	0.9%
DE	-	0.0%	0.3%
DC	2	0.2%	0.2%
FL	5	0.6%	6.1%
GA	26	3.0%	3.1%
KY	2	0.2%	1.4%
LA	9	1.0%	1.5%
MD	7	0.8%	1.9%
MS	1	0.1%	1.0%
NC	11	1.3%	3.1%
OK	24	2.8%	1.2%
SC	8	0.9%	1.5%
TN	9	1.0%	2.1%
TX	34	3.9%	8.1%
VA	12	1.4%	2.6%
WV	-	0.0%	0.6%
West	**255**	**29.2%**	**23.3%**
AK	-	0.0%	0.2%
AZ	7	0.8%	2.1%
HI	3	0.3%	0.4%
ID	1	0.1%	0.5%
MT	-	0.0%	0.3%
CA	182	20.9%	12.1%
CO	5	0.6%	1.6%
NV	-	0.0%	0.9%
NM	1	0.1%	0.7%
OR	9	1.0%	1.2%
UT	30	3.4%	0.9%
WA	17	1.9%	2.2%
WY	-	0.0%	0.2%
Midwest	**235**	**26.9%**	**21.7%**
IL	88	10.1%	4.2%
IN	12	1.4%	2.1%
IA	-	0.0%	1.0%
KS	3	0.3%	0.9%
MI	33	3.8%	3.2%
MN	16	1.8%	1.7%
MO	8	0.9%	1.9%
ND	-	0.0%	0.2%
NE	4	0.5%	0.6%
OH	28	3.2%	3.7%
SD	-	0.0%	0.3%
WI	43	4.9%	1.8%
Northeast	**227**	**26.0%**	**17.9%**
CT	20	2.3%	1.2%
ME	1	0.1%	0.4%
MA	49	5.6%	2.1%
NH	5	0.6%	0.4%
NJ	29	3.3%	2.8%
NY	80	9.2%	6.3%
PA	26	3.0%	4.1%
RI	17	1.9%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Unavailable	-	0.0%	0%
Total	**872**	**100%**	**100%**



2016–17 Workshop Participants Home Institution Classified by Countries

**Regions based on United Nations classification*

Africa			**2**
	Western Africa	Senegal	2
Americas			**947**
	Central America	Mexico	2
	North America	Canada	57
		United States	872
	South America	Brazil	13
		Chile	2
		Uruguay	1
Asia			**132**
	East Asia	China	12
		Japan	27
		Korea	34
	South-central Asia	India	17
		Kazakhstan	2
		Iran	2
	South-eastern Asia	Thailand	1
	Western Asia	Israel	32
		Saudi Arabia	4
		Turkey	1
Europe			**357**
	Eastern Europe	Hungary	2
		Poland	6
		Russian Federa	2
	Northern Europe	Denmark	4
		Finland	17
		Norway	2
		Sweden	13
		United Kingdom	111
	Southern Europe	Italy	6
		Spain	10
	Western Europe	Austria	5
		Belgium	3
		France	81
		Germany	39
		Netherlands	1
		Switzerland	55
Oceania			**14**
	Australia & NZ	Australia	13
		New Zealand	1
Unavailable information			**0**
Grand Total			**1452**



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 mathematics research. The programs MSRI organizes and hosts produce the leading research in that field of study. MSRI's postdocs engage with fellow mathematicians from all over the world to develop their interests and contribute to the Science community. During the 2016–17 academic year, MSRI selected 34 postdoctoral scholars with research interests in the programs that MSRI offers. Of those postdocs, 20 were funded by the NSF Core Grant, 4 were funded by the NSA, and 10 were funded by private funds. There were 8 named postdoctoral fellows who received additional funding from the Berlekamp, Gamelin, Huneke, McDuff, Uhlenbeck, and Viterbi Endowments, as well as the Strauch Post-Doctoral Fellowship Grant.

Of the 34 Postdoctoral Fellows at MSRI, 12 (35%) were female, 11 (32%) were a U.S. Citizen or Permanent Resident, and 26 (77%) 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 NSF Postdoctoral Fellows for each program.

GEOMETRIC GROUP THEORY

Cantrell, Michael

Name: Michael Cantrell
Year of Ph.D: 2016
Institution of Ph.D.: University of Illinois, Chicago
Dissertation title: Ergodic Theory and Geometry of Nilpotent Groups
Ph.D. advisor: Alex Furman

Mentor while at MSRI: Yves Benoist

Institution prior to obtaining the MSRI PD fellowship: University of Illinois, Chicago
Position at that institution: PhD student
Mentor (if applicable): Alex Furman

Institution (or company) where you are going after the MSRI PD fellowship: Metis Data Science Bootcamp
Position: Student
Anticipated length: 3 months

Postdoctoral fellow's comments:
Was your experience at MSRI beneficial?

By far the most beneficial part of my time at MSRI has been getting to meet and work with a huge number of specialists in and around my research area. For example, beginning my first day at the institute, I met Robert Young. I had previously corresponded with him via email, but it is difficult to do math via email. That first day we almost missed the last bus down the hill because we spoke/worked so long. These days, he keeps up on my progress and lends me his incredible intuition when I am stuck. I doubt I would have ever had the opportunity to have these discussions with Robert had we not met at MSRI. Moreover, I expect our relationship to continue after we both leave the institute.

I could not ask for a better mentor than Yves Benoist, my mentor at MSRI. He is an expert in a handful of research topics, including the area of my current project. We usually meet once a week. He has been able to clearly explain complicated cohomological techniques and calculations that I would have spent weeks trying to understand without his help. Not only has he helped me progress on my new research projects, but he has found other applications of my previous work that I was unaware of. I am confident that this relationship will endure after we leave MSRI.

I really doubt I would have formed either of this relationships had it not been for my time at MSRI, and for this I am extremely grateful.

Disarlo, Valentina

Your Name: Valentina Disarlo
Year of Ph.D: 2013
Institution of Ph.D.: Universite de Strasbourg and Scuola Normale Superiore Di Pisa
Dissertation title: Combinatorial Methods in Teichmuller Theory
Ph.D. advisor: Athanase Papadopoulos

Mentor while at MSRI: Kasra Rafi

Institution prior to obtaining the MSRI PD fellowship: Indiana University Bloomington
Position at that institution: Zorn Postdoctoral Fellow
Mentor (if applicable): Chris Judge

Institution (or company) where you are going after the MSRI PD fellowship: Universitaat Heidelberg
Position: Postdoc
Anticipated length: 2 YEARS + 1
Mentor (if applicable): Anna Weinhard

Postdoctoral fellow's comments:

I worked on a joint project with Robert Tang, who was also visiting here. During our stay, we entirely write the paper "Cubical geometry on the polygonalisation complex". It will appear on ArXiv by December 15th. Apart from that, I have also started four new projects with Catherine Pfaff, Chris Leininger, Funda Gultepe and Anja Randecker who were visiting MSRI. I had the chance to present my work to many senior mathematicians and had very fruitful conversations with other colleagues. This was one of greatest experiences of my life!

Durham, Matthew

Name: Matthew Durham
Year of Ph.D: 2014
Institution of Ph.D.:University of Illinois at Chicago
Dissertation title: The Coarse Geometry of Teichmuller Space
Ph.D. advisor: Daniel Groves

Mentor while at MSRI: Kenneth Bromberg

Institution prior to obtaining the MSRI PD fellowship: University of Michigan
Position at that institution: Assistant Professor
Mentor (if applicable): Dick Canary

Institution (or company) where you are going after the MSRI PD fellowship: University of Michigan
Position at that institution: RTG postdoctoral fellow

Postdoctoral fellow comments:

My semester at MSRI has been one of the most rewarding mathematical experiences of my life.
Nearly every important person in geometric group theory is either in residence or has visited MSRI at some point during the semester. This has provided for a wonderful opportunity to begin new collaborations and work through difficult problems. Specifically toward the former, I have begun three collaborative projects since I arrived at MSRI, with one hopefully finishing by the end of the semester.
The concentration of talent at MSRI has also gathered several of my other collaborators here at various points, and I have been able to finish two other projects during my time here.
Along with the people at MSRI, I love the working environment here. The quiet hum of mathematical chatter and being surrounded by people working hard in their offices has been beneficial to my productivity, helping me make significant progress on a major problem I have been working on for nearly three years now. Moreover, I have had many productive mathematical conversations with people with whom I would normally have a chance to interact simply because they are here. My best days at MSRI have been spent meeting with one group of colleagues after another, going home exhausted and satisfied.
It cannot go without saying that the location is fantastic. Not only is the view spectacular, but I have made regular use of the hiking trails nearby, which are great for clearing my head, refreshing my spirit, and regaining focus after a long work session or lunch.
Finally, I was applying for jobs this semester. While this was a necessary and often frustrating use of my time, the senior members were especially supportive, and having my fellow postdocs (who were also on the job market) to commiserate with made the process less painful.

Fullarton, Neil

Name: Neil J. Fullarton
Year of Ph.D: 2014
Institution of Ph.D.: University of Glasgow
Dissertation title: Palindromic automorphisms of free groups and rigidity of automorphism groups of right-angled Artin groups
Ph.D. advisor: Tara Brendle

Mentor while at MSRI: Ruth Charney

Institution prior to obtaining the MSRI PD fellowship: Rice University
Position at that institution: G.C. Evans Instructor (postdoc)
Mentor (if applicable): Andrew Putman

Institution (or company) where you are going after the MSRI PD fellowship: Rice University
Position: G.C. Evans Instructor (postdoc)
Anticipated length: One more semester, position ends June 2017.
Mentor (if applicable): Andrew Putman (although he has moved to Notre Dame)

Please give a brief description of your work while you were at MSRI as well as any publications made.
I, at least partially, worked on the following papers while at MSRI this semester: The high-dimensional cohomology of the moduli space of curves with level structures. (w/ Andrew Putman) Submitted.

Observed periodicity related to the four-strand Burau representation. (w/ Richard Shadrach) Submitted.

Hyperelliptic graphs and the period mapping on outer space. (w/ Corey Bregman) Submitted.

I also initiated, at least informally, collaborations with Robert Kropholler and Ric Wade.

Was your experience at MSRI beneficial? Why or why not?

My experience here was very beneficial. The main advantage was being surrounded by experts in my field, and also more junior colleagues, for such an extended period of time. Discussions and collaborations and the chance to arise in organic ways not possible during, for example, a short visit to an institution to give a seminar talk.

Gultepe, Funda

Name: Funda Gultepe
Year of Ph.D: 2013
Institution of Ph.D.: University of Oklahoma
Dissertation title: Normal Tori in #_n (S^2 x S^1) and the Dehn Twist Automorphisms of the Free Group
Ph.D. advisor: Kasra Rafi

Mentor while at MSRI: Ursula Hamenstadt

Institution prior to obtaining the MSRI PD fellowship: UIUC
Position at that institution: Visiting Assistant Professor
Mentor (if applicable): Chris Leininger

Institution (or company) where you are going after the MSRI PD fellowship: UIUC
Anticipated length: 6 months

Postdoctoral fellow's comments:
Was your experience at MSRI beneficial? Why or why not?

My stay was very beneficial, I have written two new papers, developed an earlier draft, and got new ideas for new projects. This is mainly because I had a chance to work with people closer that I otherwise would not.

Hume, David

Name: David Hume
Year of Ph.D.: 2013
Institution of Ph.D.: University of Oxford
Dissertation title: Embeddings of infinite groups into Banach spaces
Ph.D. advisor: Cornelia Druțu

Mentor while at MSRI: Alain Valette

Institution prior to obtaining the MSRI PD fellowship: Université Paris Sud, Orsay
Position at that institution: Postdoctoral researcher
Mentor (if applicable): Romain Tessera

Institution (or company) where you are going after the MSRI PD fellowship: University of Oxford
Position: Titchmarsh Research Fellow
Anticipated length: 3 years

Postdoctoral fellow's comments:

The msri experience has undoubtedly been the best creative and informative experience of my career to date. It has enabled me to complete certain projects which had been waiting (in some cases a long time) for a suitable opportunity, I have made great progress with many collaborators in and around the semester programme, and started new and interesting projects which will keep me busy until you decide to have another programme on geometric group theory!

Kropholler, Robert

Name: Robert Kropholler
Year of Ph.D: 2016
Institution of Ph.D.: Oxford University
Dissertation title: Finiteness Properties and CAT(0) Groups
Ph.D. advisor: Martin Bridson

Mentor while at MSRI: Robert Young

Institution prior to obtaining the MSRI PD fellowship: Oxford University
Position at that institution: PhD Student
Mentor (if applicable): Martin Bridson

Institution where you are going after the MSRI PD fellowship: Tufts University
Position: Assistant Professor
Anticipated length (if it is a tenure track position just write tenure-track): 3.5 Years
Mentor (if applicable): Genevieve Walsh

Postdoctoral fellow's comments:

I did not make any publications during my time however I have started many helpful joint projects. The working seminar on formal languages provided me with an interesting new topic to work on and should result in 2 papers in the near future. Further I was able to speak to other collaborators about projects on other topics which should result in another 2 papers. My time at the MSRI was wonderful and I felt it was very beneficial to be around such eminent people in my field. I learnt a lot in my time there and may some connections which will not only help in future for finding jobs but also for collaborative research.

Le, Giang

Name: Giang Le
Year of Ph.D: 2016
Institution of Ph.D.: Ohio State University
Dissertation title: The action dimension of Artin groups
Ph.D. advisor: Michael W. Davis

Mentor while at MSRI: Michael Kapovich

Institution prior to obtaining the MSRI PD fellowship: Ohio State University
Position at that institution: Graduate student
Mentor (if applicable):

Institution (or company) where you are going after the MSRI PD fellowship: unknown (still waiting for job application results)

Postdoctoral fellow's comments:

While at MSRI I edited my thesis, made it into a paper and submitted to a journal. I also worked with my advisor and one other postdoc on a project about action dimension. We are writing a draft right now.

Was your experience at MSRI beneficial? Why or why not?

My experience at MSRI was beneficial. I had opportunities to talk with experts in my field, learnt many new things and formed several problems for my future work.

Sapir, Eugenia

Name: Eugenia Sapir
Year of Ph.D.: 2014
Institution of Ph.D.: Stanford University
Dissertation title: Non-simple geodesics on surfaces
Ph.D. advisor: Maryam Mirzakhani

Mentor while at MSRI: Howard Masur

Institution prior to obtaining the MSRI PD fellowship: University of Illinois at Urbana-Champaign
Position at that institution: J. L. Doob Research Assistant Professor
Mentor (if applicable): Chris Leininger

Institution where you are going after the MSRI PD fellowship: University of Illinois at Urbana-Champaign
Position: J. L. Doob Research Assistant Professor
Anticipated length: (if it is a tenure track position just write tenure-track) 3 years
Mentor (if applicable): Chris Leininger

Postdoctoral fellow's comments:

I started several new projects while at MSRI. These include a long term project on distributions of length-minimizing metrics in Teichmuller space. I also have a near-term project that I started with Robert Tang about projecting strata of quadratic differentials down to Teichmuller space. Also, MSRI funded a trip to Seattle, where I restarted a joint project with Steve Lalley and Jayadev Athreya and went to a one-day workshop in probability at Microsoft.
My visit has also put me in touch we several future potential collaborators.
None of these projects are ready for publication yet, although I expect them to, eventually.

Was your experience at MSRI beneficial? Why or why not?
Yes, it was very beneficial. On top of the new work, I participated in several working seminars and had access to leading mathematicians in my field. This directly helped the progress of my projects, and gave me leads on new directions to pursue.

Schreve, Kevin

Name: Kevin Schreve
Year of Ph.D: 2015
Institution of Ph.D.: University of Wisconsin-Milwaukee
Dissertation title: The L^2-Cohomology of Discrete Groups
Ph.D. advisor: Boris Okun

Mentor while at MSRI: Alessandra Iozzi

Institution prior to obtaining the MSRI PD fellowship: University of Michigan-Ann Arbor
Position at that institution: Visiting RTG Postdoc
Mentor (if applicable): Ralf Spatzier

Institution (or company) where you are going after the MSRI PD fellowship: University of Michigan-Ann Arbor
Position: Visiting RTG Postdoc
Anticipated length: May 2018
Mentor: Ralf Spatzier

Postdoctoral fellow's comments:

My main project was with Michael Davis and Giang Le, where we extended work that I had done with Davis, Grigori Avramidi and Boris Okun. With Michael and Giang, we studied the minimal dimension of contractible manifold that a graph product can act properly discontinusouly on. I also started a project with Robert Kropholler on computing the invariants due to Bieri-Geoghegan for right angled Artin groups.

Was your experience at MSRI beneficial?

It was very beneficial to my research. The member and postdoc seminars gave me a much broader view of geometric group theory. My mentor was very helpful in helping me with both my research and professional activities such as preparing document for job applications and NSF postdoc.

Strzałkowski, Karol

Name: Karol Strzałkowski
Year of Ph.D.: 2016
Institution of Ph.D.: Institute of Mathematics of the Polish Academy of Sciences
Dissertation Title: Lipschitz simplicial volume
Ph.D. Advisor: Andrzej Weber, Piotr Nowak

Mentor while at MSRI: Koji Fujiwara

Position prior to MSRI: Institute of Mathematics of the Polish Academy of Sciences
Position at that institution: PhD student
Mentor (if applicable): Andrzej Weber, Piotr Nowak

Institution (or company) where you are going after the MSRI PD fellowship: Institute of Mathematics of the Polish Academy of Sciences
Position: NCN Grant director
Anticipated length: 3 months

Postdoctoral fellow's comments:

I was working on the paper "Lipschitz simplicial volume of connected sums" (in preparation), where I am proving that the Lipschitz simplicial volume is additive with respect to ceratin gluings of manifolds. I also got involved in the study of multiple context free languages.

My experience in MSRI was very beneficial, mostly because of:
-diversity of the people on the program, the knowledge and ideas they bring.
-presence of both short and long term visitors. On the one hand it allowed me to discuss mathematics with more people, on the other it helped me to build better relations with some longer-staying participants, which may result in the future cooperation.
-hospitality of MSRI staff

Wade, Richard

Name: Richard Wade
Year of Ph.D.: 2012
Institution of Ph.D.: University of Oxford
Dissertation title: Symmetries of free and right-angled Artin groups
Ph.D. advisor: Martin Bridson

Mentor while at MSRI: Gilbert Levitt

Institution prior to obtaining the MSRI PD fellowship: University of British Columbia
Position at that institution: Postdoctoral fellow
Mentor (if applicable): Alexandra Pettet

Institution (or company) where you are going after the MSRI PD fellowship: University of British Columbia
Position: Postdoctoral fellow
Anticipated length: 6 months (I was there previously for a year)
Mentor (if applicable): Alexandra Pettet

Postdoctoral fellow's comments:

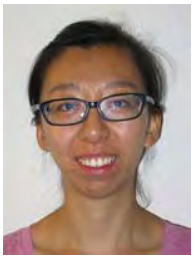
I was working with Mladen Bestvina and Camille Horbez on the boundary of the free factor graph. We finished one paper, "On the the topological dimensions of some Out(F_n) graphs," and are working on a follow-up to this. I was also working on a paper with Matt Day called "Relative automorphism groups of right-angled Artin groups," for which we now have a working draft. There is also a project with Yael-Algol Kfir and Catherine Pfaff on isometries of outer space, for which we currently are at the note-taking stage.

Was your experience at MSRI beneficial? Why or why not?
A short list of points about what I feel has been most beneficial:

-I've been able to work on several long term projects with collaborators that are usually spread around the globe. This will undoubtably accelerate my career in terms of publication record in a way that would be impossible at my home institution. At my home institution I don't have a grant, only have a small postdoc stipend, and I don't have any serious local collaborations. The support from MSRI has been invaluable.

-I gave a long-form job talk at the postdoc seminar, which was excellent both in terms of feedback and in terms of exposing established mathematicians in my field to my work. I'm on the job market this year, and MSRI makes it very easy to ask for advice and make contacts at prospective institutions. I've been shortlisted for a position in the UK, and have to give a 20 minute talk to a general audience: I was able to get instant feedback from multiple people in terms of ideas for what to do with respect to these constraints, which would not happen outside the environment of MSRI.

-My postdoc mentor is a great fit: it's someone whose work and ideas are close to mine, but we had not spoken before this semester (this is partly due to being based in different countries, and partly due to the fact that we're both fairly reserved individuals), and I'm not sure we would speak if it wasn't for the mentorship scheme. It's made it easy to have conversations with someone that I want to learn from but wouldn't normally have the opportunity to speak to.



Wang, Pei

Name: Pei Wang
Year of Ph.D: 2016
Institution of Ph.D.: Rutgers university-Newark campus
Dissertation title: Relative Rips machine and thin type components
Ph.D. Advisor: Mark Feighn

Mentor while at MSRI: Zlil Sela

Institution prior MSRI: N.A.
Position at that institution: N.A.
Mentor (if applicable): N.A.

Institution (or company) where you are going after the MSRI PD fellowship: University of the Basque Country, Spain
Position/Mentor: Postdoc
Anticipated length: 1 year
Mentor (if applicable): not sure yet

Postdoctoral fellow's comments:

1. Learned plenty of new topics in GGT and talked to lots of great people.
2. Working on a problem about limit groups with Sela, got some partial results.
3. Almost finished polishing my thesis into a paper.

Was your experience at MSRI beneficial? Why or why not?
Yes.
It was such a great experience that you got the chance to ask authors about their recent papers in person, discuss problems with peers with similar interests. And lots of social events is a plus.

ANALYTIC NUMBER THEORY

Andersen, Nickolas

Name: Nickolas Andersen
Year of Ph.D.: 2016
Institution of Ph.D.: University of Illinois at Urbana-Champaign
Dissertation title: Arithmetic of Maass forms of half-integral weight
Ph.D. advisor: Scott Ahlgren

Mentor while at MSRI: Philippe Michel
Institution prior to obtaining the MSRI PD fellowship: UCLA
Position at that institution: Assistant adjunct professor (postdoc)
Mentor (if applicable): Bill Duke

Institution (or company) where you are going after the MSRI PD fellowship: UCLA
Position: Assistant adjunct professor (postdoc)
Anticipated length: (if it is a tenure track position just write tenure-track): 2016 - 2019 (3 years)
Mentor (if applicable): Bill Duke

Postdoctoral fellow's comments:

While at MSRI I began collaborations with the following people:
- Mehmet Kiral (postdoc): Level reciprocity for twisted moments of modular L-functions
- Jesse Thorner (postdoc): Explicit estimates for sums of Kloosterman sums and faster computation of the partition function
- Tim Browning (professor) and Vinay Kumaraswamy (grad student) and Raphael Steiner (grad student): Covering exponent for S^2

I also continued some joint work with Bill Duke that we started before my MSRI visit, and I continued working on a few solo papers that I started before MSRI.
While none of the above mentioned papers have been published yet, several are quite close to completion and will be submitted soon.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was extremely beneficial. I had the opportunity to talk with many people outside my immediate research area, and many of these talks led to research ideas which I wouldn't have considered otherwise. The atmosphere of MSRI is perfectly suited for focusing on research, and I believe that I was much more productive there than I usually am.

Do you believe it had helped you find a position?
I haven't applied for a new position since being at MSRI, but I believe that the experience and the contacts that I made will be very beneficial to my future job applications.

Brandes, Julia

Name: Julia Brandes
Year of Ph.D.: 2014
Institution of Ph.D.: University of Bristol
Dissertation title: Local-global principles for linear spaces on hypersurfaces
Ph.D. advisor: Trevor D. Wooley, FRS

Mentor while at MSRI: Ciprian Demeter
Institution prior to obtaining the MSRI PD fellowship: University of Gothenburg
Position at that institution: Postdoc
Mentor (if applicable): Per Salberger

Institution (or company) where you are going after the MSRI PD fellowship: University of Gothenburg
Position: Postdoc
Anticipated length: (if it is a tenure track position just write tenure-track): until Aug 31st
Mentor (if applicable): Per Salberger

Postdoctoral fellow's comment:

I started three projects with Trevor Wooley on systems of additive equations, the first of which is already submitted ("Vinogradov systems with a slice off"). I also established contacts with several members of the Harmonic Analysis programme, particularly those with an interest in l^2-decoupling, and it looks likely that there will be a joint publication with Jonathan Hickman and Jim Wright where I am able to solve a number theoretic stumbling block they had encountered.

Was your experience at MSRI beneficial? Why or why not?
Overall, the programme has been beneficial.

Do you believe it had helped you find a position?
I found a follow-up position during the programme, but independently of it - the contact was established through my PhD supervisor and corroborated during my visit at the Fields Institute in Toronto.

Chow, Sam

Name: Sam Chow
Year of Ph.D.: 2016
Institution of Ph.D.: University of Bristol
Dissertation title: Shifts, averages and restriction of forms in several variables
Ph.D. advisor: Trevor Wooley

Mentor while at MSRI: Carl Pomerance
Institution prior to obtaining the MSRI PD fellowship: University of York, United Kingdom
Position at that institution: Postdoctoral research associate
Mentor (if applicable): Sanju Velani and Victor Beresnevich

Institution (or company) where you are going after the MSRI PD fellowship: University of York, United Kingdom
Position: Postdoctoral research associate
Anticipated length: (if it is a tenure track position just write tenure-track): 16 months
Mentor (if applicable): Sanju Velani and Victor Beresnevich

Postdoctoral fellow's comments:
Papers submitted this semester:

- Bohr sets and multiplicative diophantine approximation, submitted. Presented in the postdoc seminar. To be presented at Combinatorial and Additive Number Theory, in New York, on May 26. To be presented at a large workshop on diophantine approximation and related fields, in York, UK, in June. Discussed informally with Andrew Pollington and Terence Tao.
- (with Carl Pomerance [MSRI]) Triangles with prime hypotenuse, new project, submitted. Mentioned in my coauthor's talk in the number theory seminar.

Projects nearing completion:

- (with Rainer Dietmann [Fields Institute, Toronto]) Enumerative Galois theory for quartic polynomials, ongoing project, in preparation. Mentioned in 5-minute talks. Discussed informally with Manjul Bhargava, Tim Browning and Frank Thorne.
- (with Luka Rimanic [Simons Institute, Berkeley]) The lonely runner problem in function fields, ongoing project, in preparation. Presented by my coauthor in the joint MSRI/Simons seminar.

Projects in the early stages:

- (with Leo Goldmakher [MSRI], Dimitris Koukoulopoulos [MSRI], James Maynard [MSRI] and Andrew Pollington [MSRI]) On the Duffin--Schaeffer conjecture, new project, in progress.
- (with Sean Prendiville [Simons Institute, Berkeley] and Sofia Lindqvist [MSRI programme associate]) Partition regularity of higher degree equations, ongoing project, in progress.

- (with Sean Prendiville [Simons Institute, Berkeley] and Kirsti Biggs [visitor at Fields Institute, Toronto]) The Combinatorial Big Theory of Everything, new project, in progress.
- (with Thomas Bloom [Simons Institute, Berkeley], Ayla Gafni [MSRI] and Aled Walker [MSRI programme associate]) Additive energy and the metric Poissonian property, new project, in progress.
- (with Ayla Gafni [MSRI] and David Lowry-Duda [MSRI programme associate]), Prime paucity on fibres, new project, in progress.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was highly beneficial. There were plenty of excellent talks, there was the opportunity to present my work, there were new collaborators, useful people to talk to, and excellent resources. All in all, it has been a very inspiring semester. In addition, my living conditions have been very good. On the side, the Pseudorandomness programme at the Simons Institute was relevant, and I also found the Workshop on Efficient Congruencing and Translation-Invariant Systems (Fields Institute, Toronto) useful for collaborations and pushing new ideas.

Do you believe it had helped you find a position?
I believe that the programme will help me greatly when I look for a position. I have made many valuable contacts here, have a better idea of how things work, have more research in the pipeline, and can hope to acquire stronger letter-writers.

Gafni, Ayla

Name: Ayla Gafni
Year of Ph.D.: 2016
Institution of Ph.D.: Penn State University
Dissertation title: Asymptotic formulae in analytic number theory
Ph.D. advisor: Robert C. Vaughan

Mentor while at MSRI: Terence Tao / Kannan Soundararajan
Institution prior to obtaining the MSRI PD fellowship: University of Rochester
Position at that institution: Visiting Assistant Professor
Mentor (if applicable): Steve Gonek

Institution (or company) where you are going after the MSRI PD fellowship: University of Rochester
Position: Visiting Assistant Professor
Anticipated length: (if it is a tenure track position just write tenure-track): 2 years
Mentor (if applicable): Steve Gonek

Postdoctoral fellow's comments:

I worked on several collaborative projects with other MSRI participants. The projects are summarized in the attached document *[see end of this section]*.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was very beneficial. I made valuable connections with senior mathematicians in the field and with peers who will be collaborators for many years (hopefully). I have not had many mathematical collaborations before this, and now I have six projects with various collaborators. I expanded the breadth of my expertise this semester through reading about new topics and talking to experts. My mentors (Terence Tao and Kannan Soundararajan) gave me excellent advice about how to manage my time, become a more successful research mathematician, and make the most out of the opportunities available at MSRI.

Do you believe it had helped you find a position?
I am not currently on the job market, but I am confident that the relationships formed and the mathematics learned this semester will help me find a good position when my postdoc at University of Rochester ends.

Hu, Yueke

Name: Yueke Hu
Year of Ph.D.: 2015
Institution of Ph.D.: University of Wisconsin-Madison
Dissertation title: Period Integrals, L−Functions, and Applications to Subconvexity Bound and Mass Equidistribution
Ph.D. advisor: Tonghai Yang

Mentor while at MSRI: Kaisa Matomaki
Institution prior to obtaining the MSRI PD fellowship: ETH
Position at that institution: Post-doc
Mentor (if applicable): Emmanuel Kowalski

Institution (or company) where you are going after the MSRI PD fellowship: ETH
Position: Post-doc
Anticipated length: (if it is a tenure track position just write tenure-track): 3 years
Mentor (if applicable): Paul Nelson

Postdoctoral fellow's comments:

At MSRI, the main project I've been working on is the sup norm of automorphic forms on general linear groups in the depth aspect. At this moment I think we can work out the sup norm in terms of conductor with a power saving, when we assume the local component at ramified place is supercuspidal. I believe it can also be extended to much more general groups, like quaternion algebra as an easy example, where classical eigenvalue aspect never happens. I've made some progress on the case when the local component is a principal series representation.

I've also been working with Dinakar Ramakrishnan on certain relative trace formula, to see if it can be used to prove subconvexity bound or nonvanishing results of triple product L-function. We've made some progress, but also encountered a major obstacle which we don't know how to deal with at this moment. We will try to collaborate after MSRI program.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI is very beneficial. I met many people here. The library has been helpful. My main project on sup norm has benefitted from discussions with Simon Marshall, Paul Nelson, Nicolas Templier. Especially, Simon Marshall shared his preprint with me, which turns out to be a main ingredient of the project.

Do you believe it had helped you find a position?
I already know I should get a position at ETH in the next few years, but I do believe the experience here will be helpful in my future job hunting.

Kiral, Eren

Name: Eren Mehmet Kiral
Year of Ph.D.: 2014
Institution of Ph.D.: Brown University
Dissertation title: Spectral Theory and Shifted Convolution Sum in Analytic Number Theory
Ph.D. advisor: Jeffrey Hoffstein

Mentor while at MSRI: Dinakar Ramakrishnan
Institution prior to obtaining the MSRI PD fellowship: Texas A&M University
Position at that institution: Visiting Assistant Professor
Mentor (if applicable): Matthew Young

Institution (or company) where you are going after the MSRI PD fellowship: not determined
Position: n/a
Anticipated length: (if it is a tenure track position just write tenure-track): n/a
Mentor (if applicable): n/a

Postdoctoral fellow's comments:

I worked on reciprocity between the twist and the level parameters in twisted fourth moments of modular L functions with Nick Andersen. The paper will be published shortly.

I worked on counting cap variance of integral lattice points on spheres with Maksym Radziwill.

I had a connection with Jeffrey Lagarias and we will continue working on Lerch Zeta functions as they relate to the Heisenberg group.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was very beneficial, the environment was very conducive to mathematical research.

Do you believe it had helped you find a position?
I did not find a position but certainly I formed a lot of connections that are going to be useful. I am going to live in Japan for the following years. I will seek a job there.

Nastasescu, Maria

Name: Maria Nastasescu (Berlekamp Postdoc)
Year of Ph.D.: 2016
Institution of Ph.D.: California Institute of Technology
Dissertation title: Nonvanishing of L-functions for GL(n)
Ph.D. advisor: Dinakar Ramakrishnan

Mentor while at MSRI: Nicolas Templier
Institution prior to obtaining the MSRI PD fellowship: Brown University
Position at that institution: Tamarkin Assistant Professor
Mentor (if applicable): Jeff Hoffstein

Institution (or company) where you are going after the MSRI PD fellowship: Brown University
Position: Tamarkin Assistant Professor
Anticipated length: (if it is a tenure track position just write tenure-track): until May 31, 2019
Mentor (if applicable): Jeff Hoffstein

Postdoctoral fellow's comments:
My research is broadly speaking in the study of automorphic forms and their L-functions. The problems I have worked on at MSRI have dealt with applications and computations that use the relative trace formula. The relative trace formula generalizes the Arthur-Selberg trace formula, and is a method that is used to evaluate period integrals of automorphic forms. In certain cases, these period integrals can be related to special values of L-functions. The relative trace formula for a reductive group G integrates the kernel of a suitably chosen test function over non-diagonal subgroups of the direct product of G with itself. It gives two expressions of the integral, one (the spectral side) in terms of sums of period integrals of automorphic forms and the other (the geometric side) in terms of a sum of orbital integrals indexed over certain double coset representatives. The goal in my work at MSRI was to compute the geometric side of certain relative trace formulas, to gain new insights on their spectral sides.

While at MSRI I have worked on establishing new results on automorphic L-functions, especially concerning the nonvanishing of central L-values. My focus was on using the relative trace formula to compute weighted averages of central L-values for GSp(4) in the holomorphic case. In collaboration with Dinakar Ramakrishnan and Jeff Hoffstein, I have also looked at computing second moments of central L-values for GL(2) in the non-holomorphic case, as well as higher moments of L-functions in both the holomorphic and the non-holomorphic case using the relative trace formula. Another problem that I have worked on dealt with using the relative trace formula for the inner form of GSp(4). More specifically, I worked on reproving known results

on Saito-Kurokawa lifts, however this time providing new proofs using the relative trace formula. The insight I might gain through the new methods of proof could potentially be useful in proving new results.

Was your experience at MSRI beneficial? Why or why not?
The experience at MSRI was very beneficial since it allowed me the time and freedom to pursue uninterrupted research, as well as surrounded me with a rich mathematical community of talented colleagues. I was able to have constructive conversations with many of my peers, most notably with Dinakar Ramakrishnan, Jeff Hoffstein and Nicolas Templier.

Do you believe it had helped you find a position?
While I did not apply for jobs this year, I have the confidence that the position at MSRI, the work I have started here and the collaborations and conversations I had at MSRI will all be extremely useful in in my professional career.

Perret-Gentil, Corentin

Name: Corentin Perret-Gentil
Year of Ph.D.: 2016
Institution of Ph.D.: ETH Zürich
Dissertation title: Probabilistic aspects of trace functions over finite fields
Ph.D. advisor: Emmanuel Kowalski

Mentor while at MSRI: Maksym Radziwill
Institution prior to obtaining the MSRI PD fellowship: ETH Zürich
Position at that institution: Postdoc
Mentor (if applicable): Emmanuel Kowalski

Institution (or company) where you are going after the MSRI PD fellowship: Centre de recherches mathématiques, Montréal
Position: Postdoc
Anticipated length: (if it is a tenure track position just write tenure-track): 2 years
Mentor (if applicable): Henri Darmon (McGill), Chantal David (Concordia), Dimitris Koukoulopoulos (Montréal), Maksym Radziwill (McGill)

Postdoctoral fellow's comments:

During the semester, I in particular submitted/revised existing papers, worked on two new projects that should be finished soon and explored some new ideas.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was very beneficial thanks to the exposition to a great number of new ideas (through the seminars, workshops, discussions, etc.), the large amount of time available for research, and the support from MSRI.

Talebizadeh Sardari, Naser

Name: Naser Talebizadeh Sardari (Uhlenbeck Postdoc)
Year of Ph.D.: 2016
Institution of Ph.D.: Princeton University
Dissertation title: Optimal strong approximation for quadratic forms
Ph.D. advisor: Peter Sarnak

Mentor while at MSRI: Roger Heath-Brown
Institution prior to obtaining the MSRI PD fellowship: University of Wisconsin-Madison
Position at that institution: Van Vleck Visiting Assistant Professor
Mentor (if applicable): Simon Marshall

Institution (or company) where you are going after the MSRI PD fellowship: University of Wisconsin-Madison
Position: Van Vleck Visiting Assistant Professor
Anticipated length: (if it is a tenure track position just write tenure-track):
Mentor (if applicable): Simon Marshall

Postdoctoral fellow's comments:

I spent spring 2017 at Mathematical Science Research Institute (MSRI) in Berkeley. I published two paper on Math Arxive about my research. The first project is on the complexity of solving quadratic equations that has applications in quantum computing and combinatorics. In the second paper, I investigated the properties of random combinatorial objects known as Random Cayley graphs. I gave two seminar talks about my research at Simons Institute and MSRI. At MSRI, I finished a joint project with Professor Heath-Brown from Oxford university on the least prime number represented by a binary quadratic form. We will publish the results of our project in the summer.

Was your experience at MSRI beneficial? Why or why not?
Yes, it was beneficial. It helped me to focus on my projects in a very active and relaxing environment.

Do you believe it had helped you find a position?
I am not sure how it helps me to find a position. But I was quite productive when I was at MSRI.

Turnage-Butterbaugh, Caroline

Name: Caroline Turnage-Butterbaugh
Year of Ph.D.: 2014
Institution of Ph.D.: University of Mississippi
Dissertation title: Moments of products of L-functions
Ph.D. advisor: Micah B. Milinovich

Mentor while at MSRI: Dan Goldston
Institution prior to obtaining the MSRI PD fellowship: Duke University
Position at that institution: Elliott Assistant Research Professor Mentor (if applicable): Lillian B. Pierce

Institution (or company) where you are going after the MSRI PD fellowship: Duke University
Position: Elliott Assistant Research Professor (postdoctoral position)
Anticipated length (if it is a tenure track position just write tenure-track): 1 year (completing a 3 year appointment)
Mentor (if applicable): Lillian B. Pierce

Postdoctoral fellow's comments:
During my time at MSRI, I focused on finishing a manuscript with Lillian Pierce and Melanie Wood on bounding l-torsion in class groups. I collaborated on a new project concerning the zeros of the zeta function with Dan Goldston, my MSRI postdoctoral mentor. We are still working on this project. I was able to visit (and be visited by) Brian Conrey from AIM to collaborate on a project concerning zeros of the zeta-function. We are now writing up these results. During the Introductory Workshop I spoke with Arindam Roy, who was attending the conference, on a new collaboration. I was subsequently invited to his department at Rice University to give a seminar talk and continue our discussions. During the Recent Developments Workshop I spoke with Winston Heap, who was attending the conference, on another new collaboration.

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI has been immensely beneficial. My pairing with Dan Goldston as a mentor has been incredibly valuable; we are working on a project together and have had long discussions on connections of our work to deep questions in analytic number theory. I have been able to speak in front of some of the most accomplished number theorists of our time, and then have one-on-one conversations with some of them. This experience of sharing my ideas and being heard has pushed me to apply to positions at research universities next fall. (Prior to my time at MSRI I was primarily considering positions at liberal arts colleges.)

Do you believe it had helped you find a position?
I have one more year at my postdoctoral position at Duke University, so we will see if the position at MSRI will help me find a position when I am on the job market this coming fall.

HARMONIC ANALYSIS

Akman, Murat

Name: Murat Akman
Year of Ph.D.: 2014
Institution of Ph.D.: University of Kentucky
Dissertation title: On the Hausdorff dimension of a certain measure arising from a positive weak solution to a divergence type PDE
Ph.D. advisor: John Lewis

Mentor while at MSRI: Daniel Tataru and Tatiana Toro
Institution prior to obtaining the MSRI PD fellowship: University of Connecticut
Position at that institution: Postdoc
Mentor (if applicable): Matthew Badger

Institution (or company) where you are going after the MSRI PD fellowship: University of Connecticut
Position: Postdoc
Anticipated length: (if it is a tenure track position just write tenure-track): 2 years
Mentor (if applicable): Matthew Badger

Postdoctoral fellow's comments:
I have made progress on three projects and it is likely they will be finished in a year. I have studied the stability of the Brunn-Minkowski inequality for capacities with Michael Christ. This inequality is known for Lebesgue measure and we have partial results for the capacities.

I started to work on the Brunn-Minkowski inequality for logarithmic capacities for nonlinear elliptic PDEs. This is a joint project with Olli Saari where we developed tools to study the problem in full generality.

I also started to work with Steve Hofmann, Jose Maria Martell, and Tatiana Toro on the perturbation of elliptic operators on domains with uniformly fat complements. In this project, we consider a different approach then as it is done in the past.

Was your experience at MSRI beneficial? Why or why not?
My experience here is quite beneficial, I met new people, learned new tools, initiated new projects, advanced my current understanding on problems that I like to study.

Do you believe it had helped you find a position?
It had helped me in many ways to find a position; extended my network, likely to have more papers which will help me to have a strong CV, gave me a chance to present my work to other people who will likely be on hiring committees or can support my application for positions.

Bortz, Simon

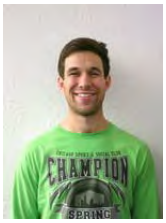
Name: Simon Bortz
Year of Ph.D.: 2016
Institution of Ph.D.: University of Missouri
Dissertation title: Harmonic Measure and Rectifiability
Ph.D. advisor: Steve Hofmann

Mentor while at MSRI: Guy David
Institution prior to obtaining the MSRI PD fellowship: University of Minnesota
Position at that institution: Postdoc
Mentor (if applicable): Svitlana Mayboroda

Institution (or company) where you are going after the MSRI PD fellowship: University of Minnesota
Position: Postdoc
Anticipated length: (if it is a tenure track position just write tenure-track): 1-2 more years
Mentor (if applicable): Svitlana Mayboroda

Postdoctoral fellow's comments:

My experience at MSRI was great. I am not sure whether it was exceptional but I believe to have done enough work for five or more future publications. I am sure that nearly completing five projects at MSRI will help me find a position after my postdoc. I thought that perhaps the most important thing about this visit was being able to work with mathematicians at all stages of their careers. The mentorship given by the senior mathematicians opened many avenues for future work and working with younger mathematicians was important to what I hope will be lifelong collaborations. All of the projects I did while at MSRI were different from my previous work and I am not sure that would be possible without the collaborative environment.



Engelstein, Max

Name: Max Engelstein (Huneke Postdoc)
Year of Ph.D.: June 2016.
Institution of Ph.D.: University of Chicago
Dissertation title: Free Boundary Problems for Harmonic and Caloric Measure
Ph.D. advisor: Carlos Kenig

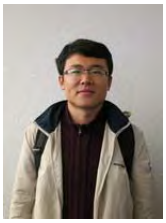
Mentor while at MSRI: Svitlana Mayboroda
Institution prior to obtaining the MSRI PD fellowship: MIT
Position at that institution: CLE Moore Instructor
Mentor (if applicable): David Jerison

Institution where you are going after the MSRI PD fellowship: MIT
Position: NSF Postdoc/CLE Moore Instructor
Anticipated length: (if it is a tenure track position just write tenure-track): 2-3 years
Mentor (if applicable): David Jerison

Postdoctoral fellow's comments:
As for my work in MSRI, I started/continued several projects with varying levels of success, almost all centered around issues of rectifiability and regularity for free boundary problems. With Tatiana Toro and Guy David we finished a paper on "Free Boundary Regularity for Almost-Minimizers" as well as continued our research on Almost-Minimizers (and their connections to minimal surfaces). We are currently working on almost-minimizers to the two-phase problem. I also began a project with Guy David and Svitlana Mayboroda, on free boundary problems for harmonic measure in co-dimension higher than one. In these investigations we uncovered a beautiful connection to differential geometry, and we hope to finish our research and publish these results soon. Finally, I worked on several problems related to the regularity of harmonic measure, with differing subsets of Murat Akman, Matthew Badger, Simon Bortz, Xavier Tolsa and Tatiana Toro. Some of these were old collaborations which should produce papers soon (one with Badger and Toro should be submitted within a month) and some of these are new projects which are quite exciting but are still far away from any results (such as the project with Tolsa on the connection between reflectionless measures and harmonic measure).

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was extremely beneficial. I got to meet several other researchers in my field (both more senior than I and other early career people), established several new collaborations and was exposed to a lot of new ideas both in my subfield and in the rest of Harmonic Analysis.

Do you believe it had helped you find a position?
I don't believe it helped me find a position (because I'm going back to my old one) but I hope that the contacts/work that happened at MSRI will make the tenure track job hunt easier. I'll let you know!



Guo, Shaoming

Name: Shaoming Guo
Year of Ph.D.: 2015
Institution of Ph.D.: University of Bonn, Germany
Dissertation title: Hilbert transforms and maximal operators along planar vector fields
Ph.D. advisor: Christoph Thiele

Mentor while at MSRI: Alexander Volberg
Institution prior to obtaining the MSRI PD fellowship: Indiana University Bloomington
Position at that institution: Postdoc
Mentor (if applicable): Ciprian Demeter

Institution (or company) where you are going after the MSRI PD fellowship: Indiana University Bloomington
Position: Postdoc
Anticipated length: (if it is a tenure track position just write tenure-track): Until 31 May 2018
Mentor (if applicable): Ciprian Demeter

Postdoctoral fellow's comments:
For the first half of the program, I was working on some combinatorics problem that is closely related to bilinear Hilbert transforms along curves. The result that is produced can be found in the joint work with Polona Durcik and Joris Roos, https://arxiv.org/abs/1704.01546.

For the second half, I was working with David Beltran, Jonathan Hickman and Andreas Seeger, on the problem of bounding the circular maximal operator on the Heisenberg group. We are currently writing a paper. Moreover, with Jonathan Hickman and Andreas Seeger, we are also trying to prove the sharp smoothing properties of convolutions along measures supported on moment curves.

Was your experience at MSRI beneficial? Why or why not?
The experience at MSRI is very beneficial. I got the chance to work with experts in different fields. This significantly broadens my research interest. I as well found applications of things that I am familiar with.

Do you believe it had helped you find a position?
I am sure that the experience at MSRI will be very helpful when I am looking for jobs in the fall of 2017.

Hickman, Jonathan

Name: Jonathan Hickman
Year of Ph.D.: 2015
Institution of Ph.D.: University of Edinburgh
Dissertation title: Topics in affine and discrete harmonic analysis
Ph.D. advisor: Prof. Jim Wright

Mentor while at MSRI: Prof. Michael Christ
Institution prior to obtaining the MSRI PD fellowship: University of Chicago
Position at that institution: Dickson Instructor (postdoctoral researcher)
Mentor (if applicable): Marianna Csornyei

Institution (or company) where you are going after the MSRI PD fellowship: University of Chicago
Position:
Anticipated length: (if it is a tenure track position just write tenure-track): Until August 2018
Mentor (if applicable): Marianna Csornyei

Postdoctoral fellow's comments:
I worked on a wide range of projects at MSRI with many collaborators. Examples include:
* I worked on a major project with Marina Iliopoulou and Larry Guth to study a class of oscillatory integral operators introduced by Hormander, which generalize the Fourier restriction operator. Using polynomial partitioning techniques introduced by Guth we managed to obtain new sharp L^p estimates for these operators under certain natural geometric conditions on the phase function. This is currently being written up as an 80 - 90 page paper.
* I worked individually on an off-shoot of the above project studying alternative conditions on the phase. I am hoping to develop this work into a follow up paper.
* With David Beltran I began to study "variable coefficient" decoupling inequalities. This problem was motivated by the research programme described above, as it involves many similiar techniques and simple versions of the decoupling estimates are used to determine our sharp L^p estimates for the oscillatory integral operators. We hope to use the full strength of the decoupling estimates to study local smoothing for wave equations on manifolds.
* With David Beltran, Shaoming Guo and Andreas Seeger I worked on a project to study the circular maximal function on the Heisenberg group. We have begun to write a joint paper detailing this work, but there are some technical issues still to be dealt with in the proof.

* With Jim Wright and Julia Brandes (the latter of the analytic number theory program) I investigated solutions to a system of congruence equations which naturally arises when investigating certain discrete formulations of the Fourier restriction problem. These questions are also natural from a combinatorial / number theoretic point of view as they can be interpreted as counting the number of ways to factorize polynomials into linear factors over Z/NZ. We hope to write a joint paper detailing these results.

Was your experience at MSRI beneficial? Why or why not?
MSRI was a tremendously beneficial experience for me, primarily as it facilitated numerous exciting collaborations. The work I began during the semester is likely to heavily influence my research direction for many years. I am determined to use the experience as a springboard and have begun to investigate opportunities and have made concrete arrangements to meet up with collaborators from the program to push forward the work we started there.

Do you believe it had helped you find a position?
I am certain the experience will have a very positive impact on my future career and am grateful for the opportunity to take part.

Iliopoulou, Marina

Name: Marina Iliopoulou (Strauch Postdoc)
Year of Ph.D.: 2013
Institution of Ph.D.: School of Mathematics, University of Edinburgh
Dissertation title: Discrete analogues of Kakeya problems
Ph.D. advisor: Anthony Carbery

Mentor while at MSRI: Ciprian Demeter
Institution prior to obtaining the MSRI PD fellowship: UC Berkeley
Position at that institution: Visiting Assistant Professor
Mentor (if applicable): Michael Christ

Institution (or company) where you are going after the MSRI PD fellowship: UC Berkeley
Position: Visiting Assistant Professor
Anticipated length: (if it is a tenure track position just write tenure-track): 2 years
Mentor (if applicable): Michael Christ

Postdoctoral fellow's comments:
- Jonathan Bennett and I completed the paper "A multilinear Fourier extension identity on R^n" https://arxiv.org/abs/1701.06099 , which will appear at Mathematics Research Letters.
- Jonathan Hickman, Larry Guth and I worked on sharp estimates on oscillatory integral operators. Currently preparing the paper, which is nearly complete.
- Michael Christ and I worked on near extremisers for the Brunn-Minkowski inequality on the circle. Work nearly complete.
- Anthony Carbery and I worked on counting joints formed by k-planes. Partial progress in this direction.

Was your experience at MSRI beneficial? Why or why not?
MSRI was a fantastic, stimulating experience. It was ideal to have no work responsibilities other than research. This, combined with so many experts in the field being so close, made progress very fast. This experience has helped me improve as a mathematician.

Ivanisvili, Paata

Name: Paata Ivanisvili
Year of Ph.D.: 2013-2015
Institution of Ph.D.: Michigan State University
Dissertation title: Geometric aspects of exact solutions of Bellman equations of Harmonic Analysis problems
Ph.D. advisor: Alexander Volberg

Mentor while at MSRI: Sergei Treil
Institution prior to obtaining the MSRI PD fellowship: Kent State University
Position at that institution: Postdoctoral Researcher
Mentor (if applicable): Fedor Nazarov

Institution (or company) where you are going after the MSRI PD fellowship: Kent State University
Position: Postdoctoral Researcher
Anticipated length: (if it is a tenure track position just write tenure-track): 2 months
Mentor (if applicable): Fedor Nazarov

Postdoctoral fellow's comments:
At MSRI I worked on several projects (see the list below together with preprints) including square function estimates, Hamming cube, flows at complex time, and number of disjoint partitions. I got one publication jointly with A. Volberg during my stay at MSRI.

1) Jointly with K. Domelevo, S. Petermichl, S. Treil, A. Volberg, On the failure of lower square function estimates in the non-homogeneous weighted setting. arXiv: 1705.08376
2) Convolution estimates and number of disjoint partitions, arXiv: 1705.08529
3) Jointly with F. Nazarov, A. Volberg, Square function and the Hamming cube (this is not posted yet but it is almost finished).
4) Jointly with S. Treil, Dyadic square function in high dimensions. (not finished yet, draft is available)
5) Jointly with A. Volberg, Hausdroff--Young inequality and Beckner--Janson flow (draft is available)
6) Jointly with A. Volberg, Hypercontractivity (rough draft)

Was your experience at MSRI beneficial? Why or why not?
My experience at MSRI was highly beneficial.

Do you believe it had helped you find a position?
MSRI helped me very much to find my tenure-track position at UC Irvine starting at July 2018.

Ou, Yumeng

Name: Yumeng Ou
Year of Ph.D.: 2016
Institution of Ph.D.: Brown University
Dissertation title: Multi-parameter commutators and new function spaces of bounded mean oscillation
Ph.D. advisor: Jill Pipher

Mentor while at MSRI: Michael Lacey
Institution prior to obtaining the MSRI PD fellowship: Massachusetts Institute of Technology
Position at that institution: CLE Moore Instructor
Mentor (if applicable): Gigliola Staffilani

Institution (or company) where you are going after the MSRI PD fellowship: Massachusetts Institute of Technology
Position: CLE Moore Instructor
Anticipated length: (if it is a tenure track position just write tenure-track): Till May 2019
Mentor (if applicable): Gigliola Staffilani

Postdoctoral fellow's comments:
I have conducted research on sparse domination of singular integrals (along curves, multi-parameter, one-sided average type), higher order commutators and BMO symbols, two-weight type inequalities for commutators, multilinear representation theorem, commutators in the flag setting, restriction estimate and decoupling for conic surfaces. Besides several preliminary notes, my work has resulted in two arXiv posts and two articles to be finalized:

1. A cone restriction estimate using polynomial partitioning, with Hong Wang, arXiv:1704.05485
2. Sparse domination of Hilbert transforms along curves, with Laura Cladek, arXiv:1704.07810
3. Bilinear representation theorem, with Kangwei Li, Henri Martikainen and Emil Vuorinen, to be finalized
4. Two weight inequalities for multilinear commutators, with Ishwari Kunwar, to be finalized

Was your experience at MSRI beneficial? Why or why not? Do you believe it had helped you find a position?
My stay at MSRI was a very productive one, during which I successfully established new collaborations, learned about new research topics from various experts and continued established collaborations. My mentor was particularly helpful who suggested many interesting problems for me to work on, exchanged discussion with me on almost a daily basis, and provided a lot of valuable career advice.

Saari, Olli

Name: Olli Saari
Year of Ph.D.: 2016
Institution of Ph.D.: Aalto University
Dissertation title: Weights arising from parabolic partial differential equations
Ph.D. advisor: Juha Kinnunen

Mentor while at MSRI: Pascal Auscher
Institution prior to obtaining the MSRI PD fellowship: Aalto University
Position at that institution: Graduate student
Mentor (if applicable): Juha Kinnunen

Institution (or company) where you are going after the MSRI PD fellowship: Universität Bonn
Position: postdoc
Anticipated length: 6 years
Mentor: Christoph Thiele

Postdoctoral fellow's comments:
I started a concrete project on higher integrability of gradients of solutions to parabolic systems with three other members of the program (Auscher, Egert, Bortz). This will result in two publications in near future. In addition, I have been having many discussions at a more general level, the outcome of which will become clear later.

Was your experience at MSRI beneficial? Why or why not?
The stay at MSRI was very beneficial. In particular, I met many colleagues from the US that I had not met before, as I am usually in Europe.

Do you believe it had helped you find a position?
I already had my next position clear when I arrived so MSRI did not have role in finding it.

Wilson, Bobby

Name: Bobby Wilson
Year of Ph.D.: 2015
Institution of Ph.D.: The University of Chicago
Dissertation title: Three Results in Analysis
Ph.D. advisor: Wilhelem Schlag

Mentor while at MSRI: Jill Pipher
Institution prior to obtaining the MSRI PD fellowship: MIT
Position at that institution: Post-Doc
Mentor (if applicable): Gigliola Staffilani

Institution (or company) where you are going after the MSRI PD fellowship: MIT
Position: Post Doc
Anticipated length: (if it is a tenure track position just write tenure-track): 1 year
Mentor (if applicable): Gigliola Staffilani

Postdoctoral fellow's comments:
My experience at MSRI was beneficial because I was able to meet and work with researchers that I wouldn't have had the opportunity to meet or work with otherwise. I haven't published any work done at MSRI yet, but I am working on publishing this work now. During my time at MSRI I worked on one project related to the stability of fixed points to Cubic NLSE. I also worked with Tatiana Toro and Matthew Badger on an old problem posed by Carleson on quantities related to Beta numbers. Finally, I worked on a problem concerning the Favard length of purely unrectifiable sets with Alexander Volberg.

Was your experience at MSRI beneficial? Why or why not? Do you believe it had helped you find a position?
I think this past semester at MSRI will help me find a position following my final year at MIT.

COMPLEMENTARY PROGRAM

Bigdeli, Mina

Your Name: Mina Bigdeli
Year of Ph.D: 2015
Institution of Ph.D.: Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran
Dissertation title: Linearly Presented Powers of Edge Ideals and Chordality of Clutters
Ph.D. advisor: Rashid Zaare-Nahandi, Jürgen Herzog

Mentor while at MSRI: David Eisenbud

Institution prior to obtaining the MSRI PD fellowship: MSRI was my first in- stitution after graduation
Position at that institution: N/A
Mentor (if applicable): N/A

Institution (or company) where you are going after the MSRI PD fellowship: Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
Position: Postdoctoral Fellow
Anticipated length: 2 years, extendable to 3 years
Mentor (if applicable): Masoud Tousi

Postdoctoral fellow's comments:

I was a postdoc in the complementary program which lasted for an academic year. My field of study is (Combinatorial) Commutative Algebra. There were three different programs running at MSRI during my stay. Despite the fact that their subjects were a bit far from my own research, I took part in some of their seminars and also discussed with young researchers about their topic of study. This helped me to widen my mathematical interests and to learn a lot about the scopes and techniques in different fields. This also inspired and gave me new ideas in dealing with my own mathematical problems.

One of the things that I benefited the most was talking to my mentor. I profited a lot from his advices not only for my research but also for preparing my talks, job interviews, etc. These discussions led me to new ideas and questions in one of my main research interests which concerns the combinatorial properties of monomial ideals having linear resolution. Based on the results obtained while at MSRI, I am going to give a talk in the conference "The Prospects in Commutative Algebra" which will be held in Osaka, Japan in July 2017.

Due to the strong relationship between MSRI and the Math department of University of California, Berkeley, I had the opportunity to make use of

scientific activities there. I took part in weekly seminars and also in some courses at the department. At this occasion, I could talk to the students there and exchange ideas. One of these discussions resulted in a contribution to a project in which we study the Algebraic properties of an ideal attached to a graph. Since the project is not completed yet, we planned to continue our discussions in the future.

Being at MSRI gave me a great chance to meet lots of excellent mathematicians and to discuss mathematics with them. I truly made use of their different views at a scientific problem. It was also extremely helpful in finding new ideas to proceed in my projects. I also started another project with Sara Faridi, a visitor of the university. In this project we try to answer the question whether the monomial localization of a componentwise linear ideal is again componentwise linear. Right after finishing my postdoctoral period at MSRI, I visited her in Canada to complete our project.

Having a postdoctoral fellowship at MSRI helped me to establish new contacts with the mathematicians from different countries. This is very important for young mathematicians, because it leads to future collaborations. I have been accepted for a postdoctoral fellowship in IPM which is very competitive among Iranian young mathematicians. I believe that having the experience of MSRI PD was extremely effective in getting such offer.

Research Statement

Ayla Gafni

1. Projects at MSRI

There are a number of projects that I continued or started while at MSRI. Below is a brief description of each project.

1.1. **Divisor Sums.** *Joint work with Steve Gonek and Trevor Wooley*

Moments of the Riemann zeta function $\zeta(s)$ are deeply tied to information about the distribution of prime numbers. In order to understand higher moments of ζ, we need to estimate correlated divisor sums of the form $\sum_{n\leq x} d_k(n)d_k(n+r)$, where $d_k(n)$ is the number of ways to write n as a product of k positive integers. The ternary divisor sum $\sum_{n\leq x} d_3(n)^2$ can be easily estimated by examining the Euler product of ζ. However, this trick does not work for higher order divisor sums, or the correlated ternary divisor sum.

Problem 1. Re-derive the formula for $\sum_{n\leq x} d_3(n)^2$ using a version of the Hardy-Littlewood circle method.

If we are successful, we hope to adapt the argument to estimate correlated and higher order divisor sums. This project could lead to significant progress toward understanding moments of ζ.

While at MSRI, I worked with Trevor Wooley to decide upon a strategy to approach this problem. We will continue to work on this with Steve Gonek over the next few years.

1.2. **Translation Invariant Systems.** *Joint work with Kirsti Biggs, Sam Chow, Kevin Hughes, and Sean Prendiville*

Recent breakthroughs of Wooley [4, 5] and Bourgain, Demeter, and Guth [2] toward the Vinogradov Mean Value Theorem have made it possible to apply the circle method to a wide range of problems that were previously out of reach. A natural next step is to solve the analogous problem in additive combinatorics:

Problem 2. Consider the system of equations

$$c_1x_1^j + \cdots + c_sx_s^j = 0 \quad (1 \leq j \leq k), \tag{1}$$

where $c_1, \ldots, c_s \in \mathbb{Z} \setminus \{0\}$ satisfy $c_1 + \cdots + c_s = 0$. Find the smallest number of variables s such that every set $\mathcal{A}$ of positive density contains a non-trivial solution to (1).

One may also consider incomplete systems in which one or more of the equations is omitted. The cubic case ($k = 3$) is the simplest that has not been fully solved. The full cubic system can be solved in 13 variables using Szemeredi's theorem to reduce it to solutions over $\mathbb{Z}$, then using the circle method.

Problem 3. If we consider the 2-equation system with $j = 1, 3$, can we do better than 13 variables?

My collaborators and I have a strategy to find solutions in only 11 variables, and we are working to improve this to 10. It should be possible to extend our results to a higher degree system of two equations with $j = 1, k$. The "convexity barrier" implies that the target to aim for is $2k + 3$ variables.

This is a project that I started to work on and later stepped away from in order to focus on other projects. I contributed to the project in the early stages, but will probably not be an author on the final paper.

1.3. **Metric Poissonian Sets.** *Joint work with Thomas Bloom, Sam Chow, and Aled Walker*
Given $\mathcal{A} \subset \mathbb{N}$ and $\alpha \in \mathbb{R}$, it is often of interest to consider pair correlations of the set $\alpha\mathcal{A}$ and their distribution modulo 1. Denote by A_N the first N elements of $\mathcal{A}$. We say that $\mathcal{A}$ is *metric Poissonian* if

$$\frac{1}{N} \sum_{\substack{a,b \in A_N \\ a \neq b}} \mathbb{1}_{[-s/N, s/N]}(\{\alpha(a-b)\}) \to 2s \quad \text{as} \quad N \to \infty, \tag{2}$$

for almost all α and for all fixed s, where $\{x\} = x - \lfloor x \rfloor$ denotes the fractional part of x. If B is a finite subset of $\mathbb{N}$, the *additive energy* $E(B)$ is the number of tuples $(a, b, c, d) \in B$ such that $a + b = c + d$. The metric Poissonian property is closely related to the additive energy of the set. Indeed, Aistleitner, Larcher, and Lewko [1] have shown that if $E(A_N) = O(N^{3-\varepsilon})$ then $\mathcal{A}$ is metric Poissonian. In an appendix to the same paper, Bourgain gives that $\mathcal{A}$ cannot be metric Poissonian if $\limsup_{n\to\infty} E(A_N)N^{-3} > 0$. Our goal is to close the gap by introducing hypotheses about the density of the set $\mathcal{A}$.

Problem 4. Let $\delta = \delta(N) = \frac{A_N}{N}$ and suppose $E(A_N) = \delta N^3$. Show that:

(1) If $\displaystyle\sum_{n\geq 1} \frac{\delta(n)}{n} < \infty$ then $\mathcal{A}$ is metric poissonian.
(2) If $\displaystyle\sum_{n\geq 1} \frac{\delta(n)}{n} = \infty$ then $\mathcal{A}$ is not metric poissonian.

This project was a major part of my work at MSRI. We have partial progress toward (1); namely, we can prove it for random sets where n is included in the set with probability $\delta(n)$. We are currently working to improve Bourgain's argument to prove (2). We are also working to find a counterexample to show that the density hypothesis is necessary in the divergence case.

1.4. **Champion Primes of Elliptic Curves.** *Joint work with Chantal David, Amita Malik, Lillian Pierce, Neha Prabhu, and Caroline Turnage-Butterbaugh*
Given an elliptic curve over $\mathbb{Q}$ and a prime p of good reduction for E, we denote by a_p the trace of the reduced elliptic curve modulo p. We are interested in the properties of a_p as p varies over the primes. A classical question to consider is the Lang-Trotter conjecture, which claims that

$$\#\{p \leq x : a_p(E) = t\} \sim C_{E,t} \frac{\sqrt{x}}{\log x}.$$

In view of the well-known upper bound $a_p \leq 2\sqrt{p}$, we say that p is a *champion prime* for E if $a_p = \lfloor 2\sqrt{p} \rfloor$. For champion primes, we have the following conjecture:

$$\#\left\{p \leq x : a_p(E) = \lfloor 2\sqrt{p} \rfloor\right\} \sim C_E \frac{x^{1/4}}{\log x}.$$

Problem 5. Can we get upper bounds for champion primes?

Upper bounds for the Lang-Trotter conjecture can be achieved using the Chebotarev Density Theorem in the extension given by adjoining the ℓ-torsion of E with the Galois group $GL(\mathbb{F}_t)$. To get similar upper bound in the case of champion primes, we consider

$$\#\left\{p \leq x : a_p(E) = [2\sqrt{p}]\right\} \leq \#\left\{p \leq x : a_p(E) \equiv [2\sqrt{p}] \bmod \ell\right\},$$

which lead us to study the distribution of $\lfloor 2\sqrt{p} \rfloor \bmod \ell$.

Problem 6. Prove that the champion prime conjecture is true on average over all elliptic curves over $\mathbb{Q}$. Let

$$E(a, b) : y^2 = x^3 + ax + b.$$

Then, we want to show for A, B sufficiently large,

$$\frac{1}{4AB}\sum_{|a|\leq A,|b|\leq B}\#\left\{p\leq x\ :\ a_p(E(a,b))=\lfloor 2\sqrt{p}\rfloor\right\}\sim C\frac{x^{1/4}}{\log x}$$

This project is part of the Women in Numbers workshop, to be held at BIRS in August 2017. While at MSRI, our group met and discussed strategies for the project, as well as small tasks to complete before we meet in August.

1.5. **Prime Paucity in Fibers.** *Joint work with Sam Chow and David Lowry-Duda*
Consider the equation

$$a^2+b^2=c^2+d^2, \tag{3}$$

with $a, b, c, d \in \mathbb{Z}_{\geq 0}$ and each variable $\leq N$. The number of "diagonal" solutions (i.e., solutions in which $a = c, b = d$ or $a = d, b = c$) is easily seen to be $2N^2$. It has been shown that there are on the order of $N^2 \log N$ total solutions. However, if we restrict a, b, c, d to all be primes, then Erdős [3] shows that there are about $2(N/\log N)^2$ diagonal solutions and only $O\left(N^2(\log N)^{-3}(\log\log N)^6\right)$ further prime solutions. So the diagonal solutions dominate. This phenomenon is called *prime paucity* and has been studied in (3) and in other diophantine equations.

We are interested in what happens when we fix one of the variables in advance. Let s_0 be a fixed prime, and consider the equation

$$p^2+q^2=r^2+s_0^2. \tag{4}$$

We wish to count solutions with $p, q, r \leq N$ prime. The diagonal solutions are those in which p or q is equal to s. Our goal is to show that there are significantly fewer off-diagonal solutions, which will establish that (4) exhibits prime paucity on fibers.

We began this project in February, and are almost finished. There is one detail that turned out be more difficult to prove than originally anticipated. Once we find a fix for that piece, we will have a paper.

1.6. **A Variation on the Lagrange Four-Square Theorem.** *Joint work with K. Soundararajan*
We wish to prove the following statement:

Problem 7. Any number of the form $n = 4m + 2$ can always be split into two parts such as $4x + 1$ and $4y + 1$, none of which has any divisor of the form $4k + 3$.

This was a question of Euler from 1747. Classical analytic methods can be used to show that the statement is true for sufficiently large n. Our goal is to make the asymptotic bounds effective so that the statement can be proved for all n.

This project is almost finished, and there should be a paper relatively soon.

2. Other activities at MSRI

2.1. **Research Talks.**

- "Partitions into Polynomial Values", Connections for Women: Analytic Number Theory, MSRI, February 2, 2017.
  Abstract: In 1918, Hardy and Ramanujan published a seminal paper which included an asymptotic formula for the partition function. In their paper, they also state without proof an asymptotic equivalence for the number of partitions of a number into k-th powers. In this talk, I will present an asymptotic formula for the number of partitions into k-th powers using a relatively simple method, verifying the claim of Hardy and Ramanujan. We will then discuss extensions of this result to partitions into integer values of polynomials.

- "Integer Partitions and Restricted Partition Functions, ANT Postdoc Seminar, MSRI, April 28, 2017.
  Abstract: The theory of integer partitions is a rich subject that lives in the intersection of number theory and combinatorics. In this colloquium-style talk, I will go through a brief history of partitions and the various tools used to study them, along with connections to Waring's problem and other topics in additive number theory. I will then state some results about counting partitions in which the parts are restricted to various subsets of the integers (e.g., primes, squares, arithmetic progressions).

2.2. **Workshops Attended.**

- Connections for Women: Harmonic Analysis, MSRI, January 19-20, 2017
- Introductory Workshop: Harmonic Analysis, MSRI, January 23-27, 2017
- Connections for Women: Analytic Number Theory, MSRI, February 2-3, 2017
- Introductory Workshop: Analytic Number Theory, MSRI, February 6-10, 2017
- Workshop on Efficient Congruencing and Translation-Invariant Systems, Fields Institute, March 13-17, 2017
- Recent Developments: Analytic Number Theory, MSRI, May 1-5, 2017

2.3. **Professional Service.**

- Organized "Five-Minute Talk" Series, MSRI, February 13-15, 2017
- Refereed four papers for peer-review journals.

References

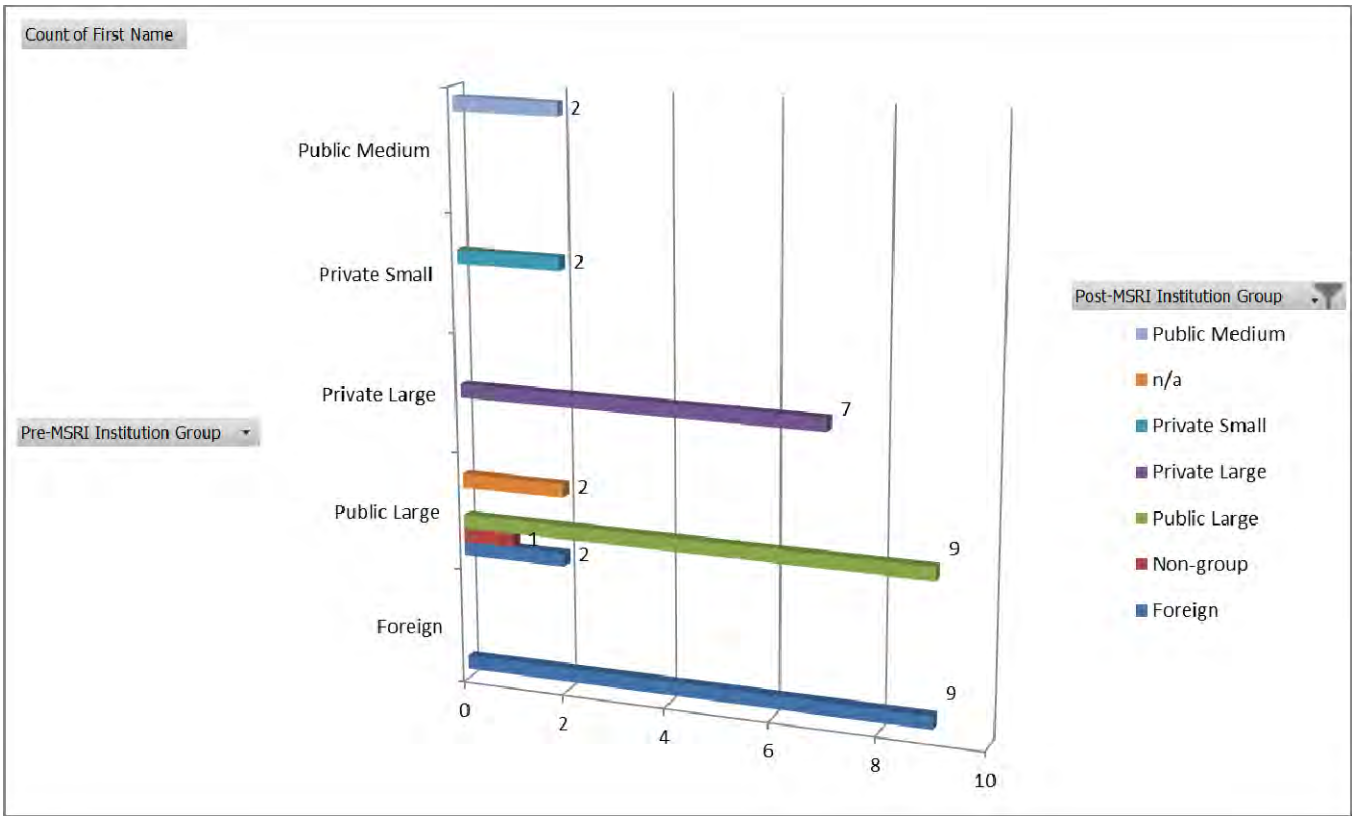
1. Christoph Aistleitner, Gerhard Larcher, Mark Lewko, and Jean Bourgain, *Additive Energy and the Hausdorff dimension of the exceptional set in metric pair correlation problems [with an appendix by Jean Bourgain]*, ArXiv:1606.03591 [Math.NT] (2016), 1–22.
2. Jean Bourgain, Ciprian Demeter, and Larry Guth, *Proof of the main conjecture in Vinogradov's Mean Value Theorem for degrees higher than three*, Annals of Mathematics **184** (2016), no. 2, 633–682.
3. Paul Erdos, *On additive properties of squares of primes, I.*, Nederl Akad Wetensch Proc **41** (1938), no. 1, 37–41.
4. Trevor Wooley, *Vinogradov's mean value theorem via efficient congruencing*, Annals of Mathematics **175** (2012), 1575–1627.
5. Trevor D Wooley, *Vinogradov's mean value theorem via efficient congruencing, II*, Duke Mathematical Journal **162** (2013), 673–730.

3.2 Postdoctoral Fellow Placement List

Family Name	First Name	Pre-MSRI Institution Group	Post-MSRI Institution Group	Pre-MSRI Institution Name	Placement Institution Name
Cantrell	Michael	Public Large	Non-group	University of Illinois, Chicago	Metis Data Science Bootcamp
Disarlo	Valentina	Public Large	Foreign	Indiana University, Bloomington	Universitaat Heidelberg
Durham	Matthew	Public Large	Public Large	University of Michigan	University of Michigan
Fullarton	Neil	Private Large	Private Large	Rice University	Rice University
Gultepe	Funda	Public Large	Public Large	University of Illinois, Urbana-Champaign	University of Illinois, Urbana–Champaign
Hume	David	Foreign	Foreign	Universite de Paris XI	University of Oxford
Kropholler	Robert	Private Small	Private Small	Tufts University	Tufts University
Le	Giang	Public Large	*n/a*	Ohio State University	*to be determined*
Sapir	Eugenia	Public Large	Public Large	University of Illinois, Urbana-Champaign	University of Illinois, Urbana-Champaign
Schreve	Kevin	Public Large	Public Large	University of Michigan-Ann Arbor	University of Michigan-Ann Arbor
Strzałkowski	Karol	Foreign	Foreign	Polish Academy of Sciences	Polish Academy of Sciences
Wade	Richard	Foreign	Foreign	University of British Columbia	University of British Columbia
Wang	Pei	Public Large	Foreign	Rutgers University	University of the Basque Country, Spain
Akman	Murat	Public Medium	Public Medium	University of Connecticut	University of Connecticut
Bortz	Simon	Public Large	Public Large	University of Minnesota, Twin Cities	University of Minnesota, Twin Cities
Engelstein	Max	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology
Guo	Shaoming	Public Large	Public Large	Indiana University, Bloomington	Indiana University, Bloomington
Hickman	Jonathan	Private Large	Private Large	University of Chicago	University of Chicago
Iliopoulou	Marina	Public Large	Public Large	UC Berkeley	UC Berkeley
Ivanisvili	Paata	Public Medium	Public Medium	Kent State University	Kent State University
Ou	Yumeng	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology
Saari	Olli	Foreign	Foreign	Aalto University	Universität Bonn
Wilson	Bobby	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology
Andersen	Nickolas	Public Large	Public Large	University of California, Los Angeles	University of California, Los Angeles
Brandes	Julia	Foreign	Foreign	University of Göteborg	University of Göteborg
Chow	Sam	Foreign	Foreign	University of York	University of York
Gafni	Ayla	Private Small	Private Small	University of Rochester	University of Rochester
Hu	Yueke	Foreign	Foreign	ETH Zürich	ETH Zürich
Kıral	Eren	Public Large	*n/a*	Texas A & M University	*to be determined*
Nastasescu	Maria	Private Large	Private Large	Brown University	Brown University
Perret-Gentil-dit-Maillard	Corentin	Foreign	Foreign	ETH Zürich	Centre de recherches mathématiques
Talebizadeh Sardari	Naser	Public Large	Public Large	University of Wisconsin, Madison	University of Wisconsin, Madison
Turnage-Butterbaugh	Caroline	Private Large	Private Large	Duke University	Duke University
Bigdelli	Mina	Foreign	Foreign	Institute for Advanced Studies in Basic Sciences, Iran	Institute for Research in Fundamental Sciences (IPM)

Postdoctoral Fellow Placement Institution

(based on AMS Groupings)



Highlights

Majority of the MSRI postdocs came from Public Large institutions. Of the 14 postdocs who came from there, nine are currently at Public Large institutions, two are at Foreign institutions, one is at a non-grouped institution, and two have not yet determined their next placement.

Of the seven postdocs who came from Private Large institutions, all went back to Private Large institutions.

The four postdocs who came from Public Medium and Private Small institutions, they went back to Public Medium and Private Small institutions.

Of the nine postdocs who came from Foreign Institutions, all nine returned to Foreign Institutions.

3.3 Postdoctoral Fellow Participant Summary

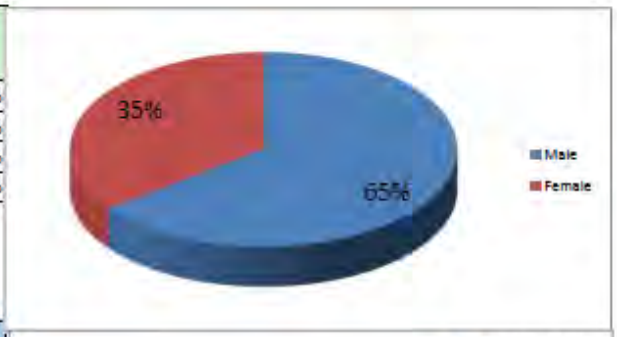
Programs	# of Members	# of Citizens & Perm. Res.	# of Female	%	# of Minorities[1]	%	US Home Institution	%
Geometric Group Theory	13	5	5	*38.5%*	0	*0.0%*	10	76.9%
Analytic Number Theory	10	3	4	*40.0%*	0	*0.0%*	6	60.0%
Harmonic Analysis	10	3	2	*20.0%*	1	*33.3%*	9	90.0%
Complementary Program (2016-17)	1	0	1	*100.0%*	0	*0.0%*	1	100.0%
Total # of Distinct Postdocs	**34**	**11**	**12**	***35.3%***	**1**	***9.1%***	**26**	***76.5%***

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

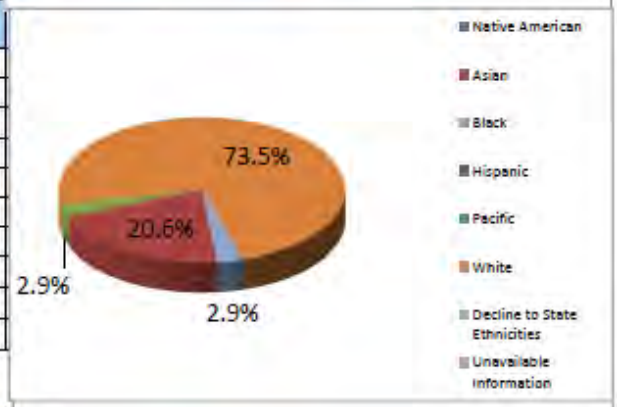
3.4 Postdoctoral Fellow Demographic Data

2016–17 Postdoctoral Fellows Demographic Summary

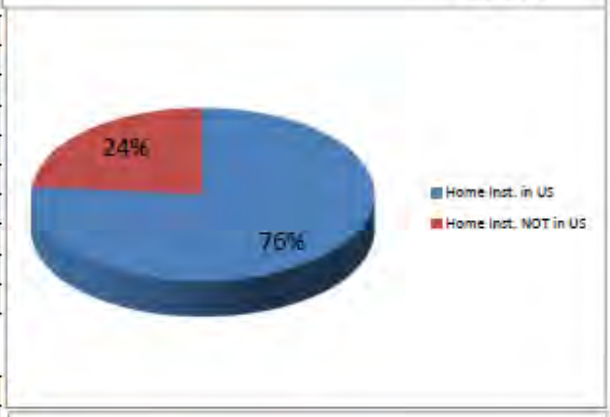
Gender	#	% (No Decl.)*	%
# of Distinct Members	34		100.0%
Male	22	64.71%	64.7%
Female	12	35.29%	35.3%
Decline to State Gender	0		0.0%



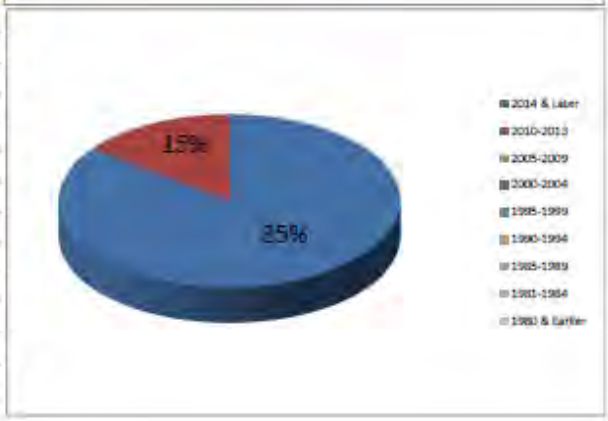
Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	7	21.21%	20.6%
Black	1	3.03%	2.9%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	25	75.76%	73.5%
Decline to State Ethnicities	1		2.9%
Unavailable Information	0		0.0%
Minorities	1		10.0%



Citizenships	#		%
US Citizen & Perm. Residents	11		32.4%
Foreign	23		67.6%
Unavailable information	0		0.0%
# of Distinct Members	34		100.0%
US Citizen	10		29.4%
Perm Residents	1		2.9%
Home Inst. in US	26		76.47%



Year of Ph.D	#		%
Program Associates (GS)	0		0.0%
2014 & Later	29		85.3%
2010-2013	5		14.7%
2005-2009	0		0.0%
2000-2004	0		0.0%
1995-1999	0		0.0%
1990-1994	0		0.0%
1985-1989	0		0.0%
1981-1984	0		0.0%
1980 & Earlier	0		0.0%
Unavailable Info.	0		0.0%
Total # of Distinct Members	34		100.0%



**Statistic Calculation based on all participants that did not decline.*

Programs

Geometric Group Theory

Analytic Number Theory

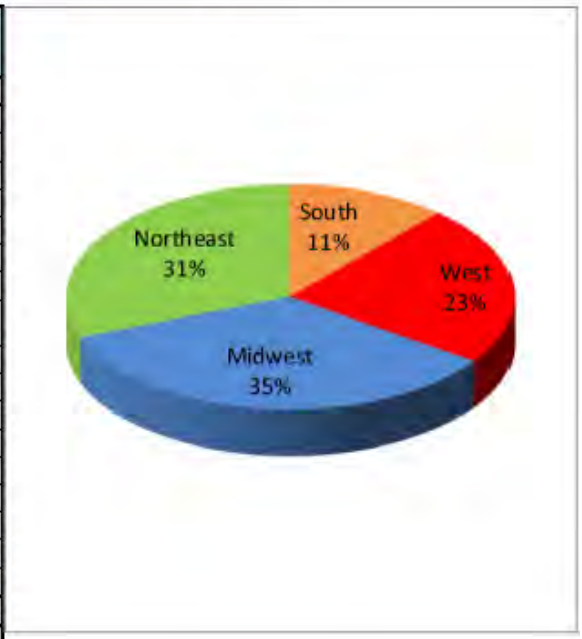
Harmonic Analysis

Complementary Program (2016-17)

2016–17 Postdoctoral Fellows Home Institution Classified by States

**Regions based on US Census classification*

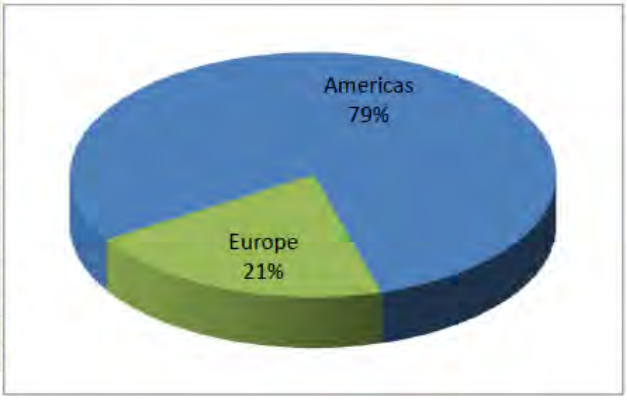
State	#	%	2010 Census Population
South	**3**	**11.5%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	1	3.8%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	2	7.7%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**6**	**23.1%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	6	23.1%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**9**	**34.6%**	**21.7%**
IL	4	15.4%	4.2%
IN	1	3.8%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	2	7.7%	3.2%
MN	1	3.8%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	1	3.8%	3.7%
SD	-	0.0%	0.3%
WI	-	0.0%	1.8%
Northeast	**8**	**30.8%**	**17.9%**
CT	1	3.8%	1.2%
ME	-	0.0%	0.4%
MA	4	15.4%	2.1%
NH	-	0.0%	0.4%
NJ	1	3.8%	2.8%
NY	1	3.8%	6.3%
PA	-	0.0%	4.1%
RI	1	3.8%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**26**	**100%**	**100%**



2016–17 Postdoctoral Fellows Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**27**
	North America	Canada	1
		United States	26
Asia			**0**
Europe			**7**
	Northern Europe	Finland	1
	Western Europe	France	1
		Sweden	1
		Switzerland	2
		United Kingdom	1
	Eastern Europe	Poland	1
Oceania			**0**
Grand Total			**34**



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 2016-17, there were three PD/RMs at MSRI.

Family Name	First Name	Pre-MSRI Institution Group	Post-MSRI Institution Group	Pre-MSRI Institution Name	Placement Institution Name
Krause	Ben	Foreign	Foreign	University of British Columbia	University of British Columbia
Thorner	Jesse	Private Large	Private Large	Stanford University	Stanford University
Taylor	Samuel	Private Large	Private Large	Yale University	Yale University

3.6 Postdoctoral Research Member Summary

Programs	# of Members	# of Citizens & Perm. Res.	# of Female	%	# of Minorities[1]	%	US Home Institution	%
Geometric Group Theory	1	1	0	*0.0%*	0	*0.0%*	1	0.0%
Analytic Number Theory	1	1	0	*0.0%*	0	*0.0%*	1	100.0%
Harmonic Analysis	1	1	0	*0.0%*	0	*0.0%*	0	0.0%
Complementary Program (2016-17)	0	0	0	*0.0%*	0	*0.0%*	0	0.0%
Total # of Distinct PDRMs	**3**	**3**	**-**	***0.0%***	**-**	***0.0%***	**2**	***66.7%***

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

4. Graduate Program

In 2016–17, 746 graduate students visited MSRI to participate in our workshops (483 graduate students), summer graduate schools (217 graduate students), and programs (46 graduate students). While the majority of the graduate students who visited MSRI were participants in our workshops or summer graduate schools, a smaller number of them were invited and funded as 'Program Associates' in our scientific programs.

4.1 Summer Graduate Schools (SGS)

Every summer, MSRI organizes several summer graduate schools (usually two weeks each), most of which are held at MSRI. Attending one of these 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 MSRI Academic Sponsoring Institutions or from Department of Mathematics at U.S. Universities are eligible for summer schools. For each institution, MSRI provides support for one or two students per summer, and will support up to four students if one of the students is female and one 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.

The following is a list of the six Summer Graduate Schools that took place during the summer of 2016. Altogether 27 lecturers and TAs, and 217 graduate students participated in these schools. Of those graduate students, 31% were female. See the table in section 4.2 for detailed demographic data.

For a complete report on each SGS, please refer to the Appendix.

SGS 1: Séminaire de Mathématiques Supérieures 2016: Dynamics of Biological Systems
May 30, 2016 - June 11, 2016
Location: Alberta, Canada
Organizers: Thomas Hillen (University of Alberta), Mark Lewis (University of Alberta), Yingfei Yi (University of Alberta)

SGS 2: Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets
June 13, 2016 - June 24, 2016
Organizers: Steven Hofmann (University of Missouri), Jose Maria Martell (Instituto de Ciencias Matematicas (ICMAT))

SGS 3: Mixed Integer Nonlinear Programming: Theory, algorithms and applications
June 20, 2016 - July 01, 2016
Location: Seville, Spain
Organizers: Francisco Castro (University of Sevilla), Elena Fernandez (Universitat Politecnica de Catalunya), Justo Puerto (University of Sevilla)

SGS 4: An Introduction to Character Theory and the McKay Conjecture
July 11, 2016 - July 22, 2016
Organizers: Robert Guralnick (University of Southern California), Pham Tiep (University of Arizona)

SGS 5: Electronic Structure Theory
July 18, 2016 - July 29, 2016
Location: Lawrence Berkeley National Laboratory
Organizers: Lin Lin (University of California, Berkeley), Jianfeng Lu (Duke University), James Sethian (University of California, Berkeley)

SGS 6: Chip Firing and Tropical Curves
July 25, 2016 - August 05, 2016
Organizers: Matthew Baker (Georgia Institute of Technology), David Jensen (University of Kentucky), Sam Payne (Yale University)

4.2 Summer Graduate Schools 2016 Data

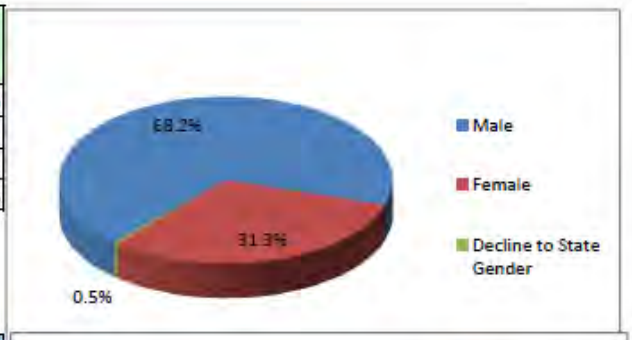
Summer Graduate Schools	# of Students	# of US Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%	US Home Institution	%
An Introduction to Character Theory and the McKay Conjecture	41	30	*73.2%*	15	*36.6%*	5	*16.7%*	39	95.1%
Chip Firing and Tropical Curves	50	30	*60.0%*	14	*28.0%*	6	*20.0%*	46	92.0%
Electronic Structure Theory	39	11	*28.2%*	4	*10.3%*	1	*9.1%*	28	71.8%
Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets	51	22	*43.1%*	14	*27.5%*	3	*13.6%*	40	78.4%
Mixed Integer Nonlinear Programming: Theory, algorithms and applications	11	5	*45.5%*	5	*45.5%*	0	*0.0%*	9	81.8%
Seminaire de Mathematiques Superieures 2016: Dynamics of Biological Systems	25	11	*44.0%*	16	*64.0%*	4	*36.4%*	20	80.0%
Total # of Students	**217**	**109**	***50.2%***	**68**	***31.3%***	**19**	***17.4%***	**182**	***83.9%***

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

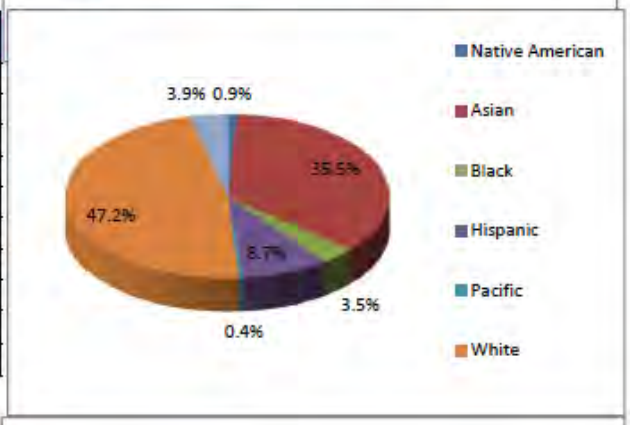
Summer Graduate School Demographic Data

2016 Summer Graduate Schools Demographic Summary

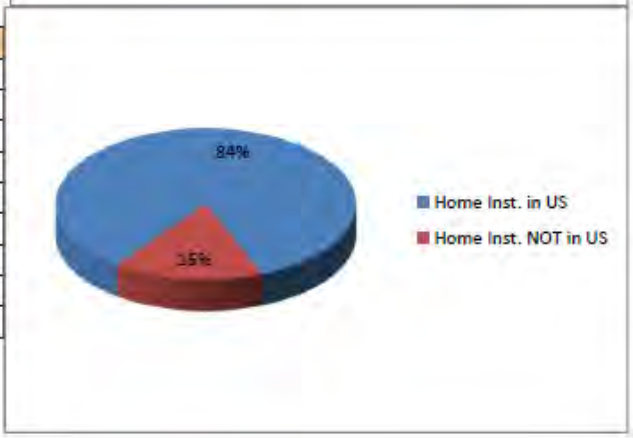
Gender	#	% (No Decl.)*	%
# of Students	217		100.0%
Male	148	68.52%	68.2%
Female	68	31.48%	31.3%
Decline to State Gender	1		0.5%



Ethnicities	#	% (No Decl.)*	%
Native American	2	0.90%	0.9%
Asian	82	36.94%	35.5%
Black	8	3.60%	3.5%
Hispanic	20	9.01%	8.7%
Pacific	1	0.45%	0.4%
White	109	49.10%	47.2%
Decline to State Ethnicities	9		3.9%
Unavailable Information	0		0.0%
Minorities	19		17.4%



Citizenships	#		%
US Citizen & Perm. Residents	109		50.2%
Foreign	108		49.8%
Unavailable information	0		0.0%
# of Students	217		100.0%
US Citizen	104		95.4%
Perm Residents	5		100.0%
Home Inst. in US	182		83.87%



**Statistic Calculation based on all participants that did not decline.*

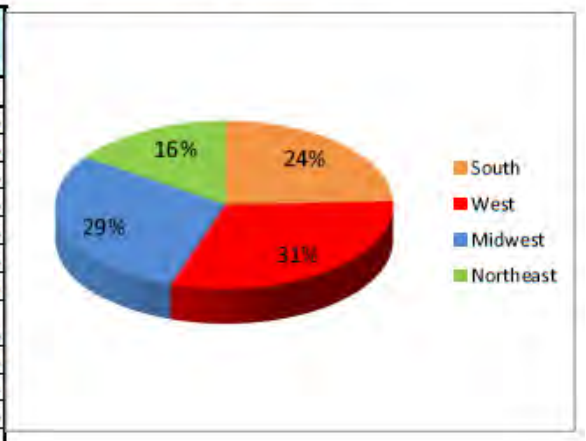
Summer Graduate Schools

An Introduction to Character Theory and the McKay Conjecture
Chip Firing and Tropical Curves
Electronic Structure Theory
Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets
Mixed Integer Nonlinear Programming: Theory, algorithms and applications
Seminaire de Mathematiques Superieures 2016: Dynamics of Biological Systems

2016 Summer Graduate Schools Home Institution Classified by States

**Regions based on US Census classification*

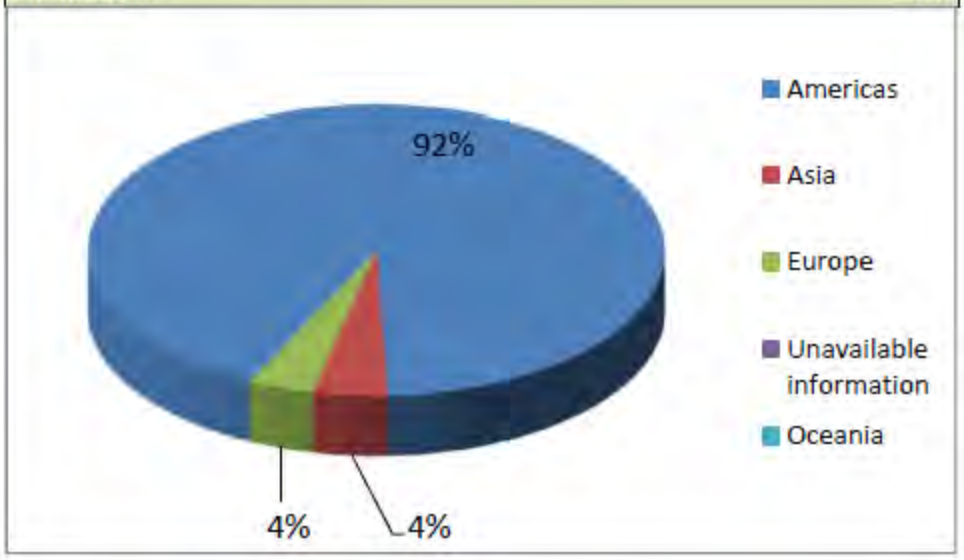
State	#	%	2010 Census Population
South	**44**	**24.2%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	4	2.2%	0.3%
DC	-	0.0%	0.2%
FL	1	0.5%	6.1%
GA	6	3.3%	3.1%
KY	4	2.2%	1.4%
LA	3	1.6%	1.5%
MD	5	2.7%	1.9%
MS	-	0.0%	1.0%
NC	6	3.3%	3.1%
OK	2	1.1%	1.2%
SC	1	0.5%	1.5%
TN	1	0.5%	2.1%
TX	9	4.9%	8.1%
VA	2	1.1%	2.6%
WV	-	0.0%	0.6%
West	**56**	**30.8%**	**23.3%**
AK	-	0.0%	0.2%
AZ	6	3.3%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	31	17.0%	12.1%
CO	5	2.7%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	6	3.3%	1.2%
UT	2	1.1%	0.9%
WA	6	3.3%	2.2%
WY	-	0.0%	0.2%
Midwest	**53**	**29.1%**	**21.7%**
IL	9	4.9%	4.2%
IN	9	4.9%	2.1%
IA	4	2.2%	1.0%
KS	5	2.7%	0.9%
MI	8	4.4%	3.2%
MN	3	1.6%	1.7%
MO	5	2.7%	1.9%
ND	3	1.6%	0.2%
NE	-	0.0%	0.6%
OH	5	2.7%	3.7%
SD	-	0.0%	0.3%
WI	2	1.1%	1.8%
Northeast	**28**	**15.4%**	**17.9%**
CT	1	0.5%	1.2%
ME	-	0.0%	0.4%
MA	6	3.3%	2.1%
NH	-	0.0%	0.4%
NJ	2	1.1%	2.8%
NY	11	6.0%	6.3%
PA	7	3.8%	4.1%
RI	-	0.0%	0.3%
VT	1	0.5%	0.2%
Other	**1**	**0.0%**	**0%**
PR	1	0.0%	0%
Other	-	0.0%	0%
Total	**182**	**99%**	**100%**



2016 Summer Graduate Schools Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**200**
	Central America	Mexico	5
	North America	Canada	13
		United States	182
Asia			**9**
	Eastern Asia	China	1
		Republic of Korea	4
	Southern Asia	India	2
	Southeastern Asia	Singapore	2
Europe			**8**
	Southern Europe	Italy	1
		Spain	1
	Western Europe	Germany	3
		Belgium	1
	Eastern Europe	Czech Republic	1
	Northern Europe	Norway	1
Oceania			**0**
Unavailable information			**0**
Grand Total			**217**



4.3 Program Associate

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 essentially benefit from all members' privileges, including shared office space. Each Program Associate was provided with an access card to the building which allows him to use the premises at any time, a bus, a library and sports facilities access pass. A grant from the National Security Agency (H98230-16-1-0325) provided funding to elegible Program Associates at $2,000 per month for up to four months. There were 46 graduate students who resided at MSRI for an extended period of time during the academic year 2016–17. See the table in section 4.4 for a detailed description of the demographic data.

4.4 Program Associate Data

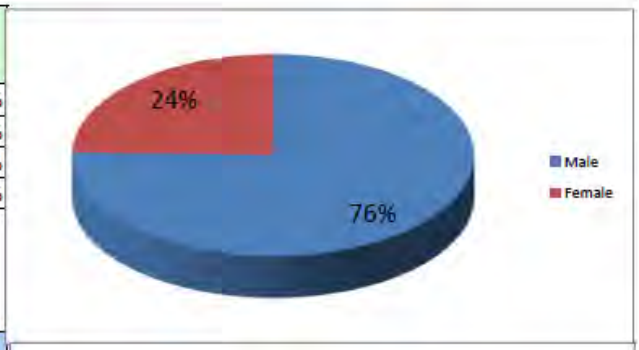
Programs	# of Members	# of Citizens & Perm. Res.	# of Female	%	# of Minorities[1]	%	US Home Institution	%
Geometric Group Theory	19	10	5	*26.3%*	2	*20.0%*	13	68.4%
Analytic Number Theory	11	3	2	*18.2%*	1	*33.3%*	3	27.3%
Harmonic Analysis	16	3	4	*25.0%*	1	*33.3%*	6	37.5%
Complementary Program (2016-17)	0	0	0	*0.0%*	0	*0.0%*	0	0.0%
Total # of Distinct PAs	**46**	**16**	**11**	***23.9%***	**4**	***25.0%***	**22**	***47.8%***

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

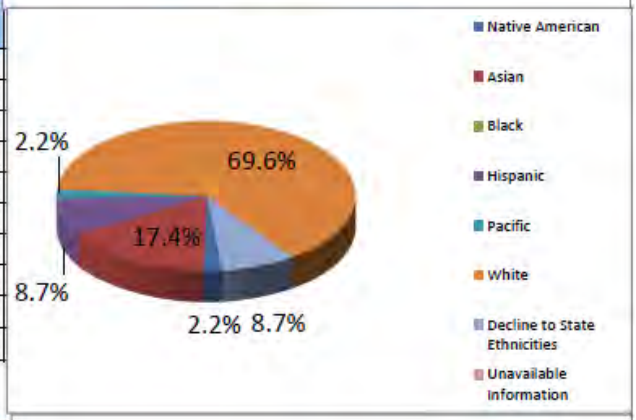
Program Associate Demographic Data

2016–17 Program Associates Demographic Summary

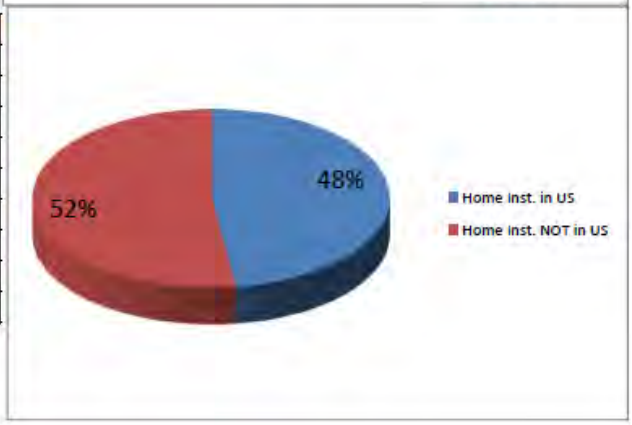
Gender	#	% (No Decl.)*	%
# of Distinct Members	46		100.0%
Male	34	75.56%	73.9%
Female	11	24.44%	23.9%
Decline to State Gender	1		2.2%



Ethnicities	#	% (No Decl.)*	%
Native American	1	2.17%	2.2%
Asian	8	17.39%	17.4%
Black	0	0.00%	0.0%
Hispanic	4	8.70%	8.7%
Pacific	1	2.17%	2.2%
White	32	69.57%	69.6%
Decline to State Ethnicities	4		8.7%
Unavailable Information	0		0.0%
Minorities	4		25.0%



Citizenships	#		%
US Citizen & Perm. Residents	16		34.8%
Foreign	30		65.2%
Unavailable information	0		0.0%
# of Distinct Members	46		100.0%
US Citizen	15		32.6%
Perm Residents	1		2.2%
Home Inst. in US	22		47.83%



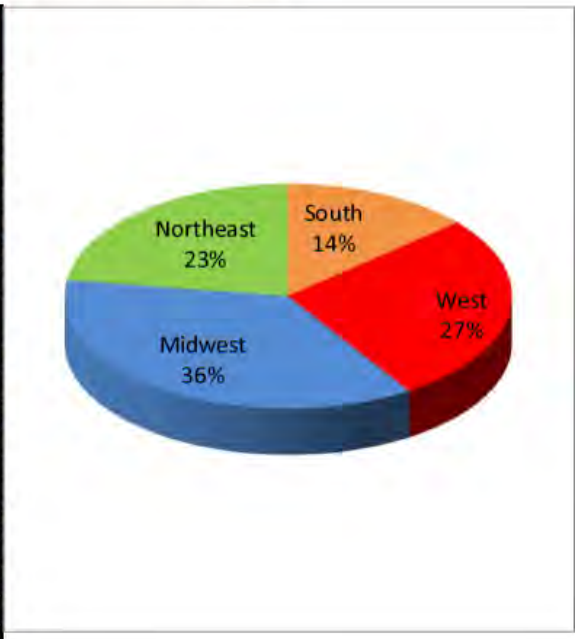
Programs

Geometric Group Theory
Analytic Number Theory
Harmonic Analysis
Complementary Program (2016-17)

2016–17 Program Associates Home Institution Classified by States

**Regions based on US Census classification*

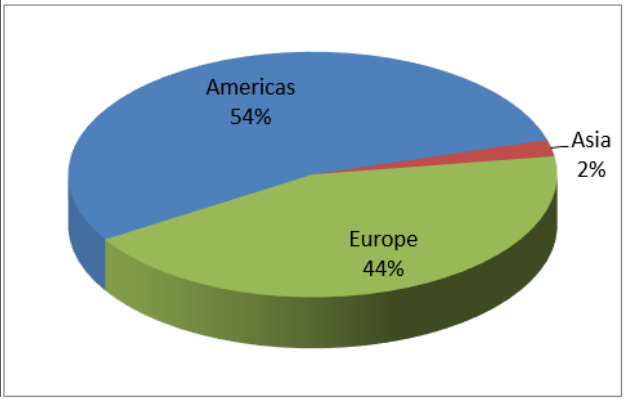
State	#	%	2010 Census Population
South	3	13.6%	37.1%
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	1	4.5%	1.9%
MS	-	0.0%	1.0%
NC	-	0.0%	3.1%
OK	1	4.5%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	1	4.5%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	6	27.3%	23.3%
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	1	4.5%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	4	18.2%	0.9%
WA	1	4.5%	2.2%
WY	-	0.0%	0.2%
Midwest	8	36.4%	21.7%
IL	3	13.6%	4.2%
IN	-	0.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	-	0.0%	3.2%
MN	1	4.5%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	-	0.0%	3.7%
SD	-	0.0%	0.3%
WI	4	18.2%	1.8%
Northeast	5	22.7%	17.9%
CT	-	0.0%	1.2%
ME	-	0.0%	0.4%
MA	2	9.1%	2.1%
NH	-	0.0%	0.4%
NJ	-	0.0%	2.8%
NY	-	0.0%	6.3%
PA	-	0.0%	4.1%
RI	3	13.6%	0.3%
VT	-	0.0%	0.2%
Other	-	0.0%	0%
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	22	100%	100%



2016–17 Program Associates Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**25**
	North America	Canada	3
		United States	22
Asia			**1**
	East Asia	Republic of Korea	1
Europe			**20**
	Northern Europe	Finland	1
	Western Europe	France	4
		Germany	4
		Switzerland	2
		United Kingdom	8
	Eastern Europe	Russia	1
Oceania			**0**
Grand Total			**46**



4.5 Graduate Student List

(Participants who attended 2016–17 workshops, excluding Summer Graduate Schools)
(See e-mail attachment)

4.6 Graduate Student Data*

(Participants who attended 2016–17 workshops, excluding Summer Graduate Schools)

Workshops	# of Participants	# of Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%	US Home Institution	%
12 Scientific Workshops									
Connections for Women: Harmonic Analysis	19	4	*21.1%*	15	*78.9%*	0	*0.0%*	12	63.2%
Introductory Workshop: Harmonic Analysis	52	20	*38.5%*	18	*34.6%*	2	*10.0%*	36	69.2%
Recent Developments in Harmonic Analysis	36	11	*30.6%*	14	*38.9%*	0	*0.0%*	23	63.9%
Groups acting on CAT(0) spaces	47	27	*57.4%*	8	*17.0%*	2	*7.4%*	36	76.6%
Introductory Workshop: Analytic Number Theory	51	13	*25.5%*	17	*33.3%*	1	*7.7%*	22	43.1%
Connections for Women: Analytic Number Theory	26	7	*26.9%*	19	*73.1%*	1	*14.3%*	13	50.0%
Amenability, coarse embeddability and fixed point properties	25	8	*32.0%*	6	*24.0%*	0	*0.0%*	14	56.0%
Geometry of mapping class groups and Out(Fn)	43	23	*53.5%*	8	*18.6%*	3	*13.0%*	34	79.1%
Hot Topics: Galois Theory of Periods and Applications	20	3	*15.0%*	3	*15.0%*	1	*33.3%*	8	40.0%
Recent developments in Analytic Number Theory	47	13	*27.7%*	9	*19.1%*	1	*7.7%*	32	68.1%
Connections for Women: Geometric Group Theory	38	21	*55.3%*	20	*52.6%*	4	*19.0%*	31	81.6%
Introductory Workshop: Geometric Group Theory	59	33	*55.9%*	20	*33.9%*	4	*12.1%*	46	78.0%
All 12 Workshops Total	**463**	**183**	***39.5%***	**157**	***33.9%***	**19**	***10.4%***	**307**	***66.3%***
1 Education & Outreach Workshop									
Critical Issues in Mathematics Education 2017: Observing for Access, Power, and Participation in Mathematics Classrooms as a Strategy to Improve Mathematics Teaching and Learning	20	18	*90.0%*	13	*65.0%*	8	*44.4%*	20	100.0%
All 15 Workshops Total	**483**	**201**	***41.6%***	**170**	***35.2%***	**27**	***13.4%***	**327**	***67.7%***

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

*Note that the overall graduate stutdent data in section 4.6 is not distinct as some participants attended multiple workshops, but the statistics of individual workshop found in Section 11, Appendix, were calculatued on distinct participant data.

5. Undergraduate Program in 2016 (MSRI-UP)

5.1 Description of Undegraduate Program

Please note: MSRI-UP is funded by an independent NSF grant, DMS-1156499. The report was filed independently to the NSF in February 2017, thus there is no report attached in Section 11.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 student participants will:

- participate in the mathematics research program under the direction faculty and graduate students mentors.
- complete a research project done in collaboration with other MSRI-UP students
- give a presentation and write a technical report on his/her research project
- attend a series of colloquium talks given by leading researches in their fields
- attend workshops aimed at developing skills and techniques needed for research careers in the mathematical sciences and
- learn techniques that will maximize a student's likelihood of admissions to graduate programs as well as the likelihood of winning fellowships
- receive a $3100 stipend, lodging, meals and round trip travel to Berkeley, CA.

After the summer, each student will:

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

MSRI-UP 2016: Sandpile Groups
June 11, 2016 – July 24, 2016

The research topic of the 2016 MSRI-UP program is Sandpile Groups, a topic at the intersection of group theory, combinatorics, linear algebra and algebraic geometry. The research program will be led by Prof. Luis Garcia-Puente of Sam Houston State University. Students who have had a linear algebra course and a course in which they have had to write proofs are eligible to apply.

In thermodynamics, a critical point is the end point of a phase equilibrium curve. The most prominent example is the liquid-vapor critical point, the end point of the pressure-temperature curve at which the distinction between liquid and gas can no longer be made. In order to drive this system to its critical point it is necessary to tune certain parameters, namely pressure and temperature. In nature, one can also observe different types of dynamical systems that have a critical point as an attractor. The macroscopic behavior of these systems displays the spatial and/or temporal scale-invariance characteristic of the critical point of a phase transition, but without the need to tune control parameters to precise values. Such a system is said to display self-organized criticality. This concept is thought to be present in a large variety of physical systems like earthquakes, forest fires and even some fluctuations in the stock market. Self-organized criticality is considered to be one of the mechanisms by which complexity arises in nature and has been extensively studied in the statistical physics literature during the last three decades.

In 1987, in their seminal paper, Bak, Tang and Wiesenfeld conceived a cellular automaton model as a paradigm of self-organized criticality. In this model, the system evolves in discrete time such that at each time step a sand grain is dropped onto a random grid cell of a rectangular grid. When a cell amasses four grains of sand, it becomes unstable. It relaxes by toppling whereby four sand grains leave the site, and each of the four neighboring sites gets one grain. If the unstable cell is on the boundary of the grid then, depending on its actual position, either one or two sand grains fall off the edge and disappear. As the sand percolates over the grid in this fashion, adjacent cells may accumulate four grains of sand and become unstable causing an avalanche. This settling process continues until all cells are stable. Then another cell is picked randomly, the height of the sand on that grid cell is increased by one, and the process is repeated.

In 1990, Dhar generalized the Bak, Tang and Wiesenfeld model replacing the rectangular grid with an arbitrary undirected or directed graph with a global sink. In this model, the sand grains are placed at the vertices of the graph. The toppling threshold depends on the degree (outdegree) of each vertex, and the existence of a global sink ensures that any avalanche terminates after a finite amount of topplings. The long-term behavior of the abelian sandpile model on a graph is encoded by the critical (or recurrent) configurations. These critical configurations have connections to parking functions, to the Tutte polynomial, and to the lattices of flows and cuts of a graph. Among other properties, the critical configurations of the sandpile model have the structure of a finite abelian group. This group has been discovered in several different contexts and received many names: the sandpile group for graphs and digraphs, the critical group, the group of bicycles, the group of components, and the jacobian of the graph. The sandpile group will be the main object of study during the 2016 MSRI-UP program.

11. Appendix – Final Reports of Activities in 2016–17

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Geometric Group Theory

August 15, 2016 to December 16, 2016
MSRI, Berkeley, CA
USA

Organizers:

Ian Agol (University of California, Berkeley)
Mladen Bestvina (University of Utah)
Cornelia Drutu (University of Oxford)
Mark Feighn (Rutgers University)
Michah Sageev (Technion---Israel Institute of Technology)
Karen Vogtmann (University of Warwick)

GEOMETRIC GROUP THEORY AT MSRI: PROGRAM REPORT

I. AGOL, M. BESTVINA, C. DRUŢU, M. FEIGHN, M. SAGEEV, AND K. VOGTMANN

1. Introduction

Although it has roots in classical work of mathematicians such as Klein, Poincaré and Dehn, geometric group theory emerged as a recognized subfield of mathematics relatively recently, impelled by the use of geometric and dynamical methods by Gromov and Thurston to settle old questions in algebra and low-dimensional topology.

The 2016 MSRI program in geometric group theory was conceived as a follow-up to a very successful program in the subject that was held at MSRI in Fall 2007. Thanks at least in part to that program the field has expanded rapidly since 2007 and there has been a steady stream of impressive new developments, in fact so many and in such diverse directions that the 2016 program was formatted as a jumbo program, occupying the entire building. At the end of the 2016 program we can already report, for the reasons outlined in this document, that this format was appropriate – the program was a resounding success! Highlights include production of a large amount of high quality research, the establishment of new collaborations across all career stages, five stimulating and successful conferences, and a variety of ambitious and well-attended weekly working seminars.

2. Research Developments

A notable feature of the program was the abundance of collaborations, old and new, across subfields of Geometric Group Theory as well as career stages, from graduate students and early career mathematicians to senior members. On entering the building it was usual to see several groups of 2-4 people discussing mathematics in offices or in the open spaces near blackboards in the halls. In exit surveys these discussions were often mentioned as a highlight of the program.

The program has just ended and it is a bit too early to tell how many of these informal discussions will lead to theorems and papers, but we have assembled below a list of some of the topics that people were discussing, taking care in particular to mention some of the new collaborations that were formed.

1. **Coulbois, Dowdall, Hilion and Taylor** discussed a possible generalization for free-by-cyclic groups of Agol's notion of veering triangulations; in such a theory some canonical object would be associated to each "fibered face".
2. **Kropholler, Leary and Soroko** discovered that there are uncountably many quasi-isometry types of groups of type FP. The collaboration began after Soroko's talk in the graduate student seminar, and involves a graduate student, a postdoc, and a senior mathematician.

Date: July 14, 2017.

3. **Rafi and Souto** established results on counting lattice points with respect to the Thurston metric. This collaboration was initiated during the *Counting seminar* organized by **Howard Masur**.
4. **Iezzi, J. Sapir, Schleimer, Tang and Taylor** discussed quasi-isometric embeddings of complexes associated to surfaces into complexes associated to $Out(F_n)$. This collaboration involves three postdocs and two senior mathematicians.
5. **Schleimer and Sisto** discussed constructing interesting examples of 3-manifolds via Heegaard splittings.
6. **Sisto and Taylor** looked at finer properties of random walks on mapping class groups. They showed that they converge to points at infinity of the curve complex, and they investigated subsurface projections along the way. There is a preprint available on arXiv.
7. **Maher and Sisto** investigated random subgroups of acylindrically hyperbolic groups (determined by independent random walks) and asked whether they hyperbolically embed. There is now a preprint available on arXiv based on their discussions.
8. **Dowdall, Durham, Leininger and Sisto** started moving beyond the notion of convex cocompactness for subgroups of mapping class groups, attempting to define a more general notion of *geometrically finite* subgroups by analogy with geometrically finite subgroups of Kleinian groups.
9. **Dymarz and Maher** discussed notions of randomness for nilpotent groups.
10. **Charney, Coulon and Durham** discussed whether it was possible to enlarge the Morse boundary of a CAT(0) space and yet keep it invariant under quasi-isometries.
11. **Bestvina, Guirardel and Horbez** discussed various open "topological" conjectures for the group $Out(F_n)$, including the Novikov and Farrell-Jones conjectures and finiteness of asymptotic dimension. They succeeded in showing that $Out(F_n)$ is boundary amenable, and therefore satisfies the Novikov conjecture.
12. **Druţu, Valette and Vdovina** discussed various ideas for constructing higher dimensional expanders.
13. **Bregman, Charney and Vogtmann** discussed problems involved in constructing Outer spaces for general right angled Artin groups.
14. **Bestvina, Bromberg, Fujiwara and Sisto** discussed how to simplify and generalize the notion of projection complexes.
15. **Hartnick and Sisto** showed that the second bounded cohomology of many groups of interest (e.g. mapping class groups) embeds in the inverse limit of second bounded cohomology groups of its virtually free subgroups. A novel feature of this work is that they use a new type of probabilistic argument. There is now a paper on the arXiv.

3. Organizational Structure

The program included five workshops, described in the next section. In addition there were several types of regular activities, which we describe in this section.

3.1. **Working seminars.** At the beginning of the program four working seminars were organized, with two more added later on. These met once a week unless there was a workshop going on, and were open to all program participants. They included

- *$Out(F_n)$-complexes*, organized by Carolyn Abbott
- *Counting problems in groups and spaces, and random walks*, organized by Howard Masur and Samuel Taylor
- *Projection complexes, rotating families, and beyond*, organized by Jing Tao
- *Median Spaces*, organized by Talia Fernos
- *Formal Languages and Geometry*, organized by Robert Gilman
- *Ozawa's proof of Gromov's Polynomial Growth Theorem*, organized by Alain Valette.

3.2. **Members' Seminar (Tuesdays).** This was organized by Michael Kapovich and Gilbert Levitt, and featured a one-hour lecture on current research by a general member or research professor. The speakers were chosen preferably among the participants who were not speakers in one of the workshops.

3.3. **Common Lunch (Wednesdays).** This was organized by Ken Bromberg. Anyone could submit a question anonymously in advance, and Bromberg found volunteers to answer them, either in advance or on the spot. The idea was to give members a safe setting in which to ask some of those embarrassing questions that many people secretly want to ask. Typical questions were of two forms. Many members found the impromptu, pithy explanations of resident experts of the "What is ... ?" type questions to be very interesting and valuable. The other type of question was more open ended. For example during one lunch three different people gave their interpretations of the geometric meaning of bounded cohomology. The common lunch also served to integrate the postdocs and graduate students into the program.

3.4. **Graduate student seminar (Thursdays).** This seminar was open only to graduate students and the senior organizer (Indira Chatterji), and proved very popular. A detailed description is given below in the section on graduate students.

3.5. **Postdoctoral seminar (Fridays).** This seminar featured post-docs giving 45-minute talks on their research. It is described in more detail in the section below on post-docs.

3.6. **Special lectures (Mondays).** Special lectures which did not fit into the regular schedule were generally scheduled for Mondays. These included presentations by Bestvina, Duchin, Dymarz, Hartnick, Hume, Arie Levit, Nir Lazarovich, Ott, Schleimer, and Valette.

4. Workshops and Conferences

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

- Connections for Women
- Introductory Workshop
- Groups acting on $CAT(0)$-spaces
- Geometry of mapping class groups and $Out(F_n)$
- Amenability, coarse embeddability and fixed point properties

5. Postdoctoral Fellows

The postdoctoral participants this semester were particularly strong and formed a vibrant backbone to the program. The postdoc seminar met every Friday and featured 45-minute talks by the postdoctoral members. There were two talks each day, followed by pizza for those who attended. The talks were of high quality and were very well attended by members at all levels, from graduate students to research professors.

The postdocs were visibly well integrated into the program. As mentioned above, every day as one would walk through the various open areas of MSRI one would see small groups of people huddled around chalkboards, working on their mathematics. Almost every one of these small working groups we noticed included postdocs.

Each postdoc was assigned a mentor from the collection of "village elders" in residence at MSRI. The mentors met weekly with their mentees. The mentoring program was successful not only in terms of having the more experienced mathematicians helping the posdocs with professional issues such as job searches, but also on the level of mathematical research. As one example Mahan Mitra, who mentored Sam Taylor, reports that their conversations will result in at least two forthcoming papers, one written jointly with Sam and one together with Sam and Spencer Dowdall, a young general member in the program.

As one can see below, a great deal of mathematical progress was made by the postdocs this semester. One breakthrough result is that of David Hume, who was able to show that Baumslag-Solitar groups do not coarsely embed in any hyperbolic group. This was a longstanding question in the subject of coarse embeddings and the proof is rather ingenious, making use of the notion of "separation profile" introduced by Benjamini, Schramm and Timar.

A survey of each postdoctoral fellow can be found in MSRI's annual report.

6. Graduate Students

In addition to the postdocs, the cadre of graduate students also formed an important component of the 2016 program. Upper level graduate students benefit greatly from exposure to the rich and concentrated research environment at MSRI. In return the graduate students added youthful energy and excitement. They were a strong and powerful presence.

To support the participation of graduate students, a graduate student seminar met weekly under the advisement of research professor Indira Chatterji. Only graduate students were permitted to participate, with the exception of Chatterji. Seminar participants developed a list of topics they felt they would like to learn more about in order to better understand the conference talks and the mathematics being discussed at MSRI. Student volunteers chose topics "out of their comfort zone" from the list and prepared talks, often by consulting with a resident expert in that topic. Each presentation consisted of a 45-minute introductory lecture followed by a 45-minute exercise session fueled by pizza. Students split up into smaller groups for the exercise session, so that everybody had the opportunity to ask questions and understand the notions presented in the lecture.

Here is the list of presenters and topics:

- Elia Fioravanti: Special cube complexes
- Radhika Gupta: Asymptotic cones

- Corey Bregman: Bounded cohomology
- Federico Vigolo: Boundaries and dimensions
- Derrick Wigglesworth: Holomorphic quadratic differentials
- James Farre: Boundary amenability
- Alexis Gilles: Property (T)
- Davide Spriano: C*-algebras
- Nicholas Cahill: Property A

Graduate student Carolyn Abbott organized the popular working seminar on $Out(F_n)$-complexes.

7. Job Market Panel

Early in the program Indira Chatterji organized a Job Market Panel targeted at both graduate students and post-docs. In this event several senior program members, both U.S. and international, gave presentations about the job application process in their countries and made observations about features of successful applications. This was followed by a question-and-answer period. Audience members were encouraged to ask other program participants for help with their applications, and by all reports they took this suggestion to heart.

8. Diversity

We note that more than a third, five out of thirteen, of our postdoctoral fellows were women. Of the research level participants, 24 out of 104 were women, and four participants were US minorities.

9. 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:

- Yves Benoist: Rice University
- Mladen Bestvina: Stanford University
- Michael Cantrell: Bowdin College
- Pallavi Dani: UC Santa Barbara
- Valentina Disarlo: University of Southern California and UC Santa Barbara
- Spencer Dowall: UC Santa Barbara
- Cornelia Drutu: Columbia University
- Mark Feighn: UC Davis
- Ursula Hamenstadt: UC Santa Barbara
- Dominique Hulin: Rice University
- David Hume: Columbia University
- Ilya Kapovich: UC Berkeley
- Giang Le: UC Santa Cruz
- Kasra Rafi: University of Southern California
- Saul Schleimer: UC Davis
- John Smillie: Stanford University
- Jing Tao: UC Santa Barbara
- Anne Thomas: UC Davis
- Karen Vogtmann: UC Berkeley, UC Davis, Stanford University
- Ric Wade: Bowdin College and Northeastern University

Alain Valette led two Berkeley Math Circle sessions for middle and high school students and their teachers.

Saul Schleimer filmed a video for NumberPhile with Brady Haran on minimal surfaces in euclidean and spherical three-space. Howard Masur filmed one as well. Masur presented some ideas from the so called "illumination problem" in billiards. This asks whether, given a light source in a room with mirrors, the light source illuminates every point in the room; that is, given another point, is there a billiard path in some direction from the source so that after bouncing off walls in the room you get to the point. He presented examples where this does not hold.

10. Highlights and Breakthroughs

10.1. **Breakthroughs.** One striking development in the 2016 Geometric Group Theory program was the emergence of new probabilistic methods. For example, **random walk** techniques can be used to find elements of a given group with particularly desirable properties. This method generalizes the classical *Drunkard's Walk* on the integers that randomly adds or subtracts 1 with equal chance. In group theory the integers are replaced by the elements of the group, one "walks" by applying group generators and their inverses, and probabilistic methods can be used to describe the properties of a typical path. In interesting cases these paths get closer and closer to a point in a standard "space at infinity," a space classically studied in geometric group theory.

One of the fundamental problems in topology is the classification of manifolds (say homotopy equivalent to a given manifold). This classification problem can be solved under the condition that a certain conjecture about the fundamental group of the manifold is true. This conjecture is called the Farrell-Jones conjecture, and the **Novikov conjecture** is a slightly weaker version. These conjectures are known to be true for many classes of groups, but the group $Out(F_n)$ of symmetries of a free group resisted all efforts. This is a naturally arising group basic to the theory of automorphism groups in general, and with many connections to other areas of mathematics. A breakthrough was achieved during this fall's program, when the Novikov conjecture was established for $Out(F_n)$.

10.2. **Highlights.** An example of the kind of serendipity fostered by the atmosphere at MSRI was reported by Bob Gilman. He explains that the first item discussed in his working seminar was whether one could improve on an interesting new result concerning languages and groups. Gilman's answer to a casual question at lunch about what was going on in the seminar reminded Koji Fujiwara of a certain lemma, which was subsequently reported to the seminar. One of the graduate students attending the seminar added a good idea of his own and produced an impressive improvement on the result. The lemma in question occurred in a paper on differential geometry, which Gilman doubts anyone attending the seminar would have found on their own.

What geometric group theorists do for fun: Using the altitudes of MSRI and the tops of the stanchions of the Golden Gate bridge (found on the web) together with the observation that from MSRI the horizon is lower than the tops of the stanchions, Yves Benoist computed the radius of the earth (to within 10% of the actual value).

Mathematical conversations also occurred at numerous social events organized by participants, including regular weekend hiking, biking or sailing trips on the

bay, an amazing feast for Saint Nicholas day, expeditions to a local rock-climbing wall, a couple of evening French tables (open to anyone willing to attempt speaking French), and a Ladies Night at a local restaurant (also attended by a few men).

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Mathematics Institute, Zeeman Building, University of Warwick, Coventry CV4 7AL, United Kingdom
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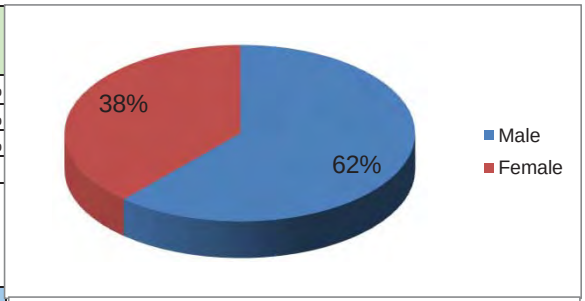
Postdoc Pre/Post-MSRI Institution Group

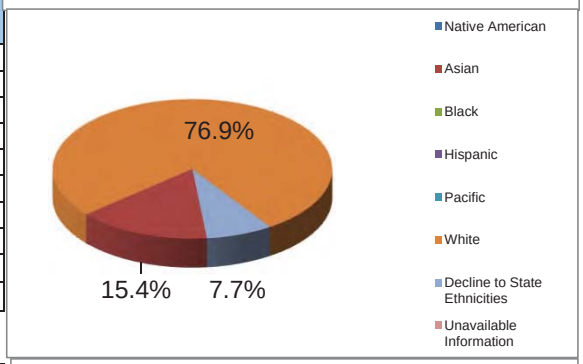
Family Name	First Name	Pre-MSRI Institution Group	Post-MSRI Institution Group	Home Institution Name	Placement Institution Name
Cantrell	Michael	Public Large	Non-group	University of Illinois, Chicago	Metis Data Science Bootcamp
Disarlo	Valentina	Public Large	Foreign	Indiana University, Bloomington	Universitaat Heidelberg
Durham	Matthew	Public Large	Public Large	University of Michigan	University of Michigan
Fullarton	Neil	Private Large	Private Large	Rice University	Rice University
Gultepe	Funda	Public Large	Public Large	University of Illinois, Urbana-Champaign	University of Illinois, Urbana–Champaign
Hume	David	Foreign	Foreign	Universite de Paris XI	University of Oxford
Kropholler	Robert	Private Small	Private Small	Tufts University	Tufts University
Le	Giang	Public Large	Non-group	Ohio State University	to be determined
Sapir	Eugenia	Public Large	Public Large	University of Illinois, Urbana-Champaign	University of Illinois, Urbana-Champaign
Schreve	Kevin	Public Large	Public Large	University of Michigan-Ann Arbor	University of Michigan-Ann Arbor
Strzałkowski	Karol	Foreign	Foreign	Polish Academy of Sciences	Polish Academy of Sciences
Wade	Richard	Foreign	Foreign	University of British Columbia	University of British Columbia
Wang	Pei	Public Large	Foreign	Rutgers University	University of the Basque Country, Spain

2016–17 Postdoctoral Fellow Demographic Summary

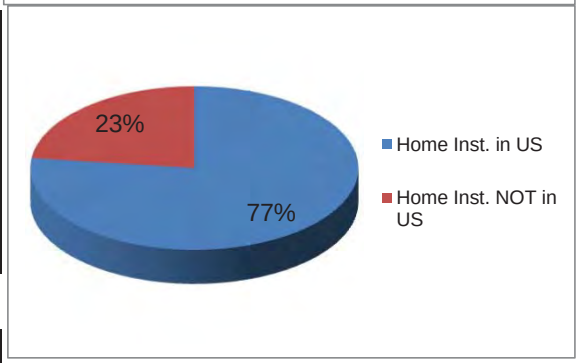
Gender	#	% (No Decl.)*	%
# of Distinct Postdocs	13		100.0%
Male	8	61.54%	61.5%
Female	5	38.46%	38.5%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	2	16.67%	15.4%
Black	0	0.00%	0.0%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	10	83.33%	76.9%
Decline to State Ethnicities	1		7.7%
Unavailable Information	0		0.0%
Minorities	0		0.0%

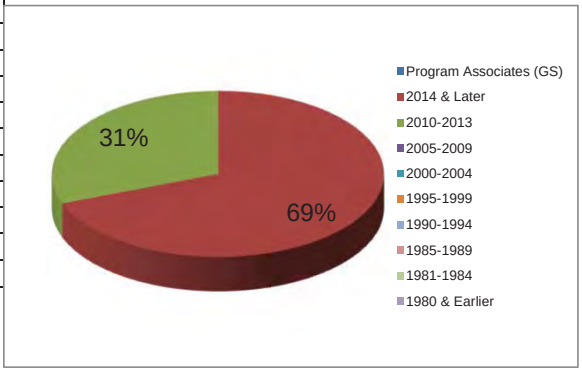


Citizenships	#		%
US Citizen & Perm. Residents	5		38.5%
Foreign	8		61.5%
Unavailable information	0		
# of Distinct Postdocs	13		100.0%
US Citizen	4		30.8%
Perm Residents	1		7.7%
Home Inst. in US	10		76.92%



Year of Ph.D	#		%
Program Associates (GS)	0		0.0%
2014 & Later	9		69.2%
2010-2013	4		30.8%
2005-2009	0		0.0%
2000-2004	0		0.0%
1995-1999	0		0.0%
1990-1994	0		0.0%
1985-1989	0		0.0%
1981-1984	0		0.0%
1980 & Earlier	0		0.0%
Total # of Distinct Postdocs	13		100.0%

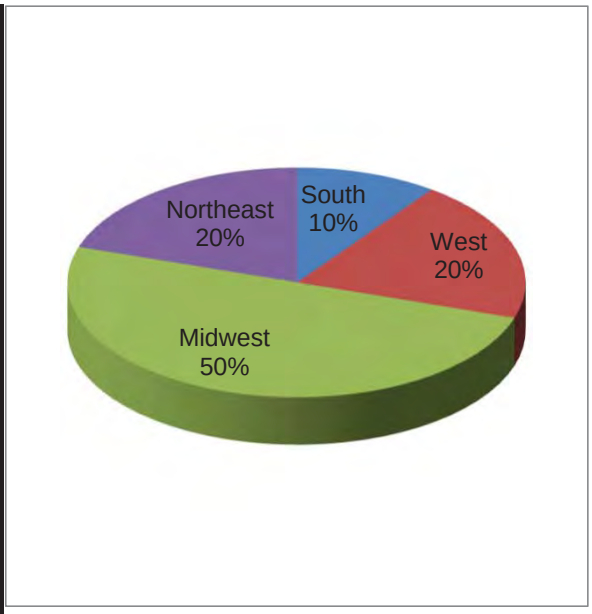
**Statistic Calculation based on all participants that did not decline.*



2016–17 Postdoctoral Fellow Home Institution Classified by States

**Regions based on US Census classification*

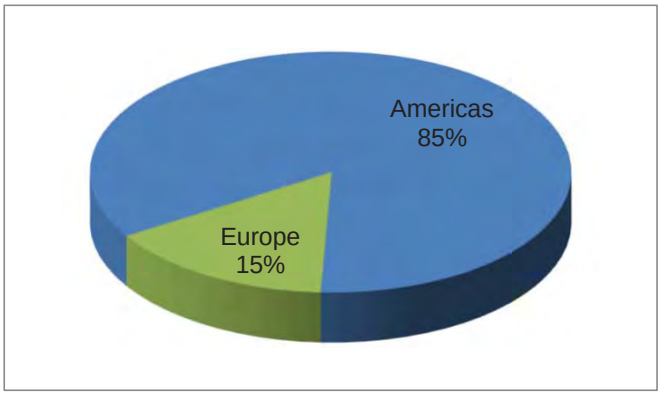
State	#	%	2010 Census Population
South	**1**	**10.0%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	-	0.0%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	1	10.0%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**2**	**20.0%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	2	20.0%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**5**	**50.0%**	**21.7%**
IL	3	30.0%	4.2%
IN	-	0.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	2	20.0%	3.2%
MN	-	0.0%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	-	0.0%	3.7%
SD	-	0.0%	0.3%
WI	-	0.0%	1.8%
Northeast	**2**	**20.0%**	**17.9%**
CT	-	0.0%	1.2%
ME	-	0.0%	0.4%
MA	1	10.0%	2.1%
NH	-	0.0%	0.4%
NJ	1	10.0%	2.8%
NY	-	0.0%	6.3%
PA	-	0.0%	4.1%
RI	-	0.0%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**10**	**100%**	**100%**



2016–17 Postdoctoral Fellow Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**11**
	North America	Canada	1
		United States	10
Asia			**0**
Europe			**2**
	Eastern Europe	Poland	1
	Western Europe	France	1
Oceania			**0**
Grand Total			**13**



Geometric Group Theory

Program Summary

Role	# of Distinct Members	%	# of US Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%
Organizers	6	5.6%	5	83.3%	2	33.3%	0	0.0%
Research Professors	14	13.1%	6	42.9%	4	28.6%	0	0.0%
Postdoctoral Fellows	13	12.1%	5	38.5%	5	38.5%	0	0.0%
PD/RM	1	0.9%	1	100.0%	0	0.0%	0	0.0%
Research Members	54	50.5%	30	55.6%	11	20.4%	2	6.7%
Program Associates	19	17.8%	10	52.6%	5	26.3%	2	20.0%
Guests	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total # of Distinct Members	**107**		**57**	***53.3%***	**27**	***25.2%***	**4**	***7.0%***

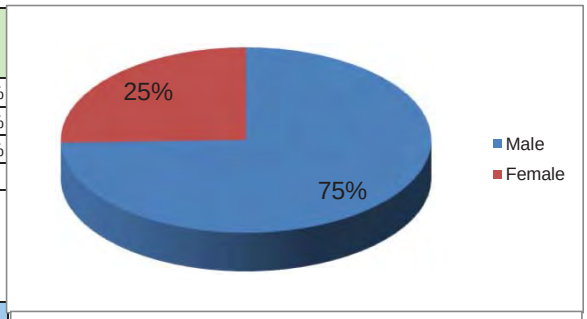
[1] *Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, or Hispanic. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.*

Home Institution Grouping

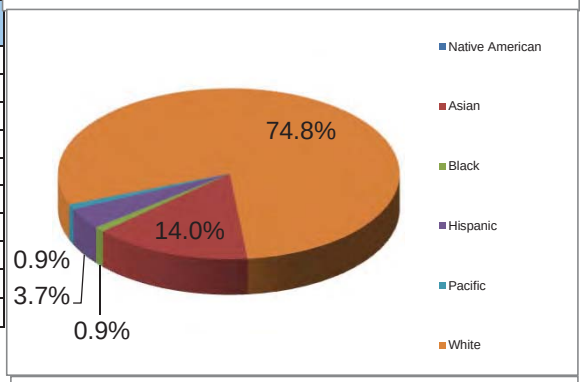
	US								
Role	**Private Large**	**Private Small**	**Public Large**	**Public Medium**	**Public Small**	**Group M or B**	**Non-Group**	**Foreign**	**Total**
Organizers	0	0	2	1	0	0	0	3	6
Research Professors	2	0	1	1	0	0	0	10	14
Postdoctoral Fellows	1	1	6	0	0	0	2	3	13
PD/RM	1	0	0	0	0	0	0	0	1
Research Members	6	3	10	2	5	0	0	28	54
Program Associates	2	1	5	4	1	0	0	6	19
Total	**12**	**5**	**24**	**8**	**6**	**-**	**2**	**50**	**107**
%	***11.2%***	***4.7%***	***22.4%***	***7.5%***	***5.6%***	***0.0%***	***1.9%***	***46.7%***	***100.0%***

2016–17 Program Members Demographic Summary

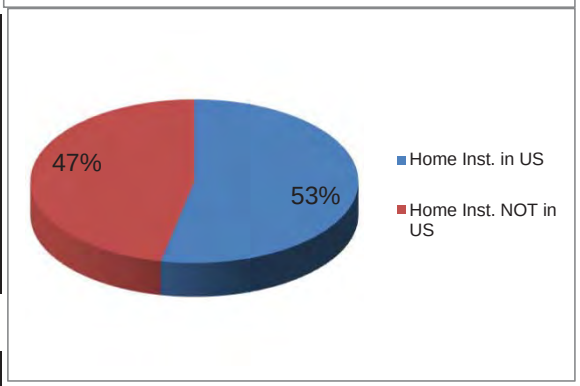
Gender	#	% (No Decl.)*	%
# of Distinct Members	107		99.1%
Male	79	74.53%	73.8%
Female	27	25.47%	25.2%
Decline to State Gender	1		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	15	14.85%	14.0%
Black	1	0.99%	0.9%
Hispanic	4	3.96%	3.7%
Pacific	1	0.99%	0.9%
White	80	79.21%	74.8%
Decline to State Ethnicities	12		11.2%
Unavailable Information	0		0.0%
Minorities	4		7.0%

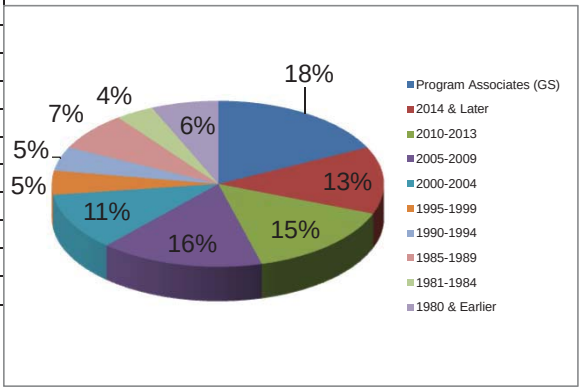


Citizenships	#		%
US Citizen & Perm. Residents	57		53.3%
Foreign	50		46.7%
Unavailable information	0		
# of Distinct Members	107		100.0%
US Citizen	49		45.8%
Perm Residents	8		7.5%
Home Inst. in US	57		53.27%



Year of Ph.D	#		%
Program Associates (GS)	19		17.8%
2014 & Later	14		13.1%
2010-2013	16		15.0%
2005-2009	17		15.9%
2000-2004	12		11.2%
1995-1999	5		4.7%
1990-1994	5		4.7%
1985-1989	8		7.5%
1981-1984	4		3.7%
1980 & Earlier	7		6.5%
Total # of Distinct Members	107		100.0%

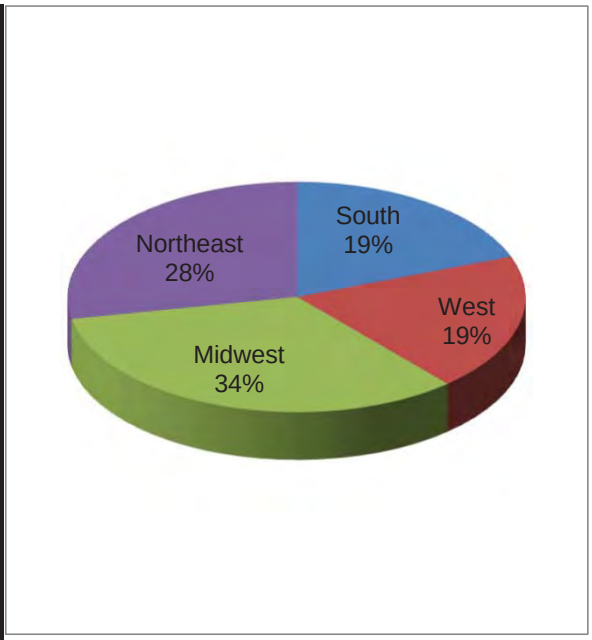
**Statistic Calculation based on all participants that did not decline.*



2016–17 Program Members Home Institution Classified by States

**Regions based on US Census classification*

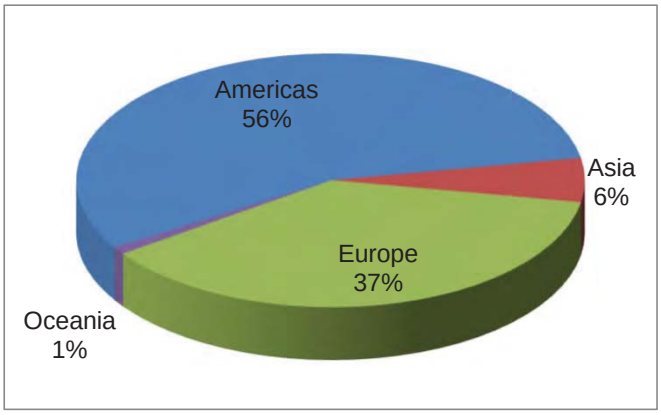
State	#	%	2010 Census Population
South	**11**	**19.3%**	**37.1%**
AL	-	0.0%	1.5%
AR	1	1.8%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	1	1.8%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	1	1.8%	3.1%
OK	3	5.3%	1.2%
SC	-	0.0%	1.5%
TN	1	1.8%	2.1%
TX	4	7.0%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**11**	**19.3%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	1	1.8%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	4	7.0%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	6	10.5%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**19**	**33.3%**	**21.7%**
IL	11	19.3%	4.2%
IN	-	0.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	2	3.5%	3.2%
MN	-	0.0%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	3	5.3%	3.7%
SD	-	0.0%	0.3%
WI	3	5.3%	1.8%
Northeast	**16**	**28.1%**	**17.9%**
CT	2	3.5%	1.2%
ME	-	0.0%	0.4%
MA	5	8.8%	2.1%
NH	-	0.0%	0.4%
NJ	3	5.3%	2.8%
NY	5	8.8%	6.3%
PA	-	0.0%	4.1%
RI	1	1.8%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**57**	**100%**	**100%**



2016–17 Program Members Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**60**
	North America	Canada	3
		United States	57
Asia			**6**
	Eastern Asia	Japan	1
	Southern Asia	India	1
	Western Asia	Israel	4
Europe			**40**
	Eastern Europe	Poland	2
	Northern Europe	United Kingdom	10
	Western Europe	Austria	1
		France	17
		Germany	4
		Switzerland	6
Oceania			**1**
	Australia & NZ	Australia	1
Grand Total			**107**



Geometric Group Theory Exit Survey Analysis

August 15, 2016 - December 16, 2016

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	103	99%
No	1	1%
Total Responses	104	

Q2. I had opportunities to present my work to new audiences		
Yes	90	87%
No	14	13%
Total Responses	104	

Q3. I initiated research with new collaborators		
Yes	86	83%
No	18	17%
Total Responses	104	

Q4. I initiated research in new areas		
Yes	87	84%
No	17	16%
Total Responses	104	

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

MSRI Experience - Postdoc Seminar

Q7. To learn new ideas and techniques		
1 - Least Satisfying	2	2%
2	1	1%
3	15	19%
4	26	32%
5 - Most Satisfying	37	46%
Total Responses (Exclusive of N/A)	81	100%

Q8. To form new acquaintances and collaborations		
1 - Least Satisfying	4	6%
2	2	3%
3	14	19%
4	27	38%
5 - Most Satisfying	25	35%
Total Responses (Exclusive of N/A)	72	100%

Q9. To be able to present my own work		
1 - Least Satisfying	0	0%
2	1	4%
3	4	14%
4	7	25%
5 - Most Satisfying	16	57%
Total Responses (Exclusive of N/A)	28	100%

MSRI Experience - Program Seminars

Q10. To learn new ideas and techniques		
1 - Least Satisfying	1	1%
2	2	2%
3	5	5%
4	34	35%
5 - Most Satisfying	54	56%
Total Responses (Exclusive of N/A)	96	100%

Q11. To form new acquaintances and collaborations

1 - Least Satisfying	3	3%
2	4	4%
3	21	22%
4	27	28%
5 - Most Satisfying	40	42%
Total Responses (Exclusive of N/A)	95	100%

Q12. To be able to present my own work

1 - Least Satisfying	3	7%
2	0	0%
3	6	15%
4	11	27%
5 - Most Satisfying	21	51%
Total Responses (Exclusive of N/A)	41	100%

MSRI Experience - General Information

Q13. My office accomodations were

1 - Least Satisfying	2	2%
2	3	3%
3	11	11%
4	25	24%
5 - Most Satisfying	63	61%
Total Responses (Exclusive of N/A)	104	100%

Q14. Professionally, my overall satisfation with MSRI was

1 - Least Satisfying	0	0%
2	3	3%
3	4	4%
4	14	13%
5 - Most Satisfying	83	80%
Total Responses (Exclusive of N/A)	104	100%

MSRI Experience - Feedback

Q15. 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

Q16. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

Link to Qualitative Responses

Q17. What suggestions would you have for improvements at MSRI?

Link to Qualitative Responses

Q18. What suggestions would you have for future MSRI programs or workshops?

Link to Qualitative Responses

MSRI Experience - Computing Services and Facilities

Q19. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	1	1%
2	0	0%
3	3	4%
4	26	33%
5 - Most Satisfying	50	63%
Total Responses (Exclusive of N/A)	80	100%

Q20. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	2	2%
2	6	7%
3	14	17%
4	24	29%
5 - Most Satisfying	37	45%
Total Responses (Exclusive of N/A)	83	100%

Q21. How could we improve our computing services?

Link to Qualitative Responses

Q22. How could we improve our computing equipment and software environment?

Link to Qualitative Responses

MSRI Experience - Relocation Advisory Services

Q23. How would you rate the following relocation advisory services you received while at MSRI: Housing

1 - Least Satisfying	4	5%
2	7	9%
3	11	14%
4	12	16%
5 - Most Satisfying	42	55%
Total Responses (Exclusive of N/A)	76	100%

Q24. How would you rate the following relocation advisory services you received while at MSRI: School and Childcare

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	5	25%
5 - Most Satisfying	15	75%
Total Responses (Exclusive of N/A)	20	100%

Q25. How would you rate the following relocation advisory services you received while at MSRI: Visa

1 - Least Satisfying	0	0%
2	2	5%
3	1	3%
4	11	28%
5 - Most Satisfying	25	64%
Total Responses (Exclusive of N/A)	39	100%

Q26. How could we improve our relocation advisory services?

Link to Qualitative Responses

MSRI Experience - Administrative Support Services

Q27. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	2	2%
4	16	16%
5 - Most Satisfying	82	82%
Total Responses (Exclusive of N/A)	100	100%

Q28. How could we improve our administrative services?

Link to Qualitative Responses

Q29. Your comments about MSRI:

Link to Qualitative Responses

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Mathematical Sciences Research Institute

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Analytic Number Theory

January 17, 2017 to May 26, 2017
MSRI, Berkeley, CA
USA

Organizers:

Chantal David (Concordia University)
Andrew Granville (Université de Montréal)
Emmanuel Kowalski (ETH Zurich)
Philippe Michel (École Polytechnique Fédérale de Lausanne (EPFL))
Kannan Soundararajan (Stanford University)
Terence Tao (University of California, Los Angeles)

FINAL REPORT ON THE "ANALYTIC NUMBER THEORY" PROGRAM AT MSRI, JAN-MAY 2017

CHANTAL DAVID, ANDREW GRANVILLE, EMMANUEL KOWALSKI, PHILIPPE MICHEL, KANNAN SOUNDARARAJAN, AND TERENCE TAO

1. Introduction

Analytic number theory, and its applications and interactions, are currently experiencing intensive progress, in sometimes unexpected directions. In recent years, many important classical questions have seen spectacular advances based on new techniques; conversely, methods developed in analytic number theory have led to the solution of striking problems in other fields.

Recent advances in analytic number theory have had repercussions in various mathematical subjects, such as harmonic analysis (including the Langlands program), ergodic theory and dynamics (especially on homogenous spaces), additive and multiplicative combinatorics and theoretical computer science (in particular, through the theory of expander graphs).

In view of the surge of activity and progress in this field, as well as the emergence of an extremely promising cohort of junior mathematicians in this area, we proposed a program in Analytic Number Theory to be held at MSRI in 2016, concurrently with a synergistic program in Harmonic Analysis at MSRI.

The program was scientifically highly successful, as the list of research projects in the next section will show. In particular, junior researchers were very positive concerning the links with the Harmonic Analysis program, which were especially relevant in view of the proof by Bourgain, Demeter and Guth of the main conjecture concerning Vinogradov's Mean Value Theorem.

2. Research developments

The research environment at MSRI was highly conducive both for the completion of research already initiated by mathematicians or groups of mathematicians before coming to the program, and for initiating new research and new collaborations. In particular, many new interactions were created among the junior participants of the Analytic Number Theory program, and the companion program in Harmonic Analysis. Furthermore, the workshops where highly effective at disseminating the latest breakthroughs in analytic number theory: these include the decoupling theorems and efficient congruencing methods that have been used recently to estimate mean values of exponential sums, and the Matomäki-Radziwiłł theory of averages of multiplicative functions, which for instance was used recently to solve the Erdős discrepancy problem.

Below is a partial list of some of the specific results that were accomplished during the MSRI program.

(1) Andersen and Kiral began a project on the twisted fourth moment of modular L-functions. Kiral comments that "this is a project I would not have started to think about were it not for the cordial enviroment at MSRI".

(2) Bellaïche, Green and Soundararajan finished a paper on finding Fourier coefficients of half-integer weight modular forms that are not divisible by a given prime ℓ.

(3) In a project started at MSRI, Bienvenu, Shao and Teräväinen consider solving linear equations in special sparse subsets of the primes. One may conjecture that any system of linear equations of "finite complexity" has a solution with all variables from a nice subset of the primes, provided that there are no local obstructions. For the whole set of primes, this was confirmed in influential works of Green-Tao and Green-Tao-Ziegler. The project is ongoing work.

(4) Blomer, Milicevic, Michel and Sawin continued work during their visits on their joint project with Fouvry and Kowalski concerning the analytic properties of the family of twisted L-functions $L(f \times \chi, s)$, where f is a fixed cusp form and χ runs over Dirichlet characters modulo a prime $q \to +\infty$.

(5) Aled Walker finished a project (started before coming to MSRI) on the lack of metric Poissonian structure in the primes. This project sparked interest amongst several other participants at MSRI, and Walker is now working with Bloom, Chow, and Fan to refine the results.

(6) Brandes and Wooley have investigated mean values of exponential sums corresponding to incomplete Vinogradov systems of equations. In particular, when such a system constitutes a Vinogradov system missing the linear equation of the system, they obtain diagonal estimates for such mean values for moments or order roughly half-way between those moments accessible to the efficient congruencing and decoupling methods, and those corresponding to the critical point in the main conjecture in the problem. Their work in progress from MSRI develops a version of the nested efficient congruencing method to achieve decisively stronger conclusions. The significance of this work is that, impressive as the decoupling and nested efficient congruencing methods may be, they deliver optimal conclusions only for translation-dilation invariant (TDI) systems, while this work conducted at MSRI decisively enlarges these near-optimal conclusions to non-TDI systems.

(7) Browning and Heath-Brown started a substantial project on studying the Manin conjecture on quadric bundles, showing for the first time that certain "thin sets" of rational points may interfere with Manin's predictions for the asymptotics of these points.

(8) Browning and Loughran were able to complete a project on sieving on Fano varieties, thanks to Loughran attending the final workshop while Browning was in residence.

(9) Browning, Pierce, and Schindler made further progress on a long term project to study the arithmetic of generalised quadratic forms over general number fields, developing a highly technical refinement of the classical Hardy-Littlewood circle method.

(10) Browning and Sawin have begun work on an extensive geometric and sheaf-theoretic reformulation of the circle method over finite fields. This has also potential applications in algebraic geometry, building on an existing collaboration of Browning and Vishe on the geometry of the space of rational curves on a smooth hypersurface of low degree over a finite field.

(11) Chandee, Matomäki, Li, and Radziwiłł started a project on obtaining asymptotics for the eighth moment of Dirichlet L-functions (averaged over the moduli). Previously such a result was established conditional on the generalized Riemann hypothesis, and their work aims to remove this assumption.

(12) Chow, Goldmakher, Koukoulopolous, Maynard, and Pollington began a collaboration at MSRI on attacking the Duffin-Schaeffer conjecture in metric approximation, locating a combinatorial formulation of the conjecture and solving a model case.
(13) Chow and Pomerance used sieve theoretic methods to show that most integers cannot be part of a Pythagorean triple with one prime member.
(14) David, Gafni, Malik, Pierce, Prabhu, and Turnage-Butterbaugh started a collaboration on the behavior of "champion primes" on elliptic curves, a project that required expertise from multiple areas in analytic number theory and was only possible thanks to the presence of the collaborators (who, incidentally, are all female) at MSRI.
(15) Almost all of the leading experts in the recent breakthoughs on large gaps between primes were present at MSRI. This led in particular to a collaboration between Ford, Konyagin, Maynard, Pomerance, and Tao producing for the first time nontrivial large gaps in certain sparse subsets of the primes, such as primes of the form $n^2 + 1$, by modifying the usual Erdős-Rankin sieving strategy to eliminate the reliance on bounds on the density of smooth numbers (which is a tool that cannot be applied in these more general settings).
(16) Ford, Green, and Koukoulopoulos began a collaboration on the study of the Hooley Δ function, which counts the maximum number of divisors of a number in a dyadic interval. They have discovered that this function has quite an unusual distribution, and analyzed a simplified model for this function to give new predictions on this distribution.
(17) Over the last couple of years Granville, Harper and Soundararajan have been developing a new proof of Halasz's theorem which is very flexible and permits, for example, simplified treatments of Hoheisel and Linnik type theorems. Work on this paper was completed at MSRI, and a version should be submitted within the month.
(18) Harper completed his work on moments of random multiplicative functions, which he also presented at the current developments seminar (as mentioned in the Highlights section).
(19) A few years back, Koukoulopoulos established a converse theorem for multiplicative functions bounded by 1 whose partial sums are small. He showed that such functions must either cancel out on their prime values, or look like the Möbius function. At MSRI Koukoulopoulos and Soundararajan worked on extending this result to more general multiplicative functions bounded by a suitable divisor type function.
(20) Lichtman and Pomerance gave completely explicit bounds on the distribution of smooth numbers, which are effective in numerical ranges of practical interest in cryptography.
(21) Matomäki, Radziwiłł, and Tao were existing collaborators, but were able for the first time to all be physically present in the same location during their stay at MSRI. As a consequence, they were able to achieve a number of research objectives, including new correlation estimates on divisor functions and on the von Mangoldt function for most shifts in a short range, and new results on the local uniformity of the Liouville and Möbius functions in short intervals, a topic of importance for its potential application to the Chowla conjecture.
(22) A few years back, Munshi announced a program to establish sub-convex bounds for symmetric square L-functions in the level aspect. This presents formidable

technical difficulties, and Munshi has made substantial progress while at MSRI towards writing up a first draft of his paper. Munshi and Nelson also began working together at MSRI, and Nelson realized that he could deduce from Munshi's result (combined with several ideas of Nelson) corresponding sub convex estimates for certain triple product L-functions. This research was described by Nelson in his lecture in the Recent Developments workshop. The work of Munshi and Nelson would have the spectacular consequence of obtaining strong rates of convergence in the Quantum Unique Ergodicity problem for holomorphic forms in the level aspect, which seemed until recently a distant hope.

(23) Pierce, Wood, and Turnage-Butterbaugh began a project on effective Chebotarev density theorems for families of fields, which have applications to the statistics of class groups.

(24) Pollack, Pomerance, and Thompson answered some questions of Erdős regarding the inverse of the sum-of-divisors function.

(25) Pomerance and Shparlinski completed a project describing the combinatorial structure of the power map in finite fields.

(26) Ramakrishnan pursued his long term project of using inequalities in the trace formula to establish new outstanding cases of functoriality (non-solvable base change for GL_2-automorphic representations). The use of inequalities (rather than identities) in the trace formula to establish base change is a very novel and soft approach is very much of analytic number theoretic flavour (analytic theory of automorphic forms of course but also technique not unrelated to sieve methods); these were discussed with Philippe Michel.

(27) Sawin worked on equidistribution problems for "harmonic" families of automorphic forms over function fields, and started a collaboration with Templier on this subject.

(28) Soundararajan began a new collaboration at MSRI with Thorner on weak subconvexity for automorphic L-functions. In previous work on weak sub-convexity, under a weak Ramanujan hypothesis a factor of almost $\log C$ was saved over the convexity bound for L-functions. The new work replaces the weak Ramanujan hypothesis by a criterion that can be checked for all automorphic L-functions, but at the cost of saving a smaller power of $\log C$.

(29) Tao began a new collaboration at MSRI with Teräväinen on variants of the Chowla and Elliott conjectures. Among other things, they were able to settle all the odd-order cases of the (logarithmically averaged) Chowla conjectures, by combining the recently developed entropy decrement argument with methods from ergodic theory. Tervainen was also able to adapt these techniques to obtain other bounds on double and triple correlations of multiplicative functions, and Sawin and Matomäki also observed applications of these results to sign patterns.

(30) Aled Walker completed a project (started before coming to MSRI) on using Gowers norms to control solutions to Diophantine inequalities, which for instance extends existing results on linear equations in primes to situations in which the coefficients of the linear equations or inequalities are irrational.

(31) Walsh was able to apply the polynomial method to obtain new bounds on the number of incidences between real varieties.

(32) Wooley was able to use his time at MSRI to nearly complete his long-awaited manuscript on the connections between the efficient congruencing method and the decoupling theorems, that have been separately used in recent years to make dramatic advances on Vinogradov's main conjecture (now solved) and related

problems. In particular he has now introduced the "nested efficient congruencing" method that combines ideas from both of these techniques.

3. Structure of the program

Besides the workshops, the main formal structure of the program consisted of the seminars, run by various members of the program:

- Regular number theory seminar (run by Adam Harper and Lilian Matthiesen);
- Postdoctoral seminar (run by Nick Andersen);
- Graduate student seminar (run by Timothy Browning);
- Joint seminar with harmonic analysis (run by Dimitris Koukoulopoulos, together with Ciprian Demeter from the harmonic analysis program);
- Joint seminar with the Simons program in pseudorandomness (run by James Maynard, together with Thomas Bloom from the pseudorandomness program).

Below are the brief reports on each seminar by their respective organizers.

Some exit surveys indicated a feeling that there were too many seminars, and it is possible that some members of the program felt less able to engage fully since they couldn't attend many of the talks. However, the organizers all indicate that their seminars were well-attended.

3.1. **Regular number theory seminar – report by A. Harper and L. Matthiesen.**

We organized the Analytic Number Theory seminar, with talks beginning on February 14th (week after the Analytic Number Theory introductory workshop) and ending on May 11th (week before the final Harmonic Analysis workshop).

There were approximately 18 seminars in total. For the first several weeks, we had seminars on Tuesday and Thursday each week, but towards the end we switched to only one seminar per week. The speakers were all members, visitors, or (in two cases) postdocs associated with the Analytic Number Theory program. We tried to coordinate a bit with the organizers of the other seminar series (postdoc, various joint seminars), for example the two postdoc speakers could not be accommodated in the Postdoc seminar so we invited them instead.

We feel the quality of the talks was generally very high. Our aim was to extend speaker invitations to everyone involved in the program not speaking elsewhere, and we believe we managed this. A few people preferred not to speak, but most accepted our invitation. One person said they felt there were too many seminars, and a few said they would have liked to have two per week for the duration of the program. But overall people seemed satisfied and the seminars were well attended (25+ people) throughout the program.

3.2. **Postdoctoral seminar – report by N. Andersen.**

The Analytic Number Theory Postdoc seminar met each Friday back-to-back with the Harmonic Analysis Postdoc seminar. Postdocs from both programs were encouraged to attend both seminars. Each talk was 50 minutes long, and MSRI provided a pizza lunch after the talks every week.

One of the ANT postdocs organized the meetings and selected the speakers. Nine of the eleven ANT postdocs presented talks, while the remaining two spoke in the main ANT seminar. Since participants from both programs were in attendance, the speakers were encouraged to design their lectures to be accessible to a broader audience. Most speakers opted for 'job talk' or 'colloquium style' presentations.

The meetings were well-attended each week; in addition to postdocs and graduate students, many experts from both programs frequently attended. Attendees (especially fellow postdocs from both programs) were encouraged to fill out anonymous feedback

forms, rating the pacing and clarity of the talk and giving constructive feedback. Many speakers reported that this feedback was quite helpful.

3.3. **Graduate student seminar series - report by T. Browning.** The graduate seminar series was given by graduate students every week that there wasn't already a conference running. The general format was 2×30 minute lectures, giving visiting graduate students the chance to present their own research and receive valuable feedback, in addition to covering core material that were deemed of interest to the whole group. The first two weeks were shared with the Harmonic Analysis programs, to highlight possible areas of interaction, before specializing to talks more directly related to analytic number theory. This is the list of speakers for the semester:

- 14th Feb: Mikhail Gabdullin and Sofia Lindqvist (+ 2 extra talks from HA)
- 21st Feb: Sarah Peluse and Joni Teräväinen (+ 2 extra talks from HA)
- 28th Feb: Aled Walker and Alex Walker
- 7th March: Carlos Alcoceba and Vladimir Mitankin
- 14th March: Aled Walker and Pierre Yves-Bienvenu
- 21st March: David Lowry and Corentin Perret-Gentil-dit-Maillard
- 28th March: Sarah Peluse and Aled Walker
- 4th April: Oleksiy Klurman and Raphael Steiner
- 11th April: Alex Walker and Robert Fraser
- 25th April: Vinay Kumaraswamy and Corina Panda
- 9th May: Raphael Steiner and Amita Malik

During the seminars, I got to know the graduate students rather well and I enjoyed discussing their research with them. A number of senior members of the program made a point of regularly coming to the graduate seminars (such as Heath-Brown and Harper, for example), which allowed the students to explain their areas of research to a wider pool of experts. Despite the focus on number theory, several students from the harmonic analysis program continued to attend. All in all, I would say roughly 10 to 15 people came each week. The informal feedback for the seminar series has been very positive. I think in some cases, such as the case of my own student Raphael Steiner, giving a talk has acted as a stepping stone to further research directions. In his case, the talk led to discussions with Nick Andersen about a 1/2-integral weight Kuznetsov formula, which is needed for one of his projects.

3.4. **Joint seminar with Harmonic analysis – report by D. Koukoulopoulos.** Harmonic Analysis and Analytic Number Theory share a lot of connections and common problems, such as problems concerning exponential sums and the discrepancy of various sequences. The principal goal of the seminar was to bring together researchers from these two subjects and facilitate interactions between them. Thus a lot of emphasis was put on choosing speakers that would appeal to both groups. The talks were generally well-attended, averaging an audience of 20-40 mathematicians. Below is the schedule of the seminar:

- Feb 24: Terence Tao - The Erdős discrepancy problem
- Mar 10: Theresa Anderson - Spherical Maximal Functions along the Primes
- Mar 24: Dmitriy Bilyk - Discrepancy theory
- Apr 7: Thomas Bloom - Additive structure of sets of Fourier coefficients
- Apr 14: Emanuel Carneiro - Fourier optimization with constraints, bounds for zeta and related stories
- Apr 21: Tamar Ziegler - Concatenating cubic structures

- Apr 28: James Wright - Polynomial congruences: some light entertainment

3.5. **Joint seminar with Simons program - report by J. Maynard.** To encourage collaboration and interaction between the MSRI program in Analytic Number Theory and the concurrent Pseudorandomness program at the Simons Institute of Computing at Berkeley, it was agreed to have a joint seminar between the two programs. This was held most weeks, alternating between an MSRI speaker at Simons and a Pseudorandomness speaker at MSRI, with one organizer from each location.

The speakers were Ben Green, Kevin Ford, Oleksiy Klurman, Luka Rimacic, Shachar Lovett and Madhur Tulsiani. In general the joint seminar was successful at forcing a reasonably regular interaction between participants of the two programs who might otherwise have had only limited interactions. Feedback indicated that this was most successful when talks were aimed at a more general audience than the specialist seminars. Given the large number of workshops and talks at both locations, the talks were reasonably well attended: typically there were around 30 attendees split roughly equally between the two programs.

3.6. **Informal working seminars.** In addition to the formally scheduled seminars, members spontaneously organized several working seminars on specific topics, such as the decoupling theorems of Bourgain, Demeter, and Guth, or the Green-Tao theorem on arithmetic progressions in primes. Finally, MSRI organized "five minute presentations" by many of the members of both programs, which were well attended and appreciated by many of the participants.

4. Workshops

In this section we give a brief description of the three workshops which, in addition to the seminars mentioned previously, formed the primary organized activities in the Analytic Number Theory program. More detailed individual reports for each workshop are also attached.

4.1. **Connections for Women workshop.** (*Organizers:* C. David (lead), K. Matomäki, L. Pierce, K. Soundararajan, T. Tao.)

The Connections for Women workshop, held just before the Introductory workshop, had ten research talks, as well as a panel discussion, poster session, and dinner for the female participants. The emphasis was on research by junior mathematicians; in particular, all of the female postdoctoral members at MSRI gave talks.

4.2. **Introductory workshop.** (*Organizers:* A. Granville, E. Kowalski (lead), K. Matomäki Ph. Michel.)

The introductory workshop had three mini-courses, ten research talks, and began with a survey talk by Ph. Michel intended in part to present current problems of analytic number theory for potential Harmonic Analysis program members.

The speakers were chosen in large part to give the opportunity to visit MSRI to a number of excellent researchers who had applied for Research Membership, but that the program was not able to accept due to limited resources (especially lack of space at MSRI).

Some effort was made to have talks accessible at least in part to members of the HA program.

4.3. **Recent developments in Analytic Number Theory.** (*Organizers:* T. Browning, C. David, K. Soundararajan, T. Tao (lead).)

This workshop featured 17 lectures presenting the latest developments in analytic number theory, including (but not restricted to) recent advances in sieve theory, multiplicative number theory, exponential sums, arithmetic statistics, estimates on automorphic forms, and the Hardy-Littlewood circle method. The talks were of an exceptionally high quality, reflecting the vibrancy of current research in these topics.

5. Postdocs

Reflecting the current state of research in this field, there was an exceptionally strong cohort of junior mathematicians present at the Analytic Number Theory program, including a number of very promising postdocs. Each of them was matched with a mentor chosen among the senior participants, who would meet with them on a weekly basis to ensure they were getting the most out of the MSRI program, and also to provide mathematical and career guidance in general. The senior members were more than happy to meet with the postdocs, who seemed to be satisfied with this arrangement. Several, though not all, of the mentorships led to research collaborations between the mentor and mentee.

A postdoc seminar was organized by N. Andersen; his report is included in Section 3.

A survey of each postdoctoral fellow can be found in MSRI's annual report.

6. Graduate Students

Many graduate students participated in the program, especially during the workshops. One of the senior participants, T. Browning, organized a Graduate Student Seminar. His report and the list of speakers is found in Section 3.

7. Diversity

Women mathematicians comprised three of the 11 program associates, four of the 11 postdocs, five of the 24 research members, and two of the four Simons Professors in the Analytic Number Theory program. Although none of the other six Research Professors was a woman, this is in part due to MSRI seniority rules that excluded some young outstanding researchers from consideration.

Thanks to efforts in particular of A. Granville, special separate funding was obtained from an MSRI sponsor for women participants with young children. This was very helpful to ensure that they could participate fully in the research activities of the program.

In the "Connections for Women" workshop, special efforts were made to ensure that the majority of speakers were female, with a final ratio of eight female to two male speakers. Unfortunately, this had the unintended consequence of reducing the availability of women speakers for the "Introductory" workshop that followed, which ended up with just one female speaker out of thirteen. The organizers of the workshop regret this disparity. In retrospect, there should have been more coordination amongst the two organizing committees.

The final workshop had 17 speakers, of whom six were female. In the participant survey, many of the attendees took particular note to praise the diversity of speakers.

One of the women postdocs commented, in her exit survey, how beneficial the program had been for her:

> "I throughly enjoyed my time at MSRI. The opportunity to discuss my work and be heard encouraged me to expand my job search to include more

> research oriented departments. (Prior to coming to MSRI I was primarily considering liberal arts jobs.) The staff did an incredible job keeping things on track so that we could focus on our work: everyday I had a clean office, plenty of coffee and tea, and my reimbursements and stipends were always promptly delivered. I was able to work on three distinct projects during my time and form a new collaboration with Dan Goldston, whose work I have admired for a long time. This experience strengthened my knowledge and helped me become more connected with my research community."

Another member echoed this:

> I have felt so honored to be part of this MSRI semester. My time was extremely productive and I made tons of new connections. I feel confident that this is going to change the trajectory of my research program, and it may even change the trajectory of my career. (I'm starting to consider whether it would be possible for me to try to move from a liberal arts college to a research university, thanks to my amazing semester at MSRI.)

8. Synergistic activities

The companion program to the Analytic Number Theory program was a program in Harmonic Analysis. This turned out to be a very fruitful combination. Indeed, these two subjects have long been associated, for instance with the circle method or the theory of L-functions. It happened that recent breakthrough results in harmonic analysis, such as the "decoupling theorems" of Bourgain, Demeter and Guth, have led to the solutions of long-standing problems in analytic number theory. Conversely, number-theoretic methods are essential to attack harmonic analysis questions in discrete or p-adic settings.

The interactions between the two programs were helped by the fact that many participants of both programs worked in both areas (e.g., N. Andersen, L. Pierce, T. Tao). In addition to the joint seminar mentioned in Section 3, there were many informal discussions between members of both groups, particularly at the junior level. In addition, many members from one program attended talks from workshops in the other. A particular highlight was the very well received lecture series of L. Guth during the Harmonic Analysis introductory workshop, which gave a very clear and accessible introduction to decoupling theorems and the methods involved in their proofs.

The Simons Institute for Computing, which is located close to MSRI, ran a program on Pseudorandomness from Jan 10 to May 12. This topic has many connections and overlapping interests with analytic number theory, which have been especially prominent in recent years (for instance, through the rise of techniques of arithmetic combinatorics in number theory, or the construction and applications of expander graphs in both subjects). As discussed in Section 3, a joint seminar between the two programs was organized. In addition, the workshops were coordinated so as not to conflict with each other, and many participants from one program attended or spoke at events held by the other.

Many of the MSRI participants also attended the workshop on "Efficient Congruencing and Translation-Invariant Systems" at the Fields Institute (Toronto) from March 13–17. This covered an essential topic in analytic number theory in which there has been much recent progress with input from harmonic analysis. Several MSRI members of both programs (Brandes, Demeter, Guo, Heath-Brown, Wooley) spoke at that workshop and some were co-organizers.

Brady Haran interviewed James Maynard, Carl Pomerance, and Terence Tao to produce three videos for his "Numberphile" YouTube channel while they were at MSRI.

Maynard discussed the twin prime conjecture, Pomerance the Goldbach problem, while Tao answered more general questions on mathematics posed by Brady's followers.

Finally, MSRI ran a "Hot topics" workshop entitled *Galois Periods and Applications* from March 27–31. This topic involves intriguing phenomena of interest to analytic number theorists, particularly with regards to special values of L-functions and multiple Dirichlet series and their conjectural relationship with periods. For instance, one off-beat proof of the infinitude of primes proceeds by using the special value $\prod_p (1-1/p^2)^{-1} = \zeta(2) = \pi^2/6$ of the Riemann zeta function, combined with the irrationality of $\pi^2/6$. Several members of the analytic number theory program attended this workshop, with the talks of Bloch and Huber being of particular interest.

9. Program highlights

The Analytic Number Theory program was well placed to disseminate many striking recent breakthroughs in the subject, including several that only emerged after the program was initially proposed. Some of these breakthroughs are discussed below. In addition, the final workshop was a particular highlight of the program, with the participant surveys of the program strongly praising the breadth, strength, and diversity of the selected speakers. Indeed, one of the few criticisms was that there ought to have been even more talks!

9.1. **Decoupling and efficient congruencing.** The *Vinogradov main conjecture* asserts an essentially optimal bound for the mean values of exponential sums such as

$$\sum_{n \le N} e^{2\pi i(\alpha_1 n + \alpha_2 n^2 + \cdots + \alpha_k n^k)}$$

as $\alpha_1, \dots, \alpha_k$ vary; such bounds have applications in many parts of analytic number theory, including such classical topics as Waring's problem of representing a number as the sum of k^{th} powers, or in establishing zero-free regions for the Riemann zeta function and its variants. In recent years there have been two major advances in understanding these sums, firstly from the "efficient congruencing" technique of T. Wooley (which resolved the Vinogradov main conjecture up to dimension three), and more recently from the "decoupling theorems" developed by Bourgain and Demeter, culminating in the proof in late 2015 of the Vinogradov main conjecture in all dimensions by Bourgain, Demeter, and Guth. Remarkably, the latter theorems rely almost completely on methods from harmonic analysis rather than analytic number theory. As such, it was particularly serendipitous timing to have the Analytic Number Theory program concurrent with the Harmonic Analysis program in 2017. Indeed, one of the highlights of both programs was the minicourse of three lectures of L. Guth during the Harmonic Analysis introductory workshop, which presented the ideas of decoupling, focusing on the intuition behind the theorems, rather than the technical details. This was very well received by participants of both programs. After the workshops, an informal discussion group on decoupling theorems continued, and moreover L. Pierce wrote parts of her Bourbaki seminar report on the Vinogradov main conjecture during her stay at MSRI. Finally, in the final workshop, Wooley revealed his latest work in developing a "nested efficient congruencing" technique which combines the best ideas from both efficient congruencing and decoupling theorems, leading to several extensions of the Vinogradov main conjecture.

9.2. **Correlations and sums of multiplicative functions.** Multiplicative number theory, a major subfield of analytic number theory, is concerned with the asymptotic statistics of multiplicative functions such as the Möbius function μ or Liouville function

λ, as well as functions related to multiplicative functions, such as the von Mangoldt function Λ. However, "local" statistics of functions like μ, such as short averages

$$\sum_{x \leq n \leq x+H} \mu(n) \tag{1}$$

or correlations

$$\sum_{n \leq x} \mu(n)\mu(n+h)$$

had long resisted analysis by known techniques, such as complex-analytic methods, unless one assumed powerful unproven conjectures such as the Riemann Hypothesis. A surprising breakthrough was achieved in early 2015 when Matomäki and Radziwiłł succeeded in proving non-trivial bounds for short sums such as (1) for most choices of x, even when H was very small compared to x. This bound was later used by Tao to control other correlations such as

$$\sum_{n \leq x} \frac{\mu(n)\mu(n+h)}{n},$$

making progress on an old conjecture of Chowla, and using this in turn to settle the long-standing Erdős discrepancy problem.

These developments were presented at several points during the program, with a particular highlight being the three lectures of Matomäki and Radziwiłł on their theorem during the introductory workshop, and the presentation by Matomäki at the final workshop of some further offshoots of this work conducted at MSRI by Matomäki, Radziwiłł, and Tao.

Another noteworthy development in this area has been the precise analysis by Harper of *random* multiplicative functions, settling a conjecture of Helson. Random multiplicative functions provide an intriguing model for deterministic functions such as the Möbius function, and lead in particular to delicate predictions for the behavior of the Riemann zeta function which deviate from more naive random models. Harper's work on random multiplicative functions was completed and posted on the arXiv while at MSRI. Moreover he has recently extended his work to handle some deterministic cases as well (such as character sums). The superb lecture by Harper at the final workshop detailing these developments was another highlight of the program.

9.3. **Links with algebraic geometry.** Several key areas of Analytic Number Theory rely extensively on sophisticated estimates for exponential sums over finite fields that in turn depend on methods of algebraic geometry, especially on the most general forms of Deligne's Riemann Hypothesis over finite fields. The presence during the program of W. Sawin, one of the most knowledgeable young researchers in these aspects of algebraic geometry, was extremely helpful to develop further contacts and make progress in some important directions. These include ongoing work with Kowalski and Michel on bilinear forms estimates below the Polyà–Vinogradov range and quantitative sheaf theory, as well as extensive collaborations with T. Browning (on geometric forms of the circle method) and with N. Templier (on function field analogues of equidistribution problems for "harmonic" families of automorphic forms).

10. Minor remarks

- The exit survey indicates overall a very high level of satisfaction with MSRI.
- The quality of the video recordings was very helpful for a number of people who were unable to participate in the workshops.

- The most common suggestions for improvement concern upgrades to the computing resources, requests for better transportation options during the highly-attended workshops, and especially some concerns with the lunch options (indeed, some participants indicated that they had taken the habit of coming to MSRI only after lunch).

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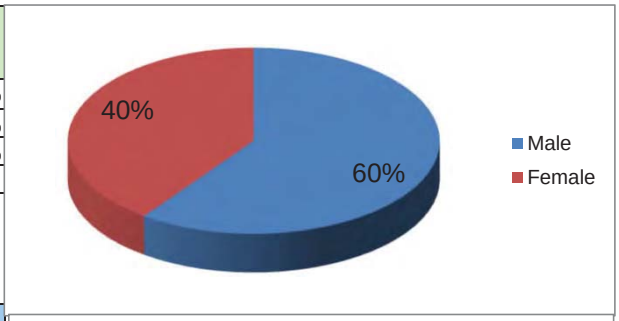
E-mail address: tao@math.ucla.edu

Postdoc Pre/Post-MSRI Institution Group

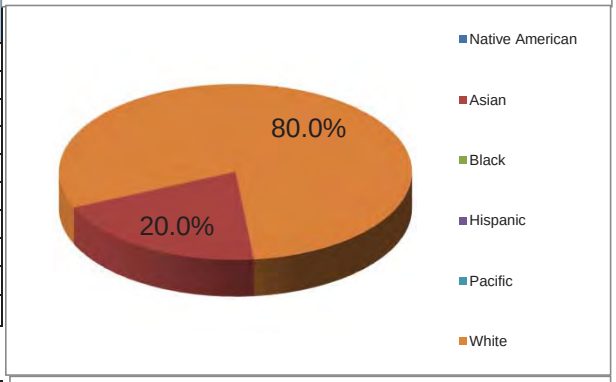
Family Name	First Name	Pre-MSRI Institution Group	Post-MSRI Institution Group	Home Institution Name	Placement Institution Name
Andersen	Nickolas	Public Large	Public Large	University of California, Los Angeles	University of California, Los Angeles
Brandes	Julia	Foreign	Foreign	University of Göteborg	University of Göteborg
Chow	Sam	Foreign	Foreign	University of York	University of York
Gafni	Ayla	Private Small	Private Small	University of Rochester	University of Rochester
Hu	Yueke	Foreign	Foreign	ETH Zürich	ETH Zürich
Kıral	Eren	Public Large	*n/a*	Texas A & M University	*not yet determined*
Nastasescu	Maria	Private Large	Private Large	Brown University	Brown University
Perret-Gentil-dit-Maillard	Corentin	Foreign	Foreign	ETH Zürich	Centre de recherches mathématiques
Talebizadeh Sardari	Naser	Public Large	Public Large	University of Wisconsin, Madison	University of Wisconsin, Madison
Turnage-Butterbaugh	Caroline	Private Large	Private Large	Duke University	Duke University

2016–17 ANT Postdoctoral Fellow Demographic Summary

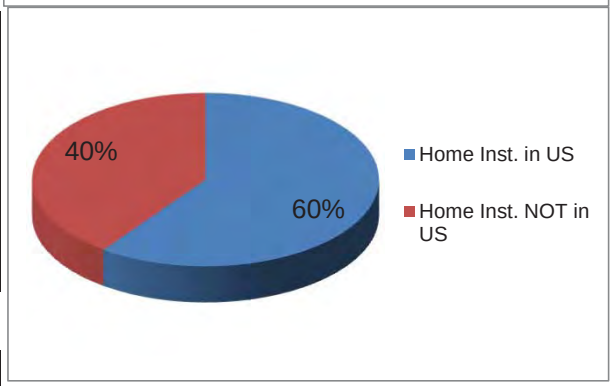
Gender	#	% (No Decl.)*	%
# of Distinct Members	10		100.0%
Male	6	60.00%	60.0%
Female	4	40.00%	40.0%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	2	20.00%	20.0%
Black	0	0.00%	0.0%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	8	80.00%	80.0%
Decline to State Ethnicities	0		0.0%
Unavailable Information	0		0.0%
Minorities	0		0.0%

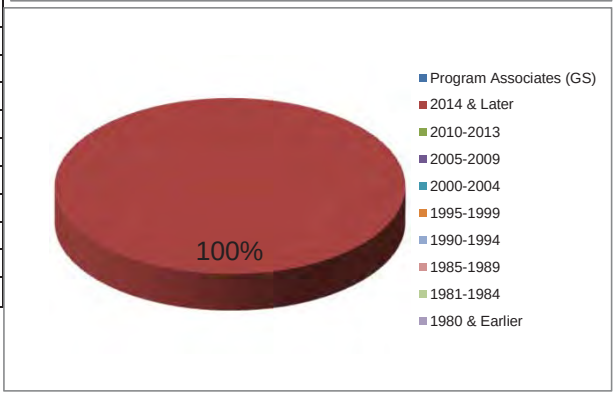


Citizenships	#		%
US Citizen & Perm. Residents	3		30.0%
Foreign	7		70.0%
Unavailable information	0		
# of Distinct Members	10		100.0%
US Citizen	3		30.0%
Perm Residents	0		0.0%
Home Inst. in US	6		60.00%



Year of Ph.D	#		%
Program Associates (GS)	0		0.0%
2014 & Later	10		100.0%
2010-2013	0		0.0%
2005-2009	0		0.0%
2000-2004	0		0.0%
1995-1999	0		0.0%
1990-1994	0		0.0%
1985-1989	0		0.0%
1981-1984	0		0.0%
1980 & Earlier	0		0.0%
Total # of Distinct Members	10		100.0%

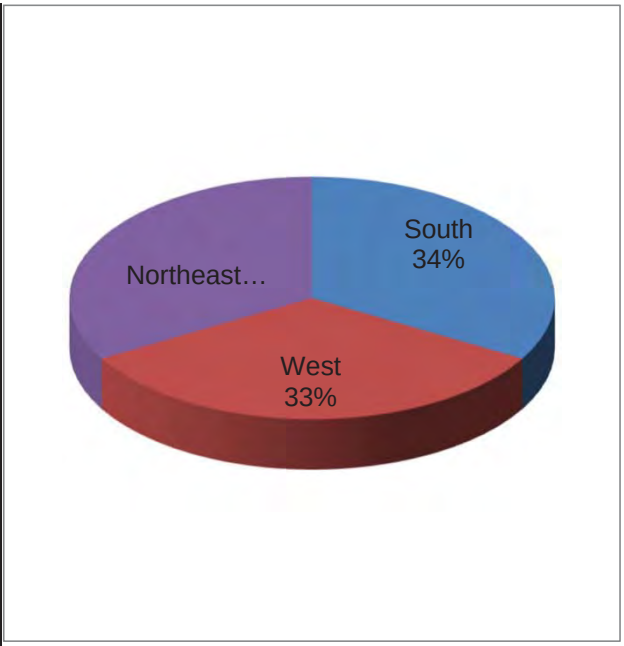
**Statistic Calculation based on all participants that did not decline.*



2016–17 ANT Postdoctoral Fellow Home Institution Classified by States

**Regions based on US Census classification*

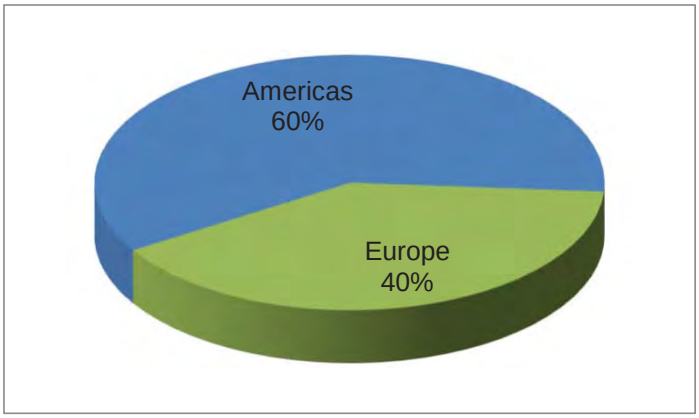
State	#	%	2010 Census Population
South	**2**	**33.3%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	1	16.7%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	1	16.7%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**2**	**33.3%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	2	33.3%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**-**	**0.0%**	**21.7%**
IL	-	0.0%	4.2%
IN	-	0.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	-	0.0%	3.2%
MN	-	0.0%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	-	0.0%	3.7%
SD	-	0.0%	0.3%
WI	-	0.0%	1.8%
Northeast	**2**	**33.3%**	**17.9%**
CT	-	0.0%	1.2%
ME	-	0.0%	0.4%
MA	-	0.0%	2.1%
NH	-	0.0%	0.4%
NJ	-	0.0%	2.8%
NY	1	16.7%	6.3%
PA	-	0.0%	4.1%
RI	1	16.7%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**6**	**100%**	**100%**



2016–17 ANT Postdoctoral Fellow Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**6**
	North America	United States	6
Asia			**0**
Europe			**4**
	Northern Europe	Sweden	1
		United Kingdom	1
	Western Europe	Switzerland	2
Oceania			**0**
Grand Total			**10**



Analytic Number Theory

Program Summary

Role	# of Distinct Members	%	# of US Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%
Organizers	4	7.0%	2	50.0%	1	25.0%	0	0.0%
Research Professors	7	12.3%	3	42.9%	1	14.3%	0	0.0%
Postdoctoral Fellows	10	17.5%	3	30.0%	4	40.0%	0	0.0%
PD/RM	1	1.8%	1	100.0%	0	0.0%	0	0.0%
Research Members	24	42.1%	10	41.7%	5	20.8%	0	0.0%
Program Associates	11	19.3%	3	27.3%	2	18.2%	1	33.3%
Guests	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total # of Distinct Members	**57**		**22**	***38.6%***	**13**	***22.8%***	**1**	***4.5%***

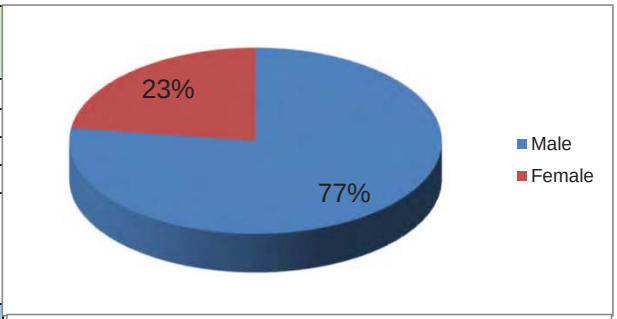
[1] *Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, or Hispanic. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.*

Home Institution Grouping

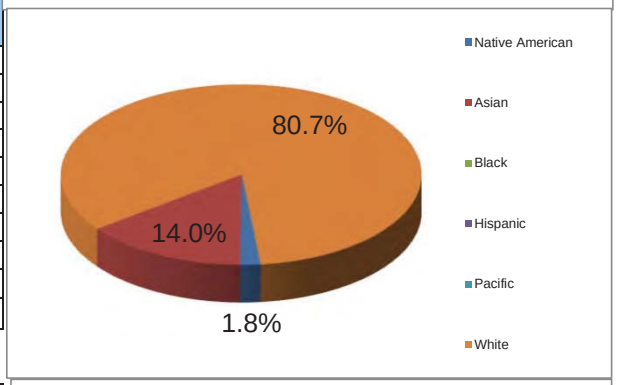
	US								
Role	**Private Large**	**Private Small**	**Public Large**	**Public Medium**	**Public Small**	**Group M or B**	**Non-Group**	**Foreign**	**Total**
Organizers	1	0	1	0	0	0	0	2	4
Research Professors	2	1	0	0	0	0	0	4	7
Postdoctoral Fellows	2	1	2	0	0	0	1	4	10
PD/RM	1	0	0	0	0	0	0	0	1
Research Members	3	0	2	0	1	1	2	15	24
Program Associates	3	0	0	0	0	0	0	8	11
Total	**12**	**2**	**5**	**-**	**1**	**1**	**3**	**33**	**57**
%	***21.1%***	***3.5%***	***8.8%***	***0.0%***	***1.8%***	***1.8%***	***5.3%***	***57.9%***	***100.0%***

2016–17 Program Members Demographic Summary

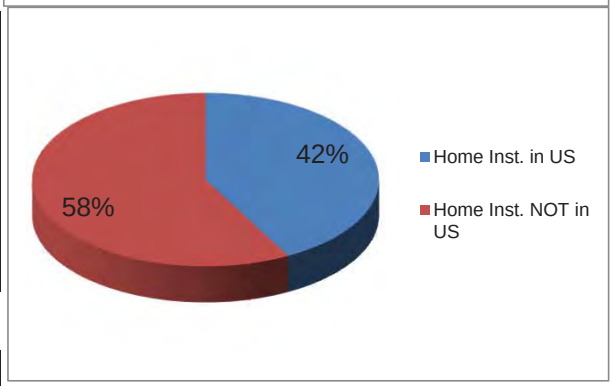
Gender	#	% (No Decl.)*	%
# of Distinct Members	57		100.0%
Male	44	77.19%	77.2%
Female	13	22.81%	22.8%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	1	1.82%	1.8%
Asian	8	14.55%	14.0%
Black	0	0.00%	0.0%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	46	83.64%	80.7%
Decline to State Ethnicities	4		7.0%
Unavailable Information	0		0.0%
Minorities	1		4.5%

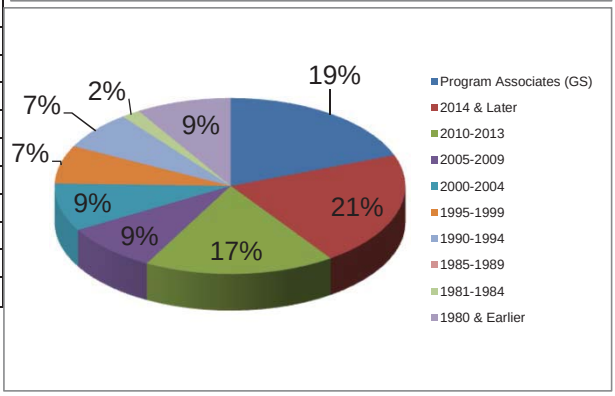


Citizenships	#		%
US Citizen & Perm. Residents	22		38.6%
Foreign	35		61.4%
Unavailable information	0		
# of Distinct Members	57		100.0%
US Citizen	21		36.8%
Perm Residents	1		1.8%
Home Inst. in US	24		42.11%



Year of Ph.D	#		%
Program Associates (GS)	11		19.3%
2014 & Later	12		21.1%
2010-2013	10		17.5%
2005-2009	5		8.8%
2000-2004	5		8.8%
1995-1999	4		7.0%
1990-1994	4		7.0%
1985-1989	0		0.0%
1981-1984	1		1.8%
1980 & Earlier	5		8.8%
Total # of Distinct Members	57		100.0%

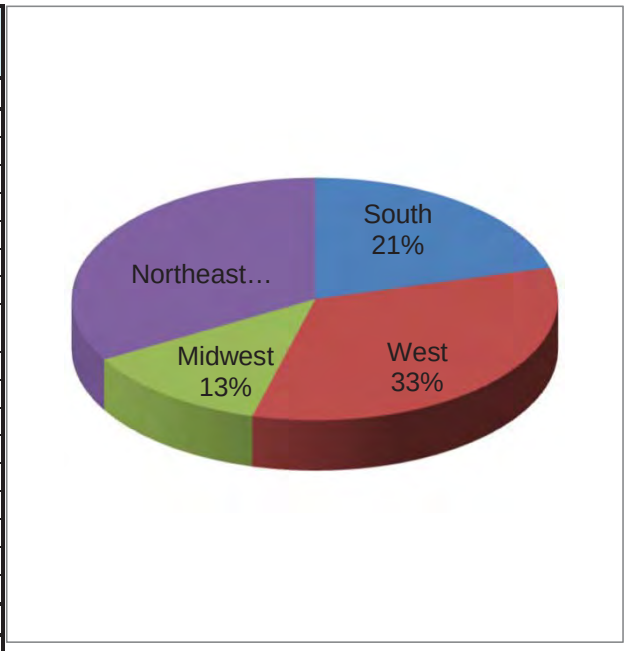
**Statistic Calculation based on all participants that did not decline.*



2016–17 Program Members Home Institution Classified by States

**Regions based on US Census classification*

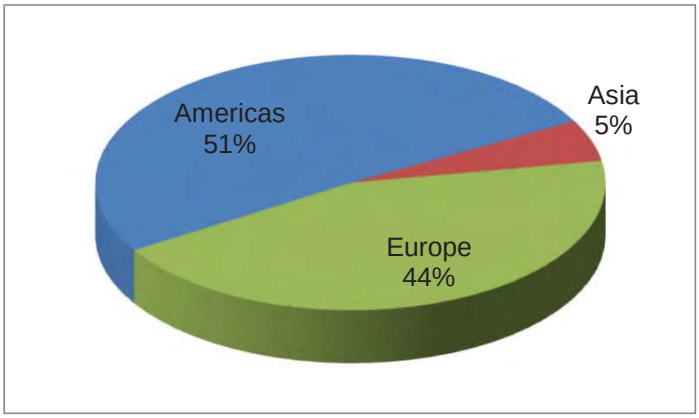
State	#	%	2010 Census Population
South	**5**	**20.8%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	2	8.3%	3.1%
OK	-	0.0%	1.2%
SC	1	4.2%	1.5%
TN	-	0.0%	2.1%
TX	1	4.2%	8.1%
VA	1	4.2%	2.6%
WV	-	0.0%	0.6%
West	**8**	**33.3%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	8	33.3%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**3**	**12.5%**	**21.7%**
IL	1	4.2%	4.2%
IN	-	0.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	-	0.0%	3.2%
MN	-	0.0%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	1	4.2%	3.7%
SD	-	0.0%	0.3%
WI	1	4.2%	1.8%
Northeast	**8**	**33.3%**	**17.9%**
CT	-	0.0%	1.2%
ME	-	0.0%	0.4%
MA	-	0.0%	2.1%
NH	1	4.2%	0.4%
NJ	1	4.2%	2.8%
NY	2	8.3%	6.3%
PA	-	0.0%	4.1%
RI	4	16.7%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**24**	**100%**	**100%**



2016–17 Program Members Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**29**
	North America	Canada	5
		United States	24
Asia			**3**
	South-eastern Asia	Thailand	1
	South-central Asia	India	1
	Western Asia	Israel	1
Europe			**25**
	Eastern Europe	Russia	2
	Northern Europe	Finland	2
		Sweden	2
		United Kingdom	13
	Western Europe	Germany	1
		Switzerland	5
Oceania			**0**
Grand Total			**57**



Analytic Number Theory

January 17, 2017 - May 26, 2017

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	54	96%
No	2	4%
Total Responses	56	

Q2. I had opportunities to present my work to new audiences		
Yes	55	98%
No	1	2%
Total Responses	56	

Q3. I initiated research with new collaborators		
Yes	43	77%
No	13	23%
Total Responses	56	

Q4. I initiated research in new areas		
Yes	46	82%
No	10	18%
Total Responses	56	

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

MSRI Experience - Postdoc Seminar

Q7. To learn new ideas and techniques		
1 - Least Satisfying	0	0%
2	6	15%
3	6	15%
4	17	41%
5 - Most Satisfying	12	29%
Total Responses (Exclusive of N/A)	41	100%

Q8. To form new acquaintances and collaborations		
1 - Least Satisfying	0	0%
2	1	3%
3	13	33%
4	14	35%
5 - Most Satisfying	12	30%
Total Responses (Exclusive of N/A)	40	100%

Q9. To be able to present my own work		
1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	7	50%
5 - Most Satisfying	7	50%
Total Responses (Exclusive of N/A)	14	100%

MSRI Experience - Program Seminars

Q10. To learn new ideas and techniques		
1 - Least Satisfying	1	2%
2	1	2%
3	5	9%
4	16	29%
5 - Most Satisfying	32	58%
Total Responses (Exclusive of N/A)	55	100%

Q11. To form new acquaintances and collaborations

1 - Least Satisfying	3	6%
2	0	0%
3	13	25%
4	14	26%
5 - Most Satisfying	23	43%
Total Responses (Exclusive of N/A)	53	100%

Q12. To be able to present my own work

1 - Least Satisfying	1	4%
2	0	0%
3	2	7%
4	10	37%
5 - Most Satisfying	14	52%
Total Responses (Exclusive of N/A)	27	100%

MSRI Experience - General Information

Q13. My office accomodations were

1 - Least Satisfying	2	4%
2	3	5%
3	3	5%
4	15	27%
5 - Most Satisfying	33	59%
Total Responses (Exclusive of N/A)	56	100%

Q14. Professionally, my overall satisfation with MSRI was

1 - Least Satisfying	1	2%
2	0	0%
3	1	2%
4	9	16%
5 - Most Satisfying	45	80%
Total Responses (Exclusive of N/A)	56	100%

MSRI Experience - Feedback

Q15. 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

Q16. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

Link to Qualitative Responses

Q17. What suggestions would you have for improvements at MSRI?

Link to Qualitative Responses

Q18. What suggestions would you have for future MSRI programs or workshops?

Link to Qualitative Responses

MSRI Experience - Computing Services and Facilities

Q19. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	3	7%
4	5	12%
5 - Most Satisfying	35	81%
Total Responses (Exclusive of N/A)	43	100%

Q20. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	0	0%
2	3	7%
3	6	13%
4	13	29%
5 - Most Satisfying	23	51%
Total Responses (Exclusive of N/A)	45	100%

Q21. How could we improve our computing services?

Link to Qualitative Responses

Q22. How could we improve our computing equipment and software environment?

Link to Qualitative Responses

MSRI Experience - Relocation Advisory Services

Q23. How would you rate the following relocation advisory services you received while at MSRI: Housing		
1 - Least Satisfying	2	5%
2	2	5%
3	2	5%
4	7	16%
5 - Most Satisfying	31	70%
Total Responses (Exclusive of N/A)	44	100%

Q24. How would you rate the following relocation advisory services you received while at MSRI: School and Childcare		
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%

Q25. How would you rate the following relocation advisory services you received while at MSRI: Visa		
1 - Least Satisfying	0	0%
2	0	0%
3	2	8%
4	5	19%
5 - Most Satisfying	19	73%
Total Responses (Exclusive of N/A)	26	100%

Q26. How could we improve our relocation advisory services?

Link to Qualitative Responses

MSRI Experience - Administrative Support Services

Q27. How would you rate the administrative support you received while at MSRI		
1 - Least Satisfying	0	0%
2	0	0%
3	1	2%
4	12	22%
5 - Most Satisfying	42	76%
Total Responses (Exclusive of N/A)	55	100%

Q28. How could we improve our administrative services?

Link to Qualitative Responses

Q29. Your comments about MSRI:

Link to Qualitative Responses

MSRI
Mathematical Sciences Research Institute

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Harmonic Analysis

January 17, 2017 to May 26, 2017
MSRI, Berkeley, CA
USA

Organizers:

Michael Christ (University of California, Berkeley)
Allan Greenleaf (University of Rochester)
Steven Hofmann (University of Missouri)
Michael Lacey (Georgia Institute of Technology)
Svitlana Mayboroda (University of Minnesota, Twin Cities)
Betsy Stovall (University of Wisconsin-Madison)
Brian Street (University of Wisconsin-Madison)

HARMONIC ANALYSIS SEMESTER PROGRAM
MSRI, SPRING 2017
FINAL REPORT

M. CHRIST, A. GREENLEAF, S. HOFMANN, M. LACEY, S. MAYABORDA, B. STOVALL, B. STREET

1. Introduction

Harmonic Analysis (HA), a subject with deep roots, potent applications, and widespread interconnections with Mathematics as a whole, has continued to grow vigorously in recent decades. Connections with linear partial differential equations (PDE), number theory, and complex analysis in one variable are ancient, while connections with several complex variables, geometric measure theory, nonlinear dispersive PDE, and image processing blossomed in the 1960s, 1970s and 1980s and remain vigorous today. During the last twenty years especially, close connections with nonlinear PDE and combinatorics, and a renewed interaction with number theory, have led to additional major trends in the field. Advances in the theory of weighted inequalities, including the ideas around sparse domination, have brought new insights into old topics.

Two decades had gone by since the last MSRI program in Harmonic Analysis. The 2017 program was proposed to consolidate the developments of those decades, to cross pollinate different subfields, to help to foster collaborations among researchers around the world, to disseminate and to exploit recent advances, and to spur future developments. The prospect of a program concurrent with a program in Analytic Number Theory was a significant additional catalyst. Given the vast array topics that can be labeled "harmonic analysis", the program focused on four subfields designated at its inception. Even so, the program received far more applications from highly qualified applicants than could possibly be accommodated at MSRI.

The program was highly successful, in terms of organized activities, of organic collaborations that arose during the semester, and of the training of those young investigators who are the lifeblood of the subject. The positive impacts of this too brief semester program will be felt for many years to come.

2. Research Developments

The program was enormously productive from a research standpoint, facilitating new results in a variety of subfields of harmonic analysis and also generating ideas for future directions. A particular strength of the program was the large number of collaborations, both old and new, that it facilitated; many of these collaborations brought together junior and senior researchers in the field. In an appendix to this report we list 57 concrete research advances attained or initiated during the program. Many more projects are at more nebulous initial stages, so the ultimate impact of the semester will be even more profound than what is indicated there.

3. Highlights and Breakthroughs

3.1. **Breakthroughs.** The semester was fortuitously timed to advance polynomial and multilinear approaches to Fourier restriction theorems, two powerful techniques which have emerged as especially promising over the last few years. Two particularly striking results in this vein were: The resolution of the cone restriction conjecture in dimension five by one of our postdocs, Yumeng Ou, in collaboration with graduate student Hong Wang; and work of our postdocs Jonathan Hickman and Marina Iliopoulou, in collaboration with L. Guth, establishing sharp estimates for certain oscillatory integral operators. In another vein, D. Müller, F. Ricci, and J. Wright found new life in the original, measure theoretic, motivation for studying Fourier restriction operators, and proved bounds for the composition of maximal operators with Fourier restriction operators; these bounds allow one to understand the restriction of $\hat{f}$ to a surface in a pointwise, rather than operator theoretic, sense.

In the final workshop of the program, J. Zahl announced breakthrough work, joint with N. Katz, on the closely related Kakeya problem. The authors have obtained an improved lower bound on the Hausdorff dimension of a Kakeya set in dimension three, the first new bound in roughly two decades, in part by using sum-product estimates. While polynomial partitioning is not used in their analysis, one senses it lurking in certain algebraic sets that arise there.

There were also significant breakthroughs in the theory of weights, and in elliptic and parabolic partial differential equations. T. Hytönen, S. Petermichl and A. Volberg proved the first optimal weighted norm estimate with matrix weight (i.e., a weighted L^2 bound, with linear growth in terms of the A_2 characteristic of the weight) for a singular operator, in this case, the dyadic square function. Building on the groundbreaking work of P. Auscher, M. Egert and K. Nyström on the Dirichlet problem for divergence form parabolic equations with time-dependent coefficients (which work itself was put into final form during the MSRI program), Auscher and Egert, jointly with S. Bortz and O. Saari, have established certain interior regularity estimates for solutions of parabolic equations and systems (thus, lying beyond the scope of the classical Nash-Moser parabolic regularity theory) with time-dependent coefficients. G. David, J. Feneuil and S. Mayboroda have developed a theory of an appropriate class of degenerate elliptic equations in domains with higher codimensional boundaries, including in particular the construction of elliptic-harmonic measure, and have obtained an analogue of the classical theorem of Dahlberg (concerning the absolute continuity of harmonic measure in Lipschitz domains) in this setting.

P. Ivanisvili and A. Volberg developed new insight into optimal constants and maximizers for isoperimetric inequalities with respect to Gaussian measure. As an application, they obtained a new isoperimetric/Sobolev inequality for the Hamming cube.

3.2. **Highlights.** It was noted by several of the senior participants in the program that the environment at MSRI was particularly advantageous for the postdoctoral members of the program. As Andreas Seeger, one of our research members, put it, the postdocs were "just exploding" during the semester. This success can already be seen in the Research Developments and Breakthroughs sections, where more than half of the collaborations, many on major new results, involve researchers within 10 years of the Ph.D. The intensity of this research activity (and proximity to the job market) could have led to a destructively competitive environment, but the postdocs seemed to get along very well, both research-wise and socially: A number of the above-listed collaborations consist entirely of junior researchers, and the postdocs quickly found a local restaurant where 15-20 people could reliably find a place to sit.

For many participants, the concurrent analytic number theory program provided a bonus in stimulus and an enhanced understanding of contemporary issues in that field. We hope that this will help to stimulate more interactions between these two fields in the coming years.

4. Organizational Structure

The Harmonic Analysis program included three Workshops which are listed in the next section. In addition, there were several types of regular activities:

4.1. **Members' Seminar (Mondays and Wednesdays).** This was organized by Tony Carbery and Jill Pipher. This seminar met twice a week and featured a one-hour lecture on current research by a general member or a research professor. The speakers were chosen among those participants who were not speakers in one of the workshops.

4.2. **Joint Number Theory-Harmonic Analysis seminar (Fridays).** Each Friday there was a joint seminar with the sister program in Analytic Number Theory. Ciprian Demeter was in charge of organizing the Harmonic Analysis side of this seminar. This seminar was designed for topics which would be of interest to participants in both programs.

4.3. **Graduate Student Seminar (Wednesdays).** This weekly seminar was a forum for graduate students to give talks. While only graduate students spoke in the seminar, everyone was invited to attend and the seminar was very popular. Every week, either one or two graduate students would give a talk. The seminar was organized by Pascal Auscher (RP) and Victor Lie (RM).

4.4. **Postdoctoral seminar (Fridays).** This seminar featured postdoctoral scholars giving talks on their research. It was organized both as a forum for postdocs to tell others about their research, and as a way for the postdocs to practice certain kinds of talks. Because of this, each talk was classified as a "job talk", "colloquium talk" or "seminar talk", in accordance for what type of talk the postdoc was practicing for. The postdocs could then give each other feedback on the various types of talks.

4.5. **Informal Seminars.** There were a few informal seminars throughout the semester, which did not fit into our regularly scheduled seminars. Informal seminars were given by Michael Lacey, Bobby Wilson, and Yumeng Ou. Bobby Wilson's seminar drew interest from participants of both the Harmonic Analysis program and the Analytic Number Theory program.

5. Workshops

Three workshops took place during the semester. Individual reports for each workshop are attached, but it's worth relating that during the workshops we received many informal comments about their high quality.

The organizers were especially heartened by the exceptionally successful talks by some early career speakers, such as Y. Ou and J. Zahl in the Recent Developments workshop.

- Connections for Women, January 19–20.
- Introductory Workshop, January 23–27.
- Recent Developments in Harmonic Analysis, May 15–19.

6. Postdoctoral Fellows

Postdoctoral fellows formed a key part of the training portion of the program. As such, the program had several features designed to support their research programs. The more senior members tracked their progress closely. Each fellow was assigned a mentor from among the research members. The latter would meet regularly with the fellows, to make sure they were progressing on research problems. The postdoc seminar met on Fridays, featuring 45 minute talks from both programs. The talks were attended by the full range of participants in the program. Discussion around the talks continued over a pizza lunch.

The postdocs started dozens of projects, with many quick advances arising from discussions around blackboards in the hallways. These quick and more informal meetings formed the daily routine of the entire program. 'This was the most intense semester of my life,' writes postdoc Simon Bortz. 'MSRI did an excellent job of making it easy for so many of the members to collaborate. I believe that when I look back I will be able to say that MSRI made a profound difference in my career.' The close proximity of experts in a variety of topics led to quick advances, and interesting new collaborations, both within the program, and with the companion Analytic Number Theory program.

A small number of postdocs were seeking jobs, as well as conducting research and, as they indicated on the exit surveys, they were appreciative of the professional mentoring they received.

One notable result by postdoctoral fellow Yumeng Ou and graduate student Hong Wang, completed during the program, applies the modern technique of polynomial partitioning to the Fourier restriction problem for the truncated cone. Their subtle technique applies in all dimensions $n \geq 3$, and in particular resolves the well-known conjecture in this subject for dimensions $3 \leq n \leq 5$. In dimension 5, this is a new result.

A survey of each postdoctoral fellow can be found in MSRI's annual report.

7. Graduate Students

The graduate students formed an important component of the MSRI research program. They had a unique opportunity to benefit from an intense flow of results, ideas, and developments in their research area, from the exposure to many seminars and conversations with the senior participants which otherwise would be hardly possible; on the other hand, they brought youthful energy to the program and even started new research projects with the colleagues from other Universities.

The graduate students actively participated in all research activities, Workshops, and seminars of the program (and, on occasion, in those of the companion Analytic Number Theory program).

The graduate student seminar, specifically tailored to younger researchers, was organized by Pascal Auscher and Victor Lie. It spanned the period from February 22nd to May 10th - see below the precise schedule and the graduate students involved. The standard time for the meetings was on Tuesdays from 10:30 a.m. to noon, with two students speaking per session for 45 minutes each. An exception to this was the first session of the seminar: this was joint with the Analytic Number Theory Program and there were 4 students involved (two from each program), each speaking for 20 minutes.

List of Graduate Student Seminars:

- February 22 (Joint with the Analytic Number Theory)
  1) Kamilia Dahmani (Université de Toulouse III (Paul Sabatier)) (HA) "Sharp weighted estimates of the Riesz vector on manifolds"
  2) Sarah Peluse (Stanford University) (ANT)
  3) Joris Roos (Rheinische Friedrich-Wilhelms-University of Bonn) (HA) "Maximal operators related to curves in the plane"
  4) Joni Tervinen (University of Turku) (ANT) "Transference principle and the Goldbach problem"
- March 1, 10:30am -12pm
  5) Bruno Poggi (University of Minnesota) "On the Exponential Decay of Fundamental Solutions to Certain Schrödinger Operators"
  6) Zihui Zhao (University of Washington) "Harmonic measure: what you do and don't expect".
- March 8th, 10:30am -12pm
  7) Kevin O'Neill (University of Berkeley) "Intro to Extremizers: A Classical Paper and Other Examples"
  8) Joris Roos (Rheinische Friedrich-Wilhelms-Universität Bonn) "Decoupling for the parabola".
- March 15th, 11am -12pm
  9) Edoardo Cavallotto (Université de Paris XI) "Sobolev spaces on metric measure spaces".
- March 22, 11am -12pm
  10) Anh Nguyen - "Stability of Gowers norms in Euclidean space*
- March 29, 10:30am -12pm
  11) Alexander Barron (Brown University) "Sparse Bounds for Rough Operators."
  12) Michal Warchalski Title (Rheinische Friedrich-Wilhelms-Universität Bonn) "Outer L^p spaces"
- April 12, 11am -12pm
  13) Alexis Drouot (University of California, Berkeley) "The Hanson–Wright inequality"
- April 19, 10:30am -12pm
  14) David Beltran (University of Birmingham) "Fefferman-Stein inequalities"
  15) Robert Fraser (University of British Columbia) "Large Sets Avoiding Patterns"
- April 26, 11am -12pm
  16) Gennady Uraltsev (Rheinische Friedrich-Wilhelms-Universität Bonn) "Rough path theory and Harmonic Analysis"
- May 3, 11am -12pm
  17) Weilin Li (University of Maryland) "A harmonic analysis perspective on deep learning"
- May 10, 10:30am -12pm
  18) Jongchon Kim (University of Wisconsin-Madison) "Bounds for the maximal Bochner-Riesz operators at the critical index."
  19) Eunhee Jeong (Seoul National University) "Uniform Sobolev inequalities in $\mathbb{R}^d$."

8. Diversity

Among 76 long-term visitors (PA, PD, RM, RP, ORG) 20 were female. Of particular note, of 21 Research Professors and organizers, 8 were women. Nearly 60% of long term visitors were from US institutions (of those receiving funding, i.e. not PA, more than 60% were from US institutions). Of the 38 US citizen and permanent resident long term visitors, 6 were from underrepresented minority groups. The participants

spanned all research age groups, ranging from those receiving Ph.D.s in early 1980s up through current graduate students.

The Connections for Women Workshop gathered 11 internationally recognized female speakers and numerous young female researchers in the field.

9. Synergistic activities and Broader Impacts

- The participation of senior researchers from abroad helped to stimulate research in Harmonic Analysis in the US. Some particular examples include:
  - A number of new collaborations were formed between US-based researchers, many of them junior, and mathematicians from overseas. These are discussed in the research developments section.
  - Aside from the many talks given by international researchers at the MSRI seminars and workshops, we also know of a number of talks given by foreign researchers at other US institutions. Examples include a colloquium at UC Davis by **C. Thiele** (RM) and a talk at an AMS sectional meeting Special Session in honor of Cora Sadofsky by **S. Petermichl** (RM).

- There was considerable interaction between the Harmonic Analysis program, the Analytic Number Theory program at MSRI, and the serendipitous pseudorandomness program at the Simons Institute for Theoretical Computing on the UC Berkeley campus. The Simons Institute program created even more opportunities for participants to broaden their scientific horizons. Julia Wolf, a co-organizer of the pseudorandomness program, kindly kept MSRI participants informed of activities of potential interest to them in her program. These interactions included:
  - **C. Demeter** (RP) mentored a postdoc, Julia Brandes, from the ANT program. Demeter also co-organized a joint ANT/HA seminar.
  - **T. Anderson**, an NSF postdoc who participated in the HA program, formed a new collaboration with F. Thorne, a research member in the ANT program. Anderson was also able to discuss recent work, joint with **Cook, Hughes** and **Kumchev**, on an ergodic Waring problem.
  - Recent developments in decoupling theory in particular led to ample discussions between members of the two programs.
  - Recent work of Durcik–Guo–Roos on "A polynomial Roth theorem on the real line" was discussed with members of the pseudorandomness program.
  - Collaboration between **J. Pipher** and J. Hoffstein, discussed below.
  - M. Christ benefitted from attending stimulating talks by B. Green and A. Wigderson at the Simons Institute, and from an extended conversation with Wigderson.

- Some of the research facilitated by the MSRI program has the potential for future real-world applications. Examples of this include:
  - **J. Pipher** (HA) collaborated with J. Hoffstein (ANT) on public key cryptography and digital signatures, finishing a paper which was just submitted to a conference proceedings.
  - **P. Ivanisvili** submitted a paper to the arXiv, "Convolution estimates and number of disjoint partitions," which extends a recent result of Kane–Tao having applications in the run time analysis of ASTRAL algorithm in phylogenetic reconstructions.

- **C. Demeter** gave a two-hour problem session for the Berkeley Math Circle.

- We also know of a number of upcoming conferences that were either advertised or partially planned at the MSRI program, and which are certain to both disseminate work completed at MSRI and to help foster the new collaborations formed during this semester. These include:
  - An upcoming AIM workshop on sparse domination, organized by Ciuliuc, di Plinio, and **Y. Ou** (PD) was advertised.
  - An upcoming conference in Edinburgh in honor of **Anthony Carbery** (RP), organized by Barcelo, **J. Bennett** (RM), **P. Gressman** (RM), **M. Iliopoulou** (PD), and **J. Wright** (RM), at which a number of MSRI members and professors will speak, was advertised.

- **L. Lanzani** (RM), **B. Stovall** (ORG), and **B. Street** (ORG) drafted an NSF proposal to support the attendance of junior, US-based researchers at a conference in honor of Fulvio Ricci to take place in Italy in Summer 2018.
- **A. Seeger** (RM) and **B. Stovall** (ORG) began planning an upcoming RTG conference in Wisconsin whose purpose is to highlight the work of young, US-based researchers in harmonic analysis.
- **M. Akman and M. Engelstein** (both PD) made plans to apply to lead a special session at the upcoming AMS Sectional at Northeastern University.
- M. Christ, D. Müller, and C. Thiele put the finishing touches on planning for a conference scheduled for July 2017 at the Mathematisches Forschungsinstitut Oberwolfach.

10. Appendix: List of research developments and collaborations

The following are some of the research advances attained or initiated during the program.

(1) **M. Akman, S. Hofmann, T. Toro** and **J. M. Martell** started a project treating perturbation theory for elliptic operators on domains with uniformly ample exteriors.
(2) **M. Akman** and **M. Christ** have initiated a project on the stability of the Brunn-Minkowski inequality.
(3) **M. Akman** and **O. Saari** have made substantial progress on a project concerning the Brunn-Minkowski inequality for logarithmic capacity.
(4) **T. Anderson** completed a project with **B. Cook, K. Hughes, and A. Kumchev** giving bounds for discrete spherical maximal operators along the primes.
(5) **P. Auscher, S. Bortz, M. Egert** and **O. Saari** proved a non-local variant of Gehring's lemma with application to the regularity of solutions of parabolic equations and systems with time dependent coefficients.
(6) **P. Auscher** and **M. Egert** obtained uniqueness results for the Dirichlet problem for elliptic systems without De Giorgi/Nash/Moser regularity.
(7) **A. Barton** finished and submitted several manuscripts concerning layer potential methods for higher order variable coefficient elliptic equations, jointly with **S. Hofmann** and **S. Mayboroda**, and initiated a project on semigroup methods for higher order elliptic equations with **P. Auscher, M. Egert** and **S. Mayboroda**.
(8) **D. Beltran** initiated a project with **L. Cladek** on sparse bounds for pseudodifferential operators.
(9) **D. Beltran, S. Guo, J. Hickman** and **A. Seeger** have initiated a project on the circular maximal function on the Heisenberg group applied to radial functions.
(10) **J. Bennett** and **M. Iliopoulou** finalized work on a multilinear extension identity in $\mathbb{R}^n$, which has been accepted.
(11) **S. Bortz** and **M. Engelstein** have obtained a geometric characterization of Reifenberg flatness assuming only small oscillation of the unit normal to the boundary.
(12) **S. Bortz** and **S. Hofmann** have proved a quantitative Fatou theorem for local John domains with uniformly rectifiable boundaries.
(13) **S. Bortz. L. Chen** and **J. M. Martell** have made progress on solvability of elliptic boundary value problems with data in weighted L^p spaces.
(14) **A. Carbery** and **M. Christ** made progress on a constructive approach to a factorization dual to Holder-Brascamp-Lieb inequalities, whose existence had earlier been shown by Carbery and Valdimarsson.
(15) **A. Carbery** and **M. Iliopoulou** initiated a project on counting joints formed by k_j-planes.
(16) **M. Christ and M. Iliopoulou** have made partial progress toward a sharpened periodic Riesz–Sobolev inequality.
(17) Conversations between **M. Christ** and **D. Mueller** led to a calculation of optimal constants in an operator norm inequality for Weyl quantization, and an inequality for twisted convolution.
(18) **G. David, M. Engelstein** and **T. Toro** completed a project on free boundary regularity for almost-minimizers, and jointly with **M. Smit-Vega Garcia** have initiated a project treating the analogous two-phase version of the problem.

(19) **C. Demeter** worked on the Fourier restriction problem for the paraboloid in $\mathbb{R}^4$ and, with **Hong Wang**, worked on the decoupling problem for the cone.
(20) **G. David, J. Feneuil** and **S. Mayboroda** have established solvability results analogous to Dahlberg's theorem for certain degenerate elliptic equations in domains with higher co-dimensional boundaries.
(21) **P. Durcik, S. Guo** and **J. Roos** proved a polynomial Roth theorem in the primes, which has been submitted.
(22) **M. Engelstein, Matthew Badger** and **Tatiana Toro** have nearly completed a project concerning regularity of the singular set in a two-phase free boundary problem.
(23) **L. Escauriaza** and **S. Hofmann** initiated a project concerning the Kato square root problem for non-divergence elliptic operators.
(24) **L. Escauriaza** completed a project, with **Hongjie Dong** and **Seick Kim**, on elliptic regularity estimates.
(25) **R. Fraser** and **M. Pramanik** initiated a project on sets with large Fourier dimension that avoid certain patterns.
(26) **S. Guo** has made substantial progress, with **R. Zhang**, toward the Vinogradov mean value theorem in two dimensions.
(27) **J. Hickman** and **M. Iliopoulou**, with **L. Guth**, have nearly completed a major project establishing sharp estimates for oscillatory integral operators via polynomial partitioning.
(28) **T. Hytönen, S. Petermichl** and **A. Volberg** proved the first sharp weighted bound for a singular integral with matrix weights.
(29) **P. Ivanisvili** and **S. Treil** have nearly completed a project on dyadic square functions.
(30) **P. Ivanisvili, F. Nazarov** and **A. Volberg** have nearly completed a project on square functions and the Hamming cube.
(31) **P. Ivanisvili, K. Domelevo, S. Petermichl, S. Treil** and **A. Volberg** have submitted a paper on the failure of lower square function estimates in the non-homogeneous weighted setting.
(32) **B. Krause** and **M. Lacey** have initiated work on a discrete Stein–Wainger theorem.
(33) **M. Lacey** and **M. Reguera** have made progress toward establishing new sparse bounds for Bochner–Riesz.
(34) **M. Lacey** completed the proof of sparse bounds for spherical maximal functions, which has been accepted.
(35) **L. Lanzani** and **M. Pramanik** have initiated work on the stability of symmetrization of Cauchy-like kernels.
(36) **L. Lanzani and E. M. Stein** have completed and submitted a preprint on the role of an interation formula in the study of Cauchy–Leray integrals.
(37) **V. Lie** has established strong L^1 boundedness of the lacunary Carleson operator; a manuscript is expected to be submitted this summer.
(38) **A. Magyar**, with **N. Lyall**, have worked on various problems relating to finding specified configurations in sufficiently large sets. These include pinned point configurations in sets of positive density in $\mathbb{Z}^d$, k-dimensional rectangles in dense subsets of Euclidean spaces, and problems in geometric Ramsey theory relating to finding circular quadrilaterals.
(39) **M. Mitrea** made progress on a project concerning multi-layer potentials for higher order systems with **G. Hoepfner, P. Liboni, D. Mitrea** and **I. Mitrea**.
(40) **D. Müller** and **A. Vargas**, with **S. Buschenhenke**, have established new restriction estimates for surfaces of negative curvature in a model case
(41) **D. Müller** and **J. Wright**, with **F. Ricci**, have completed and posted a preprint establishing a maximal restriction theorem for the Fourier transform of L^p functions.
(42) **K. Okoudjou** completed and submitted a paper on extension and restriction principles for the HRT conjecture and also completed and submitted a joint paper with **Desai Cheng** on optimal properties of the canonical tight probabilistic frame.
(43) **Y. Ou**, with **H. Wang**, proved new bounds for Fourier restriction to the cone using polynomial partitioning; their estimates are optimal in dimension 5. This paper has been submitted.
(44) **Y. Ou**, with **L. Cladek**, has proved a sparse domination theorem for Hilbert transforms along curves, which has been submitted.

(45) **J. Pipher** and **S. Mayborda**, jointly with **M. Dindos**, have initiated a project on the Regularity and Neumann problems for complex elliptic equations, and Pipher and Dindos have submitted a paper on interior regularity theory for such equations.
(46) **M. Pramanik** and **A. Seeger** initiated work on L^p Sobolev regularity of a class of generalized Radon transforms.
(47) **K. Rogers** has completed and submitted a note giving an example which shows that the solution to the Schrödinger equation may not converge, on sets of large Hausdorff dimension, to its initial data, as time goes back to zero, if the data is not Sobolev regular enough. That is a necessary condition for a question of Carleson, refining a result of Bourgain.
(48) **B. Stovall** sharpened the bilinear to linear restriction theorem for a negatively curved hypersurface in $\mathbb{R}^3$ to the scaling line
(49) **B. Stovall** and **B. Street** studied coordinates well adapted to families of vector fields, and also, with **S. Dendrinos**, worked on sharp Lebesgue estimates for weighted averages on curves.
(50) **D. Tataru**, with **M. Ifrim**, established well-posedness and dispersive decay of small data solutions for the Benjamin-Ono equation; this has been posted.
(51) **D. Tataru**, with **J. Metcalfe and J. Sterbenz**, proved local energy decay for scalar fields on time dependent non-trapping backgrounds; this has been posted.
(52) **C. Thiele** completed a project on square functions for bi-Lipschitz maps and directional operators, joint with **Francesco di Plinio, Shaoming Guo** and **Pavel Zorin-Kranich**.
(53) **X. Tolsa** has nearly completed a project with **J. Azzam, J. Garnett** and **M. Mourgoglou** on the problem of showing that uniform rectifiability is implied by square function bounds and by ϵ-approximability, for a class of variable coefficient divergence form elliptic equations.
(54) **T. Toro** and **Z. Zhao** have proved that quantitative absolute continuity of elliptic-harmonic measure implies rectifiability of the boundary of the domain, assuming that the coefficients are in $W^{1,1}$.
(55) **T. Toro** taught a course a UC-Berkeley on elliptic operators on domains beyond Lipschitz; the lecture notes for the course are a preliminary version of a book manuscript on that subject to be published jointly with **S. Hofmann** and **J. M. Martell**.
(56) **A. Volberg** and **P. Ivanisvili** wrote a paper on an improved Beckner inequality via Hermite functions.
(57) **B. Wilson** worked on a paper about the instability of irrational NLSE.

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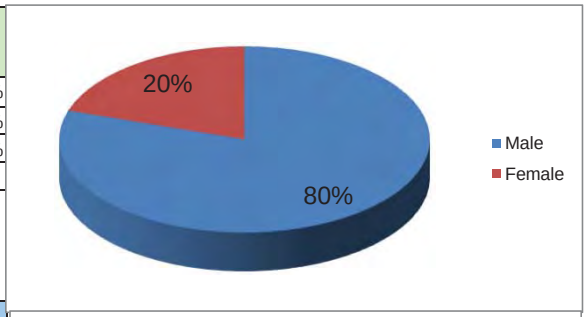
Postdoc Pre/Post-MSRI Institution Group

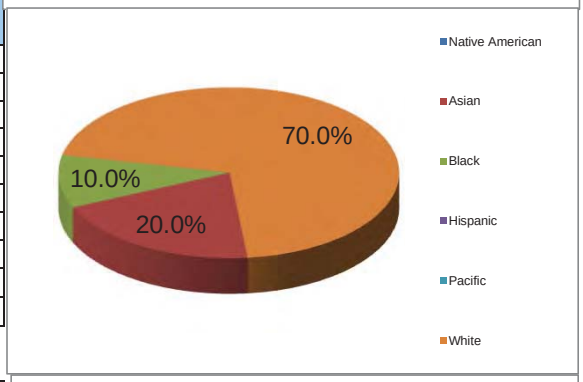
Family Name	First Name	Pre-MSRI Institution Group	Post-MSRI Institution Group	Home Institution Name	Placement Institution Name
Akman	Murat	Public Medium	Public Medium	University of Connecticut	University of Connecticut
Bortz	Simon	Public Large	Public Large	University of Minnesota, Twin Cities	University of Minnesota, Twin Cities
Engelstein	Max	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology
Guo	Shaoming	Public Large	Public Large	Indiana University, Bloomington	Indiana University, Bloomington
Hickman	Jonathan	Private Large	Private Large	University of Chicago	University of Chicago
Iliopoulou	Marina	Public Large	Public Large	UC Berkeley	UC Berkeley
Ivanisvili	Paata	Public Medium	Public Medium	Kent State University	Kent State University
Ou	Yumeng	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology
Saari	Olli	Foreign	Foreign	Aalto University	Universität Bonn
Wilson	Bobby	Private Large	Private Large	Massachusetts Institute of Technology	Massachusetts Institute of Technology

2016–17 HA Postdoctoral Fellow Demographic Summary

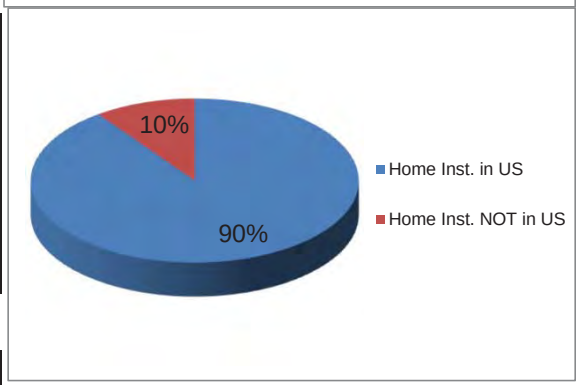
Gender	#	% (No Decl.)*	%
# of Distinct Members	10		100.0%
Male	8	80.00%	80.0%
Female	2	20.00%	20.0%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	2	20.00%	20.0%
Black	1	10.00%	10.0%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	7	70.00%	70.0%
Decline to State Ethnicities	0		0.0%
Unavailable Information	0		0.0%
Minorities	1		33.3%

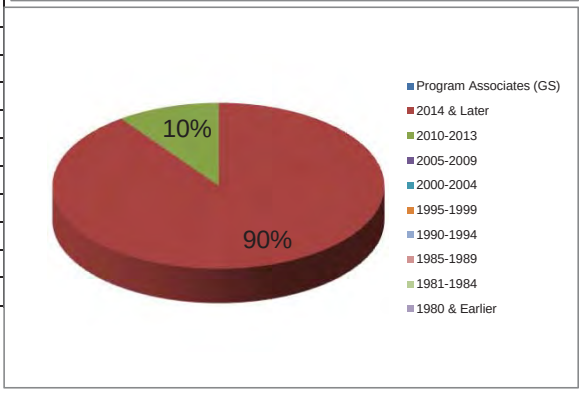


Citizenships	#		%
US Citizen & Perm. Residents	3		30.0%
Foreign	7		70.0%
Unavailable information	0		
# of Distinct Members	10		100.0%
US Citizen	3		30.0%
Perm Residents	0		0.0%
Home Inst. in US	9		90.00%



Year of Ph.D	#		%
Program Associates (GS)	0		0.0%
2014 & Later	9		90.0%
2010-2013	1		10.0%
2005-2009	0		0.0%
2000-2004	0		0.0%
1995-1999	0		0.0%
1990-1994	0		0.0%
1985-1989	0		0.0%
1981-1984	0		0.0%
1980 & Earlier	0		0.0%
Total # of Distinct Members	10		100.0%

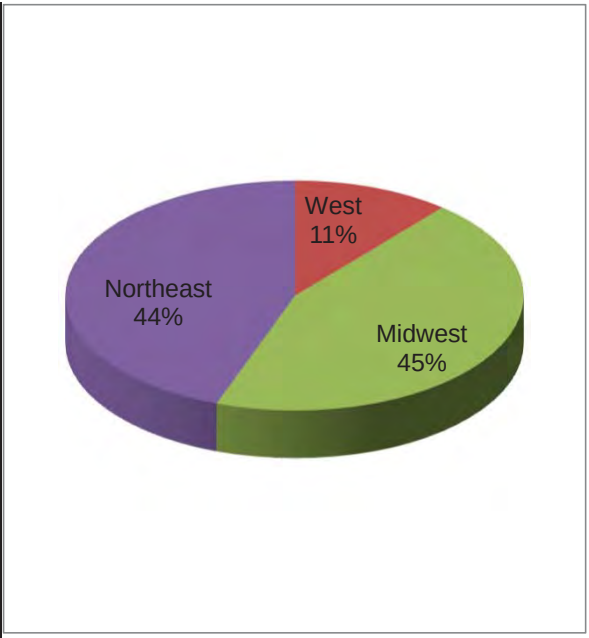
**Statistic Calculation based on all participants that did not decline.*



2016–17 HA Postdoctoral Fellow Home Institution Classified by States

**Regions based on US Census classification*

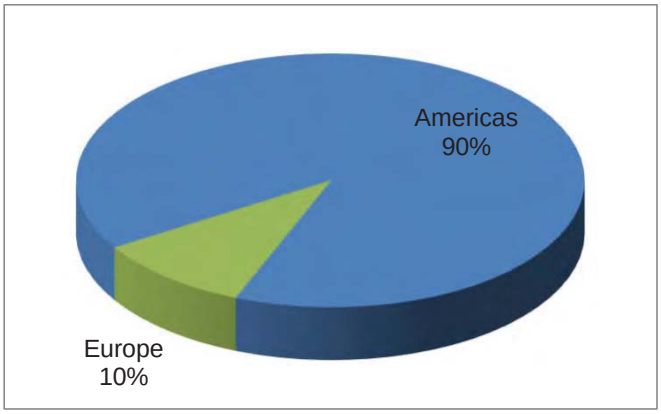
State	#	%	2010 Census Population
South	**-**	**0.0%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	-	0.0%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	-	0.0%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**1**	**11.1%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	1	11.1%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**4**	**44.4%**	**21.7%**
IL	1	11.1%	4.2%
IN	1	11.1%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	-	0.0%	3.2%
MN	1	11.1%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	1	11.1%	3.7%
SD	-	0.0%	0.3%
WI	-	0.0%	1.8%
Northeast	**4**	**44.4%**	**17.9%**
CT	1	11.1%	1.2%
ME	-	0.0%	0.4%
MA	3	33.3%	2.1%
NH	-	0.0%	0.4%
NJ	-	0.0%	2.8%
NY	-	0.0%	6.3%
PA	-	0.0%	4.1%
RI	-	0.0%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**9**	**100%**	**100%**



2016–17 HA Postdoctoral Fellow Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**9**
	North America	United States	9
Asia			**0**
Europe			**1**
	Northern Europe	Finland	1
Oceania			**0**
Grand Total			**10**



Harmonic Analysis

Program Summary

Role	# of Distinct Members	%	# of Citizens & Perm. Res.	%	US Citizens	# of Female	%	# of Minorities[1]	%
Organizers	7	9.6%	7	100.0%	6	2	28.6%	0	0.0%
Research Professors	12	16.4%	7	58.3%	6	4	33.3%	1	16.7%
Postdoctoral Fellows	10	13.7%	3	30.0%	3	2	20.0%	1	33.3%
PD/RM	1	1.4%	1	0.0%	1	0	0.0%	0	0.0%
Research Members	27	37.0%	16	59.3%	15	6	22.2%	3	20.0%
Program Associates	16	21.9%	3	18.8%	3	4	25.0%	1	33.3%
Guests	0	0.0%	0	0.0%	0	0	0.0%	0	0.0%
Total # of Distinct Members	**73**		**37**	***50.7%***	**34**	**18**	***24.7%***	**6**	***17.6%***

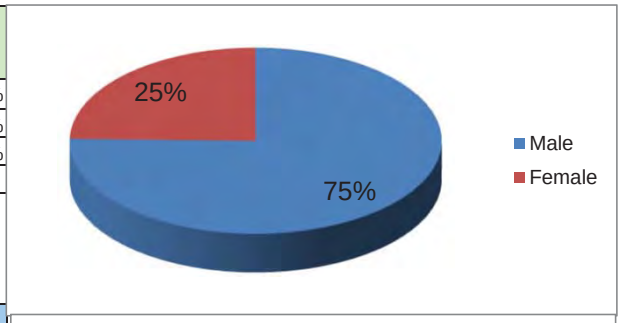
[1] *Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, or Hispanic. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.*

Home Institution Grouping

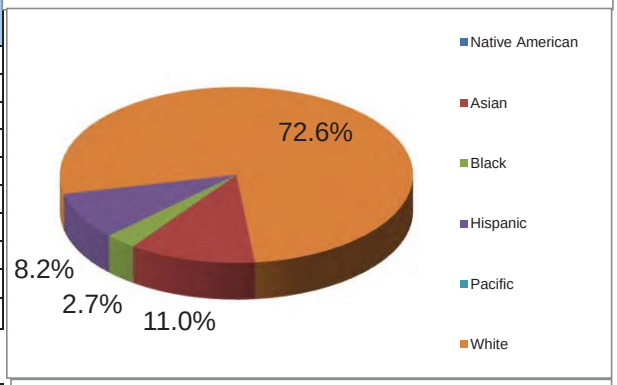
	US								
Role	**Private Large**	**Private Small**	**Public Large**	**Public Medium**	**Public Small**	**Group M or B**	**Non-Group**	**Foreign**	**Total**
Organizers	0	1	4	2	0	0	0	0	7
Research Professors	2	0	4	0	0	0	0	6	12
Postdoctoral Fellows	4	0	3	2	0	0	0	1	10
PD/RM	0	0	0	0	0	0	0	1	1
Research Members	3	1	5	4	2	0	0	12	27
Program Associates	1	0	5	0	0	0	0	10	16
Total	**10**	**2**	**21**	**8**	**2**	**-**	**-**	**30**	**73**
%	***13.7%***	***2.7%***	***28.8%***	***11.0%***	***2.7%***	***0.0%***	***0.0%***	***41.1%***	***100.0%***

2016–17 Program Members Demographic Summary

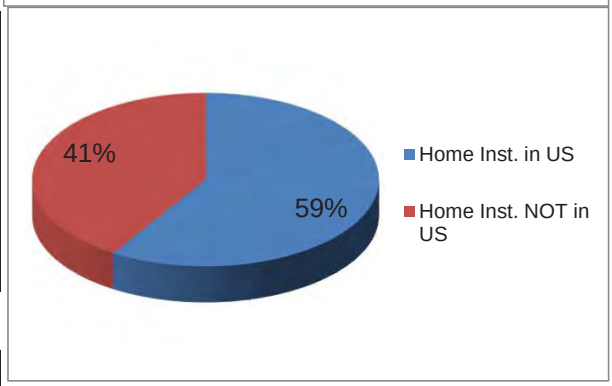
Gender	#	% (No Decl.)*	%
# of Distinct Members	73		100.0%
Male	55	75.34%	75.3%
Female	18	24.66%	24.7%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	8	11.59%	11.0%
Black	2	2.90%	2.7%
Hispanic	6	8.70%	8.2%
Pacific	0	0.00%	0.0%
White	53	76.81%	72.6%
Decline to State Ethnicities	7		9.6%
Unavailable Information	0		0.0%
Minorities	6		16.2%

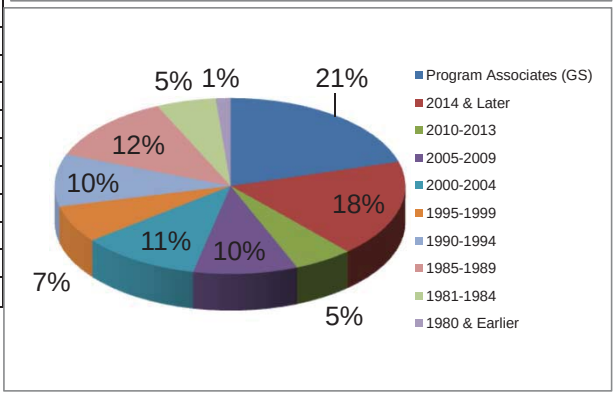


Citizenships	#		%
US Citizen & Perm. Residents	37		50.7%
Foreign	36		49.3%
Unavailable information	0		
# of Distinct Members	73		100.0%
US Citizen	34		46.6%
Perm Residents	3		4.1%
Home Inst. in US	43		58.90%



Year of Ph.D	#		%
Program Associates (GS)	15		20.5%
2014 & Later	13		17.8%
2010-2013	4		5.5%
2005-2009	7		9.6%
2000-2004	8		11.0%
1995-1999	5		6.8%
1990-1994	7		9.6%
1985-1989	9		12.3%
1981-1984	4		5.5%
1980 & Earlier	1		1.4%
Total # of Distinct Members	73		100.0%

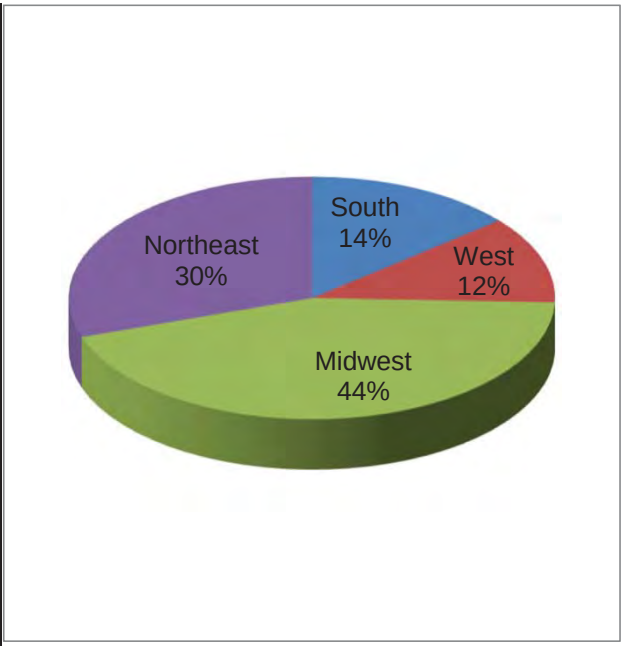
**Statistic Calculation based on all participants that did not decline.*



2016–17 Program Members Home Institution Classified by States

**Regions based on US Census classification*

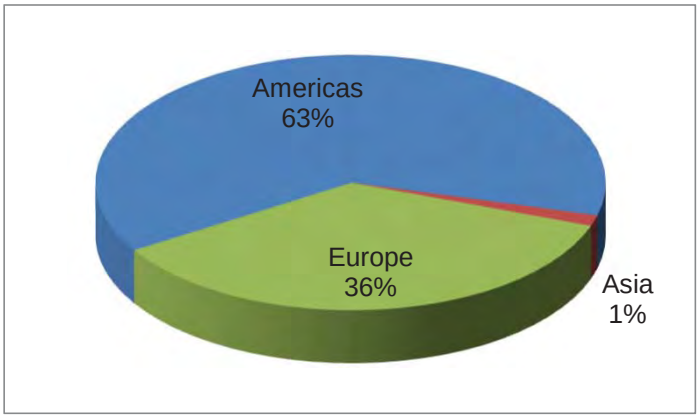
State	#	%	2010 Census Population
South	**6**	**14.0%**	**37.1%**
AL	-	0.0%	1.5%
AR	1	2.3%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	1	2.3%	6.1%
GA	2	4.7%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	2	4.7%	1.9%
MS	-	0.0%	1.0%
NC	-	0.0%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	-	0.0%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**5**	**11.6%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	3	7.0%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	2	4.7%	2.2%
WY	-	0.0%	0.2%
Midwest	**19**	**44.2%**	**21.7%**
IL	1	2.3%	4.2%
IN	3	7.0%	2.1%
IA	-	0.0%	1.0%
KS	1	2.3%	0.9%
MI	1	2.3%	3.2%
MN	4	9.3%	1.7%
MO	2	4.7%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	1	2.3%	3.7%
SD	-	0.0%	0.3%
WI	6	14.0%	1.8%
Northeast	**13**	**30.2%**	**17.9%**
CT	2	4.7%	1.2%
ME	-	0.0%	0.4%
MA	3	7.0%	2.1%
NH	-	0.0%	0.4%
NJ	1	2.3%	2.8%
NY	3	7.0%	6.3%
PA	1	2.3%	4.1%
RI	3	7.0%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**43**	**100%**	**100%**



2016–17 Program Members Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**46**
	North America	Canada	3
		United States	43
Asia			**1**
	Eastern Asia	Korea, Republic of	1
Europe			**26**
	Northern Europe	United Kingdom	6
		Finland	2
	Southern Europe	Spain	6
	Western Europe	France	6
		Germany	6
Oceania			**0**
Grand Total			**73**



Harmonic Analysis

January 17, 2017 - May 26, 2017

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	71	97%
No	2	3%
Total Responses	73	

Q2. I had opportunities to present my work to new audiences		
Yes	71	97%
No	2	3%
Total Responses	73	

Q3. I initiated research with new collaborators		
Yes	57	78%
No	16	22%
Total Responses	73	

Q4. I initiated research in new areas		
Yes	55	75%
No	18	25%
Total Responses	73	

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

MSRI Experience - Postdoc Seminar

Q7. To learn new ideas and techniques		
1 - Least Satisfying	0	0%
2	0	0%
3	9	16%
4	18	32%
5 - Most Satisfying	30	53%
Total Responses (Exclusive of N/A)	57	100%

Q8. To form new acquaintances and collaborations		
1 - Least Satisfying	1	2%
2	0	0%
3	13	23%
4	10	18%
5 - Most Satisfying	33	58%
Total Responses (Exclusive of N/A)	57	100%

Q9. To be able to present my own work		
1 - Least Satisfying	0	0%
2	0	0%
3	2	10%
4	4	20%
5 - Most Satisfying	14	70%
Total Responses (Exclusive of N/A)	20	100%

MSRI Experience - Program Seminars

Q10. To learn new ideas and techniques		
1 - Least Satisfying	0	0%
2	0	0%
3	3	4%
4	26	37%
5 - Most Satisfying	42	59%
Total Responses (Exclusive of N/A)	71	100%

Q11. To form new acquaintances and collaborations

1 - Least Satisfying	0	0%
2	1	1%
3	18	25%
4	22	31%
5 - Most Satisfying	30	42%
Total Responses (Exclusive of N/A)	71	100%

Q12. To be able to present my own work

1 - Least Satisfying	2	4%
2	0	0%
3	3	6%
4	9	19%
5 - Most Satisfying	34	71%
Total Responses (Exclusive of N/A)	48	100%

MSRI Experience - General Information

Q13. My office accomodations were

1 - Least Satisfying	2	3%
2	2	3%
3	5	7%
4	14	19%
5 - Most Satisfying	49	68%
Total Responses (Exclusive of N/A)	72	100%

Q14. Professionally, my overall satisfation with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	1	1%
4	12	17%
5 - Most Satisfying	59	82%
Total Responses (Exclusive of N/A)	72	100%

MSRI Experience - Feedback

Q15. 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

Q16. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

Link to Qualitative Responses

Q17. What suggestions would you have for improvements at MSRI?

Link to Qualitative Responses

Q18. What suggestions would you have for future MSRI programs or workshops?

Link to Qualitative Responses

MSRI Experience - Computing Services and Facilities

Q19. How would you rate the computing staff for the support you received while at MSRI

1 - Least Satisfying	0	0%
2	1	2%
3	4	7%
4	10	18%
5 - Most Satisfying	41	73%
Total Responses (Exclusive of N/A)	56	100%

Q20. How would you rate the computing equipment you used at MSRI:

1 - Least Satisfying	1	2%
2	1	2%
3	5	8%
4	22	34%
5 - Most Satisfying	35	55%
Total Responses (Exclusive of N/A)	64	100%

Q21. How could we improve our computing services?

Link to Qualitative Responses

Q22. How could we improve our computing equipment and software environment?

Link to Qualitative Responses

MSRI Experience - Relocation Advisory Services

Q23. How would you rate the following relocation advisory services you received while at MSRI: Housing

1 - Least Satisfying	4	7%
2	1	2%
3	5	9%
4	8	14%
5 - Most Satisfying	39	68%
Total Responses (Exclusive of N/A)	57	100%

Q24. How would you rate the following relocation advisory services you received while at MSRI: School and Childcare

1 - Least Satisfying	0	0%
2	0	0%
3	1	10%
4	3	30%
5 - Most Satisfying	6	60%
Total Responses (Exclusive of N/A)	10	100%

Q25. How would you rate the following relocation advisory services you received while at MSRI: Visa

1 - Least Satisfying	1	4%
2	1	4%
3	0	0%
4	5	18%
5 - Most Satisfying	21	75%
Total Responses (Exclusive of N/A)	28	100%

Q26. How could we improve our relocation advisory services?

Link to Qualitative Responses

MSRI Experience - Administrative Support Services

Q27. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	3	4%
4	5	7%
5 - Most Satisfying	63	89%
Total Responses (Exclusive of N/A)	71	100%

Q28. How could we improve our administrative services?

Link to Qualitative Responses

Q29. Your comments about MSRI:

Link to Qualitative Responses

Complementary Program 2016–17

August 15, 2016 to July 31, 2017

MSRI

Berkeley, CA

USA

Complementary Program (2016–17)

August 15, 2016 to July 31, 2017

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 2016–17 year, MSRI had a small Complementary Program comprised of one postdoctoral fellow, Mina Bigdeli (Institute for Research in Fundamental Sciences) and the following researchers: Catalin Badea (Université de Lille I (Sciences et Techniques de Lille Flandres Artois)), Valerio Capraro (Middlesex University London), Komla Domelevo (Institut de Mathématiques de Toulouse), Jeremy Gray (University of Warwick), Susana Gutierrez (University of Birmingham), Joseph Harris (Harvard University), Dominique Hulin (Université de Paris XI), Abdul Jarrah (American University of Sharjah), Francoise Point (Université de Mons-Hainaut), Alexander Postnikov (Massachusetts Institute of Technology), Sebastien Roch (University of Wisconsin-Madison), and Bernd Ulrich (Purdue University).

Catalin Badea
Research Member, August 15, 2016 to December 16, 2016
Spouse of Cornelia Drutu, Organizer in *Geometric Group Theory* program.
Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Villeneuve d'Ascq, F-59655
France

At MSRI, Dr. Badea mainly collaborated with Laurian Suciu. He produced a paper titled, *Harnack and Shmul'yan pre-order relations for Hilbert space contractions*.

Mina Bigdeli (worked with Director David Eisenbud)
Postdoctoral Fellow, September 12, 2016 to June 19, 2017
Institute for Research in Fundamental Sciences
Tehran, Iran

Dr. Bigdeli's mentor while at MSRI was our director, David Eisenbud. He advised her not only in her research but also talks, job interviews, etc. The discussions resulted Dr. Bigdeli in giving a talk in the conference "The Prospects in Commutative Algebra" in Osaka, Japan in July 2017.

Valerio Capraro (worked with Deputy Director Hélène Barcelo)
Research Member, May 8, 2017 to June 12, 2017
Middlesex University
London
United Kingdom

Komla Domelevo
Research Member, January 17, 2017 to May 24, 2017
Spouse of Stefanie Petermichl, Research Professor in *Harmonic Analysis* program.
Institut de Mathématiques de Toulouse
Université Paul Sabatier 118, route de Narbonne
Toulouse, F-31062
France

At MSRI, Dr. Domelevo collaborated with Paata Ivanisvili, Stephanie Petermichl, Sergei Treil, and Alexander Volberg. He comments “MSRI offers an incredible infrastruscture and support for research semesters.”

Jeremy Gray (worked with Director David Eisenbud)
Research Member, March 16, 2017 to April 14, 2017
University of Warwick
Coventry, CV4 7AL
United Kingdom

Susana Gutierrez
Research Member, March 29, 2017 to May 11, 2017
Spouse of Jonathan Bennet, Organizer in *Harmonic Analysis* program.
University of BirminghamEdgbaston
Birmingham, BI5277
United Kingdom

Dr. Gutierrez comments “The experience of visiting the MSRI has been very good: good atmosphere, research talks, interaction with other researchers and administrative services.”

Joseph Harris (worked with Director David Eisenbud)
Research Member, March 13, 2017 to March 17, 2017
Harvard University
Boston, MA
United States

Dominique Hulin
Research Member, August 16, 2016 to December 14, 2016
Spouse of Yves Benoist, Research Professor in *Geometric Group Theory* program.
Université de Paris XI
Bâtiment 425
Orsay, F-91405
France

At MSRI, Dr. Hulin mainly collaborated with Yves Benoist. They collaborated on two papers together.

Abdul Jarrah (worked with Deputy Director Hélène Barcelo)
Research Member, August 15, 2016 to July 31, 2017
American University of Sharjah
Sharjah,
United Arab Emirates

Francoise Point
Research Professor, February 2, 2017 to April 28, 2017
Spouse of Guy David, Research Professor in *Harmonic Analysis* program.
Université de Mons-Hainaut
Mons, Belgium

While at MSRI, Dr. Point collaborated with many researchers. She submitted two papers, *Bézout domains and lattice-valued modules* and *The Ziegler spectrum of the ring of entire complex valued functions*.

Alexander Postnikov (worked with Deputy Director Hélène Barcelo)
Research Member, August 23, 2016 to November 4, 2016
Massachusetts Institute of Technology
Cambridge, MA
United States

Sebastien Roch
Research Member, January 31, 2017 to May 15, 2017
University of Wisconsin-Madison
Madison, WI
United States

At MSRI, Dr. Roch mainly collaborated with Louis Fan and Jason Wang.

Bernd Ulrich (worked with Director David Eisenbud)
Research Member, June 23, 2017 to July 3, 2017
Purdue University
West Lafayette, IN
United States

Bigdeli, Mina

Your Name: Mina Bigdeli
Year of Ph.D: 2015
Institution of Ph.D.: Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran
Dissertation title: Linearly Presented Powers of Edge Ideals and Chordality of Clutters
Ph.D. advisor: Rashid Zaare-Nahandi, Jürgen Herzog

Mentor while at MSRI: David Eisenbud

Institution prior to obtaining the MSRI PD fellowship: MSRI was my first in- stitution after graduation
Position at that institution: N/A
Mentor (if applicable): N/A

Institution (or company) where you are going after the MSRI PD fellowship: Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
Position: Postdoctoral Fellow
Anticipated length: 2 years, extendable to 3 years
Mentor (if applicable): Masoud Tousi

Postdoctoral fellow's comments:

I was a postdoc in the complementary program which lasted for an academic year. My field of study is (Combinatorial) Commutative Algebra. There were three different programs running at MSRI during my stay. Despite the fact that their subjects were a bit far from my own research, I took part in some of their seminars and also discussed with young researchers about their topic of study. This helped me to widen my mathematical interests and to learn a lot about the scopes and techniques in different fields. This also inspired and gave me new ideas in dealing with my own mathematical problems.

One of the things that I benefited the most was talking to my mentor. I profited a lot from his advices not only for my research but also for preparing my talks, job interviews, etc. These discussions led me to new ideas and questions in one of my main research interests which concerns the combinatorial properties of monomial ideals having linear resolution. Based on the results obtained while at MSRI, I am going to give a talk in the conference "The Prospects in Commutative Algebra" which will be held in Osaka, Japan in July 2017.

Due to the strong relationship between MSRI and the Math department of University of California, Berkeley, I had the opportunity to make use of the

scientific activities there. I took part in weekly seminars and also in some courses at the department. At this occasion, I could talk to the students there and exchange ideas. One of these discussions resulted in a contribution to a project in which we study the Algebraic properties of an ideal attached to a graph. Since the project is not completed yet, we planned to continue our discussions in the future.

Being at MSRI gave me a great chance to meet lots of excellent mathematicians and to discuss mathematics with them. I truly made use of their different views at a scientific problem. It was also extremely helpful in finding new ideas to proceed in my projects. I also started another project with Sara Faridi, a visitor of the university. In this project we try to answer the question whether the monomial localization of a componentwise linear ideal is again componentwise linear. Right after finishing my postdoctoral period at MSRI, I visited her in Canada to complete our project.

Having a postdoctoral fellowship at MSRI helped me to establish new contacts with the mathematicians from different countries. This is very important for young mathematicians, because it leads to future collaborations. I have been accepted for a postdoctoral fellowship in IPM which is very competitive among Iranian young mathematicians. I believe that having the experience of MSRI PD was extremely effective in getting such offer.

Complementary Program 2016-17

Program Summary

Role	# of Distinct Members	%	# of Citizens & Perm. Res.	%	# of Female	%	# of Minorities[1]	%
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	1	7.7%	0	0.0%	1	100.0%	0	0.0%
PD/RM	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Research Members	12	92.3%	5	41.7%	3	25.0%	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	**13**		**5**	***38.5%***	**4**	***30.8%***	**-**	***0.0%***

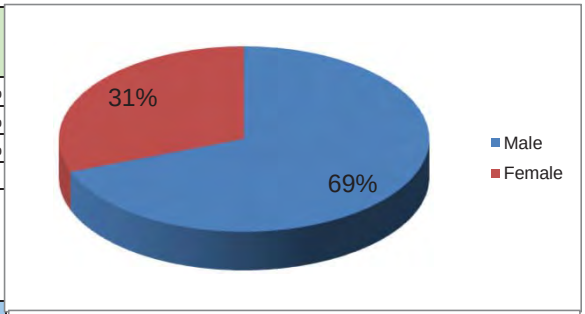
[1] *Minorities are US citizens & Permanent Residents who declare themselves American Indian, Black, or Hispanic. Minority percentage is calculated by dividing the number of Minorities by the total number of US citizens & Permanent Residents.*

Home Institution Grouping

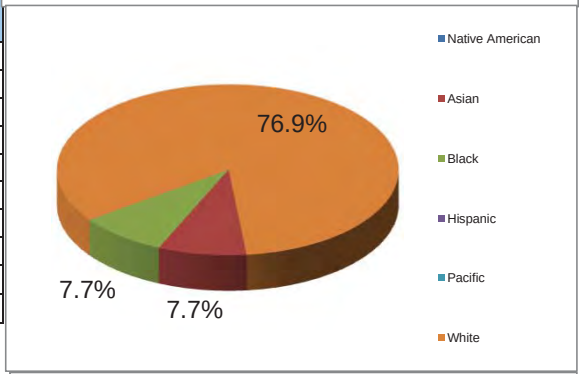
	US								
Role	**Private Large**	**Private Small**	**Public Large**	**Public Medium**	**Public Small**	**Group M or B**	**Non-Group**	**Foreign**	**Total**
Organizers	0	0	0	0	0	0	0	0	0
Research Professors	0	0	0	0	0	0	0	0	0
Postdoctoral Fellows	0	0	0	0	0	0	0	1	1
PD/RM	0	0	0	0	0	0	0	0	0
Research Members	2	0	1	0	1	0	0	8	12
Program Associates	0	0	0	0	0	0	0	0	0
Total	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**9**	**13**
%	***15.4%***	***0.0%***	***7.7%***	***0.0%***	***7.7%***	***0.0%***	***0.0%***	***69.2%***	***100.0%***

2016–17 Program Members Demographic Summary

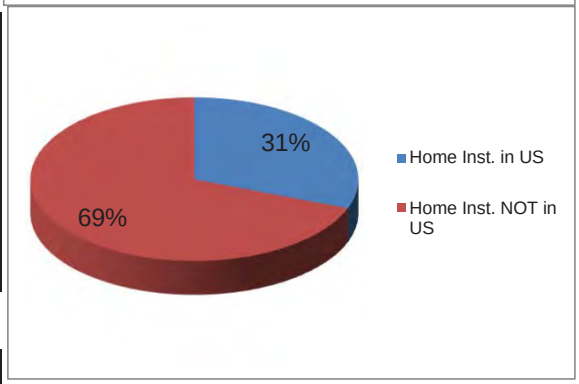
Gender	#	% (No Decl.)*	%
# of Distinct Members	13		100.0%
Male	9	69.23%	69.2%
Female	4	30.77%	30.8%
Decline to State Gender	0		



Ethnicities	#	% (No Decl.)*	%
Native American	0	0.00%	0.0%
Asian	1	8.33%	7.7%
Black	1	8.33%	7.7%
Hispanic	0	0.00%	0.0%
Pacific	0	0.00%	0.0%
White	10	83.33%	76.9%
Decline to State Ethnicities	1		7.7%
Unavailable Information	0		0.0%
Minorities	0		0.0%

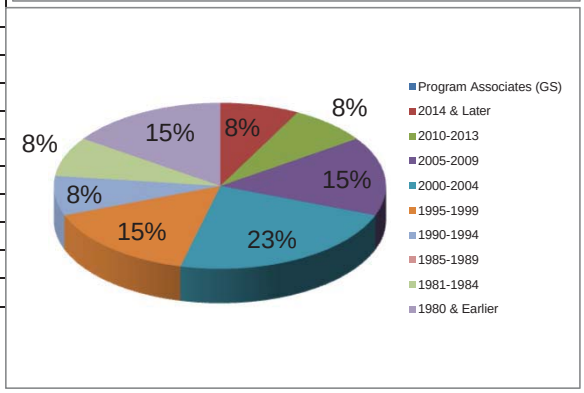


Citizenships	#		%
US Citizen & Perm. Residents	5		38.5%
Foreign	8		61.5%
Unavailable information	0		
# of Distinct Members	13		100.0%
US Citizen	2		15.4%
Perm Residents	3		23.1%
Home Inst. in US	4		30.77%



Year of Ph.D	#		%
Program Associates (GS)	0		0.0%
2014 & Later	1		7.7%
2010-2013	1		7.7%
2005-2009	2		15.4%
2000-2004	3		23.1%
1995-1999	2		15.4%
1990-1994	1		7.7%
1985-1989	0		0.0%
1981-1984	1		7.7%
1980 & Earlier	2		15.4%
Total # of Distinct Members	13		100.0%

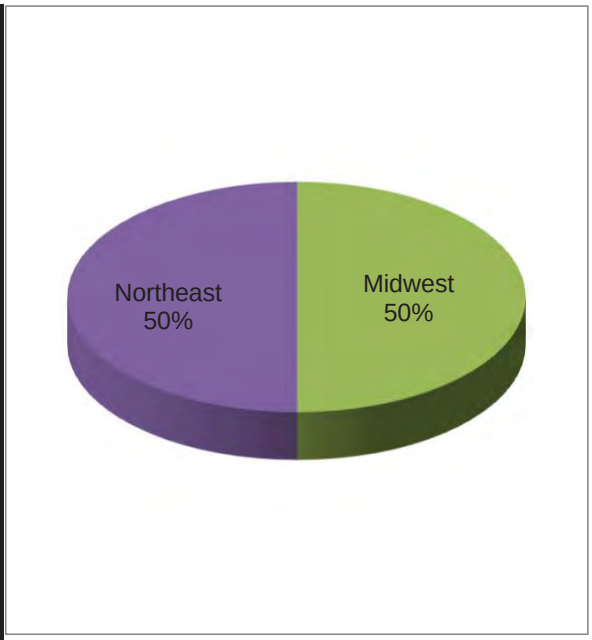
**Statistic Calculation based on all participants that did not decline.*



2016–17 Program Members Home Institution Classified by States

**Regions based on US Census classification*

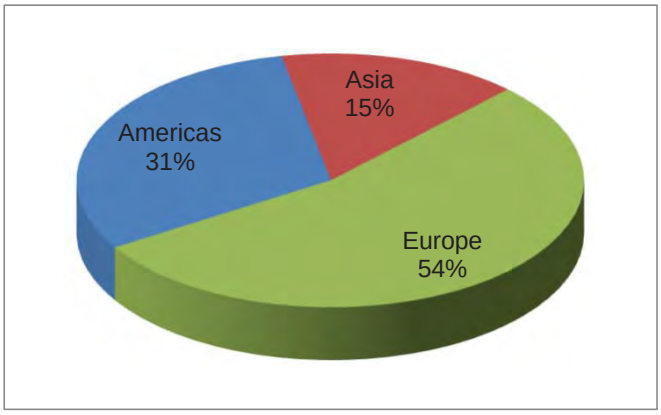
State	#	%	2010 Census Population
South	**-**	**0.0%**	**37.1%**
AL	-	0.0%	1.5%
AR	-	0.0%	0.9%
DE	-	0.0%	0.3%
DC	-	0.0%	0.2%
FL	-	0.0%	6.1%
GA	-	0.0%	3.1%
KY	-	0.0%	1.4%
LA	-	0.0%	1.5%
MD	-	0.0%	1.9%
MS	-	0.0%	1.0%
NC	-	0.0%	3.1%
OK	-	0.0%	1.2%
SC	-	0.0%	1.5%
TN	-	0.0%	2.1%
TX	-	0.0%	8.1%
VA	-	0.0%	2.6%
WV	-	0.0%	0.6%
West	**-**	**0.0%**	**23.3%**
AK	-	0.0%	0.2%
AZ	-	0.0%	2.1%
HI	-	0.0%	0.4%
ID	-	0.0%	0.5%
MT	-	0.0%	0.3%
CA	-	0.0%	12.1%
CO	-	0.0%	1.6%
NV	-	0.0%	0.9%
NM	-	0.0%	0.7%
OR	-	0.0%	1.2%
UT	-	0.0%	0.9%
WA	-	0.0%	2.2%
WY	-	0.0%	0.2%
Midwest	**2**	**50.0%**	**21.7%**
IL	-	0.0%	4.2%
IN	1	25.0%	2.1%
IA	-	0.0%	1.0%
KS	-	0.0%	0.9%
MI	-	0.0%	3.2%
MN	-	0.0%	1.7%
MO	-	0.0%	1.9%
ND	-	0.0%	0.2%
NE	-	0.0%	0.6%
OH	-	0.0%	3.7%
SD	-	0.0%	0.3%
WI	1	25.0%	1.8%
Northeast	**2**	**50.0%**	**17.9%**
CT	-	0.0%	1.2%
ME	-	0.0%	0.4%
MA	2	50.0%	2.1%
NH	-	0.0%	0.4%
NJ	-	0.0%	2.8%
NY	-	0.0%	6.3%
PA	-	0.0%	4.1%
RI	-	0.0%	0.3%
VT	-	0.0%	0.2%
Other	**-**	**0.0%**	**0%**
PR	-	0.0%	0%
Other	-	0.0%	0%
Total	**4**	**100%**	**100%**



2016–17 Program Members Home Institution Classified by Countries

**Regions based on United Nations classification*

Americas			**4**
	North America	United States	4
Asia			**2**
	Southern Asia	Iran	1
	Western Asia	United Arab Emirates	1
Europe			**7**
	Northern Europe	United Kingdom	3
	Western Europe	Belgium	1
		France	3
Oceania			**0**
Grand Total			**13**



Complementary Program

August 15, 2016 - July 31, 2017

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	9	100%
No	0	0%
Total Responses	9	

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

Yes	8	89%
No	1	11%
Total Responses	9	

Q3. I initiated research with new collaborators

Yes	5	56%
No	4	44%
Total Responses	9	

Q4. I initiated research in new areas

Yes	4	44%
No	5	56%
Total Responses	9	

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

MSRI Experience - Postdoc Seminar

Q7. To learn new ideas and techniques

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

Q8. To form new acquaintances and collaborations

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

Q9. To be able to present my own work

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%

MSRI Experience - Program Seminars

Q10. To learn new ideas and techniques

1 - Least Satisfying	0	0%
2	0	0%
3	1	25%
4	1	25%
5 - Most Satisfying	2	50%
Total Responses (Exclusive of N/A)	4	100%

Q11. To form new acquaintances and collaborations

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	25%
5 - Most Satisfying	3	75%
Total Responses (Exclusive of N/A)	4	100%

Q12. To be able to present my own work

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

MSRI Experience - General Information

Q13. My office accomodations were

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	2	22%
5 - Most Satisfying	7	78%
Total Responses (Exclusive of N/A)	9	100%

Q14. Professionally, my overall satisfation with MSRI was

1 - Least Satisfying	0	0%
2	0	0%
3	1	11%
4	1	11%
5 - Most Satisfying	7	78%
Total Responses (Exclusive of N/A)	9	100%

MSRI Experience - Feedback

Q15. 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

Q16. What aspects of the program, environment, facilities, and relationships with colleagues were most beneficial to you?

Link to Qualitative Responses

Q17. What suggestions would you have for improvements at MSRI?

Link to Qualitative Responses

Q18. What suggestions would you have for future MSRI programs or workshops?

Link to Qualitative Responses

MSRI Experience - Computing Services and Facilities

Q19. 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	14%
5 - Most Satisfying	6	86%
Total Responses (Exclusive of N/A)	7	100%

Q20. How would you rate the computing equipment you used at MSRI:

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%

Q21. How could we improve our computing services?

Link to Qualitative Responses

Q22. How could we improve our computing equipment and software environment?

Link to Qualitative Responses

MSRI Experience - Relocation Advisory Services

Q23. How would you rate the following relocation advisory services you received while at MSRI: Housing

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

Q24. How would you rate the following relocation advisory services you received while at MSRI: School and Childcare

1 - Least Satisfying	0	0%
2	1	25%
3	0	0%
4	1	25%
5 - Most Satisfying	2	50%
Total Responses (Exclusive of N/A)	4	100%

Q25. How would you rate the following relocation advisory services you received while at MSRI: Visa

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%

Q26. How could we improve our relocation advisory services?

Link to Qualitative Responses

MSRI Experience - Administrative Support Services

Q27. How would you rate the administrative support you received while at MSRI

1 - Least Satisfying	0	0%
2	0	0%
3	0	0%
4	1	13%
5 - Most Satisfying	7	88%
Total Responses (Exclusive of N/A)	8	100%

Q28. How could we improve our administrative services?

Link to Qualitative Responses

Q29. Your comments about MSRI:

Link to Qualitative Responses

Connections for Women: Geometric Group Theory

August 17, 2016 - August 19, 2016

MSRI, Berkeley, CA, USA

Organizers:

Ruth Charney (Brandeis University)

Indira Chatterji (Université Nice Sophia-Antipolis)

Mark Feighn (Rutgers University)

Talia Fernós (University of North Carolina)

REPORT ON THE MSRI WORKSHOP "CONNECTIONS FOR WOMEN: GEOMETRIC GROUP THEORY" AUGUST 17 – 19, 2016

Organizers

- Ruth Charney (Brandeis University)
- Indira Chatterji (Université Nice Sophia-Antipolis)
- Mark Feighn (Rutgers University)
- Talia Fernós (University of North Carolina)

Scientific Description

The field of geometric group theory emerged from Gromov's insight that even mathematical objects such as groups, which are defined completely in algebraic terms, can be profitably viewed as geometric objects and studied with geometric techniques. Contemporary geometric group theory has broadened its scope considerably, but retains this basic philosophy of reformulating in geometric terms problems from diverse areas of mathematics and then solving them with a variety of tools. The growing list of areas where this general approach has been successful includes low-dimensional topology, the theory of manifolds, algebraic topology, complex dynamics, combinatorial group theory, algebra, logic, the study of various classical families of groups, Riemannian geometry and representation theory.

The goals of the MSRI semester-long *Geometric Group Theory* program are to bring together people from the various branches of the field in order to consolidate recent progress, chart new directions, and train the next generation of geometric group theorists.

The three-day *Connections for Women* workshop featured talks by six prominent female mathematicians on a wide range of topics in geometric group theory. Each speaker gave two lectures, separated by a breakout session during which participants met in small groups to discuss ideas presented in the first lecture. On the second afternoon, there was a panel discussion entitled Building and Sustaining Momentum. A list of speakers and the schedule is attached. The workshop was open to all mathematicians.

Highlights of the Workshop

The discussion sessions between lectures were particularly effective. Participants broke up into groups of about 5 and senior people were advised to disperse themselves among the groups. Participants reported two important consequences. On the one hand, the discussions allowed them to clarify any questions that arose during the first lecture and to quickly gain a deeper understanding of the topic. On the other hand, the small groups provided an interesting way for people to get to know each other in a close, relaxed environment. It also provided junior participants a chance to work together with more senior participants to understand topics in which neither were experts. Comments from the surveys about the breakout sessions include:

I really enjoy the structure of the schedule : talk-discussion-talk. It was enormously helpful to understand the first part and be ready for the second.

I really enjoyed the discussion sessions between the lectures. They provided an excellent environment to clear up questions and solidify understanding.

Another highlight of the workshop was the panel discussion on Building and Sustaining Momentum. Five women at various career stages described challenges they had faced during their career due to lack of encouragement or lack of confidence. They talked about how these issues can affect career development and offered positive suggestions on how to deal with such challenges. A lively discussion followed with many questions and personal stories.

Overall, the feedback on the workshop was very positive:

The set up for the workshop (including discussions) was awesome!

Wonderful experience, amazing and helpful staff! I had great discussions and made great connections. Looking forward to the next!

Connections for Women:
Geometric Group Theory

August 17-19, 2016

Schedule

Wendnesday, August 17, 2016			
9:00AM - 9:10AM	Simons Auditorium		Welcome
9:10AM - 10:10AM	Simons Auditorium	Tullia Dymarz	Quasi-isometric rigidity
10:10AM - 10:30AM	Atrium		Break
10:30AM - 11:20PM	Simons Auditorium		Discussion Groups
11:30AM - 12:30PM	Simons Auditorium	Tullia Dymarz	Quasi-isometric rigidity
12:30PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Kim Ruane	Visual and Tits Boundaries of CAT(0) spaces
3:00PM - 3:15PM	Atrium		Tea Break
3:15PM - 4:05PM	Simons Auditorium		Discussion Groups
4:15PM - 5:15PM	Simons Auditorium	Kim Ruane	Visual and Tits Boundaries of CAT(0) spaces

Thursday, August 18, 2016			
9:00AM - 10:00AM	Simons Auditorium	Talia Fernós	CAT(0) Cube Complexes and Low Dimensional Cohomology
10:10AM - 10:30AM	Atrium		Break
10:30AM - 11:20AM	Simons Auditorium		Discussion Groups
11:20AM - 12:10PM	Simons Auditorium	Talia Fernós	CAT(0) Cube Complexes and Low Dimensional Cohomology
12:10PM - 1:20PM	Atrium		Lunch
1:20PM - 2:20PM	Simons Auditorium	Kate Juschenko	Sofic groups - an introduction
2:30PM - 3:20PM	Simons Auditorium		Discussion Groups
3:30PM - 4:30PM	Simons Auditorium	Kate Juschenko	Sofic groups - an introduction
4:30PM - 4:45PM	Atrium		Tea
4:45PM - 6:15PM	Simons Auditorium		Panel Discussion
7:00PM - 8:15PM	MSRI		Dinner at Taste of Himlayas

Friday, August 19, 2016			
9:10AM - 10:10AM	Simons Auditorium	Moon Duchin	Growth of groups
10:10AM - 10:30AM	Atrium		Break
10:30AM - 11:20PM	Simons Auditorium		Discussion Groups
11:30PM - 12:30PM	Simons Auditorium	Moon Duchin	Growth of groups
12:30PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Yael Algom-Kfir	Fiberations of free-by-cyclic groups
3:00PM - 3:15PM	Atrium		Tea
3:15PM - 4:05PM	Simons Auditorium		Discussion Groups
4:15PM - 5:05PM	Simons Auditorium	Yael Algom-Kfir	Fiberations of free-by-cyclic groups

Organizers		
First Name	**Last Name**	**Institution**
Ruth	Charney	Brandeis University
Indira	Chatterji	Université Nice Sophia-Antipolis
Mark	Feighn	Rutgers University
Talia	Fernós	University of North Carolina
Speakers		
First Name	**Last Name**	**Institution**
Yael	Algom-Kfir	University of Haifa
Moon	Duchin	Tufts University
Tullia	Dymarz	University of Wisconsin-Madison
Talia	Fernós	University of North Carolina
Kate	Juschenko	Northwestern University
Kim	Ruane	Tufts University

Participants

First Name	Last Name	Institution
Carolyn	Abbott	University of Wisconsin-Madison
Yael	Algom-Kfir	University of Haifa
Catalin	Badea	Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Calista	Bernard	Stanford University
Corey	Bregman	Rice University
Nathan	Broaddus	Ohio State University
Nic	Brody	University of California, Berkeley
Nicholas	Cahill	University of Utah
Michael	Cantrell	University of Illinois, Chicago
Yu-Chan	Chang	Louisiana State University
Ruth	Charney	Brandeis University
Indira	Chatterji	Université Nice Sophia-Antipolis
Sangbum	Cho	Hanyang University
Michelle	Chu	University of Texas
Thierry	Coulbois	Université d'Aix-Marseille (AMU)
Rémi	Coulon	Université de Rennes I
François	Dahmani	Université de Grenoble I (Joseph Fourier)
Pallavi	Dani	Louisiana State University
Angelica	Deibel	Brandeis University
Coleman	Dobson	California State University
Spencer	Dowdall	Vanderbilt University
Cornelia	Drutu	University of Oxford
Moon	Duchin	Tufts University
Thibaut	Dumont	University of Utah
Tullia	Dymarz	University of Wisconsin-Madison
James	Farre	University of Utah
Mark	Feighn	Rutgers University
Talia	Fernós	University of North Carolina
Elizabeth	Field	University of Illinois at Urbana-Champaign
Elia	Fioravanti	University of Oxford
Neil	Fullarton	Rice University
Giles	Gardam	University of Oxford
Ilya	Gekhtman	Rheinische Friedrich-Wilhelms-Universität Bonn
Funda	Gultepe	University of Illinois at Urbana-Champaign
Emily	Gunawan	University of Minnesota, Twin Cities
Neha	Gupta	University of Illinois at Urbana-Champaign
Radhika	Gupta	University of Utah
Meggan	Hass	University of Nebraska
Arnaud	Hilion	Université d'Aix-Marseille (AMU)
Meng-Che	Ho	University of Wisconsin-Madison
Camille	Horbez	Université de Paris XI
Francesca	Iezzi	University of Warwick
Alessandra	Iozzi	ETH Zürich
Kasia	Jankiewicz	McGill University
Peihong	Jiang	Brown University
Premalatha	Junius	West Chester University
Kate	Juschenko	Northwestern University

Participants

First Name	Last Name	Institution
Delaram	Kahrobaei	City University of New York (CUNY)
Fanny	Kassel	Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Noureen	Khan	University of North Texas
Heejoung	Kim	University of Illinois at Urbana-Champaign
Rostyslav	Kravchenko	Northwestern University
Swathi	Krishna	Indian Institute of Science Education and Research Mohali
Robert	Kropholler	University of Oxford
Giang	Le	Ohio State University
Ian	Leary	University of Southampton
Larsen	Louder	University College
Joel	Louwsma	Niagara University
Marissa	Loving	University of Illinois at Urbana-Champaign
Joseph	Maher	College of Staten Island, CUNY
Kathryn	Mann	University of California, Berkeley
Sarah	Mousley	University of Illinois at Urbana-Champaign
Cristina	Mullican	Boston College
peter	neuwirth	Willis Towers Watson
Anisah	Nu'Man	Trinity College
Priyam	Patel	University of California, Santa Barbara
Kala	Perkins	GTU, UC Berkeley
Catherine	Pfaff	University of California, Santa Barbara
Kim	Ruane	Tufts University
Jacob	Russell	City University of New York (CUNY)
Andrew	Sánchez	Tufts University
Eugenia	Sapir	University of Illinois at Urbana-Champaign
Lisa	Schneider	Susquehanna University
Kevin	Schreve	University of Michigan
Shane	Scott	Georgia Institute of Technology
Ignat	Soroko	University of Oklahoma
Karol	Strzałkowski	Polish Academy of Sciences
Hongbin	Sun	University of California, Berkeley
Markus	Szymik	Norwegian University of Science and Technology (NTNU)
Robert	Tang	University of Oklahoma
Jing	Tao	University of Oklahoma
Samuel	Taylor	Yale University
Tetsu	Toyoda	National Institute of Technology, Suzuka college
Siming	Tu	University of Chile
Caglar	Uyanik	University of Illinois at Urbana-Champaign
Federico	Vigolo	University of Oxford
Richard	Wade	University of British Columbia
Pei	Wang	Rutgers University
Derrick	Wigglesworth	University of Utah
Adva	Wolf	Stanford University
Yang	Xiao	Brown University
Robert	Young	New York University, Courant Institute
Letao	Zhang	State University of New York, Stony Brook

Officially Registered Participant Information

Participants		93

Gender		93
Male	49.46%	46
Female	50.54%	47
Declined to state	0.00%	0

Ethnicity*		106
White	68.82%	64
Asian	24.73%	23
Hispanic	5.38%	5
Pacific Islander	1.08%	1
Black	2.15%	2
Native American	0.00%	0
Mixed	6.45%	6
Declined to state	5.38%	5

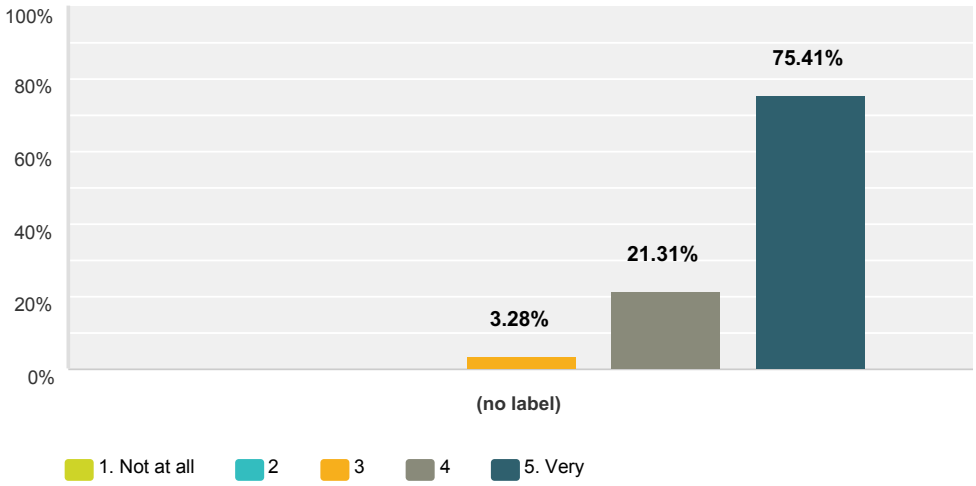
* ethnicity specifications are not exclusive

Connections for Women: Geometric Group Theory - Participant Survey

61 responses out of 93 participants = 66% response rate

Q1 The workshop was intellectually stimulating

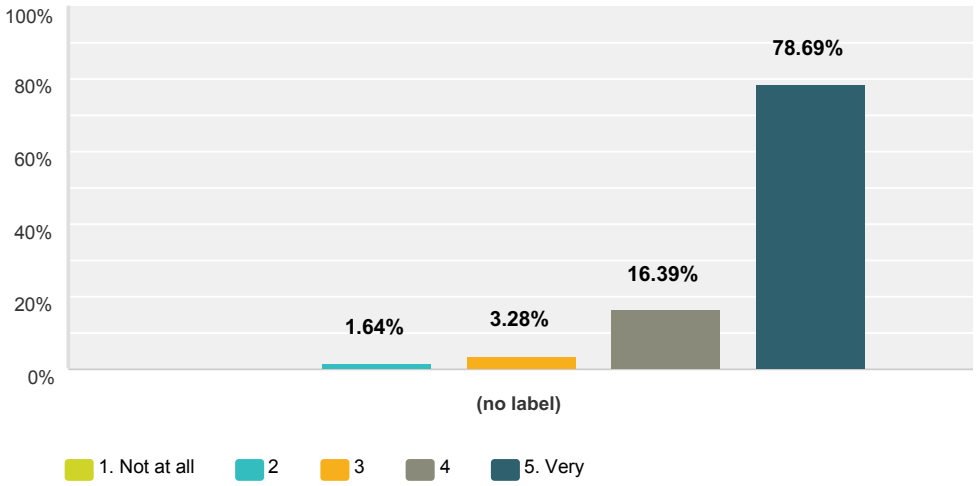
Answered: 61 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	3.28% 2	21.31% 13	75.41% 46	61	4.72

Q2 The overall experience of the workshop was worthwhile

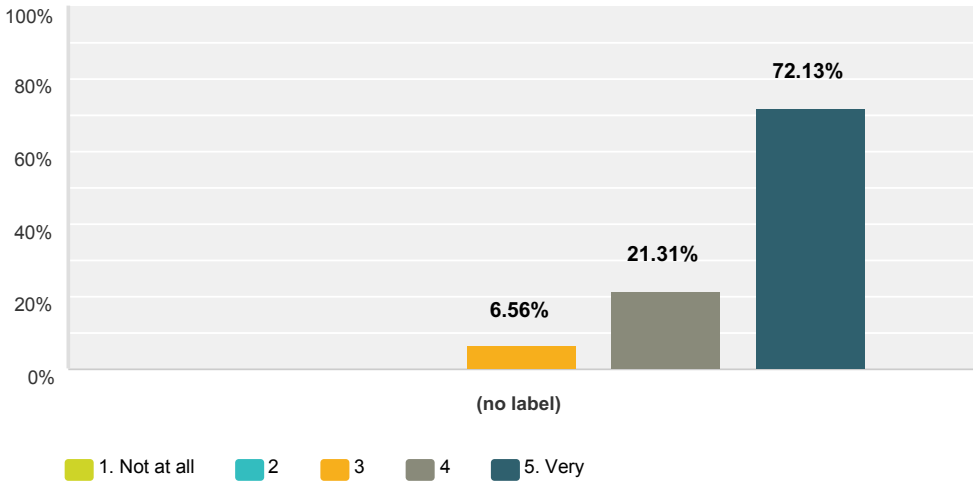
Answered: 61 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.64%** 1	**3.28%** 2	**16.39%** 10	**78.69%** 48	61	4.72

Q3 The time between lectures was adequate for discussion

Answered: 61 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**6.56%** 4	**21.31%** 13	**72.13%** 44	61	4.66

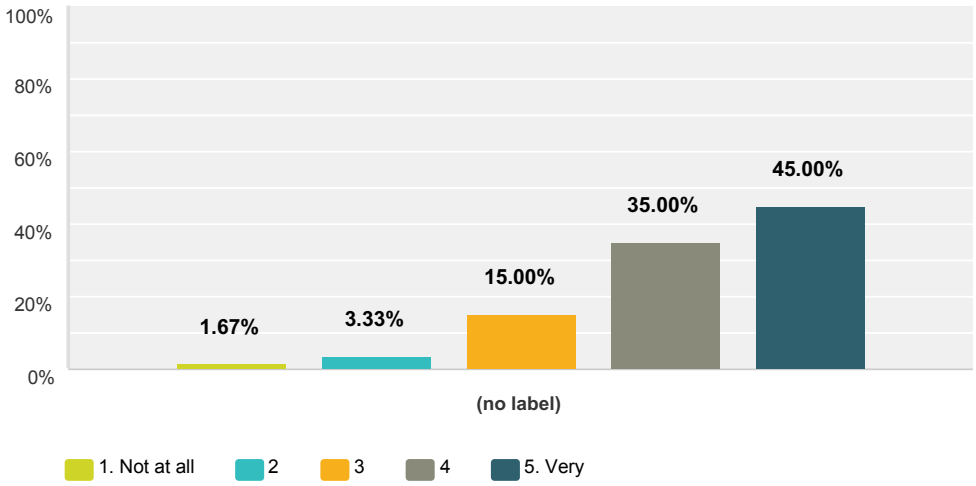
Q4 Additional comments on the workshop organization

Answered: 13 Skipped: 48

#	Responses	Date
1	Thank you!	8/27/2016 2:00 PM
2	I really enjoy the structure of the schedule : talk-discussion-talk. It was enormously helpful to understand the first part and be ready for the second.	8/26/2016 12:02 PM
3	Talks were excellent! I have recommended the recordings to many people	8/26/2016 11:57 AM
4	Discussion sections were a great idea!	8/24/2016 8:52 PM
5	The set up for the workshop (including discussions) was awesome!	8/20/2016 10:36 AM
6	I really enjoyed the discussion sessions between the lectures. They provided an excellent environment to clear up questions and solidify understanding.	8/20/2016 9:45 AM
7	A bit confusing schedule	8/20/2016 8:02 AM
8	I liked the scheduled discussion periods.	8/20/2016 7:23 AM
9	Discussion sections were excellent. Encouraging more movement and discussion among groups would be appreciated. One section, Moon interacted with many groups and got discussion moving. So, more facilitators like that would be a contribution.	8/19/2016 9:59 PM
10	Thank you!	8/19/2016 9:56 PM
11	I really enjoyed this workshop. And lectures and the discussion were helpful and great. Thank you.	8/19/2016 6:16 PM
12	I really enjoyed the conference and think the organizers did a great job picking speakers. The speakers did a good job with their respective lectures and were very accessible during the discussion session. I additionally liked how organizers also chipped in to help during the discussion session. Lastly, I found the panel helpful in navigating grad school/postdoc/tenure track positions while dealing with confidence issues and the imposter syndrome. The panelist provided practical techniques to deal with these issues. I look forward to the next conference.	8/19/2016 6:13 PM
13	The discussion sessions were great	8/19/2016 6:04 PM

Q5 I was well prepared to benefit from the lectures

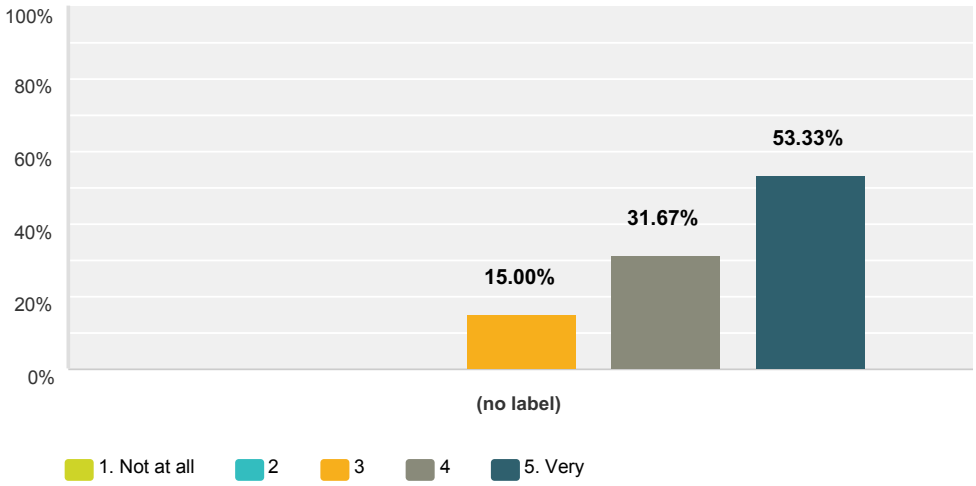
Answered: 60 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	1.67% 1	3.33% 2	15.00% 9	35.00% 21	45.00% 27	60	4.18

Q6 My interest in the subject matter was increased by the workshop

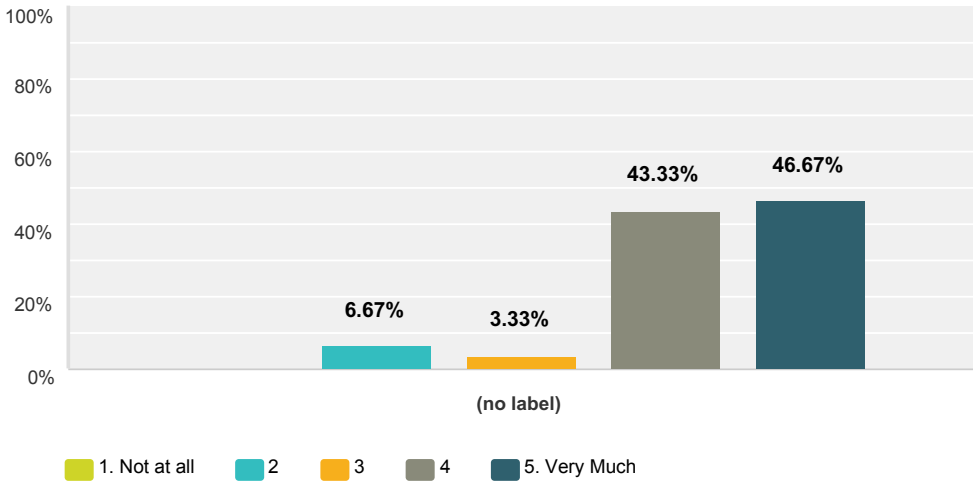
Answered: 60 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**15.00%** 9	**31.67%** 19	**53.33%** 32	60	4.38

Q7 The workshop helped me meet people with similar scientific interests

Answered: 60 Skipped: 1



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**6.67%** 4	**3.33%** 2	**43.33%** 26	**46.67%** 28	60	4.30

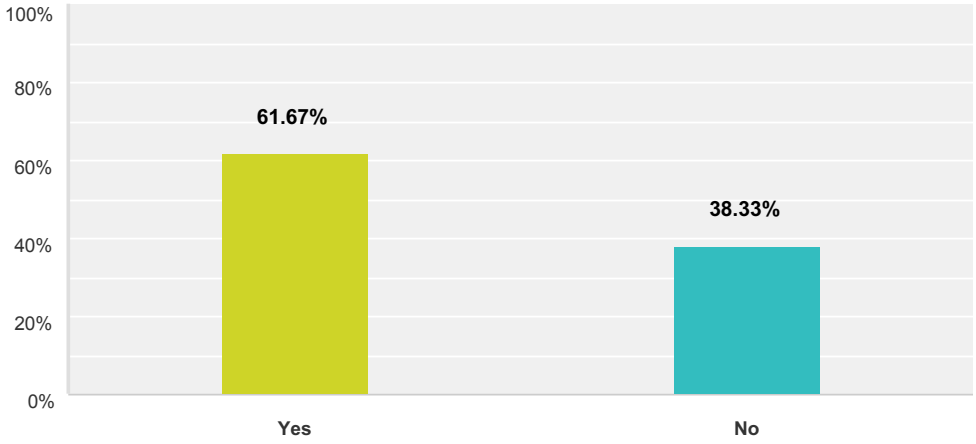
Q8 Additional comments on your personal assessment

Answered: 2 Skipped: 59

#	Responses	Date
1	Contact information of all participants will be very useful.	8/19/2016 6:14 PM
2	I am here for the whole program. I was unsure whether to go to this meeting, but I went to the first two of three days and benefitted greatly. I would have liked to go to the whole thing, but with another meeting next week I needed some time out to do other things.	8/19/2016 5:02 PM

Q9 Did you attend the panel discussions?

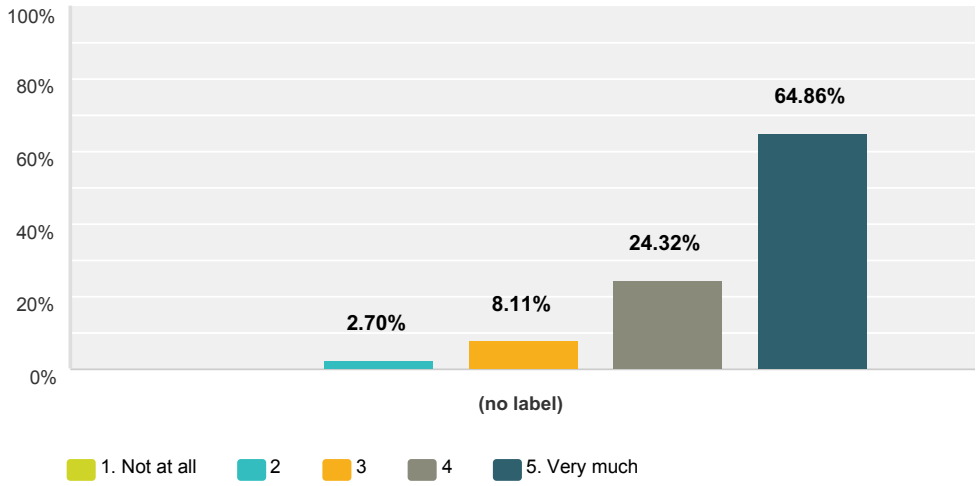
Answered: 60 Skipped: 1



Answer Choices	Responses	
Yes	**61.67%**	37
No	**38.33%**	23
Total		**60**

Q10 Did you find the panel discussion worthwhile?

Answered: 37 Skipped: 24



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**2.70%** 1	**8.11%** 3	**24.32%** 9	**64.86%** 24	37	4.51

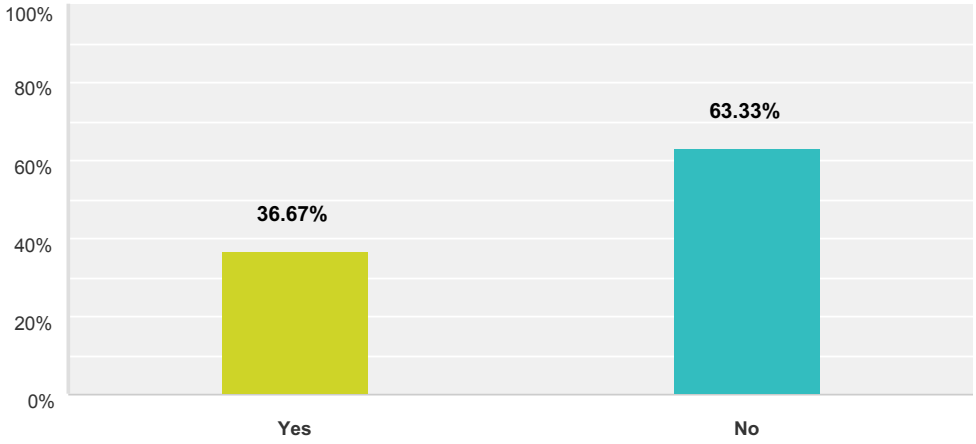
Q11 What other subjects should be discussed in future panel discussions?

Answered: 4 Skipped: 57

#	Responses	Date
1	It would be interesting to have also some men in the panel	8/20/2016 8:03 AM
2	How to stimulate minority group interests in mathematics.	8/19/2016 8:20 PM
3	Getting your dissertation published. Questions you should be asking during the early years of your tenure track (or postdoc) that you did not know you should be asking. Advice on building research collaborations Practical timeline during your tenure track position to ensure you get tenure. Have people speak from various types of institutions.	8/19/2016 6:17 PM
4	(I did not attend all of them)	8/19/2016 5:23 PM

Q12 Did you attend the dinner?

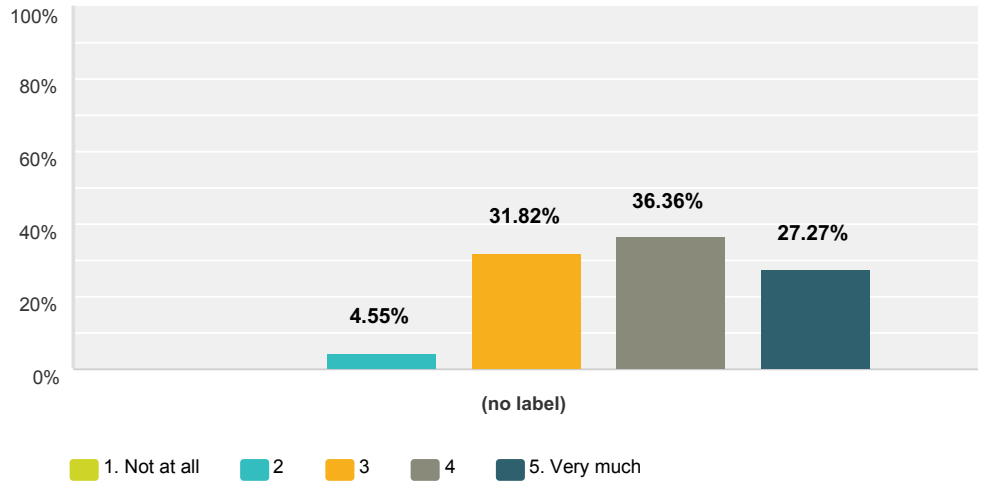
Answered: 60 Skipped: 1



Answer Choices	Responses	
Yes	36.67%	22
No	63.33%	38
Total		60

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 22 Skipped: 39



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**4.55%** 1	**31.82%** 7	**36.36%** 8	**27.27%** 6	22	3.86

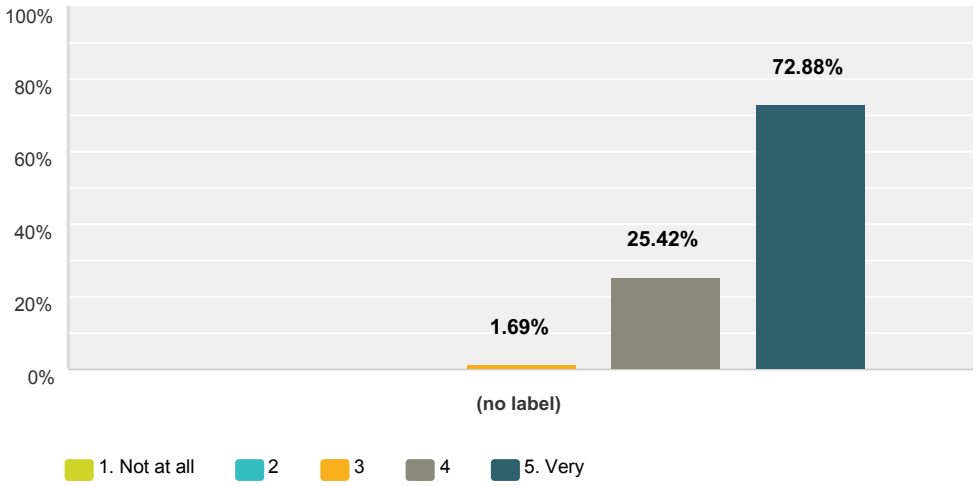
Q14 Please provide any comments about the dinner

Answered: 9 Skipped: 52

#	Responses	Date
1	I think the location was a bit too noisy and crowded for such a group gathering.	8/30/2016 3:02 PM
2	it was too crowded and loud in the restaurant. I prefer a smaller setting (smaller group at one table).	8/26/2016 12:29 PM
3	I made a very important contact during the dinner. It was fantastic!	8/21/2016 5:39 PM
4	It would have been nice if it was a buffet and we were able to move around.	8/21/2016 11:52 AM
5	Perhaps many people did not register, but it was adequate for fewer people	8/20/2016 8:04 AM
6	It was a good opportunity to get to know people both more senior and more junior than myself who I might not have met otherwise.	8/20/2016 7:24 AM
7	More tables would be great.	8/19/2016 9:58 PM
8	I think I was so shy to talk to others	8/19/2016 6:19 PM
9	The dinner was lovely but the long table was a little constraining on who we could talk to. I would have preferred an environment in which we could move around the room more.	8/19/2016 5:26 PM

Q15 I found the MSRI staff helpful

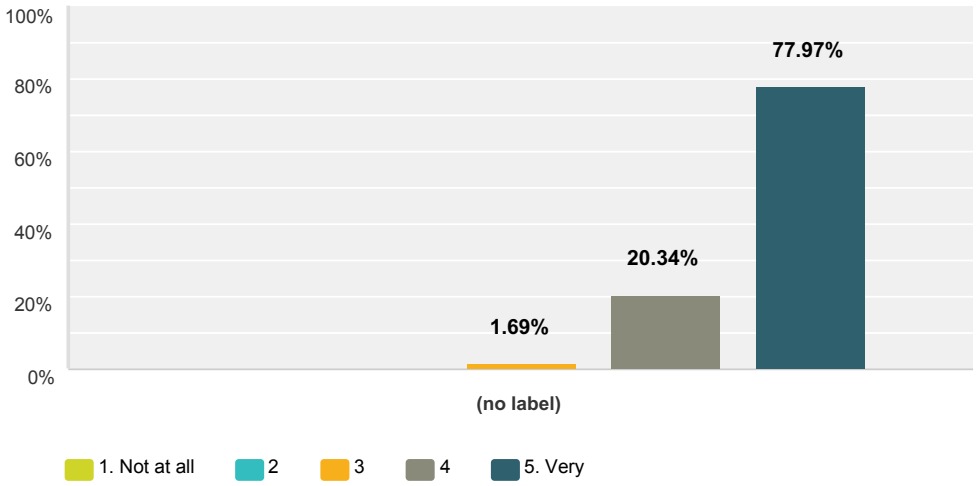
Answered: 59 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.69%** 1	**25.42%** 15	**72.88%** 43	59	4.71

Q16 The MSRI facilities were conducive for such a workshop

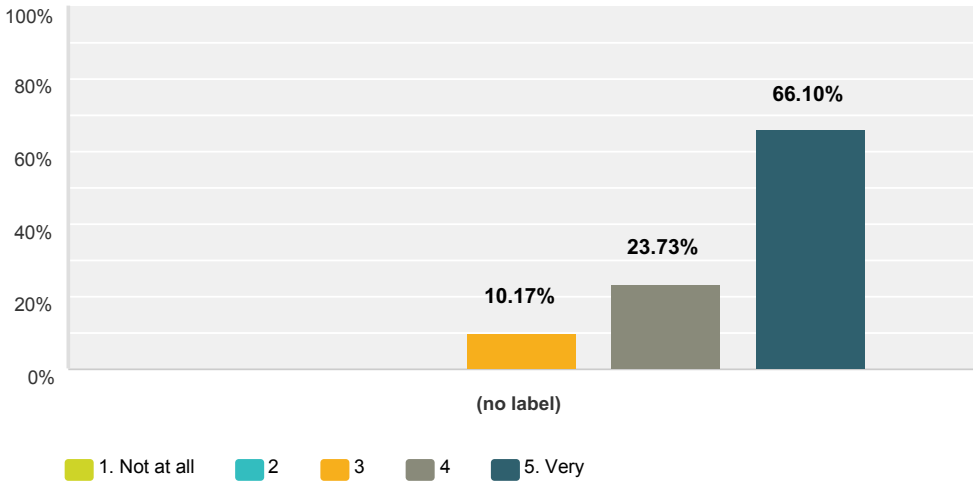
Answered: 59 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.69%** 1	**20.34%** 12	**77.97%** 46	59	4.76

Q17 The MSRI computer facilities were adequate for such a workshop

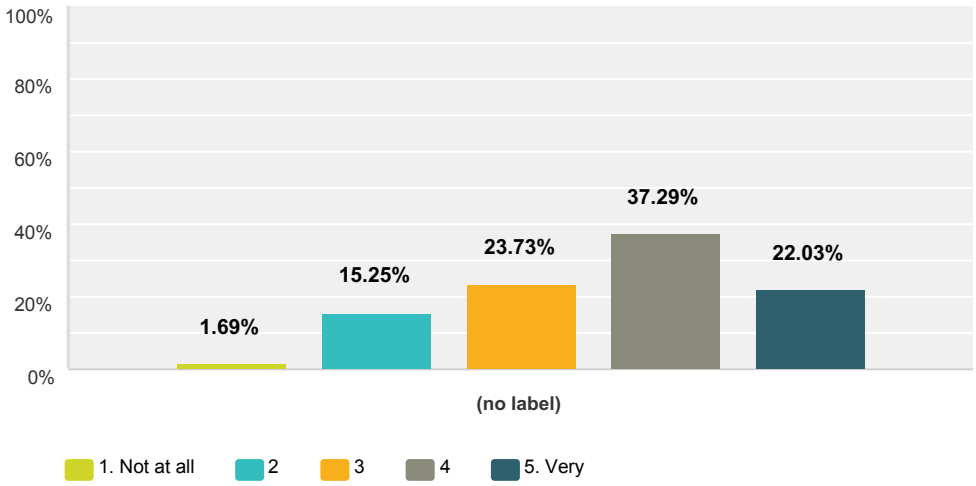
Answered: 59 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**10.17%** 6	**23.73%** 14	**66.10%** 39	59	4.56

Q18 The MSRI lunch arrangements were satisfactory

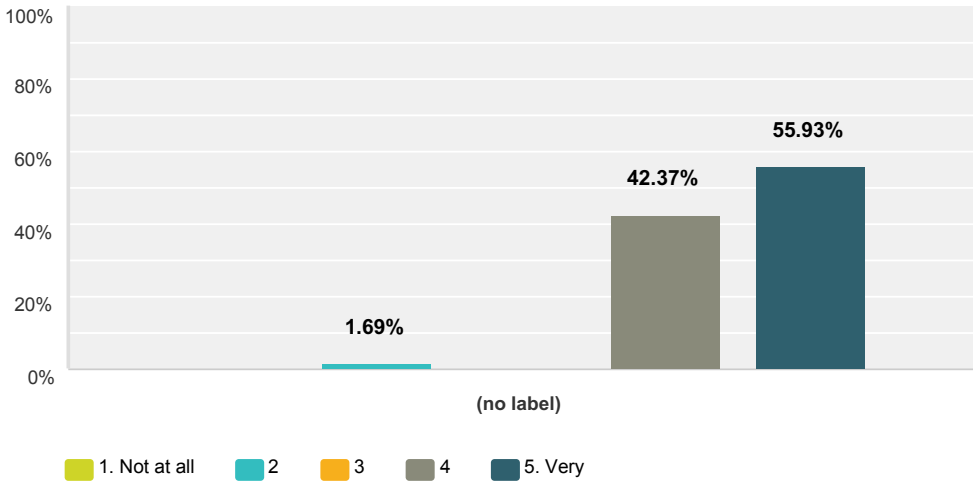
Answered: 59 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.69%** 1	**15.25%** 9	**23.73%** 14	**37.29%** 22	**22.03%** 13	59	3.63

Q19 The MSRI tea arrangements were satisfactory

Answered: 59 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.69%** 1	**0.00%** 0	**42.37%** 25	**55.93%** 33	59	4.53

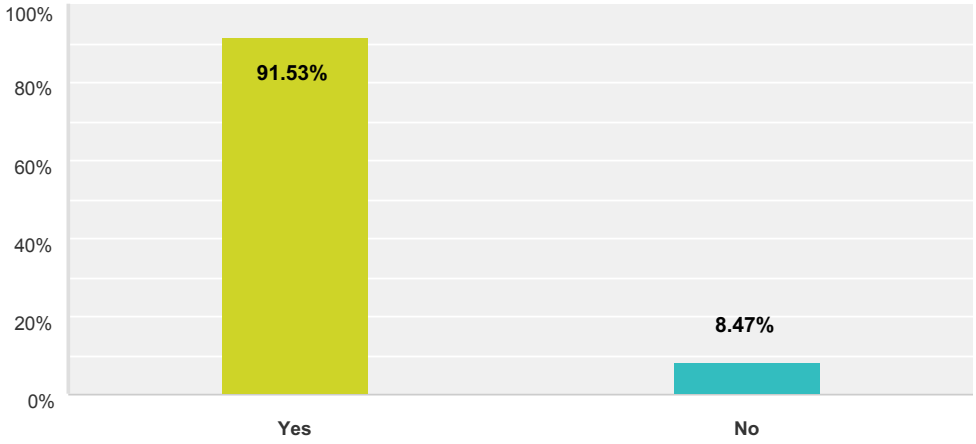
Q20 Additional comments about the venue

Answered: 8 Skipped: 53

#	Responses	Date
1	As a vegetarian, the lunch options from the vendor were limited, and were not very filling.	8/26/2016 11:23 AM
2	It would really help me to be able to drink coffee during talks. I need the caffeine.	8/22/2016 11:03 AM
3	There could be better options for the vegetarians. Also the vendor seemed under stocked.	8/21/2016 11:53 AM
4	The lunch line is long and very slow. Also most options run out before a lot of people reach the end of the line. If there was more than one person charging for food this could be better.	8/20/2016 10:39 AM
5	Lunch was overpriced and there were too few options (many things were sold out). The fruit at tea was not satisfactory.	8/19/2016 10:00 PM
6	More lunch options.	8/19/2016 10:00 PM
7	The system to pay for lunch was very slow, but the food was well worth waiting for.	8/19/2016 7:02 PM
8	Not being allowed to drink tea during lectures is hard !	8/19/2016 5:24 PM

Q21 Did you use MSRI's wireless network?

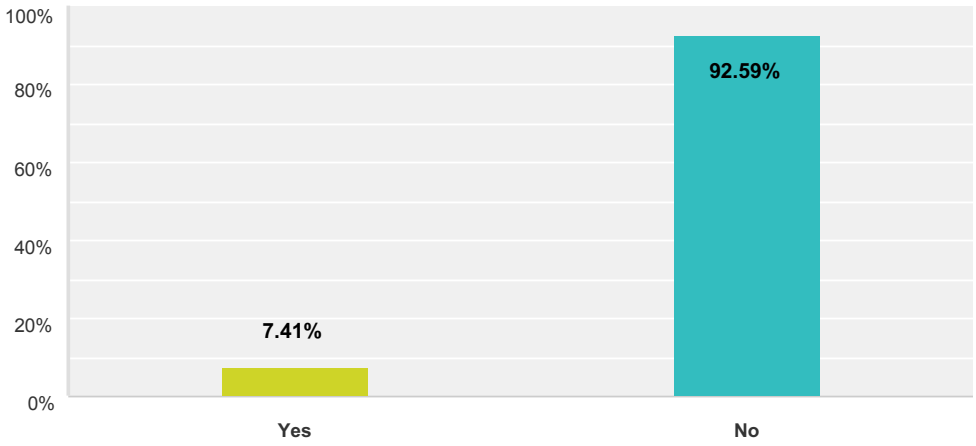
Answered: 59 Skipped: 2



Answer Choices	Responses	
Yes	**91.53%**	54
No	**8.47%**	5
Total		**59**

Q22 Did you experience any difficulties with the network?

Answered: 54 Skipped: 7



Answer Choices	Responses	
Yes	**7.41%**	4
No	**92.59%**	50
Total		**54**

#	Please if yes, please describe your difficulties	Date
1	The connection is quite slow	9/1/2016 1:29 PM
2	slow!	8/26/2016 11:16 AM
3	Poor connection in auditorium	8/22/2016 4:34 PM
4	It was not possible to access dropbox.	8/19/2016 8:21 PM

Q23 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 5 Skipped: 56

#	Responses	Date
1	It's a great workshop and I enjoyed it a lot. Thanks so much for organizing!	8/30/2016 3:03 PM
2	It is a fantastic venue with very helpful staff, thanks!	8/27/2016 2:02 PM
3	I understand and support the idea of having a moment where female participants can gather, but I wished everyone could have gone to dinner. Perhaps this could be two different event? Thanks anyway for this great workshop.	8/26/2016 12:05 PM
4	Wonderful experience, amazing and helpful staff! I had great discussions and made great connections. Looking forward to the next!	8/21/2016 11:37 PM
5	The lunch catering service on Wednesday and Friday was not great (not very good food, not many vegetarian options). Apart from this everything was fantastic!	8/19/2016 5:04 PM

Introductory Workshop: Geometric Group Theory

August 22, 2016 - August 26, 2016

MSRI, Berkeley, CA, USA

Organizers:

Martin Bridson (University of Oxford)

Benson Farb (University of Chicago)

Zlil Sela (Hebrew University)

Karen Vogtmann (University of Warwick)

A SUMMARY REPORT FOR THE INTRODUCTORY WORKSHOP 8/22-8/26.

The introductory workshop, together with the introductory Connections for Women workshop that took place the previous week, opened the Geometric Group Theory program at MSRI. It contained survey talks during the mornings on active branches of the subject, given in general by senior mathematicians, and talks on "hot" new directions and results that were presented by younger mathematicians during the afternoons.

The conference started with two talks by Mladen Bestvina and Koji Fujiwara on recent developments in the study of surface mapping class groups and outer automorphism groups of free groups. These were major focuses of activity throughout the semester. The first day continued with talks by Camille Horbez and Spencer Dowdall on their own work in these directions.

The second day opened with a talk by Ruth Charney on CAT(0) geometry and her study of the Morse boundary, and continued with Jason Manning's talk on cube complexes and the work of Ian Agol and Dani Wise on special cube complexes and the strategy of the proof of the virtual Haken conjecture. The second day continued with talks of Sam Taylor and Dennis Osin about counting problems and generalized forms of hyperbolicity. These topics were also actively pursued throughout the semester, with two of the working seminars focusing on this area.

The third day consisted only of a morning session, leaving the afternoon free for discussions and collaborations. Alan Reid talked about pro-finite classification of 3-manifold groups, and Henry Wilton talked about attempts to prove the existence of surface subgroups in various classes of hyperbolic groups.

The fourth day opened with a talk of Cornelia Drutu on amenability and somewhat more analytic directions in Geometric. Group Theory. Martin Bridson continued with a survey of classical decision problems, including what is known and what is still open. In the afternoon John McKay surveyed new results on random groups, and Fanny Kassel presented her new constructions of affine actions of right angeled Coxeter groups.

The last day opened with Kevin Wortman talking about arithmetic groups and their cohomology, and continued with a talk by Thom Church on (representation) homological stability. In the afternoon Conchita Martinez Perez talked about new theorems for Lie algebras that are analogues of similar theorems that were proven earlier for groups. Remi Coulon ended the workshop talking about his work with Vincent Guirardel on the construction of new monster groups with rather exotic properties.

The conference was well attended. The Simon lecture hall was usually packed, and the audience included not only full-term MSRI members, but also students and faculty from UC Berkeley and other universities in the area, such as Stanford and UC Davis. It also included and researchers at all levels (from graduate and postdoctoral students to senior mathematicians) who came especially for the conference, some of whom were supported by the conference funds. The organizers received many positive comments from appreciative participants, who felt they learned a lot and got a good preview of the major themes of the semester. The quality and clarity of the lectures was especially praised.

MSRI Mathematical Sciences Research Institute

Introductory Workshop: Geometric Group Theory

August 22-26, 2016

Schedule

Monday, August 22, 2016			
9:00 AM - 9:15 AM	Simons Auditorium		Welcome
9:15 AM - 10:30 AM	Simons Auditorium	Mladen Bestvina	Mapping class groups and Out(F_n)
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:30 PM	Simons Auditorium	Koji Fujiwara	Hyperbolic-like behaviour of groups
12:30 PM - 2:30 PM	Atrium		Lunch
2:30 PM - 3:20 PM	Simons Auditorium	Camille Horbez	Topological dimension of the boundaries of some hyperbolic Out(Fn)-graphs
3:20 PM - 3:50 PM	Atrium		Tea
3:50 PM - 4:40 PM	Simons Auditorium	Spencer Dowdall	Hyperbolic group extensions

Tuesday, August 23, 2016			
9:00 AM - 10:30 AM	Simons Auditorium	Ruth Charney	The geometry of CAT(0) spaces
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:30 PM	Simons Auditorium	Jason Manning	Special cube complexes and the virtual Haken conjecture
12:30 PM - 2:30 PM	Atrium		Lunch
2:30 PM - 3:20 PM	Simons Auditorium	Samuel Taylor	Counting loxodromics for hyperbolic actions
3:20 PM - 3:50 PM	Atrium		Tea
3:20 PM - 3:50 PM	Atrium		Poster Session
3:50 PM - 4:40 PM	Simons Auditorium	Denis Osin	The poset of acylindrically hyperbolic structures on a group
4:40 PM - 6:20 PM	Atrium		Reception

Wednesday, August 24, 2014			
9:00 AM - 10:30 AM	Simons Auditorium	Alan Reid	Recognizing 3-manifold groups by their finite quotients
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:30 PM	Simons Auditorium	Henry Wilton	Surface subgroups

Thursday, August 25, 2014			
9:00 AM - 10:30 AM	Simons Auditorium	Cornelia Drutu	Amenability and fixed point properties
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:30 PM	Simons Auditorium	Martin Bridson	Decision problems
12:30 PM - 1:30 PM	Atrium		Lunch
1:30 PM - 2:20 PM	Simons Auditorium	John Mackay	Random groups and large-scale geometry
2:30 PM - 3:20 PM	Simons Auditorium	Fanny Kassel	Proper affine actions of right-angled Coxeter groups
3:30 PM - 3:50 PM	Atrium		Tea

Friday, August 26, 2016			
9:00 AM - 10:30 AM	Simons Auditorium	Kevin Wortman	Arithmetic groups: geometry and cohomology
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:30 PM	Simons Auditorium	Thomas Church	Homological stability, representation stability, and FI-modules
12:30 PM - 2:30 PM	Atrium		Lunch
2:30 PM - 3:20 PM	Simons Auditorium	Conchita Martinez Perez	Extending to Lie algebras some results on subdirect products of groups
3:20 PM - 3:50 PM	Atrium		Tea
3:50 PM - 4:40 PM	Simons Auditorium	Rémi Coulon	Monster groups acting on CAT(0) spaces

Organizers		
First Name	**Last Name**	**Institution**
Martin	Bridson	University of Oxford
Benson	Farb	University of Chicago
Zlil	Sela	Hebrew University
Karen	Vogtmann	University of Warwick
Speakers		
First Name	**Last Name**	**Institution**
Mladen	Bestvina	University of Utah
Martin	Bridson	University of Oxford
Ruth	Charney	Brandeis University
Thomas	Church	Stanford University
Rémi	Coulon	Université de Rennes I
Spencer	Dowdall	Vanderbilt University
Cornelia	Drutu	University of Oxford
Koji	Fujiwara	Kyoto University
Camille	Horbez	Université de Paris XI
Fanny	Kassel	Institut des Hautes Études Scientifiques (IHES)
John	Mackay	University of Bristol
Jason	Manning	Cornell University
Conchita	Martinez Perez	Universidad de Zaragoza
Denis	Osin	Vanderbilt University
Samuel	Taylor	Yale University
Henry	Wilton	Center for Mathematical Sciences
Kevin	Wortman	University of Utah

Participants

First Name	Last Name	Institution
Carolyn	Abbott	University of Wisconsin-Madison
Victoria	Akin	University of Chicago
Yael	Algom-Kfir	University of Haifa
Javier	Almarza	New York University, Courant Institute
Hanna	Astephan	University of Utah
Catalin	Badea	Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Loretta	Bartolini	Springer
Dave	Bayer	Barnard College
Calista	Bernard	Stanford University
Mladen	Bestvina	University of Utah
Martin	Bobb	University of Texas
Benjamin	Brück	Universität Bielefeld
Corey	Bregman	Rice University
Martin	Bridson	University of Oxford
Nathan	Broaddus	Ohio State University
Nic	Brody	University of California, Berkeley
Nicholas	Cahill	University of Utah
Bugra	Can	Koç University
Michael	Cantrell	University of Illinois, Chicago
Yu-Chan	Chang	Louisiana State University
Ruth	Charney	Brandeis University
Sangbum	Cho	Hanyang University
Youngjin	Cho	Korea Advanced Institute of Science and Technology (KAIST)
Michelle	Chu	University of Texas
Woojin	Chung	Korea University
Thomas	Church	Stanford University
Thierry	Coulbois	Université d'Aix-Marseille (AMU)
Rémi	Coulon	Université de Rennes I
Ronnie	Crane	Hawaii Pacific University
François	Dahmani	Université de Grenoble I (Joseph Fourier)
Pallavi	Dani	Louisiana State University
Michael	Davis	Ohio State University
Atasi	Debray	University of Calcutta
Angelica	Deibel	Brandeis University
Spencer	Dowdall	Vanderbilt University
Cornelia	Drutu	University of Oxford
Moon	Duchin	Tufts University
Thibaut	Dumont	University of Utah
Matthew	Durham	University of Michigan
Tullia	Dymarz	University of Wisconsin-Madison
Benson	Farb	University of Chicago
James	Farre	University of Utah
Mark	Feighn	Rutgers University
Elizabeth	Field	University of Illinois at Urbana-Champaign
Elia	Fioravanti	University of Oxford
David	Fisher	Indiana University
Dominik	Francoeur	Université de Genève
Koji	Fujiwara	Kyoto University

Participants

First Name	Last Name	Institution
Neil	Fullarton	Rice University
Giles	Gardam	University of Oxford
Jonah	Gaster	Boston College
Ilya	Gekhtman	Rheinische Friedrich-Wilhelms-Universität Bonn
Funda	Gultepe	University of Illinois at Urbana-Champaign
Radhika	Gupta	University of Utah
Tobias	Hartnick	Technion---Israel Institute of Technology
Joel	Hass	University of California, Davis
Simon	Heil	Christian-Albrechts Universität Kiel
Jake	Herndon	University of Illinois, Chicago
George	Herrmann	University of Denver
Arnaud	Hilion	Université d'Aix-Marseille (AMU)
Meng-Che	Ho	University of Wisconsin-Madison
Camille	Horbez	Université de Paris XI
Zheng	Huang	CUNY, Graduate Center
David	Hume	Université de Paris XI
Francesca	Iezzi	University of Warwick
Alessandra	Iozzi	ETH Zürich
Kasia	Jankiewicz	McGill University
Seong Gu	Jeong	Korea Advanced Institute of Science and Technology (KAIST)
Peihong	Jiang	Brown University
Yasushi	Kasahara	Kochi University of Technology
Fanny	Kassel	Institut des Hautes Études Scientifiques (IHES)
Karina	Kelly	University of Nebraska
Alvin	Kerber	University of California, Berkeley
Sang-hyun	Kim	Seoul National University
Heejoung	Kim	University of Illinois at Urbana-Champaign
Jin Hong	Kim	Chosun University
Kihyoung	Ko	Korea Advanced Institute of Science and Technology (KAIST)
Swathi	Krishna	Indian Institute of Science Education and Research Mohali
Robert	Kropholler	University of Oxford
Giang	Le	MSRI - Mathematical Sciences Research Institute
Ian	Leary	University of Southampton
Yuqing	Lin	University of Texas
John	Lott	University of California, Berkeley
Larsen	Louder	University College
Joel	Louwsma	Niagara University
Marissa	Loving	University of Illinois at Urbana-Champaign
John	Mackay	University of Bristol
Joseph	Maher	College of Staten Island, CUNY
Johanna	Mangahas	University at Buffalo (SUNY)
Kathryn	Mann	University of California, Berkeley
Jason	Manning	Cornell University
Albert	Marden	University of Minnesota Twin Cities
Conchita	Martinez Perez	Universidad de Zaragoza
Anthony	Martino	University of Oklahoma
Howard	Masur	University of Chicago
Izaak	Meckler	University of California, Berkeley

Participants

First Name	Last Name	Institution
Mahan	Mj	Tata Institute of Fundamental Research
Dave	Morris	University of Lethbridge
Sarah	Mousley	University of Illinois at Urbana-Champaign
Cristina	Mullican	Boston College
Jean Pierre	Mutanguha	University of Arkansas
Margaret	Nichols	University of Chicago
Sangrok	O	Korea Advanced Institute of Science and Technology (KAIST)
Boris	Okun	University of Wisconsin
Denis	Osin	Vanderbilt University
Priyam	Patel	University of California, Santa Barbara
Catherine	Pfaff	University of California, Santa Barbara
Paul	Plummer	University of Oklahoma
Yulan	Qing	University of Toronto
Kasra	Rafi	University of Toronto
Louann	Rieger	University of Southern California
Simon	Rubinstein-Salzedo	Euler Circle
Jacob	Russell	City University of New York (CUNY)
Andrew	Sánchez	Tufts University
Eugenia	Sapir	University of Illinois at Urbana-Champaign
Kevin	Schreve	University of Michigan
Shane	Scott	Georgia Institute of Technology
Richard	Scott	Santa Clara University
Zlil	Sela	Hebrew University
John	Smillie	University of Warwick
Ignat	Soroko	University of Oklahoma
Karol	Strzałkowski	Polish Academy of Sciences
Benjamin	Stucky	University of Oklahoma
Daniel	Studenmund	University of Utah
Hongbin	Sun	University of California, Berkeley
Matt	Sunderland	CUNY, Graduate Center
Markus	Szymik	Norwegian University of Science and Technology (NTNU)
Robert	Tang	University of Oklahoma
Jing	Tao	University of Oklahoma
Samuel	Taylor	Yale University
Tetsu	Toyoda	National Institute of Technology, Suzuka college
Siming	Tu	University of Chile
Christopher	Tuffley	Massey University
Weston	Ungemach	Stanford University
Caglar	Uyanik	University of Illinois at Urbana-Champaign
Federico	Vigolo	University of Oxford
Karen	Vogtmann	University of Warwick
Richard	Wade	University of British Columbia
Pei	Wang	Rutgers University
Derrick	Wigglesworth	University of Utah
Henry	Wilton	Center for Mathematical Sciences
Adva	Wolf	Stanford University
Kevin	Wortman	University of Utah
Chenxi	Wu	Cornell University

Participants		
First Name	**Last Name**	**Institution**
Wenyuan	Yang	Peking University
Mehdi	Yazdi	Princeton University
Robert	Young	New York University, Courant Institute
Letao	Zhang	State University of New York, Stony Brook

Officially Registered Participant Information

Participants		148

Gender		148
Male	68.24%	101
Female	29.73%	44
Declined to state	2.03%	3

Ethnicity*		165
White	66.89%	99
Asian	24.32%	36
Hispanic	4.05%	6
Pacific Islander	0.68%	1
Black	1.35%	2
Native American	0.00%	0
Mixed	5.41%	8
Declined to state	8.78%	13

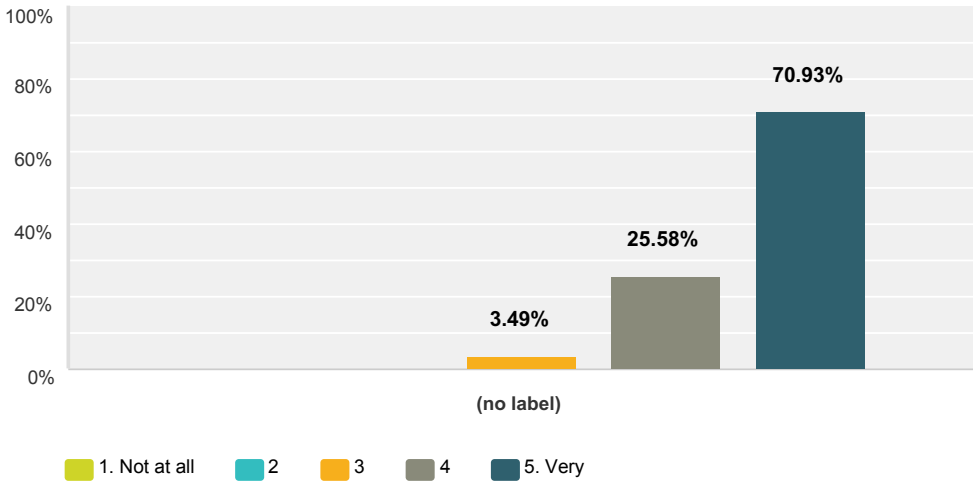
* ethnicity specifications are not exclusive

Introductory Workshop: Geometric Group Theory - Participant Survey

86 responses out of 148 participants = 59% response rate

Q1 The workshop was intellectually stimulating

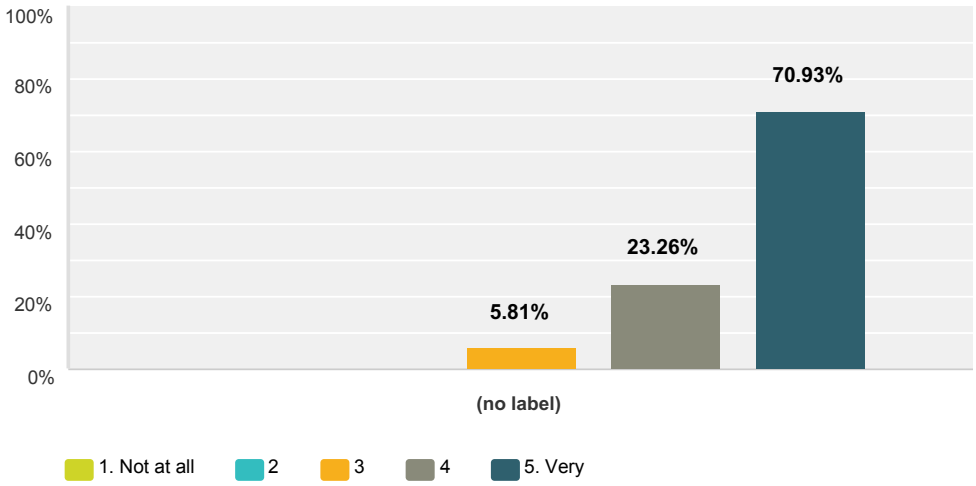
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.49%** 3	**25.58%** 22	**70.93%** 61	86	4.67

Q2 The overall experience of the workshop was worthwhile

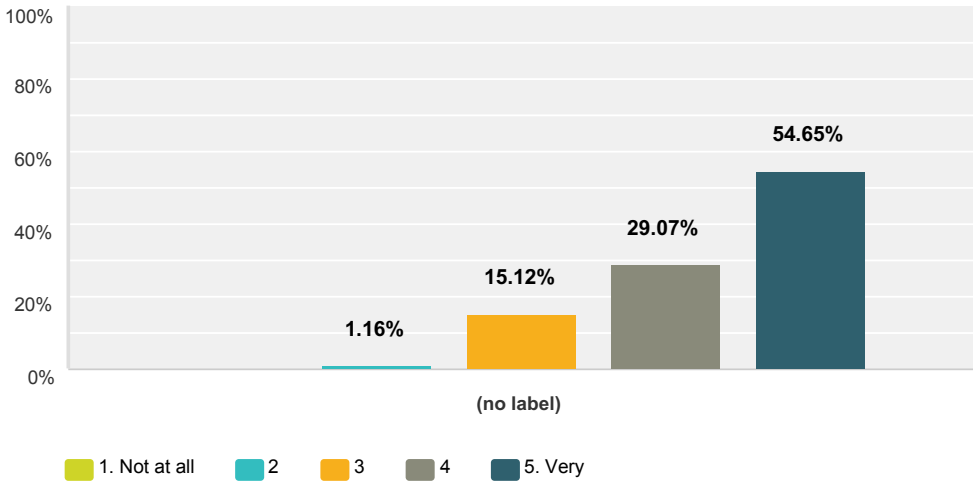
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**5.81%** 5	**23.26%** 20	**70.93%** 61	86	4.65

Q3 The time between lectures was adequate for discussion

Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.16%** 1	**15.12%** 13	**29.07%** 25	**54.65%** 47	86	4.37

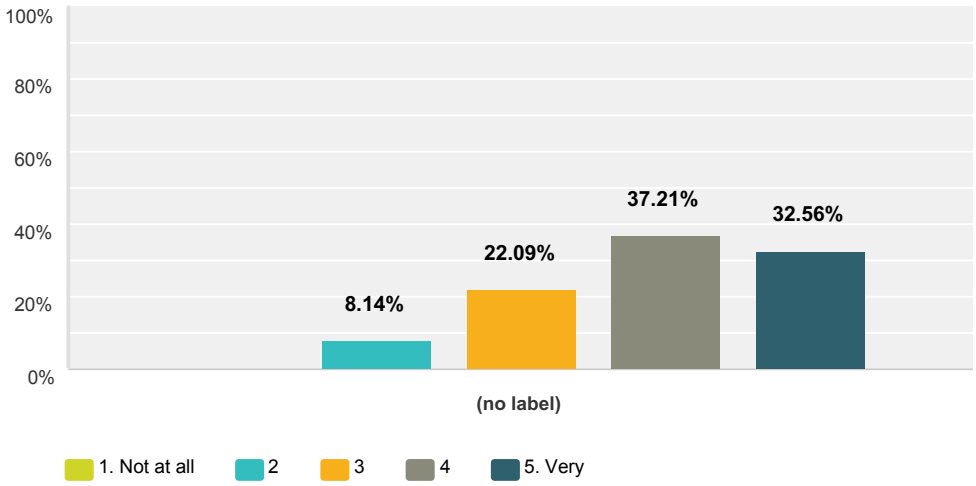
Q4 Additional comments on the workshop organization

Answered: 12 Skipped: 74

#	Responses	Date
1	New accomodation facilities on or near Berkeley campus were very convenient for me.	9/22/2016 8:09 PM
2	I thought 1 1/2 hour talks without a break was a bit much	9/7/2016 8:20 AM
3	Thanks	9/2/2016 1:10 PM
4	Not a lot of food options; also not ideal to not have coffee in the main lecture hall	9/2/2016 12:12 PM
5	The one and a half hour long talks where a bit too long in my opinion.	9/2/2016 12:07 PM
6	The morning talks were too long to keep me focused. I think splitting them into two smaller talks like the Connections for Women workshop would work better.	9/2/2016 12:07 PM
7	I again argue for being allowed to drink my tea during the lectures... The congress was very nice. I appreciated the scheduling of introductory/wide 1:30h talks	8/29/2016 9:14 AM
8	Perfect!	8/27/2016 4:30 PM
9	This being an "introductory workshop," it would have been nice if the speakers provided explicit references (eg background material, expository papers) during the talk.	8/26/2016 7:37 PM
10	It would be nice to start and end an hour later. Also, it would be better to have on 1.5 hour talk and one 50 minute talk in both the morning and afternoon, instead of both 90 minute talks in the morning	8/26/2016 6:35 PM
11	Breakfast food before first lecture	8/26/2016 4:07 PM
12	I hoped the afternoon talks were less technical. Thanks for organizing.	8/26/2016 3:56 PM

Q5 I was well prepared to benefit from the lectures

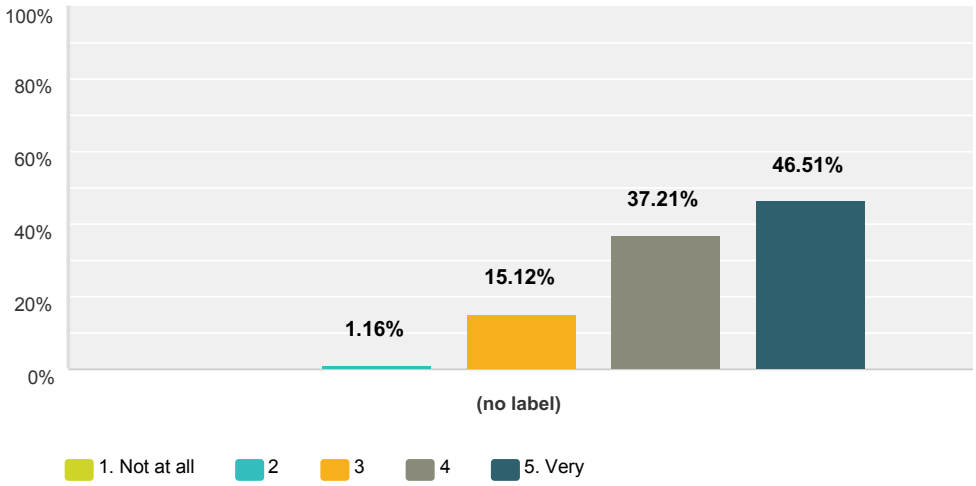
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**8.14%** 7	**22.09%** 19	**37.21%** 32	**32.56%** 28	86	3.94

Q6 My interest in the subject matter was increased by the workshop

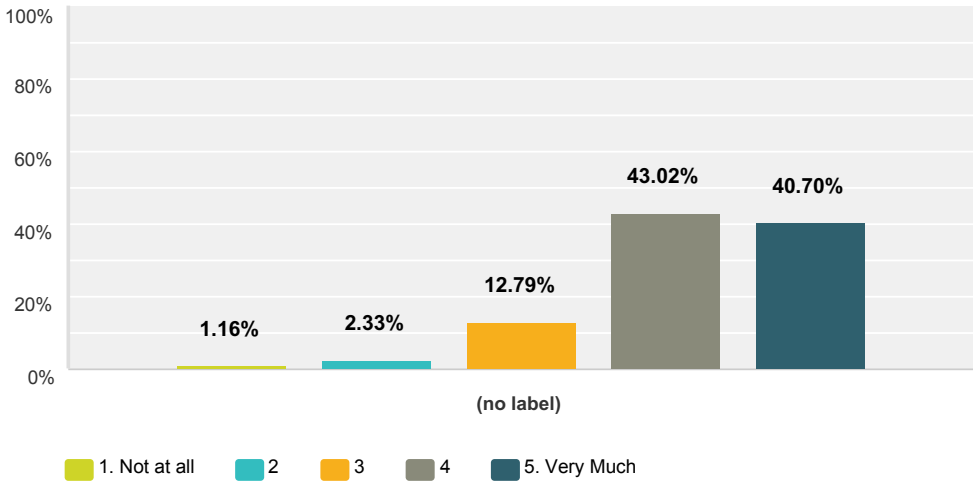
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	1.16% 1	15.12% 13	37.21% 32	46.51% 40	86	4.29

Q7 The workshop helped me meet people with similar scientific interests

Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**1.16%** 1	**2.33%** 2	**12.79%** 11	**43.02%** 37	**40.70%** 35	86	4.20

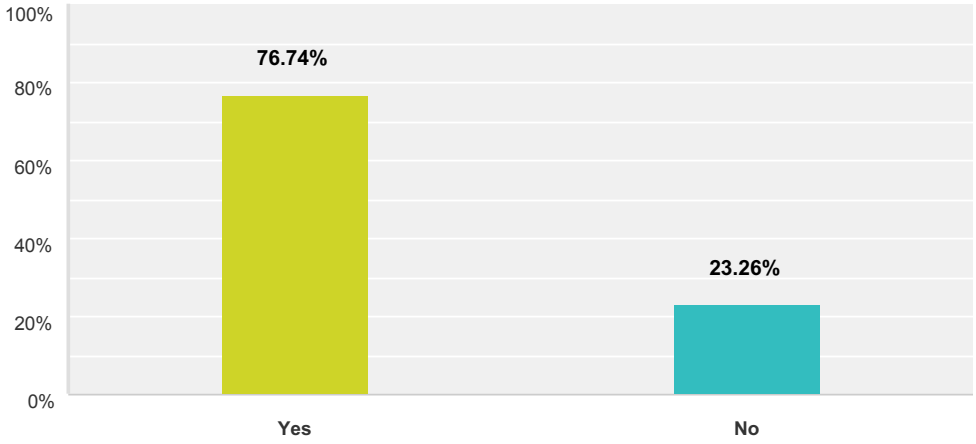
Q8 Additional comments on your personal assessment

Answered: 5 Skipped: 81

#	Responses	Date
1	It will be better to give more funding for attendants outside US, especially young graduate students.	9/22/2016 8:12 PM
2	The topic of the workshop is one that I am interested in and have had some prior exposure to (I work in topology, geometry and algebra), but is not an area I am active in. I was attracted to attend the workshop by the MSRI description that the intended audience of the introductory workshops is researchers not in the program/researchers not necessarily active in the field. I found the workshop beneficial, but not to the extent that I had hoped: some of the talks were truly introductory, while others were highly technical.	9/22/2016 2:07 PM
3	Even though I am merely an undergraduate student, talks aroused my interest about related topics and I think my gain from this workshop was extraordinary.	9/2/2016 12:17 PM
4	CAT(0) cube complexes were not so familiar to me and I learnt a lot from the week.	8/29/2016 9:15 AM
5	I was only in the atrium where there were lots of tables with at most four sits. A higher sits to tables ratio would make meeting new people easier. In most cases, 3 or 4 people already knew each other and sat together but I couldn't join them at the table.	8/26/2016 7:47 PM

Q9 Did you attend the reception?

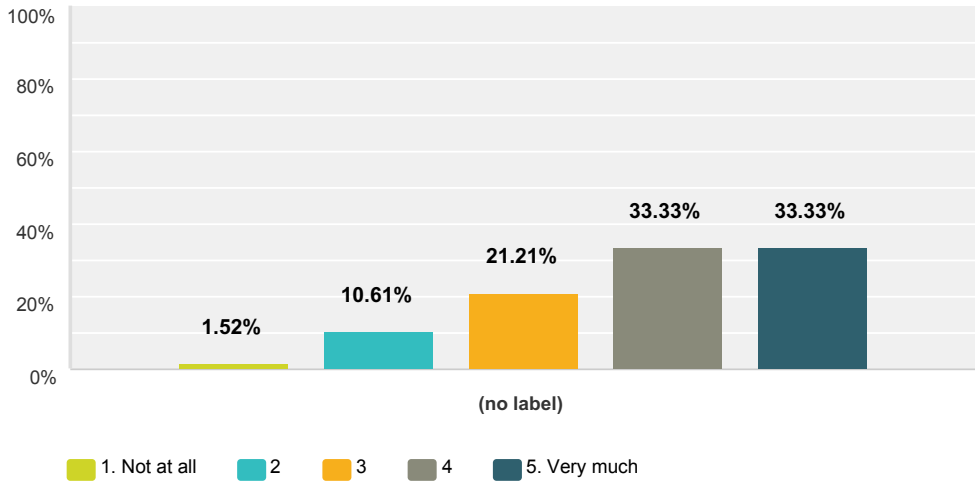
Answered: 86 Skipped: 0



Answer Choices	Responses	
Yes	**76.74%**	66
No	**23.26%**	20
Total		**86**

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 66 Skipped: 20



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**1.52%** 1	**10.61%** 7	**21.21%** 14	**33.33%** 22	**33.33%** 22	66	3.86

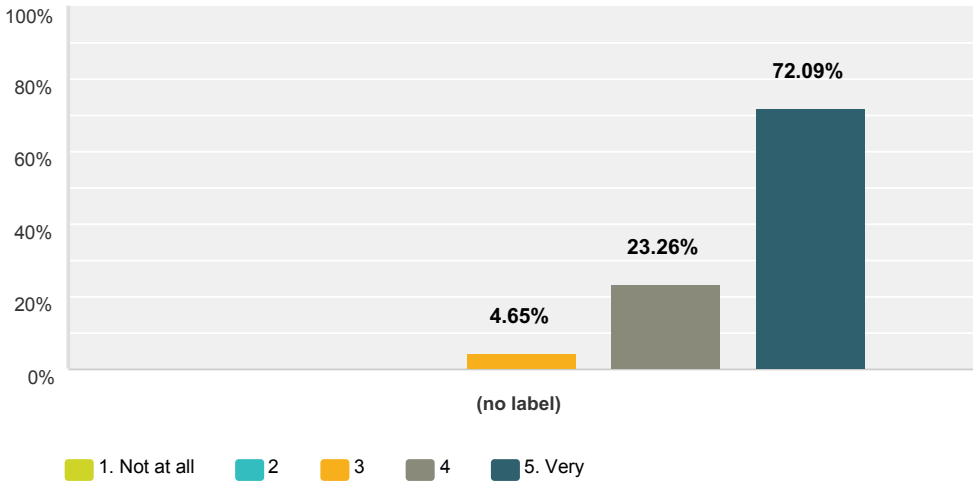
Q11 Please provide any comments about the reception

Answered: 5 Skipped: 81

#	Responses	Date
1	(I was only able to attend briefly due to another commitment)	9/22/2016 2:12 PM
2	The wine was great (as mathematicians with limited social habilities this help) :-)	8/29/2016 9:21 AM
3	The food was delicious	8/27/2016 10:09 PM
4	See previous comment.	8/26/2016 7:48 PM
5	Great food, an excellent event.	8/26/2016 5:19 PM

Q12 I found the MSRI staff helpful

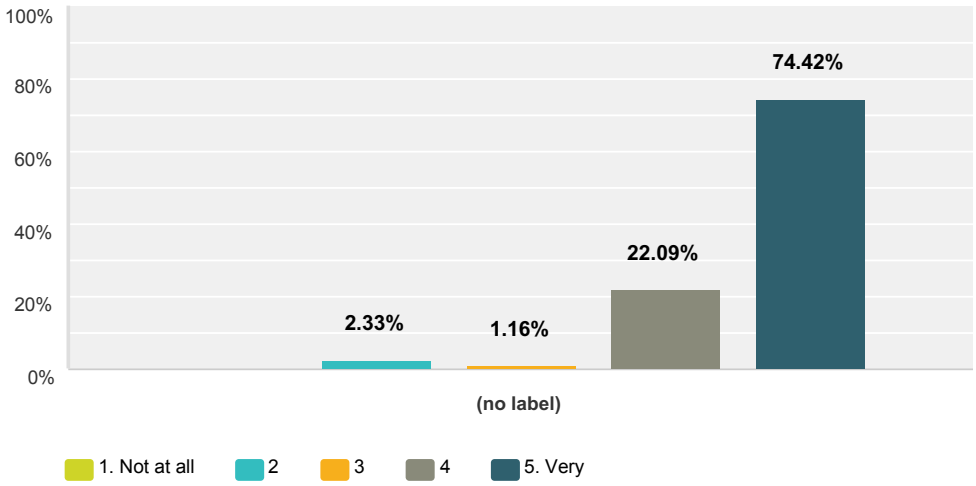
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**4.65%** 4	**23.26%** 20	**72.09%** 62	86	4.67

Q13 The MSRI facilities were conducive for such a workshop

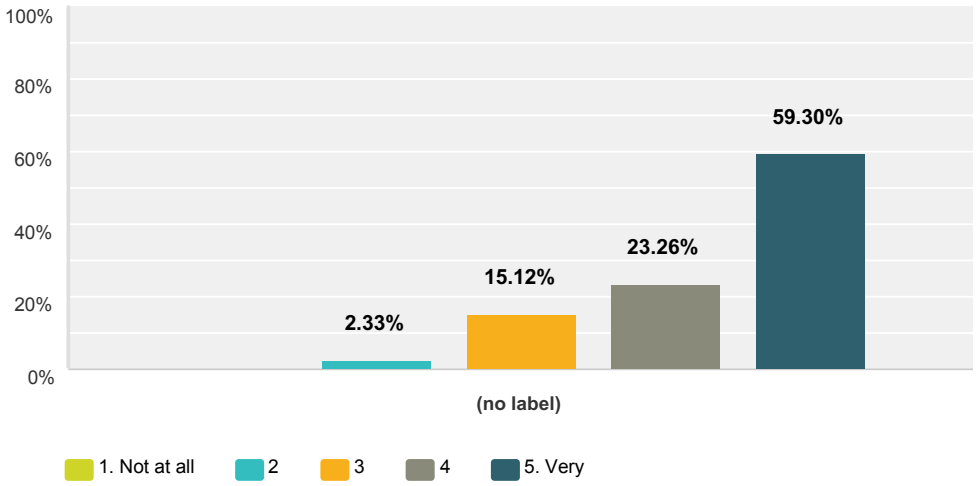
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.33%** 2	**1.16%** 1	**22.09%** 19	**74.42%** 64	86	4.69

Q14 The MSRI computer facilities were adequate for such a workshop

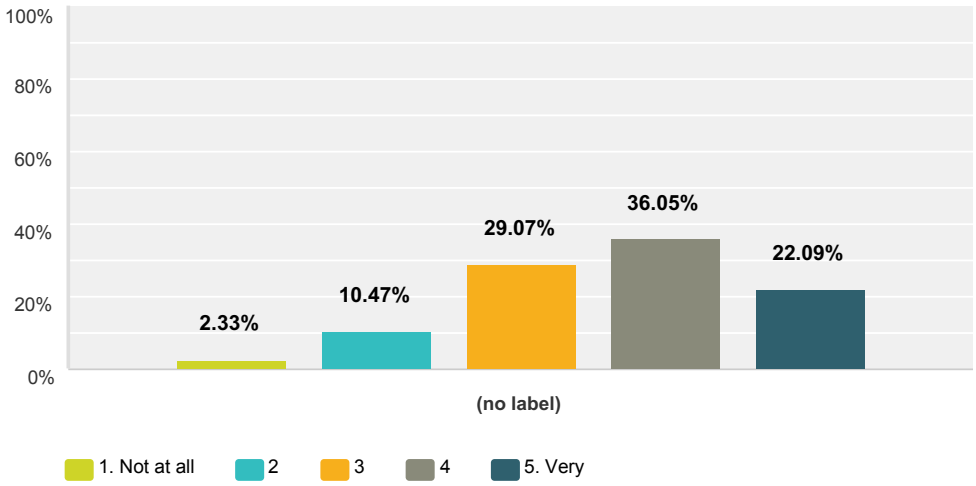
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.33%** 2	**15.12%** 13	**23.26%** 20	**59.30%** 51	86	4.40

Q15 The MSRI lunch arrangements were satisfactory

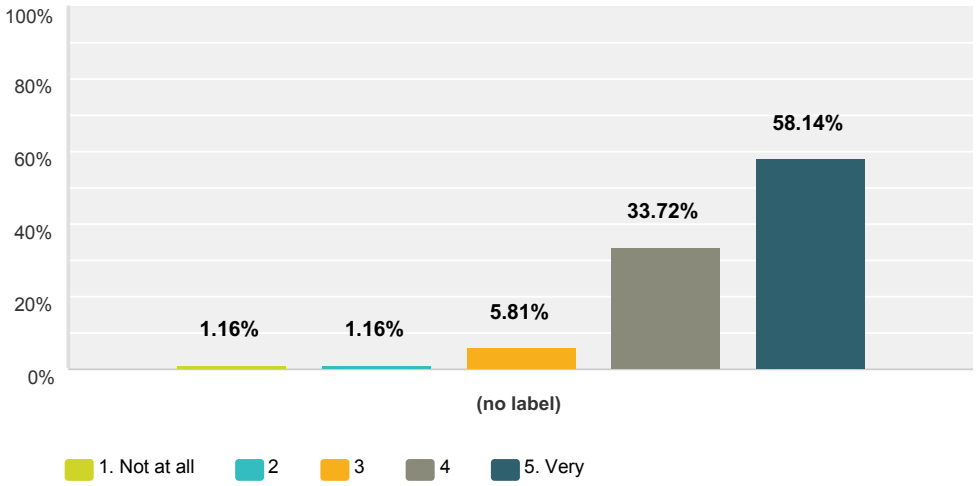
Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.33%** 2	**10.47%** 9	**29.07%** 25	**36.05%** 31	**22.09%** 19	86	3.65

Q16 The MSRI tea arrangements were satisfactory

Answered: 86 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.16%** 1	**1.16%** 1	**5.81%** 5	**33.72%** 29	**58.14%** 50	86	4.47

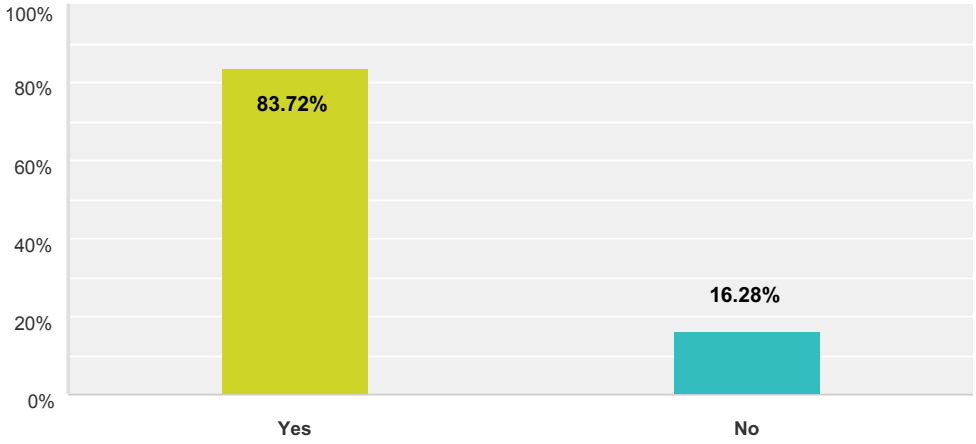
Q17 Additional comments about the venue

Answered: 11 Skipped: 75

#	Responses	Date
1	During the lectures, the main blackboard is usuaslly too dark. So it was very hard to read letters on blackboard.	9/22/2016 8:15 PM
2	The lunch is very repetitive, and the queue was long and slow.	9/22/2016 4:27 PM
3	I brought my own lunch so cannot comment on the lunch arrangements, but the question requires an answer.	9/22/2016 2:17 PM
4	I have always appreciated the way MSRI staff make the lives of visitors easy. The staff is great	9/7/2016 8:23 AM
5	Dropbox was unavailable at MSRI, which made ongoing research slightly more difficult.	9/2/2016 12:13 PM
6	Both quality and price of the lunch were unsatisfactory; However, the well equipped kitchen compesated a lot for this	8/26/2016 8:44 PM
7	Add an extra option for "Not Applicable" or "I Don't Know" on the survey. I'm forced to rate MSRI's computer facilities, which I never even got to see.	8/26/2016 7:51 PM
8	Coffee and tea should be allowed in the lecture hall	8/26/2016 6:37 PM
9	I tend to bring my own lunch because I'm lactose intolerant and I eat a lot.	8/26/2016 5:20 PM
10	Shuttle not nice	8/26/2016 4:08 PM
11	Slow internet connection (sometimes).	8/26/2016 4:03 PM

Q18 Did you use MSRI's wireless network?

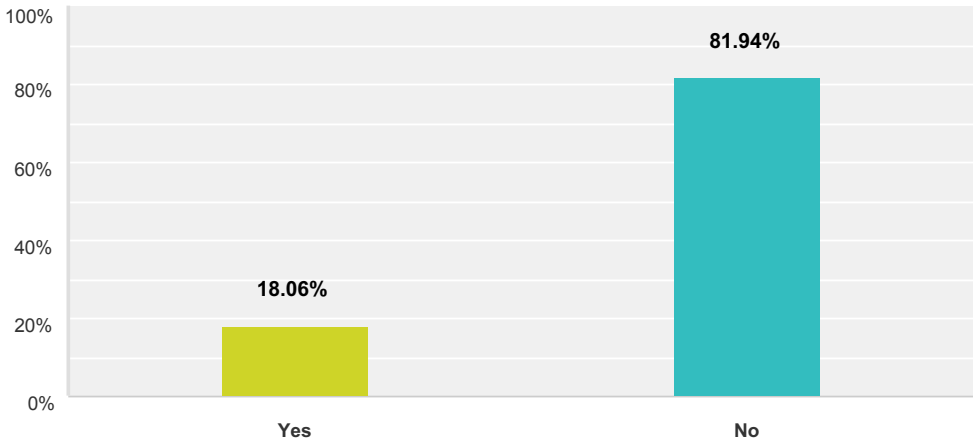
Answered: 86 Skipped: 0



Answer Choices	Responses	
Yes	83.72%	72
No	16.28%	14
Total		86

Q19 Did you experience any difficulties with the network?

Answered: 72 Skipped: 14



Answer Choices	Responses	
Yes	**18.06%**	13
No	**81.94%**	59
Total		**72**

#	Please if yes, please describe your difficulties	Date
1	The signal strength fluctuated a lot on my phone during the day.	9/22/2016 1:47 PM
2	Poor connection in certain areas of the building (e.g., bathrooms), and basically none even just steps outside the building.	9/16/2016 9:52 AM
3	The Guest wifi is sometimes not connected well.	9/5/2016 6:31 PM
4	Internet connection was going on and off frequently and cellular network was out of reach.	9/2/2016 12:18 PM
5	Dropbox was unavailable	9/2/2016 12:14 PM
6	the connection is quite slow	9/1/2016 1:40 PM
7	my phone wouldn't connect but I had no trouble with my computer	8/28/2016 1:28 PM
8	Wifi did not work in the bathroom	8/27/2016 8:56 AM
9	Veryslow	8/26/2016 10:59 PM
10	It would be nice if the wifi was stronger at the tables on the outside.	8/26/2016 8:45 PM
11	It would be good to use the internet during a workshop without resigning it.	8/26/2016 6:53 PM
12	My phone (Samsung Galaxy S5; Android 6.0.1) did not load the redirect page, so I couldn't accept the conditions to connect.	8/26/2016 4:09 PM
13	Slow internet connection (sometimes).	8/26/2016 4:05 PM
14	I couldn't connect to the wifi sometimes.	8/26/2016 3:58 PM

Q20 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 82

#	Responses	Date
1	One of the main problems is the shuttle bus to MSRI. It was too inconvenient for me. In the future, this problems should be sloved for all.	9/22/2016 8:18 PM
2	Thank you	9/22/2016 2:18 PM
3	I was happy to be here. it would be great to have a workshop before the semester starts.	8/26/2016 6:54 PM
4	I can't think of anything.	8/26/2016 5:20 PM

Amenability, coarse embeddability and fixed point properties

December 06, 2016 - December 09, 2016

MSRI, Berkeley, CA, USA

Organizers:

Goulnara Arzhantseva (University of Vienna)

Cornelia Drutu (University of Oxford)

Graham Niblo (University of Southampton)

Piotr Nowak (Polish Academy of Sciences)

REPORT ON THE MSRI WORKSHOP "AMENABILITY, COARSE EMBEDDABILITY AND FIXED POINT PROPERTIES" DECEMBER 6-9, 2016

Organizers

- Goulnara Arzhantseva (University of Vienna)
- Cornelia Drutu (University of Oxford)
- Graham Niblo (University of Southampton)
- Piotr Nowak (Polish Academy of Sciences)

Scientific Description

The main theme of the workshop is the spectrum of analytic properties, running from Kazhdan's property (T) at one end to von Neumann's amenability at the other, which forms a foundational organizing structure for infinite groups and spaces. These properties can be described both analytically, via unitary representation theory, and geometrically, using embedding properties for discrete spaces. Connections with probability and combinatorics were likewise addressed during this meeting.

Highlights of the Workshop

The workshop gathered first rate specialists in the area of Geometric Group Theory that is closest to Analysis and C*-algebras. The results covered the entire spectrum of the theme, from various versions of amenability and their attached geometry (Guentner, Haissinsky, Cornulier, Yu, Juschenko, Kassabov, Zheng, Grigorchuk) to properties of an opposite nature, generically known as "fixed point properties" (Bekka, Badea Khukhro, Li, Bader, Mimura, Mann).

The special feature of the workshop was that it was intended not only to cover the most recent advances in the field for the information of the specialists, but also to present, for non-specialists, the entire range of exisiting approaches for this kind of problems for infinite groups. Note that for all the groups that were the object of study of the other workshops (Mapping Class Groups, Out(Fn), groups of isometries of CAT(0) spaces) the question of their being amenable or, on the contrary, of their having a fixed point property such as (T), turned out to be difficult to tackle. Within the last decade several high profile researchers have announced one or the other of the properties for one or the other of these groups, and then had to withdraw their statement. It was the workshop organizers' intention that the participants would leave with this new sets of techniques in their luggage, so that hopefully there would be more progress in the future in this area, of classifying infinite groups within one or the other of the categories, where a lot of attempts have been made, but few successes registered.

Among the remarkable results presented: Peter Haissinsky explained the proof of the quasi-isometric rigidity in the last remaining open cases of groups of isometries of symmetric spaces, Kate Juschenko announced progress on the much investigated question of the existence of non-

sofic groups, Katie Mann presented an answer to an open problem from the Scottish Book (a celebrated book of open problems), Tianyi Zheng explained a counter-example to the conjecture of Naor-Peres, Badea and Mimura provided answers to open questions of Shalom.

Amenability, coarse embeddability and fixed point properties

December 6-9, 2016

Schedule

Tuesday, December 6, 2016			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Erik Guentner	Weak forms of amenability for CAT(0) cubical groups
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00	Simons Auditorium	Bachir Bekka	Irreducible group actions by affine isometries on Hilbert spaces
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Catalin Badea	Kazhdan sets in groups and equidistribution properties
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Peter Haissinsky	Quasi-isometric rigidity of fundamental groups of compact 3–manifolds.
3:30 PM - 6:20 PM	Atrium		Reception

Wednesday, December 7, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Yves Cornulier	Sublinearly bilipschitz maps, hyperbolic and nilpotent groups
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 AM	Simons Auditorium	Anastasia Khukhro	Box spaces, expanders, and rigidity
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Hanfeng Li	Sofic mean length
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Guoliang Yu	Finite embeddability of groups and its applications to geometry and topology

Thursday, December 8, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Uri Bader	Equicontinuous actions of semisimple Lie groups
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Kate Juschenko	Glueing together copies of amenable groups
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Masato Mimura	Superintrinsic synthesis in fixed point properties
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Kathryn Mann	Strong boundedness and distortion in transformation groups

Friday, December 9, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Martin Kassabov	A nice trick involving amenable groups
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00	Simons Auditorium	Tianyi Zheng	L_p-compression of wreath products and some related groups
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Rostislav Grigorchuk	On spectra of Koopman, groupoid and quasi-regular representations
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Gilles Pisier	Amenability, group C*-algebras and operator spaces

Organizers

First Name	Last Name	Institution
Goulnara	Arzhantseva	University of Vienna
Cornelia	Drutu	University of Oxford
Graham	Niblo	University of Southampton
Piotr	Nowak	Polish Academy of Sciences

Speakers

First Name	Last Name	Institution
Catalin	Badea	Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Uri	Bader	Weizmann Institute of Science
Bachir	Bekka	Université de Rennes 1
Yves	Cornulier	Centre National de la Recherche Scientifique (CNRS)
Rostislav	Grigorchuk	Texas A & M University
Erik	Guentner	University of Hawaii at Manoa
Peter	Haissinsky	Université d'Aix-Marseille (AMU)
Kate	Juschenko	Northwestern University
Martin	Kassabov	Cornell University
Anastasia	Khukhro	Université de Neuchâtel
Kathryn	Mann	University of California, Berkeley
Masato	Mimura	Tohoku University
Gilles	Pisier	Texas A & M University
John	Roe	Pennsylvania State University
Guoliang	Yu	Texas A & M University
Tianyi	Zheng	University of California, San Diego

Participants

First Name	Last Name	Institution
Carolyn	Abbott	University of Wisconsin-Madison
Goulnara	Arzhantseva	University of Vienna
Catalin	Badea	Université de Lille I (Sciences et Techniques de Lille Flandres Artois)
Uri	Bader	Weizmann Institute of Science
Bachir	Bekka	Université de Rennes 1
Mark	Bell	University of Illinois at Urbana-Champaign
Adrien	Boyer	Weizmann Institute of Science
Corey	Bregman	Rice University
Nic	Brody	University of California, Berkeley
Nicholas	Cahill	University of Utah
Michael	Cantrell	University of Illinois, Chicago
Ruth	Charney	Brandeis University
Indira	Chatterji	Université Nice Sophia-Antipolis
Yves	Cornulier	Centre National de la Recherche Scientifique (CNRS)
Rémi	Coulon	Université de Rennes 1
François	Dahmani	Université de Grenoble I (Joseph Fourier)
Kajal	Das	École Normale Supérieure de Lyon
Rhiannon	Dougall	University of Warwick
Cornelia	Drutu	University of Oxford
Constantin	Dumitrascu	Adrian College
Thibaut	Dumont	University of Utah
Matthew	Durham	University of Michigan
Tullia	Dymarz	University of Wisconsin-Madison
Mark	Feighn	Rutgers University
Vladimir	Finkelshtein	University of Illinois at Chicago
Martin	Finn-Sell	University of Vienna
Elia	Fioravanti	University of Oxford
Koji	Fujiwara	Kyoto University
Neil	Fullarton	Rice University
Alex	Furman	University of Illinois at Chicago
Alejandra	Garrido	Heinrich-Heine-Universität Düsseldorf
Alexis	Gilles	Université Nice Sophia-Antipolis
Rostislav	Grigorchuk	Texas A & M University
Erik	Guentner	University of Hawaii at Manoa
Funda	Gultepe	University of Illinois at Urbana-Champaign
Peter	Haissinsky	Université d'Aix-Marseille (AMU)
Kei	Hasegawa	Kyushu University
Arnaud	Hilion	Université d'Aix-Marseille (AMU)
Meng-Che	Ho	University of Wisconsin-Madison
Camille	Horbez	Université de Paris XI
David	Hume	Université de Paris XI
Alessandra	Iozzi	ETH Zürich
Lison	Jacoboni	Université de Paris XI
Kate	Juschenko	Northwestern University
Martin	Kassabov	Cornell University
Alvin	Kerber	University of California, Berkeley
Olga	Kharlampovich	Hunter College, CUNY
Anastasia	Khukhro	Université de Neuchâtel

Participants

First Name	Last Name	Institution
Yoshikata	Kida	University of Tokyo
Juhani	Koivisto	Syddansk Universitet (University of Southern Denmark)
Robert	Kropholler	University of Oxford
Giang	Le	MSRI - Mathematical Sciences Research Institute
Ian	Leary	University of Southampton
Hanfeng	Li	University at Buffalo (SUNY)
John	Lott	University of California, Berkeley
Joel	Louwsma	Niagara University
Joseph	Maher	College of Staten Island, CUNY
Johanna	Mangahas	University at Buffalo (SUNY)
Kathryn	Mann	University of California, Berkeley
Masato	Mimura	Tohoku University
Mahan	Mj	Tata Institute of Fundamental Research
Graham	Niblo	University of Southampton
Piotr	Nowak	Polish Academy of Sciences
Thibault	Pillon	Katholieke Universiteit Leuven
Gilles	Pisier	Texas A & M University
Sanaz	Pooya	Université de Neuchâtel
Timothy	Riley	Cornell University
John	Roe	Pennsylvania State University
Javier	Ronquillo Rivera	Ohio University
Kevin	Schreve	University of Michigan
Zlil	Sela	Hebrew University
Alessandro	Sisto	ETH
Rachel	Skipper	Binghamton University (SUNY)
Yanli	Song	Dartmouth College
Davide	Spriano	ETH Zürich
Karol	StrzaÅ‚kowski	Polish Academy of Sciences
Daniel	Studenmund	University of Utah
Yuhei	Suzuki	China University
Krzysztof	Święcicki	Texas A & M University
Jing	Tao	University of Oklahoma
Samuel	Taylor	Yale University
Tetsu	Toyoda	National Institute of Technology, Suzuka college
Caglar	Uyanik	University of Illinois at Urbana-Champaign
Alain	Valette	Université de Neuchâtel
Federico	Vigolo	University of Oxford
Richard	Wade	University of British Columbia
Pei	Wang	Rutgers University
Qingyun	Wang	University of Oregon
Kevin	Whyte	University of Illinois, Chicago
Derrick	Wigglesworth	University of Utah
Robert	Young	New York University, Courant Institute
Guoliang	Yu	Texas A & M University
Zehou	Zhang	University of Virginia
Yong	Zhang	University of Manitoba
Tianyi	Zheng	University of California, San Diego

Officially Registered Participant Information

Participants		95

Gender		95
Male	75.79%	72
Female	23.16%	22
Declined to state	1.05%	1

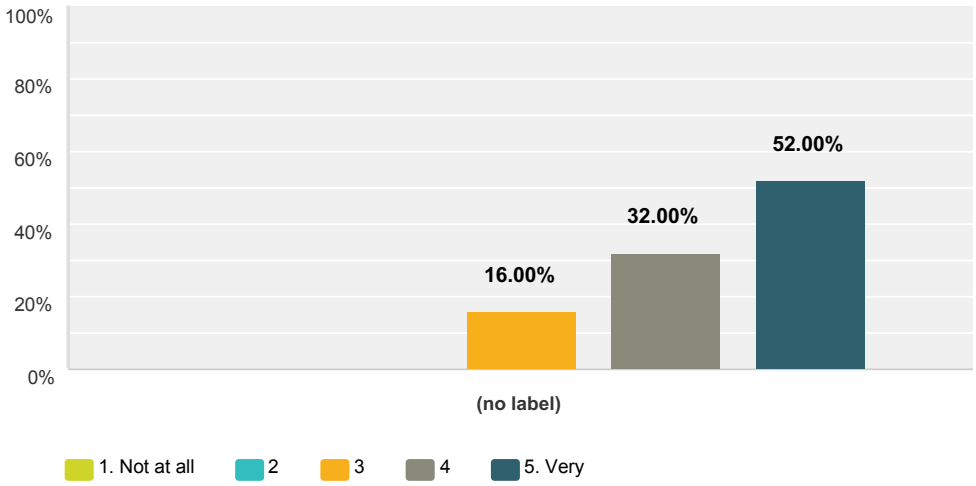
Ethnicity*		97
White	68.42%	65
Asian	21.05%	20
Hispanic	1.05%	1
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	1.05%	1
Declined to state	10.53%	10

* ethnicity specifications are not exclusive

50 responses out of 95 participants = 53% response rate

Q1 The workshop was intellectually stimulating

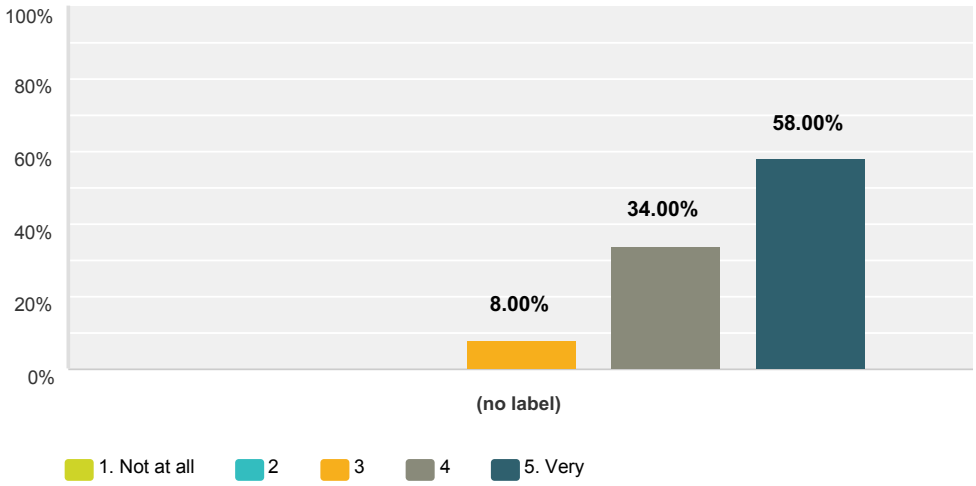
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	16.00% 8	32.00% 16	52.00% 26	50	4.36

Q2 The overall experience of the workshop was worthwhile

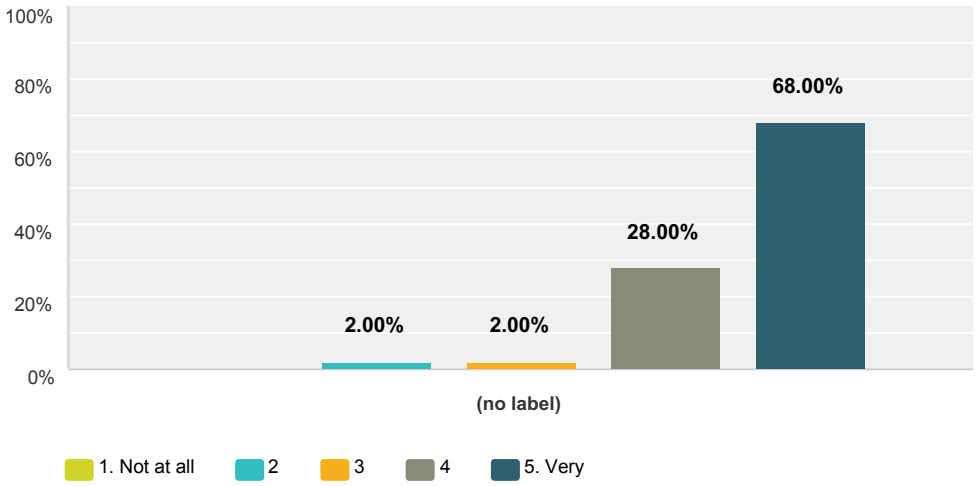
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**8.00%** 4	**34.00%** 17	**58.00%** 29	50	4.50

Q3 The time between lectures was adequate for discussion

Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.00%** 1	**2.00%** 1	**28.00%** 14	**68.00%** 34	50	4.62

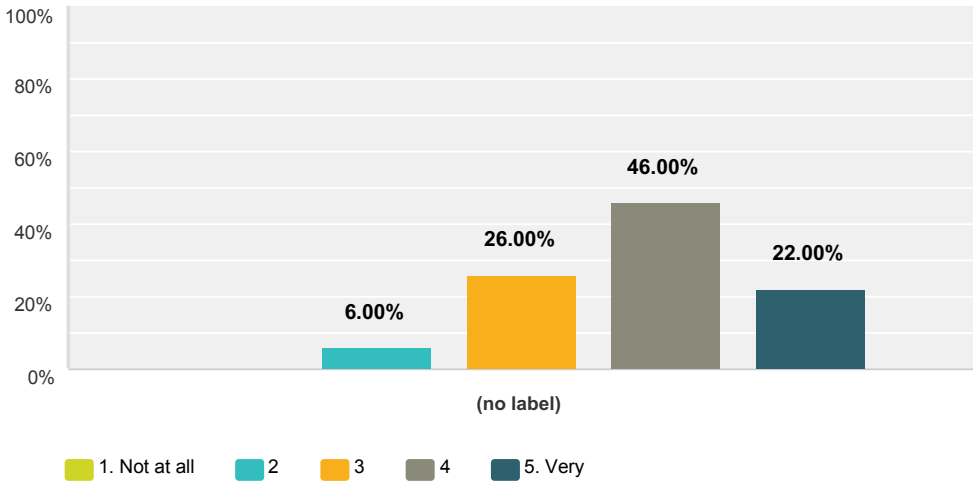
Q4 Additional comments

Answered: 4 Skipped: 46

#	Responses	Date
1	Please bear in mind that my interests matched more with the one of previous workshops during this semester. For this reason I enjoyed this workshop less than others, but I believe that it was very stimulating for other people.	12/12/2016 1:33 PM
2	I much enjoyed the workshop, thank you.	12/12/2016 11:58 AM
3	I am not an expert on this field.	12/12/2016 11:36 AM
4	Notably less participants then at other workshop. It seems the semester was very emphasised on OutFn and MCG.	12/11/2016 12:40 PM

Q5 I was well prepared to benefit from the lectures

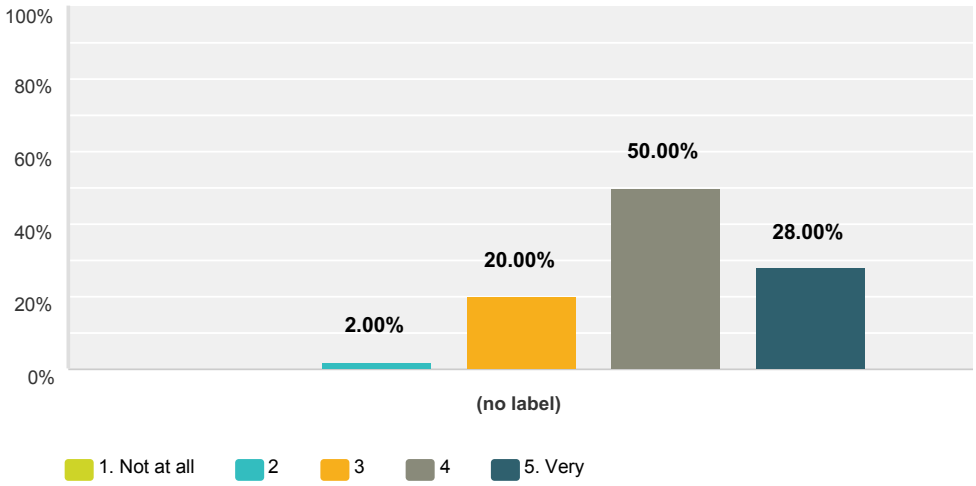
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	6.00% 3	26.00% 13	46.00% 23	22.00% 11	50	3.84

Q6 My interest in the subject matter was increased by the workshop

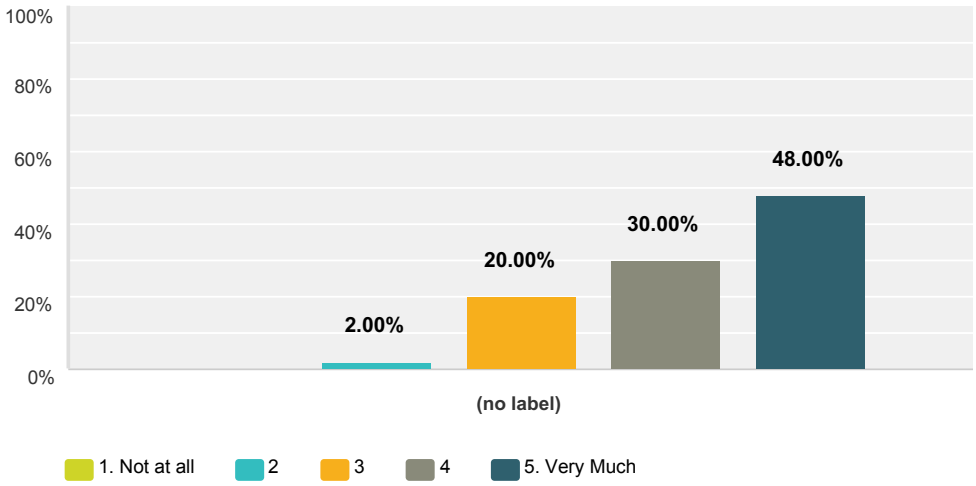
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	2.00% 1	20.00% 10	50.00% 25	28.00% 14	50	4.04

Q7 The workshop helped me meet people with similar scientific interests

Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**2.00%** 1	**20.00%** 10	**30.00%** 15	**48.00%** 24	50	4.24

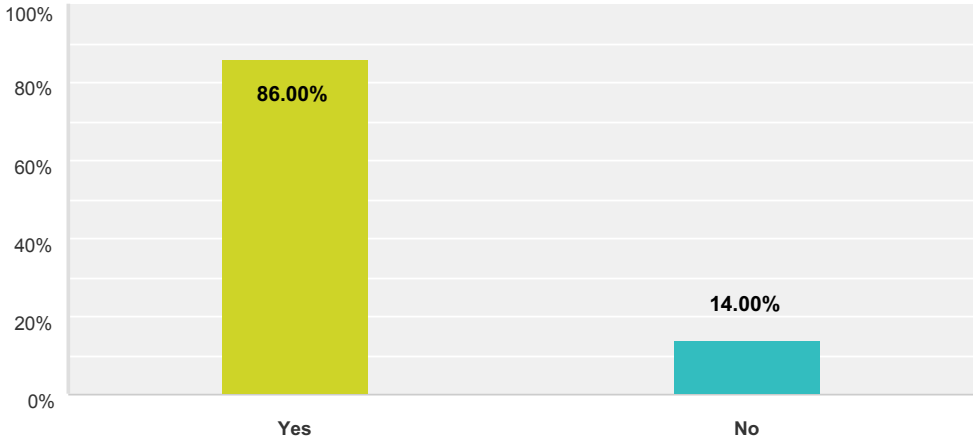
Q8 Additional comments on your personal assessment

Answered: 2 Skipped: 48

#	Responses	Date
1	This workshop was a bit outside my area of interest. I attended since I was at MSRI anyway as part of the semester program.	1/12/2017 11:38 AM
2	Food available has greatly improved.	12/10/2016 9:19 PM

Q9 Did you attend the reception?

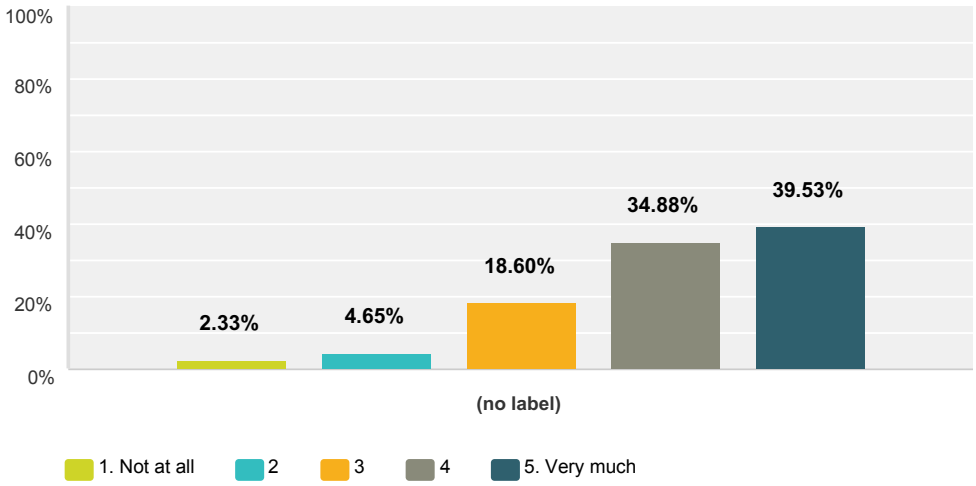
Answered: 50 Skipped: 0



Answer Choices	Responses	
Yes	86.00%	43
No	14.00%	7
Total		50

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 43 Skipped: 7



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	2.33% 1	4.65% 2	18.60% 8	34.88% 15	39.53% 17	43	4.05

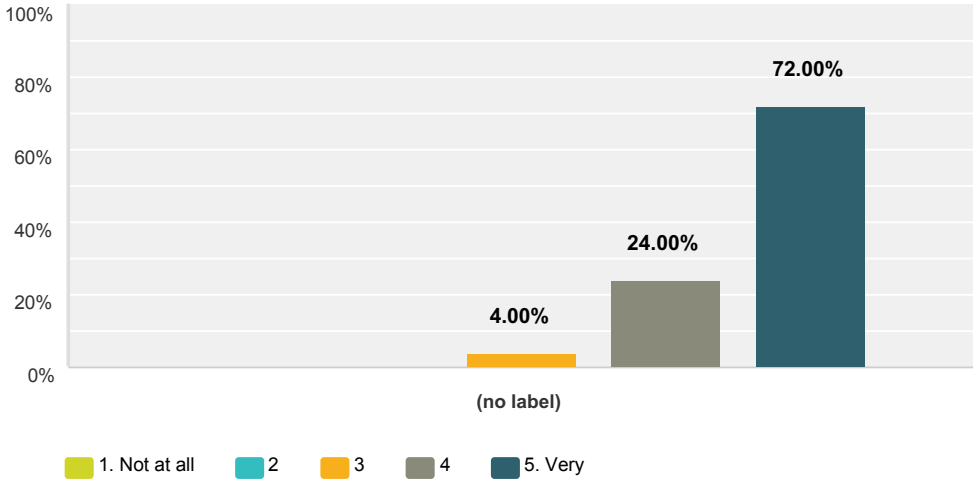
Q11 Please provide any comments about the reception

Answered: 2 Skipped: 48

#	Responses	Date
1	Wine tends to run out fairly quickly	1/13/2017 2:53 AM
2	Great food, and lots of it (unlike one of the earlier receptions). Plus we saw an owl on a tree visible from the balcony during the reception, which was amazing.	12/12/2016 11:37 AM

Q12 I found the MSRI staff helpful

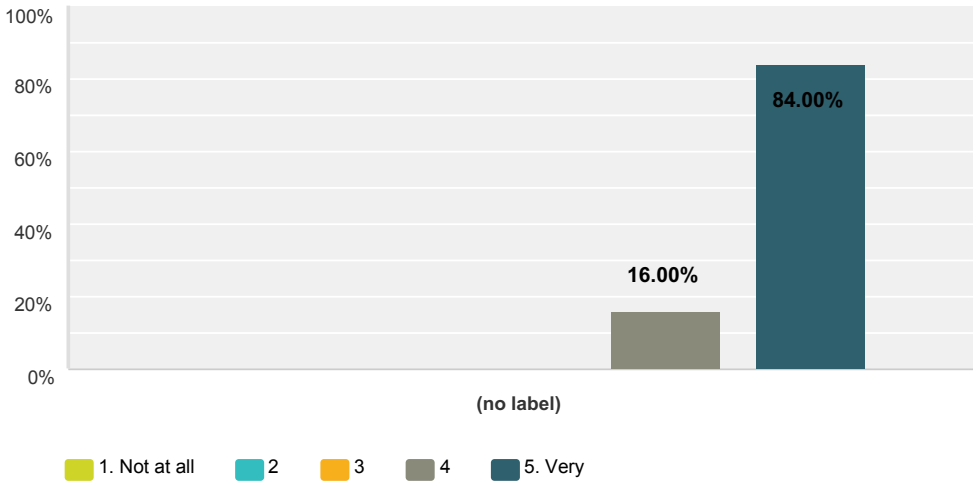
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**4.00%** 2	**24.00%** 12	**72.00%** 36	50	4.68

Q13 The MSRI facilities were conducive for such a workshop

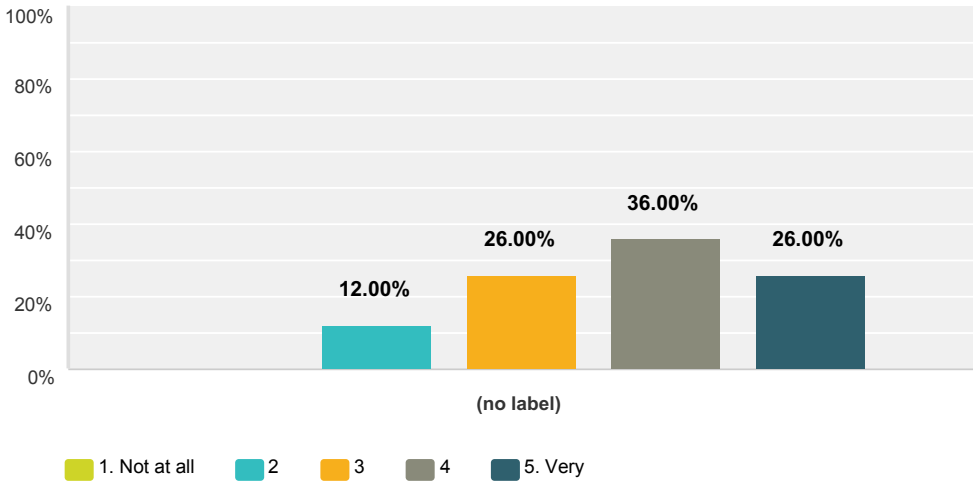
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**16.00%** 8	**84.00%** 42	50	4.84

Q14 The MSRI lunch arrangements were satisfactory

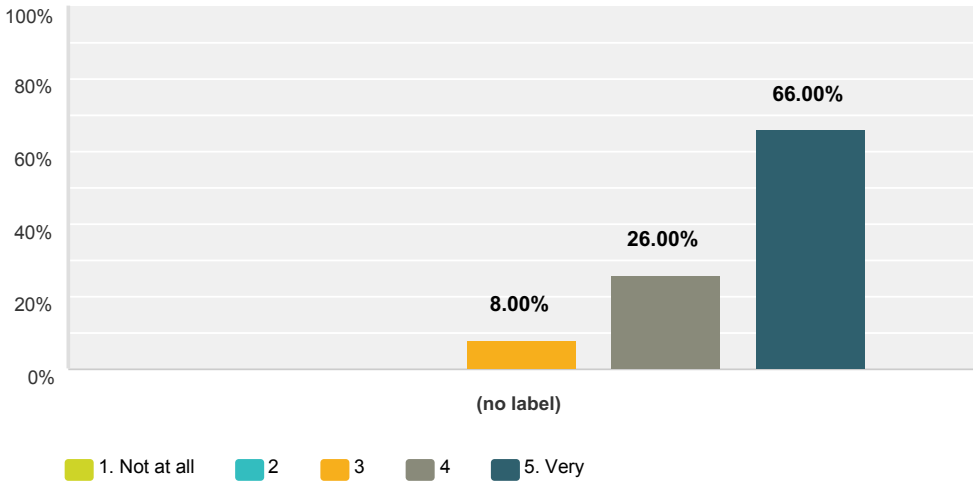
Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**12.00%** 6	**26.00%** 13	**36.00%** 18	**26.00%** 13	50	3.76

Q15 The MSRI tea arrangements were satisfactory

Answered: 50 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**8.00%** 4	**26.00%** 13	**66.00%** 33	50	4.58

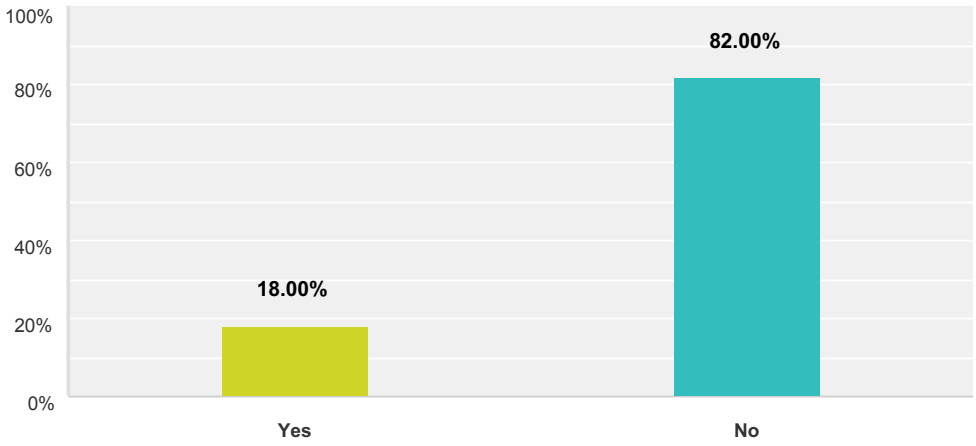
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 5 Skipped: 45

#	Responses	Date
1	For lunches: they will run out quickly of the better food options. If you were not there first in line, you will end up with not that attractive items.	12/15/2016 5:53 AM
2	Lunches and tea produce a lot of waste. MSRI should aim at more sustainable arrangements, the environment is a serious issue and scientists should give an example.	12/12/2016 3:11 PM
3	I brought my own lunch, so you should ignore my comment about the lunches.	12/12/2016 11:37 AM
4	Food for the first 2 days was terrible, much better the last two days.	12/11/2016 11:21 AM
5	It would be useful to have soy milk	12/10/2016 8:11 PM

Q17 Did you use the computer facilities located in the library?

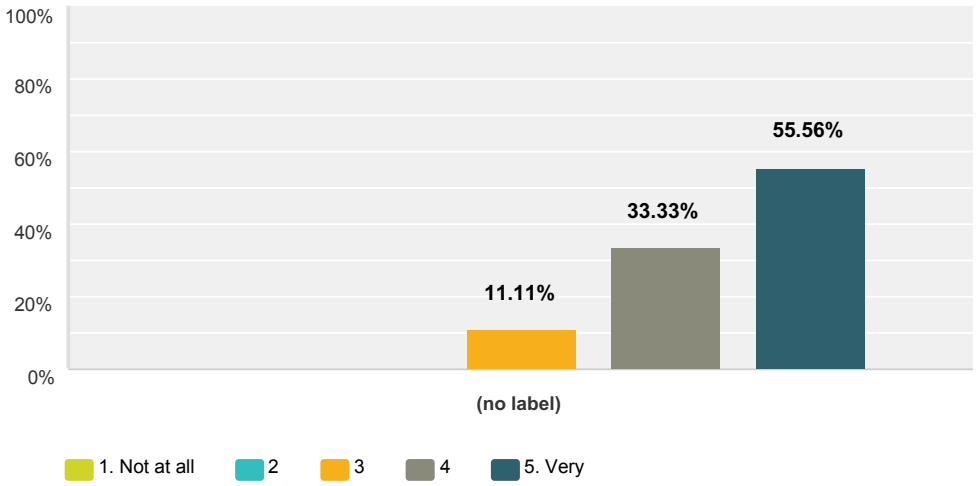
Answered: 50 Skipped: 0



Answer Choices	Responses	
Yes	18.00%	9
No	82.00%	41
Total		50

Q18 The MSRI computer facilities in the library were adequate

Answered: 9 Skipped: 41

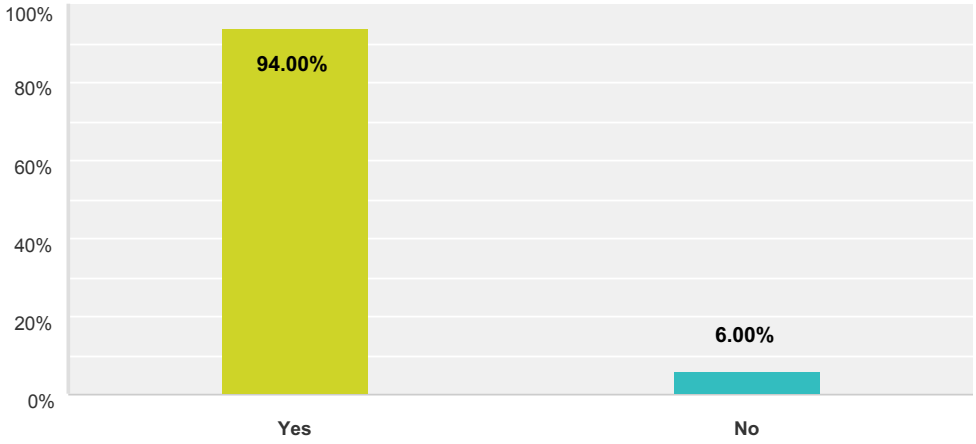


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	11.11% 1	33.33% 3	55.56% 5	9	4.44

#	Comments about computer facilities	Date
	There are no responses.	

Q19 Did you use MSRI's wireless network?

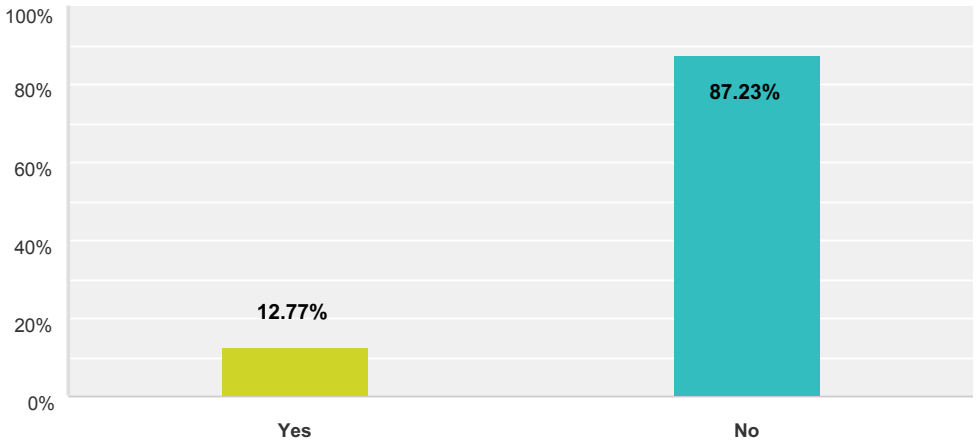
Answered: 50 Skipped: 0



Answer Choices	Responses	
Yes	94.00%	47
No	6.00%	3
Total		50

Q20 Did you experience any difficulties with the network?

Answered: 47 Skipped: 3



Answer Choices	Responses	
Yes	**12.77%**	6
No	**87.23%**	41
Total		**47**

#	Please if yes, please describe your difficulties	Date
1	Internet was very slow on a couple days, and occasionally wouldn't work at all.	12/12/2016 4:18 PM
2	Slow connectivity, poor reception in the bathroom	12/12/2016 3:27 PM
3	Some firewall or other stopped my university's version of Dropbox working while I can at MSRI.	12/12/2016 12:00 PM
4	Dropbox not available is an issue for me as usual.	12/11/2016 12:41 PM
5	Dropbox does not sync over the guest network	12/10/2016 9:43 PM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 47

#	Responses	Date
1	Thank you! This was my first visit at MSRI and I found it completely worthwhile, from all points of view - scientific, intellectual, networking etc. Everything was extremely well organized. I really have no suggestions for improvement.	12/15/2016 5:56 AM
2	It would have been nice to have a women's dinner but this time nobody organized it.	12/12/2016 3:13 PM
3	This meeting was great; four talks per day with adequate spacing works very well.	12/12/2016 11:38 AM

Geometry of mapping class groups and Out(Fn)

October 25, 2016 - October 28, 2016

MSRI, Berkeley, CA, USA

Organizers:

Yael Algom-Kfir (University of Haifa)

Mladen Bestvina (University of Utah)

Richard Canary (University of Michigan)

Gilbert Levitt (Université de Caen)

REPORT ON THE MSRI WORKSHOP "GEOMETRY OF MAPPING CLASS GROUPS AND OUT (FN)" OCTOBER 25-28, 2016

Organizers

- Mladen Bestvina (University of Utah)
- Richard Canary (University of Michigan)
- Yael Algom-Kfir (University of Haifa)
- Gilbert Levitt (Université de Caen)

Scientific Description

This workshop was part of the semester-long *Geometric Group Theory* program. This was a four-day workshop with research-level talks on the latest advances in the geometry of mapping class groups and Out(F_n), and spaces on which they act. The workshop brought together researchers to discuss recent developments and chart new directions in the field. A list of speakers and the schedule is attached.

Highlights of the Workshop

There were many interesting talks with a lot of new ideas. Below we list a sample.

- *Mark Bell and Dan Margalit talked about polynomial-time algorithms in the mapping class group, answering several long standing questions.*
- *Spencer Dowdall and Camille Horbez represented what might be considered a resurgence of probabilistic and measure-theoretic methods in geometric group theory.*
- *Michael Handel and Lee Mosher, who proved some very important theorems in the past, both attended (with Handel giving a talk). This is unusual for both, giving younger members a chance to finally meet them.*
- *Mark Feighn presented the theory of completely split train tracks, that solves many algorithmic problems in Out(F_n).*
- *The conference was closed out by Ursula Hamenstadt with a very inspiring talk, leaving the audience to think about many things.*
- *Several speakers referred to the previous MSRI program in Geometric Group Theory, in 2007.*

Geometry of mapping class groups and Out(Fn)

October 25-28, 2016

Schedule

Tuesday, October 25, 2016			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Vogtmann	Tethered curve complexes and homology stability
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Dowdall	Counting finite-order lattice points in Teichmüller space
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Leininger	Word-hyperbolic surface bundles
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Hironaka	Dilatations of pseudo-Anosov mapping classes
4:30 PM - 6:20 PM	Atrium		Reception

Wendesday, October 26, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Minsky	Fibrations, subsurface projections and veering triangulations
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Feighn	CTs and applications
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Rafi	Shape of the moduli space
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Mangahas	Purely loxodromic RAAG subgroups and purely pseudo-Anosov MCG subgroups

Thursday, October 27, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Handel	Hyperbolic actions and 2nd bounded cohomology of subgroups of Out(Fn)
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Taylor	The geometry of hyperbolic free group extensions
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Horbez	A multiplicative ergodic theorem for mapping class groups
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Clay	L2-torsion of free-by-cyclic groups

Friday, October 28, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Margalit	Fast Nielsen-Thurston Classification
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Durham	A new boundary for the mapping class group
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Drutu	The geometry of hyperbolic groups and their fixed point properties
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Hamenstadt	Tame hierarchies for curve graphs

Organizers		
First Name	**Last Name**	**Institution**
Yael	Algom-Kfir	University of Haifa
Mladen	Bestvina	University of Utah
Richard	Canary	University of Michigan
Gilbert	Levitt	Université de Caen
Speakers		
First Name	**Last Name**	**Institution**
Mark	Bell	University of Illinois at Urbana-Champaign
Matthew	Clay	University of Arkansas
Spencer	Dowdall	Vanderbilt University
Cornelia	Drutu	University of Oxford
Matthew	Durham	University of Michigan
Mark	Feighn	Rutgers University
Ursula	Hamenstädt	Universität Bonn
Michael	Handel	Lehman College
Eriko	Hironaka	Florida State Univesrity
Camille	Horbez	Université de Paris XI
Christopher	Leininger	University of Illinois at Urbana-Champaign
Dan	Margalit	Georgia Institute of Technology
Yair	Minsky	Yale University
Kasra	Rafi	University of Toronto
Samuel	Taylor	Yale University
Karen	Vogtmann	University of Warwick

Participants

First Name	Last Name	Institution
Carolyn	Abbott	University of Wisconsin-Madison
Yael	Algom-Kfir	University of Haifa
Javier	Aramayona	Universidad Autónoma de Madrid
Refik	Baykur	University of Massachusetts Amherst
Benjamin	Beeker	University of Haifa
Mark	Bell	University of Illinois at Urbana-Champaign
Robert	Bell	Michigan State University
Maxime	Bergeron	University of Chicago
Edgar	Bering	University of Illinois at Chicago
Mladen	Bestvina	University of Utah
Corey	Bregman	Rice University
Tara	Brendle	University of Glasgow
Martin	Bridson	University of Oxford
Nathan	Broaddus	Ohio State University
Nic	Brody	University of California, Berkeley
Kenneth	Bromberg	University of Utah
Nicholas	Cahill	University of Utah
Richard	Canary	University of Michigan
Michael	Cantrell	University of Illinois, Chicago
Ruth	Charney	Brandeis University
Indira	Chatterji	Université Nice Sophia-Antipolis
Matthew	Clay	University of Arkansas
Matthew	Cordes	Technion---Israel Institute of Technology
Yves	Cornulier	Centre National de la Recherche Scientifique (CNRS)
Thierry	Coulbois	Université d'Aix-Marseille (AMU)
Rémi	Coulon	Université de Rennes I
Tommaso	Cremaschi	Boston College
Marc	Culler	University of Illinois, Chicago
François	Dahmani	Université de Grenoble I (Joseph Fourier)
Saikat	Das	Rutgers University
Michael	Davis	Ohio State University
Matthew	Day	University of Arkansas
Soumya	Dey	Indian Institute of Science Education and Research Mohali
Coleman	Dobson	California State University
Michael	Dougherty	University of California, Santa Barbara
Spencer	Dowdall	Vanderbilt University
Benjamin	Dozier	Stanford University
Cornelia	Drutu	University of Oxford
Thibaut	Dumont	University of Utah
Matthew	Durham	University of Michigan
Federica	Fanoni	University of Warwick
James	Farre	University of Utah
Mark	Feighn	Rutgers University
Elia	Fioravanti	University of Oxford
Ser-Wei	Fu	Temple University
Koji	Fujiwara	Kyoto University

Participants

First Name	Last Name	Institution
Neil	Fullarton	Rice University
Alexis	Gilles	Université Nice Sophia-Antipolis
Robert	Gilman	Stevens Institute of Technology
Dominik	Gruber	ETH Zürich
Vincent	Guirardel	Institut de Recherche Mathematique (IRMAR)
Funda	Gultepe	University of Illinois at Urbana-Champaign
Radhika	Gupta	University of Utah
Ursula	Hamenstädt	Universität Bonn
Sang Yong	Han	Chung-Ang University
Michael	Handel	Lehman College
Jesús	Hernández Hernández	UNAM
Arnaud	Hilion	Université d'Aix-Marseille (AMU)
Eriko	Hironaka	Florida State Univesrity
Meng-Che	Ho	University of Wisconsin-Madison
Camille	Horbez	Université de Paris XI
Zheng	Huang	CUNY, Graduate Center
David	Hume	Université de Paris XI
Francesca	Iezzi	University of Warwick
Alessandra	Iozzi	ETH Zürich
Peihong	Jiang	Brown University
Ilya	Kapovich	University of Illinois at Urbana-Champaign
Richard	Kent	University of Wisconsin-Madison
Steven	Kerckhoff	Stanford University
Eiko	Kin	Osaka University
Thomas	Koberda	University of Virginia
Robert	Kropholler	University of Oxford
Christopher	Kuo	University of California, Berkeley
François	Labourie	Université Nice Sophia-Antipolis
Michael	Landry	Yale University
Justin	Lanier	Georgia Institute of Technology
Ian	Leary	University of Southampton
Christopher	Leininger	University of Illinois at Urbana-Champaign
Gilbert	Levitt	Université de Caen
Shixuan	Li	University of Illinois at Urbana-Champaign
John	Lott	University of California, Berkeley
Joel	Louwsma	Niagara University
Marissa	Loving	University of Illinois at Urbana-Champaign
Joseph	Maher	College of Staten Island, CUNY
Justin	Malestein	University of Oklahoma
Dan	Margalit	Georgia Institute of Technology
Alexandre	Martin	University of Vienna
Hidetoshi	Masai	University of Tokyo
Howard	Masur	University of Chicago
Masato	Mimura	Tohoku University
Yair	Minsky	Yale University
Mahan	Mj	Tata Institute of Fundamental Research

Participants		
First Name	**Last Name**	**Institution**
Lee	Mosher	Rutgers University
Sarah	Mousley	University of Illinois at Urbana-Champaign
Andreas	Ott	Ruprecht-Karls-Universität Heidelberg
Joshua	Pankau	University of California, Santa Barbara
Priyam	Patel	University of California, Santa Barbara
Frédéric	Paulin	Université Paris-Saclay
Bram	Petri	Max-Planck-Institut für Mathematik
Catherine	Pfaff	University of California, Santa Barbara
Witsarut	Pho-on	University of Illinois at Urbana-Champaign
Eugene	Plotkin	Bar-Ilan University
Paul	Plummer	University of Oklahoma
Kasra	Rafi	University of Toronto
Anja	Randecker	University of Toronto
Alexander	Rasmussen	Yale University
Jacob	Russell	City University of New York (CUNY)
Andrew	Sale	Vanderbilt University
Eugenia	Sapir	University of Illinois at Urbana-Champaign
Kevin	Schreve	University of Michigan
Shane	Scott	Georgia Institute of Technology
Zlil	Sela	Hebrew University
Alessandro	Sisto	ETH
Ignat	Soroko	University of Oklahoma
Juan	Souto	Institut de Recherche Mathematique (IRMAR)
Davide	Spriano	ETH Zürich
Balazs	Strenner	Georgia Institute of Technology
Karol	Strzałkowski	Polish Academy of Sciences
Benjamin	Stucky	University of Oklahoma
Hongbin	Sun	University of California, Berkeley
Tim	Susse	University of Nebraska
Krzysztof	Święcicki	Texas A & M University
Robert	Tang	University of Oklahoma
Jing	Tao	University of Oklahoma
Samuel	Taylor	Yale University
Ivan	Telpukhovskiy	University of Toronto
Hung	Tran	University of Georgia
Weston	Ungemach	Stanford University
Caglar	Uyanik	University of Illinois at Urbana-Champaign
Alain	Valette	Université de Neuchâtel
Alina	Vdovina	University of Newcastle upon Tyne
Federico	Vigolo	University of Oxford
Nicholas	Vlamis	University of Michigan
Karen	Vogtmann	University of Warwick
Richard	Wade	University of British Columbia
Pei	Wang	Rutgers University
Yohsuke	Watanabe	University of Hawaii at Manoa
Derrick	Wigglesworth	University of Utah

Participants		
First Name	**Last Name**	**Institution**
Rebecca	Winarski	University of Wisconsin
Chenxi	Wu	Max-Planck-Institut für Mathematik
Miguel	Xicotencatl	Centro de Investigacion y de Estudios Avanzados del IPN
Binbin	Xu	Korea Institute for Advanced Study (KIAS)
Mehdi	Yazdi	Princeton University
Kaidi	Ye	Université d'Aix-Marseille (AMU)
Robert	Young	New York University, Courant Institute

Officially Registered Participant Information

Participants		145

Gender		145
Male	78.62%	114
Female	20.00%	29
Declined to state	1.38%	2

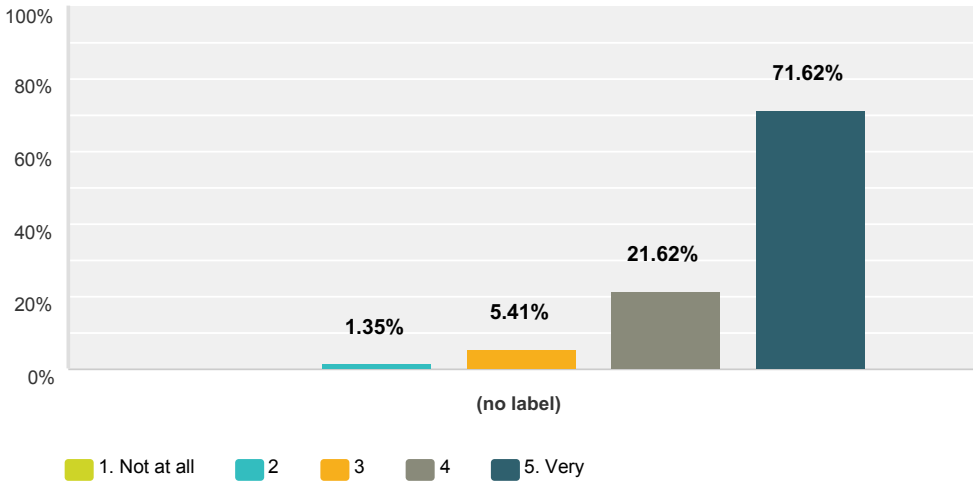
Ethnicity*		162
White	69.66%	101
Asian	20.00%	29
Hispanic	4.83%	7
Pacific Islander	0.69%	1
Black	0.69%	1
Native American	0.00%	0
Mixed	5.52%	8
Declined to state	10.34%	15

* ethnicity specifications are not exclusive

74 responses out of 145 participants = 51% response rate

Q1 The workshop was intellectually stimulating

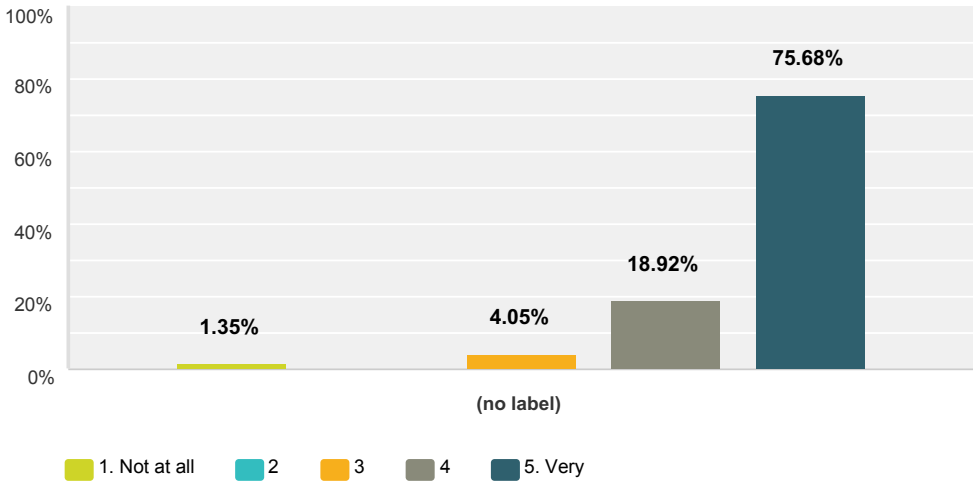
Answered: 74 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.35%** 1	**5.41%** 4	**21.62%** 16	**71.62%** 53	74	4.64

Q2 The overall experience of the workshop was worthwhile

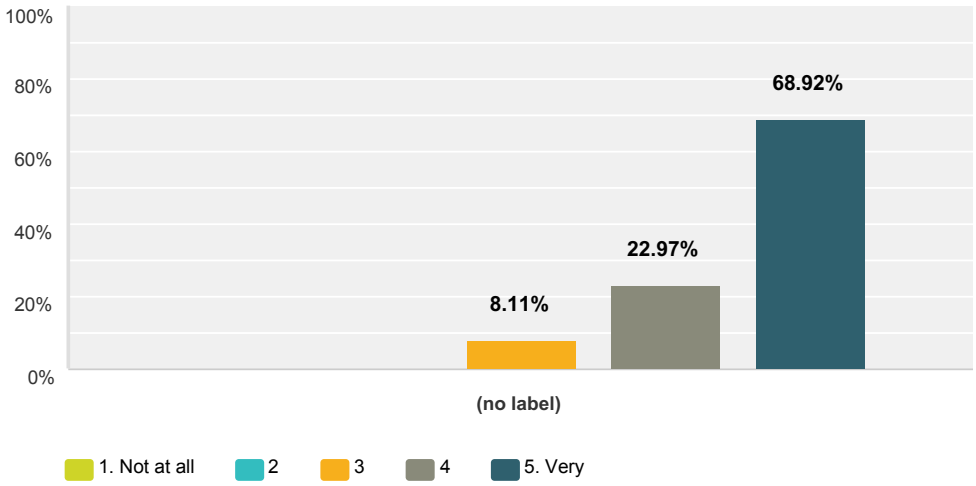
Answered: 74 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.35%** 1	**0.00%** 0	**4.05%** 3	**18.92%** 14	**75.68%** 56	74	4.68

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)	**0.00%** 0	**0.00%** 0	**8.11%** 6	**22.97%** 17	**68.92%** 51	74	4.61

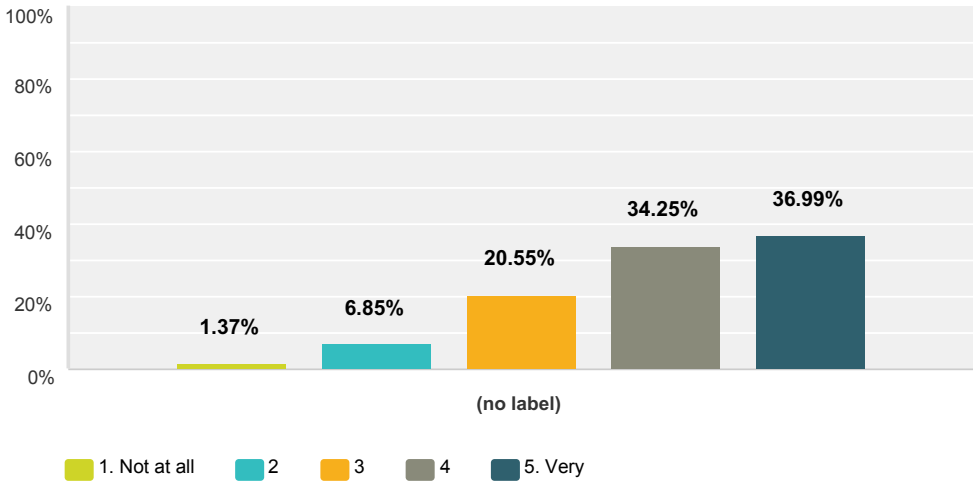
Q4 Additional comments

Answered: 12 Skipped: 62

#	Responses	Date
1	It was a very valuable event. Definitely, it will be very influential.	11/6/2016 9:17 PM
2	Excellent time shcedule !!!	11/6/2016 12:59 PM
3	Amazing workshop and amazing connections made.	11/4/2016 1:18 PM
4	It was a wonderful experience!	11/3/2016 1:38 AM
5	At a smaller workshop (<100 participants) or longer workshop (6+ days) the provided schedule definitely provides enough discussion time between lectures. However with 160 people and 4 days it felt frantic trying to speak to everyone I had something to speak to about.	10/31/2016 5:25 PM
6	Great Workshop with many interesting talks.	10/31/2016 3:40 PM
7	The topics of the talks were in most cases too specific to follow for the person not deeply interested in MCG.	10/31/2016 1:10 PM
8	With so many interesting people to talk to, I would have liked a bigger break between morning and afternoon lectures.	10/31/2016 10:59 AM
9	Ensuring sufficient vegetarian options available for lunch.	10/31/2016 10:51 AM
10	good	10/31/2016 10:50 AM
11	I had a lot of trouble at this workshop, but I don't think it was because of the choice of speakers, or anything like that. I couldn't follow the talks and I didn't have good conversations, but I think it was just me having trouble, not you.	10/31/2016 10:50 AM
12	Workshop much too focused in my opinion.	10/31/2016 10:49 AM

Q5 I was well prepared to benefit from the lectures

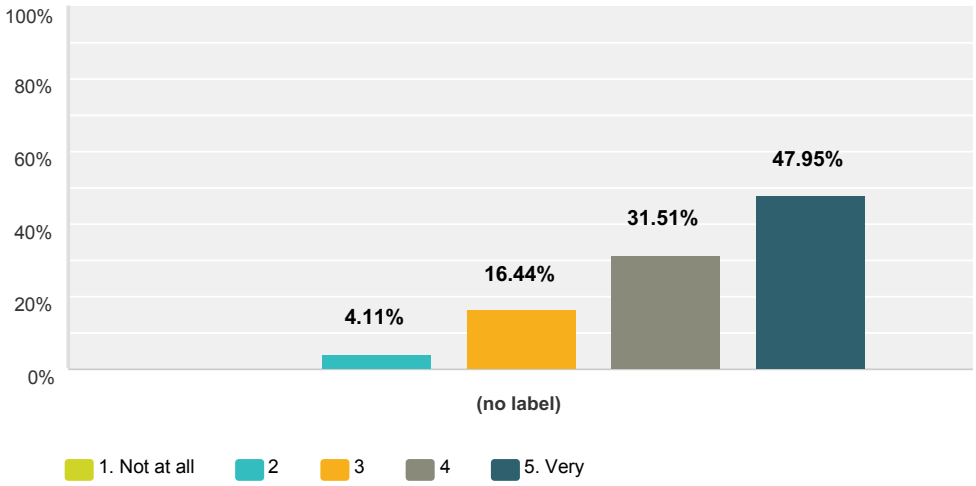
Answered: 73 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.37%** 1	**6.85%** 5	**20.55%** 15	**34.25%** 25	**36.99%** 27	73	3.99

Q6 My interest in the subject matter was increased by the workshop

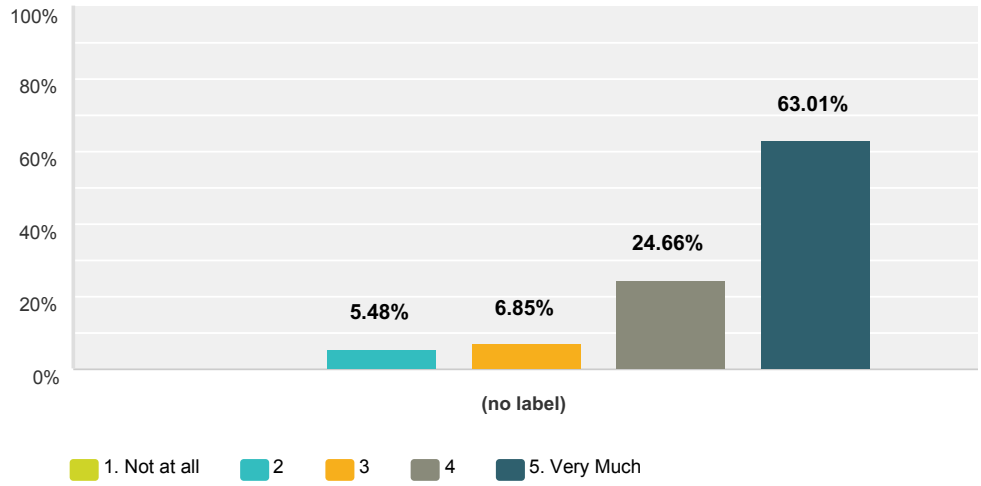
Answered: 73 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**4.11%** 3	**16.44%** 12	**31.51%** 23	**47.95%** 35	73	4.23

Q7 The workshop helped me meet people with similar scientific interests

Answered: 73 Skipped: 1



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**5.48%** 4	**6.85%** 5	**24.66%** 18	**63.01%** 46	73	4.45

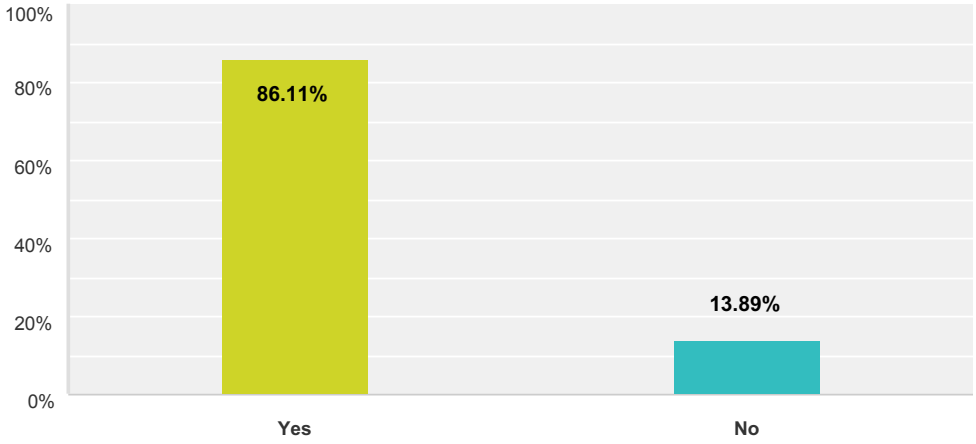
Q8 Additional comments on your personal assessment

Answered: 4 Skipped: 70

#	Responses	Date
1	The workshop really helped me in understanding some new ideas.	11/3/2016 1:39 AM
2	My scientific interests do not align only somewhat with the focus of the Workshop.	10/31/2016 6:05 PM
3	I have thought about this area for a long time, so my response to question 6 is not a criticism	10/31/2016 11:00 AM
4	should be glad to meet scientist	10/31/2016 10:52 AM

Q9 Did you attend the reception?

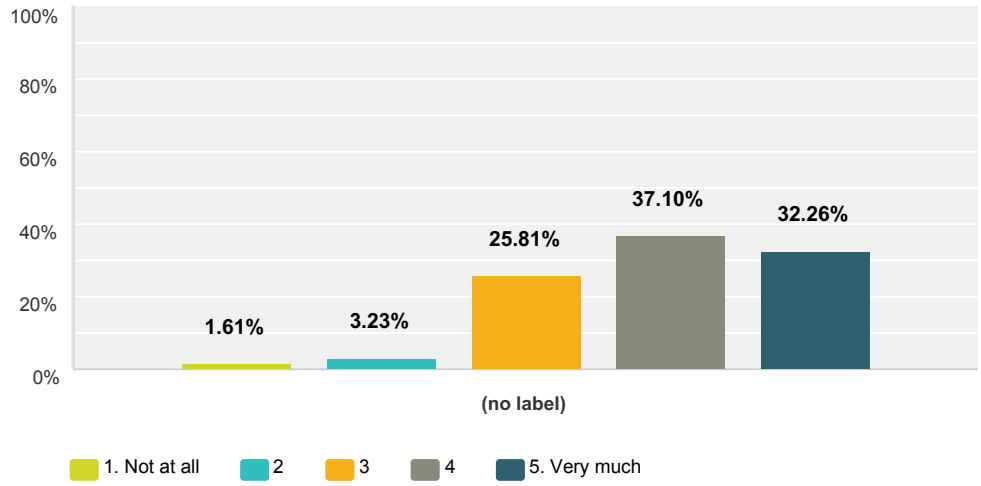
Answered: 72 Skipped: 2



Answer Choices	Responses	
Yes	86.11%	62
No	13.89%	10
Total		72

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 62 Skipped: 12



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**1.61%** 1	**3.23%** 2	**25.81%** 16	**37.10%** 23	**32.26%** 20	62	3.95

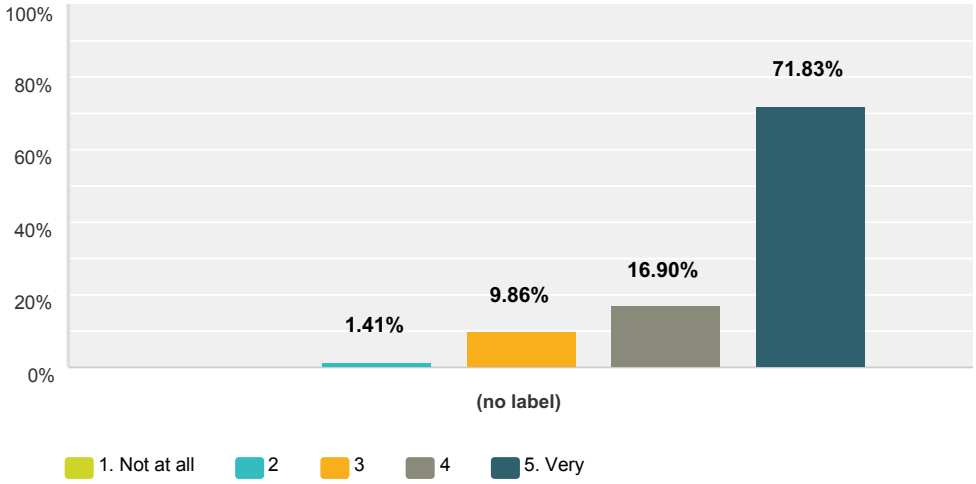
Q11 Please provide any comments about the reception

Answered: 5 Skipped: 69

#	Responses	Date
1	I remember thes very friendly and stimulating atmosphere of the reception	11/6/2016 9:21 PM
2	It was very nice, though a bigger space for the venue would have been better in my opinion, even if it was adequate.	11/4/2016 10:25 PM
3	It was okay.	11/3/2016 1:40 AM
4	The reception being on day one and the number of participants made it more a time to renew old contacts than to make new ones.	10/31/2016 5:26 PM
5	The food ran out early	10/31/2016 11:01 AM

Q12 I found the MSRI staff helpful

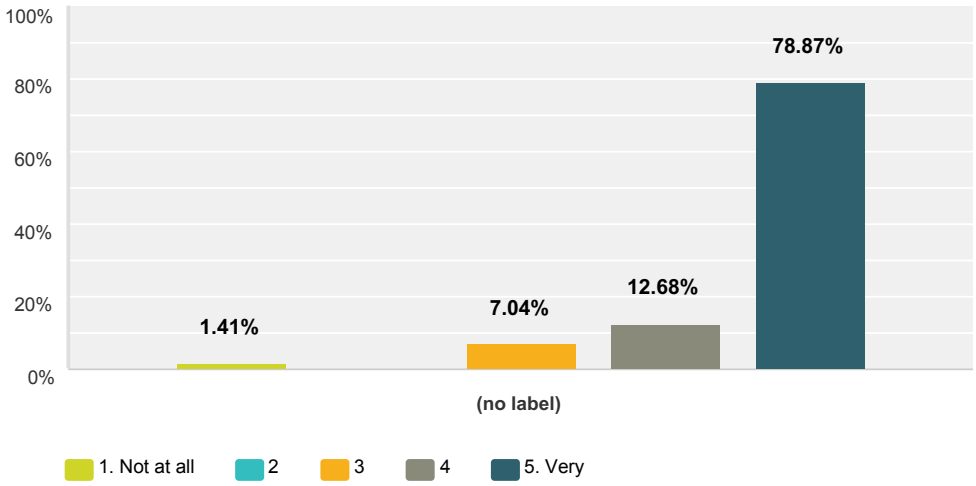
Answered: 71 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.41%** 1	**9.86%** 7	**16.90%** 12	**71.83%** 51	71	4.59

Q13 The MSRI facilities were conducive for such a workshop

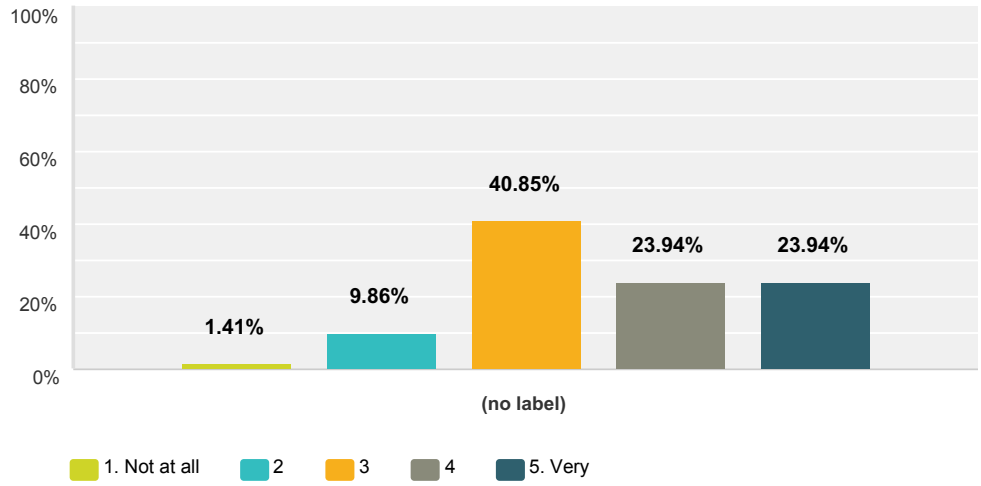
Answered: 71 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.41%** 1	**0.00%** 0	**7.04%** 5	**12.68%** 9	**78.87%** 56	71	4.68

Q14 The MSRI lunch arrangements were satisfactory

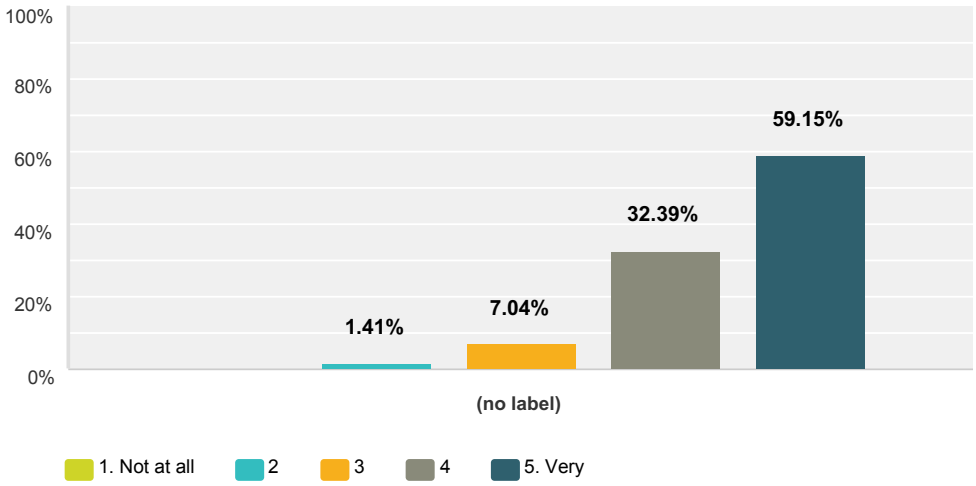
Answered: 71 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.41%** 1	**9.86%** 7	**40.85%** 29	**23.94%** 17	**23.94%** 17	71	3.59

Q15 The MSRI tea arrangements were satisfactory

Answered: 71 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.41%** 1	**7.04%** 5	**32.39%** 23	**59.15%** 42	71	4.49

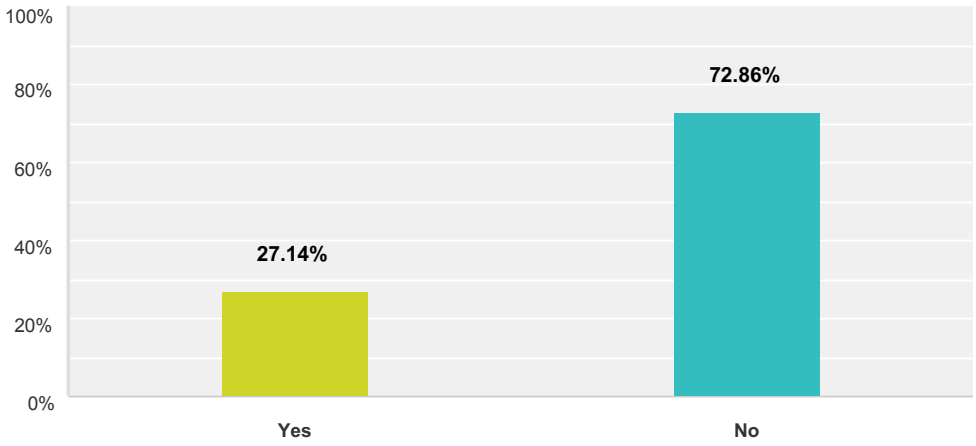
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 13 Skipped: 61

#	Responses	Date
1	I am a member. It would be better if I can order lunch as usual, since then I don't have to wait and also the queue for the non-members will be short.	11/4/2016 6:47 PM
2	As an Indian, the foods served at MSRI Lunch and Reception, were not very attractive to me. But that's okay.	11/3/2016 1:42 AM
3	I brought my own lunch	11/1/2016 5:19 PM
4	Lunch is much improved since I was here 9 years ago. I still haven't received email receipts that I was promised from the first vendor though.	11/1/2016 7:50 AM
5	More options for lunch would be good	10/31/2016 10:58 PM
6	I'd like it if there were more healthy/less sweet options for tea. The day with tangerines was great!	10/31/2016 10:37 PM
7	MSRI staff are super.	10/31/2016 6:06 PM
8	Need an N/A option for question 14, I brought packed lunch each day. Staff and facilities are excellent.	10/31/2016 5:27 PM
9	Excellent cheese cake on Friday!	10/31/2016 1:45 PM
10	The caterer on the first two days of the workshop didn't have many vegetarian options and also ran out of non-hot meals both the days.	10/31/2016 12:37 PM
11	I tend to bring my own lunch as I have unusual dietary requirements	10/31/2016 11:02 AM
12	Tea available after last talk, enough veggie options at lunch.	10/31/2016 10:53 AM
13	didn't use the lunch arrangements but can not leave that question empty	10/31/2016 10:48 AM

Q17 Did you use the computer facilities located in the library?

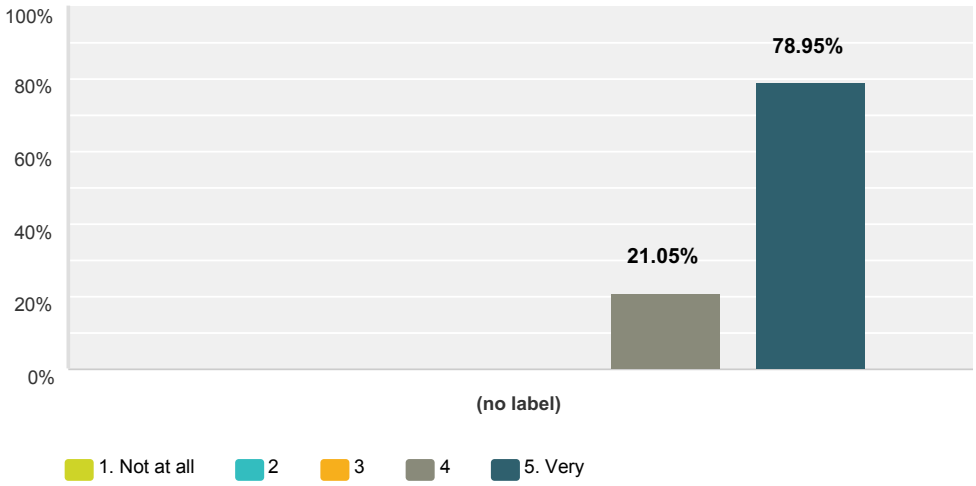
Answered: 70 Skipped: 4



Answer Choices	Responses	
Yes	27.14%	19
No	72.86%	51
Total		70

Q18 The MSRI computer facilities in the library were adequate

Answered: 19 Skipped: 55

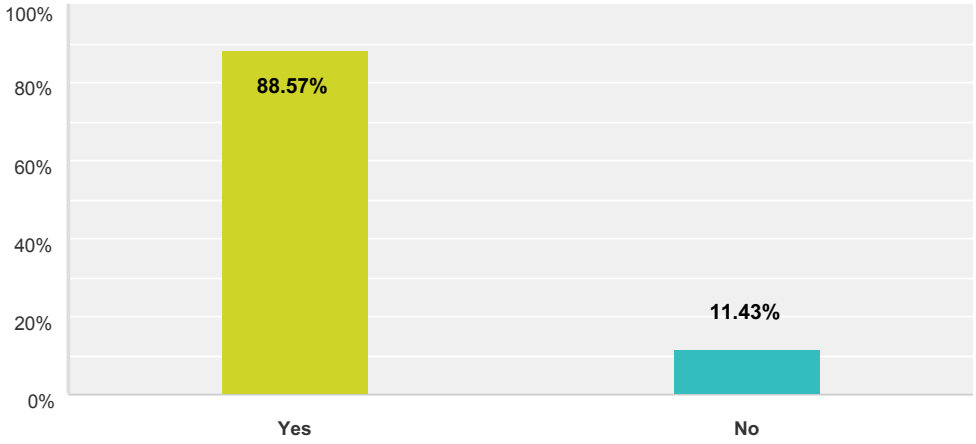


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**21.05%** 4	**78.95%** 15	19	4.79

#	Comments about computer facilities	Date
	There are no responses.	

Q19 Did you use MSRI's wireless network?

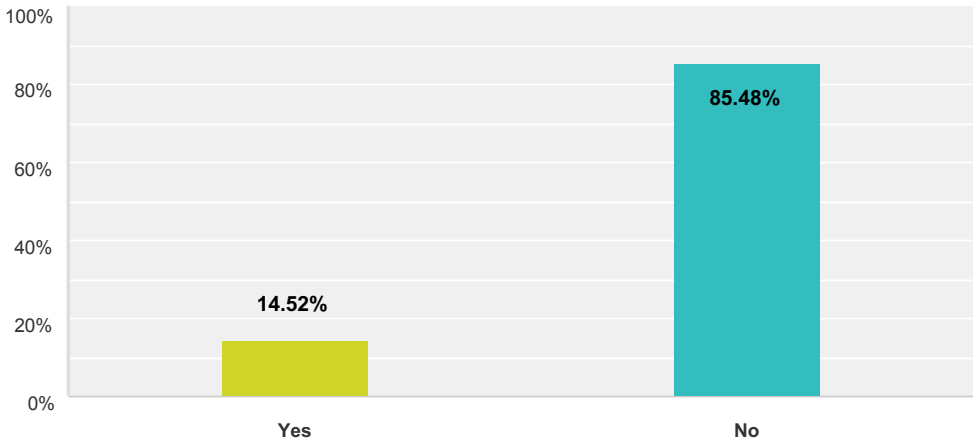
Answered: 70 Skipped: 4



Answer Choices	Responses	
Yes	88.57%	62
No	11.43%	8
Total		70

Q20 Did you experience any difficulties with the network?

Answered: 62 Skipped: 12



Answer Choices	Responses	
Yes	**14.52%**	9
No	**85.48%**	53
Total		**62**

#	Please if yes, please describe your difficulties	Date
1	intermittent disconnections	11/4/2016 8:56 AM
2	I couldn't figure out how to print, and had to get a member to do this for me.	11/1/2016 7:51 AM
3	No dropbox available	11/1/2016 12:42 AM
4	Does not work well outdoors close to the building (e.g. the terrace next to the common room would be convenient)	10/31/2016 11:00 PM
5	The guest network does something so that Dropbox does not want to connect, so I had to use a VPN whenever I was on the network	10/31/2016 10:38 PM
6	Dropbox is not permitted on the guest network. This service is necessary for successful collaboration.	10/31/2016 2:07 PM
7	Couldn't use Dropbox as the network is not secure.	10/31/2016 10:53 AM
8	Dropbox couldn't synchronize my source files for a paper I was working on.	10/31/2016 10:51 AM
9	Dropbox still completely blocked, preventing me from easily consulting my work in progress. But I found my way around.	10/31/2016 10:48 AM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 8 Skipped: 66

#	Responses	Date
1	The iphone connection in the area around MSRI was poor.	11/6/2016 9:23 PM
2	As mentioned before, I think the only comment I can make would be on the reception. A larger venue would have been much appreciated.	11/4/2016 10:27 PM
3	I hope the two side screens in the auditorium will be fixed soon.	11/4/2016 6:48 PM
4	MSRI provided me the reimbursement (hotel stay and daily allowance) through a cheque, which when I encashed in the Bank of America branch downhill, cost me $8 as service charge. MSRI should provide the money as cash.	11/3/2016 1:45 AM
5	MSRI is a wonderful place to come and work. Please keep up the great work you do here.	11/2/2016 9:45 AM
6	More funding for participants would always help! Grant money in Europe is getting more and more scarce, and the amount of funding offered doesn't go very far for someone coming from abroad.	11/1/2016 7:52 AM
7	I wish you had eduroam wireless netwrok in MSRI.	10/31/2016 3:42 PM
8	It would be useful to have a list of restaurants for dinner and breakfast	10/31/2016 11:30 AM

Groups acting on CAT(0) spaces

September 27, 2016 - September 30, 2016

MSRI, Berkeley, CA, USA

Organizers:

Ian Agol (University of California, Berkeley)

Pierre-Emmanuel Caprace (Université Catholique de Louvain)

Koji Fujiwara (Kyoto University)

Alessandra Iozzi (ETH Zürich)

Michah Sageev (Technion---Israel Institute of Technology)

REPORT ON THE MSRI WORKSHOP "GROUP ACTING ON CAT (0) SPACES" SEPTEMBER 27-30, 2016

Organizers

- Ian Agol (University of California, Berkeley)
- Pierre-Emmanuel Caprace (Université Catholique de Louvain)
- Koji Fujiwara (Kyoto University)
- Alessandra Iozzi (ETH Zürich)
- Michah Sageev (Technion---Israel Institute of Technology)

Scientific Description

This workshop was part of the semester-long *Geometric Group Theory* program. The theme of the workshop was algebraic, geometric and analytical aspects of groups that act by isometries on spaces of non-positive curvature known as CAT(0) spaces. The world of CAT(0) spaces includes classical spaces such as symmetric spaces and buildings, as well as more avant-garde arrivals, such as CAT(0) cube complex. The workshop brought together researchers studying various aspects of such groups and spaces to discuss recent developments and chart new directions in the field. A list of speakers and the schedule is attached.

Highlights of the Workshop

The workshop illustrated quite well the liveliness of the field, and especially its ramifications and interrelations with neighboring areas.

One highlight was the talk by Piotr Prytycki. The use of some fundamental concepts from geometric group theory in the study of groups of birational transformations has been pioneered by Cantat-Lamy, who solved a century-old problem from algebraic geometry by showing that the Cremona group of the complex projective plane is acylindrically hyperbolic, and hence cannot be simple. In the study of groups of birational transformations, very little is known beyond dimension 2. Piotr discussed joint work with S. Lamy on their remarkable contribution in the study of the 3-dimensional case, showing that the tame automorphism group of the 3-dimensional complex affine space is acylindrically hyperbolic. The techniques rely on an ingenious combination of combinatorial arguments from geometric group theory with algebraic geometry. This also provides further evidence for the fundamental unifying feature of the concept of acylindrical hyperbolicity.

Another highlight was Uri Bader's talk on his joint work with Pierre-Emmanuel Caprace and Jean Lécureux on the linearity/non-linearity of lattices in affine buildings. While classical ones are linear by definition, their striking theorem says that exotic ones are not. This work relies on a beautiful geometric construction called the singular Cartan flow, as well as the groundbreaking ergodic machinery of Bader and Furman.

In another direction, the talk by Schwer also showed how certain specific combinatorial considerations on Coxeter groups and affine buildings, that pertain to geometric group theory, are actually relevant to answer basic questions on affine Deligne-Lusztig varieties.

The talk by Dominique Hulin presented a fundamental theorem on the existence of harmonic maps at finite distance from any quasi-isometry between rank one symmetric spaces. This provides in particular the definitive solution to a classical conjecture by R. Schoen from 1993 and its strengthening by Li-Wang in 1998.

The talk by Roman Sauer reported important progress providing upper bounds on the torsion in the homology of Riemannian manifolds with pinched negative curvature.

The workshop also illustrated well how much CAT(0) cube complexes have become pervasive in geometric group theory (talks by Fernos, Jankiewicz, Haettel, Hagen, Lazarovich, Mackay, Sisto, Thomas), and are studied and used from a wide variety of viewpoints.

MSRI Mathematical Sciences Research Institute

Groups acting on CAT(0) spaces

September 27-30, 2016

Schedule

Tuesday, September 27, 2016			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:20 AM	Simons Auditorium	Yves Benoist	On dense subgroups of Lie groups
10:20 AM - 11:00 AM	Atrium		Coffee Break
11:00 AM - 11:50 PM	Simons Auditorium	Roman Sauer	Homotopy and homology complexity in negative curvature
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 2:50 PM	Simons Auditorium	Petra Schwer	Geometric methods for affine Deligne Lusztig varieties
2:50 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:20 PM	Simons Auditorium	Ursula Hamenstädt	Hyperbolicity in CAT(0)-spaces
4:30 PM - 6:20 PM	Atrium		Reception

Wendnesday , September 28, 2016			
9:00 AM - 9:50 AM	Simons Auditorium	Piotr Przytycki	Tame automorphism group
9:50 AM - 10:30 AM	Atrium		Coffee Break
10:30 AM - 11:20 PM	Simons Auditorium	Alessandro Sisto	Hierarchically hyperbolic structures on cube complexes and applications
11:40 AM - 12:30 PM	Simons Auditorium	Mark Hagen	Cubical geometry via hyperbolicity

Thursday, September 29, 2016			
9:00 AM - 09:50 AM	Simons Auditorium	Ruth Charney	Quasi-mobius maps between Morse boundaries of CAT(0) spaces
9:50 AM - 10:30 AM	Atrium		Coffee Break
10:30 AM - 11:20 AM	Simons Auditorium	Nir Lazarovich	Cubical accessibility and bounds on curves on surfaces
11:40 AM - 12:30 PM	Simons Auditorium	Dominique Hulin	Harmonic quasiisometries
12:30 PM - 2:30 PM	Atrium		Lunch
2:30 PM - 3:20 PM	Simons Auditorium	Kasia Jankiewicz	Cocompactly cubulated Artin groups
3:20 PM - 4:00 PM	Atrium		Tea
4:00 PM - 4:50 PM	Simons Auditorium	Thomas Haettel	Artin groups and nonpositive curvature

Friday, September 30, 2016			
9:30 AM - 10:20 AM	Simons Auditorium	Uri Bader	On the linearity of lattices in affine buildings
10:20 AM - 11:00 AM	Atrium		Coffee Break
11:00 AM - 11:50 PM	Simons Auditorium	Talia Fernós	Regular Isometries of CAT(0) Cube Complexes are Plentiful
11:50 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 2:50 PM	Simons Auditorium	John Mackay	Which random groups are cubulated
2:50 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:20 PM	Simons Auditorium	Anne Thomas	Quasi-isometry and commensurability classification of certain right-angled Coxeter groups

Organizers		
First Name	**Last Name**	**Institution**
Ian	Agol	University of California, Berkeley
Pierre-Emmanuel	Caprace	Université Catholique de Louvain
Koji	Fujiwara	Kyoto University
Alessandra	Iozzi	ETH Zürich
Michah	Sageev	Technion---Israel Institute of Technology
Speakers		
First Name	**Last Name**	**Institution**
Uri	Bader	Weizmann Institute of Science
Yves	Benoist	Université de Paris XI
Ruth	Charney	Brandeis University
Talia	Fernós	University of North Carolina
Thomas	Haettel	Université de Montpellier
Mark	Hagen	University of Cambridge
Ursula	Hamenstädt	Universität Bonn
Dominique	Hulin	Université de Paris XI
Kasia	Jankiewicz	McGill University
Nir	Lazarovich	ETH Zürich
John	Mackay	University of Bristol
Piotr	Przytycki	McGill University
Roman	Sauer	Karlsruhe Institute of Technology
Petra	Schwer	Karlsruhe Institute of Technology
Alessandro	Sisto	ETH
Anne	Thomas	University of Sydney

Participants

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Robert	Bell	Michigan State University
Yves	Benoist	Université de Paris XI
Michael	Ben-Zvi	Tufts University
Maxime	Bergeron	University of Chicago
Corey	Bregman	Rice University
Nathan	Broaddus	Ohio State University
Nic	Brody	University of California, Berkeley
Nicholas	Cahill	University of Utah
Michael	Cantrell	University of Illinois, Chicago
Pierre-Emmanuel	Caprace	Université Catholique de Louvain
Yu-Chan	Chang	Louisiana State University
Ruth	Charney	Brandeis University
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Rex	Cheung	Yale University
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Tommaso	Cremaschi	Boston College
Charles	Cunningham	Bowdoin College
François	Dahmani	Université de Grenoble I (Joseph Fourier)
Pallavi	Dani	Louisiana State University
Michael	Davis	Ohio State University
Carlos Alberto	De la Cruz Mengual	ETH Zürich
Spencer	Dowdall	Vanderbilt University
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Thibaut	Dumont	University of Utah
Matthew	Durham	University of Michigan
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Eduard	Einstein	Cornell University
Abdelrhman	Elkasapy	Max Planck institute for Mathematics in the Sciences
Michael	Falk	Northern Arizona University
James	Farre	University of Utah
Mark	Feighn	Rutgers University
Talia	Fernós	University of North Carolina
Elia	Fioravanti	University of Oxford
Max	Forester	University of Oklahoma
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Steven	Kerckhoff	Stanford University
Sang-hyun	Kim	Seoul National University
Thomas	Koberda	University of Virginia
Sadayoshi	Kojima	Tokyo Institute of Technology
Takefumi	Kondo	Kagoshima University
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Robert	Kropholler	University of Oxford
Erika	Kuno	Tokyo Institute of Technology
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Arie	Levit	Weizmann Institute of Science
Gilbert	Levitt	Université de Caen
John	Lott	University of California, Berkeley
Joel	Louwsma	Niagara University
John	Mackay	University of Bristol
Joseph	Maher	College of Staten Island, CUNY
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Mahan	Mj	Tata Institute of Fundamental Research
Shahar	Mozes	Hebrew University
Devin	Murray	Brandeis University
Thomas	Ng	Temple University
Sangrok	O	Korea Advanced Institute of Science and Technology (KAIST)
Christopher	O'Donnell	Tufts University
Andreas	Ott	Ruprecht-Karls-Universität Heidelberg
Julien	Paupert	Arizona State University
Catherine	Pfaff	University of California, Santa Barbara
Paul	Plummer	University of Oklahoma
Piotr	Przytycki	McGill University
Jessica	Purcell	Monash University
Kasra	Rafi	University of Toronto
Alan	Reid	University of Texas
Jacob	Russell	City University of New York (CUNY)
Michah	Sageev	Technion---Israel Institute of Technology
Bakul	Sathaye	Ohio State University
Roman	Sauer	Karlsruhe Institute of Technology
Kevin	Schreve	University of Michigan
Petra	Schwer	Karlsruhe Institute of Technology
Zlil	Sela	Hebrew University
Alessandro	Sisto	ETH
Ignat	Soroko	University of Oklahoma
Juan	Souto	Institut de Recherche Mathematique (IRMAR)
Davide	Spriano	ETH Zürich
Emily	Stark	University of Haifa
Micky	Steinberg	University of Wisconsin-Madison
Karol	Strzałkowski	Polish Academy of Sciences
Benjamin	Stucky	University of Oklahoma
Hongbin	Sun	University of California, Berkeley
Robert	Tang	University of Oklahoma
Jing	Tao	University of Oklahoma
Samuel	Taylor	Yale University
Anne	Thomas	University of Sydney
Tetsu	Toyoda	National Institute of Technology, Suzuka college
Alain	Valette	Université de Neuchâtel
Federico	Vigolo	University of Oxford
Richard	Wade	University of British Columbia
Genevieve	Walsh	Tufts University
Pei	Wang	Rutgers University
Joseph	Wells	Arizona State University
Robert	Williams	University of Virginia
Henry	Wilton	Center for Mathematical Sciences
Chenxi	Wu	Cornell University

Participants		
First Name	**Last Name**	**Institution**
Robert	Young	New York University, Courant Institute
Feng	Zhu	University of Michigan

Officially Registered Participant Information

Participants		140

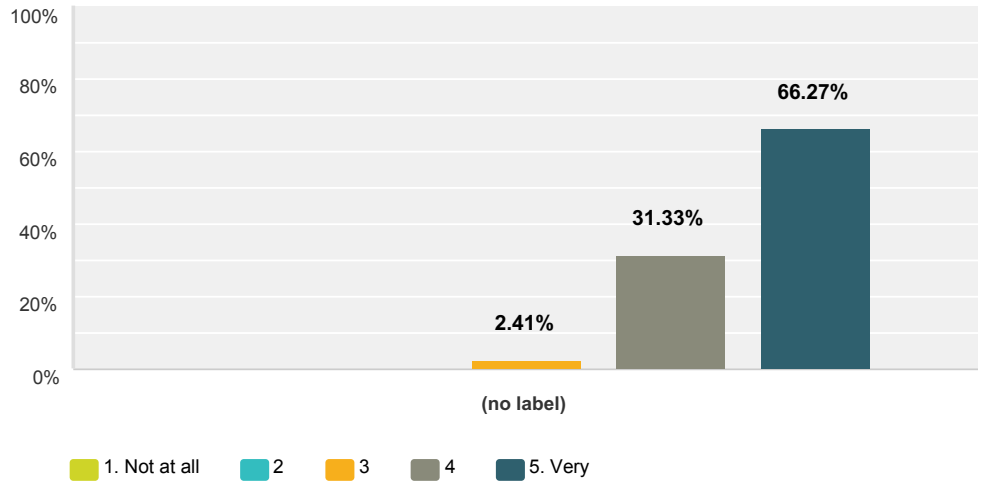
Gender		140
Male	78.57%	110
Female	20.00%	28
Declined to state	1.43%	2
Ethnicity*		**162**
White	72.86%	102
Asian	17.86%	25
Hispanic	3.57%	5
Pacific Islander	0.00%	0
Black	0.71%	1
Native American	0.00%	0
Mixed	7.86%	11
Declined to state	12.86%	18

* ethnicity specifications are not exclusive

83 responses out of 143 participants = 59% response rate

Q1 The workshop was intellectually stimulating

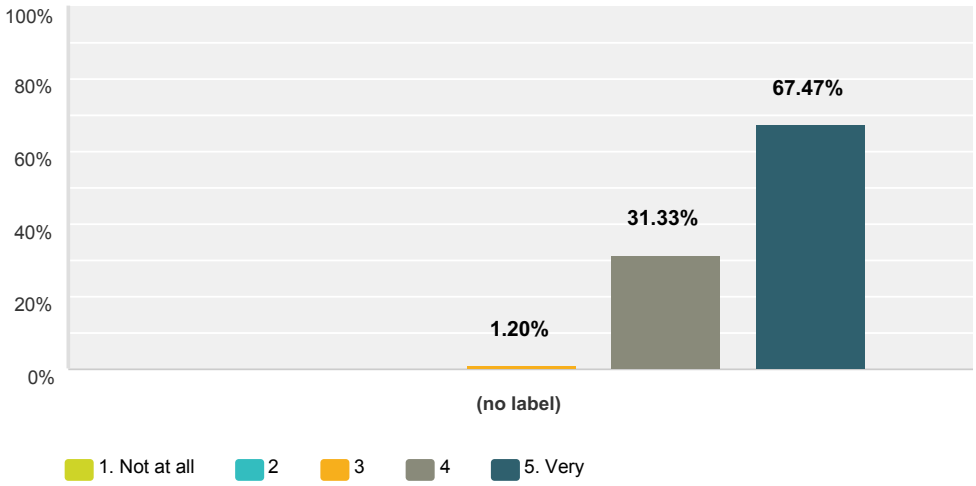
Answered: 83 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	2.41% 2	31.33% 26	66.27% 55	83	4.64

Q2 The overall experience of the workshop was worthwhile

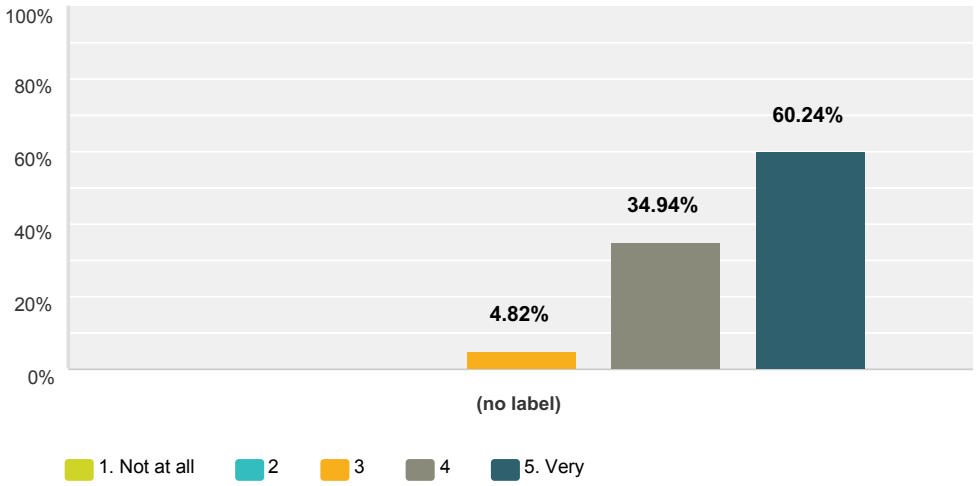
Answered: 83 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.20%** 1	**31.33%** 26	**67.47%** 56	83	4.66

Q3 The time between lectures was adequate for discussion

Answered: 83 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**4.82%** 4	**34.94%** 29	**60.24%** 50	83	4.55

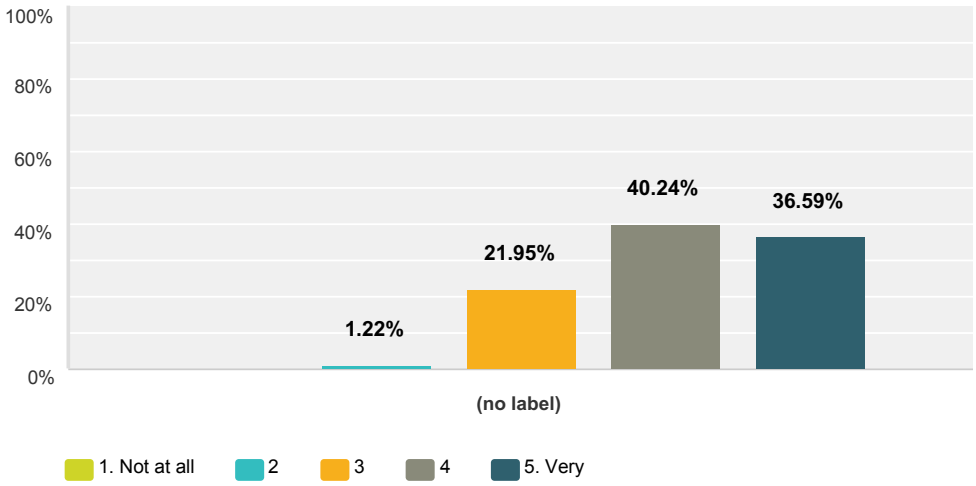
Q4 Additional comments

Answered: 5 Skipped: 78

#	Responses	Date
1	The best part was the personal discussions I had; I appreciate the chance to talk with other people knowledgable about the same things.	11/4/2016 8:44 AM
2	In my opinion there was a lack of "conducting line" in the topics covered; many interesting but not outstanding contributions, or in specialized topics which should have required more time to be considered seriously.	10/7/2016 4:14 PM
3	Good work with the constant supply of coffee. Keep it up!	10/7/2016 3:06 PM
4	Was a great conference.	10/3/2016 11:33 AM
5	MSRI is a well-oiled machine. The conference was very well run.	9/30/2016 11:11 PM

Q5 I was well prepared to benefit from the lectures

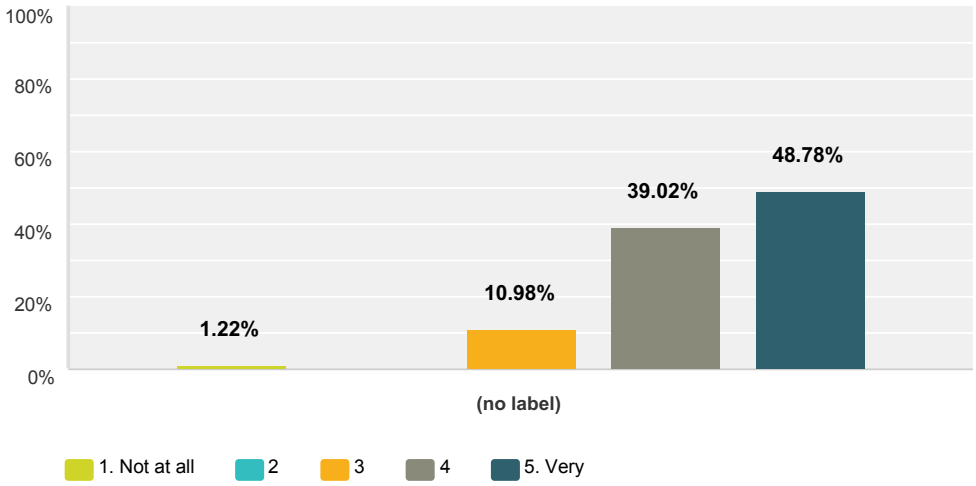
Answered: 82 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	1.22% 1	21.95% 18	40.24% 33	36.59% 30	82	4.12

Q6 My interest in the subject matter was increased by the workshop

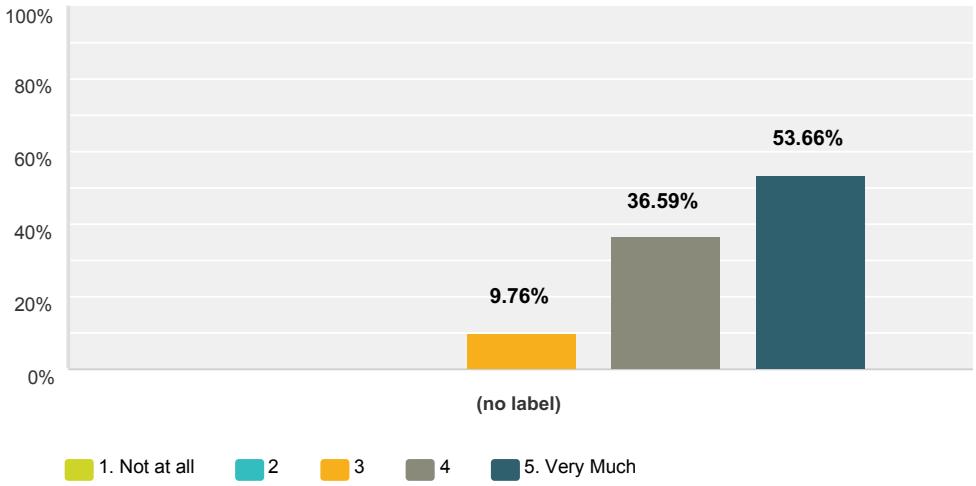
Answered: 82 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.22%** 1	**0.00%** 0	**10.98%** 9	**39.02%** 32	**48.78%** 40	82	4.34

Q7 The workshop helped me meet people with similar scientific interests

Answered: 82 Skipped: 1



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**9.76%** 8	**36.59%** 30	**53.66%** 44	82	4.44

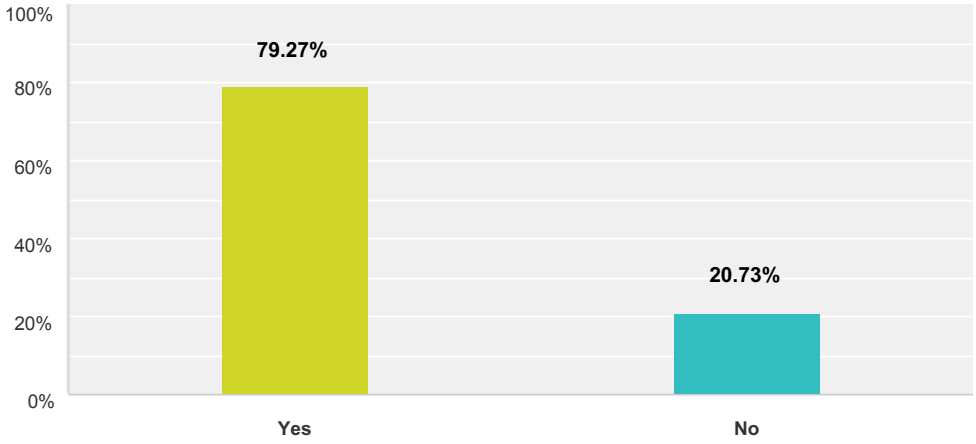
Q8 Additional comments on your personal assessment

Answered: 0 Skipped: 83

#	Responses	Date
	There are no responses.	

Q9 Did you attend the reception?

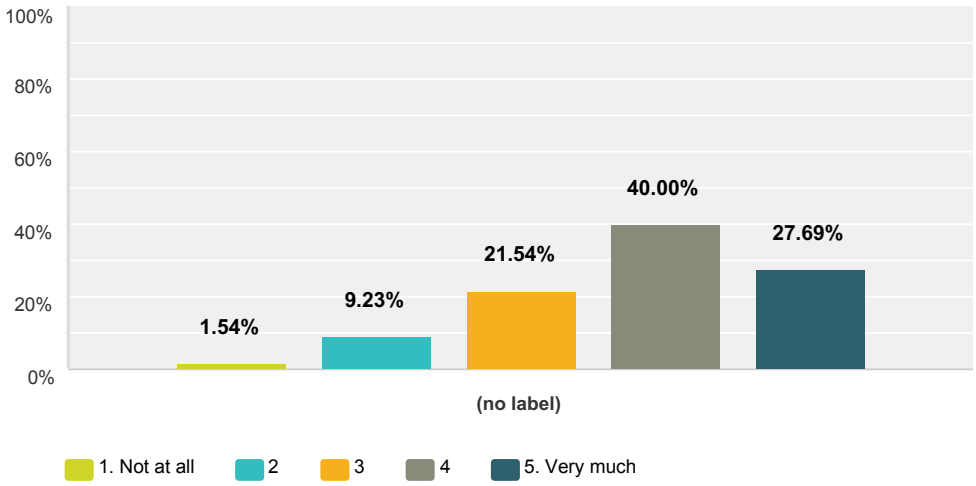
Answered: 82 Skipped: 1



Answer Choices	Responses	
Yes	**79.27%**	65
No	**20.73%**	17
Total		**82**

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 65 Skipped: 18



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**1.54%** 1	**9.23%** 6	**21.54%** 14	**40.00%** 26	**27.69%** 18	65	3.83

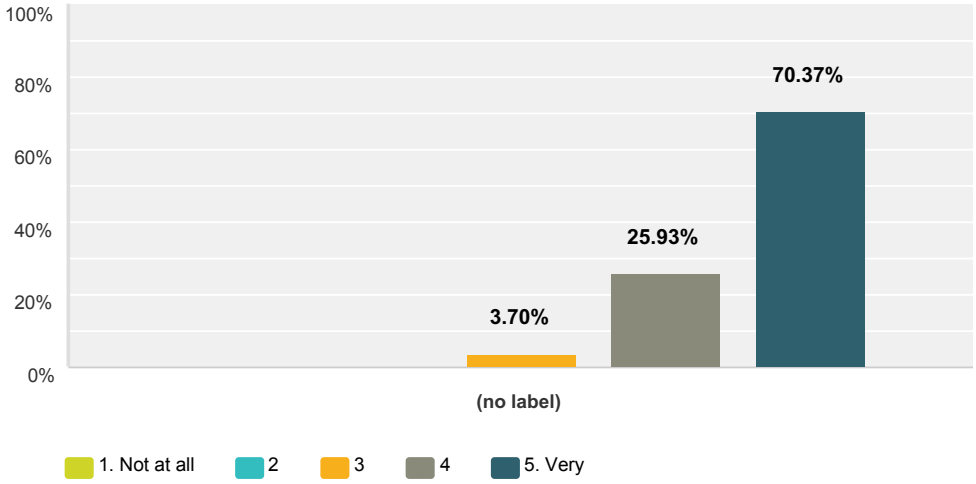
Q11 Please provide any comments about the reception

Answered: 5 Skipped: 78

#	Responses	Date
1	Fun, I met a few new people	11/4/2016 8:45 AM
2	Being at the beginning of the workshop I had not yet met with some of my new contacts by the time of the reception.	10/7/2016 5:19 PM
3	I think having the reception later in the week may have been preferable.	10/3/2016 11:46 AM
4	Might be useful to have signs indicating which foods are vegan.	9/30/2016 5:23 PM
5	Reception on the first day does not help solidify contacts which were not made yet.	9/30/2016 3:33 PM

Q12 I found the MSRI staff helpful

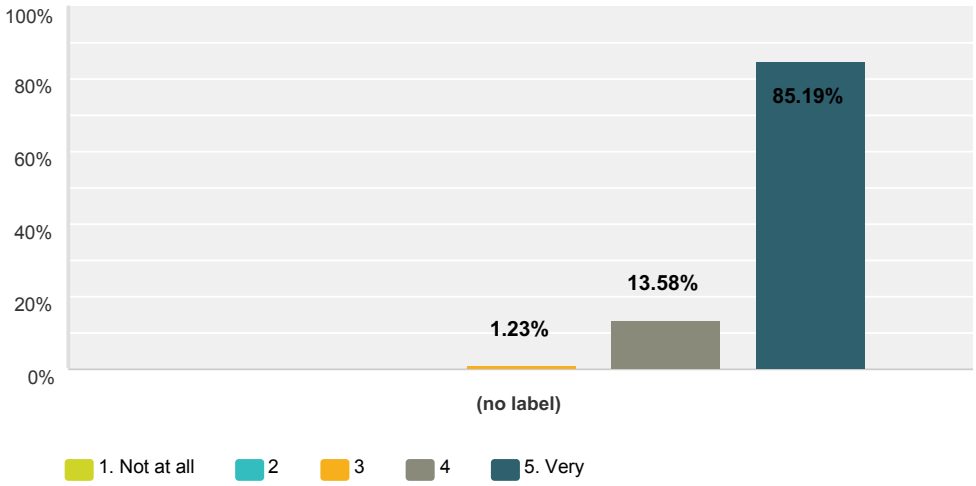
Answered: 81 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.70%** 3	**25.93%** 21	**70.37%** 57	81	4.67

Q13 The MSRI facilities were conducive for such a workshop

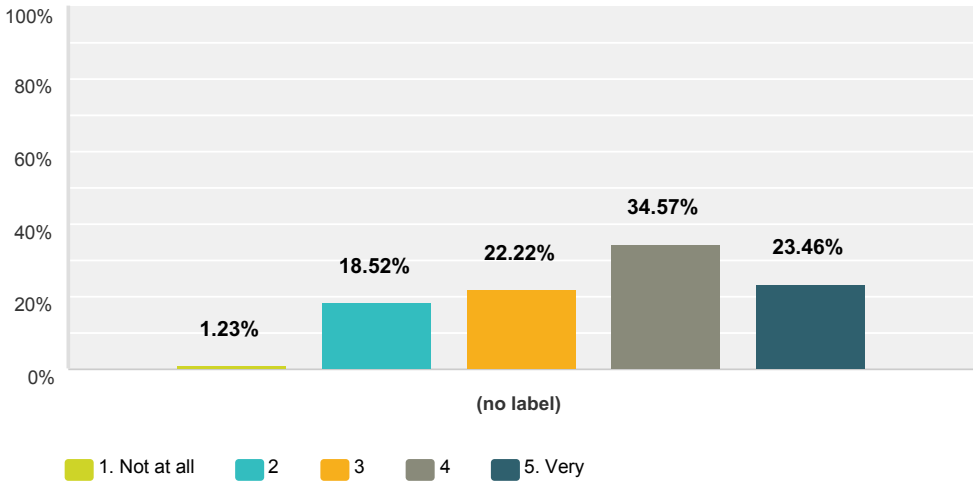
Answered: 81 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.23%** 1	**13.58%** 11	**85.19%** 69	81	4.84

Q14 The MSRI lunch arrangements were satisfactory

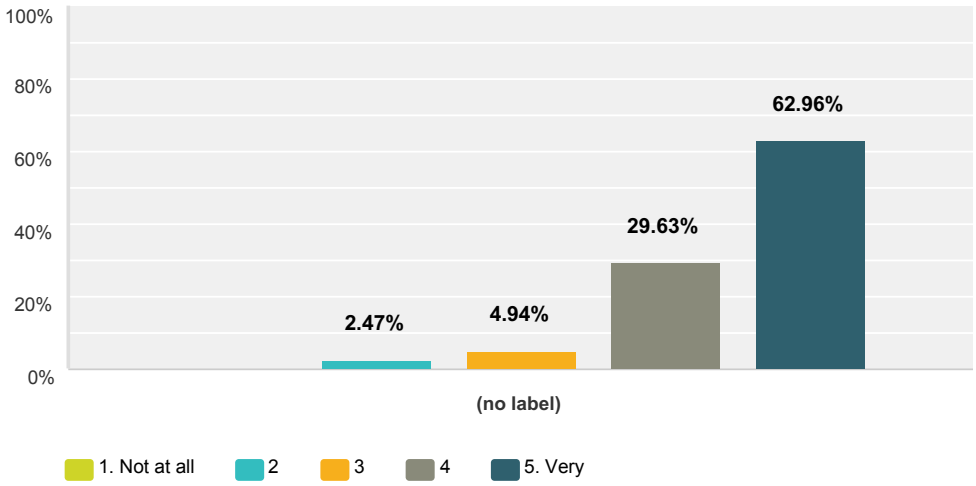
Answered: 81 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	1.23% 1	18.52% 15	22.22% 18	34.57% 28	23.46% 19	81	3.60

Q15 The MSRI tea arrangements were satisfactory

Answered: 81 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.47%** 2	**4.94%** 4	**29.63%** 24	**62.96%** 51	81	4.53

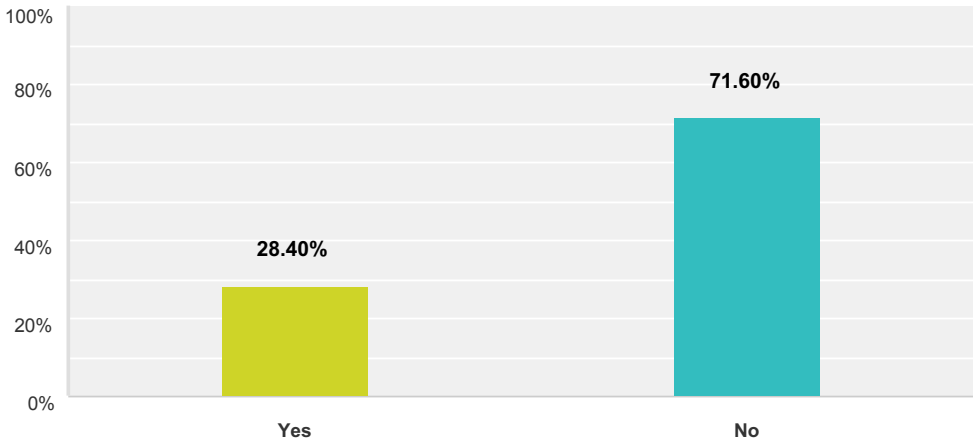
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 10 Skipped: 73

#	Responses	Date
1	Lunch has gotten much much better than it used to be. I really like it, and it is also nice to be able to order food.	11/4/2016 8:46 AM
2	Wednesday lunch would have been nice	10/8/2016 8:03 PM
3	The food is rather pricey and not commensurate to the quality	10/7/2016 5:21 PM
4	Soda/juices would be welcome in tea breaks. In general, the lack of lunch place (as in IAS Princeton) is a serious weakness of MSRI in my opinion.	10/7/2016 4:17 PM
5	Should have a compost to reduce trash, and an adequate bin for the bigger plastic	10/7/2016 4:14 PM
6	Lunch options were very limited and nutritionally incomplete (e.g., basically no protein) for people who don't/can't consume animal products (I was one of more than a few). Similarly, the tea options for people like me are very limited, but this is easier to fix. For instance, having fruit, nuts, and fresh vegetables available at all teas would go a long way toward accommodating people who can't eat cheesecake. On bagel days, one could provide some vegan spread, e.g. hummus.	10/4/2016 2:29 PM
7	Ran out of lunch food on Thursday, which was disappointing.	10/3/2016 9:36 AM
8	Not enough food. Ran out of lunch sandwiches.	9/30/2016 6:07 PM
9	It would be nice to have a pitcher of water living next to the tea.	9/30/2016 5:23 PM
10	The lunch is repetitive, and the queue generally moves slowly, good things can be gone if you are not quick enough getting from the talk.	9/30/2016 4:34 PM

Q17 Did you use the computer facilities located in the library?

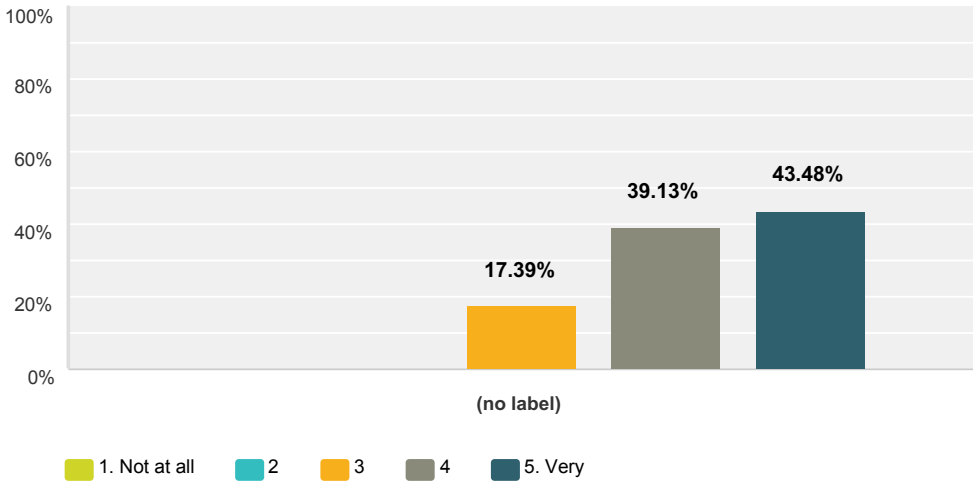
Answered: 81 Skipped: 2



Answer Choices	Responses	
Yes	28.40%	23
No	71.60%	58
Total		81

Q18 The MSRI computer facilities in the library were adequate

Answered: 23 Skipped: 60

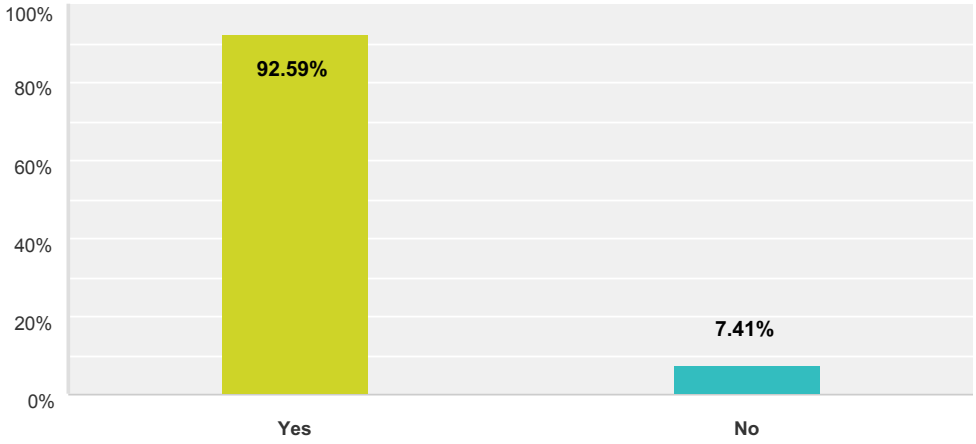


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**17.39%** 4	**39.13%** 9	**43.48%** 10	23	4.26

#	Comments about computer facilities	Date
1	ok so printer wasn't really working smoothly...	10/15/2016 7:06 PM
2	Printing happens after 3 min delay, or doesn't happen at all.	10/7/2016 3:16 PM
3	Some technical issues trying to connect laptop to one library printer, but the color printer worked.	9/30/2016 5:24 PM

Q19 Did you use MSRI's wireless network?

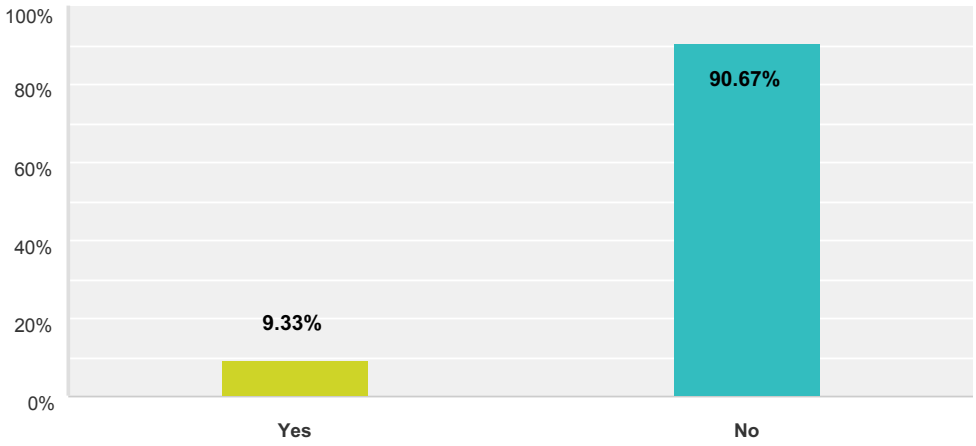
Answered: 81 Skipped: 2



Answer Choices	Responses	
Yes	**92.59%**	75
No	**7.41%**	6
Total		**81**

Q20 Did you experience any difficulties with the network?

Answered: 75 Skipped: 8



Answer Choices	Responses	
Yes	**9.33%**	7
No	**90.67%**	68
Total		**75**

#	Please if yes, please describe your difficulties	Date
1	too slow	1/22/2017 5:40 PM
2	Had some trouble connecting. Had to have my computer forget the network and then reconnect.	10/14/2016 12:43 PM
3	We didn't get instructions on how to connect from a phone (you have to open up the msri.org page), so i had to guess that for myself.	10/13/2016 1:07 PM
4	Apparently Dropbox is blocked by the guest networked.	10/1/2016 4:41 PM
5	One day (9/27/16, I believe, or maybe 9/28/16), I could not access the internet at all in the Simons auditorium. It is possible that this was an issue with my own laptop, though. The rest of the time, throughout the building, it worked well.	9/30/2016 11:17 PM
6	The MSRI members network is great. The MSRI guest network is very limiting. It seems to prohibit SMTP access to email and Dropbox syncing. It would be helpful to extend these features to guests.	9/30/2016 4:02 PM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 80

#	Responses	Date
1	Great conference.	11/4/2016 8:46 AM
2	MSRI and it's administration are wholly excellent.	10/4/2016 2:29 PM
3	One of the window blind sticks in the library is broken (the big window by the printers)	9/30/2016 5:26 PM

Connections for Women: Analytic Number Theory

February 02, 2017 - February 03, 2017

MSRI, Berkeley, CA, USA

Organizers:

Chantal David (Concordia University)

Kaisa Matomäki (University of Turku)

Lillian Pierce (Duke University)

Kannan Soundararajan (Stanford University)

Terence Tao (University of California, Los Angeles)

REPORT ON THE MSRI WORKSHOP "CONNECTIONS FOR WOMEN: ANALYTIC NUMBER THEORY" FEBRUARY 2-3, 2017

Organizers

- Chantal David (Concordia University)
- Kaisa Matomäki (University of Turku)
- Lillian Pierce (Duke University)
- Kannan Soundararajan (Stanford University)
- Terence Tao (University of California, Los Angeles)

Scientific Description

The Connections for Women workshop was the opening activity for the semester-long scientific program on Analytic Number Theory. In recent years, many important classical questions in analytic number theory have seen spectacular advances based on new techniques; conversely, methods developed in analytic number theory have, sometimes unexpectedly, led to the solution of striking problems in other fields such as harmonic analysis (including the Langlands programme), ergodic theory and dynamics (especially on homogenous spaces), additive and multiplicative combinatorics and theoretical computer science (in particular, through the theory of expander graphs).

This workshop consisted of lectures on the current state of research in analytic number theory, given by prominent women and men in the field. The workshop was open to all graduate students, post-docs, and researchers in areas related to the program; it included a panel discussion session among female researchers on career issues, as well as other social events.

Highlights of the Workshop

The workshop talks and panel discussion were well received by the participants. The ten research talks were for the great majority clear and contained interesting and unexpected results. The audience took active part in those talks. In addition to the lectures, we had two special highlights during the conference: Firstly, a very interesting poster session which gave junior participants a great opportunity to present their work. Secondly, a lively career panel with discussion topics ranging from sexual harassment to reference letters. We invited Katrin Wehrheim from UC Berkeley to participate in the panel, and her presence and energy were appreciated by the participants. The panel was very well attended; so much that perhaps a larger room could be used in the future.

There was a lot of interaction between participants and lecturers, particularly during the tea breaks. In particular, female participants were able to get to know each other during the workshop breaks and the conference dinner, many commented on the benefits of such socializing.

Mathematical Sciences Research Institute

Connections for Women: Analytic Number Theory

February 2-3, 2017

Schedule

Thursday, February 2, 2017			
9:00AM - 9:15AM	Simons Auditorium		Welcome
9:15AM - 10:15AM	Simons Auditorium	Lilian Matthiesen	Correlations of multiplicative functions
10:15AM - 10:45AM	Atrium		Break
10:45AM - 11:45PM	Simons Auditorium	Robert Lemke Oliver	The distribution of consecutive prime biases
11:45AM - 12:15PM	Simons Auditorium	Ayla Gafni	Partitions into Polynomial Values
12:15PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Alexandra Florea	Moments of quadratic Dirichlet L-functions in function fields
3:00PM - 4:00PM	Atrium		Tea and Poster Session
4:00PM - 4:30PM	Simons Auditorium	Maria Nastasescu	Determination of elliptic curves by their adjoint p-adic L-functions
4:30PM - 5:30PM	Commons		Panel Discussion
6:30PM - 8:30PM	MSRI		Dinner at the Taste of Himlayas

Friday, Febrauary 2, 2017			
9:15AM - 10:15AM	Simons Auditorium	Dimitris Koukoulopoulos	Sieve weights and their smoothings
10:15AM - 10:45AM	Atrium		Break
10:45AM - 11:45PM	Simons Auditorium	Caroline Turnage-Butterbaugh	Bounding l-torsion in class groups of families of number fields of arbitrary degree
11:45AM - 12:15PM	Simons Auditorium	Julia Brandes	Quadratic and cubic diagonal equations
12:15PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Chantal David	Average root number in families of elliptic curves
3:00PM - 3:30PM	Simons Auditorium	Lola Thompson	Sums of distinct divisors
3:30PM - 4:00PM	Atrium		Tea

Organizers		
First Name	**Last Name**	**Institution**
Chantal	David	Concordia University
Kaisa	Matomäki	University of Turku
Kannan	Soundararajan	Stanford University
Terence	Tao	University of California, Los Angeles
Speakers		
First Name	**Last Name**	**Institution**
Julia	Brandes	University of Göteborg
Chantal	David	Concordia University
Alexandra	Florea	Stanford University
Ayla	Gafni	University of Rochester
Dimitris	Koukoulopoulos	Université de Montréal
Robert	Lemke Oliver	Tufts University
Lilian	Matthiesen	Royal Institute of Technology (KTH)
Maria	Nastasescu	Brown University
Lola	Thompson	Oberlin College
Caroline	Turnage-Butterbaugh	Duke University

Participants		
First Name	**Last Name**	**Institution**
Shabnam	Akhtari	University of Oregon
Nickolas	Andersen	University of California, Los Angeles
Theresa	Anderson	University of Wisconsin-Madison
Pierre	Bienvenu	University of Bristol
Dante	Bonolis	ETH Zürich
Julia	Brandes	University of Göteborg
Tim	Browning	University of Bristol
Hannah	Burson	University of Illinois at Urbana-Champaign
Carlos	Chirre Chávez	Institute of Pure and Applied Mathematics (IMPA)
Sam	Chow	MSRI - Mathematical Sciences Research Institute
Chantal	David	Concordia University
Lucile	Devin	Université de Paris XI
Lara	Du	University of Michigan
bernadette	Faye	AIMS Senegal(African institute for mathematical sciences)
Taryn	Flock	University of Birmingham
Alexandra	Florea	Stanford University
Kevin	Ford	University of Illinois at Urbana-Champaign
Ayla	Gafni	University of Rochester
Heidi	Goodson	Haverford College
Shaoming	Guo	Indiana University
Adam	Harper	University of Warwick
David (Roger)	Heath-Brown	University of Oxford
Yueke	Hu	ETH Zürich
Kevin	Hughes	University of Bristol
Marina	Iliopoulou	University of California, Berkeley
Subhajit	Jana	ETH Zürich
Habiba	Kadiri	University of Lethbridge
Dimitris	Koukoulopoulos	Université de Montréal
Kalliopi	Koutsaki	University of Illinois at Urbana-Champaign
Robert	Lemke Oliver	Tufts University
Junxian	Li	University of Illinois at Urbana-Champaign
Wanlin	Li	University of Wisconsin-Madison
Subong	Lim	Sungkyunkwan University
Sofia	Lindqvist	University of Oxford
David	Lowry-Duda	Brown University
Amita	Malik	University of Illinois at Urbana-Champaign
Maria Adelina	Manzateanu	University of Bristol
Kaisa	Matomäki	University of Turku
Lilian	Matthiesen	Royal Institute of Technology (KTH)
Katie	McKeon	Rutgers University
Maria	Nastasescu	Brown University
Paul	Nelson	ETH Zürich
Carlos	Pastor	Instituto de Ciencias Matematicas (ICMAT)
Sarah	Peluse	Stanford University
Corentin	Perret-Gentil-dit-Maillard	ETH Zürich
Andrew	Pollington	National Science Foundation

Participants		
First Name	**Last Name**	**Institution**
Carl	Pomerance	Dartmouth College
Neha	Prabhu	Indian Institute of Science Education and Research
Ali	Rajaei	Tarbiat Modares
Kenneth	Ribet	University of California, Berkeley
Arindam	Roy	Rice University
Manami	Roy	University of Oklahoma
Lauren	Ruth	University of California, Riverside
Fernando	Shao	University of Oxford
Kannan	Soundararajan	Stanford University
Ade Irma	Suriajaya	Nagoya University
Terence	Tao	University of California, Los Angeles
Karen	Taylor	Bronx Community College
Joni	Teräväinen	University of Turku
Lola	Thompson	Oberlin College
Frank	Thorne	University of South Carolina
Jesse	Thorner	Stanford University
Caroline	Turnage-Butterbaugh	Duke University
Seraina	Wachter	ETH Zürich
Aled	Walker	University of Oxford
Ping	Xi	Xi'an Jiaotong University
Rupei	Xu	University of Texas at Dallas
Giamila	Zaghloul	Università di Genova
Ana	Zumalacarregui	University of New South Wales

Officially Registered Participant Information

Participants		69

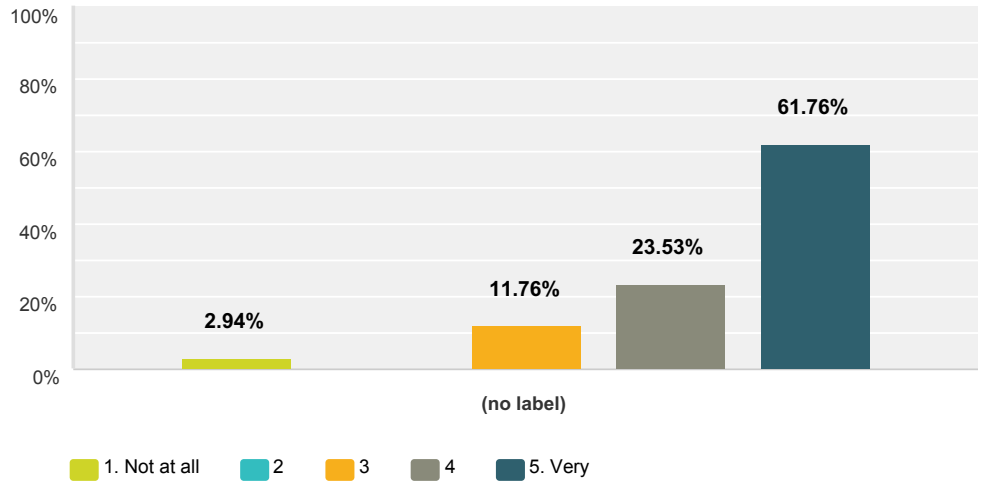
Gender		69
Male	46.38%	32
Female	52.17%	36
Declined to state	1.45%	1
Ethnicity*		**73**
White	62.32%	43
Asian	26.09%	18
Hispanic	4.35%	3
Pacific Islander	0.00%	0
Black	2.90%	2
Native American	1.45%	1
Mixed	2.90%	2
Declined to state	5.80%	4

* ethnicity specifications are not exclusive

34 responses out of 69 participants = 49% response rate

Q1 The workshop was intellectually stimulating

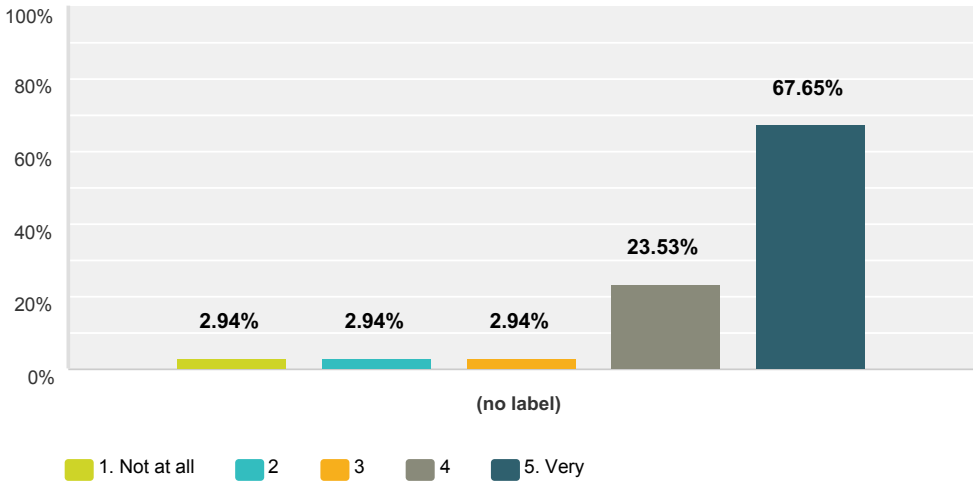
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**11.76%** 4	**23.53%** 8	**61.76%** 21	34	4.41

Q2 The overall experience of the workshop was worthwhile

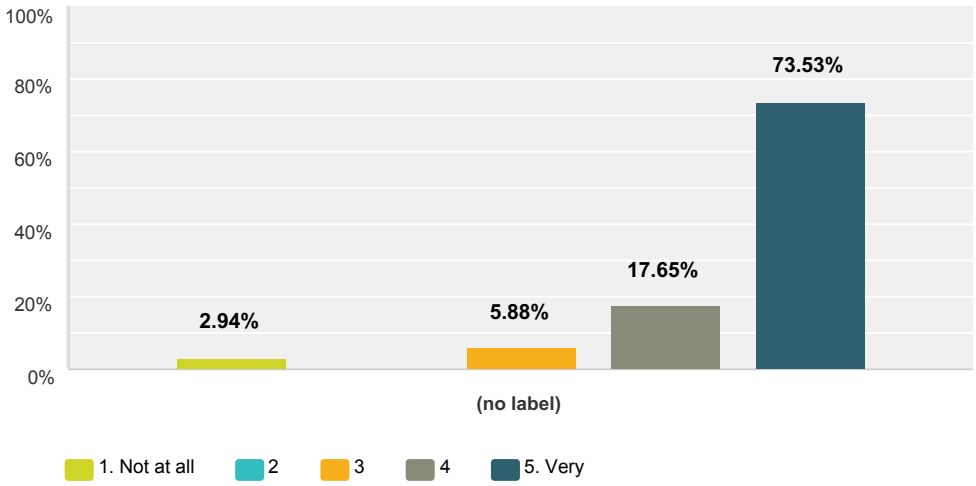
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	2.94% 1	2.94% 1	2.94% 1	23.53% 8	67.65% 23	34	4.50

Q3 The time between lectures was adequate for discussion

Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**5.88%** 2	**17.65%** 6	**73.53%** 25	34	4.59

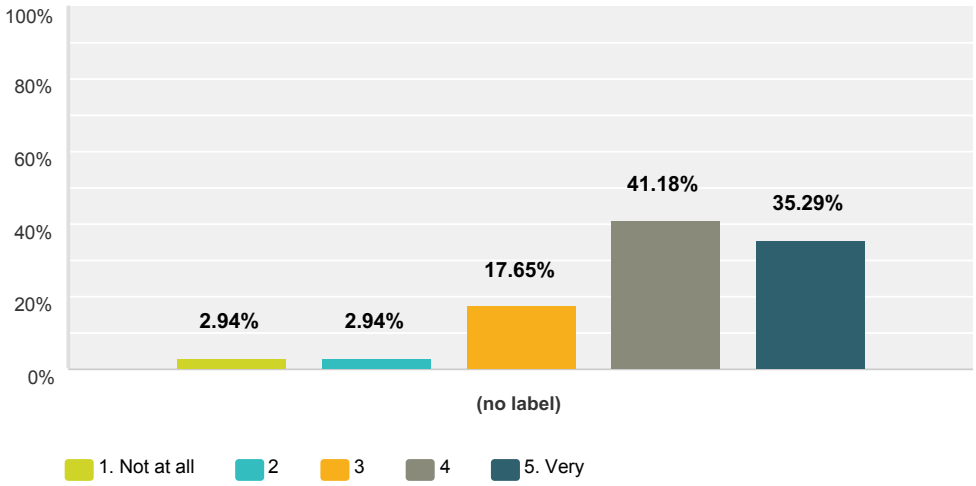
Q4 Additional comments

Answered: 2 Skipped: 32

#	Responses	Date
1	The panel discussion was very good and could be a bit longer. Such workshops could be very useful (for men and women) for women empowerment.	2/6/2017 10:07 PM
2	As a member of the concurrent program in harmonic analysis, I found it frustrating to not have all the titles published in advance. I'd like to be able to get some idea of whether or not I will be able to follow the talk before attending.	2/3/2017 4:20 PM

Q5 I was well prepared to benefit from the lectures

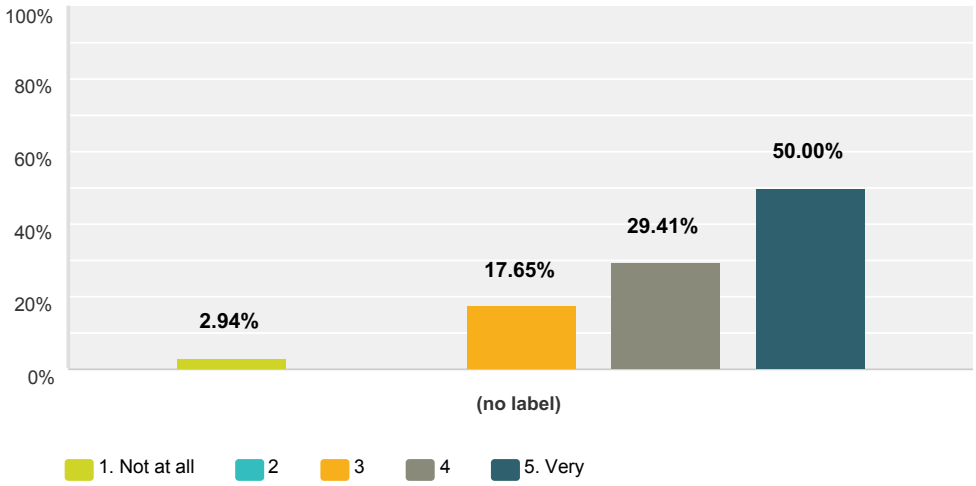
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	2.94% 1	2.94% 1	17.65% 6	41.18% 14	35.29% 12	34	4.03

Q6 My interest in the subject matter was increased by the workshop

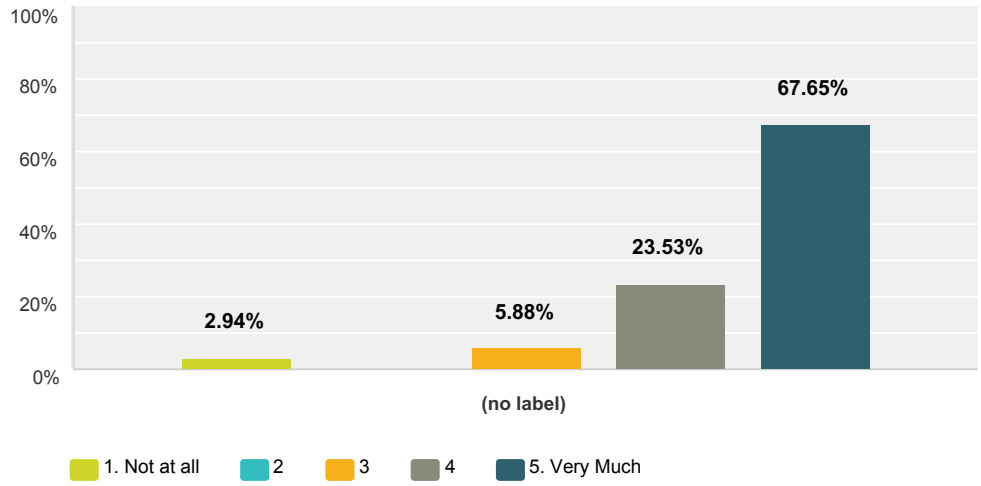
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**17.65%** 6	**29.41%** 10	**50.00%** 17	34	4.24

Q7 The workshop helped me meet people with similar scientific interests

Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**5.88%** 2	**23.53%** 8	**67.65%** 23	34	4.53

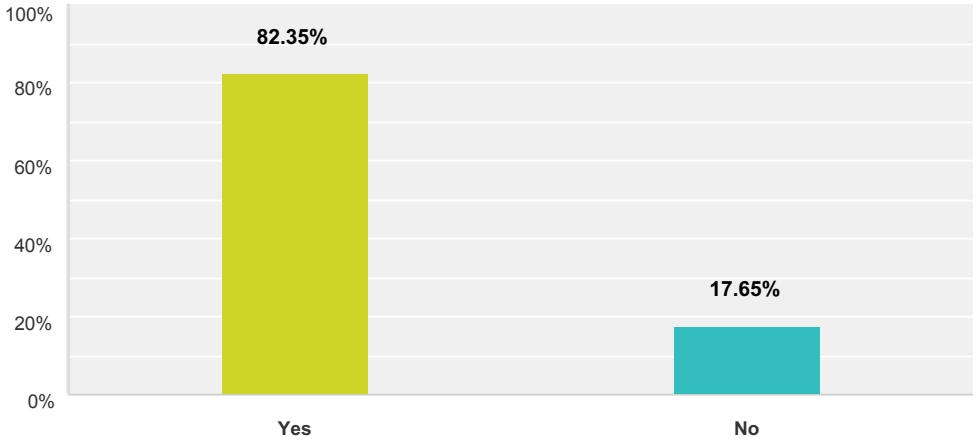
Q8 Additional comments on your personal assessment

Answered: 2 Skipped: 32

#	Responses	Date
1	The workshop was intellectually stimulating.	2/10/2017 5:36 PM
2	People were nice and it felt good to talk to talk to them. Because there were only half of the people as there are in the next workshop, it was easier to talk to others.	2/6/2017 10:08 PM

Q9 Did you attend the panel discussion?

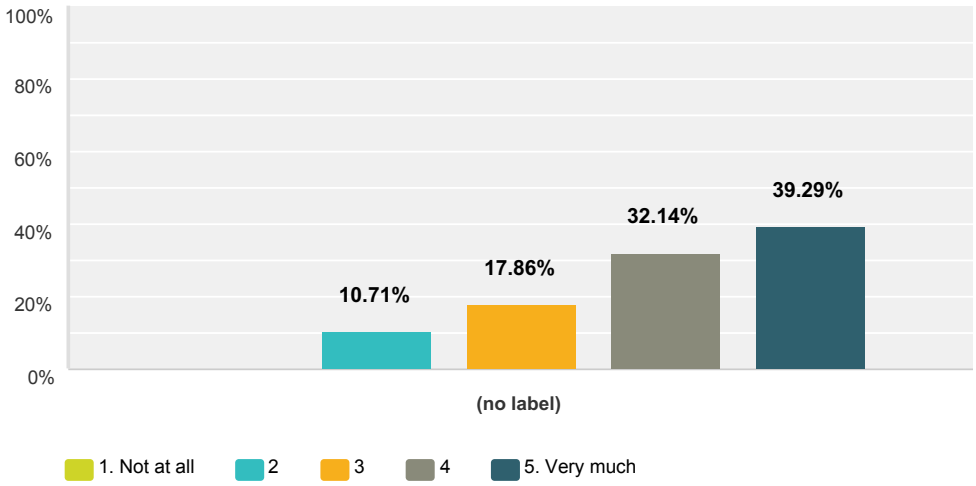
Answered: 34 Skipped: 0



Answer Choices	Responses	
Yes	82.35%	28
No	17.65%	6
Total		34

Q10 Did you find the panel discussion worthwhile?

Answered: 28 Skipped: 6



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**10.71%** 3	**17.86%** 5	**32.14%** 9	**39.29%** 11	28	4.00

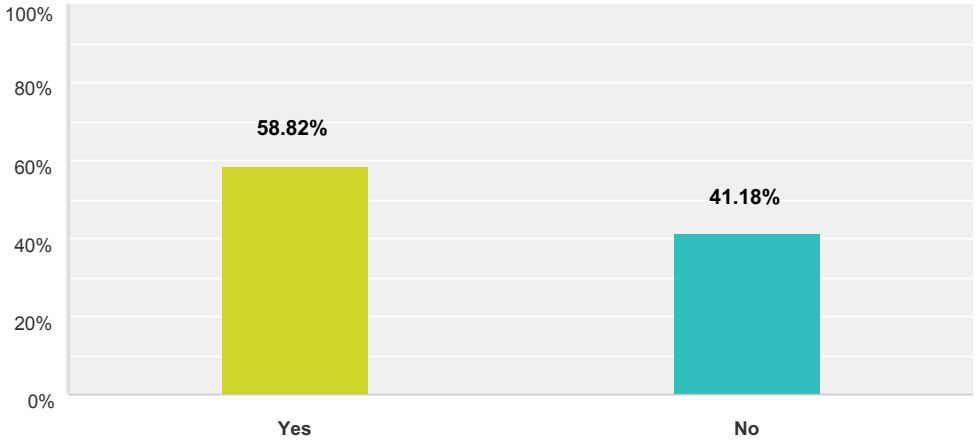
Q11 What other subjects should be discussed in future panel discussions?

Answered: 4 Skipped: 30

#	Responses	Date
1	How men can contribute towards making the journey better for women.	2/6/2017 10:09 PM
2	The panel had 4 people from R1 universities. I work at a small liberal arts school and I couldn't relate to most of what they were saying. It would be good to have a balance of different types of research mathematicians.	2/5/2017 8:00 AM
3	Time managing in academia with family	2/3/2017 5:51 PM
4	Spousal hire Job market in Europe	2/3/2017 4:40 PM

Q12 Did you attend the dinner?

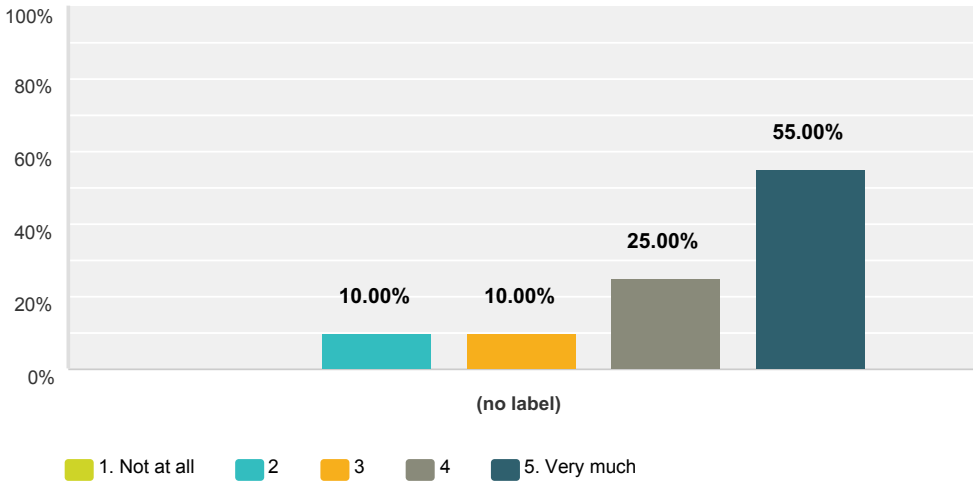
Answered: 34 Skipped: 0



Answer Choices	Responses	
Yes	58.82%	20
No	41.18%	14
Total		34

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 20 Skipped: 14



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	0.00% 0	10.00% 2	10.00% 2	25.00% 5	55.00% 11	20	4.25

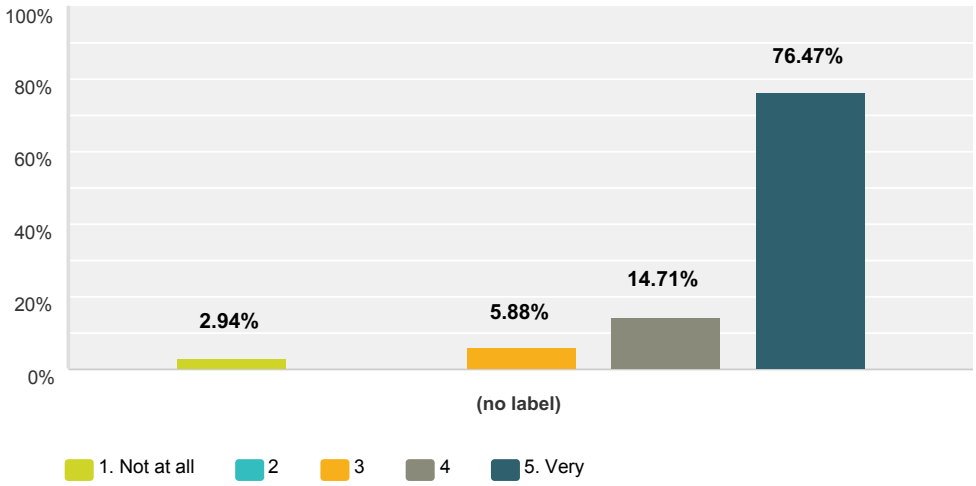
Q14 Please provide any comments about the dinner

Answered: 1 Skipped: 33

#	Responses	Date
1	The dinner was the best part of the workshop.	2/5/2017 8:01 AM

Q15 I found the MSRI staff helpful

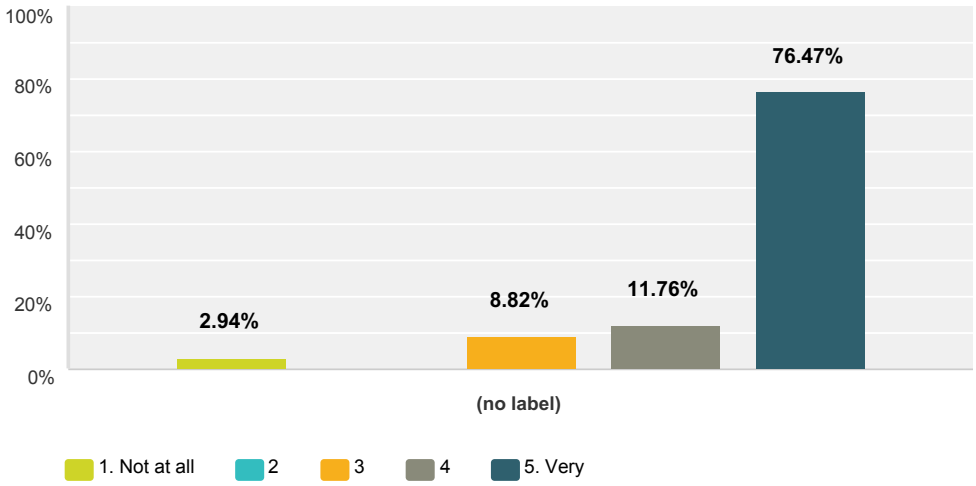
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**5.88%** 2	**14.71%** 5	**76.47%** 26	34	4.62

Q16 The MSRI facilities were conducive for such a workshop

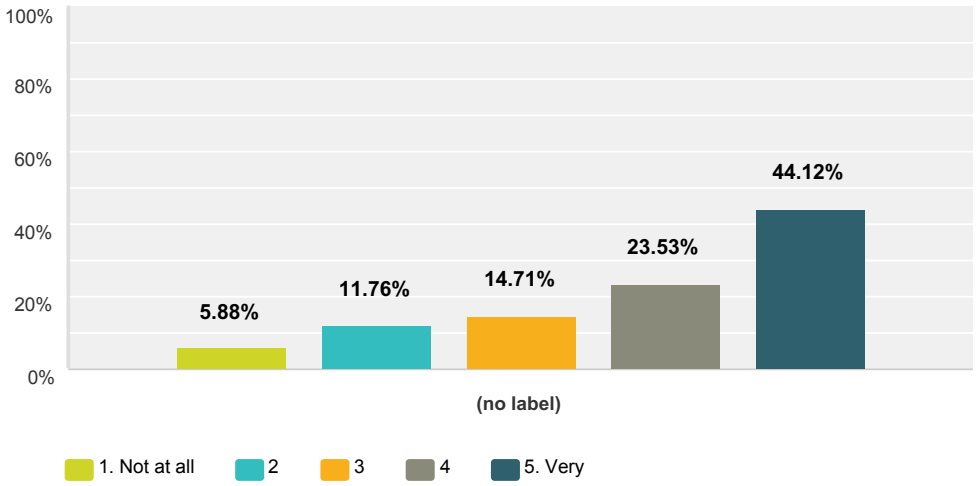
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**8.82%** 3	**11.76%** 4	**76.47%** 26	34	4.59

Q17 The MSRI lunch arrangements were satisfactory

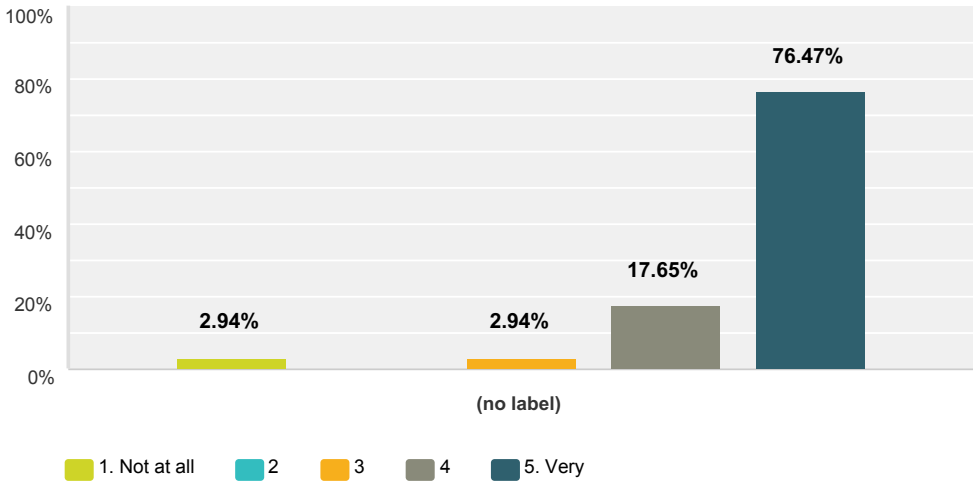
Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	5.88% 2	11.76% 4	14.71% 5	23.53% 8	44.12% 15	34	3.88

Q18 The MSRI tea arrangements were satisfactory

Answered: 34 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**2.94%** 1	**0.00%** 0	**2.94%** 1	**17.65%** 6	**76.47%** 26	34	4.65

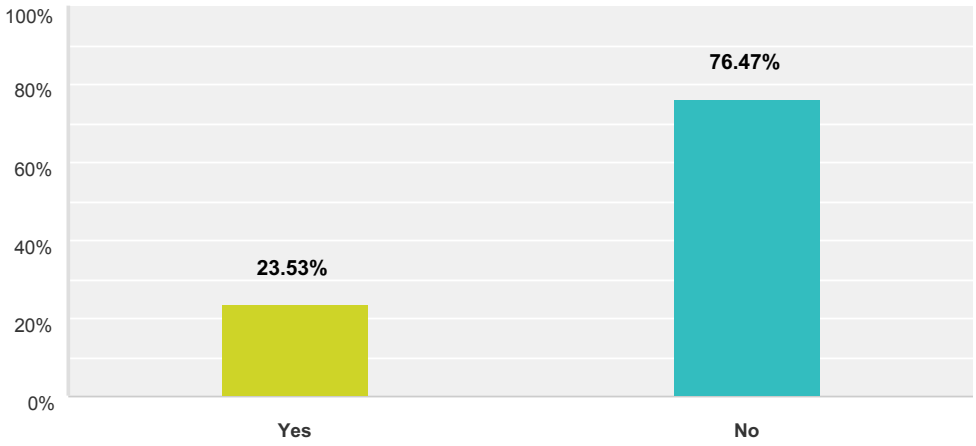
Q19 Additional comments about MSRI staff, facilities and food

Answered: 2 Skipped: 32

#	Responses	Date
1	It would be great if there were an ATM or if we could use a card to pay for lunch. Lunch options are very limited.	2/10/2017 5:38 PM
2	It might be necessary to arrange more seating options for lunch to accommodate all participants.	2/3/2017 11:27 PM

Q20 Did you use the computer facilities located in the library?

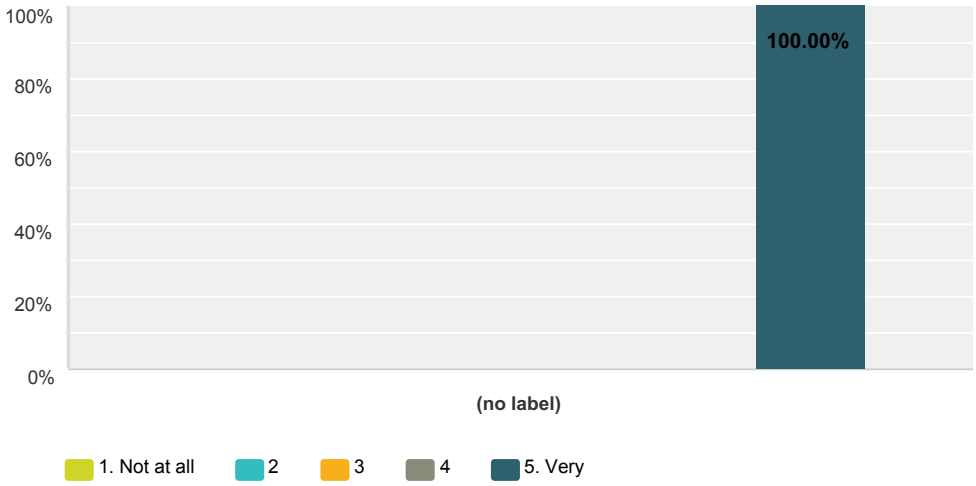
Answered: 34 Skipped: 0



Answer Choices	Responses	
Yes	23.53%	8
No	76.47%	26
Total		34

Q21 The MSRI computer facilities in the library were adequate

Answered: 8 Skipped: 26

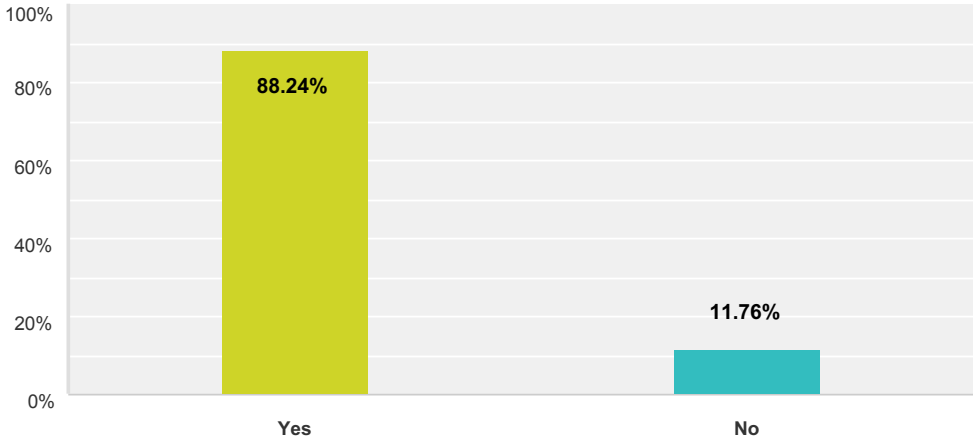


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	**100.00%** 8	8	5.00

#	Comments about computer facilities	Date
	There are no responses.	

Q22 Did you use MSRI's wireless network?

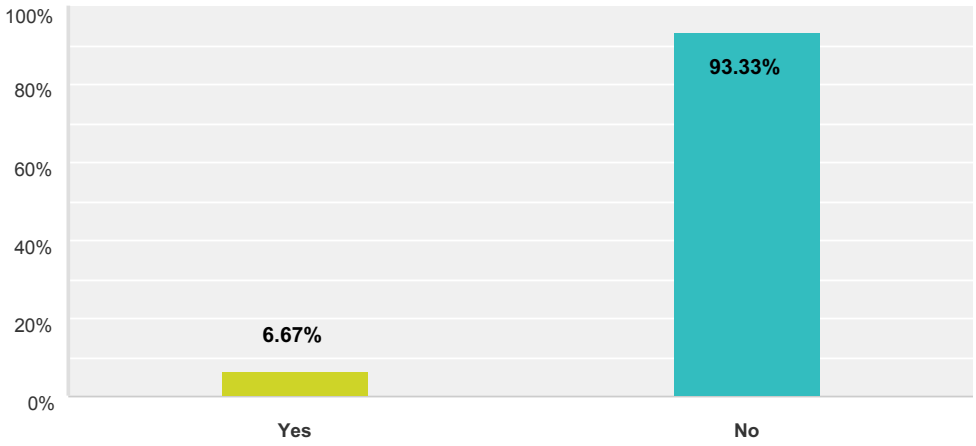
Answered: 34 Skipped: 0



Answer Choices	Responses	
Yes	88.24%	30
No	11.76%	4
Total		34

Q23 Did you experience any difficulties with the network?

Answered: 30 Skipped: 4



Answer Choices	Responses	
Yes	6.67%	2
No	93.33%	28
Total		30

#	Please if yes, please describe your difficulties	Date
1	The MSRI-guest seemed pretty unstable.	2/5/2017 10:26 AM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 2 Skipped: 32

#	Responses	Date
1	Overall I thought that scientifically the conference was great. It feels a bit weird to have a separate conference for women -- especially since it was kinda sort of for women, but with male invited speakers too. Given that there was only one talk given by a woman the entire following week, it seemed like perhaps the conference should have been wrapped into the main conference that followed. But I'm a man and perhaps I should leave these kinds of things for women to decide whether they found it more beneficial or awkward. From a purely scientific perspective, it was a great two days. Thanks for putting it on.	2/17/2017 1:44 PM
2	Overall I'm pretty disappointed in the workshop. On the first day there was a male mathematician who repeatedly interrupted and talked over the female speakers. He felt the need to "correct them" when they did not provide an exhaustive list of related results, mostly needing to remind everyone of his own results. I was very upset by this and it's not clear to me that anyone did anything to follow up on this. I see things like this happen at almost every conference I go to, but I assumed that things would be better at a workshop for women. It's clear that I was wrong and that attending this workshop was a waste of my time. I think this whole experience would have been better if it had not been a separate workshop. I would recommend just having a dinner for female participants at the "regular" workshop in the future. This will give female speakers and mathematicians just as much exposure as our male colleagues. Furthermore, more needs to be done to teach our male colleagues to not behave so poorly. We need to fix the toxic environment that many women face in academia. Finally, the organization of the poster session seemed a bit haphazard. I received an email that said I should apply to be considered to present a poster one week before the conference. I never heard back from the organizers about whether or not my abstract was accepted, so I assumed it wasn't. However, it seems as though I was just supposed to know that once I applied, I should just bring a poster.	2/5/2017 8:15 AM

Introductory Workshop: Analytic Number Theory

February 06, 2017 - February 10, 2017

MSRI, Berkeley, CA, USA

Organizers:

Andrew Granville (Université de Montréal)

Emmanuel Kowalski (ETH Zuerich)

Kaisa Matomäki (University of Turku)

Philippe Michel (Ecole Polytechnique Federale de Lausanne)

REPORT ON THE MSRI WORKSHOP "INTRODUCTORY WORKSHOP: ANALYTIC NUMBER THEORY" FEBRUARY 6-10, 2017, 2016

Organizers

- Andrew Granville (Université de Montréal)
- Emmanuel Kowalski (ETH Zuerich)
- Kaisa Matomäki (University of Turku)
- Philippe Michel (Ecole Polytechnique Federale de Lausanne)

Scientific Description

In recent years, many important classical questions in analytic number theory have seen spectacular advances based on new techniques; conversely, methods developed in analytic number theory have, sometimes unexpectedly, led to the solution of striking problems in other fields such as harmonic analysis (including the Langlands programme), ergodic theory and dynamics (especially on homogenous spaces), additive and multiplicative combinatorics and theoretical computer science (in particular, through the theory of expander graphs).

The introductory workshop presented, through short minicourses and introductory lectures, the main topics that were the subject of much of the Analytic Number Theory program. These topics include the theory of multiplicative functions, the theory of modular forms and L-functions, the circle method, sieve methods, and the theory of exponential sums over finite fields.

Highlights of the Workshop

The workshop included three three-hour long minicourses which introduced the participants to the latest developments in analytic number theory. There were also nine colloquium style research talks, as well as an introductory talk for the harmonic analysts.

The audience took active part in the lectures, asking questions and making comments. All the talks were videotaped, which has been appreciated by the people who had to miss all or parts of the workshop.

The workshop had adequate time for informal discussions during lunch and coffee breaks, and there seemed to be vivid conversations, including many of the junior participants getting to talk with the more senior people.

Introductory Workshop: Analytic Number Theory

February 6-10, 2017

Schedule

Monday, February 6, 2017			
9:00 AM - 9:15 AM	Simons Auditorium		Welcome
9:15AM - 10:00 AM	Simons Auditorium	Philippe Michel	Introductory talk (Ph. Michel) -- targeted in particular to members of the harmonic analysis program
10:00 AM - 10:30 AM	Atrium		Break
10:30 AM - 11:30 PM	Simons Auditorium	Kaisa Matomäki Maksym Radziwill	Mini-course on multiplicative functions
11:30 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Jordan Ellenberg	Geometric analytic number theory
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Daniel Fiorilli	Moments of arithmetical sequences
4:45 PM - 5:45 PM	Simons Auditorium	Ian Petrow	TBA

Tuesday, February 7, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Philippe Michel	ℓ-adic trace functions in analytic number theory
10:30 AM - 11:00 AM	Atrium		Tea
11:00 AM - 12:00 PM	Simons Auditorium	Gergely Harcos	A glimpse at arithmetic quantum chaos
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Robert Lemke Oliver	TBA
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Kaisa Matomäki Maksym Radziwill	Mini-course on multiplicative functions
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, February 8, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Philippe Michel	ℓ-adic trace functions in analytic number theory
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Ian Petrow	TBA

Thursday,February 9, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Youness Lamzouri	Large fixed order character sums
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Anders Sodergren	On Epstein's zeta function and related results in the geometry of numbers
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Kaisa Matomäki Maksym Radziwill	Mini-course on multiplicative functions
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Philippe Michel	ℓ-adic trace functions in analytic number theory

Friday, February 10, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Will Sawin	Trace functions and special functions
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Ian Petrow	TBA
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	florent jouve	Variations on the Chebychev bias phenomenon
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Valentin Blomer	TBA

Organizers

First Name	Last Name	Institution
Andrew	Granville	Université de Montréal
Emmanuel	Kowalski	ETH Zuerich
Kaisa	Matomäk	University of Turku
Philippe	Michel	Ecole Polytechnique Federale de Lausanne

Speakers

First Name	Last Name	Institution
Valentin	Blomer	Georg-August-Universität zu Göttingen
Jordan	Ellenberg	University of Wisconsin-Madison
Daniel	Fiorilli	University of Ottawa
Gergely	Harcos	Central European University
Florent	Jouve	Université de Bordeaux I
Youness	Lamzouri	York University
Robert	Lemke Oliver	Tufts University
Kaisa	Matomäk	University of Turku
Philippe	Michel	Ecole Polytechnique Federale de Lausanne
Ian	Petrow	ETH Zürich
Maksym	Radziwill	McGill University
Will	Sawin	ETH Zürich
Anders	Sodergren	University of Copenhagen

Participants		
First Name	**Last Name**	**Institution**
Shabnam	Akhtari	University of Oregon
Nickolas	Andersen	University of California, Los Angeles
Theresa	Anderson	University of Wisconsin-Madison
Efrat	Bank	University of Michigan
Pierre	Bienvenu	University of Bristol
Valentin	Blomer	Georg-August-Universität zu Göttingen
Thomas	Bloom	University of Bristol
Dante	Bonolis	ETH Zürich
Herivelto	Borges	University of Sao Paulo
Julia	Brandes	University of Göteborg
Tim	Browning	University of Bristol
Hannah	Burson	University of Illinois at Urbana-Champaign
Anthony	Carbery	University of Edinburgh
Dan	Carmon	Tel Aviv University
Emanuel	Carneiro	Institute of Pure and Applied Mathematics (IMPA)
Carlos	Chirre Chávez	Institute of Pure and Applied Mathematics (IMPA)
Peter	Cho	UNIST
youn-seo	choi	Korea Institute for Advanced Study (KIAS)
Jiyoung	Choi	Ewha Women's University
Sam	Chow	MSRI - Mathematical Sciences Research Institute
Nicholas	Cook	Stanford University
Lucile	Devin	Université de Paris XI
Lara	Du	University of Michigan
Jordan	Ellenberg	University of Wisconsin-Madison
bernadette	Faye	AIMS Senegal(African institute for mathematical sciences)
Andrey	Feuerverger	Dept of Statistical Sciences University of Toronto
Daniel	Fiorilli	University of Ottawa
Taryn	Flock	University of Birmingham
Alexandra	Florea	Stanford University
JoÃ£o	Fontinha	ETH Zürich
Kevin	Ford	University of Illinois at Urbana-Champaign
Ethan	Fox	Arizona State University
Jonas	Fransson	Linnaeus University
Ayla	Gafni	University of Rochester
Satadal	Ganguly	Indian Statistical Institute
Yoav A.	Gath	Technion---Israel Institute of Technology
Surya Teja	Gavva	Rutgers University
Leo	Goldmakher	Williams College
Ofir	Gorodetsky	Tel Aviv University
Andrew	Granville	Université de Montréal
Joseph	Gunther	CUNY, Graduate Center
Junsoo	Ha	Korea Institute for Advanced Study (KIAS)
Gergely	Harcos	Central European University
Adam	Harper	University of Warwick
David (Roger)	Heath-Brown	University of Oxford
Yueke	Hu	ETH Zürich

Participants		
First Name	**Last Name**	**Institution**
Bingrong	Huang	Shandong University
Kevin	Hughes	University of Bristol
Marina	Iliopoulou	University of California, Berkeley
Subhajit	Jana	ETH Zürich
Florent	Jouve	Université de Bordeaux I
Habiba	Kadiri	University of Lethbridge
Asaf	Katz	Hebrew University
Eren	Kıral	Texas A & M University
David	Kohel	Université d'Aix-Marseille (AMU)
Dimitris	Koukoulopoulos	Université de Montréal
Kalliopi	Koutsaki	University of Illinois at Urbana-Champaign
Emmanuel	Kowalski	ETH Zuerich
Cho Ho	Lam	Simon Fraser University
Youness	Lamzouri	York University
Yoonbok	Lee	Incheon National University
Seok Hyeong	Lee	National Institute for Mathematical Sciences
Robert	Lemke Oliver	Tufts University
Didier	Lesesvre	Université de Paris XIII (Paris-Nord)
Junxian	Li	University of Illinois at Urbana-Champaign
Wanlin	Li	University of Wisconsin-Madison
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Yongxiao	Lin	Ohio State University
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Nir	Marcus	Hebrew University
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Lilian	Matthiesen	Royal Institute of Technology (KTH)
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Kevin	McGown	California State University
Katie	McKeon	Rutgers University
Nathan	McNew	Towson University
Harsh	Mehta	University of South Carolina
Xianchang	Meng	University of Illinois at Urbana-Champaign
Philippe	Michel	Ecole Polytechnique Federale de Lausanne
Kazuki	Morimoto	Kobe University
Marc	Munsch	Technische Universität Graz
Maria	Nastasescu	Brown University
Kunjakanan	Nath	Université de Montréal
Paul	Nelson	ETH Zürich
Jeongho	Park	UNIST
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Hans	Parshall	University of Georgia

Participants		
First Name	**Last Name**	**Institution**
Carlos	Pastor	Instituto de Ciencias Matematicas (ICMAT)
Sarah	Peluse	Stanford University
Corentin	Perret-Gentil-dit-Maillard	ETH Zürich
Ian	Petrow	ETH Zürich
Alexandre	Peyrot	École Polytechnique Fédérale de Lausanne (EPFL)
Andrew	Pollington	National Science Foundation
Carl	Pomerance	Dartmouth College
Neha	Prabhu	Indian Institute of Science Education and Research
Sean	Prendiville	University of Manchester
Maksym	Radziwill	McGill University
Ali	Rajaei	Tarbiat Modares
Chandrasekhar	Raju	Stanford University
Kenneth	Ribet	University of California, Berkeley
Luka	Rimanic	University of Bristol
Arindam	Roy	Rice University
Simon	Rubinstein-Salzedo	Euler Circle
Lauren	Ruth	University of California, Riverside
Will	Sawin	ETH Zürich
Fernando	Shao	University of Oxford
Mark	Shusterman	Tel Aviv University
Anders	Sodergren	University of Copenhagen
Andreas	Steiger	ETH Zürich
Betsy	Stovall	University of Wisconsin-Madison
Ade Irma	Suriajaya	Nagoya University
Naser	Talebizadeh Sardari	MSRI - Mathematical Sciences Research Institute
Joni	Teräväinen	University of Turku
Lola	Thompson	Oberlin College
Frank	Thorne	University of South Carolina
Jesse	Thorner	Stanford University
Caroline	Turnage-Butterbaugh	Duke University
Anton	Vassilyev	Moscow State University, Kazakhstan branch
Paul	Verschueren	Imperial College, London
Seraina	Wachter	ETH Zürich
Aled	Walker	University of Oxford
Alexander	Walker	Brown University
Matthew	Welsh	Rutgers University
Julia	Wolf	University of Bristol
Ping	Xi	Xi'an Jiaotong University
Kam Hung	Yau	University of New South Wales
Terence	Yi	Fresno Pacific University
Giamila	Zaghloul	Università di Genova
Liyang	Zhang	Yale University
Yufei	Zhao	University of Oxford
Tamar	Ziegler	Hebrew University
Ana	Zumalacarregui	University of New South Wales
Sebastian	Zuniga Alterman	Institut de Mathematiques de Jussieu

Officially Registered Participant Information

Participants		138

Gender		138
Male	71.01%	98
Female	26.81%	37
Declined to state	2.17%	3

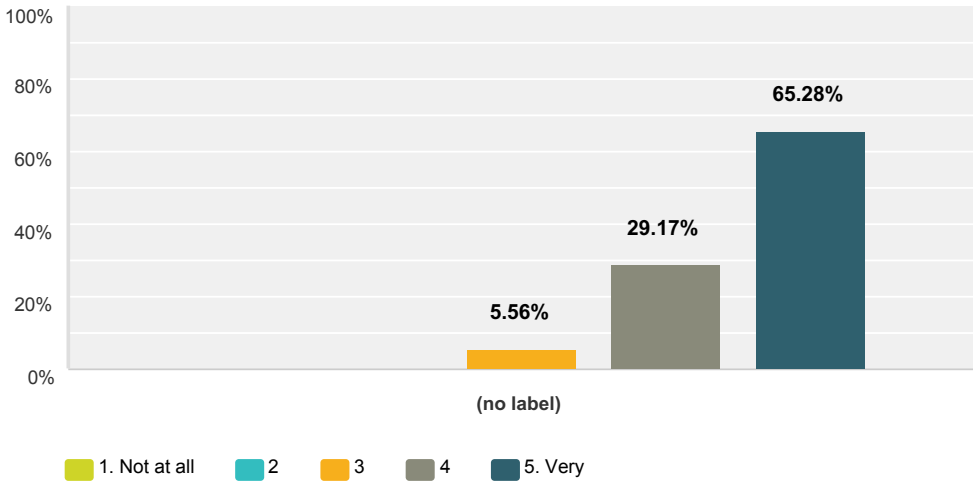
Ethnicity*		142
White	61.59%	85
Asian	26.09%	36
Hispanic	2.90%	4
Pacific Islander	0.00%	0
Black	0.72%	1
Native American	0.72%	1
Mixed	1.45%	2
Declined to state	9.42%	13

* ethnicity specifications are not exclusive

72 responses out of 138 participants = 52% response rate

Q1 The workshop was intellectually stimulating

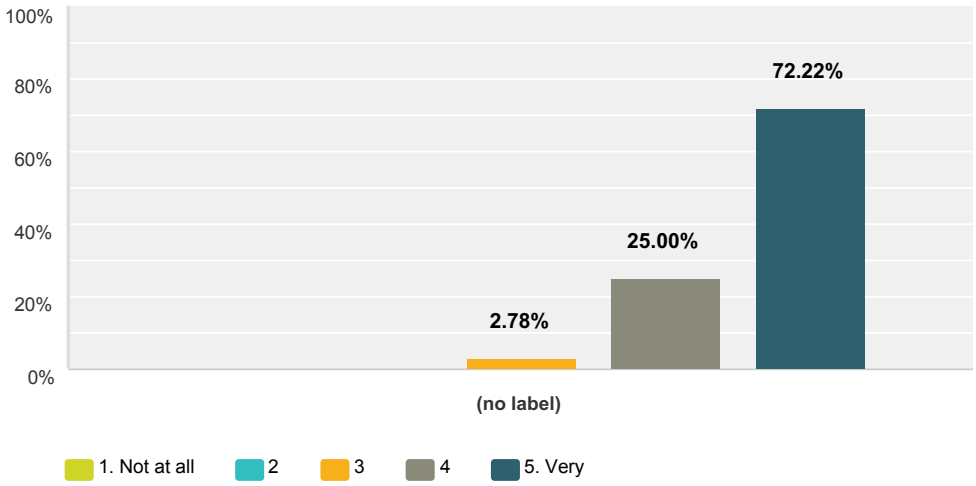
Answered: 72 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**5.56%** 4	**29.17%** 21	**65.28%** 47	72	4.60

Q2 The overall experience of the workshop was worthwhile

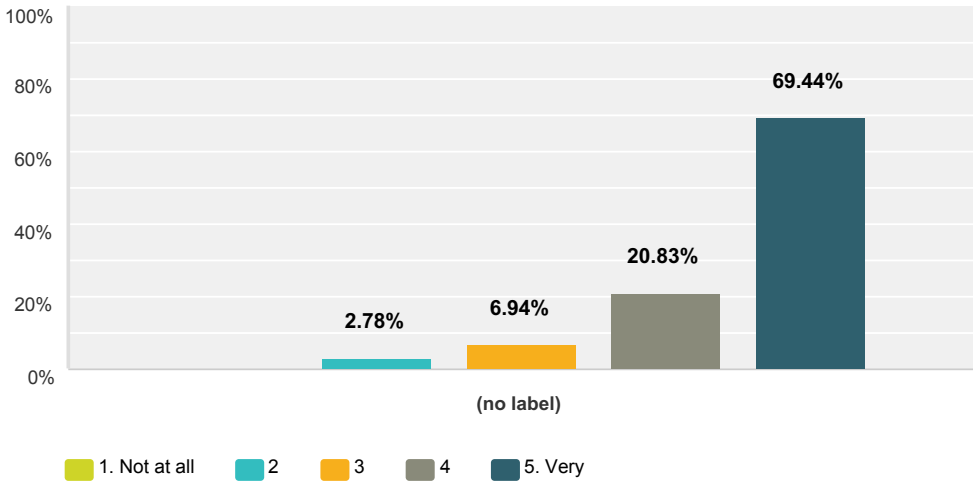
Answered: 72 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.78%** 2	**25.00%** 18	**72.22%** 52	72	4.69

Q3 The time between lectures was adequate for discussion

Answered: 72 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.78%** 2	**6.94%** 5	**20.83%** 15	**69.44%** 50	72	4.57

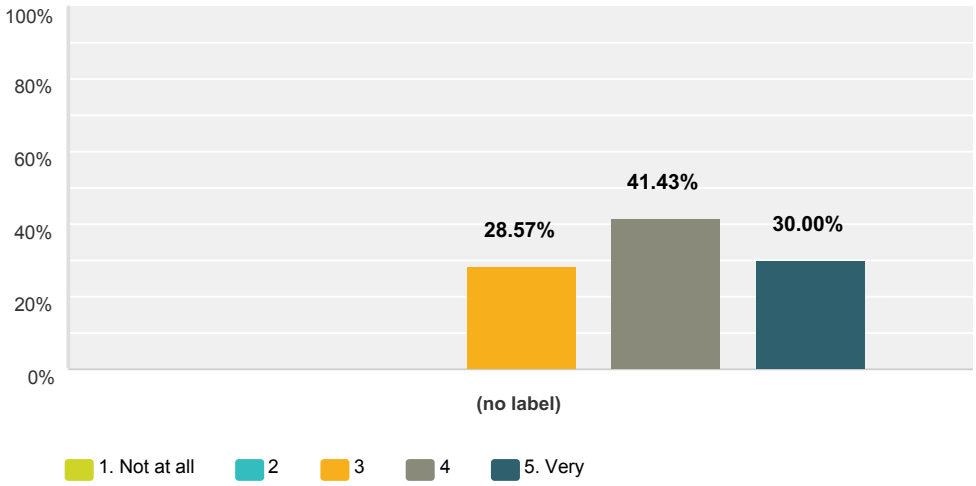
Q4 Additional comments

Answered: 10 Skipped: 62

#	Responses	Date
1	Tea breaks were a little too short. 45 minutes would be better than 30.	2/24/2017 10:49 AM
2	I do have one comment. I have a real problem with the fact that in a weeklong workshop there was only one woman speaker. I recognize that there was a "connections for women" workshop the week before, and that many relevant women had spoken in that one; but so what? The audience was not identical. A. Florea or C. David certainly could have talked. David in particular has a rich and broad portfolio of work, she could easily give two completely different talks -- Florea could have surveyed L-functions over function fields -- etc.	2/22/2017 1:36 PM
3	I was a bit disheartened to see that only 1 out of the 19 talks was given by a woman. There are many excellent women doing research in analytic number theory these days. It would have been nice to hear from them as well.	2/15/2017 1:34 PM
4	There was a severe lack of diversity among the invited speakers. Out of 19 lectures, only 1 was given by a woman. Moreover, the 1 invited female speaker was an organizer of the workshop. For future workshops in number theory, may I suggest https://womeninnumbertheory.org as a resource which maintains a list of female number theorists at varying stages of their careers.	2/13/2017 11:04 AM
5	Too much lectures about function fields, probably it would have been better to discuss automorphism forms instead, as Boomer's talk was splendid.	2/11/2017 3:43 AM
6	The breaks were too long, especially the one at lunchtime.	2/10/2017 8:55 PM
7	The workshop was great and I was happy to be there. I just want to recommend more women's talk during such an event for next time...	2/10/2017 7:42 PM
8	1. There was only 1 female speaker. I'm sure those from the Connections for Women workshop still had interesting things to talk about. (There was already a great common speaker for the 2 workshops, but not a female speaker.) 2. First day was very long and a 2 hours and a half lunch break could have been reduced to 1 hour and a half to finish at a reasonable hour. 3. I'm very happy that the lectures are available online!	2/10/2017 5:36 PM
9	There could be more Hill busses scheduled for the workshop weeks. People were left stranded once the busses overfilled. This is a major inconvenience. Otherwise it was a great conference.	2/10/2017 5:04 PM
10	Only one lecture was given by a female researcher, while there were so many that could have given more. We are far from 30%. It was the only, but significant, disappointment.	2/10/2017 3:48 PM

Q5 I was well prepared to benefit from the lectures

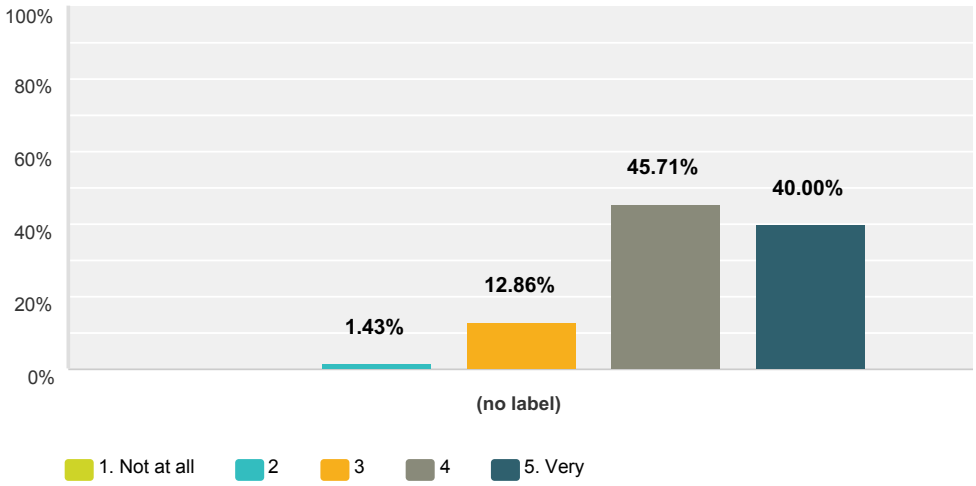
Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**28.57%** 20	**41.43%** 29	**30.00%** 21	70	4.01

Q6 My interest in the subject matter was increased by the workshop

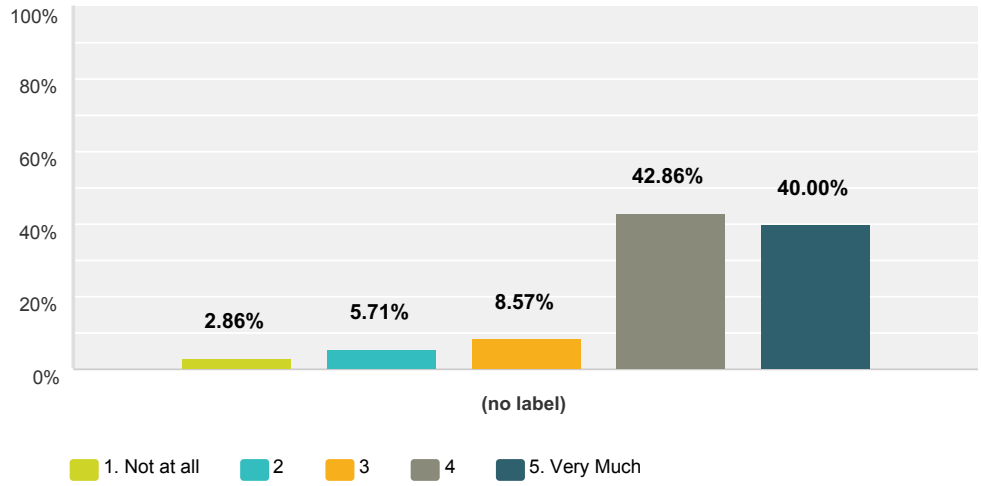
Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	1.43% 1	12.86% 9	45.71% 32	40.00% 28	70	4.24

Q7 The workshop helped me meet people with similar scientific interests

Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**2.86%** 2	**5.71%** 4	**8.57%** 6	**42.86%** 30	**40.00%** 28	70	4.11

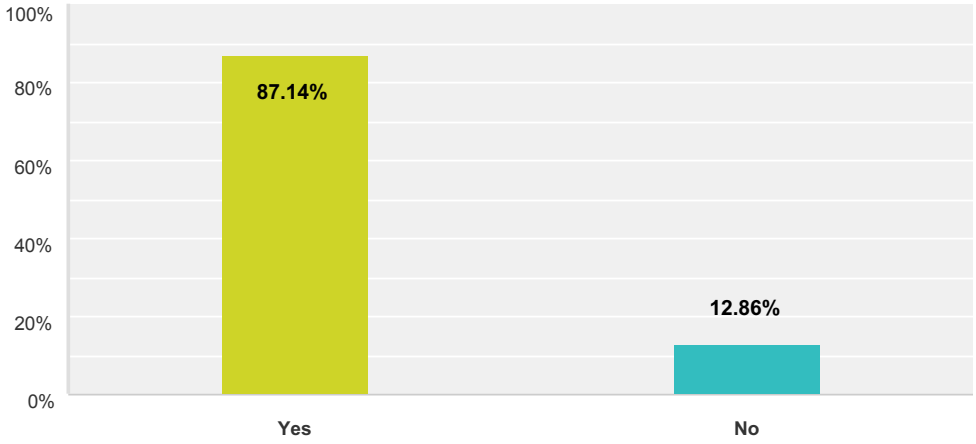
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 71

#	Responses	Date
1	(i was a member of the concurrent program, so only some of the talks were at a level which I was well prepared to benefit from, and similarly my interests were slightly distinct from those of the program).	2/12/2017 7:25 PM

Q9 Did you attend the reception?

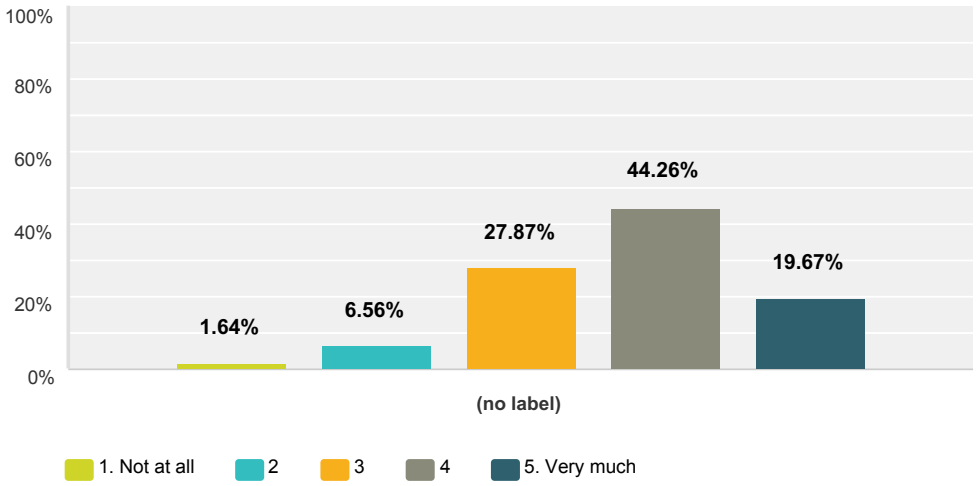
Answered: 70 Skipped: 2



Answer Choices	Responses	
Yes	87.14%	61
No	12.86%	9
Total		70

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 61 Skipped: 11



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	1.64% 1	6.56% 4	27.87% 17	44.26% 27	19.67% 12	61	3.74

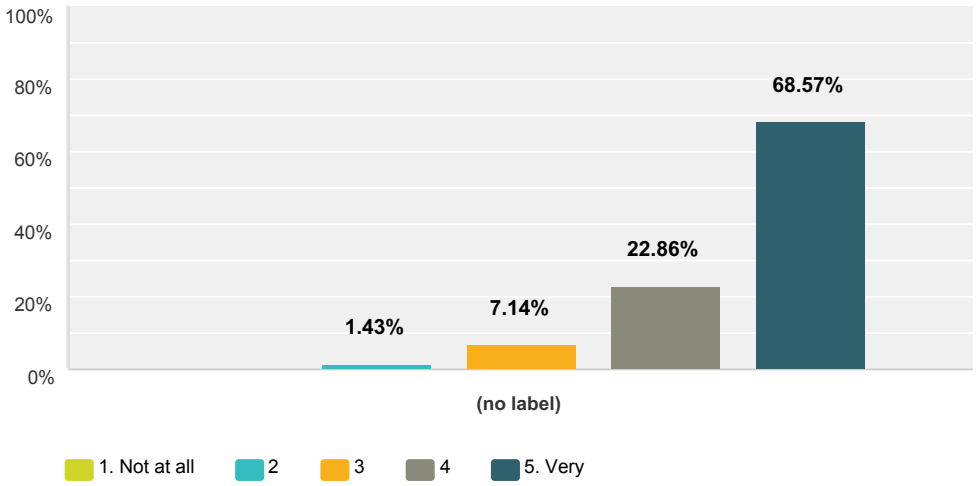
Q11 Please provide any comments about the reception

Answered: 6 Skipped: 66

#	Responses	Date
1	The food was excellent!	2/24/2017 10:50 AM
2	The queue was very long. It would be nice if you could set up food at different stations in order to allow more time for mingling, rather than waiting in the queue. Also, the bus schedule really had a negative impact on the reception. It would be nice to have an additional bus leaving at 6:25 and at 7:15 so that participants don't feel pressured to leave early in order to reduce the load on the last two buses.	2/15/2017 1:36 PM
3	The reception was as an additional coffee-tea break, so this could have been more convivial so that people can sit together longer	2/10/2017 7:44 PM
4	If the goal of the reception is to solidify contacts it should be later in the week.	2/10/2017 5:39 PM
5	More shrimp would be greatly appreciated. Otherwise great food.	2/10/2017 5:05 PM
6	I was alone during almost all the week of workshop (many people feeling like me I think). Strictly speaking, instances of meeting were not guaranteed. Lunch times did not allow to meet people for first time ever visitors! Conversations were very short!	2/10/2017 3:40 PM

Q12 I found the MSRI staff helpful

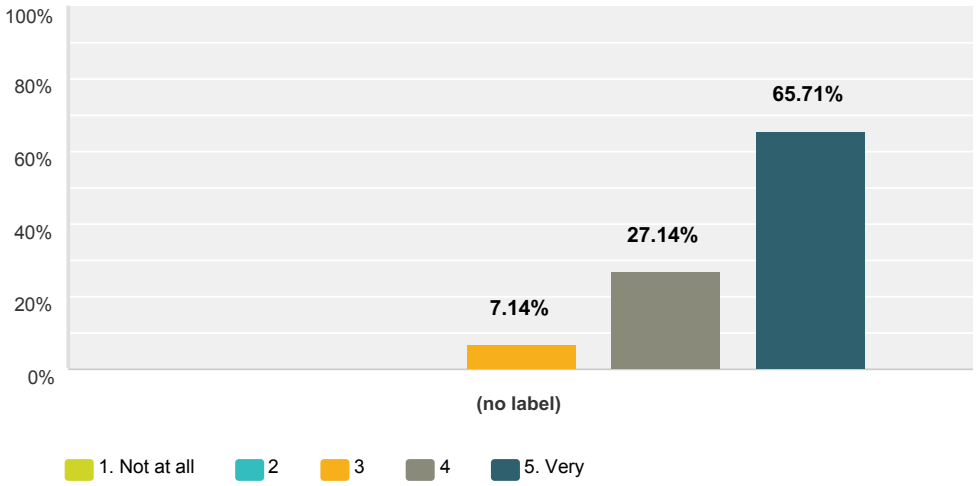
Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.43%** 1	**7.14%** 5	**22.86%** 16	**68.57%** 48	70	4.59

Q13 The MSRI facilities were conducive for such a workshop

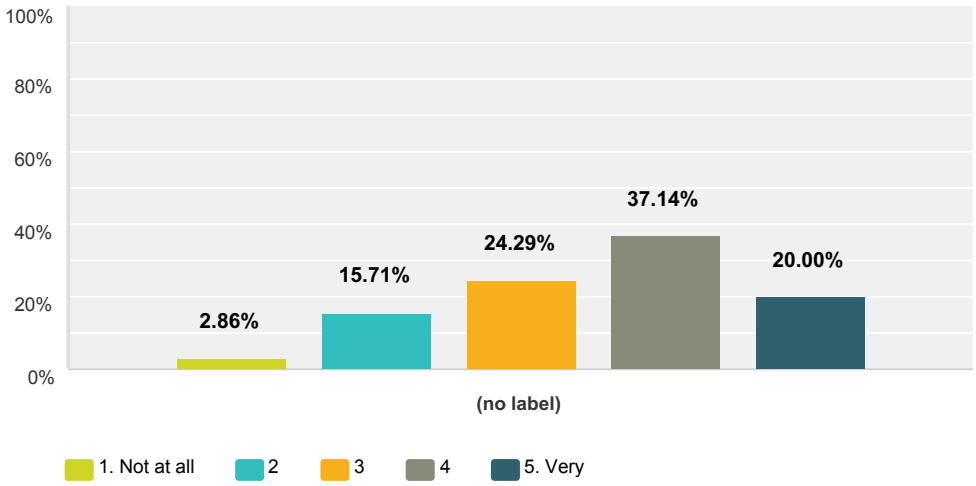
Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**7.14%** 5	**27.14%** 19	**65.71%** 46	70	4.59

Q14 The MSRI lunch arrangements were satisfactory

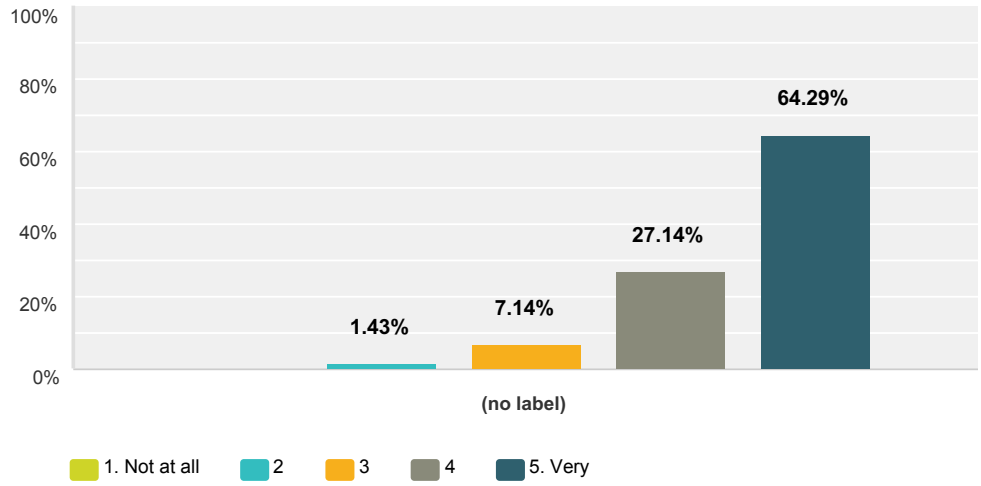
Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	2.86% 2	15.71% 11	24.29% 17	37.14% 26	20.00% 14	70	3.56

Q15 The MSRI tea arrangements were satisfactory

Answered: 70 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.43%** 1	**7.14%** 5	**27.14%** 19	**64.29%** 45	70	4.54

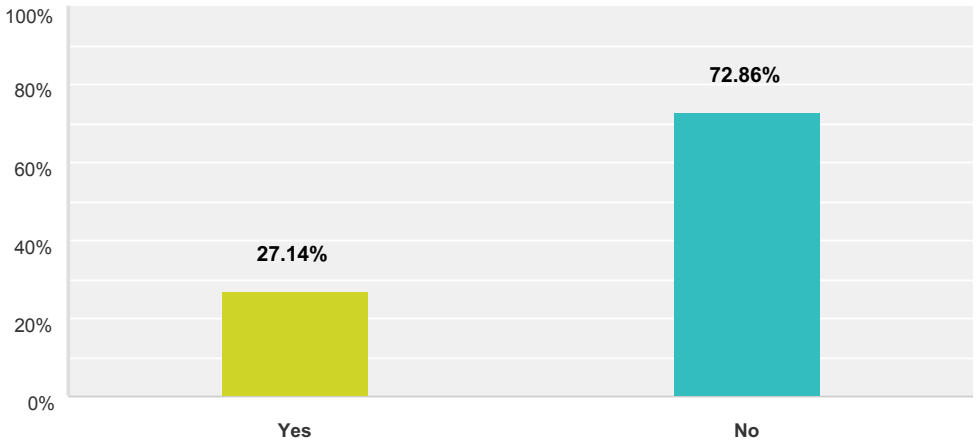
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 13 Skipped: 59

#	Responses	Date
1	It is hard for everyone to fit on the bus in the morning and the evening.	2/24/2017 10:51 AM
2	Please change caterer, the food is mediocre and very repetitive	2/22/2017 10:38 PM
3	Probably no way around this but the amount of food at the lunch served up the hill is just too small, I was hungry in the afternoon!	2/22/2017 1:37 PM
4	The sandwiches were pretty dull, especially for vegetarians and vegans. I spoke with a few vegan participants who took the bus down the hill at lunch time in order to find vegan options. In general, it would have been nice to have a few more meat-free options available for purchase.	2/15/2017 1:39 PM
5	The bus line was not able to accommodate the large number of attendees of the workshop. The bus drivers were concerned about the brakes burning out due to the additional weight. I feel that there should be additional buses provided during a workshop to accommodate the participants safely.	2/13/2017 11:58 AM
6	lines were a bit long.	2/12/2017 8:42 PM
7	- Lunch food was a bit overpriced - There could be more fresh fruit at tea breaks instead of canned fruits or pastries.	2/11/2017 10:26 AM
8	More shuttles, especially around 9AM and 5PM. Sometimes the driver refused to allow people to board the downhill direction (while he boarded some UC employees), that's much more problematic when it rains.	2/11/2017 3:46 AM
9	The number of participants was huge, unfortunately, the capacity and frequency of the shuttle bus from downhill to MSRI were not sufficient to carry everyone who needs the ride to MSRI. Meanwhile it is the only convenient access to MSRI, it would have been better if there is something can be improved about this, during the conference week.	2/10/2017 11:26 PM
10	Insufficient number of chairs at lunch. Perhaps this will change when the weather improves and more people eat outside.	2/10/2017 5:40 PM
11	It was a tight space, especially for lunch time.	2/10/2017 3:50 PM
12	It was almost obligation to take a bus from downhill, which was not mentioned in the very beginning. The first day I walked throughout the hill to get to the MSRI hoping to knew the environment. I had barely energie afterwards. Big mistake. You HAD to say that it was highly advised to pick up the shuttle.	2/10/2017 3:43 PM
13	The food could be better	2/10/2017 3:38 PM

Q17 Did you use the computer facilities located in the library?

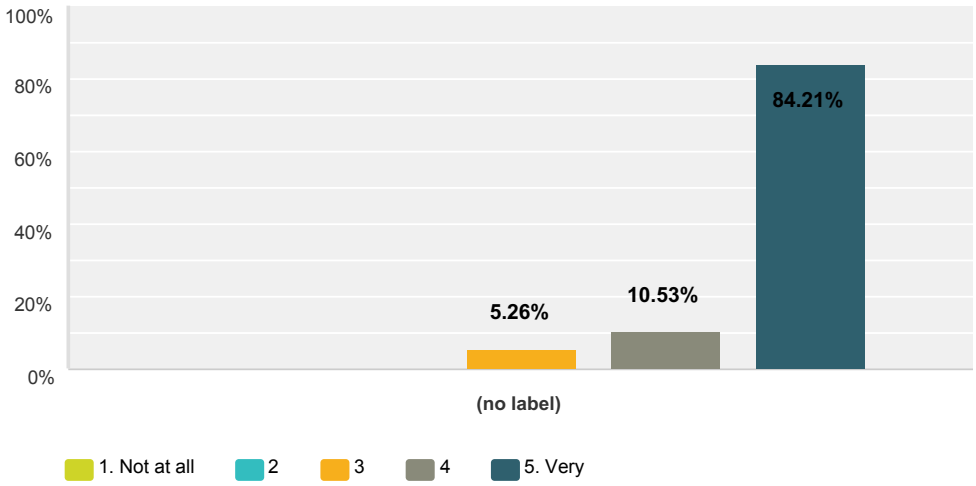
Answered: 70 Skipped: 2



Answer Choices	Responses	
Yes	27.14%	19
No	72.86%	51
Total		70

Q18 The MSRI computer facilities in the library were adequate

Answered: 19 Skipped: 53

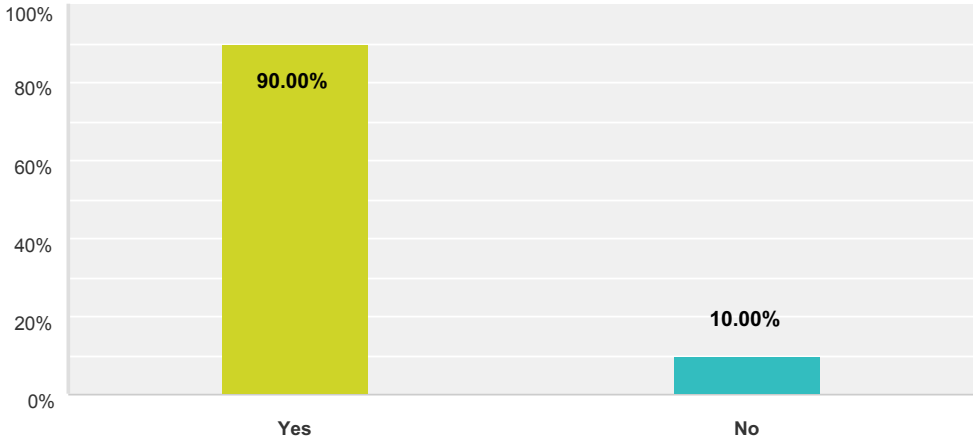


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**5.26%** 1	**10.53%** 2	**84.21%** 16	19	4.79

#	Comments about computer facilities	Date
1	I had my own laptop, but the ability to print was very convenient.	2/13/2017 5:55 AM

Q19 Did you use MSRI's wireless network?

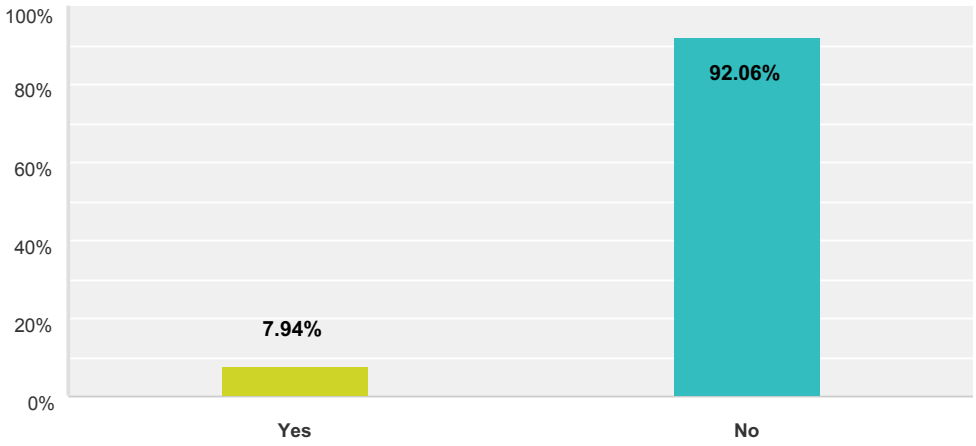
Answered: 70 Skipped: 2



Answer Choices	Responses	
Yes	**90.00%**	63
No	**10.00%**	7
Total		**70**

Q20 Did you experience any difficulties with the network?

Answered: 63 Skipped: 9



Answer Choices	Responses	
Yes	**7.94%**	5
No	**92.06%**	58
Total		**63**

#	Please if yes, please describe your difficulties	Date
1	I could not connect to my Dropbox account.	2/22/2017 5:39 PM
2	Device would not stay connected and had to manually connect a couple of times a day	2/13/2017 9:02 PM
3	The network is often slow and sometimes unresponsive.	2/13/2017 11:58 AM
4	I could not access some of the journals as I was on the Guest network.	2/13/2017 12:40 AM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 10 Skipped: 62

#	Responses	Date
1	There were 19 talks, and only 1 was by a woman. It felt like the Connections for Women workshop served to get all the female speakers out of the way before the "real" workshop began. I think it would be better if the connections for women was Monday-Tuesday after the intro workshops, instead of before	2/24/2017 10:53 AM
2	I disagree with the idea of relegating the bulk of the female speakers to a special workshop that takes place before the Introductory workshop. I think it sends the message that the women's workshop is "pre-introductory" and it also means that those speakers don't get as much exposure for their work as those in the Introductory Workshop. I really liked the fact that the Introductory Workshop had mini-courses. It was useful to be able to study a subject more deeply over a period of several days.	2/15/2017 1:47 PM
3	It would definitely be a great improvement if there were some extra buses during the workshop. In particular, at the last day when the last talk is over there should be an additional bus as some people need to catch a plane or similar. This time after about 15 people the driver didn't let more Math people enter the bus in order to still have free seats at the next stop...	2/13/2017 8:08 PM
4	There should be one or more problem sessions where experts can pose research problems for younger researchers to answer.	2/13/2017 12:41 AM
5	This was a fantastic workshop, but there were three problems I noticed that in my opinion need addressing. (1) The bus service is not adequate. I was told the buses can safely accommodate only 25 people at a time, and they only come every half hour. The workshop had over 100 people --- the results were as you might guess. Sometimes the buses went overfull, and risked safety issues (I smelled burning rubber once). -- and at other times they left people behind (in both directions). This might have included non-MSRI people who didn't even know there was a workshop happening. I think that during workshop weeks MSRI should hire someone to drive a van back and forth before and after the talks, or something like that. (2) There was only one woman speaker all week. You don't have to be 50-50 (research math is not yet 50-50) but I think this isn't good enough. This is especially odd in light of the "connections for women" the week before -- it almost feels like women get a consolation prize conference, and the real conference is for the men. I know the organizers didn't have this in mind (at all), and indeed that both genders are very welcome at both conferences, but nevertheless I think the organizers should make a severe effort to avoid this impression. (3) The weather. Can't you guys make the sun shine? :) Thanks for putting together a great conference!	2/12/2017 8:50 PM
6	The conference was just great. I can't think of anything that could have been done better!	2/12/2017 8:26 PM
7	- It would be very handy to have a shuttle at 18:55. - The shuttle drivers did not drive very safely.	2/11/2017 10:27 AM
8	I recommend more women talk for a next event. Further, the MSRI support was very helpful for me but I think the reimbursement of the hotel payment could have been done a bit earlier.	2/10/2017 7:51 PM
9	If the morning and afternoon busses should were made more frequent. Iwlt would be a great boon to personal convenience.	2/10/2017 5:09 PM
10	You should say that one can find the downhill bus live schedule on internet. Otherwise one never know when is convenient to wait for the bus.	2/10/2017 3:45 PM

Connections for Women: Harmonic Analysis

January 19, 2017 - January 20, 2017

MSRI, Berkeley, CA, USA

Organizers:

Svitlana Mayboroda (University of Minnesota, Twin Cities)

Betsy Stovall (University of Wisconsin-Madison)

REPORT ON THE MSRI WORKSHOP "CONNECTIONS FOR WOMEN: HARMONIC ANALYSIS" JANUARY 19-20, 2017

Organizers

- Svitlana Mayboroda (University of Minnesota, Twin Cities)
- Betsy Stovall (University of Wisconsin-Madison)

Scientific Description

The Connections for Women workshop was the opening activity for the semester-long scientific program on Harmonic Analysis, a field which dates back to the 19th century, and has its roots in the study of the decomposition of functions using Fourier series and the Fourier transform. In recent decades, the subject has undergone a rapid diversification and expansion, though the decomposition of functions and operators into simpler parts remains a central tool and theme.

This program has brought together researchers representing the breadth of modern Harmonic Analysis and seeks to capitalize on and continue recent progress in four major directions:

- Restriction, Kakeya, and Geometric Incidence Problems
- Analysis on Nonhomogeneous Spaces
- Weighted Norm Inequalities
- Quantitative Rectifiability and Elliptic PDE

Many of these areas draw techniques from or have applications to other fields of mathematics, such as analytic number theory, partial differential equations, combinatorics, and geometric measure theory.

The two-day *Connections for Women* workshop featured talks by eleven prominent female mathematicians on a wide range of topics in Harmonic Analysis. Each speaker gave one lecture, separated by a poster session during which participants presented posters to discuss ideas presented their work. A list of speakers and the schedule is attached. The workshop was open to all mathematicians.

Highlights of the Workshop

Five internationally renowned senior women and six nationally recognized junior women discussed their work in conference lectures, and six junior participants presented their recent results in the conference poster session.

In one talk, 2006 Salem Prize winner Stefanie Petermichl began with an introduction and historical overview of the theory of sharp weighted estimates. She then turned to a discussion of exciting recent work establishing sharp A_p bounds for subordinate pairs of martingales, a

generality in which not even the boundedness of the maximal function had previously been known.

Another speaker, Malabika Pramanik, was awarded the 2016 CMS Krieger-Nelson prize for her work on configurations in sparse sets. In her talk, she gave an overview of this area, emphasizing some recent results on configurations in sets of sufficiently large Hausdorff and Fourier dimension and also stating some important open questions, such as the Erdos similarity problem, which asks whether there exists an infinite subset of the line, a similar copy of which can be found in any set of positive Lebesgue measure.

During the panel discussion, four of the senior speakers, Loredana Lanzani, Tatiana Toro, Stefanie Petermichl, and Jill Pipher answered questions and shared some of their personal experiences connected with building a life in mathematics. The panel discussion was followed by the conference dinner, where the conversations begun during the panel continued. During dinner, there was a particularly lively discussion over the under-addressed issue of ways women without children can balance their work and personal lives.

Mathematical Sciences Research Institute

Connections for Women:
Harmonic Analysis

January 19 - 20, 2017

Schedule

Thursday, January 19, 2017			
9:00AM - 9:15AM	Simons Auditorium		Welcome
9:15AM - 10:15AM	Simons Auditorium	Malabika Pramanik	Configurations in sets
10:15AM - 11:00AM	Atrium		Tea
11:00AM - 11:30PM	Simons Auditorium	Mariana Smit Vega Garcia	The obstacle problem for the fractional Laplacian with drift
11:30AM - 12:00PM	Simons Auditorium	Krystal Taylor	On the interior of sums of fractal sets
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 3:00PM	Simons Auditorium	Stefanie Petermichl	From weighted estimates to change of law.
3:00PM - 4:00PM	Atrium		Tea and Poster Session
4:00PM - 4:30PM	Simons Auditorium	Irina Holmes	Two-Weight Inequalities for Commutators with Calderon-Zygmund Operators
4:30PM - 5:30PM	Commons	Jill Pipher, Tatiana toro, Stefanie Petermichl, Loredana Lanzani	Panel Discussion
6:30PM - 8:30PM	MSRI		Dinner at the Taste of Himlayas

Friday, January 20, 2017			
9:00AM - 10:00AM	Simons Auditorium	Jill Pipher	Regularity of solutions to second order divergence form elliptic equations
10:00AM - 11:00AM	Atrium		Break & Poster Session
11:00AM - 12:00PM	Simons Auditorium	Svetlana Jitomirskaya	Sharp arithmetic spectral transitions and universal hierarchical structure of quasiperiodic eigenfunctions
12:00PM - 2:00PM	Atrium		Lunch
2:00PM - 2:30PM	Simons Auditorium	Blair Davey	Fundamental solutions and Green functions for non-homogeneous elliptic systems
2:30PM - 3:00PM	Simons Auditorium	Constanze Liaw	Functional model for finite rank perturbations
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:00 PM	Simons Auditorium	Laura Cladek	Radial Fourier Multipliers
4:00PM - 5:00PM	Simons Auditorium	Loredana Lanzani	Harmonic Analysis techniques in Several Complex Variables

Organizers		
First Name	**Last Name**	**Institution**
Svitlana	Mayboroda	University of Minnesota, Twin Cities
Betsy	Stovall	University of Wisconsin-Madison
Speakers		
First Name	**Last Name**	**Institution**
Laura	Cladek	University of British Columbia
Blair	Davey	City College, CUNY
Irina	Holmes	Washington University in St. Louis
Loredana	Lanzani	Syracuse University
Constanze	Liaw	Baylor University
Stefanie	Petermichl	Université de Toulouse III (Paul Sabatier)
Malabika	Pramanik	University of British Columbia
Mariana	Smit Vega Garcia	University of Washington
Krystal	Taylor	Ohio State University

Participants		
First Name	**Last Name**	**Institution**
Murat	Akman	University of Connecticut
Theresa	Anderson	University of Wisconsin-Madison
Pascal	Auscher	Université de Paris XI
Matthew	Badger	University of Connecticut
Ariel	Barton	University of Arkansas
chandan	biswas	University of Wisconsin-Madison
Simon	Bortz	University of Minnesota, Twin Cities
Julia	Brandes	University of Göteborg
Anthony	Carbery	University of Edinburgh
Valentina	Casarino	University of Padua
Michael	Christ	University of California, Berkeley
paolo	ciatti	University of Padua
Laura	Cladek	University of British Columbia
Kamilia	Dahmani	Université de Toulouse III (Paul Sabatier)
Blair	Davey	City College, CUNY
Polona	Durcik	Rheinische Friedrich-Wilhelms-Universität Bonn
Max	Engelstein	Massachusetts Institute of Technology
Taryn	Flock	University of Birmingham
Ayla	Gafni	University of Rochester
Yessica	Gaitan	Purdue University
Rachel	Greenfeld	Bar-Ilan University
Shaoming	Guo	Indiana University
Jonathan	Hickman	University of Chicago
Irina	Holmes	Washington University in St. Louis
Marina	Iliopoulou	University of California, Berkeley
Paata	Ivanisvili	Kent State University
Eren	Kıral	Texas A & M University
Seick	Kim	Yonsei University
Ben	Krause	University of British Columbia
Chun Kit	Lai	San Francisco State University
Loredana	Lanzani	Syracuse University
Constanze	Liaw	Baylor University
Itay	Londner	Tel Aviv University
Dominique	Maldague	University of California, Berkeley
Svitlana	Mayboroda	University of Minnesota, Twin Cities
Stephanie	Mills	University of South Australia
Anh	Nguyen	University of California, Berkeley
Richard	Oberlin	Florida State University
Yumeng	Ou	Massachusetts Institute of Technology
Corentin	Perret-Gentil-dit-Maillard	ETH Zürich
Stefanie	Petermichl	Université de Toulouse III (Paul Sabatier)
Bruno	Poggi	University of Minnesota Twin Cities
Malabika	Pramanik	University of British Columbia
Johanna	Richter	Universität Stuttgart
Keith	Rogers	Instituto de Ciencias Matematicas (ICMAT)
Marie-Jose	Saad	Washington University

Participants		
First Name	**Last Name**	**Institution**
Olli	Saari	Aalto University
Xi Sisi	Shen	Northwestern University
Danielle	Smiley	Bryn Mawr College
Mariana	Smit Vega Garcia	University of Washington
Alex	Stokolos	Georgia Southern University
Betsy	Stovall	University of Wisconsin-Madison
Brian	Street	University of Wisconsin-Madison
Krystal	Taylor	Ohio State University
Lola	Thompson	Oberlin College
Rodolfo	Torres	University of Kansas
Sergei	Treil	Brown University
Caroline	Turnage-Butterbaugh	Duke University
Hong	Wang	Massachusetts Institute of Technology
Lesley	Ward	University of South Australia
Bobby	Wilson	Massachusetts Institute of Technology
Zhen	Zeng	University of Pennsylvania
Zihui	Zhao	University of Washington
Yue	Zhao	University of Washington

Officially Registered Participant Information

Participants		64

Gender		64
Male	42.19%	27
Female	57.81%	37
Declined to state	0.00%	0

Ethnicity*		74
White	73.44%	47
Asian	21.88%	14
Hispanic	7.81%	5
Pacific Islander	0.00%	0
Black	1.56%	1
Native American	0.00%	0
Mixed	7.81%	5
Declined to state	3.13%	2

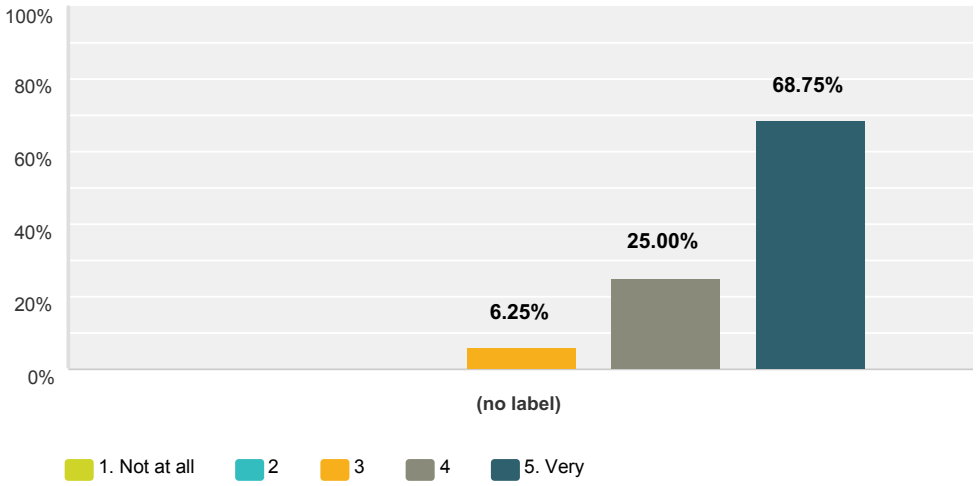
* ethnicity specifications are not exclusive

802 - Connections for Women Workshop: Harmonic Analysis - Participant Survey

32 responses out of 64 participants = 50% response rate

Q1 The workshop was intellectually stimulating

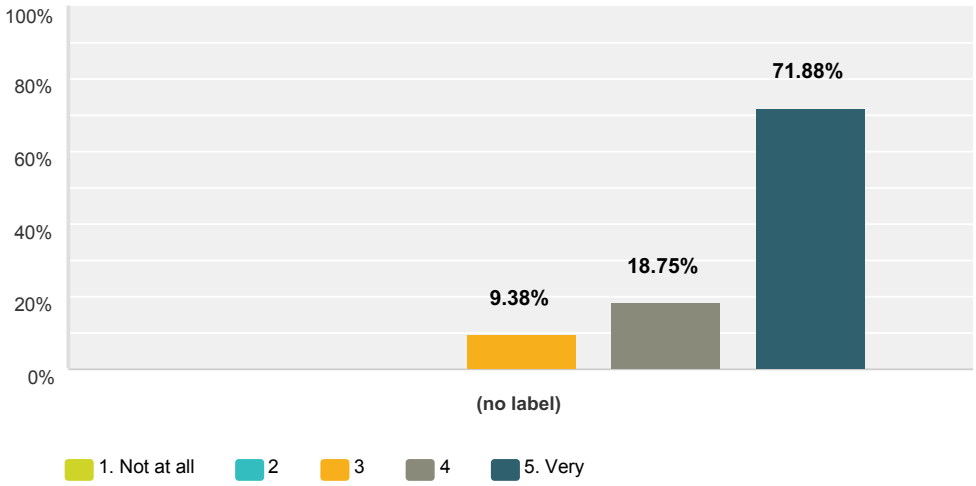
Answered: 32 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	6.25% 2	25.00% 8	68.75% 22	32	4.63

Q2 The overall experience of the workshop was worthwhile

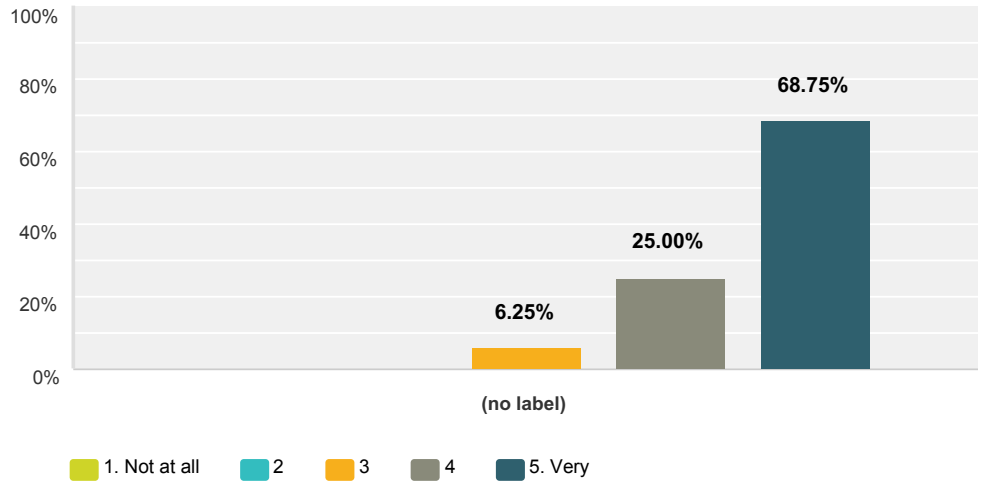
Answered: 32 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**9.38%** 3	**18.75%** 6	**71.88%** 23	32	4.63

Q3 The time between lectures was adequate for discussion

Answered: 32 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**6.25%** 2	**25.00%** 8	**68.75%** 22	32	4.63

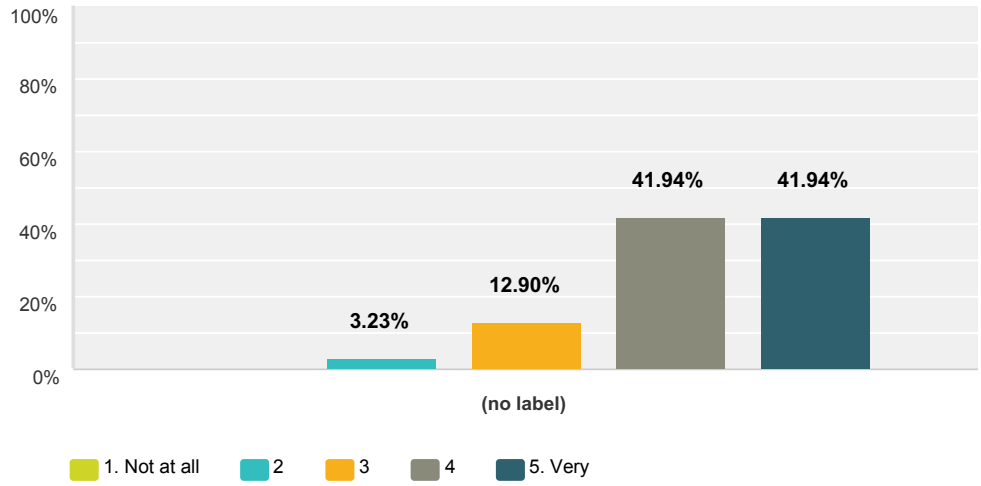
Q4 Additional comments

Answered: 10 Skipped: 22

#	Responses	Date
1	I appreciated the diversity of the group of participants: mostly female and from many different backgrounds. Scheduling the Connections for Women workshop right before the Introductory Workshop is very effective, since then during the Introductory Workshop women have already formed some connections with other participants, and are already familiar with the Institute. Personally, the Connections for Women workshop has led to a potential new collaboration for me with one of the speakers.	1/30/2017 3:51 PM
2	Lessen the time between lectures to only 30 minutes. Shorten the lunch period to 1 hour. Warn participants that the lunch catering is only from 1-1:30ish.	1/23/2017 10:50 AM
3	Nice conferences and very good speakers.	1/21/2017 5:33 PM
4	Panel session was really stimulating (to me as a "senior" male who has done lots of training in unconscious bias etc but who still learned a lot...)	1/21/2017 8:39 AM
5	The environment was very friendly and easy, adequate also to families (there was my 13 years old daughter with me, and she could spend her time in a very nice way at MSRI, doing her homework in the common room).	1/21/2017 7:48 AM
6	The breaks were a bit too long	1/21/2017 1:22 AM
7	Too long tea breaks	1/20/2017 7:18 PM
8	I've registered to the workshop, I don't know why I don't have a name tag?	1/20/2017 6:31 PM
9	I particularly enjoyed the discussion panel - it was the first I ever attended, and found it very useful being in a safe environment, and talking about the things that worry me regarding the life of an academic.	1/20/2017 5:12 PM
10	1 hour breaks was a little bit too much.	1/20/2017 5:09 PM

Q5 I was well prepared to benefit from the lectures

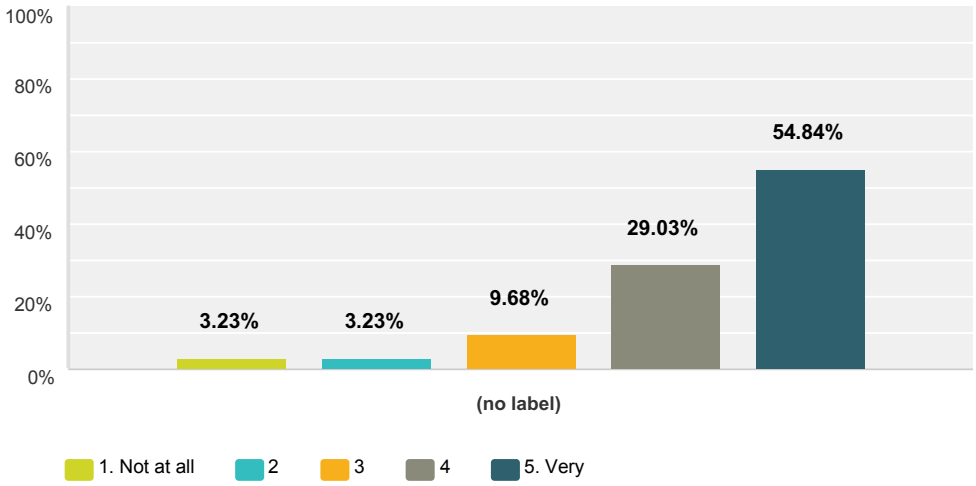
Answered: 31 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**3.23%** 1	**12.90%** 4	**41.94%** 13	**41.94%** 13	31	4.23

Q6 My interest in the subject matter was increased by the workshop

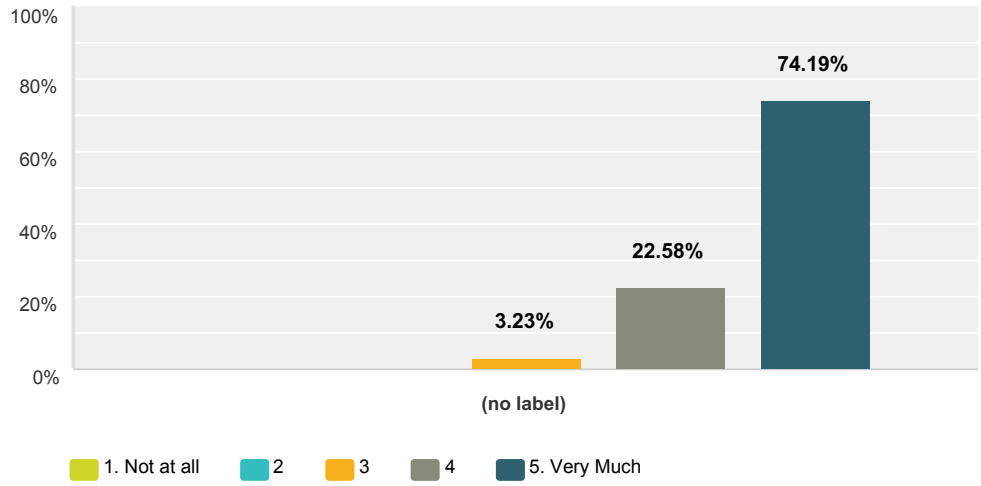
Answered: 31 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	3.23% 1	3.23% 1	9.68% 3	29.03% 9	54.84% 17	31	4.29

Q7 The workshop helped me meet people with similar scientific interests

Answered: 31 Skipped: 1



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.23%** 1	**22.58%** 7	**74.19%** 23	31	4.71

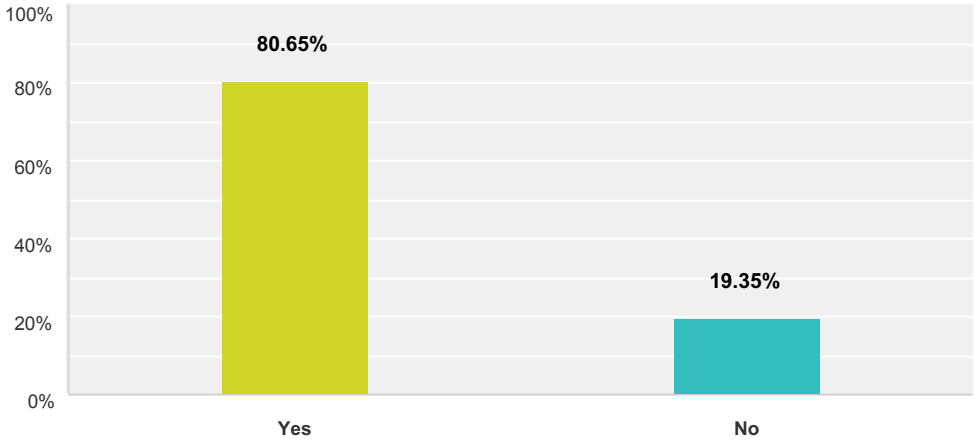
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 31

#	Responses	Date
1	The workshop was very interesting, also since I had the opportunity to attend many lectures given by American mathematicians. I would like very much to partecipate, in the future, to a joint meeting Europe-Usa at MSRI.	1/21/2017 7:51 AM

Q9 Did you attend the panel discussion?

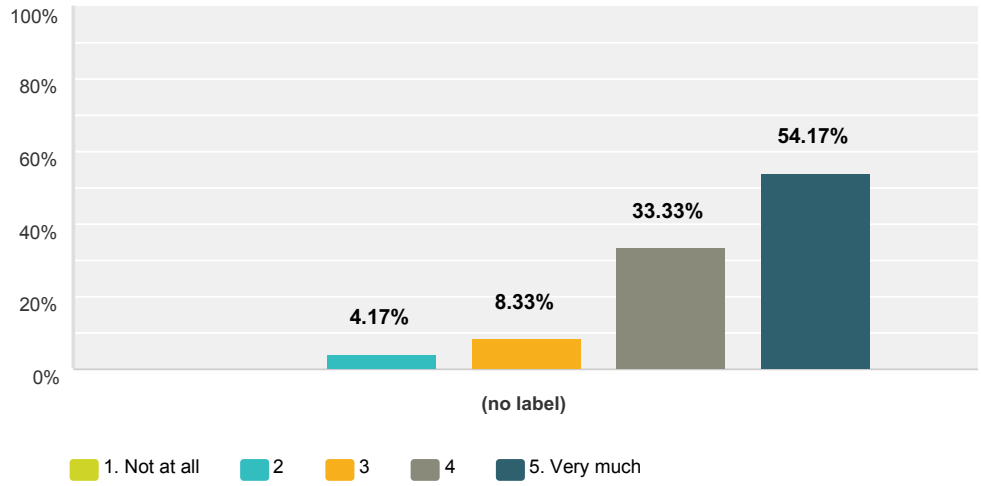
Answered: 31 Skipped: 1



Answer Choices	Responses	
Yes	80.65%	25
No	19.35%	6
Total		31

Q10 Did you find the panel discussion worthwhile?

Answered: 24 Skipped: 8



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**4.17%** 1	**8.33%** 2	**33.33%** 8	**54.17%** 13	24	4.38

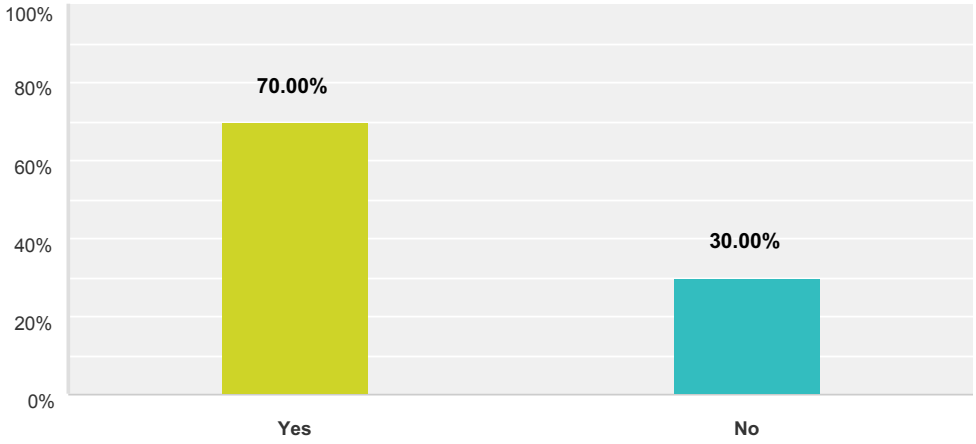
Q11 What other subjects should be discussed in future panel discussions?

Answered: 6 Skipped: 26

#	Responses	Date
1	Surviving your first year in an academic position	1/23/2017 10:51 AM
2	Job application process, balancing work travel, work and free time	1/21/2017 12:39 PM
3	I feel that there are, probably, too many publications in Mathematics and too much strong pressure on people to publish. This is a more general problem, not only for women, but I would like to consider this problem in a panel discussion.	1/21/2017 7:59 AM
4	Involvement of male students with female professors	1/20/2017 7:19 PM
5	Not about the subjects: the attitude. Be frank. Be a bit more brutal. It might be worth it to survey opinions/questions before hand from participants, so the panel can have some topics even when the audience is too shy to have questions.	1/20/2017 6:32 PM
6	maybe the bad experiences that senior women professors had just so that juniors would realize that we all are going through some tough times sometimes.	1/20/2017 5:10 PM

Q12 Did you attend the dinner?

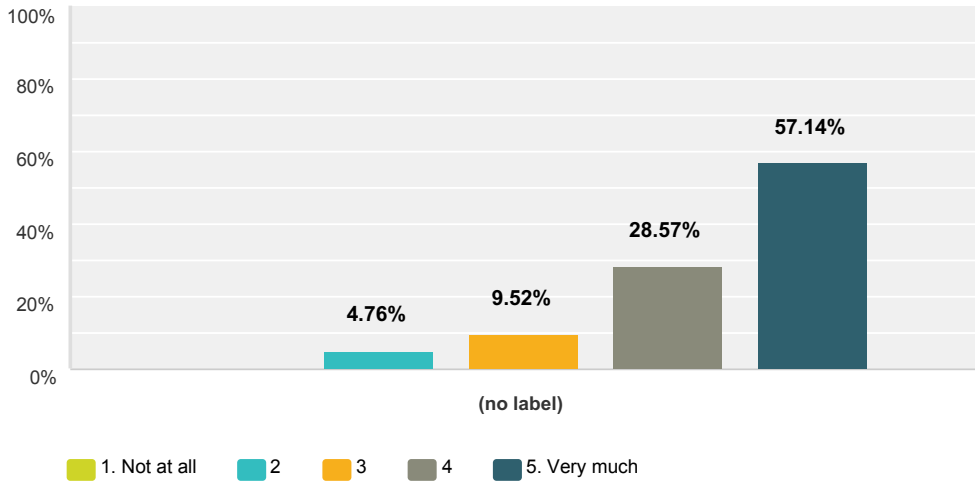
Answered: 30 Skipped: 2



Answer Choices	Responses	
Yes	**70.00%**	21
No	**30.00%**	9
Total		**30**

Q13 Did the dinner help to solidify the contacts you made in the workshop?

Answered: 21 Skipped: 11



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**4.76%** 1	**9.52%** 2	**28.57%** 6	**57.14%** 12	21	4.38

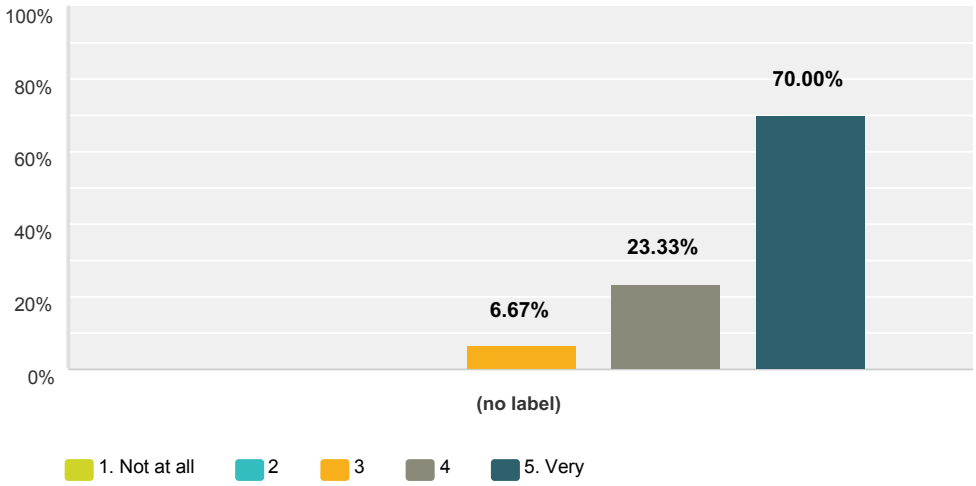
Q14 Please provide any comments about the dinner

Answered: 7 Skipped: 25

#	Responses	Date
1	Dinner was great to create bonds and provided a more relaxed atmosphere to talk to people.	1/23/2017 10:52 AM
2	Excellent addition to the day.	1/21/2017 3:30 PM
3	I knew many of the women already but have benefitted from dinners like this throughout my career	1/21/2017 12:40 PM
4	Very nice, I liked very much tastes from Himalayas.	1/21/2017 8:00 AM
5	The dinner was a very good opportunity to start conversation with other women, the discussion about research and other academic topics was very stimulating	1/20/2017 7:21 PM
6	Didn't like the appetizer. No desert?	1/20/2017 6:33 PM
7	It was a little bit loud and i would have prefered something more related to America than it was to india/nepal. Or even neutral.	1/20/2017 5:11 PM

Q15 I found the MSRI staff helpful

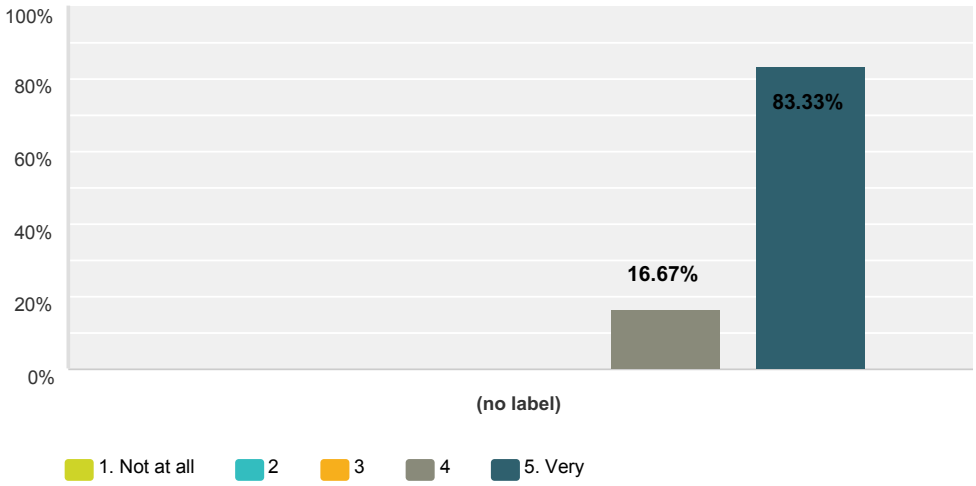
Answered: 30 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**6.67%** 2	**23.33%** 7	**70.00%** 21	30	4.63

Q16 The MSRI facilities were conducive for such a workshop

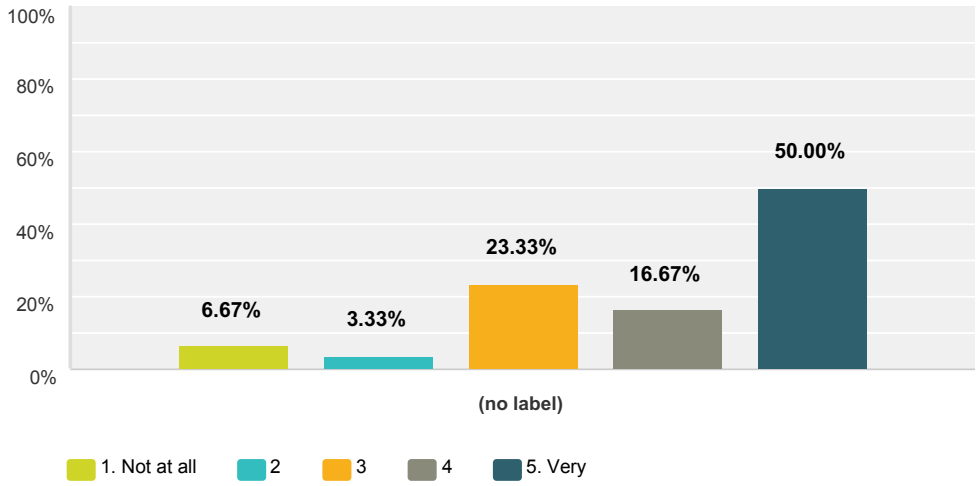
Answered: 30 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**16.67%** 5	**83.33%** 25	30	4.83

Q17 The MSRI lunch arrangements were satisfactory

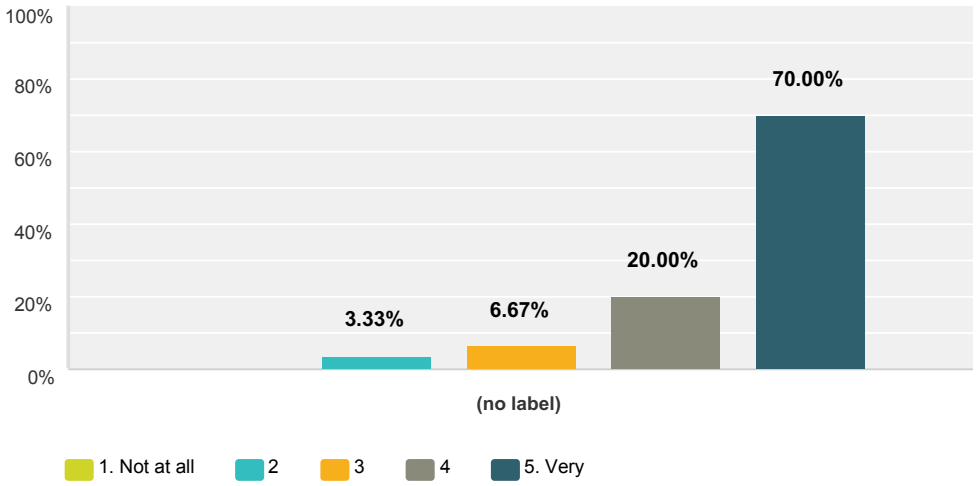
Answered: 30 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	6.67% 2	3.33% 1	23.33% 7	16.67% 5	50.00% 15	30	4.00

Q18 The MSRI tea arrangements were satisfactory

Answered: 30 Skipped: 2



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**3.33%** 1	**6.67%** 2	**20.00%** 6	**70.00%** 21	30	4.57

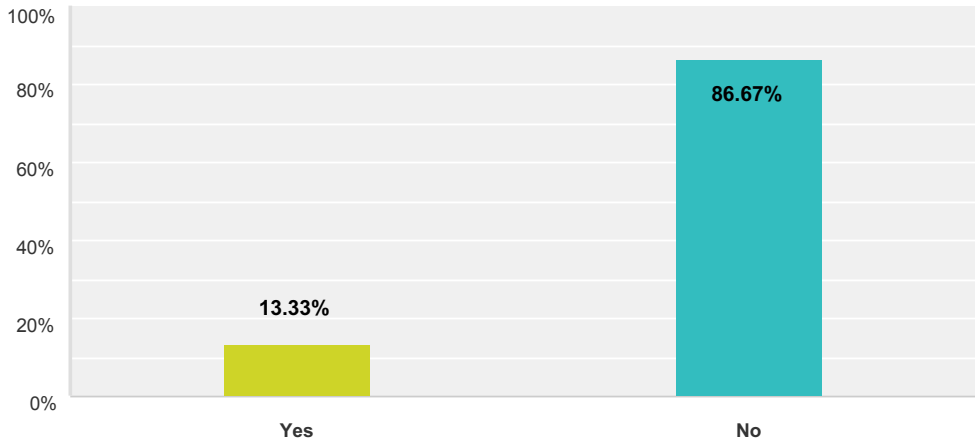
Q19 Additional comments about MSRI staff, facilities and food

Answered: 7 Skipped: 25

#	Responses	Date
1	Did not take lunch so I made a moderate answer: you should provide a possible NA check	2/3/2017 3:11 PM
2	Comments were stated at the beginning. Get better coffee. Not so many sweets at the teas.	1/23/2017 10:53 AM
3	Excellent!	1/21/2017 8:40 AM
4	All was perfect.	1/21/2017 8:00 AM
5	Incredible installations and a great working environment	1/20/2017 7:23 PM
6	Sandwiches are expensive. Tea and coffee should be available all the time.	1/20/2017 6:34 PM
7	Lunches were a bit expensive for what it was.	1/20/2017 5:12 PM

Q20 Did you use the computer facilities located in the library?

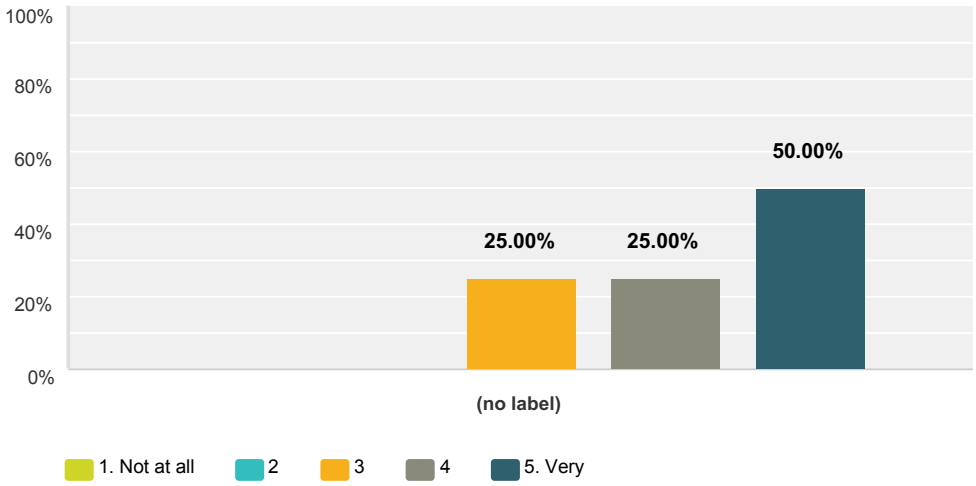
Answered: 30 Skipped: 2



Answer Choices	Responses	
Yes	13.33%	4
No	86.67%	26
Total		30

Q21 The MSRI computer facilities in the library were adequate

Answered: 4 Skipped: 28

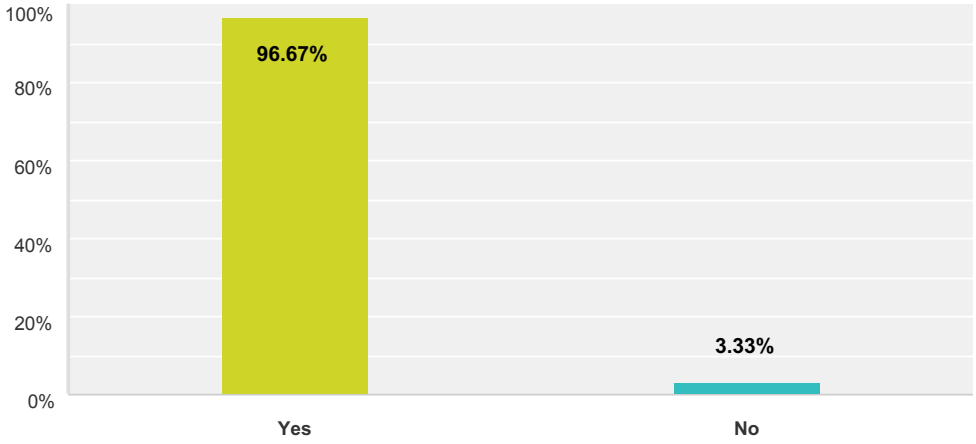


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**25.00%** 1	**25.00%** 1	**50.00%** 2	4	4.25

#	Comments about computer facilities	Date
1	I had some difficulties at first working out how to print from the library computers, but figured it out.	1/30/2017 3:53 PM
2	The printer was not working, it was impossible to print a paper	1/20/2017 7:24 PM

Q22 Did you use MSRI's wireless network?

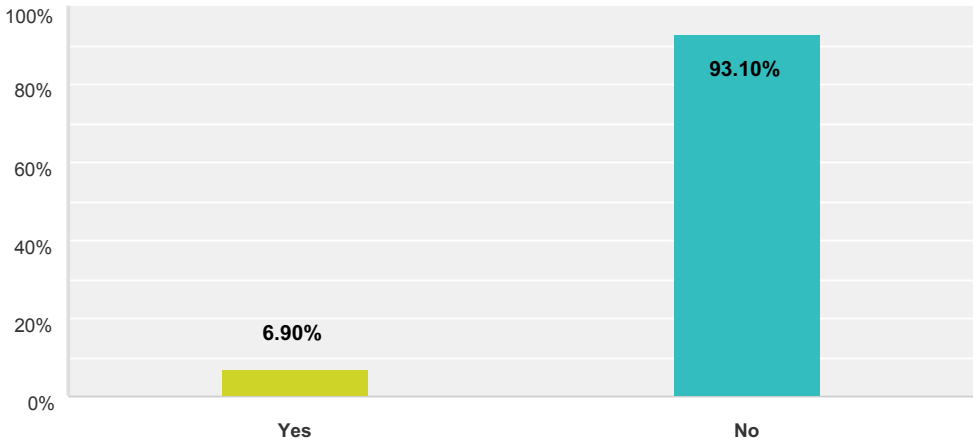
Answered: 30 Skipped: 2



Answer Choices	Responses	
Yes	**96.67%**	29
No	**3.33%**	1
Total		**30**

Q23 Did you experience any difficulties with the network?

Answered: 29 Skipped: 3



Answer Choices	Responses	
Yes	**6.90%**	2
No	**93.10%**	27
Total		**29**

#	Please if yes, please describe your difficulties	Date
1	It worked perfectly.	1/21/2017 8:01 AM
2	The 'guest' network did not always connect and was wuite slow when it did.	1/20/2017 8:23 PM
3	Horrible Wifi strength. Can't get an Uber up there.	1/20/2017 6:35 PM

Q24 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 3 Skipped: 29

#	Responses	Date
1	Put NA as possible answers in the survey	2/3/2017 3:12 PM
2	All was perfect, Thanks!	1/21/2017 8:01 AM
3	Please allow lunch people to charge credit cards. I have to borrow people money for lunch.	1/20/2017 6:35 PM

Introductory Workshop: Harmonic Analysis

January 23, 2017 - January 27, 2017

MSRI, Berkeley, CA, USA

Organizers:

Allan Greenleaf (University of Rochester)

Michael Lacey (Georgia Institute of Technology)

Svitlana Mayboroda (University of Minnesota, Twin Cities)

Betsy Stovall (University of Wisconsin-Madison)

Brian Street (University of Wisconsin-Madison)

REPORT ON THE MSRI WORKSHOP "INTRODUCTORY WORKSHOP: HARMONIC ANALYSIS" JANUARY 23-27, 2017

Organizers

- Allan Greenleaf (University of Rochester),
- Michael Lacey (Georgia Institute of Technology),
- Svitlana Mayboroda (University of Minnesota, Twin Cities),
- Betsy Stovall (University of Wisconsin-Madison),
- Brian Street (University of Wisconsin-Madison)

Scientific Description

The Introductory workshop took place at the beginning of the semester-long scientific program on Harmonic Analysis, a field which dates back to the 19th century, and has its roots in the study of the decomposition of functions using Fourier series and the Fourier transform. In recent decades, the subject has undergone a rapid diversification and expansion, though the decomposition of functions and operators into simpler parts remains a central tool and theme.

This program has brought together researchers representing the breadth of modern Harmonic Analysis and seeks to capitalize on and continue recent progress in four major directions:

- Restriction, Kakeya, and Geometric Incidence Problems
- Analysis on Nonhomogeneous Spaces
- Weighted Norm Inequalities
- Quantitative Rectifiability and Elliptic PDE

Many of these areas draw techniques from or have applications to other fields of mathematics, such as analytic number theory, partial differential equations, combinatorics, and geometric measure theory.

The week long introductory workshop served as an introduction for graduate students, postdocs, and other researchers to the main themes of the program. It featured accessible talks by a number of leading harmonic analysts, including several short courses on the core ideas and techniques in the field. There was also a problem session, to which all participants are encouraged to contribute. A list of speakers and the schedule is attached.

Highlights of the Workshop

The audience was drawn from graduate students, postdoctoral fellows, and professors from around the world. The workshop consisted of a total of 18 hours of lecture, divided among seven lecturers. The topics were chosen to introduce the audience to current trends in the subject of Harmonic Analysis.

Larry Guth took as his topic the work of Jean Bourgain and Ciprian Demeter, specifically their decoupling theorems in Fourier analysis. These results contain as corollaries very sharp estimates for the L^p norms of various trigonometric sums. In particular, Bourgain, Demeter and Guth have resolved the Vinogradov's mean value theorem in all degrees, a very deep and long standing question about the number of solutions to systems of equations in the integers. It had been open for many decades.

These trigonometric sums appear in PDE when one studies the Schrodinger equation on a torus, and they appear in analytic number theory in connection with the circle method. Lectures explained what decoupling theorems say, and gave an overview of examples. The next two lectures developed the elements of the proof in the simplest example, reducing the decoupling theorem to various geometric considerations about overlapping rectangles.

Marianna Csornyei spoke on exotic exceptional sets in the plane, of the type first exhibited by Besicovitch: A set of measure zero so that a unit line segment can be moved inside set, to point in every possible direction of the plane. Such sets, seemingly esoteric, are foundational to a range of questions in higher dimensions, including the fine features of the Schrodinger and wave equations.

Remarkably, variants of this classical result remain true if the unit line segment of Besicovitch is replaced by an arbitrary rectifiable set. The construction is phrased in the language of Baire Category, and a series of elegant and insightful rephrasing of the equation in projective spaces. Besicovitch himself could have understood the question. These examples are relevant to the fine behavior of wave and Schrodinger equations in non-homogeneous media.

Michael Christ spoke on the existence and fine properties of extremizers of different classes of inequalities. Inequalities with full affine invariance are rare. Fundamental examples include the inequalities of Brunn-Minkowski, Young, Riesz-Sobolev, and Hausdorff-Young. For each of these, a sharp form with an optimal constant is known, including a characterization of all extremizing functions, or sets.

Refinements of these inequalities quantify the uniqueness of extremizers. The first lecture was a general introduction, reviewing several inequalities, stating refinements, and introducing associated ideas. The second lecture outlined a proof of a sharpened Riesz-Sobolev inequality. The arguments entail features of the inequalities that are not immediately apparent. In some cases, one sees ideas from arithmetic combinatorics arise. In the context of the Riesz-Sobolev inequalty, the affine group arises as a symmetry group of the set of cosets of one-parameter subgroups of the Euclidean group.

Introductory Workshop: Harmonic Analysis

January 23-27, 2017

Schedule

Monday, Jan 23, 2017			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Svitlana Mayboroda	Analysis and PDEs on uniformly rectifiable sets
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Michael Christ	Sharpened affine-invariant inequalities
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Larry Guth	Introduction to decoupling
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Daniel Tataru	The energy critical Yang-Mills flow 2

Tuesday, Jan 24, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	David Jerison	Regularity and singularities of stable critical points and higher critical points in variational problems
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Larry Guth	Ingredients of the proof of decoupling
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Marianna Csornyei	The Kakeya needle problem for rectifiable sets
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Svitlana Mayboroda	Analysis and PDEs on uniformly rectifiable sets
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, Jan 25, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Michael Christ	Sharpened affine-invariant inequalities
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Daniel Tataru	Energy dispersed Yang-Mills waves

Thursday, Jan 26, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Larry Guth	The proof of decoupling for the parabola
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Daniel Tataru	Morawetz estimates and nonconcentration of Yang-Mills waves
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	David Jerison	Regularity and singularities of stable critical points and higher critical points in variational problems
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Marianna Csornyei	The Kakeya needle problem for rectifiable sets

Friday, Jan 27, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Michael Lacey	Weighted Inequalities: Two Weight and Ap
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Marianna Csornyei	The Kakeya needle problem for rectifiable sets
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	David Jerison	Regularity and singularities of stable critical points and higher critical points in variational problems
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Michael Lacey	Weighted Inequalities: Sparse Forms

Organizers		
First Name	**Last Name**	**Institution**
Allan	Greenleaf	University of Rochester
Michael	Lacey	Georgia Institute of Technology
Svitlana	Mayboroda	University of Minnesota, Twin Cities
Betsy	Stovall	University of Wisconsin-Madison
Brian	Street	University of Wisconsin-Madison
Speakers		
First Name	**Last Name**	**Institution**
Michael	Christ	University of California, Berkeley
Marianna	Csornyei	University of Chicago
Larry	Guth	Massachusetts Institute of Technology
David	Jerison	MIT
Michael	Lacey	Georgia Institute of Technology
Svitlana	Mayboroda	University of Minnesota, Twin Cities
David	Tataru	University of California, Berkeley

Participants		
First Name	**Last Name**	**Institution**
Murat	Akman	University of Connecticut
Dallas	Albritton	University of Minnesota Twin Cities
Theresa	Anderson	University of Wisconsin-Madison
Razvan	Anisca	Lakehead University
Pascal	Auscher	Université de Paris XI
Matthew	Badger	University of Connecticut
Alex	Barron	Brown University
Ariel	Barton	University of Arkansas
Dmitriy	Bilyk	University of Minnesota, Twin Cities
Chandan	Biswas	University of Wisconsin-Madison
Simon	Bortz	University of Minnesota, Twin Cities
Julia	Brandes	University of Göteborg
Almaz	Butaev	Concordia University
Anthony	Carbery	University of Edinburgh
Emanuel	Carneiro	Institute of Pure and Applied Mathematics (IMPA)
Valentina	Casarino	University of Padua
Jacky	Chong	University of Maryland
Sam	Chow	MSRI - Mathematical Sciences Research Institute
Michael	Christ	University of California, Berkeley
paolo	ciatti	University of Padua
Marianna	Csornyei	University of Chicago
Amalia	Culiuc	Georgia Institute of Technology
Kamilia	Dahmani	Université de Toulouse III (Paul Sabatier)
Blair	Davey	City College, CUNY
Polona	Durcik	Rheinische Friedrich-Wilhelms-Universität Bonn
Moritz	Egert	Université de Paris XI
Max	Engelstein	Massachusetts Institute of Technology
Taryn	Flock	University of Birmingham
Ayla	Gafni	University of Rochester
Yessica	Gaitan	Purdue University
Michael	Geis	Northwestern University
Ryan	Gibara	Concordia University
Maxim	Gilula	Michigan State University
Max	Goering	University of Washington
Michael	Goldberg	University of Cincinnati
Daniel	Goldston	San Jose State University
Felipe	GonÃ§alves	University of Alberta
Rachel	Greenfeld	Bar-Ilan University
Allan	Greenleaf	University of Rochester
Shaoming	Guo	Indiana University
Larry	Guth	Massachusetts Institute of Technology
Timo	Haenninen	University of Helsinki
Rui	Han	University of California, Irvine
Jonathan	Hickman	University of Chicago
Irina	Holmes	Washington University in St. Louis
Tuomas	Hytönen	University of Helsinki

Participants		
First Name	**Last Name**	**Institution**
Marina	Iliopoulou	University of California, Berkeley
Paata	Ivanisvili	Kent State University
Casey	Jao	University of California, Berkeley
David	Jerison	MIT
Eren	KÄ±ral	Texas A & M University
Asaf	Katz	Hebrew University
Dewey	Kemp	Indiana University
Robert	Kesler	Georgia Institute of Technology
Jongchon	Kim	University of Wisconsin-Madison
Seick	Kim	Yonsei University
Akshat	Kumar	Sandia National Laboratories
Michael	Lacey	Georgia Institute of Technology
Zane	Li	University of California, Los Angeles
Itay	Londner	Tel Aviv University
Kevin	Luli	University of California, Davis
José Ramón	Madrid Padilla	Aalto University
Dominique	Maldague	University of California, Berkeley
Juan José	Marín	Instituto de Ciencias Matematicas (ICMAT)
Kaisa	Matomäki	University of Turku
Svitlana	Mayboroda	University of Minnesota, Twin Cities
James	Maynard	University of Oxford
Sean	McCurdy	University of Washington
Dario	Mena	Georgia Institute of Technology
Tomas	Merchan	Kent State University
Stephanie	Mills	University of South Australia
Lisa	Naples	University of Connecticut
Anh	Nguyen	University of California, Berkeley
Richard	Oberlin	Florida State University
Itamar	Oliveira	Cornell University
Kevin	O'Neill	University of California, Berkeley
Yumeng	Ou	Massachusetts Institute of Technology
Eyvindur	Palsson	Virginia Polytechnic Institute and State University
Josiah	Park	Georgia Institute of Technology
Hans	Parshall	University of Georgia
Bruno	Poggi	University of Minnesota Twin Cities
Andrew	Pollington	National Science Foundation
Malabika	Pramanik	University of British Columbia
Robert	Rahm	Washington University
Johanna	Richter	Universität Stuttgart
Luka	Rimanic	University of Bristol
Keith	Rogers	Instituto de Ciencias Matematicas (ICMAT)
Marie-Jose	Saad	Washington University
Olli	Saari	Aalto University
Jeremy	Schwend	University of Wisconsin-Madison
Xi Sisi	Shen	Northwestern University
Angad	Singh	California Institute of Technology

Participants		
First Name	**Last Name**	**Institution**
Danielle	Smiley	Bryn Mawr College
Mariana	Smit Vega Garcia	University of Washington
Mateus	Sousa	Institute of Pure and Applied Mathematics (IMPA)
Sophie	Stevens	University of Bristol
Dmitriy	Stolyarov	Michigan State University
Betsy	Stovall	University of Wisconsin-Madison
Martin	Strömqvist	Uppsala University
Brian	Street	University of Wisconsin-Madison
Naser	Talebizadeh Sardari	MSRI - Mathematical Sciences Research Institute
David	Tataru	University of California, Berkeley
Krystal	Taylor	Ohio State University
Joni	Teräväinen	University of Turku
Frank	Thorne	University of South Carolina
Tatiana	Toro	University of Washington
Rodolfo	Torres	University of Kansas
Sergei	Treil	Brown University
Dominick	Villano	University of Pennsylvania
Aled	Walker	University of Oxford
Hong	Wang	Massachusetts Institute of Technology
Lesley	Ward	University of South Australia
Bobby	Wilson	Massachusetts Institute of Technology
Mahishanka	Withanachchi	Texas A & M University
Julia	Wolf	University of Bristol
Yakun	Xi	Johns Hopkins University
Lechao	Xiao	University of Pennsylvania
Fan	Yang	University of California, Irvine
Po Lam	Yung	The Chinese University of Hong Kong
Zhen	Zeng	University of Pennsylvania
Yujia	Zhai	Cornell University
Shiwen	Zhang	Michigan State University
Zihui	Zhao	University of Washington
Yue	Zhao	University of Washington

Officially Registered Participant Information

Participants		123

Gender		123
Male	67.48%	83
Female	32.52%	40
Declined to state	0.00%	0

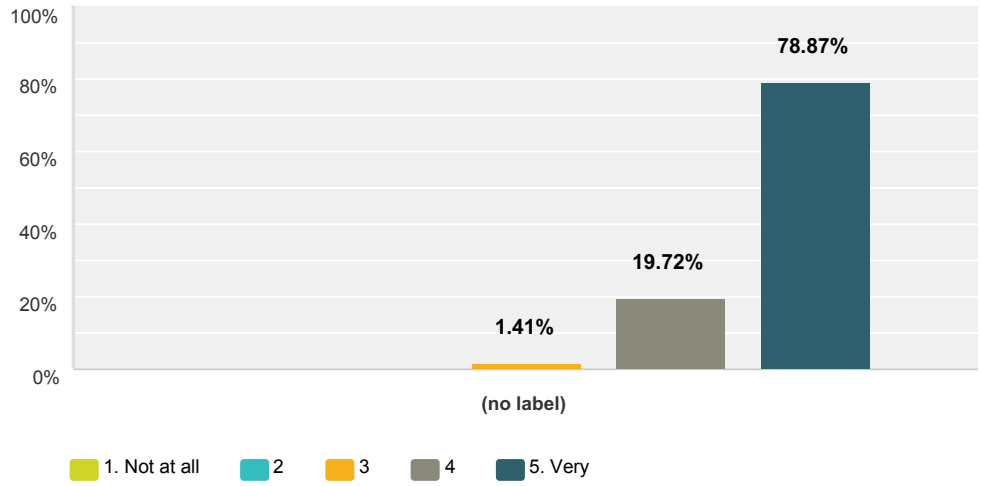
Ethnicity*		135
White	68.29%	84
Asian	21.14%	26
Hispanic	7.32%	9
Pacific Islander	0.00%	0
Black	1.63%	2
Native American	0.81%	1
Mixed	4.88%	6
Declined to state	5.69%	7

* ethnicity specifications are not exclusive

71 responses out of 123 participants = 58% response rate

Q1 The workshop was intellectually stimulating

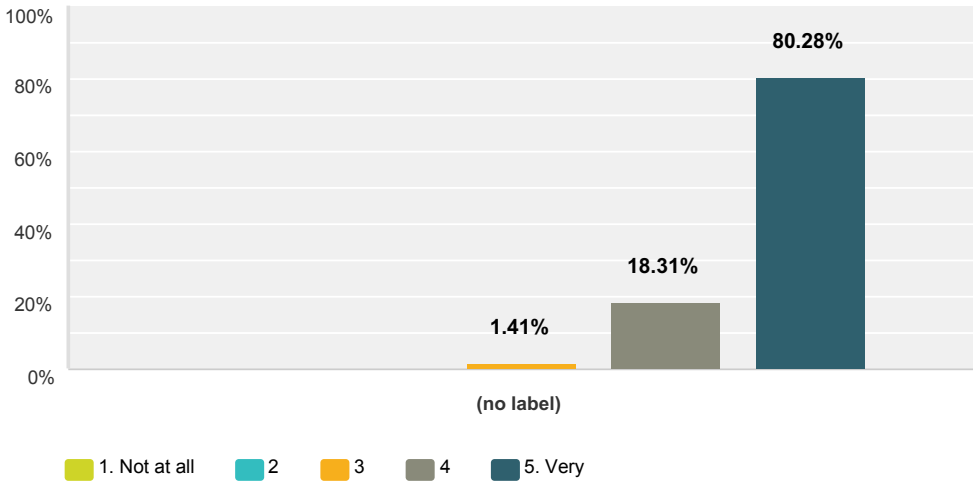
Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	0.00% 0	1.41% 1	19.72% 14	78.87% 56	71	4.77

Q2 The overall experience of the workshop was worthwhile

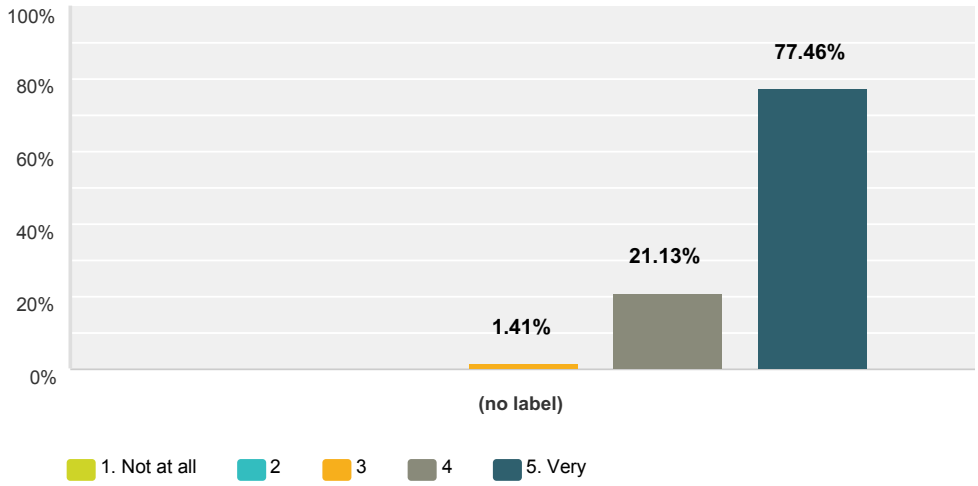
Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.41%** 1	**18.31%** 13	**80.28%** 57	71	4.79

Q3 The time between lectures was adequate for discussion

Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.41%** 1	**21.13%** 15	**77.46%** 55	71	4.76

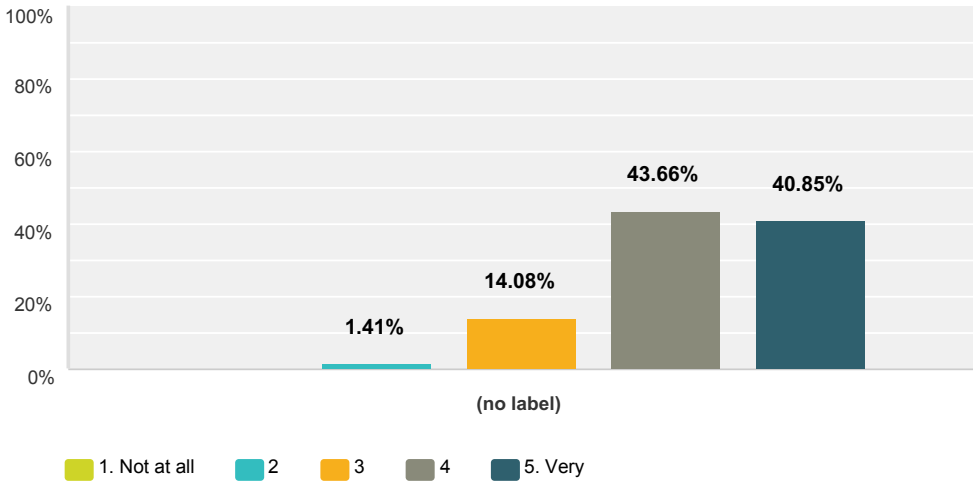
Q4 Additional comments

Answered: 11 Skipped: 60

#	Responses	Date
1	It was a very useful workshop. Also I met some very excellent researchers	2/24/2017 1:59 PM
2	The courses were very interesting, I think I learned a lot, thank you very much for the opportunity!	2/24/2017 11:00 AM
3	It was a good choice to have a half-dozen speakers give multiple lectures instead of twenty people speaking for one hour each.	2/24/2017 10:51 AM
4	Great speakers.	2/6/2017 6:28 AM
5	The lectures of Larry Guth were wonderful, the best lectures I've attended in my life: he really tried to explain the ideas behind the arguments.	2/4/2017 9:56 AM
6	Excellent workshop. Enjoyed every day of it.	1/29/2017 7:34 PM
7	This was the best conference I have ever attended. The time between lectures allowed for discussion. Also, there was a great mixture of different areas of math, and I broadened my network.	1/28/2017 9:33 AM
8	Great choice of speakers, it felt like an appropriate level	1/27/2017 8:48 PM
9	One of the most interesting events I have ever attended!	1/27/2017 5:22 PM
10	The workshop was a great success and I hope for many more to be organised in the future.	1/27/2017 4:26 PM
11	I particularly enjoyed Larry Guth's brilliant three-lecture course, and also those by Michael Christ.	1/27/2017 4:24 PM

Q5 I was well prepared to benefit from the lectures

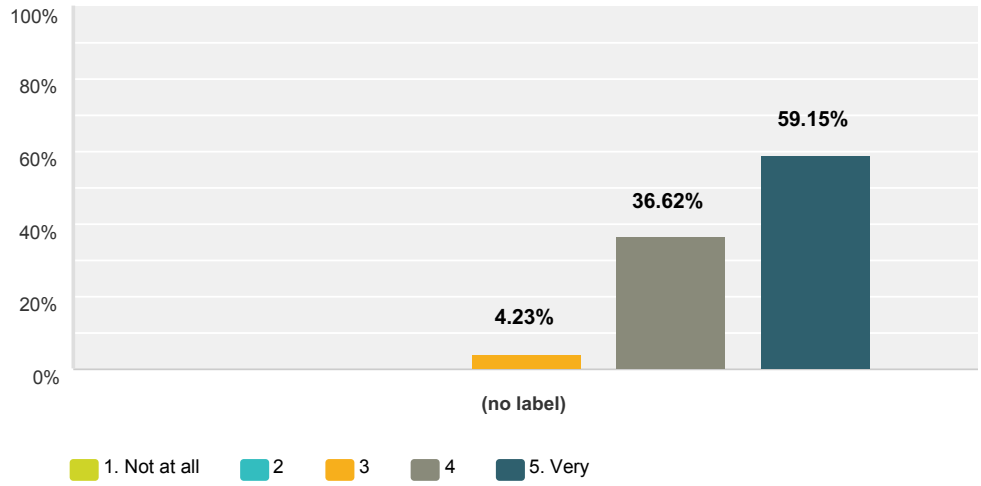
Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	1.41% 1	14.08% 10	43.66% 31	40.85% 29	71	4.24

Q6 My interest in the subject matter was increased by the workshop

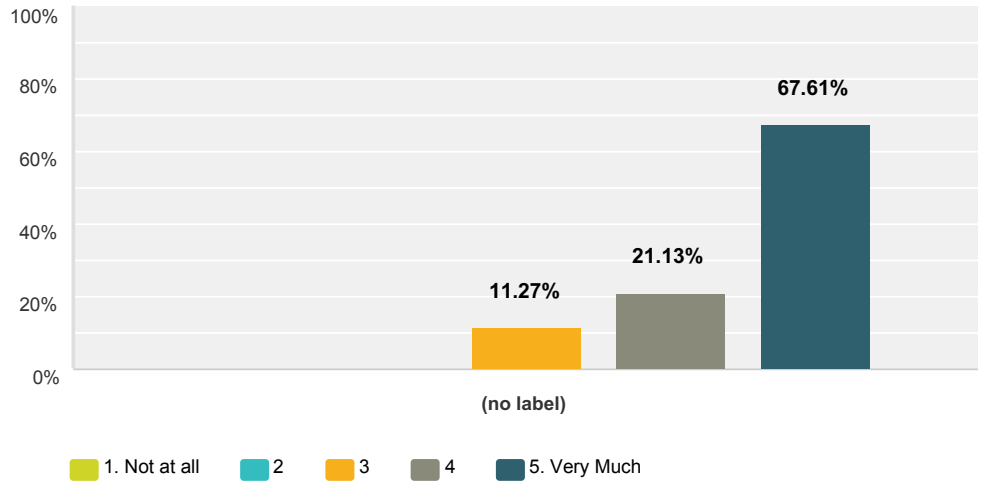
Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**4.23%** 3	**36.62%** 26	**59.15%** 42	71	4.55

Q7 The workshop helped me meet people with similar scientific interests

Answered: 71 Skipped: 0



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**11.27%** 8	**21.13%** 15	**67.61%** 48	71	4.56

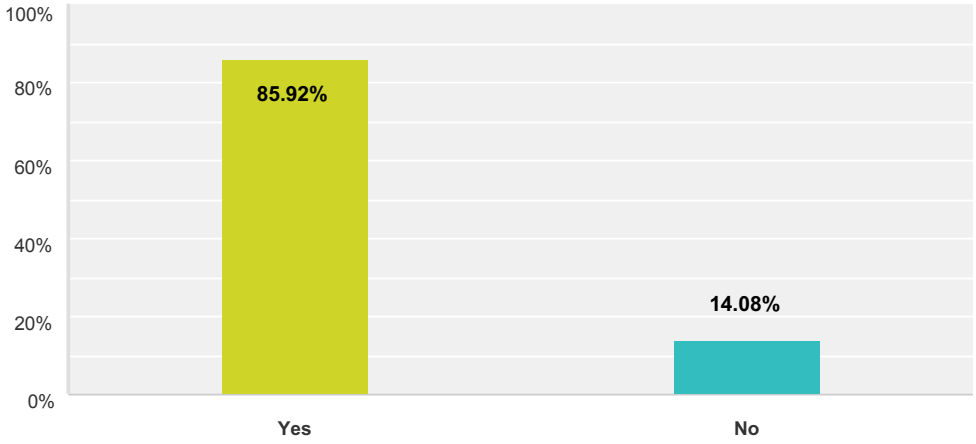
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 70

#	Responses	Date
1	Great speakers	1/29/2017 7:34 PM

Q9 Did you attend the reception?

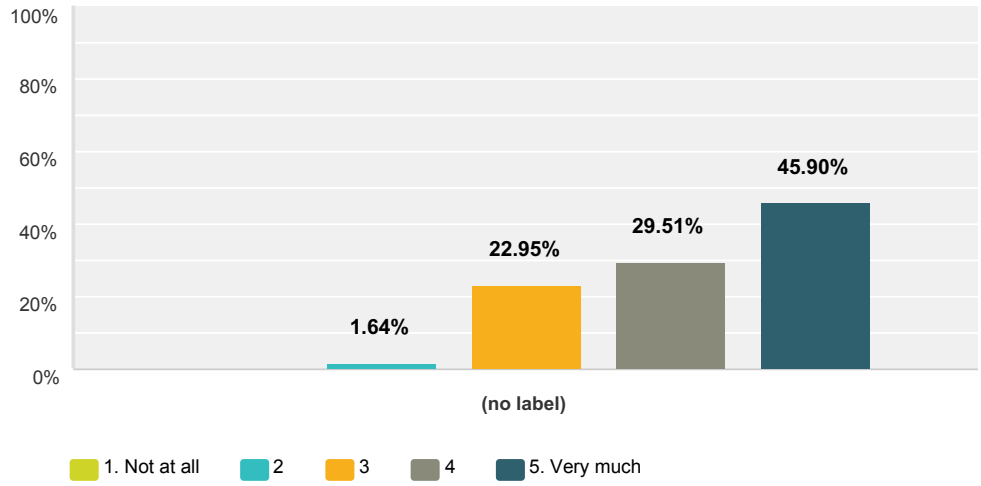
Answered: 71 Skipped: 0



Answer Choices	Responses	
Yes	85.92%	61
No	14.08%	10
Total		71

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 61 Skipped: 10



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**1.64%** 1	**22.95%** 14	**29.51%** 18	**45.90%** 28	61	4.20

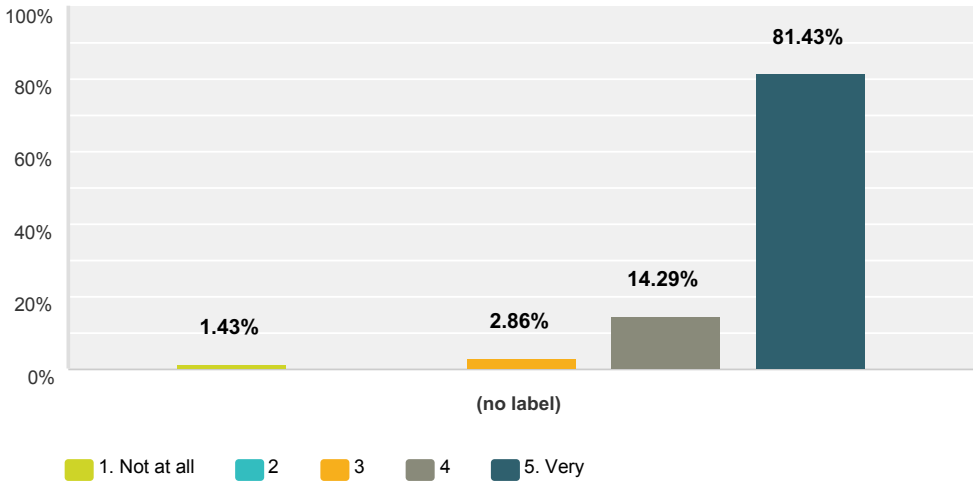
Q11 Please provide any comments about the reception

Answered: 1 Skipped: 70

#	Responses	Date
1	I know it was very helpful for some people. I was a bit too nervous to talk to some people that I should have.	1/27/2017 4:16 PM

Q12 I found the MSRI staff helpful

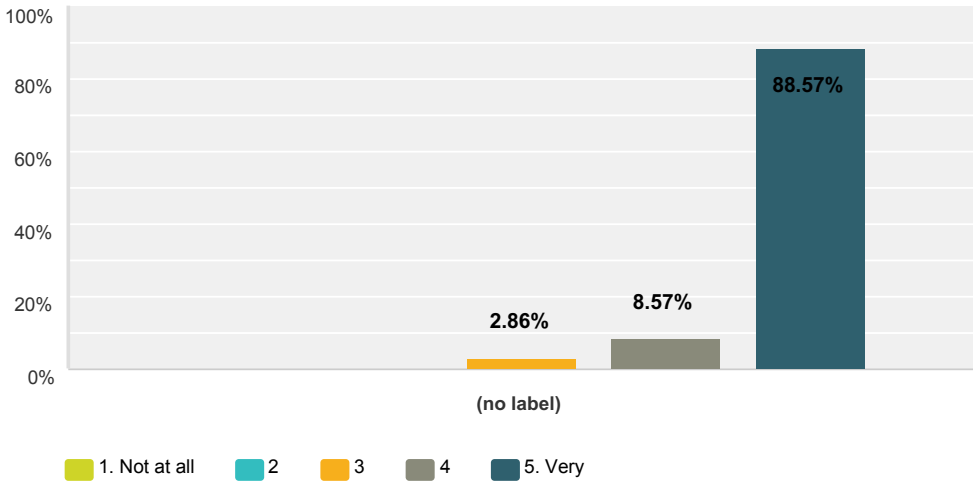
Answered: 70 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**1.43%** 1	**0.00%** 0	**2.86%** 2	**14.29%** 10	**81.43%** 57	70	4.74

Q13 The MSRI facilities were conducive for such a workshop

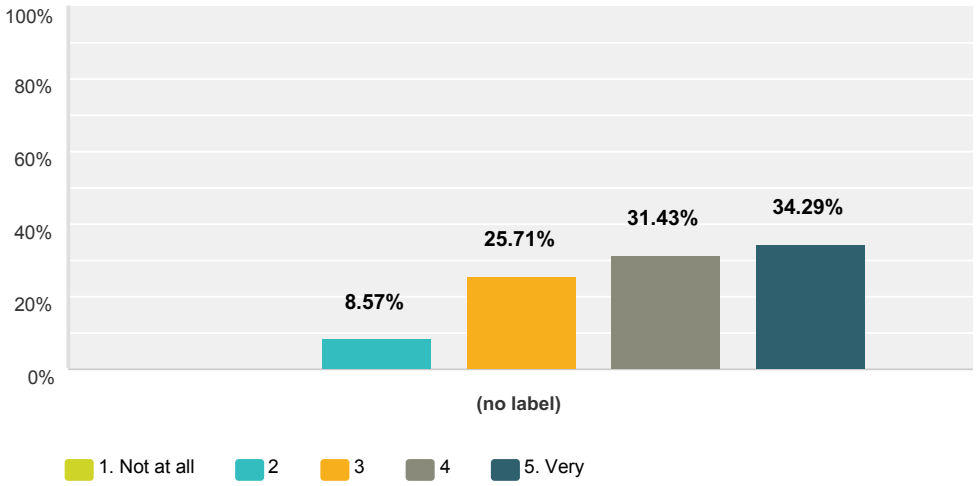
Answered: 70 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.86%** 2	**8.57%** 6	**88.57%** 62	70	4.86

Q14 The MSRI lunch arrangements were satisfactory

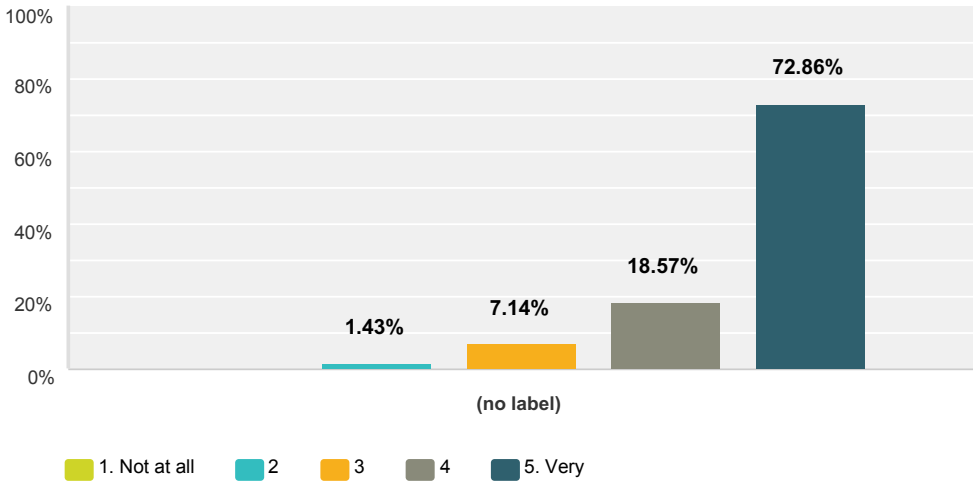
Answered: 70 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**8.57%** 6	**25.71%** 18	**31.43%** 22	**34.29%** 24	70	3.91

Q15 The MSRI tea arrangements were satisfactory

Answered: 70 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.43%** 1	**7.14%** 5	**18.57%** 13	**72.86%** 51	70	4.63

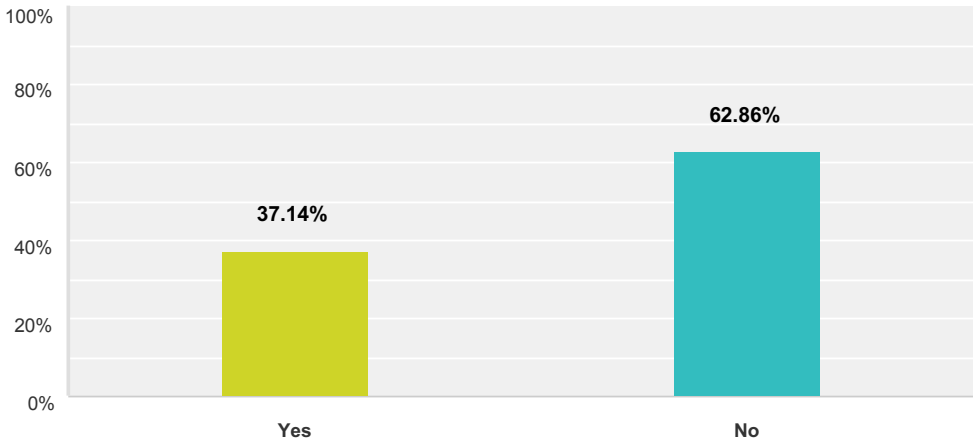
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 9 Skipped: 62

#	Responses	Date
1	This can't be helped, but MSRI really is a nuisance to get to.	2/24/2017 10:54 AM
2	There were not enough sandwiches and salads for everyone. If you were at the end of the lunch line, you had very few options.	2/24/2017 10:48 AM
3	The MSRI staff was great, especially Jacari Scott helped me to solve a lot of problems.	2/6/2017 6:30 AM
4	The librarian (Linda) is one of the kindest person I've ever met in my life. She is really nice.	2/4/2017 10:08 AM
5	Healthier protein options at the tea might be good given that we are up on the hill	1/28/2017 9:34 AM
6	I would recommend informing future visitors that name tags can be used to avoid payment on in-campus bus.	1/27/2017 10:56 PM
7	I appreciated getting so much food during the breaks!	1/27/2017 5:00 PM
8	Everybody was helpful, kind, and informative while the premises are absolutely ideal for this kind of workshop.	1/27/2017 4:30 PM
9	did not have any interaction with staff (but unable to leave the box blank!), and did not stick around for tea	1/27/2017 4:17 PM

Q17 Did you use the computer facilities located in the library?

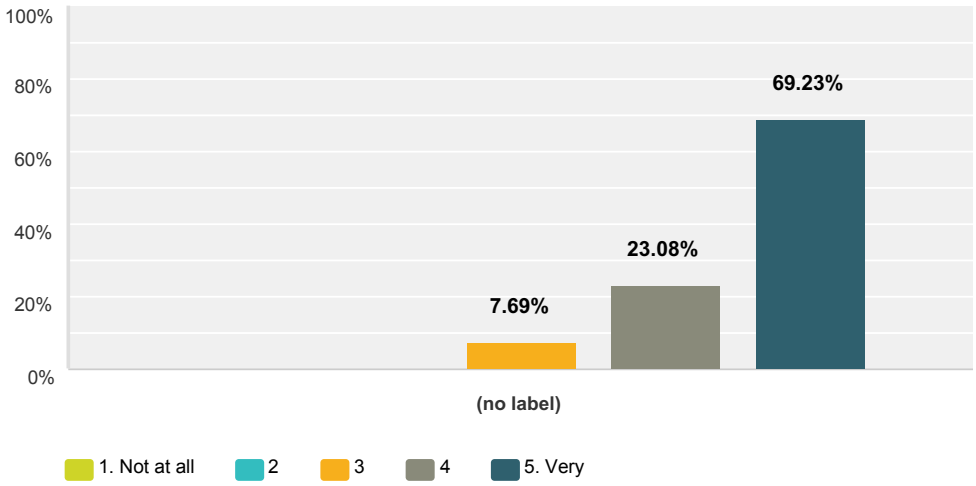
Answered: 70 Skipped: 1



Answer Choices	Responses	
Yes	37.14%	26
No	62.86%	44
Total		70

Q18 The MSRI computer facilities in the library were adequate

Answered: 26 Skipped: 45

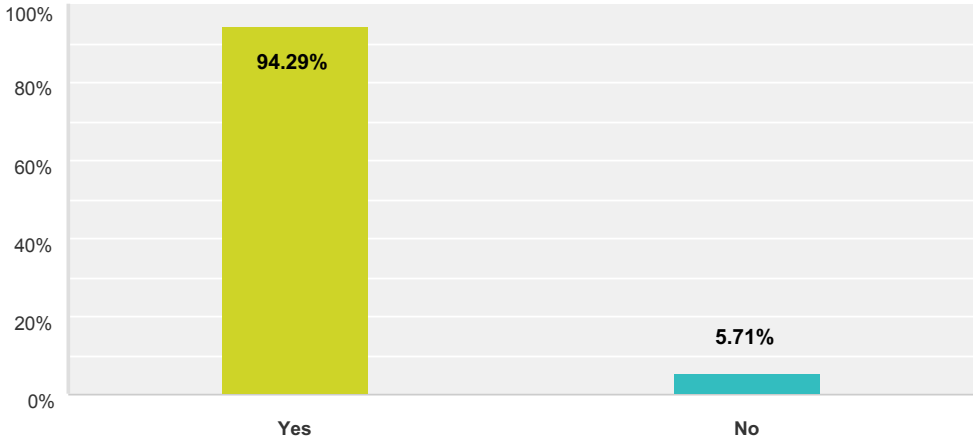


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**7.69%** 2	**23.08%** 6	**69.23%** 18	26	4.62

#	Comments about computer facilities	Date
1		2/24/2017 2:03 PM
2	Sometimes the six computers were not enough for all those of the 200 workshop participants who wanted to use them. Mostly it worked though.	1/30/2017 4:25 PM

Q19 Did you use MSRI's wireless network?

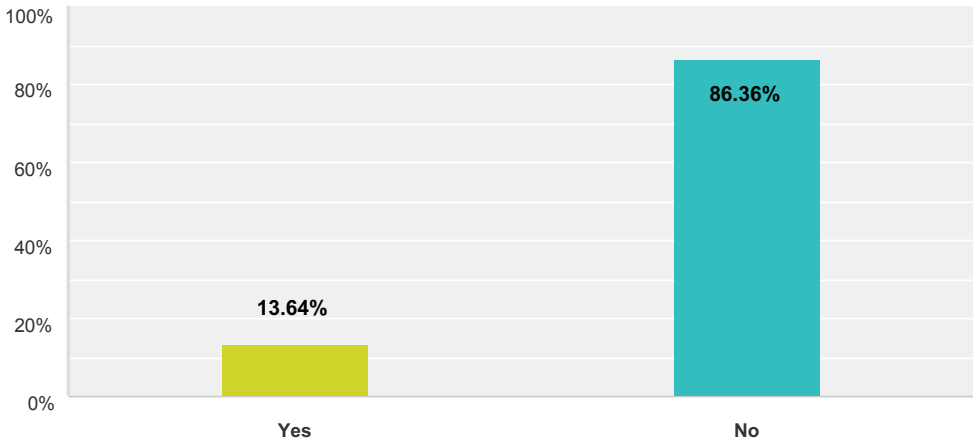
Answered: 70 Skipped: 1



Answer Choices	Responses	
Yes	**94.29%**	66
No	**5.71%**	4
Total		**70**

Q20 Did you experience any difficulties with the network?

Answered: 66 Skipped: 5



Answer Choices	Responses	
Yes	**13.64%**	9
No	**86.36%**	57
Total		**66**

#	Please if yes, please describe your difficulties	Date
1	msri network was so slow I couldn't stream the video recordings of the lectures	2/24/2017 10:48 AM
2	Slow and lost of connection	1/29/2017 7:35 PM
3	Regular disconnects and issues with Dropbox.	1/28/2017 12:34 PM
4	Slow	1/27/2017 10:56 PM
5	Very slow at times	1/27/2017 7:52 PM
6	the guest network seems to get stuck	1/27/2017 4:33 PM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 67

#	Responses	Date
1	In my opinion, MSRI is perfect.	2/6/2017 6:31 AM
2	The lecture hall is large and sometime was crowded and it was difficult to listen the speaker. It could be useful to provide the desks with earphones.	2/4/2017 10:16 AM
3	Lunch is the unique weak point in the otherwise splendid research environment.	1/30/2017 8:53 AM
4	Have a board online for housing so people can arrange for roommates. Or have a list of participants online.	1/30/2017 4:58 AM

Recent Developments in Harmonic Analysis

May 15, 2017 - May 19, 2017

MSRI, Berkeley, CA, USA

Organizers:

Michael Christ (University of California, Berkeley)

Steven Hofmann (University of Missouri)

***Michael Lacey (Georgia Institute of Technology)**

Betsy Stovall (University of Wisconsin-Madison)

Brian Street (University of Wisconsin-Madison)

REPORT ON THE MSRI WORKSHOP
"Recent Developments in Harmonic Analysis"
May 15-19, 2017

Organizers

- Michael Christ (University of California, Berkeley),
- Steven Hofmann (University of Missouri)
- Michael Lacey (Georgia Institute of Technology)
- Betsy Stovall (University of Wisconsin-Madison)
- Brian Street (University of Wisconsin-Madison)

Scientific Description

This workshop was the closing activity of the semester-long program on Harmonic Analysis. The field of Harmonic Analysis dates back to the 19th century, and has its roots in the study of the decomposition of functions using Fourier series and the Fourier transform. In recent decades, the subject has undergone a rapid diversification and expansion, though the decomposition of functions and operators into simpler parts remains a central tool and theme.

Topics for this workshop were drawn from the main research directions of the program, including:

(1) Restriction, Kakeya, and geometric incidence problems
(2) Analysis on nonhomogenous spaces
(3) Weighted estimates
(4) Quantitative rectifiability and other topics in PDE

This week-long workshop featured talks by 18 well-respected harmonic analysts from a range of career stages. Each speaker gave a one-hour lecture, and two poster sessions provided graduate students an opportunity to present their work.

Highlights of the Workshop

Yumeng Ou, one of the postdoctoral members of the MSRI program, presented her recent work, joint with graduate student Hong Wang, completed during the MSRI program. In it, they applied recent breakthroughs in the polynomial method to prove new estimates for the restriction problem on the cone in all dimensions above 4. In particular, the restriction conjecture for the cone is now completely solved in dimension 5; it had previously been solved in all lower dimensions. The restriction problem for the cone asks for the full range of Lebesgue space bounds for the operator that restricts the Fourier transform of a function on Euclidean space to a given frequency annulus on the cone, and its study is related to questions about wave propagation.

Joshua Zahl, a 2013 Ph.D., presented his amazing recent result, joint with Nets Katz that improves on Wolff's 1995 lower bound for the dimension of Besicovitch sets. Zahl also discussed potential issues in obtaining further improvements on his and Katz's result. A Besicovitch set is a set containing a length-1 line segment in every direction. Such sets can have measure zero. One of the major open questions in harmonic analysis is whether Besicovitch sets must nevertheless have Hausdorff dimension at least n. A lively question and answer period ensued in which particular obstructions to a full resolution of the conjecture in three dimensions were discussed.

Jonas Azzam a 2011 Ph.D., presented joint work with Ranaan Schul on a variation on the "Analyst's Traveling Salesman Theorem." The original Traveling Salesman Problem asks to find the shortest path that will allow a door-to-door salesman to visit all of the houses on her route exactly once. The analyst's version replaces the discrete collection of houses with an arbitrary set, and gives an essentially optimal minimal length, which may be infinite. Azzam and Schul's work is a generalization of this second version wherein the (one-dimensional) path is replaced by a higher dimensional set.

Tuomas Hytönen, one of the leading senior researchers in the field, presented recent joint work with Assaf Naor and Sean Li on the question of when the delta in the epsilon-delta definition of differentiability of a 1-Lipschitz function may be chosen independently of the function itself. In particular, for functions between certain pairs of spaces, the authors obtained new lower bounds on the size of this delta.

The workshop itself and the workshop breaks were extremely well attended. The organizers personally saw a number of graduate students and recent Ph.D.s make new connections with senior researchers in the field.

MSRI Mathematical Sciences Research Institute

Recent Developments in Harmonic Analysis

May 15 - 19, 2017

Schedule

Monday, May 15, 2017			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Anthony Carbery	Recent developments in some multilinear problems
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Mariusz Mirek	Jump inequalities for translation-invariant polynomial averages and singular integrals on $\mathbb Z^d$
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Yumeng Ou	A cone restriction estimate using polynomial partitioning
3:00 PM - 3:30 PM	Atrium		Tea & Poster Session
3:30 PM - 4:30 PM	Simons Auditorium	Philip Gressman	Radon-like operators of intermediate dimension

Tuesday, May 16, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Xavier Tolsa	Uniform rectifiability, bounded harmonic functions, and elliptic PDE's
10:30 AM - 11:00 AM	Atrium		Break & Poster Session
11:00 AM - 12:00 PM	Simons Auditorium	Francisco Di Plino	Sparse domination of singular integral operators
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Alexander Iosevich	Rigidity, group actions and finite point configurations in thin sets
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Lesley Ward	Product Hardy spaces associated to operators with heat kernel bounds on spaces of homogeneous type
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, May 17, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Zongwei Shen	Boundary Layers in Periodic Homogenization
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Tuomas Hytonen	Quantitative differentiation

Thursday, May 18, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Jonas Azzam	The Analyst's Traveling Salesman Theorem for large dimensional objects
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Sviltana Mayboroda	The hidden landscape of localization of eigenfunctions
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Po Lam Yung	Approximation of $\dot{W}^{s,n/s}$ functions by bounded functions on $\mathbb{R}^n$
3:00 PM - 3:30 PM	Atrium		Tea & Poster Session
3:30 PM - 4:30 PM	Simons Auditorium	Bobby Wilson	Applications of decoupling-type estimates to the cubic NLSE

Friday, May 19, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Ignacio Uriarte-Tuero	Two weight norm inequalities for singular and fractional integral operators in R^n.
10:30 AM - 11:00 AM	Atrium		Break and Poster Session
11:00 AM - 12:00 PM	Simons Auditorium	Joshua Zahl	An improved bound on the Hausdorff dimension of Besicovitch sets in R^3
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Stefanie Petermichl	On the failure of lower square function estimates in the non-homogenous weighted setting.
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Ciprian Demeter	Recent developments in decoupling theory

Organizers		
First Name	**Last Name**	**Institution**
Michael	Christ	University of California, Berkeley
Steven	Hofmann	University of Missouri
Michael	Lacey	Georgia Institute of Technology
Betsy	Stovall	University of Wisconsin-Madison
Brian	Street	University of Wisconsin-Madison
Speakers		
First Name	**Last Name**	**Institution**
Jonas	Azzam	University of Edinburgh
Anthony	Carbery	University of Edinburgh
Ciprian	Demeter	Indiana University
Francesco	Di Plinio	University of Virginia
Philip	Gressman	University of Pennsylvania
Tuomas	Hytönen	University of Helsinki
Alex	Iosevich	University of Rochester
Svitlana	Mayboroda	University of Minnesota, Twin Cities
Mariusz	Mirek	Hausdorff Research Institute for Mathematics, University of Bonn
Yumeng	Ou	Massachusetts Institute of Technology
Stefanie	Petermichl	Niversité de Toulouse III (Paul Sabatier)
Zhongwei	Shen	University of Kentucky
Xavier	Tolsa	Autonomous University of Barcelona
Ignacio	Uriarte-Tuero	Michigan State University
Lesley	Ward	University of South Australia
Bobby	Wilson	Massachusetts Institute of Technology
Po Lam	Yung	The Chinese University of Hong Kong
Joshua	Zahl	University of British Columbia

Participants		
First Name	**Last Name**	**Institution**
Murat	Akman	University of Connecticut
Rauan	Akylzhanov	Imperial College, London
Obaid	Algahtani	King Saud University
Marco	Aymone	Universidade Federal de Minas Gerais
Jonas	Azzam	University of Edinburgh
David	Beltran	University of Birmingham
Arunima	Bhattacharya	University of Oregon
Simon	Bortz	University of Minnesota, Twin Cities
Julia	Brandes	University of Göteborg
Anthony	Carbery	University of Edinburgh
Emanuel	Carneiro	Institute of Pure and Applied Mathematics (IMPA)
Alejandro J.	Castro	Nazarbayev University
Mei-Chu	Chang	University of California, Riverside
Carlos	Chirre Chávez	Institute of Pure and Applied Mathematics (IMPA)
Michael	Christ	University of California, Berkeley
Randolf	Chung	San Francisco State University
Amalia	Culiuc	Georgia Institute of Technology
Matthew	Dellatorre	University of Maryland
Ciprian	Demeter	Indiana University
Francesco	Di Plinio	University of Virginia
Dong	Dong	University of Illinois at Urbana-Champaign
Xiumin	Du	University of Illinois at Urbana-Champaign
Max	Engelstein	Massachusetts Institute of Technology
Joseph	Feneuil	University of Minnesota, Twin Cities
Marco	Fraccaroli	Universität Bonn
Maxim	Gilula	Michigan State University
Felipe	Gonçalves	University of Alberta
Allan	Greenleaf	University of Rochester
Philip	Gressman	University of Pennsylvania
Shaoming	Guo	Indiana University
Rupali	Gupta	Indian Institute of technology, roorkee
Timo	Haenninen	University of Helsinki
Kyle	Hambrook	University of Rochester
Kornélia	Héra	Eotvos University
Jonathan	Hill	University of Minnesota Twin Cities
Steven	Hofmann	University of Missouri
Kevin	Hughes	University of Bristol
Tuomas	Hytönen	University of Helsinki
Marina	Iliopoulou	University of California, Berkeley
Alex	Iosevich	University of Rochester
paata	ivanisvili	Kent State University
Benjamin	Jaye	Kent State University
Eunhee	Jeong	Seoul National University
David	Jerison	MIT
Robert	Kesler	Georgia Institute of Technology
Seick	Kim	Yonsei University
Jongchon	Kim	University of Wisconsin-Madison
Doowon	Koh	Chungbuk National University

Participants

First Name	Last Name	Institution
Lyudmila	Korobenko	University of Pennsylvania
Michael	Lacey	Georgia Institute of Technology
Chun Kit	Lai	San Francisco State University
John	Lewis	University of Kentucky
Weilin	Li	University of Maryland
Linhan	Li	Brown University
Bochen	Liu	University of Rochester
Grace	Liu	University of California, Berkeley
José Ramón	Madrid Padilla	Aalto University
Dominique	Maldague	University of California, Berkeley
Alessandro	Marinelli	University of British Columbia
Dario	Mena	Georgia Institute of Technology
Stephanie	Mills	University of South Australia
Mariusz	Mirek	Hausdorff Research Institute for Mathematics, University of Bonn
Phuc	Nguyen	Louisiana State University
Anh	Nguyen	University of California, Berkeley
Trang	Nguyen	University of South Australia
Aleksandra	Niepla	Cornell University
Senthil Raani	Nimalan	Indian Institute of Science Education and Research Bhopal
Richard	Oberlin	Florida State University
Itamar	Oliveira	Cornell University
Diogo	Oliveira e Silva	Hausdorff Research Institute for Mathematics, University of Bonn
Kevin	O'Neill	University of California, Berkeley
Yumeng	Ou	Massachusetts Institute of Technology
Eyvindur	Palsson	Virginia Polytechnic Institute and State University
Josiah	Park	Georgia Institute of Technology
Stefanie	Petermichl	Niversité de Toulouse III (Paul Sabatier)
Bruno	Poggi	University of Minnesota Twin Cities
Pierre	Portal	Australian National University
Joao Pedro	Ramos	Universität Bonn
Javier	Ramos	Instituto de Ciencias Matematicas (ICMAT)
Olli	Saari	Aalto University
Jeremy	Schwend	University of Wisconsin-Madison
Zhongwei	Shen	University of Kentucky
NIRAJ	Shukla	Indian Institute of Technology Indore, India
Mateus	Sousa	Institute of Pure and Applied Mathematics (IMPA)
Dmitriy	Stolyarov	Michigan State University
Betsy	Stovall	University of Wisconsin-Madison
Brian	Street	University of Wisconsin-Madison
Olli	Tapiola	University of Helsinki
Krystal	Taylor	Ohio State University
Xavier	Tolsa	Autonomous University of Barcelona
Tatiana	Toro	University of Washington
Ignacio	Uriarte-Tuero	Michigan State University
Cornel Andrei	Velicu	Imperial College, London
Dominick	Villano	University of Pennsylvania
Francisco	Villarroya Alvarez	University of Georgia
Lesley	Ward	University of South Australia

Participants		
First Name	**Last Name**	**Institution**
Yakun	Xi	Johns Hopkins University
Ping	Xi	Xi'an Jiaotong University
Lechao	Xiao	University of Pennsylvania
Xiangjin	Xu	Binghamton University (SUNY)
Hong	Yue	Georgia College
Po Lam	Yung	The Chinese University of Hong Kong
Joshua	Zahl	University of British Columbia
Zhen	Zeng	University of Pennsylvania
Shiwen	Zhang	Michigan State University
Zihui	Zhao	University of Washington
Tamar	Ziegler	The Hebrew University of Jerusalem

Officially Registered Participant Information

Participants		107

Gender		107
Male	71.96%	77
Female	26.17%	28
Declined to state	1.87%	2

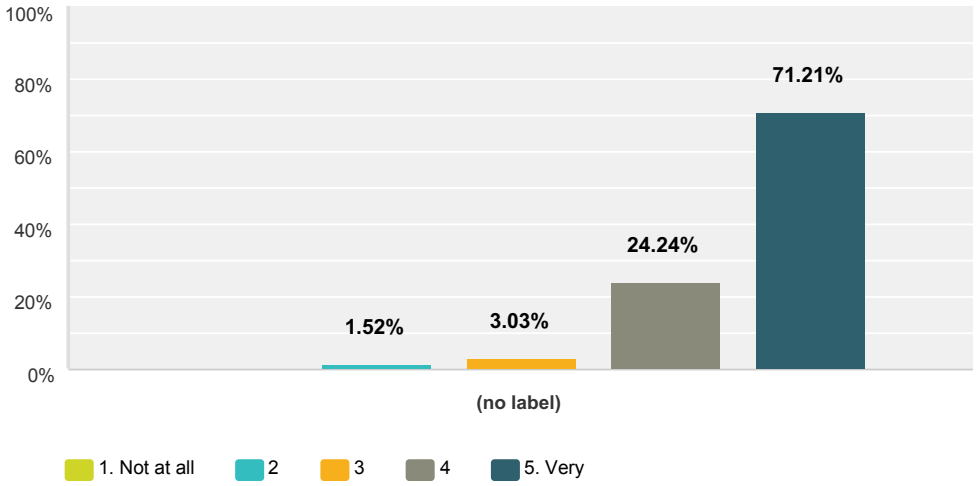
Ethnicity*		113
White	52.34%	56
Asian	31.78%	34
Hispanic	8.41%	9
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	2.80%	3
Declined to state	10.28%	11

* ethnicity specifications are not exclusive

66 responses out of 107 participants = 62% response rate

Q1 The workshop was intellectually stimulating

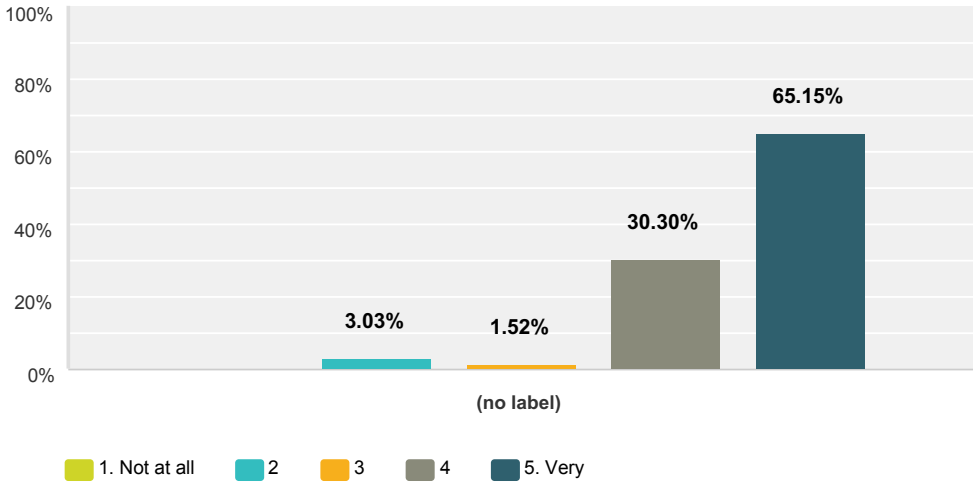
Answered: 66 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.52%** 1	**3.03%** 2	**24.24%** 16	**71.21%** 47	66	4.65

Q2 The overall experience of the workshop was worthwhile

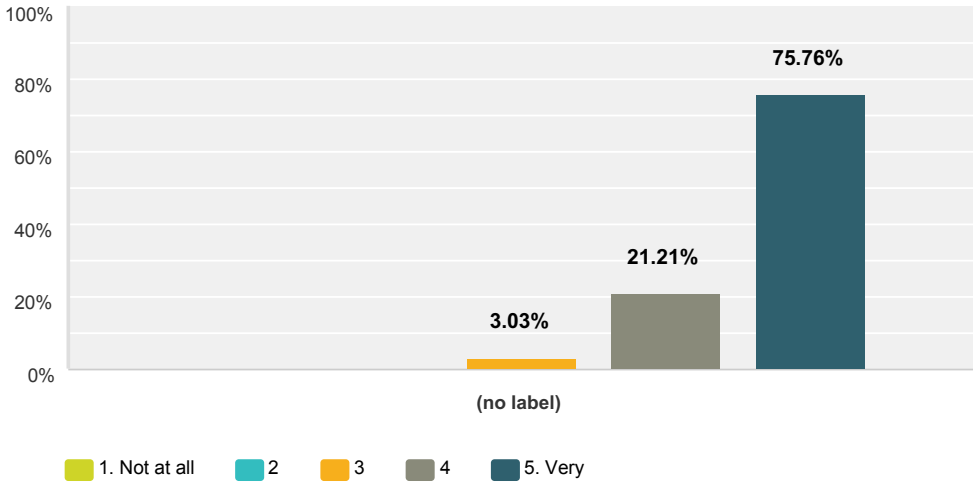
Answered: 66 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**3.03%** 2	**1.52%** 1	**30.30%** 20	**65.15%** 43	66	4.58

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%** 0	**0.00%** 0	**3.03%** 2	**21.21%** 14	**75.76%** 50	66	4.73

Q4 Additional comments

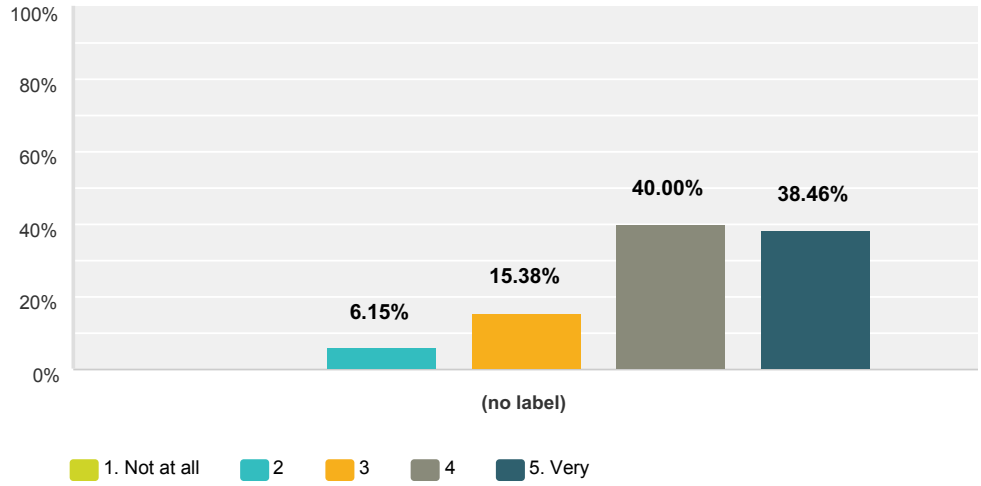
Answered: 9 Skipped: 57

#	Responses	Date
1	Allow for more participation by graduate students; maybe short talks?	5/25/2017 2:01 AM
2	thank you for organizing	5/24/2017 1:28 PM
3	I cannot think of a better place for a conference. The outside blackboard and on screen viewing of a speaker are quite nice touches. Also there was plenty of time between talks to get coffee and talk to the post docs, etc.	5/24/2017 9:04 AM
4	This is one of the best conferences I attended so far.	5/23/2017 7:46 PM
5	..	5/23/2017 10:11 AM
6	Excellent workshop!	5/23/2017 2:16 AM
7	It is unfortunate that, even in a specialised workshop, some speakers still aim their talks at a small fraction of the audience, and try (unsuccessfully in my opinion) to impress rather than to truly communicate information. Maybe the MSRI could lead the way in setting standards as to what constitute a valuable talk at a time where specialisation keeps increasing rapidly, and the number of conferences seems to also be increasing. Forcing people to use the beautiful boards rather than the projector could be a simple step in this direction. There only is so much information that one can write in an hour!	5/22/2017 6:25 PM
8	The promised local support to buy food given to me amounted to 30 dollars per day when promised allowance was 74 dollars per day for meal.	5/22/2017 4:21 PM
9	In meetings with various people, including my advisor, I was able to make further breakthroughs with my research.	5/22/2017 10:10 AM

Response to comment #8: Participant misunderstood the offer letter, assuming they would receive $140 for hotel plus an additional $74 for meals, rather than a total daily amount of $140.

Q5 I was well prepared to benefit from the lectures

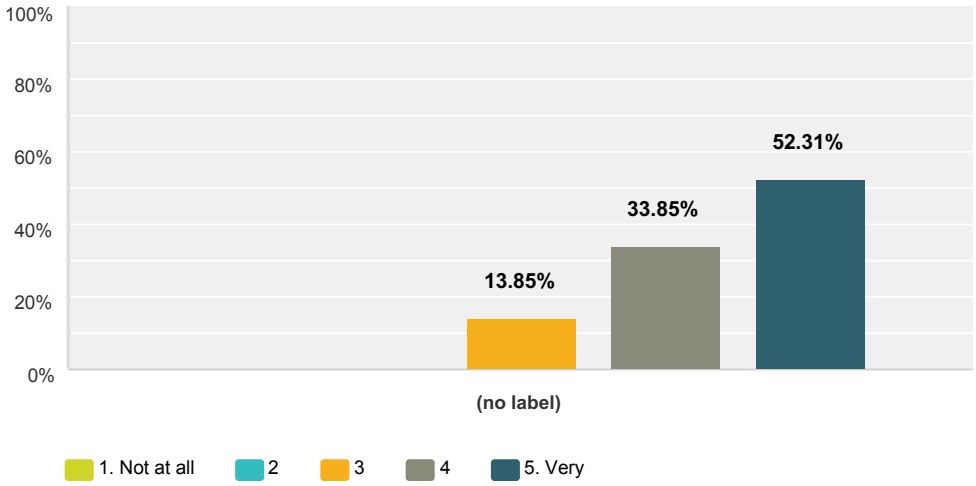
Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	0.00% 0	6.15% 4	15.38% 10	40.00% 26	38.46% 25	65	4.11

Q6 My interest in the subject matter was increased by the workshop

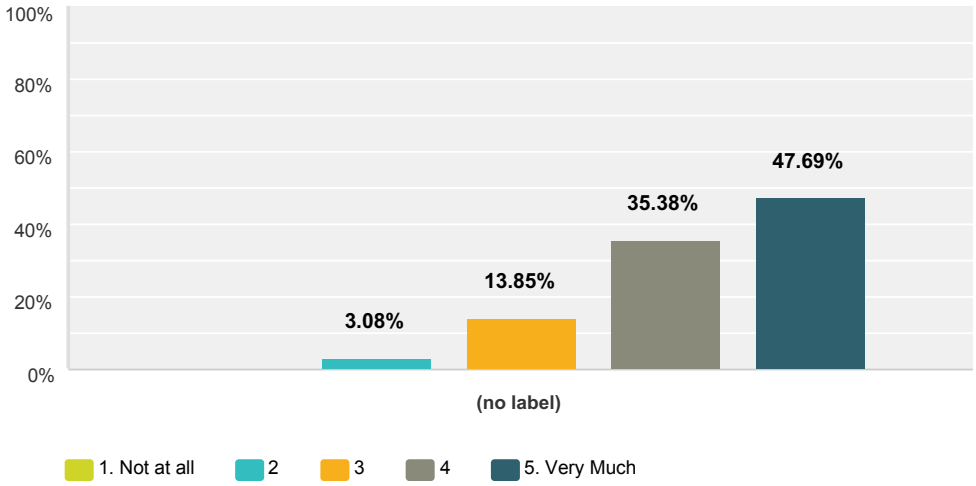
Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**13.85%** 9	**33.85%** 22	**52.31%** 34	65	4.38

Q7 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%** 0	**3.08%** 2	**13.85%** 9	**35.38%** 23	**47.69%** 31	65	4.28

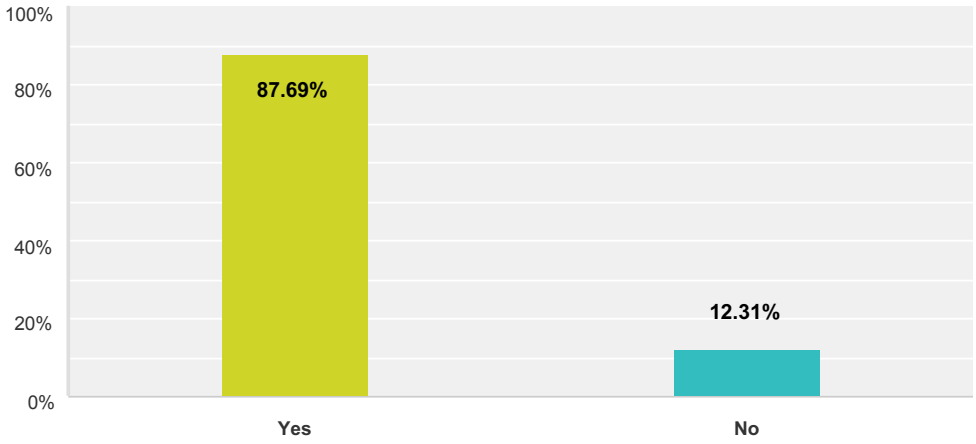
Q8 Additional comments on your personal assessment

Answered: 0 Skipped: 66

#	Responses	Date
	There are no responses.	

Q9 Did you attend the reception?

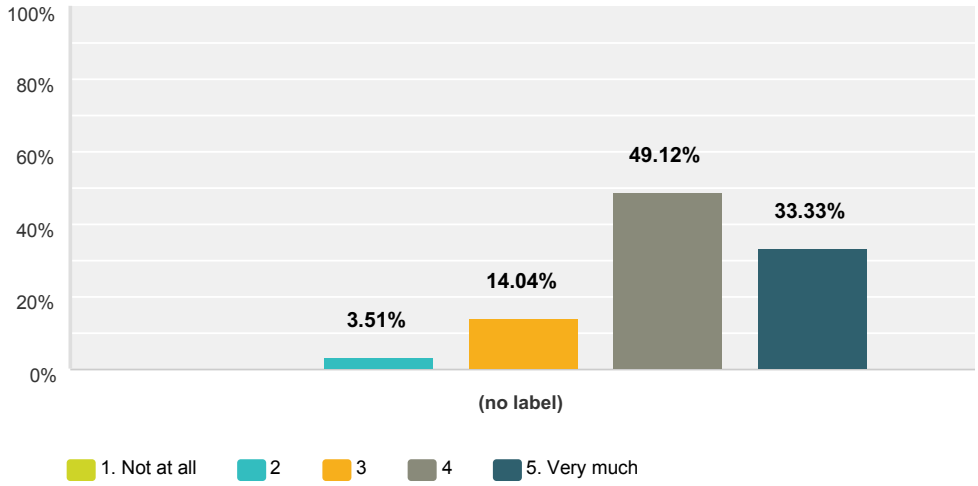
Answered: 65 Skipped: 1



Answer Choices	Responses	
Yes	87.69%	57
No	12.31%	8
Total		65

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 57 Skipped: 9



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**3.51%** 2	**14.04%** 8	**49.12%** 28	**33.33%** 19	57	4.12

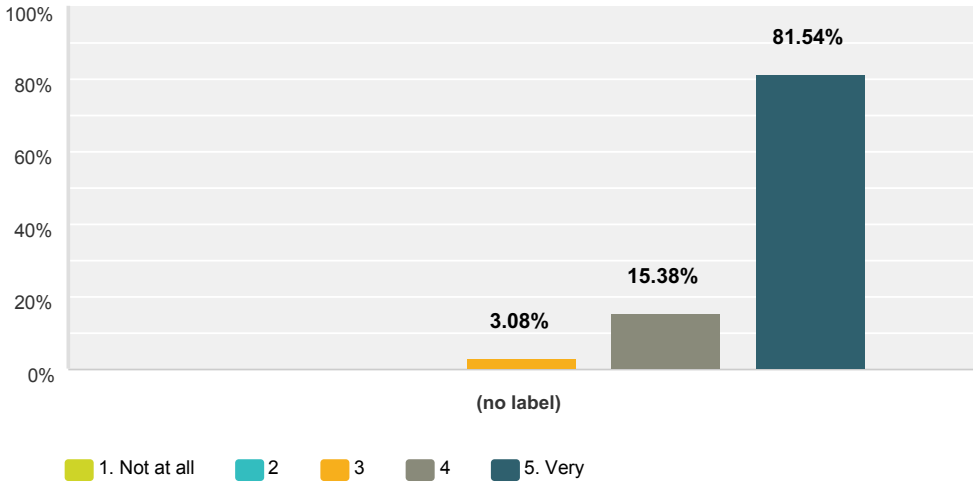
Q11 Please provide any comments about the reception

Answered: 0 Skipped: 66

#	Responses	Date
	There are no responses.	

Q12 I found the MSRI staff helpful

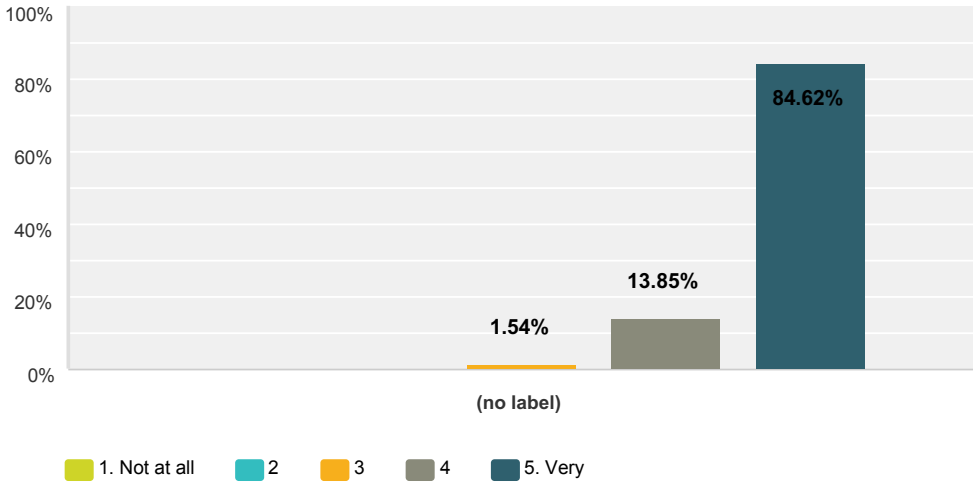
Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.08%** 2	**15.38%** 10	**81.54%** 53	65	4.78

Q13 The MSRI facilities were conducive for such a workshop

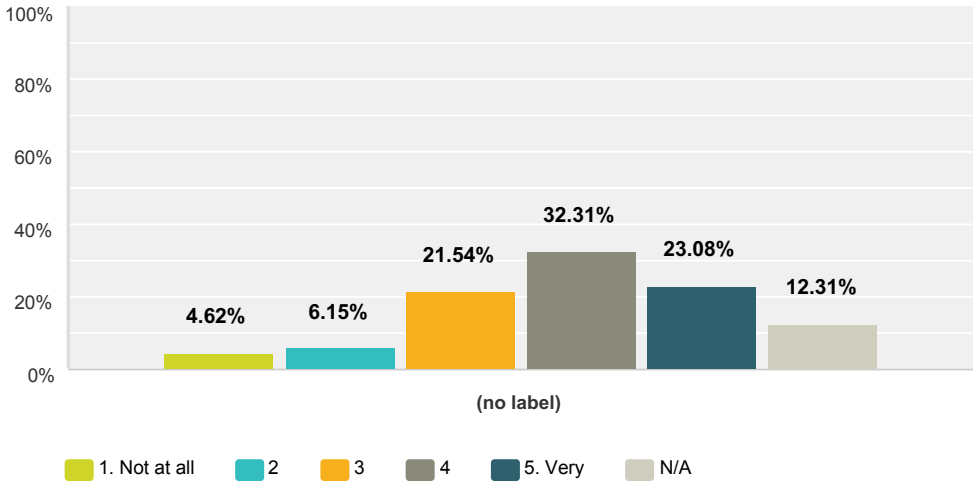
Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.54%** 1	**13.85%** 9	**84.62%** 55	65	4.83

Q14 The MSRI lunch arrangements were satisfactory

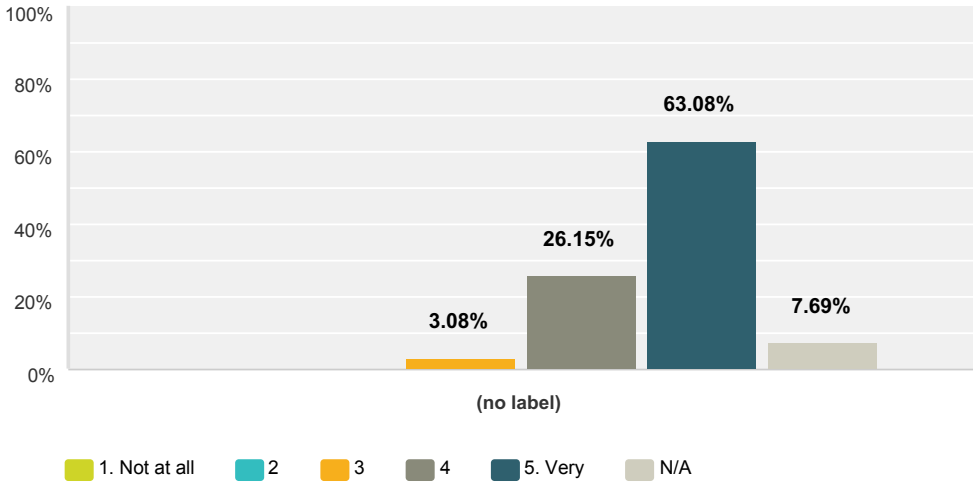
Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**4.62%** 3	**6.15%** 4	**21.54%** 14	**32.31%** 21	**23.08%** 15	**12.31%** 8	65	3.72

Q15 The MSRI tea arrangements were satisfactory

Answered: 65 Skipped: 1



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.08%** 2	**26.15%** 17	**63.08%** 41	**7.69%** 5	65	4.65

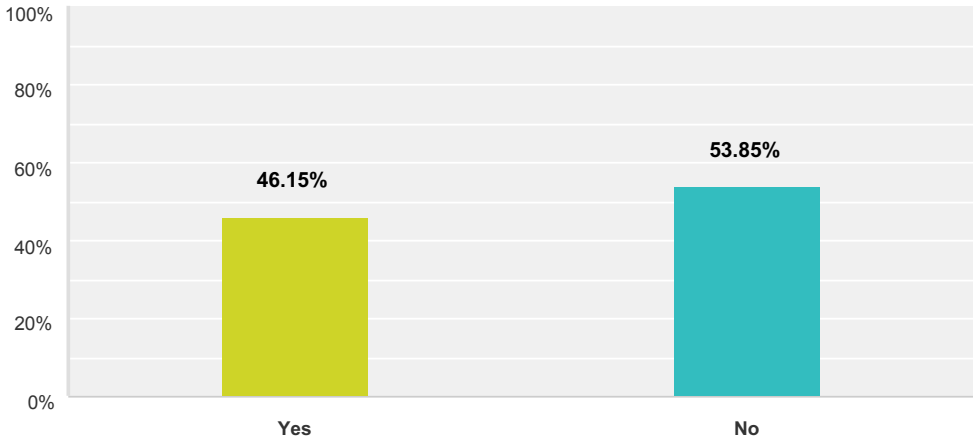
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 1 Skipped: 65

#	Responses	Date
1	If possible, more variety in the lunch providers would be nice. Could a selection rotate through the week?	5/22/2017 9:51 AM

Q17 Did you use the computer facilities located in the library?

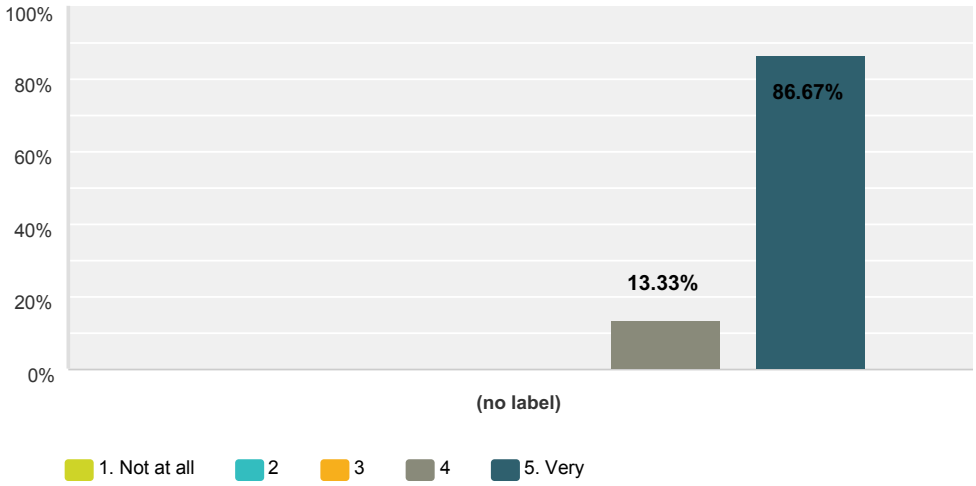
Answered: 65 Skipped: 1



Answer Choices	Responses	
Yes	46.15%	30
No	53.85%	35
Total		65

Q18 The MSRI computer facilities in the library were adequate

Answered: 30 Skipped: 36

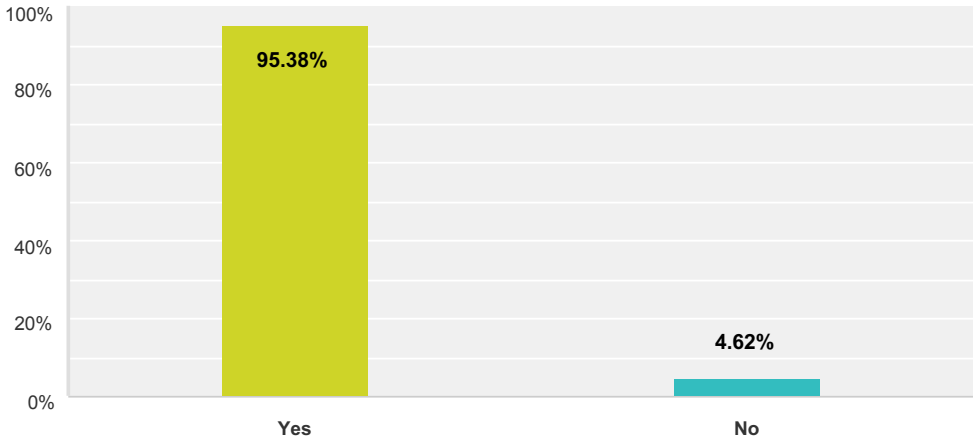


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**13.33%** 4	**86.67%** 26	30	4.87

#	Comments about computer facilities	Date
	There are no responses.	

Q19 Did you use MSRI's wireless network?

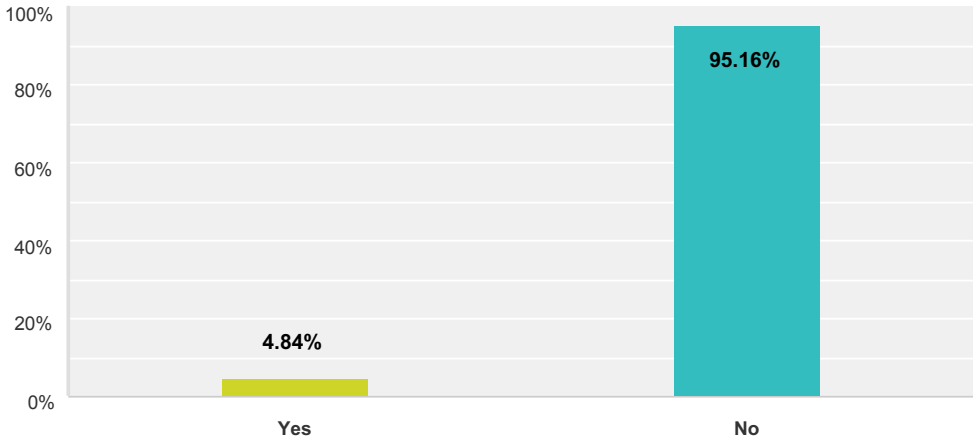
Answered: 65 Skipped: 1



Answer Choices	Responses	
Yes	**95.38%**	62
No	**4.62%**	3
Total		**65**

Q20 Did you experience any difficulties with the network?

Answered: 62 Skipped: 4



Answer Choices	Responses	
Yes	**4.84%**	3
No	**95.16%**	59
Total		**62**

#	Please if yes, please describe your difficulties	Date
1	Eduroam doesn't always work well.	5/23/2017 7:47 PM
2	the guest network did not really for well the member one works great	5/22/2017 6:05 PM
3	Slow connection	5/22/2017 9:49 AM

Q21 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	More lunch options. The rest was great.	5/25/2017 7:20 AM
2	On Wednesday the afternoon was free of lectures- but no excursion/other social program was organized. I wish there was more social events.	5/22/2017 6:56 PM

Recent developments in Analytic Number Theory

May 01, 2017 - May 05, 2017

MSRI, Berkeley, CA, USA

Organizers:

Tim Browning (University of Bristol)

Chantal David (Concordia University)

Kannan Soundararajan (Stanford University)

***Terence Tao (University of California, Los Angeles)**

REPORT ON THE MSRI WORKSHOP
"Recent developments in Analytic Number Theory"
May 1-5, 2017

Organizers

- Tim Browning (University of Bristol)
- Chantal David (Concordia University)
- Kannan Soundararajan (Stanford University))
- Terence Tao (University of California, Los Angeles)

Scientific Description

In recent years, many important classical questions in analytic number theory have seen spectacular advances based on new techniques; conversely, methods developed in analytic number theory have, sometimes unexpectedly, led to the solution of striking problems in other fields such as harmonic analysis (including the Langlands programme), ergodic theory and dynamics (especially on homogenous spaces), additive and multiplicative combinatorics and theoretical computer science (in particular, through the theory of expander graphs).

This workshop focused on presenting the latest developments in analytic number theory, including (but not restricted to) recent advances in sieve theory, multiplicative number theory, exponential sums, arithmetic statistics, estimates on automorphic forms, and the Hardy-Littlewood circle method.

Highlights of the Workshop

The talks were of a uniformly high quality, reflecting the breadth and vibrant state of analytic number theory at present. Particular highlights (in no particular order) include:

- The talk of Manjul Bhargava on his beautiful work with Shankar and Wang on squarefree values of polynomials, settling a question of Lenstra and revealing a surprising connection with orbit-counting;
- The talk of Damaris Schindler on precisely locating the obstructions to solving Diophantine equations arising from two quadratic equations in four variables, including obstructions of Brauer-Manin type that could not be explainable by more elementary obstructions;
- The talk of Adam Harper on the refined analysis of random bounded multiplicative functions, showing in particular that their partial sums exhibit slightly more cancellation than that of their non-multiplicative counterparts;
- The talk of Melanie Matchett-Wood on the Cohen-Martinet heuristics described a growing body of evidence in the function field setting, around disparities in the amount of p-torsion in the class group of cubic extensions;

- The talk of Matt Young giving an overview of the remarkable and deep fifth moment estimate of Young and Kiral on central values of L-functions, which has broken the "convexity barrier" for this problem, and which has introduced new technical tools that will surely be useful for other researchers;
- The talk of Will Sawin on the bilinear exponential sum estimates obtained with Michel, Kowalski, and others using ell-adic cohomology, and their applications to the equidistribution of arithmetic functions associated to cusp forms;
- The talk of Akshay Venkatesh on using the Kirrilov orbit method to obtain precise asymptotics on the integrals on Lie groups arising in the study of L-functions;
- The talk of Trevor Wooley on the latest advances in the theory of efficient congruencing, in particular incorporating ideas from the decoupling theorems of Bourgain, Demeter, and Guth; and
- The talk of James Maynard on new techniques developed with Ford, Konyagin, Pomerance, and Tao on establishing large gaps between certain sets of primes that could not be treated by previous methods.

Many of the results discussed above were completed during the MSRI program. The talks were generally well received by the participants, with several of the speakers (e.g. Venkatesh and Wooley) giving talks that were also of interest to the companion program in Harmonic Analysis. There was a popular and well-attended poster session with 7 posters offered from junior participants, ranging from additive combinatorics to analytic number theory to point counting on Fano varieties.

Recent developments in Analytic Number Theory

May 1-5 2017

Schedule

Monday, May 1, 2017			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Adam Harper	Better than squareroot cancellation for multiplicative functions
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Tamar Ziegler	Approximate cohomology
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Paul Nelson	Subconvex equidistribution of cusp forms
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Melanie Wood	Averages of p-torsion in class groups over function fields---good and bad primes

Tuesday, May 2, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Lillian Pierce	A Chebotarev density theorem for families of fields, with applications to class groups
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Will Sawin	Applications of Exponential Sums
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Atrium		Poster Session
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Manjul Bhargava	Squarefree values of polynomial discriminants
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, May 3, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Kaisa Matomäki	Correlations of von Mangoldt and higher order divisor functions
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Alex Kontorovich	Beyond Expansion and Arithmetic Chaos

Thursday, May 4, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Damaris Schindler	On integral points on degree four del Pezzo surfaces
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Paul Pollack	Arithmetic functions: something old, something new
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Akshay Venkatesh	The orbit method and analysis of automorphic forms
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	James Maynard	Large gaps between primes in subsets

Friday, May 5, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Matthew Young	The fifth moment of modular L-functions.
10:30 AM - 11:00 AM	Atrium		Tea
11:00 AM - 12:00 PM	Simons Auditorium	Elena Fuchs	Local to global principles in integral circle packings
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Fernando Shao	Bombieri-Vinogradov for general multiplicative functions
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Trevor Wooley	Nested Efficient Congruencing and (non) translation-dilation invariance.

Organizers		
First Name	**Last Name**	**Institution**
Tim	Browning	University of Bristol
Chantal	David	Concordia University
Kannan	Soundararajan	Stanford University
Terence	Tao	University of California, Los Angeles
Speakers		
First Name	**Last Name**	**Institution**
Elena	Fuchs	University of California, Davis
Adam	Harper	University of Warwick
Alex	Kontorovich	Rutgers University
Kaisa	Matomäki	University of Turku
James	Maynard	University of Oxford
Ritabrata	Munshi	Indian Statistical Institute
Paul	Nelson	ETH Zürich
Lillian	Pierce	Duke University
Paul	Pollack	University of Georgia
Will	Sawin	ETH Zürich
Damaris	Schindler	Rijksuniversiteit te Utrecht
Fernando	Shao	University of Oxford
Melanie	Wood	University of Wisconsin-Madison
Trevor	Wooley	University of Bristol
Matthew	Young	Texas A & M University

Participants

First Name	Last Name	Institution
Keshav	Aggarwal	Ohio State University
Shabnam	Akhtari	University of Oregon
Levent	Alpoge	Princeton University
fahd	alshammari	King Saud University
Nickolas	Andersen	University of California, Los Angeles
Marco	Aymone	Universidade Federal de Minas Gerais
Siegfred	Baluyot	University of Rochester
Thomas	Bloom	University of Bristol
Dante	Bonolis	ETH Zürich
Julia	Brandes	University of Göteborg
Tim	Browning	University of Bristol
Claire	Burrin	Rutgers University
Anthony	Carbery	University of Edinburgh
Emanuel	Carneiro	Institute of Pure and Applied Mathematics (IMPA)
Kestutis	Cesnavicius	University of California, Berkeley
Vorrapan	Chandee	Burapha University
Mei-Chu	Chang	University of California, Riverside
Sneha	Chaubey	University of Illinois at Urbana-Champaign
Carlos	Chirre Chávez	Institute of Pure and Applied Mathematics (IMPA)
Peter	Cho	UNIST
Youn-seo	Choi	Korea Institute for Advanced Study (KIAS)
Sam	Chow	MSRI - Mathematical Sciences Research Institute
Fatma	Cicek	University of Rochester
Chantal	David	Concordia University
Anne	de Roton	Université de Lorraine
Korneel	Debaene	Georg-August-Universität zu Göttingen
Kevin	Destagnol	Institut de Mathematiques de Jussieu
Alexander	Dunn	University of Illinois at Urbana-Champaign
Max	Ehrman	Yale University
Elena	Fuchs	University of California, Davis
Ayla	Gafni	University of Rochester
Surya Teja	Gavva	Rutgers University
Fan	Ge	University of Rochester
Leo	Goldmakher	Williams College
Daniel	Goldston	San Jose State University
Felipe	Gonçalves	University of Alberta
Junsoo	Ha	Korea Institute for Advanced Study (KIAS)
Brandon	Hanson	Pennsylvania State University
Adam	Harper	University of Warwick
Winston	Heap	University College
David (Roger)	Heath-Brown	University of Oxford
Yueke	Hu	ETH Zürich
Peter	Humphries	Princeton University
Yeongseong	Jo	Ohio State University
Pin Hung	Kao	Central Michigan University
Jongchon	Kim	University of Wisconsin-Madison

Participants		
First Name	**Last Name**	**Institution**
Byungchan	Kim	Seoul National University of Science and Technology
Eren	Kıral	Texas A & M University
Scott	Kirila	University of Rochester
Oleksiy	Klurman	Université de Montréal
Alex	Kontorovich	Rutgers University
Dimitris	Koukoulopoulos	Université de Montréal
Jeffrey	Lagarias	University of Michigan
Thai Hoang	Le	University of Mississippi
Yoonbok	Lee	Incheon National University
Stephen	Lester	Centre de Recherches Mathematiques
Zane	Li	University of California, Los Angeles
Junxian	Li	University of Illinois at Urbana-Champaign
Yongxiao	Lin	Ohio State University
Shenhui	Liu	Ohio State University
Sheng-Chi	Liu	Washington State University
Daniel	Loughran	University of Manchester
David	Lowry-Duda	Brown University
Karl	Mahlburg	Louisiana State University
Amita	Malik	University of Illinois at Urbana-Champaign
Alexander	Mangerel	University of Toronto
Maria Adelina	Manzateanu	University of Bristol
Oscar	Marmon	University of Copenhagen
Greg	Martin	University of British Columbia
Kaisa	Matomäki	University of Turku
Lilian	Matthiesen	Royal Institute of Technology (KTH)
James	Maynard	University of Oxford
Kevin	McGown	California State University
Harsh	Mehta	University of South Carolina
Xianchang	Meng	University of Illinois at Urbana-Champaign
Djordje	Milicevic	Bryn Mawr College
Djordjo	Milovic	Institute for Advanced Study
Vladimir	Mitankin	University of Bristol
Ritabrata	Munshi	Indian Statistical Institute
Maria	Nastasescu	Brown University
Paul	Nelson	ETH Zürich
Asbjørn	Nordentoft	University of Copenhagen
Carlos	Pastor	Instituto de Ciencias Matematicas (ICMAT)
Sarah	Peluse	Stanford University
Corentin	Perret-Gentil-dit-Maillard	ETH Zürich
Chantell	Petrell	None
Ian	Petrow	ETH Zürich
Alexandre	Peyrot	École Polytechnique Fédérale de Lausanne (EPFL)
Lillian	Pierce	Duke University
Paul	Pollack	University of Georgia
Andrew	Pollington	National Science Foundation
Carl	Pomerance	Dartmouth College

Participants		
First Name	**Last Name**	**Institution**
Priyanka	Prasad	Codetheory India Pvt Ltd
Kyle	Pratt	University of Illinois at Urbana-Champaign
Lenore	Ralston	Bryn Mawr College
Joao Pedro	Ramos	Universität Bonn
Mattia	Righetti	CRM - Centre de Recherches Mathématiques
Brad	Rodgers	University of Michigan
Nick	Rome	University of Bristol
Simon	Rubinstein-Salzedo	Euler Circle
Simon	Rydin Myerson	University College
Garo	Sarajian	University of California, Santa Barbara
Will	Sawin	ETH Zürich
Damaris	Schindler	Rijksuniversiteit te Utrecht
Alisa	Sedunova	Université de Paris XI
George	Shakan	University of Illinois at Urbana-Champaign
Fernando	Shao	University of Oxford
Yaoming	Shi	Qingdao University
Kaneenika	Sinha	Indian Institute of Science Education and Research
Anders	Sodergren	Chalmers University of Technology
Kannan	Soundararajan	Stanford University
Qingfeng	Sun	Shandong University, Weihai
Ade Irma	Suriajaya	Nagoya University
Terence	Tao	University of California, Los Angeles
Johann	Thiel	New York City College of Technology
Lola	Thompson	Oberlin College
Frank	Thorne	University of South Carolina
Jesse	Thorner	Stanford University
Berke	Topacogullari	École Polytechnique Fédérale de Lausanne (EPFL)
Tien	Trinh	University of Colorado
Lee	Troupe	University of British Columbia
Caroline	Turnage-Butterbaugh	Duke University
Akshaa	Vatwani	University of Waterloo
Vinay	Viswanathan	University of Bristol
Alexander	Walker	Brown University
Jiuya	Wang	University of Wisconsin-Madison
Matthew	Welsh	Rutgers University
Melanie	Wood	University of Wisconsin-Madison
Trevor	Wooley	University of Bristol
Ping	Xi	Xi'an Jiaotong University
Zhao	Xu	Shandong University
Shuntaro	Yamagishi	Queen's University
Liyang	Yang	California Institute of Technology
Matthew	Young	Texas A & M University
Asif	Zaman	University of Toronto
Liyang	Zhang	Yale University
Ruixiang	Zhang	Princeton University
Yufei	Zhao	University of Oxford

Officially Registered Participant Information

Participants		138

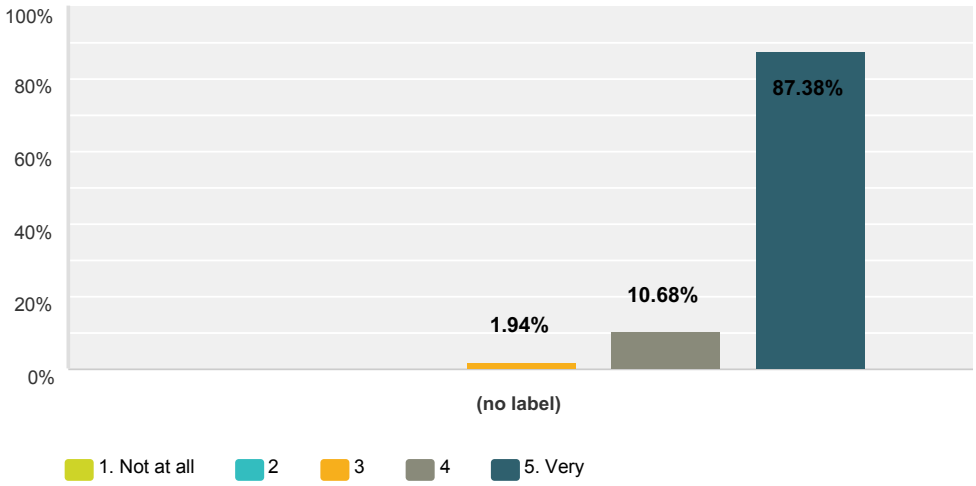
Gender		138
Male	75.36%	104
Female	23.19%	32
Declined to state	1.45%	2
Ethnicity*		**146**
White	57.25%	79
Asian	33.33%	46
Hispanic	2.90%	4
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.72%	1
Mixed	2.90%	4
Declined to state	8.70%	12

* ethnicity specifications are not exclusive

103 responses out of 138 participants = 75% response rate

Q1 The workshop was intellectually stimulating

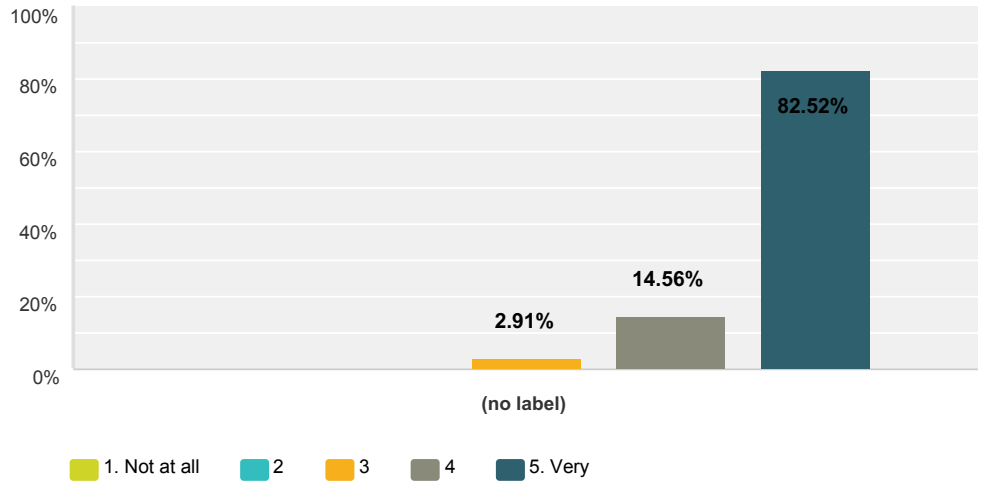
Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**1.94%** 2	**10.68%** 11	**87.38%** 90	103	4.85

Q2 The overall experience of the workshop was worthwhile

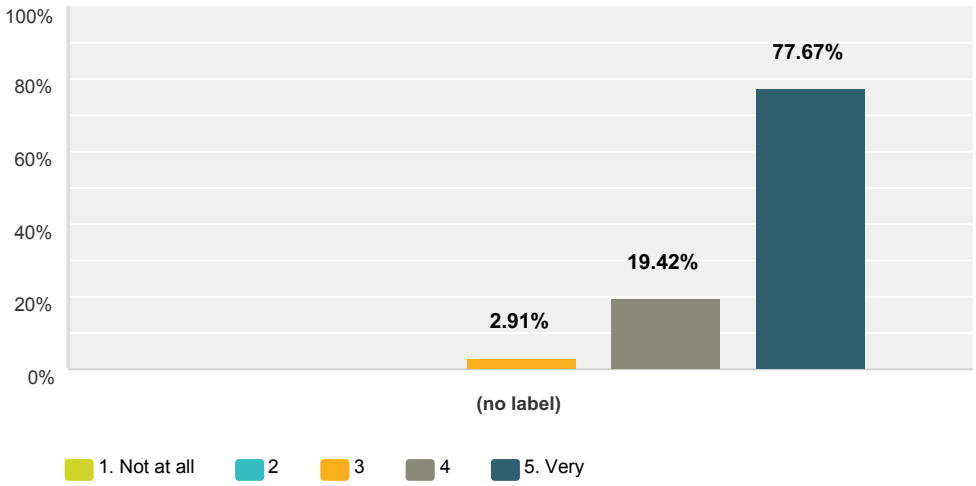
Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.91%** 3	**14.56%** 15	**82.52%** 85	103	4.80

Q3 The time between lectures was adequate for discussion

Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.91%** 3	**19.42%** 20	**77.67%** 80	103	4.75

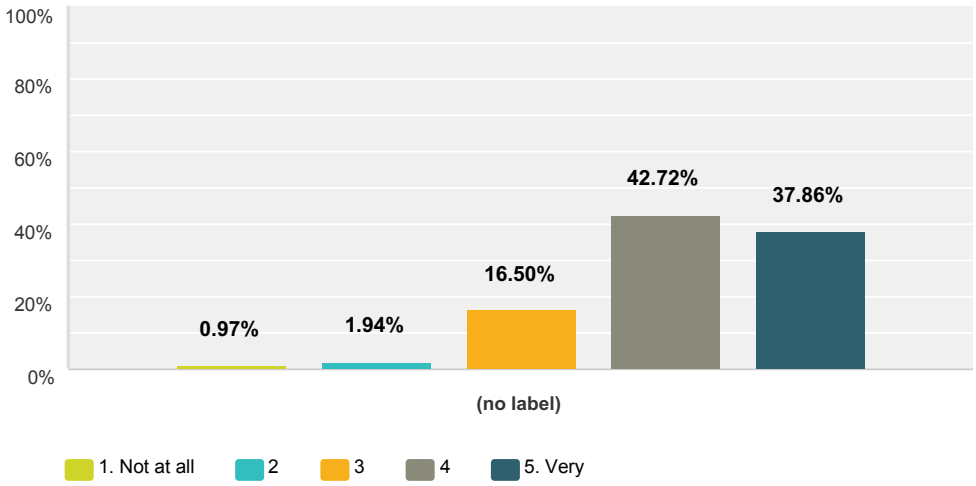
Q4 Additional comments

Answered: 11 Skipped: 92

#	Responses	Date
1	Great experience!	5/24/2017 11:17 PM
2	Very edifying lectures by the best researchers in the field.	5/22/2017 2:30 AM
3	The place was so nice and beautiful.	5/19/2017 4:08 AM
4	Best workshop of the programme, exciting talks, good opportunities to discuss with other participants, and the number of participants seemed perfect.	5/12/2017 7:35 AM
5	In fact, I went out of my way to compliment the time between lectures and how it facilitates the important informal discussions that make conferences so valuable.	5/10/2017 3:53 AM
6	The workshop was fantastic. All the talks were great! I thoroughly enjoyed my visit. That being said, here's a couple comments where things could be improved. One day we had a 2 hour lunch, followed by a poster session, followed by a tea. This led to an almost 4 hour gap between talks, if I'm recalling correctly. This was too long, in my opinion. It would have been better to have another talk, or just end the day earlier. Some days the catering was not so great and other days it was okay. With so much good food near Berkeley it seems that the quality of the lunch could definitely be improved.	5/7/2017 9:59 AM
7	It has been a wonderful workshop. The talks are excellent, and the participants outstanding.	5/5/2017 12:41 PM
8	I had a great time at this conference! One of the best I've ever been to. One standard criticism of MSRI is that there is no place to go out to eat nearby. But I don't see any way that problem can be reasonably solved. The catering was a good solution.	5/5/2017 12:34 PM
9	It was great to get pretty much the whole field together in one place!	5/5/2017 11:09 AM
10	This workshop was unbelievably stimulating --- so much so that I wish we could all just stay, rather than going back to our own departments! Many, many great theorems would be proved.	5/5/2017 11:01 AM
11	There should be less junk food and more fruits at the breaks.	5/5/2017 8:54 AM

Q5 I was well prepared to benefit from the lectures

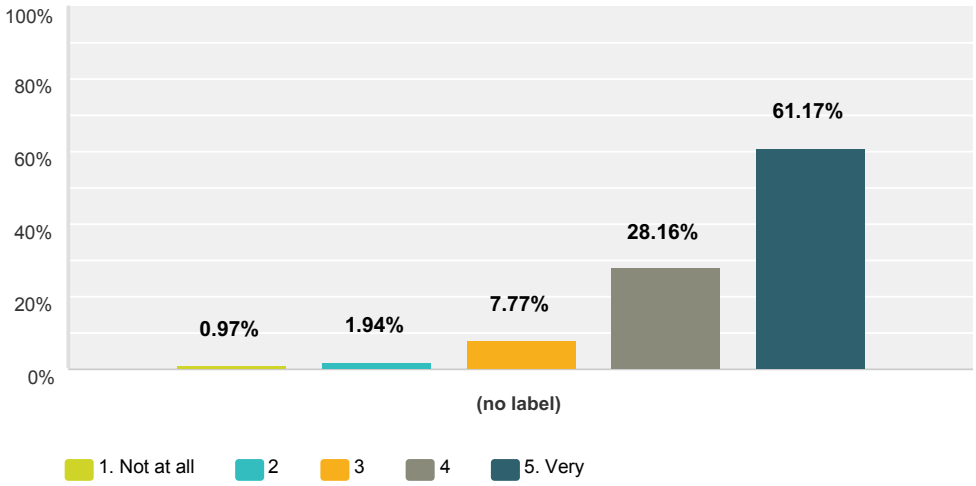
Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.97%** 1	**1.94%** 2	**16.50%** 17	**42.72%** 44	**37.86%** 39	103	4.15

Q6 My interest in the subject matter was increased by the workshop

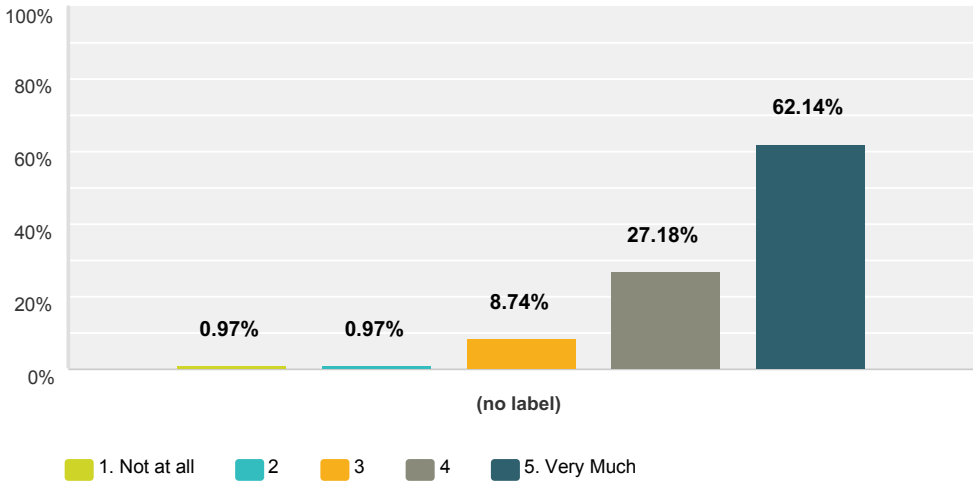
Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.97%** 1	**1.94%** 2	**7.77%** 8	**28.16%** 29	**61.17%** 63	103	4.47

Q7 The workshop helped me meet people with similar scientific interests

Answered: 103 Skipped: 0



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**0.97%** 1	**0.97%** 1	**8.74%** 9	**27.18%** 28	**62.14%** 64	103	4.49

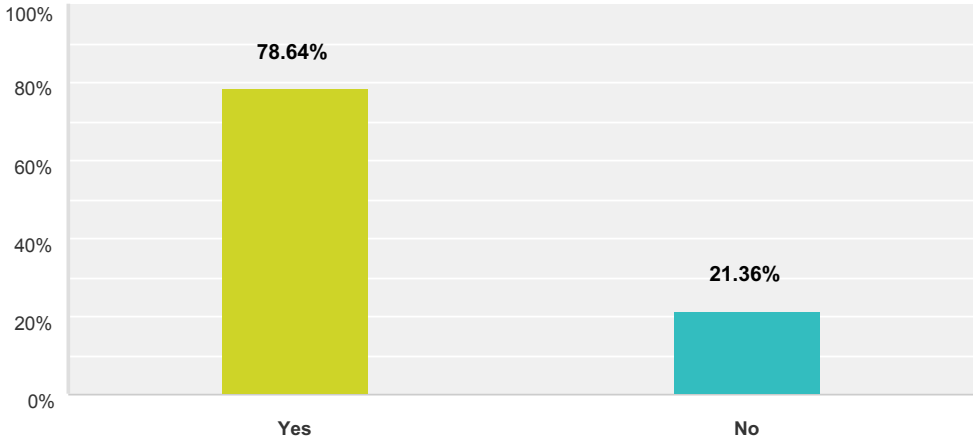
Q8 Additional comments on your personal assessment

Answered: 1 Skipped: 102

#	Responses	Date
1	I might have responded well to one day with more lectures, say six lectures on the first day and then back to the spaced out schedule we had!	5/5/2017 11:10 AM

Q9 Did you attend the reception?

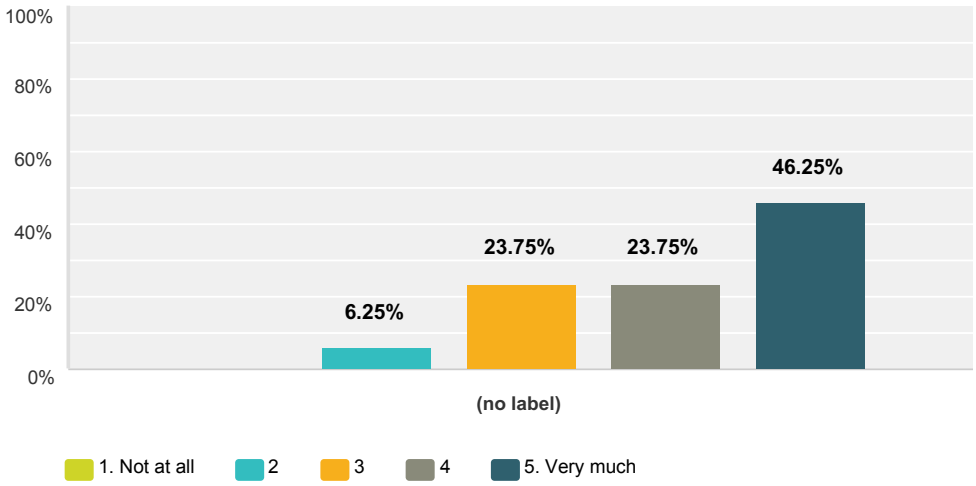
Answered: 103 Skipped: 0



Answer Choices	Responses	
Yes	**78.64%**	81
No	**21.36%**	22
Total		**103**

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 80 Skipped: 23



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	**0.00%** 0	**6.25%** 5	**23.75%** 19	**23.75%** 19	**46.25%** 37	80	4.10

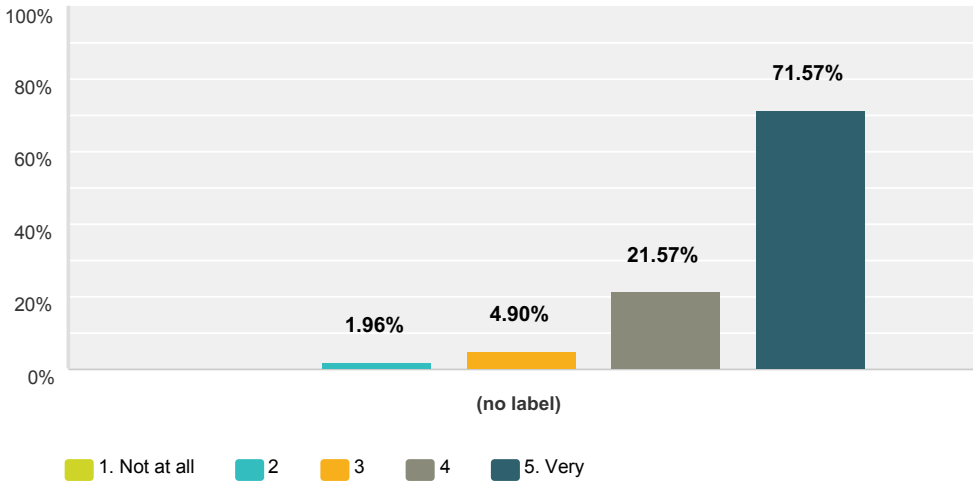
Q11 Please provide any comments about the reception

Answered: 5 Skipped: 98

#	Responses	Date
1	I enjoyed the reception very much. I think it was an important component of the conference. However, it did get a bit loud and crowded in the room where it was held. Perhaps there's not really another space to hold it. It would be nice if there was somehow a bunch of small high tables to set plates on and to stand around. This would also help bring groups of people together instead of milling around somewhat awkwardly in a very crowded space with no room to move.	5/7/2017 10:02 AM
2	The food and drink at MSRI receptions is always impressively good. Unfortunately, it tends to be overly crowded - the physical space in the atrium cannot comfortably handle 100 people, and so receptions are frequently uncomfortable.	5/5/2017 11:38 AM
3	I would have been happy to pay a little toward the food if it meant there was slightly more. That said, I had a great and productive time!	5/5/2017 11:12 AM
4	The reception should take place later, it doesn't make sense to have dinner at 4pm, and an hour after the tea break.	5/5/2017 8:55 AM
5	During the reception I had began a discussion with a former collaborator regarding some aspects of my new work that could be generalized. We are now going to explore this problem together. As this person is based in the UK, the reception marked our first in-person conversation since 2014. It was very helpful, so I am glad I attended the reception.	5/5/2017 8:33 AM

Q12 I found the MSRI staff helpful

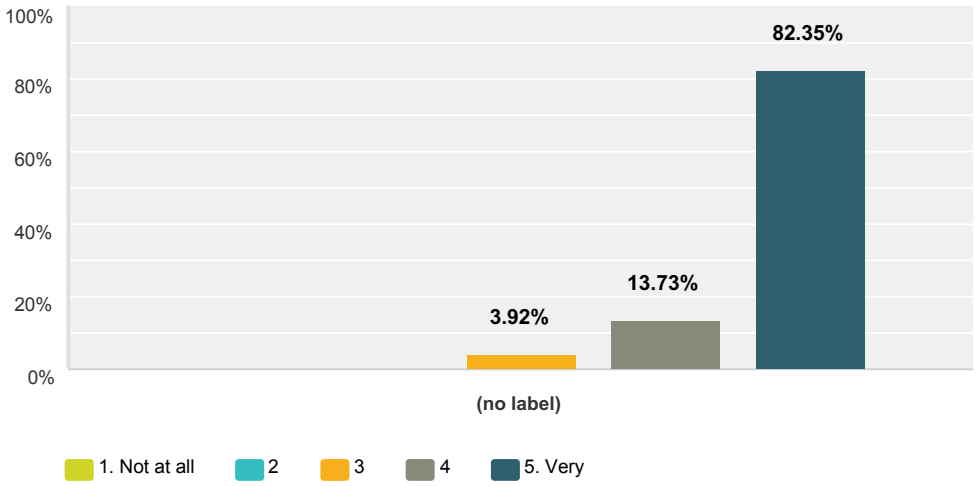
Answered: 102 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**1.96%** 2	**4.90%** 5	**21.57%** 22	**71.57%** 73	102	4.63

Q13 The MSRI facilities were conducive for such a workshop

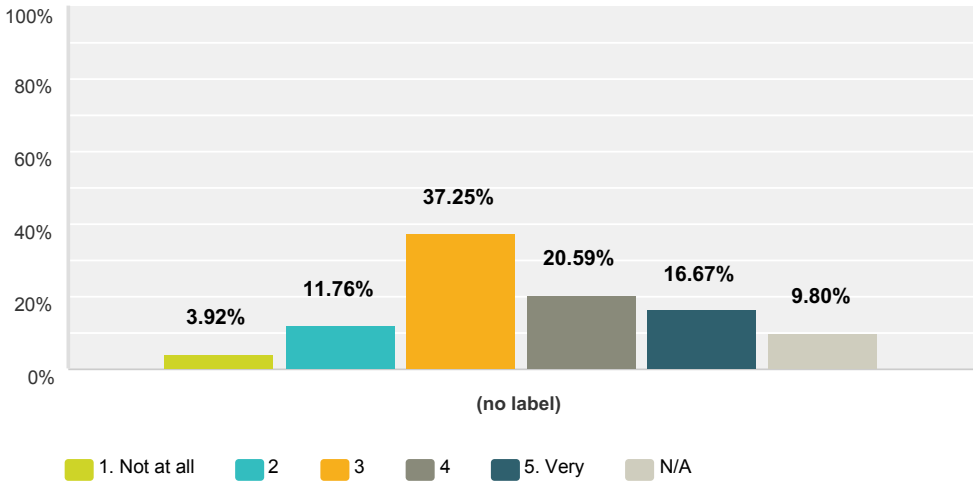
Answered: 102 Skipped: 1



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**3.92%** 4	**13.73%** 14	**82.35%** 84	102	4.78

Q14 The MSRI lunch arrangements were satisfactory

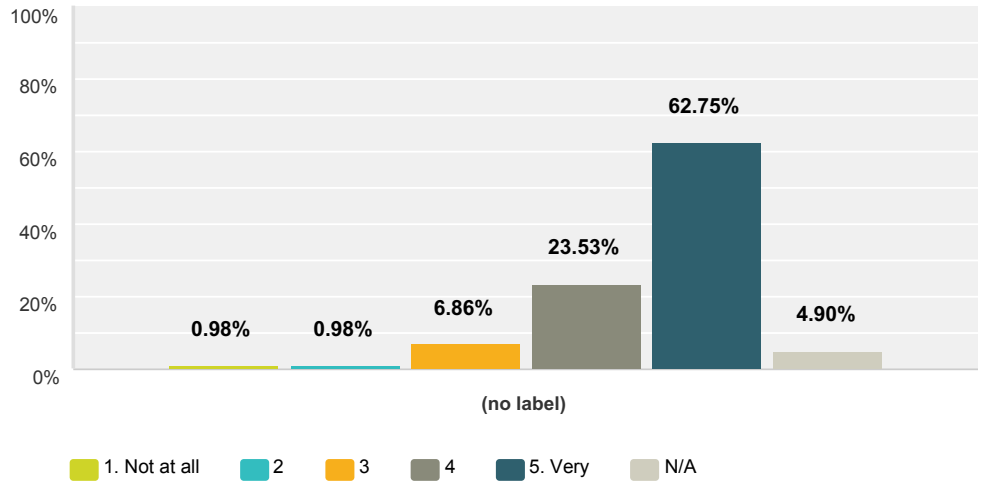
Answered: 102 Skipped: 1



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**3.92%** 4	**11.76%** 12	**37.25%** 38	**20.59%** 21	**16.67%** 17	**9.80%** 10	102	3.38

Q15 The MSRI tea arrangements were satisfactory

Answered: 102 Skipped: 1



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**0.98%** 1	**0.98%** 1	**6.86%** 7	**23.53%** 24	**62.75%** 64	**4.90%** 5	102	4.54

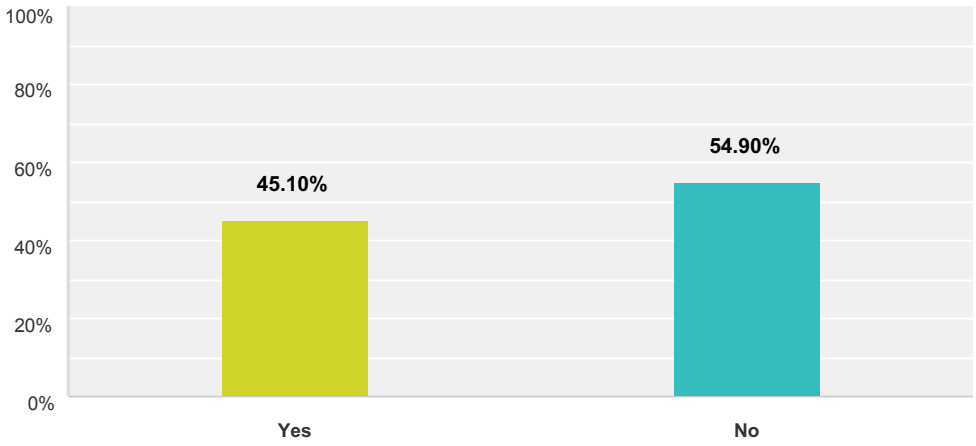
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 15 Skipped: 88

#	Responses	Date
1	The caterers don't bring enough food, so they are out of sandwiches by the time the line ends	5/24/2017 6:52 AM
2	I think there need to be more chairs and tables when an event is prepared for many people, especially for the lunch time.	5/18/2017 11:05 AM
3	The food was very expensive for the small quantity received.	5/12/2017 8:02 AM
4	MSRI fascilities: For this workshop they were very conductive. During the first two workshops I had the impression that the venue was too small for the amount of participants who attended. (Possible due to bad weather which did not allow people to use the outdoor areas too.) Lunch: Monday/Tuesday lunch options were not at all satisfactory. Thursday/Friday options (soup) were reasonable	5/12/2017 7:43 AM
5	The facilities are excellent, especially the many places to sit (inside and outside) and talk or work. The logistics of the lunch arrangements were excellent and well advertised; however, I found the quality of the catered food to be not that high. In addition, I was not able to successfully follow MSRI's instructions on how to join the lunch-delivery order; perhaps those instructions could be revisited and clarified.	5/10/2017 3:55 AM
6	The staff were very helpful and efficient! I already commented on the lunch and facilities in the previous comment boxes.	5/7/2017 10:04 AM
7	The Stuffed Inn guy should bring someone to help him; the line moves rather slow.	5/7/2017 1:49 AM
8	The location is too hard to get to.	5/6/2017 1:59 PM
9	The lunch options were fairly limited (particularly for vegetarian/vegan diets) and the lines were quite long. Many conference participants wound up ordering food delivery via Uber Eats instead.	5/6/2017 8:15 AM
10	I would really appreciate some healthier food options.	5/6/2017 1:41 AM
11	As I said in the previous comment box, the one unfortunate thing about MSRI is that there is nowhere to go out to eat. The lunch arrangements were satisfactory, but only satisfactory. One day they ran out of sandwiches and there was little choice. All in all, the extremely high value of the conversations I had overshadowed any downside on the food.	5/5/2017 12:36 PM
12	The facilities are great, with the exception of crowding in the atrium during workshops of 100+ people. The lunch options are bad, but I was aware of this and made arrangements to bring my own food.	5/5/2017 11:39 AM
13	Air conditioning woukd have been nice. The lunch could be better.	5/5/2017 11:19 AM
14	Lots of attitude in the administrative office. It's not fitting for the otherwise fantastic environment.	5/5/2017 9:06 AM
15	The addition of more chalkboards throughout the facility would be helpful.	5/5/2017 8:34 AM

Q17 Did you use the computer facilities located in the library?

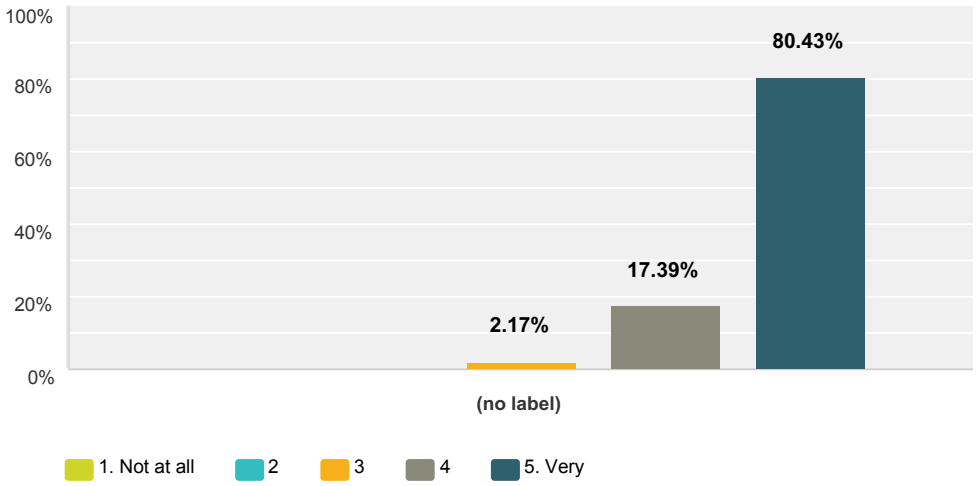
Answered: 102 Skipped: 1



Answer Choices	Responses	
Yes	**45.10%**	46
No	**54.90%**	56
Total		**102**

Q18 The MSRI computer facilities in the library were adequate

Answered: 46 Skipped: 57

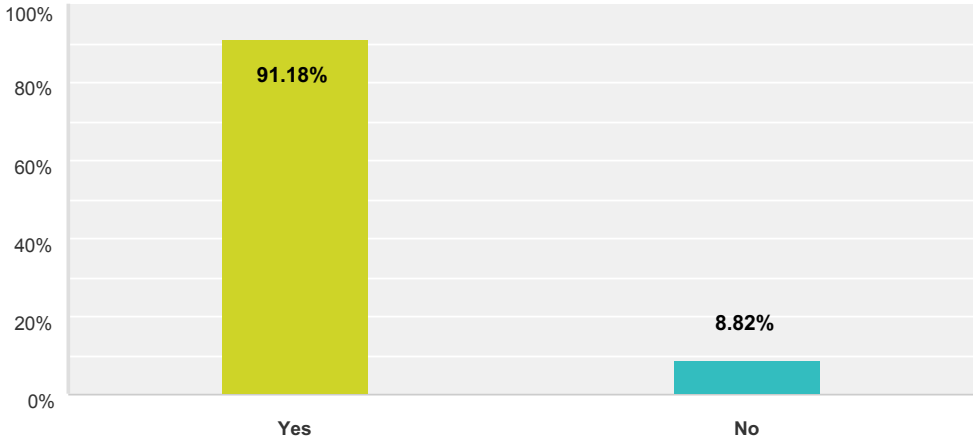


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.17%** 1	**17.39%** 8	**80.43%** 37	46	4.78

#	Comments about computer facilities	Date
1	The computing facilities were top class! Actually I didn't realise how good they were for a few days - maybe I was just not paying attention!	5/5/2017 11:14 AM

Q19 Did you use MSRI's wireless network?

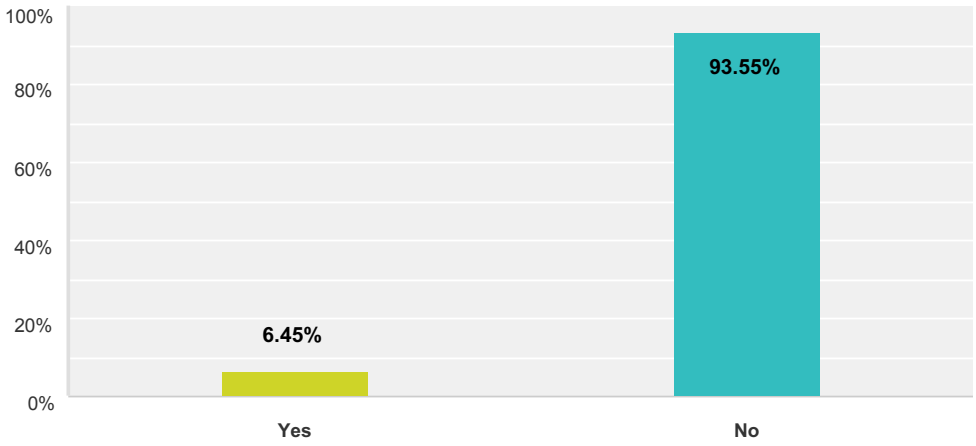
Answered: 102 Skipped: 1



Answer Choices	Responses	
Yes	**91.18%**	93
No	**8.82%**	9
Total		**102**

Q20 Did you experience any difficulties with the network?

Answered: 93 Skipped: 10



Answer Choices	Responses	
Yes	**6.45%**	6
No	**93.55%**	87
Total		**93**

#	Please if yes, please describe your difficulties	Date
1	sometimes slow	5/6/2017 2:00 PM
2	The connection was pretty slow at one point.	5/5/2017 12:37 PM
3	Often eduroam didn't work and I switched to MSRI-guest. This might have been a problem with my account I guess.	5/5/2017 11:15 AM
4	Slow connection	5/5/2017 8:34 AM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 9 Skipped: 94

#	Responses	Date
1	The lodging is quite expensive around the university. I would be much appreciate it if people can get more funding on it in the future.	5/18/2017 10:50 PM
2	Thanks for a great workshop!!	5/12/2017 7:43 AM
3	I very much appreciate the fact that the organizers considered gender diversity in their invitations; there were a good number of women among the list of speakers and the attendees. I strongly encourage MSRI to be on the leading edge of proactively promoting diversity in every single one of their events!	5/10/2017 3:56 AM
4	More vegetarian options for lunch would be welcome.	5/8/2017 12:27 AM
5	This conference kicked ass; thanks for putting it together!!	5/7/2017 1:49 AM
6	I was also at the Introductory Workshop in February and I have to say that I enjoyed this one much more. It was nice that more speakers at the Recent Developments workshop had a chance to give talks on their work, in contrast with the mini-course format at the Introductory workshop, which greatly limited the number of speakers. I was also heartened to see that a higher proportion speakers at this workshop were women (the Introductory Workshop was a bit embarrassing in that respect). I was happy to see so much diversity in the research areas represented at this workshop, not to mention diversity in the speakers' genders, ages, career stages, etc. I thought it was very interesting to see talks on current work, with the speakers giving caveats that details are still being worked out. It was exciting to see the real "state-of-the-art" and get a sense of where the field is heading.	5/6/2017 8:25 AM
7	excellent conference. made progress on some projects.	5/5/2017 11:25 AM
8	Great workshop well organized in a fantastic location!	5/5/2017 11:16 AM
9	The speaker list was full of strong, active, and influential researchers. I was happy, in contrast to the Introductory Workshop, with the healthy level of representation of female speakers.	5/5/2017 8:36 AM

Hot Topics: Galois Theory of Periods and Applications

March 27, 2017 - March 31, 2017

MSRI, Berkeley, CA, USA

Organizers:

Francis Brown (University of Oxford)

Clément Dupont (Université de Montpellier)

Richard Hain (Duke University)

Vadim Vologodsky (University of Oregon)

REPORT ON THE MSRI WORKSHOP
"Hot Topics: Galois Theory of Periods and Applications"
March 27-31, 2017

Organizers

- Francis Brown (University of Oxford)
- Clément Dupont (Université de Montpellier)
- Richard Hain (Duke University)
- Vadim Vologodsky (University of Oregon)

Scientific Description

Periods are integrals of algebraic differential forms over algebraically-defined domains and are ubiquitous in mathematics and physics. A deep idea, originating with Grothendieck, is that there should be a Galois Theory of periods. This general principle provides a unifying approach to several problems in the theory of motives, quantum groups and geometric group theory. This workshop brought together leading experts around this subject and covered topics such as the theory of multiple zeta values, modular forms, and motivic fundamental groups.

Highlights of the Workshop

The workshop brought together a mathematically diverse group of researchers working on periods of motives and related subjects. One premise of the workshop was that there are deep and currently unrealized connections between the study of motives and their periods on the one hand, and outstanding problems in several other areas of mathematics, such as Kontsevich's non-commutative symplectic geometry and representation theory on the other. As hoped, many researchers became convinced of such connections during the workshop.

Since the study of periods is an emerging field, the organizers invited many young researchers. Of the 19 speakers, 11 were young researchers whose interests spanned the conference. These younger participants interacted energetically with each other and with more senior participants, and built new relationships which should help shape the future of the field.

There was also significant interaction between participants from areas of mathematics that do not typically communicate with each other. This is expected to result in new collaborations which transcend current research communities. The fact that most speakers made the effort to make their talks accessible to graduate students also contributed to the success of the workshop.

MSRI Mathematical Sciences Research Institute

Hot Topics: Galois Theory of Periods and Applications

March 27-31, 2017

Schedule

Monday, March 27, 2017			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome
9:30 AM - 10:30 AM	Simons Auditorium	Yves Andre	Galois theory of period and the André-Oort conjecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Spencer Bloch	Motivic Gamma Functions and recursion
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Nils Matthes	Elliptic multiple zeta values and periods
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Ding Ma	Period Polynomial Relations among Double Zeta Values and Various Generalizations

Tuesday, March 28, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Annette Huber-Klawitter	Why you should care about motives
10:30 AM - 11:00 AM	Atrium		Tea
11:00 AM - 12:00 PM	Simons Auditorium	Karen Vogtmann	Outer space, symplectic derivations of free Lie algebras and modular forms
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Javier Fresán	A Galois theory of exponential periods
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Geoffroy Horel	Galois actions on operads
4:30 PM - 6:20 PM	Atrium		Reception

Wednesday, March 29, 2017			
9:00 AM - 10:00 AM	Simons Auditorium	Anton Alekseev	The Goldman-Turaev Lie bialgebra and the Kashiwara-Vergne problem
10:00 AM - 10:30 AM	Atrium		Break
10:30 AM - 11:30 AM	Simons Auditorium	Benjamin Enriquez	A stabilizer interpretation de double shuffle Lie algebras
11:30 AM - 12:30 PM	Simons Auditorium	Anton Khoroshkin	the operad structure of $\overline{M_{0,n+1}}({\mathbb{R}})$

Thursday, March 30, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	James Conant	Quotients of Kontsevich's "Lie" Lie algebra
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Kirsten Wickelgren	Motivic Euler numbers and an arithmetic count of the lines on a cubic surface
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Claire Glanois	Galois theory for motivic cyclotomic multiple zeta values
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Deepam Patel	Motives arising from higher homotopy theory of hyperplane arrangements

Friday, March 31, 2017			
9:30 AM - 10:30 AM	Simons Auditorium	Madhav Nori	Hypergeometric Motives
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Kiran Kedlaya	p-adic periods via perfectoid spaces
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium	Jennifer Balakrishnan	Iterated p-adic integrals and rational points on curves
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium	Julian Rosen	A Galois theory of supercongruences

Organizers		
First Name	**Last Name**	**Institution**
Francis	Brown	University of Oxford
Clément	Dupont	Université de Montpellier
Richard	Hain	Duke University
Vadim	Vologodsky	University of Oregon
Speakers		
First Name	**Last Name**	**Institution**
Anton	Alekseev	Université de Genève
Yves	Andre	Centre National de la Recherche Scientifique (CNRS)
Jennifer	Balakrishnan	Boston University
Spencer	Bloch	Retired
Jim	Conant	University of Tennessee
Benjamin	Enriquez	Université de Strasbourg
Javier	Fresán	ETH Zürich
Martin	Gallauer	University of California, Los Angeles
Claire	Glanois	Max-Planck-Institut für Mathematik
Geoffroy	Horel	Université de Paris XIII (Paris-Nord)
Annette	Huber-Klawitter	Albert-Ludwigs-Universität Freiburg
Kiran	Kedlaya	University of California, San Diego
Anton	Khoroshkin	Higher School of Economics
Ding	Ma	Duke University
Nils	Matthes	Universität Hamburg
Deepam	Patel	Purdue University
Julian	Rosen	University of Michigan
Karen	Vogtmann	University of Warwick
Kirsten	Wickelgren	Georgia Institute of Technology

Participants

First Name	Last Name	Institution
Anton	Alekseev	Université de Genève
Mansoor	Alshehri	King Saud University
Yves	Andre	Centre National de la Recherche Scientifique (CNRS)
Jitendra	Bajpai	Mathematisches Institut Georg-August Universität Göttingen
Jennifer	Balakrishnan	Boston University
Iuliya	Beloshapka	Max-Planck-Institut für Mathematik
Marko	Berghoff	Humboldt-Universität
Candace	Bethea	University of South Carolina
Nasser	Bin Turki	King Saud University
Spencer	Bloch	Retired
Johannes	Broedel	Humboldt-Universität
Francis	Brown	University of Oxford
Jin	Cao	Mathematical Sciences Center, Tsinghua University
Steven	Charlton	Eberhard-Karls-Universität Tübingen
Dohoon	Choi	Korea Aerospace University
Jim	Conant	University of Tennessee
David	Corwin	École Normale Supérieure
Coleman	Dobson	California State University
Dmitry	Doryn	Institute for basic science
Clément	Dupont	Université de Montpellier
Benjamin	Enriquez	Université de Strasbourg
Travis	Ens	University of Toronto
Matteo	Felder	Université de Genève
Javier	Fresán	ETH Zürich
Martin	Gallauer	University of California, Los Angeles
Claire	Glanois	Max-Planck-Institut für Mathematik
Martin	Gonzalez	Institut de Mathématiques de Jussieu
Richard	Hain	Duke University
David	Harbater	University of Pennsylvania
Geoffroy	Horel	Université de Paris XIII (Paris-Nord)
Ivan	Horozov	City University of New York (CUNY)
Nick	Howell	University of Oregon
Annette	Huber-Klawitter	Albert-Ludwigs-Universität Freiburg
David	Jarossay	Université de Strasbourg
Lizhen	Ji	University of Michigan
Fangzhou	Jin	Universität Regensburg
Martin	Kassabov	Cornell University
Makoto	Kawashima	Osaka university
Kiran	Kedlaya	University of California, San Diego
Adam	Keilthy	University of Oxford
Anton	Khoroshkin	Higher School of Economics
Shun-ichi	Kimura	Hiroshima University
Yordanka	Kovacheva	University of Chicago
Ulf	Kuehn	Universität Hamburg
Ma	Luo	Duke University
Ding	Ma	Duke University

Participants		
First Name	**Last Name**	**Institution**
Olivier	Martin	University of Chicago
Yuki	Matsuoka	Nagoya University
Nils	Matthes	Universität Hamburg
Arthur	Ogus	University of California, Berkeley
Erik	Panzer	University of Oxford
Owen	Patashnick	University of Bristol
Deepam	Patel	Purdue University
Corentin	Perret-Gentil-dit-Maillard	ETH Zürich
Alexander	Petrov	Higher School of Economics
Aaron	Pollack	Stanford University
Elise	Raphael	Université de Genève
Kenneth	Ribet	University of California, Berkeley
Julian	Rosen	University of Michigan
Daniil	Rudenko	University of Chicago
Alex	Saad	University of Oxford
Jyoti Prakash	Saha	Math. Forschungsinstitut Oberwolfach
Tokio	Sasaki	Washington University
Shrenik	Shah	Columbia University
Artane	Siad	University of Toronto
Claudio	Sibilia	ETH Zürich
Koji	Tasaka	Aichi Prefectural University
Jean-Baptiste	Teyssier	Katholieke Universiteit Leuven
Frank	Thorne	University of South Carolina
Karen	Vogtmann	University of Warwick
Vadim	Vologodsky	University of Oregon
Kirsten	Wickelgren	Georgia Institute of Technology
Junyan	Xu	Indiana University
Federico	Zerbini	Max-Planck-Institut für Mathematik
Yihang	Zhu	Harvard University

Officially Registered Participant Information

Participants		74

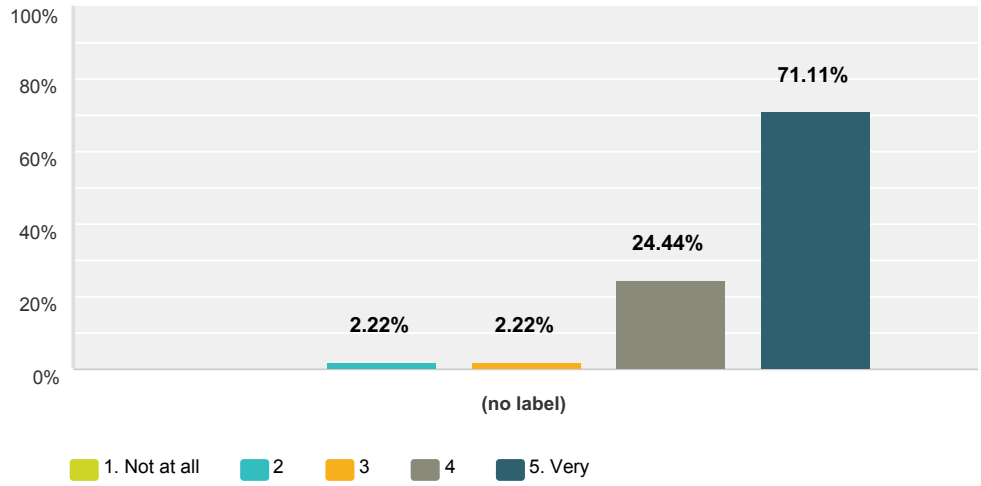
Gender		74
Male	83.78%	62
Female	13.51%	10
Declined to state	2.70%	2
Ethnicity*		**78**
White	54.05%	40
Asian	24.32%	18
Hispanic	1.35%	1
Pacific Islander	1.35%	1
Black	4.05%	3
Native American	0.00%	0
Mixed	2.70%	2
Declined to state	17.57%	13

* ethnicity specifications are not exclusive

45 responses out of 74 participants = 60% response rate

Q1 The workshop was intellectually stimulating

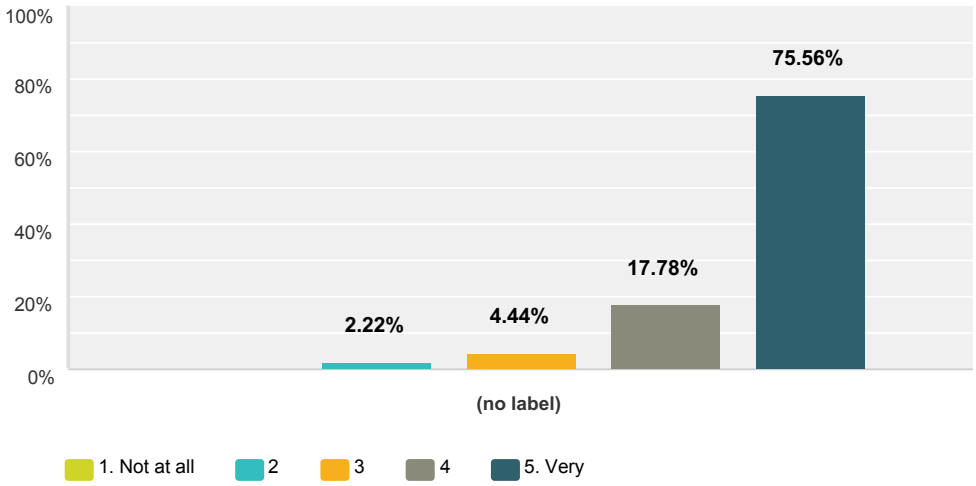
Answered: 45 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.22%** 1	**2.22%** 1	**24.44%** 11	**71.11%** 32	45	4.64

Q2 The overall experience of the workshop was worthwhile

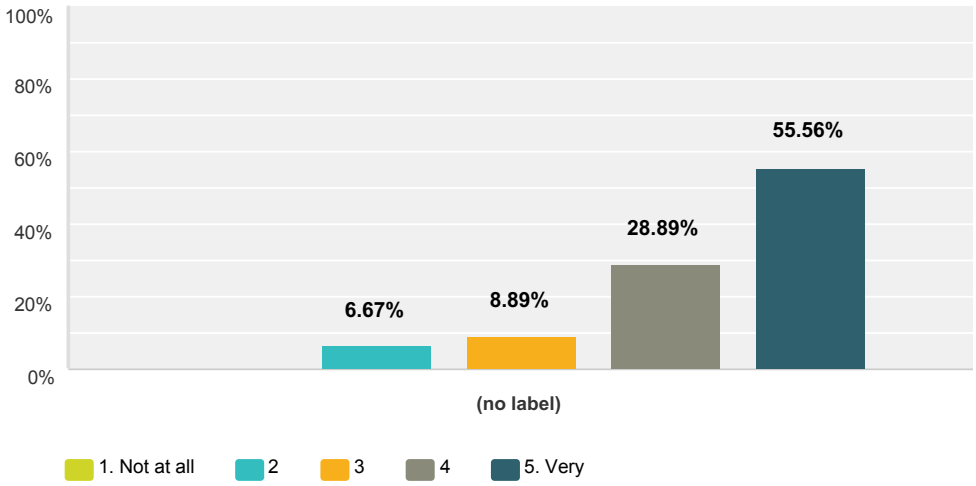
Answered: 45 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.22%** 1	**4.44%** 2	**17.78%** 8	**75.56%** 34	45	4.67

Q3 The time between lectures was adequate for discussion

Answered: 45 Skipped: 0



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**6.67%** 3	**8.89%** 4	**28.89%** 13	**55.56%** 25	45	4.33

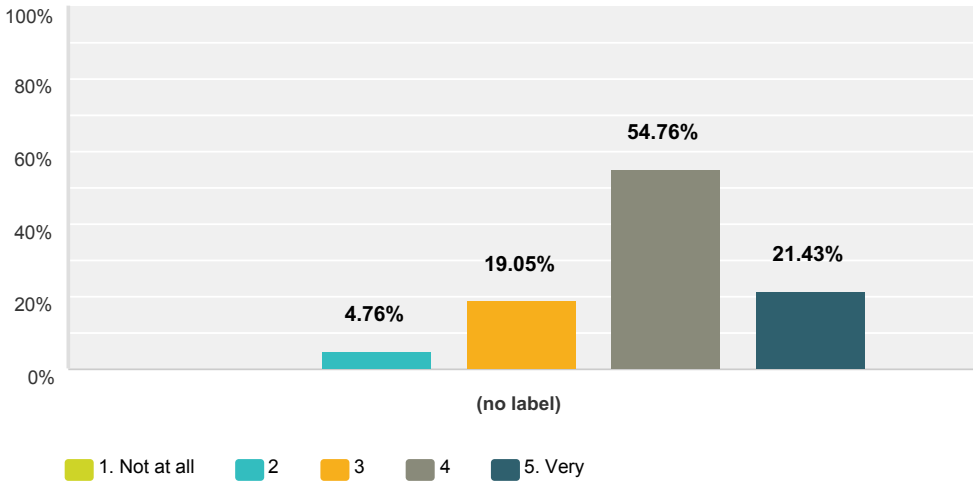
Q4 Additional comments

Answered: 9 Skipped: 36

#	Responses	Date
1	I was only in attendance Friday afternoon, but both of the talks were great!	4/10/2017 10:20 PM
2	I wanted more time for discussion	4/6/2017 8:01 AM
3	This was an excellent workshop. The talks were all very interesting and the organizers did a great job in making them useful to varied audience, emphasizing the interconnections between the various research areas showcased.	4/5/2017 10:01 PM
4	Amazing speakers!!	4/5/2017 5:19 PM
5	Food might be better.	4/5/2017 2:16 PM
6	The workshop brought together people with overlapping but varied interests in a way that stimulated interactions and connections. The one thing that would have been better to have done differently would have been to have one or two introductory/framing lectures at the beginning.	4/4/2017 8:53 PM
7	everything was great. i'll love to come again to msri.	3/31/2017 10:24 PM
8	The staff were really helpful too!	3/31/2017 6:35 PM
9	It seems to me inappropriate to begin every workshop with a talk about the history, funding, and rules of MSRI. Put that on a handout rather than force your captive audience to listen.	3/31/2017 6:33 PM

Q5 I was well prepared to benefit from the lectures

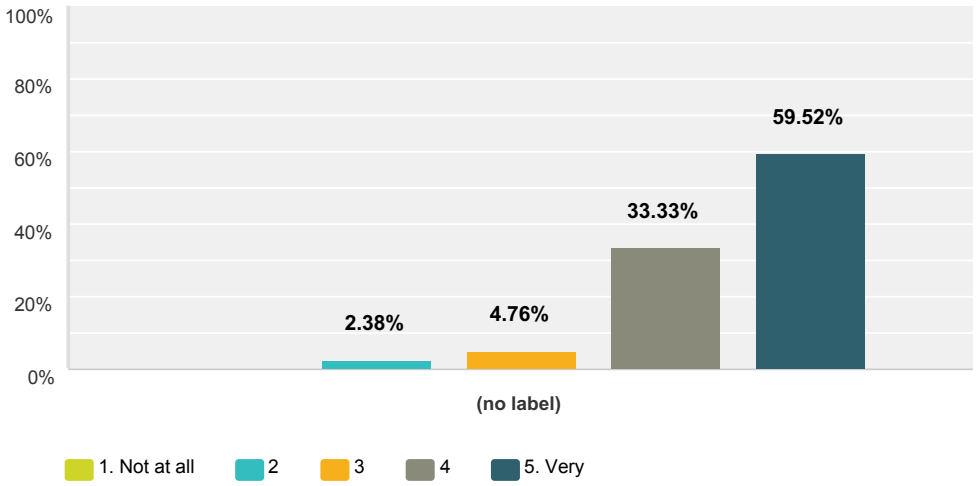
Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**4.76%** 2	**19.05%** 8	**54.76%** 23	**21.43%** 9	42	3.93

Q6 My interest in the subject matter was increased by the workshop

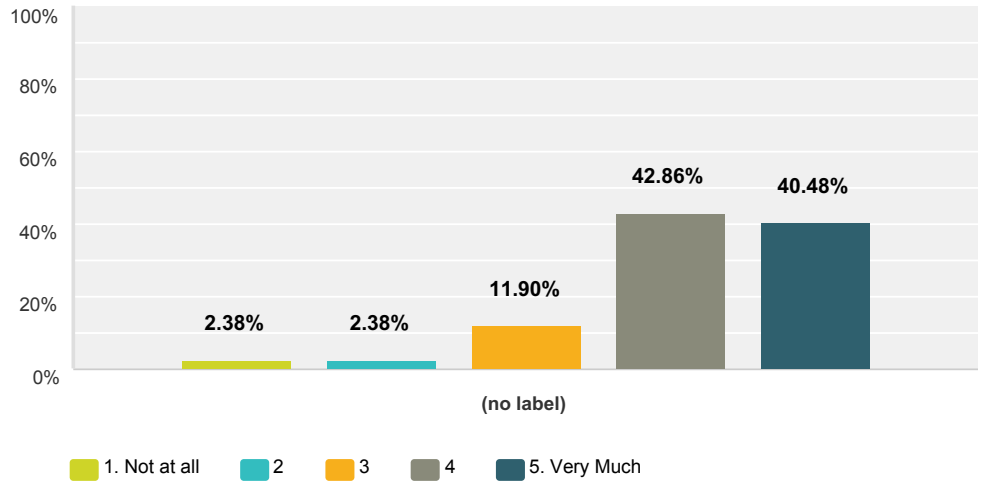
Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.38%** 1	**4.76%** 2	**33.33%** 14	**59.52%** 25	42	4.50

Q7 The workshop helped me meet people with similar scientific interests

Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very Much	Total	Weighted Average
(no label)	**2.38%** 1	**2.38%** 1	**11.90%** 5	**42.86%** 18	**40.48%** 17	42	4.17

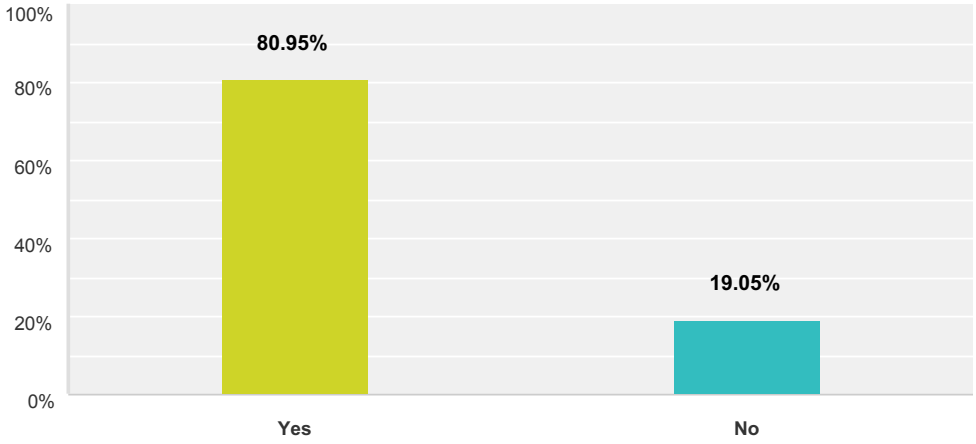
Q8 Additional comments on your personal assessment

Answered: 0 Skipped: 45

#	Responses	Date
	There are no responses.	

Q9 Did you attend the reception?

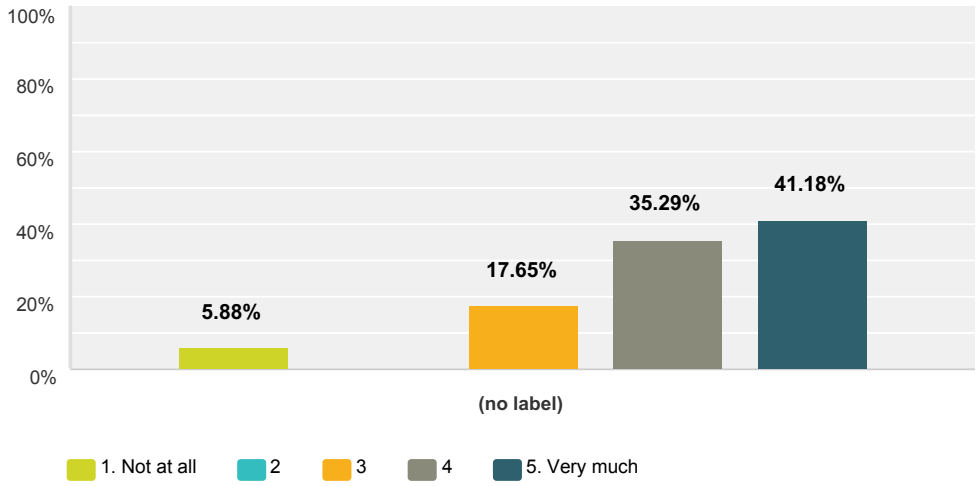
Answered: 42 Skipped: 3



Answer Choices	Responses	
Yes	80.95%	34
No	19.05%	8
Total		42

Q10 Did the reception help to solidify the contacts you made during the workshop?

Answered: 34 Skipped: 11



	1. Not at all	2	3	4	5. Very much	Total	Weighted Average
(no label)	5.88% 2	0.00% 0	17.65% 6	35.29% 12	41.18% 14	34	4.06

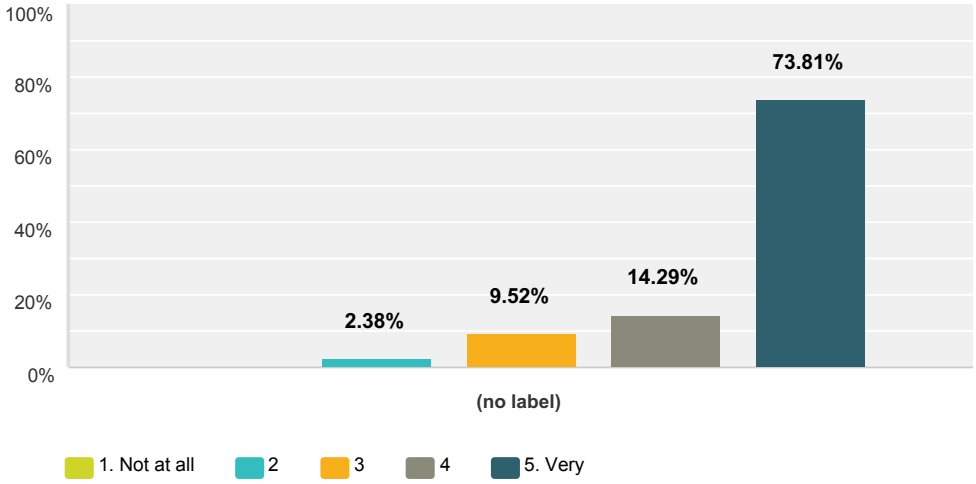
Q11 Please provide any comments about the reception

Answered: 2 Skipped: 43

#	Responses	Date
1	Most people left early	4/6/2017 8:01 AM
2	Having the reception so early in the week was excellent for meeting new people, but perhaps less useful for establishing who was a useful contact	3/31/2017 6:37 PM

Q12 I found the MSRI staff helpful

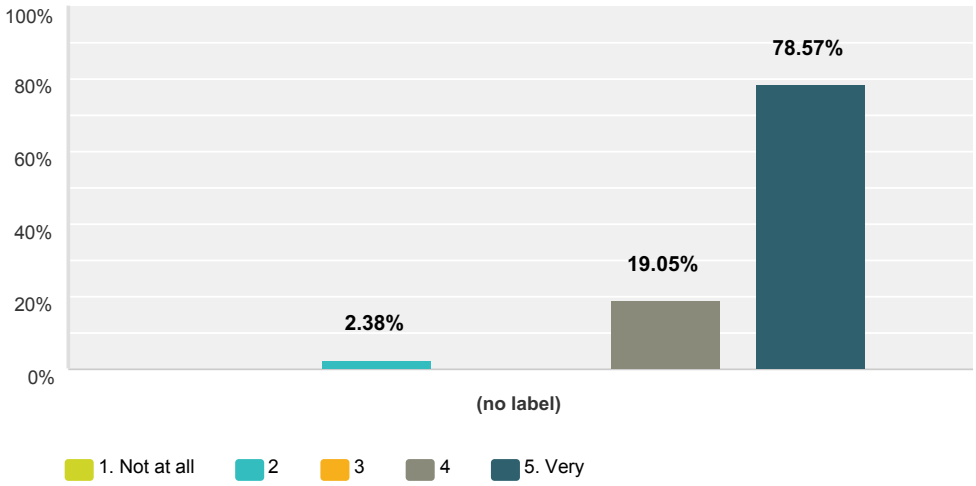
Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.38%** 1	**9.52%** 4	**14.29%** 6	**73.81%** 31	42	4.60

Q13 The MSRI facilities were conducive for such a workshop

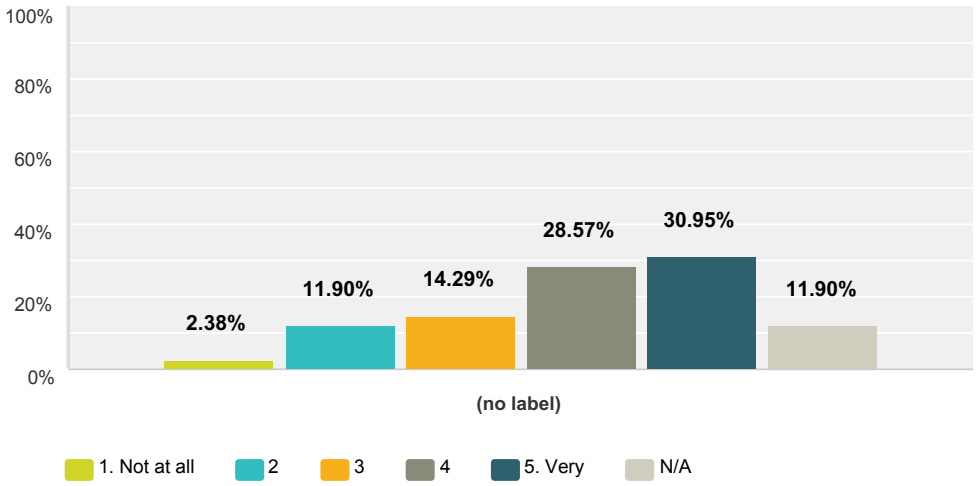
Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**2.38%** 1	**0.00%** 0	**19.05%** 8	**78.57%** 33	42	4.74

Q14 The MSRI lunch arrangements were satisfactory

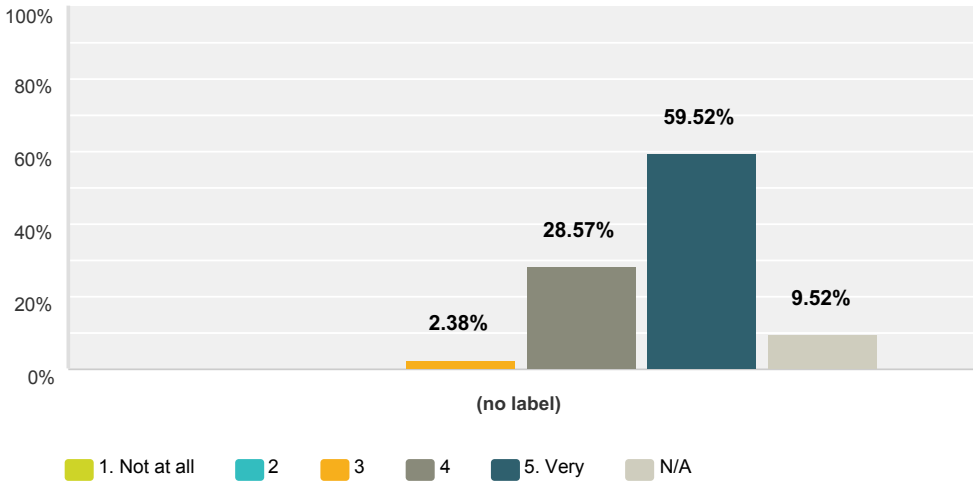
Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**2.38%** 1	**11.90%** 5	**14.29%** 6	**28.57%** 12	**30.95%** 13	**11.90%** 5	42	3.84

Q15 The MSRI tea arrangements were satisfactory

Answered: 42 Skipped: 3



	1. Not at all	2	3	4	5. Very	N/A	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**2.38%** 1	**28.57%** 12	**59.52%** 25	**9.52%** 4	42	4.63

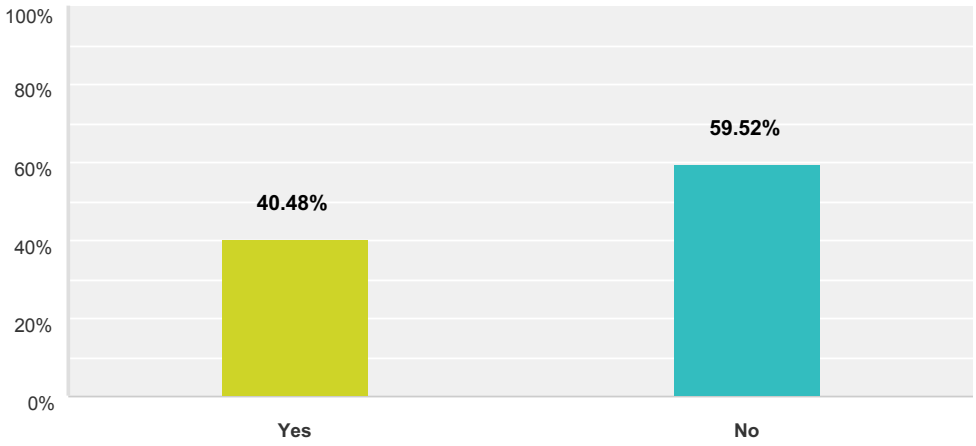
Q16 Additional comments about the MSRI staff, facilities and food

Answered: 5 Skipped: 40

#	Responses	Date
1	The lunch at Wednesday was complicated to order;)	4/3/2017 6:02 AM
2	missed juices or other cold drinks	3/31/2017 10:26 PM
3	Jacari was SO helpful, she made the process easier than I could have hoped for (and I ask a lot of questions, so that is saying something). Coffee was always stocked, and the snacks were good. Facilities were clean and there was enough seating. No complaints whatsoever.	3/31/2017 9:55 PM
4	The food is really an embarrassment. The schedule of talks was often incorrect. The bus schedule is hard to find online, because of broken links.	3/31/2017 6:35 PM
5	Better/more vegetarian options please	3/31/2017 6:26 PM

Q17 Did you use the computer facilities located in the library?

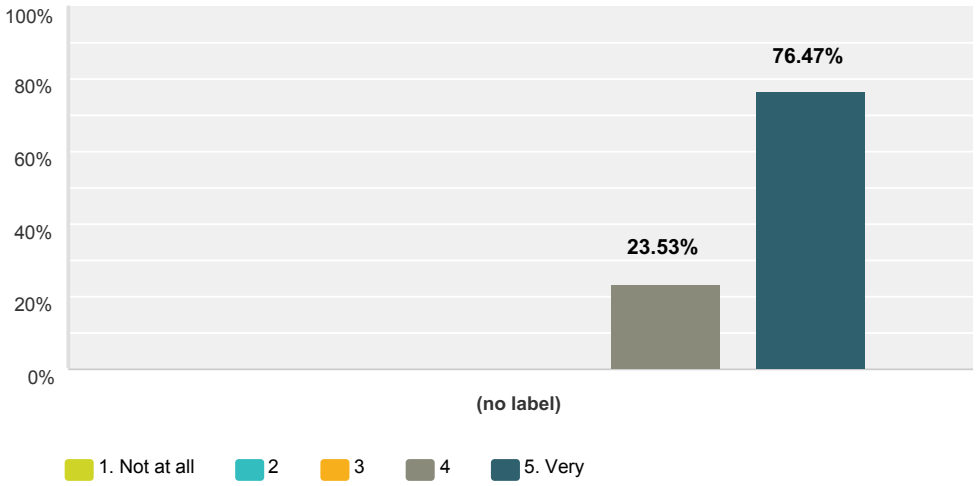
Answered: 42 Skipped: 3



Answer Choices	Responses	
Yes	40.48%	17
No	59.52%	25
Total		42

Q18 The MSRI computer facilities in the library were adequate

Answered: 17 Skipped: 28

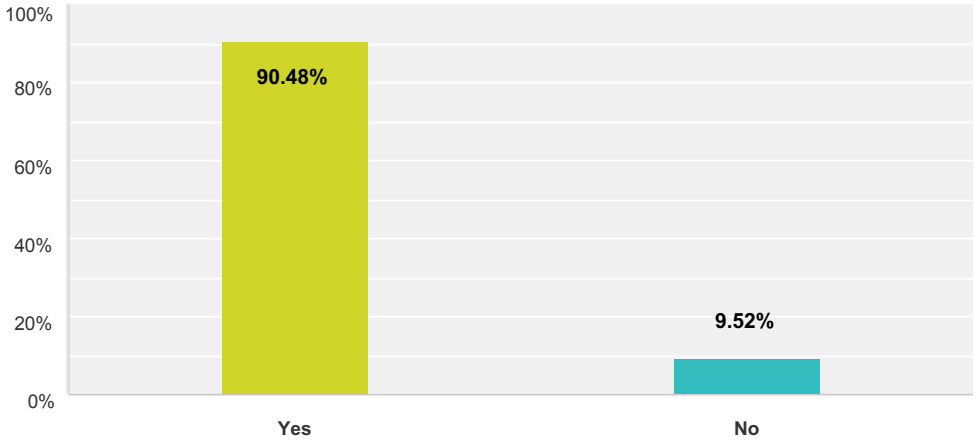


	1. Not at all	2	3	4	5. Very	Total	Weighted Average
(no label)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**23.53%** 4	**76.47%** 13	17	4.76

#	Comments about computer facilities	Date
	There are no responses.	

Q19 Did you use MSRI's wireless network?

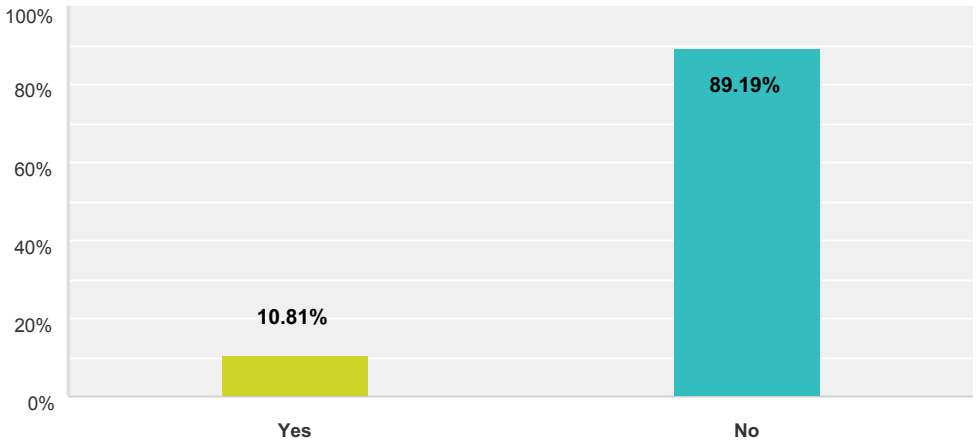
Answered: 42 Skipped: 3



Answer Choices	Responses	
Yes	**90.48%**	38
No	**9.52%**	4
Total		**42**

Q20 Did you experience any difficulties with the network?

Answered: 37 Skipped: 8



Answer Choices	Responses	
Yes	**10.81%**	4
No	**89.19%**	33
Total		**37**

#	Please if yes, please describe your difficulties	Date
1	unfortunally, your Eduroam is spelled with big lettter at front, thus my local eduroam (with small e) did not work. why not set up also a "eduroam" . this would help all the european visitors a lot.	3/31/2017 10:28 PM
2	Low signal	3/31/2017 10:11 PM
3	Please provide wireless security on the guest network	3/31/2017 6:27 PM

Q21 We welcome any additional comments or suggestions you may have to improve the overall experience for future participants.

Answered: 4 Skipped: 41

#	Responses	Date
1	I'm in the analytic number theory program. Since the conference was in the building, I decided to go to about a half dozen of the talks. For the most part they sailed above my head ---- but I was not exactly the target audience, so perhaps that was to be expected!	4/13/2017 7:26 PM
2	Everything was perfect for me :)	4/5/2017 5:20 PM
3	Stronger coffee	3/31/2017 10:12 PM
4	Keep running great programs like this one! Thanks!	3/31/2017 6:28 PM

Mathematical Sciences Research Institute
2017 National Math Festival

Report to the National Science Foundation
July 2017

Overview

The 2017 National Math Festival brought 20,000 children and adults of all ages to enjoy more than 80 events – lectures, demos, puzzles, games, films, mathletic competitions, and other hands-on, interactive activities – on Saturday, April 22 in the Convention Center in Washington, DC.

The National Science Foundation grant allowed us to bring a full and diverse slate of lecturers. The Festival featured 30 mathematicians, scientists, and educators, who collectively gave 34 different presentations. Most lectures were offered twice in order to allow for easy access; and 20 of them were videotaped. These videos are being gradually released at the nationalmathfestival.org web site.

Having demonstrated a successful, large-scale national event in both 2015 and 2017, we look forward to finding ways to stay engaged with the public in between Festivals. In the run-up to the 2017 Festival, we created and launched a new, curated resource of fun family math resources – videos, puzzles, games, children's math books, and more -- in the More Math! section of the National Math Festival web site. We hosted a Reddit "Ask Me Anything" online Q&A with statistician Rebecca Goldin on stats and the media; and we look forward to hosting additional such events in the future. Students, parents, and interested adults are eager for more ways to engage with math in their everyday lives, and we are eager to join them in that conversation!

Speakers, performers, and activity presenters were selected for being outstanding mathematical thinkers, whether in pure or applied subjects, with a strong ability to convey enthusiasm and inspire the next generation of researchers and educators in mathematics. The presenter slate was also very diverse, with about one-half female lecturers, and approaching one-third lecturers of color.

The aim of the National Math Festival is to immerse children and adults in math in new and unexpected ways. This supports MSRI's mission "to cultivate in the larger society an awareness and appreciation of the beauty, power, and importance of mathematical ideas and ways of understanding the world." To this end we provided easy-entry mathematics experiences that led, whenever possible, to deep and even sometimes open questions in mathematics.

This is the second such large-scale Festival MSRI has produced. The first, held April 2015 in collaboration with the Smithsonian Museums, drew comparable crowds. MSRI's key partners in the 2017 Festival were the Institute for Advanced Study (IAS) and the National Museum of Mathematics (MoMath). The 2017 Festival ran from 10:00 am to 7:00 pm. Photos may be explored on the National Math Festival site.

Program

Attendees arriving at the Festival encountered a large, brightly-colored hall teeming with activities and many interesting options.

Lectures at the 2017 National Math Festival encompassed many aspects of life: we searched carefully and worked closely with presenters to develop juicy talks, with something of interest for just about everyone. Topics ranged from the mathematics of eyesight, drag racing, climate change, and zika epidemiology, to the math behind the blockbuster movie “Hidden Figures” (which we also screened), Google PageRank, the beginning and end of the universe, current NASA missions, math and art, hurricane storm surges, and DNA recombination. More playful topics included stand-up math comedy, a math-inspired magic show, math and sports, place-value games with “Exploding Dots,” jazz improvisation, math and baking, and the high school game show contest “Who Wants to Be a Mathematician.”

For middle and high school girls, we offered a talk on the math behind cheerleading, a session on female mathematicians in history, and the relatable personal journey of a female mathematician of color. For parents of young children, we included a commissioned mathematical musical, and a sprinkling of lectures on children’s math storybooks and how to encourage your preschool-aged child to see math in the everyday world. We invited teens to explore whether statistics show that video games cause violence; and to meet some of their favorite YouTube icons including Brady Haran, Matt Parker, and Cliff Stoll from Numberphile. A complete list of lectures is attached to this report.

Activities for elementary-age children and up ranged from carnival games and maze mats, courtesy of the National Museum of Mathematics (MoMath); to puzzles, games, math, and magic from the Julia Robinson Mathematics Festival, Gathering 4 Gardner, the Elwyn and Jennifer Berlekamp Foundation, ThinkFun Games, and others; to a relay race with oobleck and other mathematical ingredients; to a set of factoring games (both tabletop and on a colorful race track, in team competition); to paper-folding of Platonic solids (worn as necklaces, of course); to a Math Dice tournament. Attendees called out answers in a solved-problems barker-style game show; immersed themselves in a hands-on geometry festival; wandered through a mathematical art exhibit by the Bridges Organization; settled into Giant SOMA Cube workshops and Sudoku puzzle making workshops; piloted robots with FIRST; learned about planetary mathematics hands-on with NASA; touched ice core samples from thousands of years ago in the Mathematics of Planet Earth; played Conway’s Game of Life with the Association for Women in Mathematics; and explored new math-rich games using real data sets from NOVA Labs. They built geometric sculptures, leaped and shouted during a math cheer clinic with Science Cheerleader, and cheered middle school teams from around the US during the first-ever national Flagway tournament hosted by the Young People’s Project.

For younger children, we offered geometric balloon bending, a preschool play date with Natural Math, colorful manipulatives for small hands, and crafts activities based on math heroes (Zero the Hero, of course!). Magicians and jugglers were also enjoyed by the youngest attendees. For older children and adults, we offered a slate of nine films, including MSRI’s “Navajo Math Circles,” NOVA’s “The Origami Revolution,” the feature film “Hidden Figures,” and six short math-themed films underwritten both originally and at the National Math Festival by the Sloan Foundation’s program in public science. A complete list of 45 distinct activities and 9 films can be found in the online schedule.

Audience Reached

The evaluation report by Karen Peterman Consulting, Co shows that about 20,000 people attended: 33% from VA; 29% from MD; 18% from DC, and 10% from elsewhere. 57% of adults were female, 43% male. Most people attended in groups, which ranged in size from two, to large school or community groups. 84% of groups included at least one child. 39% of groups included children 8-10 years old, 37% of groups included children 5-7 years old, 28% included children 11-13 years old, 24% of groups included children under 5 years old, and 13% of groups included children 14-17 years old.

39% of attendees were white, 24% Asian, 21% African American, 8% Mixed, 5% Latino, 1% American Indian; 1% Pacific Islander. The March for Science, planned long after our date was set, was held on the same day. A total of 23% of National Math Festival attendees also attended the March. Of these, about a fifth reported that they were in DC for the March for Science and decided to drop by, indicating that the coincidence of the March was their primary motivation for attending. Four-fifths reported their primary motivation for attending the Festival was due to an aspect of the National Math Festival itself.

Here are a few representative quotes gathered by Karen Peterman's team at the Festival:

From Adults:

I studied Math in college and the opportunity to come volunteer here seemed really interesting and I loved how they, like, had really complex math but also really simple math for the kids and sometimes the kids are doing complex math, they didn't even know it.

I came with my daughter, because part of her math curriculum in 8th grade is to attend this event.

I'm a teacher and I wanted to get my second and third-grade students in here to learn a little bit more because they are curious about math and wanna learn and they wanna do so in an exciting and engaging way. / Cool and so you brought your students with you? / Mm-hmm. / Oh awesome on a field trip? / Sort of. I told parents that they're welcome to join. I'd be here most likely all day and I've got about eight or nine families who were able to show up.

A pleasant surprise, once again, with the number of young people of all ages and races.

Probably [my son solving one of the challenging math puzzles quickly]. Just surprised that he was able to pick up on it so quickly and that he felt like he was enjoying it. Most of the time for us math is a challenge. He likes more science and social studies and things like that but math it's like pulling teeth so I think he had fun today.

I'm surprised at the diversity of people here. I was expecting all one sort of person.

The volume of attendance -- cold and rainy day with multiple events happening in DC that so many people are here.

From Children Ages 7-17:

I think you should do it next year, and the year after that, and maybe even do it twice a year. Yeah. See if we can do that.

It's just been amazing. I've never seen anything like this before!

The full demographic report is included as an attachment to this grant report. Yet to come, and which may follow 4-6 weeks from now: the entirety of the transcription of all interviews in the form of raw quotations; a narrative coding of the interview data, with an eye toward attendee storytelling and “stickiness” of the one-day Festival experience; and transcripts and coding of follow-up telephone interviews, again aimed at glimpsing how the Festival has an impact beyond a single-day extravaganza.

Conclusion

We are grateful for the support of the National Science Foundation, the IAS, the Alfred P. Sloan, the Simons, the Kavli, the Gordon and Betty Moore, the Qualcomm, and the John Templeton Foundations, the Carnegie Corporation of New York, the Charles and Lisa Simonyi Fund for Arts and Sciences, Google.org, Eric+Wendy Schmidt, Renaissance, ResearchC Corporation for Science Advancement, Amazon, Northrop Grumman, and Visa whom helped us reach and inspire the next generation of children who may grow up to become more comfortable “owning” math as part of their everyday identities, and academic and career skill sets, more likely to find math enjoyable, and more inclined to see math as a beautiful, rich patterning in their everyday lives, nature, and society.

The list of speakers with titles of talks follows together with the event’s evaluation prepared by Peterman & Jacobson, and the financial report for this supplement.

2017 National Math Festival Presentations	
Presenter	**Presentation**
American Mathematical Society	Who Wants to Be a Mathematician
FIRST®	Math and the Holonomic Drive: the Pursuit of a Smooth Ride
Dr. Stephon Alexander Brown University	The Jazz of Physics
Dr. Eugenia Cheng School of the Art Institute of Chicago	How to Bake Pi: Math Made Tasty
Dr. Alissa Crans Loyola Marymount University	• Patterns + Women = Figures in Mathematics • A Surreptitious Sequence: The Catalan Numbers
Dr. Christopher Danielson Normandale Community College and Desmos	Which One Doesn't Belong? and Other Ambiguous Math Questions
Dr. Robbert Dijkgraaf Institute for Advanced Study	The End of Space and Time: The Mathematics of Black Holes and the Big Bang
Dr. Maria Droujkova Natural Math	A Better Story of Math: Calculus for 5-Year-Olds, Grief, and Natural Math Adventures
Dr. Marcus du Sautoy University of Oxford	The Math of Art and the Art of Math
Mark Mitton and Dr. James Gardner	Impromptu Magic and Math: Learn Stunts to Dazzle your Friends and Family!
Dr. Herbert Ginsburg Columbia University Teachers College	How to Find Good Math Storybooks and Read Them with Your Children
Dr. Rebecca Goldin George Mason University and STATS	Do Video Games Cause Violence? Exploring the Mind with Statistics
Brady Haran Numberphile	• Numberphile: Brady Haran & Matt Parker • Numberphile: Brady Haran & Cliff Stoll
Dr. George Hart Making Math Visible	Making Math Visible
Dr. Emille Davie Lawrence University of San Francisco	How Does Google Do It? The PageRank Algorithm
Dr. Marc Lipsitch Harvard University School of Public Health	Measure, Understand, Control: Applications of Mathematics to Zika Virus Disease
Dr. Po-Shen Loh Carnegie Mellon University	• Creative Math Insights for the Everyday — Sports and Recreation Edition • Creative Math Insights for the Everyday — Life Edition
Dr. Talea Mayo University of Central Florida	• When Will I Ever Use This: How Scientists Use Math to Model and Understand Hurricane Storm Surges • Not Your Average Mathematician

Michael Morgan Oakland Symphony	Peace Comes to the Unusual Kingdoms: An Outstanding Mathematical Musical for Children
Laura Overdeck Bedtime Math	Bedtime Math and Beyond
Dr. Stephanie Palmer University of Chicago	Great Vision from Crummy Optics: How Do Your Eyes Do It?
Matt Parker Queen Mary University of London	• Matt Parker: Stand-Up Mathematician • Numberphile: Brady Haran & Matt Parker
Andrea Razzaghi National Aeronautics and Space Administration (NASA)	Math: Charting NASA's Journey in Space
Dr. Clifford Stoll	• Moebius Loops and Klein Bottles, Oh My! • Numberphile: Brady Haran & Cliff Stoll
Dr. James Tanton Mathematical Association of America	Exploding Dots: A Preview to Global Math Week 2017
Dr. Richard Tapia Rice University	Math at Top Speed
Janel Thomas NASA / NOAA	2, 4, 6, 8 = Science!
Dr. Mariel Vazquez University of California, Davis	Connections and Reconnections: A Link Between Mathematics, Physics, and DNA
Dr. Talitha Washington Howard University	The Mathematics of the 'Hidden Figures'
Dr. Mary Lou Zeeman Bowdoin College	Math, Tipping Points, and Planet Earth

National Math Festival
Evaluation Report

Prepared by Karen Peterman Consulting, Co.
Leanne Jacobson, M.A. & Karen Peterman, Ph.D.

The 2017 evaluation of the National Math Festival was designed to include three components. A vast majority of the data were collected via the first two of these components, and on the day of the festival. These included demographic surveys collected from 765 festival attendees and qualitative interviews collected from 194 attendees.[1] The third component of the evaluation will include follow-up phone interviews with 50 participants from the demographic survey; these data will be collected in June and July 2017.

A total of 16 field researchers collected data from attendees during the National Math Festival. Ten collected demographic survey data throughout the day and six collected interview data. All received a minimum of two hours of training prior to the event. Researchers watched a training video to describe the data collection procedures, participated in one remote training session, reviewed all relevant materials prior to the festival, and then took part in an in-person training on the morning of the event.

To collect data, all field researchers were assigned to specific geographic zones to ensure comprehensive coverage of the venue throughout the data collection. Field researchers used a common procedure for approaching attendees to invite their participation in the evaluation, by approaching the fifth person or group to cross their line of sight. When approaching a group, the field researcher narrowed down the individual who would participate by asking to speak to the person who met the age requirement for the method they were using and who had their birthday most recently.

Demographic survey participants were required to be age 10 or older. iPads were used to collect demographic survey data using the tablet-based survey program called QuickTap. Participants were given the choice to hold the iPad and complete the survey themselves or to have the field researcher read it to them like an interview. See Appendix A for a full list of the survey questions.

Two groups were of interest for the qualitative interviews; the child interview protocol was designed for participants aged 7-17 and the adult interview protocol was designed for adults age 18 and older. See Appendix B for a copy of each interview protocol. All qualitative interview participants were audio-recorded as they shared their responses to the interview questions. Interviews were then transcribed.

The purpose of this report is to share results from the demographic surveys. An output report of all qualitative interview responses from the day of the festival accompanies this report to provide a comprehensive record of the interview data collected. Both these data

[1] A total of 169 additional attendees declined participation in the demographic survey.

and those collected through the follow-up interviews will be coded and included in the final evaluation report that is due in August.

The remainder of this report is organized by evaluation question to describe who attended the festival, the ways that festival-goers engage in other science and math activities, and their motivations for attending.

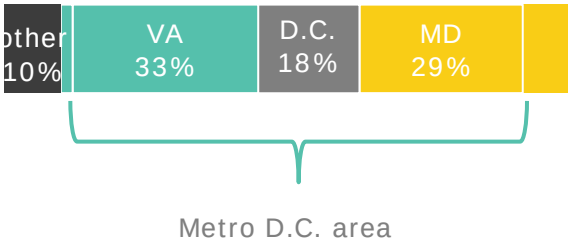
Who attended the National Math Festival?

Several items on the demographic survey collected information to describe the survey participants themselves. Traditional demographics questions were included, as well as items that were less traditional and that focused on more peripheral characteristics of attendees. This section summarizes the results of the traditional demographic items.

Figure 1 and Figure 2 below present information to demonstrate the geographic reach of the National Math Festival. Almost all attendees resided in the United States (99%). Figure 1 uses the zip codes of U.S.-based attendees to show the festival's reach. The majority of residents lived in the D.C. metropolitan area (80%; referred to henceforth as metro D.C.), though attendees also include those from as far away as California and Utah. In total, attendees were from 20 states. Figure 2 presents a breakdown of those who attended from the metro D.C. area. An Excel file of zip codes was submitted with this report to provide the National Math Festival team with the full list of zip codes provided.

Figure 1
Though most attendees were from the metro D.C. area, people attended from across the county

Figure 2
Metro D.C. attendees were mostly from Virginia and Maryland



Given that the majority of attendees were from the metro D.C. area, the 2015 census data from this region were used to compare festival attendees to the local population (https://censusreporter.org/profiles/16000US1150000-washington-dc/). As with the metro D.C. area, slightly more females than males attended the festival; 57% of attendees were

female (compared to 52% of the metro D.C. population). The percentage of adults interviewed was also similar to that of the metro D.C. area. The majority of attendees were adults; 83% of those interviewed were above the age of 18 (compared to 82% of the population in the metro D.C. area).

While it is true that the majority of those interviewed were adults, most attendees were part of a group and many of those groups included children. As shown in Figure 3, 90% of those surveyed were part of a group of people who attended the Festival together. Group sizes ranged from dyads to large school or community groups. Groups typically included at least one child (84%). Figure 4 presents the ages of children who attended the festival with those who were surveyed. The largest groups of children to attend the festival were in the elementary school age range. Note that the percentages reported total more than 100% because groups could have attended with children in multiple age categories.

Figure 3
Most Festival-goers attended the National Math Festival in groups of two, three, or four people.

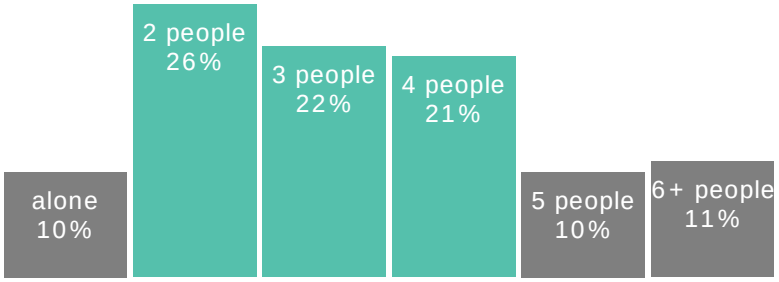
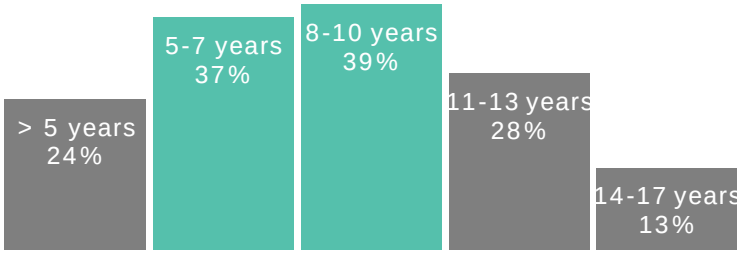
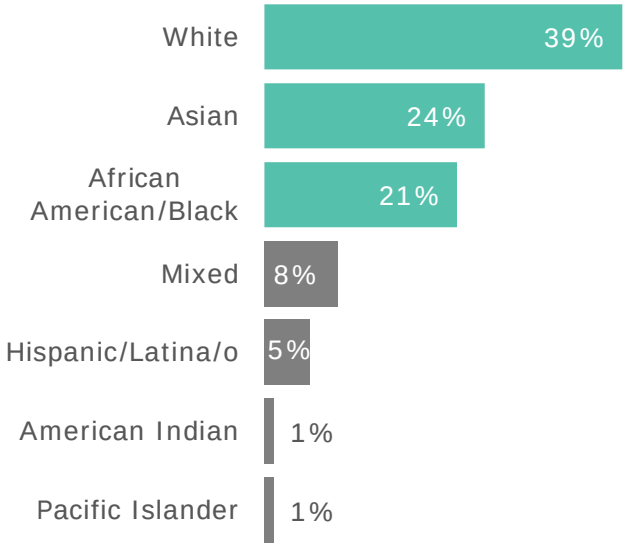


Figure 4
Children of all ages were part of the groups who participated in the survey.



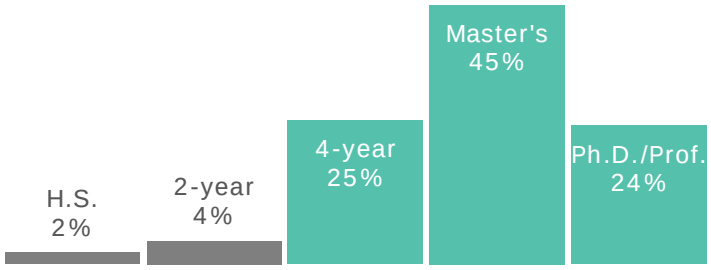
Interview attendees were racially diverse. As shown in Figure 5, attendees who identified as White were the most widespread, followed by Asians and African Americans. Few attendees identified as the remaining racial/ethnic categories, and 3% preferred not to answer this question. This profile differs from that from the metro D.C. area, which identifies as Black (47%), White (36%), and Hispanic (11%). All other categories are reported as 5% or less in the census data. These data indicate that the National Math Festival served a comparable number of White, American Indian and Pacific Islander attendees as found in the population. Asian community members were over-represented among festival attendees, while Black community members were under-represented.

Figure 5
Most attendees identified as White, Asian, and/or Black.



National Math Festival attendees were well-educated. Attendees age 25 and older were asked to share the highest degree they had earned. As shown in Figure 6, 94% had earned a Bachelor's or a post-graduate degree. The percentage of attendees in this category is well above that of the metro D.C. population; 33% of the local population holds a post-graduate degree and 24% have a Bachelor's degree (for a total of 57%).

Figure 6
National Math Festival attendees were well-educated



In what other ways do attendees engage with science and math?

The remaining demographic items on the survey focused on other ways that attendees might engage with science and math, including content created by the Mathematical

Sciences Research Institute (MSRI). The first of these questions asked attendees to share how long it had been since their most recent visit to a science museum. Festival attendees tended to be regular museum-goers; nearly three-quarters had visited a science museum within the past year (74%). An additional 21% reported that they had visited a science museum within the past one to two years. Few reported that they had not visited a museum in more than three years (5%).

Though most attendees seemed engaged with science, based on their visits to science museums, few were involved in the March for Science that occurred on the same day of the National Math Festival. A total of 23% of attendees also attended the March. Of these, only a small portion (3%; *n*=24) reported that they were *in D.C. for the March for Science and decided to drop by,* indicating that the coincidence of the March was their primary motivation for attending. The remaining 20% (*n*=146) or March-goers reported that their primary motivation for attending the festival was due to an aspect of the National Math Festival itself (see more on motivations in the next section). These attendees were evenly divided between those who went to the March before coming to the National Math Festival (49% of 146) and those who planned to attend the March after their festival experience (51% of 146).

Attendees were also asked about their awareness of two MSRI resources. The first of these was the Numberphile You Tube channel. One in four attendees (25%; *n*=188) had heard of Numberphile prior to attending the festival. This group included 65% (*n*=116 of 188) who had watched Numberphile and 45% (*n*=72) who had heard of it but who had not tuned in.

Most attendees (75%; *n*=569) learned about Numberphile during the interview. This group included attendees who stated that they hadn't heard of it but planned to visit now that they were aware (83%; *n*=471 out of 569) and those who were not interested in watching (17%; *n*=98).

A similar pattern of results was found when attendees were asked about the MoreMath! section of the festival web site. Approximately one-quarter (23%; *n*=169) had heard of MoreMath!. Of those, half (51%; *n*=86 of 169) had visited the site and half (49%; *n*=83) were aware of the web page but who had not visited.

The remaining attendees learned of the MoreMath! resources during the interview (77%; *n*=586). Most (85%; *n*=497 of 586) planned to visit to site to look at these resources. A few reported that they would not visit (15%; *n*=89).

Why did people come to the National Math Festival?

Falk (2013)[2] suggests that evaluation and research on museum visitors should explore beyond demographic characteristics to determine the reason for the visit. His research documents several patterns in the reasons that people choose to attend museums. These ideas were applied to a list of motivations for attending the National Math Festival. Using

[2] Falk, J.H. (2013) Understanding the Museum Visitor's Motivations and Learning.

this typology, five response options were developed to assess attendees' reason for festival attendance. A sixth "other" option was also offered.

Table 1 presents each visitor type category and definition from Falk's work, the response option on the National Math Festival survey that aligns to that category, and the percent of National Math Festival attendees who endorsed each as their primary reason for attending the festival. Based on these responses, the two most common reasons that attendees came to the National Math Festival were to do something with family/friends or because they were curious about math and wanted to learn more.

Attendee type categories were also analyzed in conjunction with other demographic variables to look for trends. Reason for attendance did not vary systematically across gender, age, race, or education level. Differences were found in the motivation types represented by those who attended the festival alone. Rechargers and Professional/Hobbyists were much more likely to attend the festival on their own when compared to the overall sample. Though 10% of the overall sample attended on their own, this percentage increases to 25% and 26% for Rechargers and Professional/Hobbyists, respectively.

There are many ways to interpret this result. One interpretation that may be supported by other data from the survey is that these groups are among the most engaged and committed to math. These same two groups were more likely to have heard of Numberphile (38% of Rechargers and 31% of Professional/Hobbyists) and they were the most likely to have watched the YouTube videos (83% and 70%, respectively) when compared to the percentage of attendees in the sample overall (recall that 24% had heard of Numberphile and 62% of those had watched). The same pattern was true for Rechargers but not Professional/Hobbyists, with regard to MoreMath!. Rechargers were the most likely to have visited the "MoreMath!" website (80%).

Table 1
Falk Museum Visitor Typology, NMF Survey Options, and Attendee Endorsement

Visitor Type	Definition	NMF Survey Option	% NMF attendees
FACILITATOR	Visitors who are socially motivated. Their visit is focused on primarily enabling the experience and learning of others in their accompanying social group.	I came to do something with family and/or friends.	39%
EXPLORER	Visitors who are curiosity-driven with a generic interest in the content of the museum. They expect to find something that will grab their attention and fuel their learning.	I am curious about math and came to learn more.	32%
EXPERIENCE SEEKER	Visitors who are motivated to visit because they perceive the museum as an important destination. They go to find something new, something that has become popular among peers. Their satisfaction primarily derives from the mere fact of having 'been there and done that'.	I wanted to see what the festival is all about.	12%
PROFESSIONAL/ HOBBYIST	Visitors who feel a close tie between the museum content and their professional or hobbyist passions. Their visits are typically motivated by a desire to gain knowledge or another specific content-related objective.	I came for a particular activity or for this event in particular.	9%
RECHARGERS	Visitors who are primarily seeking to have a contemplative, spiritual and/or restorative experience. They see the museum as a refuge from the work-a-day world or as a confirmation of their beliefs.	I came to do something relaxing.	2%

Summer Graduate School

An Introduction to Character Theory and the McKay Conjecture

July 11, 2016 - July 22, 2016

MSRI, Berkeley, CA, USA

Organizers:

Robert Guralnick (University of Southern California)

Pham Tiep (University of Arizona)

FINAL REPORT
MSRI SUMMER GRADUATE WORKSHOP

"AN INTRODUCTION TO CHARACTER THEORY AND THE MCKAY CONJECTURE"

JULY 11–22, 2016

1. Organizers

- Robert M. Guralnick, University of Southern California, Los Angeles, CA
- Pham Huu Tiep, University of Arizona, Tucson, AZ

2. Overview of the workshop

The goal of the workshop was to introduce graduate students to basic results in the Character Theory of Finite Groups and some of the main conjectures in Group Representation Theory, with particular emphasis on the McKay Conjecture. To achieve this goal, we had:

1. **Two lecture series**, ten 75-minute each, delivered by I. Martin Isaacs (University of Wisconsin, Madison, WI) and Gabriel Navarro (Universitat de València, València, Spain), on the mornings. One lecture of the second series was given by Pham Tiep.

2. **Question/problem sessions**, two 75-minute sessions each afternoon (except Wednesdays), led by Christina Durfee (University of Oklahoma, Norman, OK) and Sara Jensen (Carthage College, Kenosha, WI). Part of these sessions was spent on discussing students' questions related to the morning lectures. Then the students worked on problem sets designed to reinforce and deepen their understanding of the lectures. Solutions of selected problems were also presented by students.

The workshop was attended by 43 graduate students selected by the MSRI, as well as some faculty members.

3. Evaluation of the components of the workshop

Character Theory of Finite Groups (the study of the traces of the linear representations of the groups) provides one of the most powerful tools to study groups. More generally, Character Theory is a part of Group Representation Theory, a central area of Group Theory that has important and deep connections to areas of mathematics as varied as topology, algebraic geometry, number theory, homological algebra, and mathematical physics. Much of recent research in the area centers around several fundamental conjectures, some of which have been open for the last fifty years, and among which the McKay conjecture of 1971 is perhaps the most well-known and simplest to appreciate.

The principal lecturers of the workshop are world leaders in the field of Character Theory of Finite Groups. Their seminal paper (jointly with G. Malle) in *Invent. Math.* (2007) has

developed the new strategy that led to the very recent proof of the McKay conjecture for the prime 2 (by Malle and B. Späth) and hopefully will eventually lead to a complete proof of the conjecture. The lecturers are also well known for the clarity of their expositions.

The student attendance at the lectures always seemed good. Judging from conversations with and questions from the worskhop students, we can say that many of them were engaged and consistently impressed with the lectures. They were particularly happy to have the PDF slides provided to them for review and they were excited to work through the problems. They were also impressed with the problem sets and the intrinsic way that they arose from the previous lectures and/or problems, as well as with the natural interrelations between the lecture series.

Many students and lecturers commented that the afternoon problem sessions were also highly successful. The students were truly model citizens for these sections. The general format of these sessions was to spend the first afternoon session having them work in groups on the problems, while the two TAs would circle around the groups during the session answering any questions they had on the morning lectures or the problems. Then students would present their solutions during the second session. The TAs never had to implore the students for volunteers and the volunteers were generally varied.

4. Students

The workshop's students had very diverse backgrounds and reasons for attending. Some of the students were unfamiliar with the notion that permutations with the same cycle structure in S_n were necessarily conjugate, for example, while others were writing dissertations in Character Theory. The different backgrounds and interests presented the main difficulty, according to the lecturers.

It should be noted, however, that even the students with very little background in the subject were attending the lectures and the problem solving sessions. The students with weaker backgrounds were still working through the problem sets, just at a slower pace. The students with the stronger backgrounds easily completed all the problems and were often willing to present solutions to the entire audience. Regarding reasons for attending, some were very interested in the subject matter as their PhD theses were in related areas; others were simply curious and wanted to broaden their understanding of any type of mathematics given the opportunity. But, even the exceptionally well prepared students mentioned in conversations to us that the course was of value to them for consolidating their knowledge, and no one complained that the course was too elementary.

It was very nice to talk to some of the students that came with non-trivial questions. A student asked us about minimal dimensions of representations of cyclic groups over finite fields; another about minimal fields affording characters. Some others discussed questions about relationships between tensor powers of representations and fixed points of permutations and a conjecture of J. Saxl about tensor powers of complex representations of simple groups. These and other questions reflected that they were very much engaged in the theory, and that were enjoying the subject.

It was also very nice interacting with the students outside of the academic settings, such as at tea time or during lunch. We often talked about mathematical curiosities, our

families, the job market, and other issues relating to academia, such as underrepresented groups and methods of teaching.

5. Details on the lecture series

I. Martin Isaacs' lecture series gave a concise introduction to Character Theory and its classic applications. Main topics of the series include:

(1) Reviewing ordinary characters.
(2) Integrality. Burnside's p^aq^b-Theorem.
(3) Induction of characters. Frobenius groups. M-groups.
(4) Normal subgroups. Clifford's theorem and Clifford correspondence.
(5) Itô-Michler Theorem on character degrees: A reduction to finite simple groups.
(6) Brauer's characterization of characters.
(7) Frobenius-Schur involution count and applications.

The lecture series of Gabriel Navarro aimed to first introduce the Glauberman correspondence to the students, so that one could prove the first cases of the McKay conjecture: in finite groups with a normal p-complement, and in solvable groups with a self-normalizing Sylow p-subgroup. Then he lectured about the McKay conjecture, its Galois refinement, and ideas behind the reduction theorem for the McKay conjecture. As an important application, he explained how the McKay/Galois Conjecture has helped solve the famous Brauer's Problem 12 to detect properties of the Sylow subgroups from the character table. He also introduced the students to some basics and main problems in the modular representation theory, including the Alperin Weight Conjecture. Pham Tiep gave a lecture about complex representations of the finite general linear groups (of degree 2), pointing out some very basic ideas towards the Deligne-Lusztig theory, and of the symmetric groups.

The main topics of this second lecture series include:

(1) Extension of characters. Gallagher's theorem and determinantal orders.
(2) The Glauberman correspondence.
(3) Complex representations of $GL_2(q)$ and S_n.
(4) The McKay conjecture and its Galois refinement. Reductions and consequences.
(5) Modular representations and Brauer characters.
(6) Open problems and future directions.

6. Conclusion

Our overall impression is that many of the workshop's students learned something new (even if they were doing PhD theses on the subject), and they got a good understanding of what Character Theory is about and good for (even if they were not going to work on this). The whole atmosphere of the workshop was fantastic, and we all, organizers, lecturers, TAs, and students, would like to thank the MSRI for providing to us this wonderful opportunity.

MSRI Mathematical Sciences Research Institute

An Introduction to Character Theory and the McKay Conjecture

July 11-22, 2016

Schedule

Monday July 11, 2016			
8:40 AM - 8:55 AM	Simons Auditorium		Introduction to MSRI
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00PM - 2:00 PM	Atrium		Lunch
2:00 PM- 3:15 PM	Simons Auditorium		Discussion session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:45 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Tuesday July 12, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea
3:45PM -5:00 PM	Simons Auditorium		Discussion Session 2

Wednesday July 13, 2016			
8:45 AM - 10:00 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:00 AM -10:15 PM	Atrium		Break
10:15 PM - 11:30 PM	Simons Auditorium	Gabriel Navarro	Lecture
11:30 PM - 2:00 PM	Tilden Park		BBQ Lunch
2:00 PM - 5:00 PM	Simons Auditorium		Free afternoon

Thursday July 14, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:35 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Friday July 15, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. M. Isaacs	Lecture
10:15AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15PM - 3:45 PM	Atrium		Tea Break
3:45 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Monday July 18, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:45 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Tuesday July 19, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:45 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Wednesday July 20, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 5:00 PM	Simons Auditorium		Free afternoon

Thursday July 21, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:45 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Friday July 22, 2016			
9:00 AM - 10:15 AM	Simons Auditorium	I. Martin Isaacs	Lecture
10:15 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Gabriel Navarro	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:15 PM	Simons Auditorium		Discussion Session 1
3:15 PM - 3:45 PM	Atrium		Tea Break
3:35 PM - 5:00 PM	Simons Auditorium		Discussion Session 2

Organizers		
First Name	**Last Name**	**Institution**
Robert	Guralnick	University of Southern California
Pham	Tiep	University of Arizona
Speakers		
First Name	**Last Name**	**Institution**
I. Martin	Isaacs	University of Wisconsin-Madison
Gabriel	Navarro	University of Valencia
Pham	Tiep	University of Arizona

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Jamison	Barsotti	University of California, Santa Cruz
Ana	Berrizbeitia	University of Iowa
Aram	Bingham	Tulane University
Shawn	Burkett	University of Colorado
Rob	Carman	University of California, Santa Cruz
Patrick	Cesarz	University of Delaware
Vernon	Chan	Rutgers University
Daniel	Copeland	University of California, San Diego
Sarah	Croome	Kent State University
Matthew	Donner	University of Southern California
Christina	Durfee	University of Oklahoma
Josh	Edge	Indiana University
Joseph	Eisner	Saint Louis University
Melissa	Emory	University of Missouri
Spencer	Gerhardt	University of Southern California
Kevin	Gerstle	University of Iowa
Jillian	Glassett	Washington State University
Robert	Guralnick	University of Southern California
Nadir	Hajouji	University of California, Santa Barbara
Taehyeok	Heo	Seoul National University
Tara	Hudson	University at Buffalo (SUNY)
I. Martin	Isaacs	University of Wisconsin-Madison
Adam	Jacoby	Temple University
Sara	Jensen	Carthage College
Debanjana	Kundu	University of Toronto
Thomas	Lane	University of Oklahoma
Hyereem	Lee	University of Arizona
Xiao	Li	University of Illinois at Urbana-Champaign
Megan	Ly	University of Colorado
Andrew	Maurer	University of Georgia
Eilidh	McKemmie	University of Southern California
Jeremy	Meza	University of California, Berkeley
Isaac	Michael	Baylor University
Ryan	Moruzzi	University of California, Riverside
Gabriel	Navarro	University of Valencia
Tefjol	Pllaha	University of Kentucky
Dan	Rossi	University of Arizona
Lauren	Ruth	University of California, Riverside
Maria	Sanchez Muniz	City College, CUNY
Luis	Sordo Vieira	University of Kentucky
Pham	Tiep	University of Arizona
Edward	Voskanian	University of California, Riverside
Benjamin	West	University of California, Los Angeles
Szu-Ting	Yang	Northwestern University
Yingnan	Zhang	University of Delaware
Jianru	Zhang	University of Pennsylvania
Shijie	Zhu	Northeastern University

Officially Registered Student Information

Participants		47

Gender		47
Male	63.83%	30
Female	36.17%	17
Declined to state	0.00%	0

Ethnicity*		57
White	52.63%	30
Asian	19.30%	11
Hispanic	8.77%	5
Pacific Islander	1.75%	1
Black	0.00%	0
Native American	0.00%	0
Mixed	8.77%	5
Declined to state	8.77%	5

* ethnicity specifications are not exclusive

Edit this form

33 responses

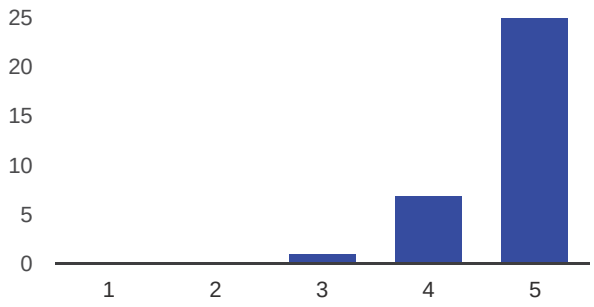
33 responses out of 47 participants = 70% response rate

View all responses Publish analytics

Summary

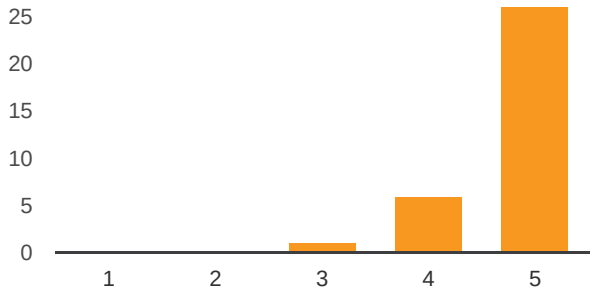
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	3%
	4	**7**	21.2%
Very much:	5	**25**	75.8%

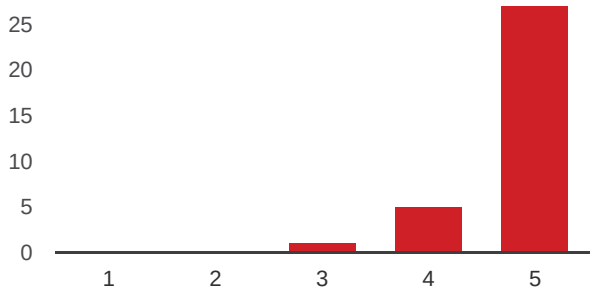
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**0**	0%

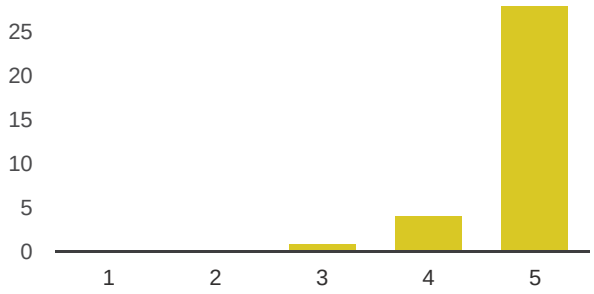
	3	**1**	3%
	4	**6**	18.2%
Very much:	5	**26**	78.8%

The school was intellectually stimulating



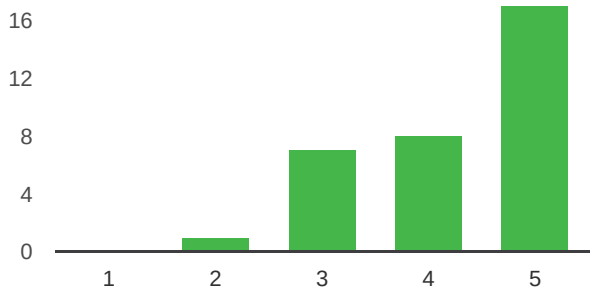
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	3%
	4	**5**	15.2%
Very:	5	**27**	81.8%

The overall experience of the school was worthwhile



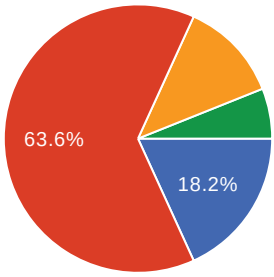
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	3%
	4	**4**	12.1%
Very:	5	**28**	84.8%

The TA sessions were helpful



Not at all: 1	**0**	0%
2	**1**	3%
3	**7**	21.2%
4	**8**	24.2%
Very much: 5	**17**	51.5%

The amount of material presented was:



Too much	**6**	18.2%
Just the right amount	**21**	63.6%
Not enough	**4**	12.1%
No opinion	**2**	6.1%

Additional comments on the topic presentation and organization

The material was pretty much entirely new to me, and I felt very comfortable with the pace of the lectures and the amount of material covered (although it was very intense). I thought it was great. I'm glad I came and a little sad it's over.

Thank you very much for organizing such a wonderful workshop and generously offer us such great financial support. I benifit a lot in two weeks. The lectures are great. I would expect some more expert lectures on the related topics about group representation theory, like the one given by Prof Tiep if possible. That will tell us more about the relation or application of group representation theory with maybe other mathematical fields. Anyway, the conference really gives us plenty of things to learn and enough problems to wirk with even after the conference. Thank you again for your exceleent job.

Every thing is great! At one time, the bus up the hill (to MSRI) went down and half of the class cannot get to lecture in time. Also, when we were leaving MSRI, our group may fill up all the rooms in the bus. I think we might need extra transportation.

There was a lot of material, and it was presented quickly. But I really think that Isaacs and Navarro did a great job. The lectures did seem to get less coherent toward the end of the two weeks, but that may have been the depth of my understanding instead.

It could have been improved if the speakers organized between each other on what content they would present. Regardless, it still seemed to work together well.

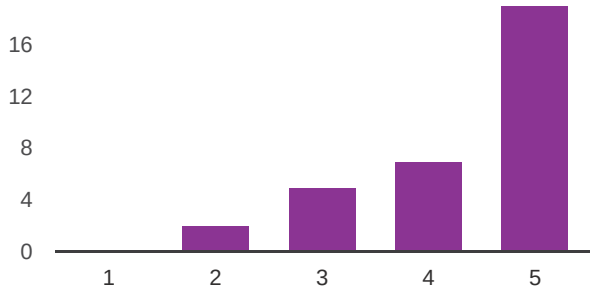
There were many proofs in lectures and merely exercises in discussion session. I felt somewhat lost in details and didn't know where I was going. I suggest more paper reading and research like problems. Prof. Navarro and Prof. Martin were friendly, welcoming questions. They introduced relevant research going on from time to time during the lectures, which were organized and clearly delivered.

Excellent experience! Thank you for the opportunity to learn under some of the greatest mathematical minds of our time! I learned a lot, and look forward to future conferences.

The lectures by Isaacs and Navarro were possibly the best lectures I've ever received. I felt like I received a true "insider's view" of the subject, especially through Navarro's presentation of current research on the McKay conjecture, and the historical comments provided by both Isaacs and Navarro. Usually when I feel like a get an insider's view on an area of research outside my own, I can't understand a thing, but instead the lectures were very comprehensible. The pace and subject of the talks seemed to be pitched perfectly for grad students, and the lecturers were enthusiastic and inspiring.

Personal assessment

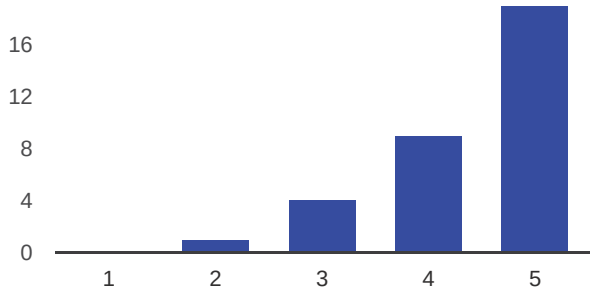
I was well prepared to benefit from the school



Not at all:	1	**0**	0%
	2	**2**	6.1%
	3	**5**	15.2%
	4	**7**	21.2%

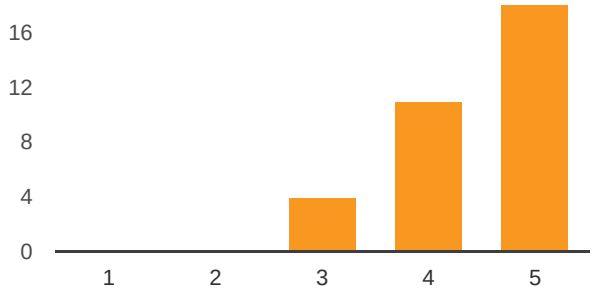
Very: 5	**19**	57.6%

My interest in the subject matter was increased by the school



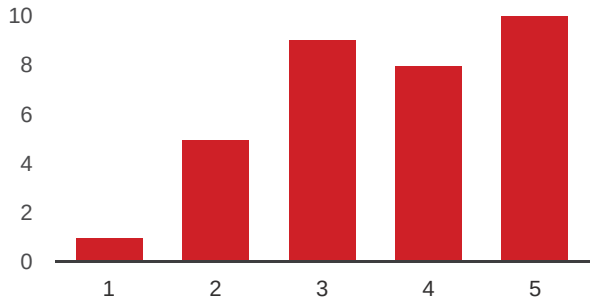
Not at all: 1	**0**	0%
2	**1**	3%
3	**4**	12.1%
4	**9**	27.3%
Very much: 5	**19**	57.6%

The school helped me meet people with similar scientific interests



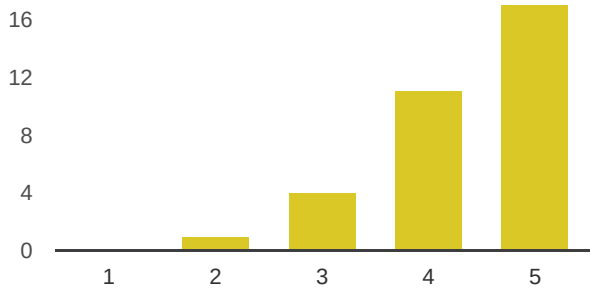
Not at all: 1	**0**	0%
2	**0**	0%
3	**4**	12.1%
4	**11**	33.3%
Very much: 5	**18**	54.5%

It is likely that I will work in the area of the school subject in the future



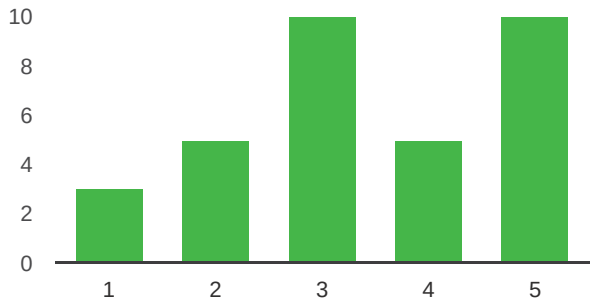
2	**5**	15.2%
3	**9**	27.3%
4	**8**	24.2%
Very: 5	**10**	30.3%

How would you evaluate your interaction with other participants?



not satisfactory: 1	**0**	0%
2	**1**	3%
3	**4**	12.1%
4	**11**	33.3%
above satisfactory: 5	**17**	51.5%

Did you find the library session useful?



not satisfactory:	1	**3**	9.1%
	2	**5**	15.2%
	3	**10**	30.3%
	4	**5**	15.2%
above satisfactory:	5	**10**	30.3%

Additional Comments on personal assessment

The people were all wonderful. I feel like I'm leaving with a lot of new friends.

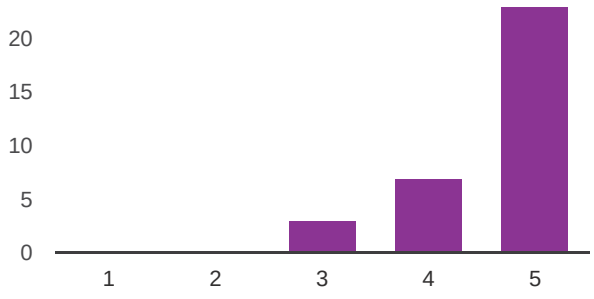
I just finished my first year of my PhD program, while many others completed their third year. So on one hand, I feel that I cannot contribute to their discussion, and on the other hand, I learnt a lot about their ideas and ways of thinking.

The library session could be improved by showing MSRI-specific resources. I, along with many others, am familiar with MathSciNet, BibTeX, and some of the other resources presented.

The school as a whole was utterly fantastic, particularly the lectures & the general learning environment fostered during the day at MSRI. Socially it was a very intense experience for me, living dorm style with 10 or so other people who are all interested in math meant a lot more socializing than I'm used to. In general this isn't bad, in fact I absolutely loved talking about math day and night with all sorts of new people, but it was certainly intense and I left a little more self-conscious than when I entered.

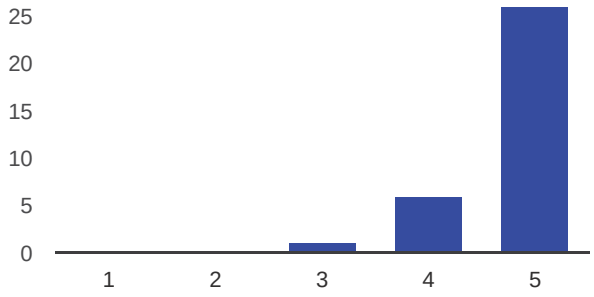
MSRI Venue

I found the MSRI staff helpful



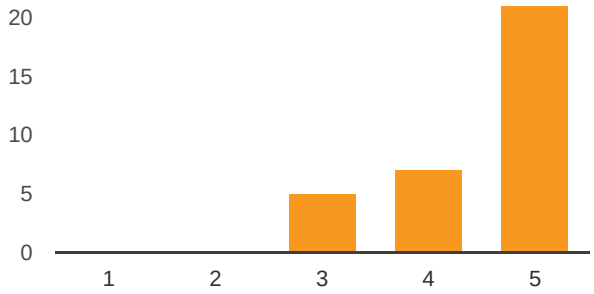
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**3**	9.1%
	4	**7**	21.2%
Very:	5	**23**	69.7%

The MSRI physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	3%
	4	**6**	18.2%
Very:	5	**26**	78.8%

The MSRI computer facilities were adequate for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**5**	15.2%
	4	**7**	21.2%
Very:	5	**21**	63.6%

Additional comments on the MSRI venue

At one point I wanted to use Mathematica for something and it wasn't available. The Internet (wifi) was not very reliable either.

It was nice having coffee available between lectures, but I was surprised to find out we couldn't bring coffee into the main lecture hall. It's not a big deal, but I have an easier time staying

focused if I can drink coffee through the lecture. It was hard using phones at the top of the hill - the cell service is limited, which you can't really do much about, but the Wifi wasn't accessible in certain areas. It made it hard to place calls during the day without being in one of the common areas. Finally, I think it would have been helpful to hold the problem solving sessions in a room with more board space - I think it would have made it easier to collaborate and share ideas.

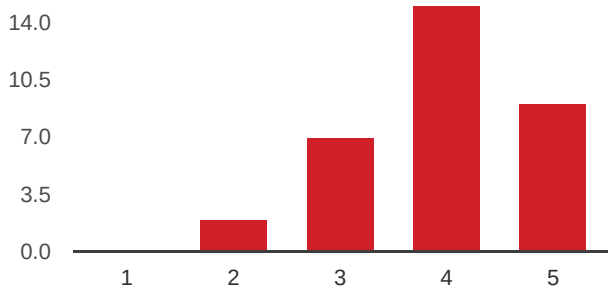
Beautiful!

Just wonderful! Sometimes we cannot find enough seats and tables for lunch though. Our group has about 45 students.

My only complaint is that coffee is not allowed in the Simon's auditorium.

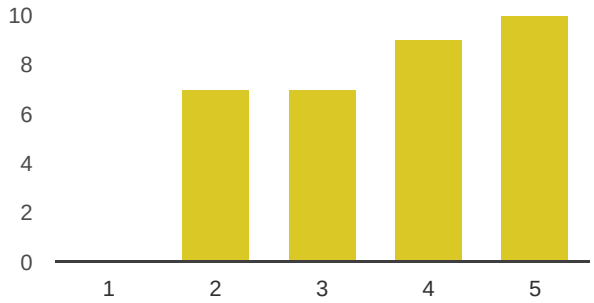
Accommodation and Food

The summer school accommodation



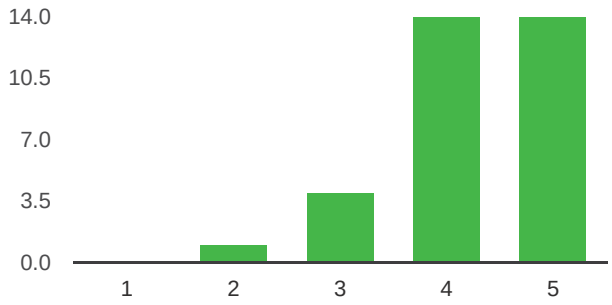
not satisfactory:	1	**0**	0%
	2	**2**	6.1%
	3	**7**	21.2%
	4	**15**	45.5%
above satisfactory:	5	**9**	27.3%

The food at the dormitories



not satisfactory:	1	**0**	0%
	2	**7**	21.2%
	3	**7**	21.2%
	4	**9**	27.3%
above satisfactory:	5	**10**	30.3%

The food provided at MSRI



not satisfactory:	1	**0**	0%
	2	**1**	3%
	3	**4**	12.1%
	4	**14**	42.4%
above satisfactory:	5	**14**	42.4%

Additional comments on accommodation and food

Not a fan of sandwich day, personally.

The food was OK. My biggest issue with the facilities on campus was the lack of study areas. It felt a little awkward to bring boys into the girls' dorm to study, so that made it somewhat difficult to work together. We ended up working on picnic tables outside.

It was hard to continue working once we got back to the dorms. There were a lot of high school camps that were really loud. It would have been nice if we had cheap whiteboards or chalkboards in the dorms, too. I also don't think my towels were changed the entire time I was here, even though the dorm guidelines said they'd be changed every other day.

There were no window screens in many of the dorm rooms, and my roommate and I were bitten several times by mosquitos while in bed. Just keeping the windows closed all the time was not an option since we had to keep the room at a comfortable temperature.

As a vegetarian I was never disappointed with the meal offerings. The beds in the dormitories were...tough. But it is a dormitory, after all.

The food was excellent but they sometimes ran out

The vegan food options at MSRI were quite bland and not very nutritious (little protein/carbs).

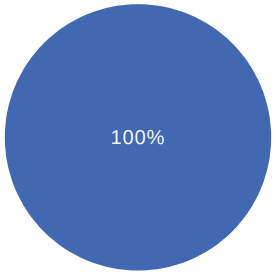
Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

I would have appreciated more social events - maybe a day trip during one of the Wednesday trips or the weekend.

It would have been helpful to know how far the hike was for the picnic lunch, and also a reminder to wear/bring sunblock on that day would have been helpful. The TA sessions were fantastic.

Thank you MSRI for hosting this, it was an incredible experience and really inspires me to become a professional mathematician. I'm honored to have been a part of the summer school, and I look forward to encouraging other grad students to attend such events.



Option 1 **6** 100%

Number of daily responses

Mixed Integer Nonlinear Programming: Theory, algorithms and applications

June 20, 2016 - July 01, 2016

IMUS, Seville, Spain

Organizers:

Franscisco Castro (University of Sevilla)

Elena Fernandez (Universitat Politècnica de Catalunya)

Justo Puerto (University of Sevilla)

FINAL REPORT

Graduate Summer School on
Mixed Integer Nonlinear Programming
June-July 2016
Seville, Spain

ORGANIZERS:
Francisco Castro (Universidad de Sevilla)
Elena Fernández (Universitat Politècnica de Catalunya)
Justo Puerto (Universidad de Sevilla)

The School took place at IMUS, the Institute of Mathematics of the University of Seville, from June 20th till July 1st, 2016 and all the information is available at:

http://www.imus.us.es/IMUS-MSRI2016/en/

The school was oriented toward the presentation of theory, algorithms and applications for the solution of **mixed integer nonlinear problems (MINLP).** This type of problems appears in numerous application areas where the modelization of nonlinear phenomena with logical constraints is important; as the adage goes, "the world is nonlinear". On the one hand, the theoretical aspects of this area have spread in a number of directions with several recent important papers, which makes it difficult, for non-specialist, to have a solid background of the existing results and new advances in the field. This school aimed to organize and present this material in a unified way. Two of the most well regarded specialists in the field were lecturing. On the other hand, the school also aimed to link theory with actual applications. In particular, remarkable applications can be found in production planning for companies using complex technologies such as air traffic control agencies, airlines companies, electric power generation companies or chemical complex units. Another important source of nonlinear problems are, for example, product design in industrial environments, analysis of financial products usually associated with risk dealing, statistical algorithms, and artificial intelligence as artificial neural networks, etc. We can find in the literature numerous algorithms for the solution of nonlinear problems from unconstrained optimization and box restrictions up to nonlinearly constrained nonlinear problems. However, there are a reduced number of algorithms that take into account logical constraints determining the need of model tight constraints with 0-1 variables.

The school presented, in a unified way, the current theory together with the more recent algorithms designed to address some families of problems. The lectures started with basic concepts, in order to be interesting for beginners, to eventually discuss advanced topics of this emerging area of mathematical optimization.

The program activities were the following:

1. Two sets of lectures.
   a) **Towards a theory for integer nonlinear optimization**
   b) **MINLP for convex and concave functions**

   Lectures were organized in the mornings.

2. Problem solving and applications sessions were organized during the afternoons, and led by the TAs. These sessions were devoted to working on problem sets, on real life applications, and on various projects developed by the students. Lab sessions with available MINLP solvers also took place in the afternoons.

3. Students' presentations and exercises delivered to the teaching assistants. These activities allowed students, even those with a more limited background, to work with source materials, and to practice organizing or lecturing about what they learnt.

PLAN OF THE PROGRAM IN SEVILLE, SPAIN.

Lead Organizer:
Justo Puerto, Universidad de Sevilla, Spain.

Local Organizers:

Franscisco J. Castro, Universidad de Sevilla, Spain.
Elena Fernández, Universitat Politecnica Cataluña, Spain.

Lecturers:

Jeff Linderoth, University of Wisconsin-Madisson, USA.
Robert Weismantel, ETH Zurich, Switzerland.

Assistants:

Victor Blanco, Universidad de Granada, Spain.
Maria I. Hartillo, Universidad de Sevilla, Spain.
Jonas Schweiger, Zuse Institute Berlin.

Lecturers

This school had two main sets of lectures together with some modeling and problem solving sessions supervised by experts in the field.

Jeff Linderoth is a Professor in the Departments of Industrial and Systems Engineering and Computer Sciences at the University of Wisconsin-Madison, joining both departments in 2007. Dr. Linderoth received his Ph.D. degree from the Georgia Institute of Technology in 1998. He was previously employed in the Mathematics and Computer Science Division at Argonne National Laboratory, with the optimization-based financial products firm of Axioma; he was also an Assistant Professor at Lehigh University. His awards include an Early Career Development Award from the Department of Energy, the SIAM Activity Group on Optimization Prize, and the INFORMS Computing Society (ICS) Prize. Dr. Linderoth currently serves on the editorial boards of 4 journals.

Robert Weismantel is professor at the Institute of Operations Research of ETH, Zurich. Dr. Weismantel received his Ph.D. (Mathematics) at the Technische Universität Berlin in 1992. He was the Associate Head of the Department of Combinatorial Optimization at ZIB from 1995-97. From 1998-2010 he was Professor (C4) fof Discrete Optimization at the University of Magdeburg. Since 2011 he is the Head of the Institute for Operations Research, ETH Zurich. His awards include the Gerhard Hess-Prize of the German Science Foundation (1997), the Chair of DFG Research Group "Methods from Discrete Mathematics for the Synthesis and Control of Chemical Processes" (2002-2009) and IBM-Faculty Award 2007 and 2010. Prof. Weismantel

currently serves as Associate editor of several journals on Discrete Optimization and Computing, and he is Co-Editor in Chief of Mathematical Programming since 2010.

Organizers

Justo Puerto received his PhD in Seville in 1992. He is full professor in the Department of Statistics and Operations Research in the Universidad de Sevilla (Spain) and has held visiting positions in the universities of Kaiserslautern, Bologna, and Rome. Dr. Puerto research interests are in discrete and multiobjective optimization and location and game theory. He has written 4 books and over 140 papers in specialized professional journals. Dr. Puerto has served as associate editors on several journals such as Computers and Operations Research, Discrete Optimization or TOP. He has been co-Editor in Chief of TOP, the Spanish Journal of Operation Research, from 2007-2012. He has edited several guest issues in prestigious journal such as Annals of O.R. and Computers and O.R. Prof. Puerto also has been involved in the application of mathematics to actual problems with several industrial projects funded by industry and the European Union.

Francisco-Jesus Castro-Jimenez is Full Professor in the Department of Algebra at the Faculty of Mathematics at the University of Seville (Spain), since 1997. In 1984 he obtained his PhD in Mathematics at the Université de Paris VII (France). He has been the Principal Investigator of several Spanish Research Projects in Algebra, D-modules and Representation theories. He has been the Spanish coordinator of bilateral Spanish-French and Spanish-German Research Projects and he is the Principal Investigator of the Spanish Reseach network Red-EACA (in Symbolic Computation, Computer Algebra and Applications). He is the author of over 45 scientific papers with 22 co-authors. He has been the Head of the Department of Algebra from 2007 to 2012 and he has supervised 5 doctoral theses in Mathematics.

Elena Fernández is Full Professor in the Department of Statistics and Operations Research at Universitat Politècnica de Catalunya- BcnTech (UPC) in Barcelona (Spain), since 2007. In 1988 she obtained her PhD in Operations Research at UPC. She has held several faculty positions, first at the Basque Country University and then at UPC. Dr. Fernández's research interest focuses on discrete optimization, mainly in discrete location and network design. She has been the principal investigator of several of research projects and has supervised a number of doctoral theses. She is an author of over 60 scientific papers, published in highly reputed journals, with about 40 co-authors from a dozen of different countries. Prof. Fernández is an associate editor of TOP, the Operations Research Journal of the Spanish Society SEIO, and belongs to the editorial board of Computers & Operations Research and of the recently created EURO Journal on Computation Optimization. Dr. Fernández is the President of the European Association of Operational Research Societies (EURO) for the term 2015-2016.

Evaluation of the components of the program

The lecturers were chosen for the clarity of their expositions and despite the wildly variable backgrounds of the students, most students seem to get quite a bit out of the lectures. Their enthusiasm and interest in the material stayed high throughout the two weeks. There were comments from the students concerning the tight organization of all the lectures — basic theoretical results during the first week and a lot of models and applications in the second. This

sequence of topics set the foundations of this theory and then showed its many applications and actual problem solving possibilities.

Many students and the lecturers commented that the afternoon question/problem and lab sessions and were highly successful and really added a great deal to the school. In particular, these accommodated the varied background of the participants very well, in that the more advanced students could work with the less advanced students and all get something from the interaction

Students

This school was addressed to PhD students and young researchers who wished to gain expertise in this field. The school was also included within the panel of courses offered to PhD students of the "*Programa de Doctorado Matemáticas de la US*" for the academic year 2015-16 and also offered to other PhD programs in Mathematics in Spain.

MSRI and the local organizers selected 35 candidates from all over the world. Thirteen were proposed directly by MSRI among the applications received from its academic sponsors and the remaining chosen by the local organizers out of a number of over 80 applications. Applicants come from more than 15 different countries covering America, Asia and Europe. The proportion of PhD/postdoc students was 2/3-1/3. Thus, around 20 participants were PhD students and 15 were young postdoctoral ones. The students in the program had very diverse backgrounds ranging from pure or applied mathematics to computer science and civil and industrial engineering with strong math orientation. Approximately, more than 80% had some exposure to linear mixed integer programing before and somewhat less than 1/3 had exposure to nonlinear mixed integer programming. Having students from that many origins and different backgrounds was a real strong point of the school because the lecturers found the right level to aim their lectures. Overall, students were excited by the material presented and the direct interaction with the lecturers and teaching assistants during the two weeks of the school.

LIST OF PARTICIPANTS:

NAME	SURNAME	UNIVERSITY
Halil İbrahim	Bayrak	Bilkent University (Turkey)
Sönke	Behrends	University of Göttingen, Germany
Samuel	Deleplanque	Université Libre de Bruxelles
Jorge Miguel	García García	Universidad de Sevilla
Oliver	Habeck	Technische Universität Darmstadt (Germany)
Robert	Hult	Chalmers University of Technology, (Sweden)
Philipp	Hungerländer	Alpen-Adria-Universität Klagenfurt (Austria)
Mehdi	Mahnam	Ecole Polytechnique de Montreal
Luisa Isabel	Martínez Merino	Universidad de Cádiz
Mercedes	Pelegrín García	Universidad de Murcia
Miguel Angel	Pozo	Universidad de Cadiz
Marco Luigi	Premoli	Università degli Studi di Milano
Elisabeth	Rodriguez Heck	University of Liege, Belgium
Jessica	Rodríguez Pereira	Universitat Politècnica de Catalunya
Ozge	Safak	Bilkent University (Turkey)
José Luis	Sainz-Pardo Auñón	University Miguel Hernández of Elche
Fabio	Sciamannini	Université libre de Bruxelles
Emily	Speakman	University of Michigan
Mario	Zanon	Chalmers University of Technology, (Sweden)

Javier	León Caballero	Universidad Complutense Madrid
Lukas Matthias	Schäfer	University of Edinburgh
Mengyuan	Xiang	University of Edinburgh
Alexander	Ayvazov	UC San Diego
Lily	Silverstein	UC Davis
Ben	Rapone	Washington State University (NO SHOW)
Abraham	Varghese	University of Georgia
Yuwen	Wang	Cornell University
Danielle	Brager	Arizona State University (NO SHOW)
Tegan	Emerson	Colorado State University
Zachary	Gershkoff	Louisiana State University
Lokendra S	Thakur	Louisiana State University
Xiaoqi	Zhang	SUNY, Buffalo
Kelly	O'Connell	Vanderbilt University
Yuan	Zhou	UC Davis
Nguyen Luu	Danh	UCLA (NO SHOW)
Francisco	Saldanha	Universidad de Lisboa
Almudena	Marchena Gómez	Universidad de Sevilla
Diego	Ponce	Universidad de Sevilla
Lecturers, T.A. and organizers		
Jeff	Linderoth	(University of Wisconsin)
Robert	Weinsmantel	(ETH, Zurich)
Francisco	Castro Jiménez	Universidad de Sevilla
Justo	Puerto Albandoz	Universidad de Sevilla
Elena	Fernández Aréizaga	Universitat Politècnica de Catalunya
Víctor	Blanco Izquierdo	Universidad de Granada
Jonas	Schweiger	MSRI
Maribel	Hartillo	Universidad de Sevilla

DETAILS OF THE LECTURES SERIES

Towards a theory for integer nonlinear optimization

Robert Weismantel

The goal of this series of lectures was to develop some tools that are indispensable to understand the complexity of nonlinear integer programming problems. We assume that the standard representation of an integer nonlinear optimization problem is max{f(x) : Ax <= b; x IN Z^n } where A in Z^{mxn}, b in Z^m and f : R^n ---→ R is a nonlinear function presented by different oracles and encoding schemes. Whenever we speak about the mixed integer version of such a problem we replace Z^n by R^d x Z^{nxd}.

The study of mixed integer nonlinear optimization problems is still in the beginning. There is no comprehensive theory yet that allows us to understand when such a problem becomes polynomial time tractable. As a first step into this direction we presented mostly algebraic and

geometric tools that help us to obtain positive algorithmic results for various special cases of the general problem.

The lecture was organized in 14 slots, of 50 minutes each. There were several pointers to literature and sometimes referred to background material for details on the subject.

Day 1: Basics of Linear Integer Optimization

1. From vector spaces to lattices
2. Integer programming in fixed dimension
3. From bases of lattices to bases of cones

Day 2: Mixed Integer Convex Optimization

1. State of the art and preliminaries
2. A first attempt to generalize continuous algorithms
3. A first attempt to generalize linear integer optimization
4. Optimality certificates via lattice free polyhedra, shrinking of polytopes

Day 3: Polynomial integer optimization in dimension two

1. The two-dimensional geometry of the S-Lemma and its generalization to integers
2. Polynomials in integers and number theory
3. Integer quadratic programming in the plane
4. Higher degree polynomials in two integers

Day 4: FPTAS results for nonlinear integer optimization

1. Maximization of positive polynomials
2. An axiomatic attempt

Day 4: Bridging the gap between fixed and variable dimension

1. Affine TU decomposition of matrices
2. A polyhedral Frobenius problem

Day 5: Parametric nonlinear optimization

1. Parametric nonlinear optimization in general
2. Nonlinear parametric optimization over independence systems

MINLP for convex and concave functions

Prof. Jeffrey Linderoth.

Day 1: ***Practical MINLP Intro***

1. Complexity of MINLP
2. Classifications of MINLP
3. Convexity and its importance
4. Software for solving MINLP

Day 1: ***Applications and models of MINLP***

1. Uncapacitated Facility Location
2. Pooling
3. Water Network Design
4. Others Models

Day 2: ***Modeling techniques in MINLP***

1. Using Integer Variables to Model Logical Restrictions
2. PW-Linear Modeling

Day 2: ***Advanced Modeling techniques***

1. Perspective strengthening

2. Exploiting Separability
3. Pooling: P formulation, Q formulation, PQ-formulation

Day 3: ***Algorithmic Basics for MINLP***

1. Relaxations and Search
2. NLP-Based Branch and Bound
3. Linearization-Based Methods (Quesada-Grossman and Outer-approximation)

Day 4: ***Algorithmic techniques for nonconvex problems***

1. Factorable Functions, Expression Trees and Relaxations
2. QCQP: RLT, SDP
3. Spatial Branching
4. OBBT and FBBT

Day 4: ***Cutting planes in convex MINLP***

1. Disjunctive Inequalities
2. MIR Inequalities
3. Gomory Cut

Day 5: ***Cutting planes in convex MINLP (continued)***

1. Extended formulations and cutting planes
2. Theory results about CG-Closures
3. SOC disjunctions

Day 5: ***Strong Relaxations for Pooling***

1. Discussion of enhanced relaxations for pooling

CONCLUSION.

The three organizers of this graduate program thought that the it worked out very well. We are very satisfied with the implication shown by the two lecturers and the three T.A. and by the high level of the material that they prepared and delivered to the participants. All this material was available for downloading during the course and the links will remain active until the end of the summer for the participants that wish to complete it. (See http://www.imus.us.es/IMUS-MSRI2016/en/downloads).

We are also very much satisfied with the students by their enthusiasm and high demanding requirements that made us to work hard to answer positively all their scientific and technical request.

Organizers		
First Name	**Last Name**	**Institution**
Francisco	Castro	University of Sevilla
Elena	Fernandez	Universitat Politècnica de Catalunya
Justo	Puerto	University of Sevilla
Speakers		
First Name	**Last Name**	**Institution**
Jacob	Bedrossian	University of Maryland
Roman	Shvydkoy	University of Illinois, Chicago
Vlad	Vicol	Princeton University

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Aleksandr	Ayvazov	University of California, San Diego
Francisco	Castro	University of Sevilla
Tegan	Emerson	Colorado State University
Elena	Fernandez	Universitat Politècnica de Catalunya
Zachary	Gershkoff	Louisiana State University
Jeff	Linderoth	University of Wisconsin-Madison
Kelly	O'Connell	Vanderbilt University
Justo	Puerto	University of Sevilla
Jonas	Schweiger	Friedrich-Alexander-Universität Erlangen-Nürnberg
Lily	Silverstein	University of California, Davis
Lokendra singh	Thakur	Bharati Vidyapeeth Deemed University
Abraham	Varghese	University of Georgia
Yuwen	Wang	Cornell University
Xiaoqi	Zhang	University at Buffalo (SUNY)
Yuan	Zhou	University of California, Davis

Officially Registered Student Information

Participants		15

Gender		15
Male	60.00%	9
Female	40.00%	6
Declined to state	0.00%	0

Ethnicity*		15
White	46.67%	7
Asian	33.33%	5
Hispanic	13.33%	2
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	6.67%	1

* ethnicity specifications are not exclusive

Edit this form

6 responses

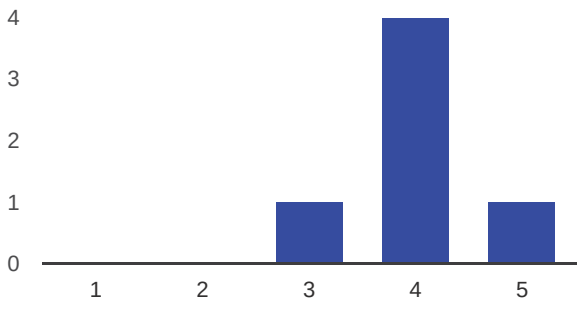
6 out of 15 participants = 40% response rate

View all responses Publish analytics

Summary

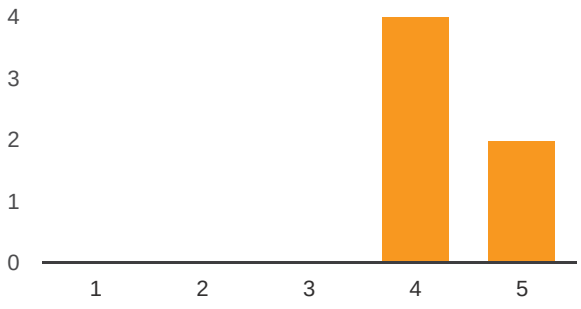
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	16.7%
	4	**4**	66.7%
Very much:	5	**1**	16.7%

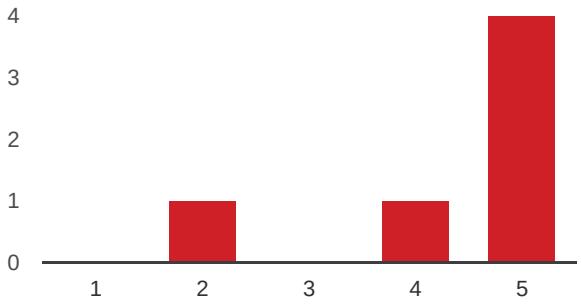
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**0**	0%

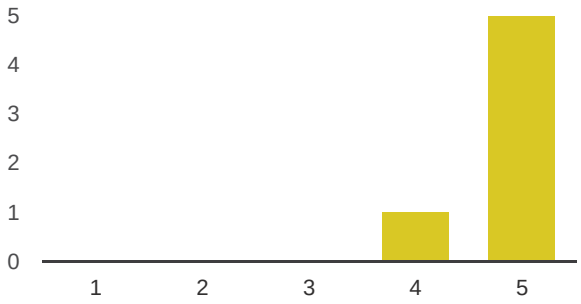
	3	**0**	0%
	4	**4**	66.7%
Very much:	5	**2**	33.3%

The school was intellectually stimulating



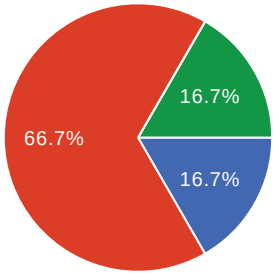
Not at all:	1	**0**	0%
	2	**1**	16.7%
	3	**0**	0%
	4	**1**	16.7%
Very:	5	**4**	66.7%

The overall experience of the school was worthwhile



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**1**	16.7%
Very:	5	**5**	83.3%

The amount of material presented was:



Too much	**1**	16.7%
Just the right amount	**4**	66.7%
Not enough	**0**	0%
No opinion	**1**	16.7%

Additional comments on the topic presentation and organization

The lectures were excellent. However, the practical exercises and homework were tedious and not very interesting. Due to limited time, we had to skip many proofs in the lectures, which was a pity. It would be nice if the exercises in the afternoon session were dedicated to proving theorems and lemmas that were mentioned in the lectures, rather than doing cargo cult programming.

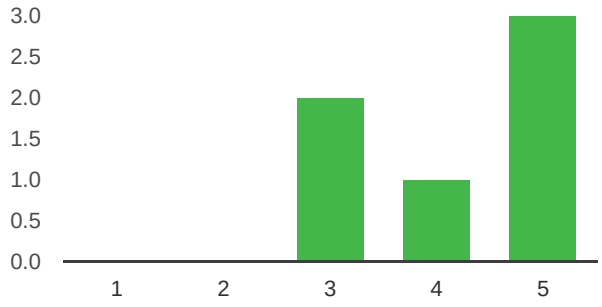
My impression is that the speakers were not given information about the background of the students. So they had a lot of questions about what we had seen before, whether the pace was too slow or fast, etc. Perhaps if they had been given an overview of students' backgrounds a few weeks before the school, for instance, they would have had a better idea of what kind of audience to prepare their lectures for.

I found that both weeks were very different in style and format.

The first week lectures were unrelated in the morning and in the evenings. This was not an issue by itself, but it was a lot less effective than the lecture/problem session combination of the second week.

Personal assessment

I was well prepared to benefit from the school



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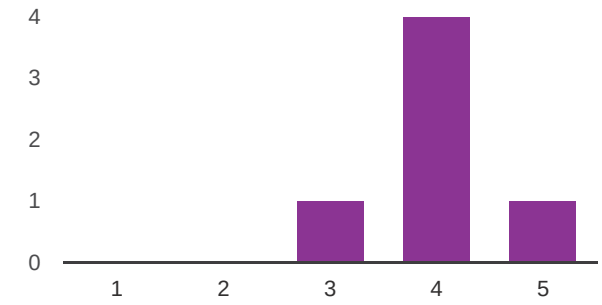
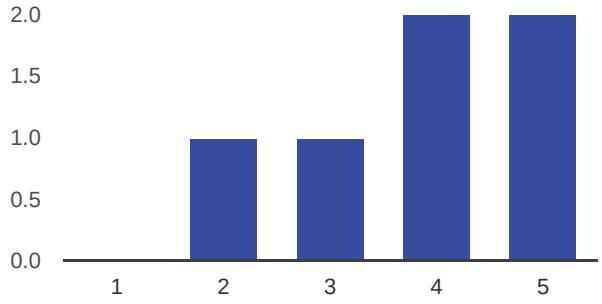


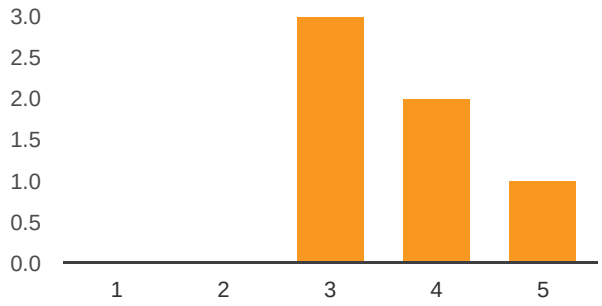
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	16.7%
	4	**4**	66.7%
Very much:	5	**1**	16.7%

The school helped me meet people with similar scientific interests



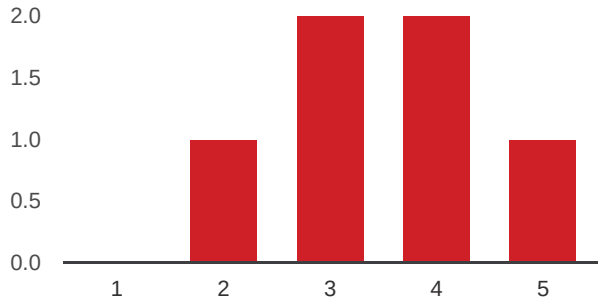
Not at all:	1	**0**	0%
	2	**1**	16.7%
	3	**1**	16.7%
	4	**2**	33.3%
Very much:	5	**2**	33.3%

It is likely that I will work in the area of the school subject in the future



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**3**	50%
	4	**2**	33.3%
Very:	5	**1**	16.7%

How would you evaluate your interaction with other participants?



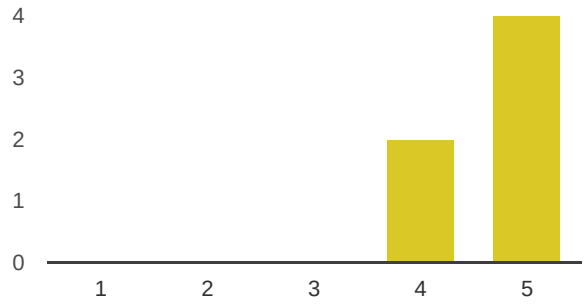
not satisfactory:	1	**0**	0%
	2	**1**	16.7%
	3	**2**	33.3%
	4	**2**	33.3%
above satisfactory:	5	**1**	16.7%

Additional comments on your personal assessment

The variety in backgrounds and academic levels was phenomenal.

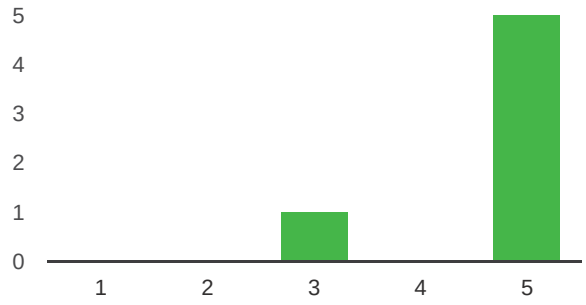
Venue

I found the onsite staff helpful



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**2**	33.3%
Very:	5	**4**	66.7%

The physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	16.7%
	4	**0**	0%
Very:	5	**5**	83.3%

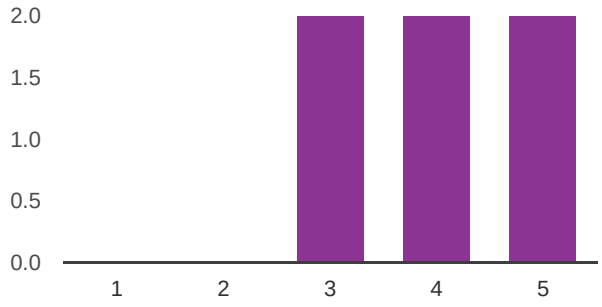
Additional comments on the venue

We had everything we needed.

It was very hot weather.

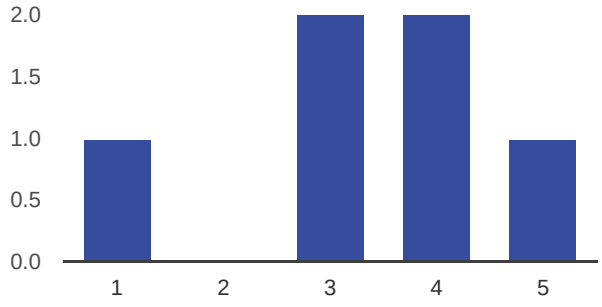
Accommodation and Food

The summer school accommodation



not satisfactory:	1	**0**	0%
	2	**0**	0%
	3	**2**	33.3%
	4	**2**	33.3%
above satisfactory:	5	**2**	33.3%

The food provided



not satisfactory:	1	**1**	16.7%
	2	**0**	0%
	3	**2**	33.3%
	4	**2**	33.3%
above satisfactory:	5	**1**	16.7%

Additional comments on accommodation and food

Accommodation was great, but there was some confusion abut what meals and when were provided. Coming from the US, I almost wish those meals weren't provided - exploring Seville

turned out to be something I wish I had done more often on lunch breaks.

Did not get the vegetarian food.

Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

Number of daily responses

Seminaire de Mathematiques Superieures 2016: Dynamics of Biological Systems

May 30, 2016 - June 11, 2016

University of Alberta, Canada

Organizers:

Thomas Hillen (University of Alberta)

Mark Lewis (University of Alberta)

Yingfei Yi (University of Alberta)

Université de Montréal

Faculté des arts et des sciences
Département de mathématiques
et de statistique

SMS 2016: Director's report.

The 55th *Séminaire de Mathématiques Supérieures* took place in Edmonton in the period May 29 – June 11, 2016. Focused on the interraction between dynamical systems and biology, it brought together 84 participants, carefully selected students as well as lecturers that are world leaders in the field. This was the first time this summer school took place away from Montréal and the experience was highly successful.

The organizers, **Mark Lewis**, **Thomas Hillen** and **Yingfei Yi** have done a fantastic job in putting together this event and I thank them for their effort, particularly as the usual Montréal arrangements were no longer available this time.

This year **PIMS** was the leading partner of the school and my thanks go to it and its staff for making the event possible. As in past years, the *SMS* was only possible with the co-operation of our other main partners, the **CRM**, **Fields Institute**, and the **MSRI** as well as with support from the the **University of Montréal**, the **University of Alberta**, **CAIMS** , and from the **Canadian Mathematical Society**. I thank all these institutions for their contributions and I also thank the board of directors of the SMS for their work and support.

In the following you will find a detailed scientific, organizational and budgetary report. I thank again the organizers for taking the time to prepare this document.

Sincerely Yours,

Octav Cornea
Director, Séminaire de Mathématiques Supérieures
cornea@dms.umontreal.ca

August 31, 2016

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Montréal QC H3C 3J7

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2016 Séminaire de Mathématiques Supérieures:
Dynamics of Biological Systems
May 29 – June 11, 2016

1. Organizers

Mark Lewis (University of Alberta)
Thomas Hillen (University of Alberta)
Yingfei Yi (University of Alberta)

2. Organization

This year, the summer school featured 84 participants (including the speakers and the local participants) from 11 countries spanning 5 continents. The speakers featured world leaders in their fields. The local organizers (Lewis, Hillen and Yi) also gave lectures to introduce the subject and orient the students to the remainder of the summer school.

128 students applied to participate and each organizer reviewed the applications carefully before rating them. Once rated, the applications were reviewed a second time and discussed between the organizers. The applications were of a very high calibre and the decision was difficult.

37 of the participants were males and 32 were female. Of those, 14 participants were from the University of Alberta.

3 of the 12 invited speakers were female and 2 of the 12 were from the University of Alberta.

3. Invited Speakers

1. **Benîot Perthame (Universite Pierre et Marie Currie):** Kinetic Models in Biology
1.1 Bacterial motion, motivation and analysis
1.2 Micro-macro
1.3 Travelling pulses, internal states, fast reaction – stiff response

2. **Philip Maini (Oxford):**
2.1 Pattern formation, Turing Model, chemotaxis model, linear stability analysis, applications
2.2 Travelling Waves, description of the Fisher equation and analysis for minimum wavespeed, applications
2.3 Applications of hybrid models for cell motion.

3. **Gerda de Vries (University of Alberta):** Models for membrane electrical behavior
3.1 The cell membrane and the Hodgkin-Huxley model
3.2 Numerical exploration and qualitative analysis
3.3 Models for bursting electrical activities.

4. **Hong Qian (University of Washington):** Complex Biological Dynamics: A Chemical Reaction Kinetic Perspective Part I, II, and III

2016 Séminaire de Mathématiques Supérieures:
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5. **Réka Albert (Purdue University):** Modelling of Molecular Networks
5.1 The structure of molecular networks
5.2 Logic modeling of the dynamics of molecular networks
5.3 Connecting the structure and dynamics of molecular networks.

6. **Zhilan Feng (USA):** Bifurcations, outbreaks and mixing in epidemic models.
6.1 An elaboration of theory about preventing outbreaks in homogeneous populations to include heterogeneity or preferential mixing,
6.2 Emerging disease dynamics in a model coupling within-host and between-host systems,
6.3 Hopf and homoclinic bifurcations and applications in epidemiological models.

7. **Michael Li (University of Alberta):** Large Scale Epidemic Models and Graph Theoretic Methods of Constructing Lyapunov Functions Part I, II, and III

8. **Chris Cosner (University of Miami):** Interacting Populations
8.1 Models for a single population
8.2 Interacting populations in ecology
8.3 Interacting populations in evolution.

9. **Martin Golubitsky (Distinguished Professor of Mathematical and Statistical Sciences, The Ohio State University):** Networks, Symmetries and applications Part I, II, and III

10. **Jianhong Wu (York University):** Spatial spread in epidemics.
10.1 Spatiotemporal patterns of bird migration and seasonal stage-activities of tick populations: model formulation and parametrization
10.2 global dynamics
10.3 Avian influenza spread and Lyme disease epidemics.

11. **Yuan Lou (The Ohio State University):** Persistence and Extinction
11.1 An introduction to the logistic model
11.2 Diffusion driven extinction in heterogeneous environment
11.3 Persistence and competition in rivers.

12. **Henri Berestyicki (L'Ecole de Hautes Etudes Sciences Sociales, Paris):** Reaction-diffusion and propagation in non-homogenous media Part I, II, and III

4. Special Talks

1. **Mark Lewis,** Genetic consequences of range expansion under climate change.
2. **Yingfei Yi,** Degeneracy, complexity and robustness of bio-systems.
3. **Thomas Hillen,** Modelling of brain tumors.

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5. Summary

Analysis of biological dynamics is rapidly growing, from both mathematical and biological perspectives. While solidly grounded in the theory of nonlinear dynamical systems, the interplay between mathematics and biological systems has been fertile ground for new developments.

The purpose of this summer school was to focus on the interplay of dynamical and biological systems, developing the rich interplay between science and mathematics that has been so successful to date. Our focus was on understanding the mathematical structure of dynamical systems that come from biological problems, and then relating the mathematical structures back to the biology to provide scientific insight. We focussed on five key areas: complex bio-networks, multi scale biological dynamics, biological waves, nonlinear dynamics of pattern formation, and disease dynamics.

This event brought together students and internationally renowned experts. Participants of the school were exposed to foundational theory as well as a broad spectrum of new developments in dynamics of biological systems. The summer school prepared students for new original research in the field.

The summer school structure involved 12 lecture sequences for 69 students, spread over two weeks.

6. Record of Activities

Each lecturer presented approximately 3 hours of lectures and 1.5 hours of hands-on problem solving in groups (labs). The lectures introduced the new mathematics and theory, while the labs allowed the students to apply the mathematical methods to biological problems. This interplay of theory and application was a major educational pillar upon which the learning was structured.

Two of the organizers (Thomas Hillen, Mark Lewis) gave introductory lectures on biological dynamics so as to bring students with diverse backgrounds together in connecting mathematics and biology.

Core lectures were structured around five key areas in biological dynamics:

a. Complex bio-networks. (principal lecturers Reka Albert, Hong Qian) Neural networks, gene networks, cellular networks and disease networks are examples of distributed dynamical systems. Here each node exhibits its own dynamics, but the nodes are also connected, and therefore influence each other's dynamics. The study of these networks extends the theory of

dynamical complexity, ergodicity and stochastic dynamics, and also employs areas such as graph theory to understand emergent network structure.

b. Multi-scale biological systems. (principle lecturers Yuan Lou, Benoit Berthame) Here, mechanisms are understood on the micro-scale, but we wish to understand emergent properties through meso-scales and then at the macro-scale. Biological examples include signalling systems, biochemical reaction systems, complex tissue structure, and the evolutionary dynamics of dynamical systems. Physically, the scales can either be time (eg., signalling, evolutionary dynamos) or space (eg., tissue structure). The key mathematical challenge is to rigorously map from micro-scale structure to macro-scale behaviours. Established methods are based multiple time scale analysis and homogenization theory. However, the multi-scale phenomena arising from these systems exceed the scope of the geometric theory of singular perturbation, based on normal hyperbolicity, making this a very rich area for current research.

c. Biological waves. (principle lecturers Henri Berestycki, Chris Cosner) Traveling waves for spreading populations with nonlocal dispersal, breathers in DNA chains, and spread of electrical impulses in the brain are examples of biological waves. Here the dynamical equations are infinite dimensional, involving both time and space, taking the form of parabolic partial differential equations, or related nonlocal operators. Although the theory for single-species systems is fairly well understood, analysis is challenging and is now only in the process of being developed when there are multiple interacting species.

d. Nonlinear dynamics of pattern formation. (principle lecturers Marty Golubitsky, Gerda de Vries, Philip Maini) The process of biological development involves the seemingly spontaneous formation of emergent structures at crucial developmental stages. Elements that feed into the development involve a complicated mixture of genes, biochemistry and physics. However, the mathematical theory of nonlinear pattern formation can be used to explain how the pattern arise, and their properties, based on underlying elements. This is a very active area of mathematical theory, with close ties to experimental biologists. Recent mathematical challenges involve analysis of patterns on growing domains and structural symmetries in the development of patterns

e. Disease dynamics. (principle lecturers Zhilan Feng, Michael Li, Jianhong Wu) Methods to understand and control emergence of disease are of paramount importance in today's world. Here nonlinear dynamical systems have played a crucial role, giving researchers the opportunity to understand factors influencing disease emergence patterns and to design and evaluate control measures before implementing them. The underlying mathematical models, based on nonlinear dynamical systems, rapidly become complex once relevant environmental factors and heterogeneity are included. Here the fundamental challenge is to understand the processes of disease outbreak and control. These processes are intimately connected with the bifurcation structure of the related nonlinear dynamical system.

Finally, each of the organizers (Thomas Hillen, Mark Lewis and Yingfei Yi) gave research lectures in areas complementary to the core lectures.

Many of the students presented their own research at a highly successful poster session. This was held early in the summer school, and allowed a great deal of interchange of ideas about the student's research projects, which lasted throughout the entire summer school.

7. Participant Survey

The participants response to and evaluation of the activities was recorded by a survey facilitated through the Pacific Institute for Mathematical Sciences. 45 responses were received and a summary of the results follow.

50% of the survey respondents were informed about the summer school through their advisor while 17% received information about it through PIMS (either their website, newsletter or Connection email). 11% of the respondents say a colleague informed them of the summer school and the remaining participants were informed through an interdepartmental email or newsletter, the organizers, MSRI or they saw the advertising poster.

Registration was completed through the PIMS website by 78% of the respondents whereas 9% registered through MSRI. The remaining 13% say they registered either in person, directly through the organizers or through the mail.

The majority of questions in the survey were rated on a scale of 1 – 5 with 1 being very dissatisfied and 5 being very satisfied.

Overall, the responses to the survey questions were very positive.

Communication/support: Pre-event support 4.6, PIMS website 4.0, financial support 4.5, post-event support 4.5.

Venue, accommodations and social activities: Venue: 4.7, food/catering: 3.7, accommodation: 4.6, social functions 4.6,

Organization: Event organization 4.9, scheduling 4.6, audio-visual 4.3.

Timeliness/Importance/novelty/quality: Timeliness and importance 4.6, novelty 4.4, quality of presentations 4.7.

Potential impact: Work/research/education 4.6, future collaboration 4.3, interdisciplinary applications 4.3, advancing the field 4.4.

Overall satisfaction: Scientific value 4.6, overall satisfaction 4.7.

The survey also gave the respondents the opportunity to leave comments. The majority of the comments were positive and there were also some suggestions on how to improve future events.

8. PARTICIPANTS

ORGANIZERS	
Mark Lewis	University of Alberta
Thomas Hillen	University of Alberta
Yingfei Yi	University of Alberta
SPEAKERS	
Benoît Perthame	Universite Pierre et Marie Currie
Chris Cosner	University of Miami
Gerda de Vries	University of Alberta
Henri Berestyicki	L'Ecole de Hautes Etudes Sciences Sociales
Hong Qian	University of Washington
Jianhong Wu	York University
Martin Golubitsky	Ohio State University
Michael Li	University of Alberta
Philip Maini	Oxford
Réka Albert	Pennsylvania State University
Yuan Lou	The Ohio State University
Zhilan Feng	Purdue University
PARTICIPANTS	
Stephen Ashton	University of Sussex
Somyi Baek	University of Minnesota, Twin Cities
Javier Baez	Arizona State University
Mikahl Banwarth-Kuhn	UC Riverside
Jamie Bennett	Maxwell Institute Grad School
Dana-Adriana Botesteanu	University of Maryland
James Brunner	University of Wisconsin
Andreas Buttenschoen	University of Alberta
Nils Caillerie	Université Claude Bernard Lyon 1
Wendy Caldwell	Arizona State University
Cecile Carrere	Aix-Marseille Universite
Ricardo Cervantes Casiano	University of South Dakota
Tyler Cassidy	McGill University
Qun Cheng	University of Alberta
Beomjun Choi	National Institute for Mathematical Sciences
Rebekah Coggin	University of Kansas
Carlos Contreras	University of Alberta

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Kyle Dahlin	Purdue University
Jummy David	University of British Columbia
Patrick Davis	Central Michigan University
Thomas Dinitz	Ohio State University
Stephanie Dodson	Brown University, Rhode Island
Valentin Doli	University Rennes, France
Marina Esteban	Universidad de Sevilla
Samuel Fischer	University of Alberta
Havard Froysa	University of Bergen
Chunyi Gai	Dalhousie University
Tatiana Galochkina	Moscow State University/University Claude Bernard Lyon1
Arielle Gaudiello	University of Central Florida
Leo Girardin	Universite Pierre et Marie Curie
Meghan Hall	University of Victoria
Pratima Hebbar	University of Maryland, College Park
Christopher Heggerud	University of Alberta
Carolin Herrmann	University of Bielefeld
Adrianne Jenner	University of Sydney
Jinsu Kim	University of Wisconsin
Yeon Eung Kim	National Institute for Mathematical Sciences
Jude Kong	University of Alberta
Sherli Koshy Chenthittayil	Clemson University
Ao Li	Western University Ontario
Sumei Li	University of Alberta
Shuo Liu	University of Alberta
Jane MacDonald	University of Ottawa
Moriah Magcalas	University of Waterloo
Nathan Marculis	University of Alberta
Tyler Meadows	McMaster University
Inom Mirzaev	University of Colorado, Boulder
Patrick Murray	University of Alberta
Samuel Nordmann	L'Ecole de Hautes Etudes Sciences Sociales
Kamaldeen Okuneye	Arizona State University
Oluwole Olobatuyi	University of Alberta
Jasmine Otto	University of Illinois, Chicago
Frederic Paquin-Lefebre	University of British Columbia
Jeungeun Park	University of Iowa
Jody Reimer	University of Alberta
Vanessa Rivera-Quinones	University of Illinios at Urbana-Champaign
Weston Roda	University of Alberta

Diana Schepens	Montana State University
Robyn Shuttleworth	University of Dundee
Penfei Song	Xian Jiaotong University
Mahesh Sunkula	University of Oklahoma
Cecile Taing	Universite Pierre et Marie Curie
Imelda Trejo Lorenzo	University of Texas - Arlington
Yang Wang	Western University Ontario
Yan Wang	University of Alberta
Asia Wyatt	University of Maryland
Ying Xin	Ohio University
Xige Yang	Ohio State University
Sofya Zaytseva	College of William and Mary
Cole Zmurchok	University of British Columbia

10. PROGRAM

Week I

Monday, May 30

9:00-9:30 **Thomas Hillen, Mark Lewis and Yingfei Yi (University of Alberta)**
Welcome

9:30-10:50 **Thomas Hillen**
Introduction to Mathematical Modeling in Biology Part I

10:50-11:10 Coffee Break

11:10-12:30 **Mark Lewis**
Introduction to Mathematical Model in Biology Part II

12:30-14:00 Lunch Break

14:00-14:50 **Benoît Perthame (Universite Pierre et Marie Currie)**
Bacterial motion; motivations and analysis

15:00-15:50 **Benoît Perthame (Universite Pierre et Marie Currie)**
Micro-macro

15:50-16:10 Coffee Break

16:10-17:00 **Philip Maini (Oxford)**
Pattern formation, turing model, chemotaxis model, linear stability analysis, applications

18:00 Welcome Reception – Pizza Party

Tuesday, May 31

9:00-9:50 **Philip Maini (Oxford)**
Traveling waves, description of the Fischer equation and analysis for minimum wavespeed, applications

10:00-10:50 **Benoît Perthame (Universite Pierre et Marie Currie)**
Traveling pulses, internal states, fast reaction – stiff response

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10:50-11:10 Coffee Break
11:10-12:30 **Benoît Perthame (Universite Pierre et Marie Currie)**
Lab
12:30-14:00 Lunch Break
14:00-14:50 **Gerda de Vries (University of Alberta)**
The cell membrane and the Hodgkin-Huxley model
15:00-15:50 **Philip Maini (Oxford)**
Applications of hybrid models for cell motion
15:50-16:10 Coffee Break
16:10-17:30 **Philip Maini (Oxford)**
Lab

Wednesday, June 1
9:00-9:50 **Gerda de Vries (University of Alberta)**
Numerical exploration and qualitative analysis
10:00-10:50 **Gerda de Vries (University of Alberta)**
Models for bursting electrical activities
10:50-11:10 Coffee Break
11:10-12:30 **Gerda de Vries (University of Alberta)**
Lab
12:30-14:00 Lunch Break
14:00-14:50 **Mark Lewis (University of Alberta)**
Special Talk
15:00-1730 **Poster Session**

Thursday, June 2
9:00-9:50 **Hong Qian (University of Washington)**
Complex Biological Dynamics – A chemical reaction kinetic perspective-Part I
10:00-10:50 **Hong Qian (University of Washington)**
Complex Biological Dynamics – A chemical reaction kinetic perspective-Part II
10:50-11:10 Coffee Break
11:10-12:30 **Réka Albert (Pennsylvania State University)**
The structure of molecular networks
12:30-14:00 Lunch Break
14:00-14:50 **Zhilan Feng (Purdue University)**
An elaboration of theory about preventing outbreaks in homogeneous populations to include heterogeneity or preferential mixing
15:00-15:50 **Hong Qian (University of Washington)**
Complex Biological Dynamics – A chemical reaction kinetic perspective-Part III
15:50-16:10 Coffee Break
16:10-17:30 **Hong Qian (University of Washington)**
Lab

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18:00 Dinner and poster prizes at St. Joe's

Friday, June 3

9:00-9:50 **Réka Albert (Pennsylvania State University)**
Logic modeling of the dynamics of molecular networks

10:00-10:50 **Réka Albert (Pennsylvania State University)**
Connecting the structure and dynamics of molecular networks

10:50-11:10 Coffee Break

11:10-12:30 **Réka Albert (Pennsylvania State University)**
Lab

12:30-14:00 Lunch Break

14:00-14:50 **Zhilan Feng (Purdue University)**
Emerging disease dynamics in a model coupling within-host and between-host systems

15:00-15:50 **Zhilan Feng (Purdue University)**
Hopf and homoclinic bifurications and applications in epidemiological models

15:50-16:10 Coffee Break

16:10-17:30 **Zhilan Feng (Purdue University)**
Lab

Monday, June 6

9:00-9:50 **Michael Li (University of Alberta)**
Large scale epidemic models and graph theoretic methods of constructing Lyapunov Functions-Part I

10:00-10:50 **Michael Li (University of Alberta)**
Large scale epidemic models and graph theoretic methods of constructing Lyapunov Functions-Part II

10:50-11:10 Coffee Break

11:10-12:30 **Chris Cosner (University of Miami)**
Models for a single population

14:00-14:50 **Chris Cosner (University of Miami)**
Interacting populations in ecology

15:00-15:50 **Michael Li (University of Alberta)**
Large scale epidemic models and graph theoretic methods of constructing Lyapunov Functions-Part III

15:50-16:10 Coffee Break

16:10-17:30 **Michael Li (University of Alberta)**
Lab

Tuesday, June 7

9:00-9:50 **Martin Golubitsky (Ohio State University)**
Networks, symmetries, and applications-Part I

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10:00-10:50 **Chris Cosner (University of Miami)**
Interacting populations in evolution
10:50-11:10 Coffee Break
11:10-12:30 **Chris Cosner (University of Miami)**
Lab
14:00-14:50 **Martin Golubitsky (Ohio State University)**
Networks, symmetries, and applications-Part II
15:00-15:50 **Martin Golubitsky (Ohio State University)**
Networks, symmetries, and applications-Part III
15:50-16:10 Coffee Break
16:10-17:30 **Martin Golubitsky (Ohio State University)**
Lab

Wednesday, June 8

9:00-9:50 **Jianhong Wu (York University)**
Patterns of bird migration and seasonal stage-activities of tick populations: model formulation and parameterization
10:00-10:50 **Jianhong Wu (York University)**
Spatiotemporal patterns of bird migration and seasonal stage-activities of tick populations: global dynamics
10:50-11:10 Coffee Break
11:10-12:30 **Yuan Lou (Ohio State University)**
An Introduction to Logistic Model
14:00-14:50 **Yingfei Yi (University of Alberta)**
Special Talk
15:00-15:50 **Jianhong Wu (York University)**
Avian influenza spread and Lyme disease epidemics: persistence and irregular infection dynamics
15:50-16:10 Coffee Break
16:10-17:30 **Jianhong Wu (York University)**
Lab

Thursday, June 9

9:00-9:50 **Yuan Lou (Ohio State University)**
Diffusion driven extinction in heterogeneous environment
10:00-10:50 **Yuan Lou (Ohio State University)**
Spatiotemporal patterns of bird migration and seasonal stage-activities of tick populations: global dynamics
10:50-11:10 Coffee Break
11:10-12:30 **Yuan Lou (Ohio State University)**

Lab
14:00-14:50 **Henri Berestycki (L'Ecole de Hautes Etudes Sciences Sociales)**
Reaction-diffusion and propagation in non-homogenous media-Part I
15:00-15:50 **Thomas Hillen (University of Alberta)**
Special Talk
15:50-16:10 Coffee Break

Friday, June 10

9:00-9:50 **Henri Berestycki (L'Ecole de Hautes Etudes Sciences Sociales)**
Reaction-diffusion and propagation in non-homogenous media-Part II
10:00-10:50 **Henri Berestycki (L'Ecole de Hautes Etudes Sciences Sociales)**
Reaction-diffusion and propagation in non-homogenous media-Part III
11:10-12:30 **Henri Berestycki (L'Ecole de Hautes Etudes Sciences Sociales)**
Lab
18:00 Farewell BBQ – Emily Murphy Park

Organizers

First Name	Last Name	Institution
Thomas	Hillen	University of Alberta
Mark	Lewis	University of Alberta
Yingfei	Yi	University of Alberta

Speakers

First Name	Last Name	Institution
Réka	Albert	Pennsylvania State University
Henri	Berestycki	École des Hautes Études en Sciences Sociales
Chris	Cosner	University of Miami
Gerda	de Vries	University of Alberta
Zhilan	Feng	Purdue University
Marty	Golubitsky	Ohio State University
Michael	Li	University of Alberta
Yuan	Lou	Ohio State University
Philip	Maini	University of Oxford
Benoit	Perthame	Université Pierre et Marie Curie
Hong	Qian	University of Washington
Jianhong	Wu	York University

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Somyi	Baek	University of Minnesota Twin Cities
Javier	Baez	Arizona State University
Mikahl	Banwarth-Kuhn	University of California, Riverside
Dana	Botesteanu	University of Maryland
James	Brunner	University of Wisconsin-Madison
Wendy	Caldwell	Arizona State University
Ricardo	Cervantes Casiano	Inter-Amer. Univ. of Puerto Rico, San German
Rebekah	Coggin	University of Kansas
Jummy	David	University of British Columbia
Patrick	Davis	Central Michigan University
Thomas	Dinitz	Ohio State University
Marina	Esteban Pérez	University of Sevilla
Meghan	Hall	University of Victoria
Pratima	Hebbar	University of Maryland
Thomas	Hillen	University of Alberta
Jinsu	Kim	University of Wisconsin-Madison
Sherli	Koshy Chenthittayil	Clemson University
Mark	Lewis	University of Alberta
Moriah	Magcalas	University of Waterloo
Tyler	Meadows	McMaster University
Kamaldeen	Okuneye	Arizona State University
Jasmine	Otto	University of Illinois, Chicago
Jeungeun	Park	University of Iowa
Vanessa	Rivera Quinones	University of Illinois at Urbana-Champaign
Mahesh	Sunkula	University of Oklahoma
Asia	Wyatt	University of Maryland
Ying	Xin	Ohio University
Yingfei	Yi	University of Alberta

Officially Registered Student Information

Participants		28

Gender		28
Male	42.86%	12
Female	57.14%	16
Declined to state	0.00%	0

Ethnicity*		30
White	36.67%	11
Asian	33.33%	10
Hispanic	13.33%	4
Pacific Islander	0.00%	0
Black	10.00%	3
Native American	0.00%	0
Mixed	3.33%	1
Declined to state	3.33%	1

* ethnicity specifications are not exclusive

Edit this form

23 responses

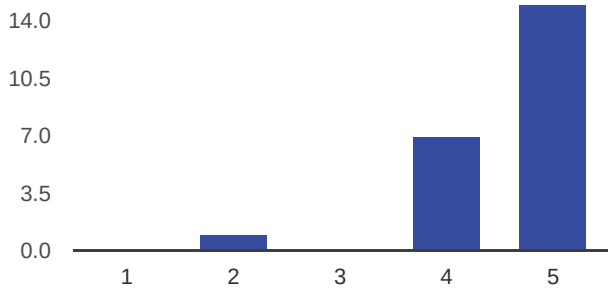
23 out of 28 participants = 82% response rate

View all responses Publish analytics

Summary

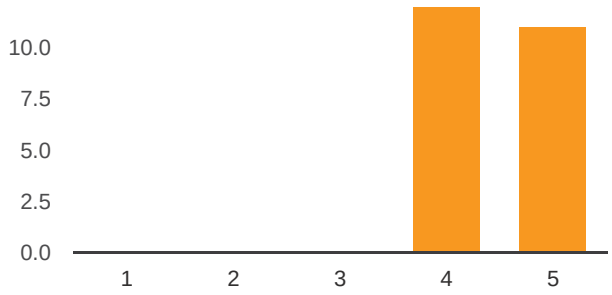
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**1**	4.3%
	3	**0**	0%
	4	**7**	30.4%
Very much:	5	**15**	65.2%

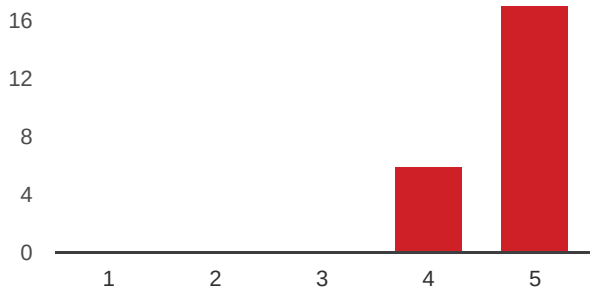
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**0**	0%

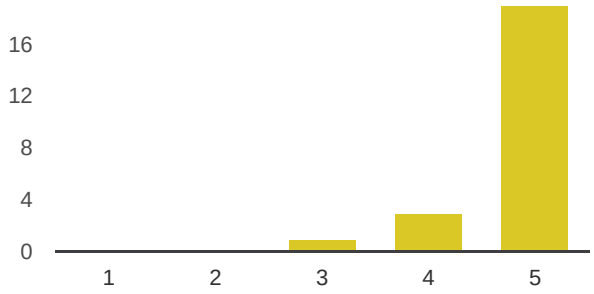
	3	**0**	0%
	4	**12**	52.2%
Very much:	5	**11**	47.8%

The school was intellectually stimulating



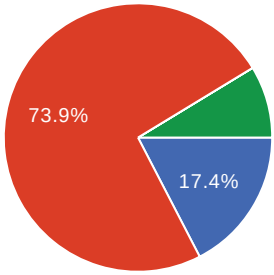
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**6**	26.1%
Very:	5	**17**	73.9%

The overall experience of the school was worthwhile



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	4.3%
	4	**3**	13%
Very:	5	**19**	82.6%

The amount of material presented was:



Too much	**4**	17.4%
Just the right amount	**17**	73.9%
Not enough	**0**	0%
No opinion	**2**	8.7%

Additional comments on the topic presentation and organization

I thought the content was extremely well organized and that the speakers were very well picked. The topics were arranged in a matter that made it not be overwhelming for the students.

Group work(Lab) was the best time for me.

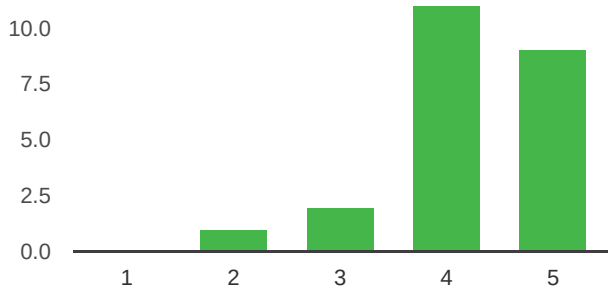
Since the program was organized as a series of guest lecturers, we were able to see a large variety of topics; however, this served to decrease depth. It also resulted in some speakers presenting the same background material. I think it would have been helpful to have a more sizable set of initial background lectures - the notes for which could be provided to the guest lecturers ahead of time. This would have bolstered understanding and prevented the overlap.

It would be great if the lab sessions are not just about exercises

This was very well organized, and I learned a great deal. I also like how they scheduled coffee breaks so that we would be able to focus for longer periods.

Personal assessment

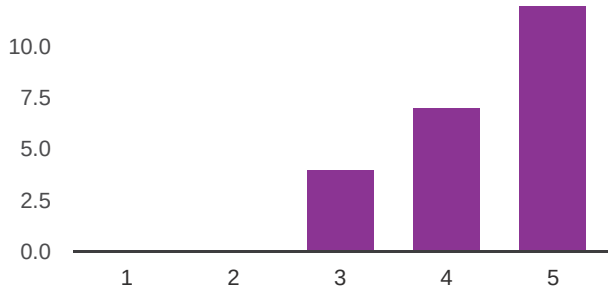
I was well prepared to benefit from the school



Not at all: 1	**0**	0%

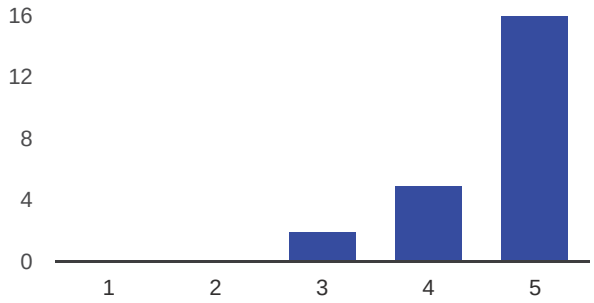
2	**1**	4.3%
3	**2**	8.7%
4	**11**	47.8%
Very: 5	**9**	39.1%

My interest in the subject matter was increased by the school



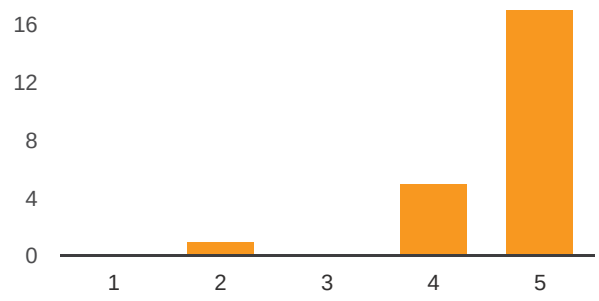
Not at all: 1	**0**	0%
2	**0**	0%
3	**4**	17.4%
4	**7**	30.4%
Very much: 5	**12**	52.2%

The school helped me meet people with similar scientific interests



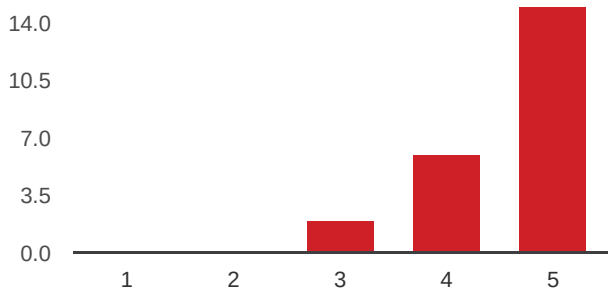
Not at all: 1	**0**	0%
2	**0**	0%
3	**2**	8.7%
4	**5**	21.7%
Very much: 5	**16**	69.6%

It is likely that I will work in the area of the school subject in the future



Not at all:	1	**0**	0%
	2	**1**	4.3%
	3	**0**	0%
	4	**5**	21.7%
Very:	5	**17**	73.9%

How would you evaluate your interaction with other participants?



not satisfactory:	1	**0**	0%
	2	**0**	0%
	3	**2**	8.7%
	4	**6**	26.1%
above satisfactory:	5	**15**	65.2%

Additional comments on your personal assessment

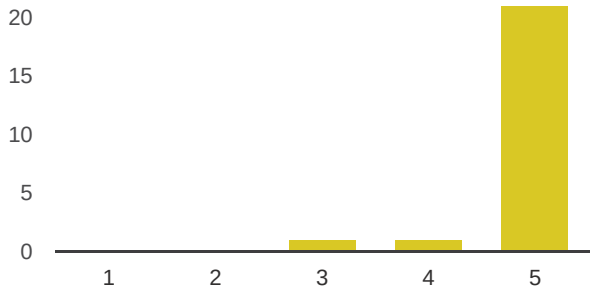
I think the group works could be organized so that people interact with different groups. Overall, I loved the group work. Also, I thought having a poster session was great because it opened the door to collaboration. Speakers and organizers we very accessible to students which was great! Having meals and housing together with other participants definitely help out interactions within and outside the school. It was an excellent experience!

It was really helpful that the prerequisite had provided before the school. At least, I could prepare for it, so it helped me to better understand the lectures.

I made a lot of lasting connections at the school, which I find very valuable. I know this will help me in my career.

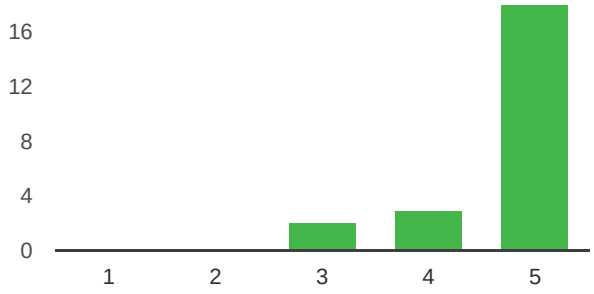
Venue

I found the onsite staff helpful



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	4.3%
	4	**1**	4.3%
Very:	5	**21**	91.3%

The physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**2**	8.7%
	4	**3**	13%

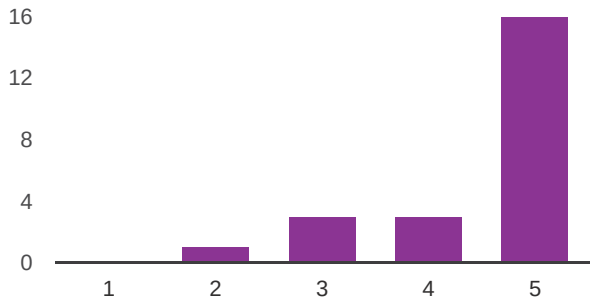
Very: 5	**18**	78.3%

Additional comments on the venue

Everything was perfect!

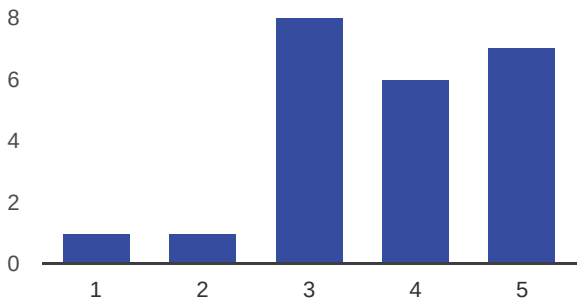
Accommodation and Food

The summer school accommodation



not satisfactory: 1	**0**	0%
2	**1**	4.3%
3	**3**	13%
4	**3**	13%
above satisfactory: 5	**16**	69.6%

The food provided



not satisfactory: 1	**1**	4.3%
2	**1**	4.3%
3	**8**	34.8%

	4	**6**	26.1%
above satisfactory:	5	**7**	30.4%

Additional comments on accommodation and food

The sweet secretary was beyond helpful in making sure we had the information we needed for travel plans and accommodations. The dorms we new, private, clean and comfortable. The kitchen staff was careful to keep my food separate because of allergies.

Awesome accommodations.

I believe people who work in the dorm should be more familiar with the needs of disabilities. My roommate had to sleep in her wheel chair for the first night as the bed was way too high for her, and after they made the bed lower, she couldn't get out of the bed the next morning as the bed was too low this time... Moreover, it was kind of chilly those days in the night, and there was no way to make the room warmer...

Again, couldn't be better! Perfect!

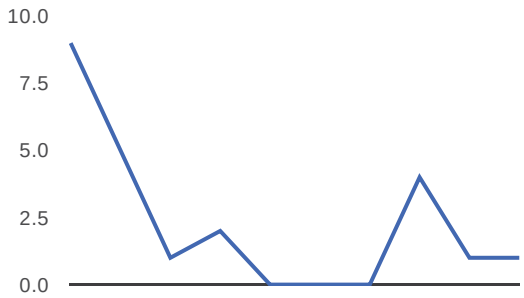
Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

Really great program. Thanks for organizing it!

Thank you for providing me the great opportunity. I deeply appreciate it. Every moments with the organizers, lecturers, participants and staffs and every lectures provided were valuable. I am pretty sure it was greatly helpful for my research or future professional track. I will never forget this summer school. Again, thank you so much for giving me such a wonderful opportunity!

Number of daily responses



Summer Graduate School

Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets

June 13, 2016 - June 24, 2016

MSRI, Berkeley, CA, USA

Organizers:

Steven Hofmann (University of Missouri)

Jose Maria Martell (Instituto de Ciencias Matematicas (ICMAT))

Final Report

MSRI Summer Graduate School

Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets

June 13–24, 2016

Organizers:

Steve Hofmann (University of Missouri, USA)

José María Martell (Instituto de Ciencias Matemáticas, Spain)

The goal of the workshop was to introduce the students to an active, current research area: the interface between harmonic analysis, elliptic partial differential equations, and geometric measure theory. To achieve that goal, some harmonic analysis techniques were first presented $\mathbb{R}^d$ (the "flat" setting), and afterwards passing to much more rough settings where the theory of harmonic functions was also covered. Ultimately, the tools developed were combined to prove a state-of-the-art result.

1. Organization of the summer school

Every day there were two main lectures given by the organizers in the morning. After lunch, there was some free time for the students to work independently on material covered during that day, as well as on the assigned homework. Then, the TAs (Simon Bortz and José Luis Luna García, graduate students from University of Missouri) ran one discussion session each. During that time the students could ask questions about the morning session or the homework. After that the TAs also covered some complementary material that was useful for the main lectures.

José María Martell (10 lectures)

During the first week, the lectures covered basic harmonic analysis tools in the Euclidean setting. Topics such as the Hardy-Littlewood maximal function, stopping time constructions, the dyadic cubes, the Whitney decomposition of an open set, BMO and the John-Nirenberg lemma and the theory of Muckenhoupt weights were developed in full detail. The goal was to familiarize the students with these nowadays standard tools, to help them prepare for the more advanced topics treated in the second week.

The second week was devoted to presenting the proof of a particular version of a recent "free boundary" result proved by S. Hofmann, J.M. Martell and T. Toro. The main idea was to show that under some background topological assumptions on some domain, good properties for the associated harmonic measure (in terms of solvability of the Dirichlet problem) produces some "flatness" or "regularity" in a wide sense of the boundary. We worked in the class of 1-sided chord-arc domains (open and connected in a quantitative fashion, with boundaries satisfying the so-called Ahlfors-David Regular condition). The proof of the aforementioned result was lengthy and required the use of techniques from harmonic analysis, elliptic partial differential equations, and geometric measure theory. In this way, the students could discover how the three fields interact, which was a primary

motivation of the summer course. The basic material covered during the first week by Martell, the topics developed by Hofmann about PDE and harmonic measure, as well as some of the lectures given by the TAs were crucial to the proof presented. With the exception of some minor technical details the argument presented was self-contained and the students were exposed to some state-of-the-art results in the area.

Steve Hofmann (10 lectures)

The first week started with the construction of the Hausdorff measure. Next, the lectures moved into the study of the properties of harmonic, subharmonic and superharmonic functions. Basic tools for these functions were studied such as the maximum principle, Harnack's inequality and Harnack's convergence theorem. Next, the Perron-Wiener-Brelot method was introduced to construct harmonic solutions of the classical Dirichlet problem, and to show that continuous data are resolutive. All this enables the construction of harmonic measure. During the second week the lectures explored more deeply the properties of harmonic functions and of harmonic measure, including boundary behavior of the harmonic measure solutions (Bourgain's estimate and Hölder continuity at the boundary). These properties were used to construct Green's function and to obtain its corresponding properties and its relation with harmonic measure including the "Riesz Formula". In the particular case of 1-sided chord-arc domains some further properties were obtained: Carleson's estimate, Caffarelli-Fabes-Mortola-Salsa's estimates, doubling property of harmonic measure, etc. These were then used to establish the equivalence between the higher integrability of the Poisson kernel, and the solvability of the L^p-Dirichlet problem (in the non-tangential sense). The second week concluded with the classical theorem of Dahlberg regarding the higher integrability of the Poisson kernel in Lipschitz domains, and its extension to chord-arc domains by David-Jerison and Semmes.

Simon Bortz and José Luis Luna García (10 lectures each)

During part of the TAs sessions, the students interacted and asked questions related to the assigned homework, or regarding the details that were left from the main lectures. This was a good opportunity for the students to make sure that they could follow the forthcoming lectures. Also, some extra material needed for the main lectures was covered, including M. Christ's construction of dyadic cubes on sets with a doubling measure, David-Jerison "Big Pieces of Lipschitz graphs" construction, Sobolev spaces, Sobolev-Poincare inequalities, fractional integrals, etc.

2. Evaluation of the summer school

The group of students attending the summer school had very different backgrounds. The short survey that the students took before the course was very useful for the organizers to get a clear picture of the kind of the students attending. In view of the interdisciplinary character of the summer course, we found out that the majority of the students had not taken a basic graduate courses in at least one of the three topics on which the school was focused. This was very challenging as it required us to start our courses from a somewhat basic level.

Some of the topics covered during the two weeks were rather technical and difficult for those students lacking a solid background in the three different fields. Taking this into account, the first week was used to cover basic tools and techniques that some students were already familiar with. The lectures were self-contained and tried to give full details of the topics covered. As the school proceeded, there was an increase in both the rhythm

and difficulty so that we could achieved the initial proposed goals. Most of the students could follow the two weeks. They had a very good attitude, they took notes, worked on the homework, asked questions during the lectures, etc. During the lectures some students were actively participating and could spot things that were not clear enough or not entirely correct. The lectures were quite dynamic and the students showed interest throughout the two weeks, this was particularly encouraging for the organizers. Although the summer school was quite intense and some of the topics were pretty advanced, many students kept working and seemed to be following the arguments presented.

3. Conclusion

Both organizers are very satisfied with the whole summer course. The MSRI staff was very resourceful and everything was handled with care so that there were no unexpected surprises. We believe that the course worked well and that many students benefited from it in different ways. Those that were in a early stage of their career were exposed to several topics and could see a general framework where mathematical problems can be attacked. Those that were already more experienced could get into the difficult details, see the proof of a state-of-the-art result and at the same time revisit some topics with a different perspective. Students showed interest throughout the two weeks: on a regular basis we could see students working on the topics of the course, either in the library or on the several blackboards in the MSRI building. The last day after lunch we had a more relaxed chat with some of the students and they seemed to have enjoyed the course.

On the less positive side, one of the most difficult things was to deal with a group of students having many different backgrounds and being at very different stages of their careers. This is perhaps an issue that MSRI might want to take into account. It could be useful to split the summer courses in different categories so that they are aimed at different levels of students. For instance, in our case we saw that some students had a difficult time to follow the full two weeks of lectures, because they were probably not mathematically mature enough to take an advanced course. Having said that, it is worth mentioning that a big group of students were working hard and could follow most of the material during the two weeks. We also sadly observed that a few students were missing the last days of the course. This is somehow disappointing, as those students were financially supported to attend the summer school, and in addition they took places that could have been offered to other students who would have liked to attend, but could not because the course was fully subscribed. For future summer schools, MSRI might consider telling students during the orientation that attendance is a “privilege” and that they are expected to take advantage of it. Perhaps, asking the students to sign in every morning is sufficient to “encourage” them to stay there. Last, since the summer school lasted only two weeks it would have been useful to have had a list of students with names and photos to learn some of the students’ names.

MSRI Mathematical Sciences Research Institute

Harmonic Analysis and Elliptic Equations on real Euclidean Spaces and on Rough Sets

June 13-24, 2016

Schedule

Monday Jun 13, 2016			
9:00 AM - 9:15 AM	Simons Auditorium		Introduction to MSRI
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00PM - 1:30 PM	Atrium		Lunch
1:30 PM- 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Tuesday June 14, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM - 1:30PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea
4:00 PM -5:00 PM	Simons Auditorium		Discussion Session II

Wednesday June 15, 2016			
9:15 AM - 10:15 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:15 AM -10:45 PM	Atrium		Break
10:30 PM - 11:30 PM	Simons Auditorium	Steven Hofmann	Lecture
11:30 PM - 2:00 PM	Tilden Park		BBQ Lunch
2:00 PM - 2:45 PM	Simons Auditorium		Free time to work on problems
2:45 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 4:45 PM	Simons Auditorium		Discussion Session II

Thursday June 16, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Friday June 17, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Monday June 20, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Tuesday June 21, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Wednesday June 22, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Thursday June 23, 2016			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Friday June 24, 2015			
9:15 AM - 10:30 AM	Simons Auditorium	Jose Maria Martell	Lecture
10:30 AM - 10:45 AM	Atrium		Break
10:45 AM - 12:00 PM	Simons Auditorium	Steven Hofmann	Lecture
12:00 PM- 1:30 PM	Atrium		Lunch
1:30 PM - 2:30 PM	Simons Auditorium		Free time to work on problems
2:30 PM - 3:30 PM	Simons Auditorium		Discussion Session I
3:30 PM - 4:00 PM	Atrium		Tea Break
4:00 PM - 5:00 PM	Simons Auditorium		Discussion Session II

Organizers		
First Name	**Last Name**	**Institution**
Steven	Hofmann	University of Missouri
Jose Maria	Martell	Instituto de Ciencias Matematicas (ICMAT)
Speakers		
First Name	**Last Name**	**Institution**
Steven	Hofmann	University of Missouri
Jose Maria	Martell	Instituto de Ciencias Matematicas (ICMAT)

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Enrique	Alvarado	Washington State University
Ashok	Aryal	Kansas State University
Hussein	Awala	Temple University
Mauricio	Barrera Ceballos	Centro de Investigacion y de Estudios Avanzados del IPN
Tyler	Bongers	Michigan State University
Simon	Bortz	University of Missouri
Hsiang	Chang	Northwestern University
Alan	Chang	University of Chicago
Alexandr	Chernyavskiy	McMaster University
Alyssa	Cherry	University of Missouri
Brian	Choi	Boston University
Gabriella	Clemente	University of Notre Dame
Briceyda	Delgado López	Centro de Investigacion y de Estudios Avanzados del IPN
Katie	Elliott	Baylor University
Lanbo	Fang	University of Arizona
Cuiying	Feng	University of Victoria
John	Forsman	North Dakota State University
Abraham	Frei-Pearson	University of Texas
Dale	Frymark	Baylor University
Silvia	Ghinassi	State University of New York, Stony Brook
Siming	He	University of Maryland
Martin	Hiserote	University of Oregon
Steven	Hofmann	University of Missouri
Dwight	Holland	Oregon State University
Yunfeng	Hu	Washington State University
Aziz	Issaka	North Dakota State University
Hyo Seok	Jang	Seoul National University
Dewey	Kemp	Indiana University
Qinfeng	Li	Purdue University
Jose Luis	Luna Garcia	University of Missouri
Alessandro	Marinelli	University of British Columbia
Jose Maria	Martell	Instituto de Ciencias Matematicas (ICMAT)
Evan	Miller	University of Toronto
Sang-hyuck	Moon	Korea Advanced Institute of Science and Technology (KAIST)
Monika	Pichler	Northeastern University
Giorgio	Poggesi	Università di Firenze
Iurii	Posukhovskyi	University of Kansas
Keaton	Quinn	University of Illinois at Chicago
Robert	Rahm	Washington University
Jacob	Rezac	University of Delaware
Brandon	Russell	University of Kentucky
Marie-Jose	Saad	Washington University
Luis Rene	San Martin Jimenez	UNAM - Universidad Nacional Autonoma de Mexico
Sarah	Schwarzentraub	North Dakota State University
Shan	Shan	Duke University
William	Thompson	University of Victoria
Amir	Vig	University of California, Irvine
Xiang	Wan	University of Virginia
Tao	Wang	University of Iowa
Yijing	Wu	University of Texas
Xin	Yang	Michigan State University
Gene	Yoo	California Institute of Technology
Zhen	Zeng	University of Pennsylvania
Yue	Zhao	University of Washington
Zihui	Zhao	University of Washington

Officially Registered Student Information

Participants		55

Gender		55
Male	72.73%	40
Female	25.45%	14
Declined to state	1.82%	1

Ethnicity*		62
White	43.55%	27
Asian	32.26%	20
Hispanic	9.68%	6
Pacific Islander	0.00%	0
Black	4.84%	3
Native American	1.61%	1
Mixed	4.84%	3
Declined to state	3.23%	2

* ethnicity specifications are not exclusive

Edit this form

47 responses

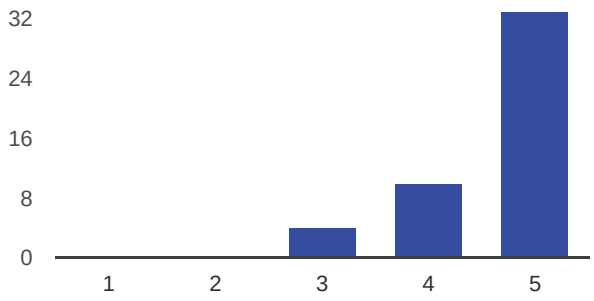
47 responses out of 55 participants = 85% response rate

View all responses Publish analytics

Summary

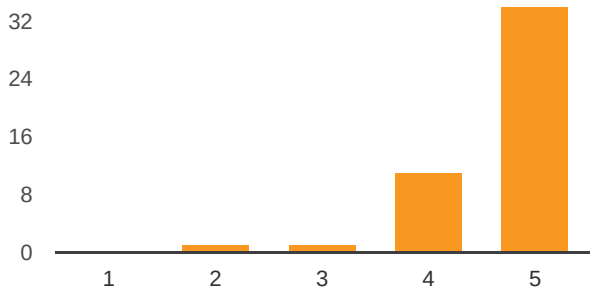
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**4**	8.5%
	4	**10**	21.3%
Very much:	5	**33**	70.2%

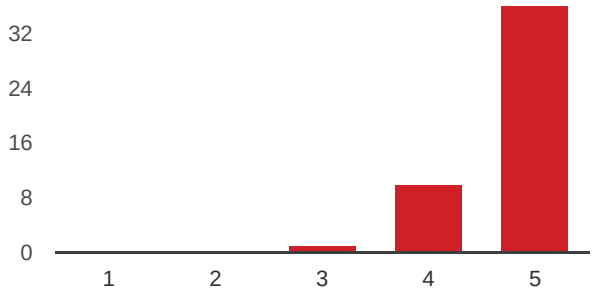
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**1**	2.1%

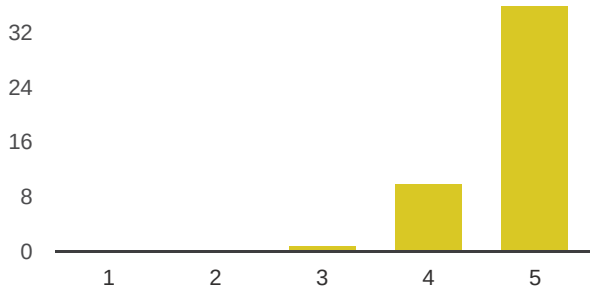
	3	**1**	2.1%
	4	**11**	23.4%
Very much:	5	**34**	72.3%

The school was intellectually stimulating



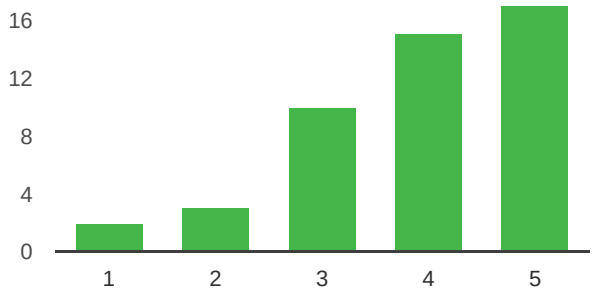
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	2.1%
	4	**10**	21.3%
Very:	5	**36**	76.6%

The overall experience of the school was worthwhile



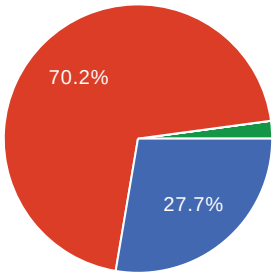
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	2.1%
	4	**10**	21.3%
Very:	5	**36**	76.6%

The TA sessions were helpful



Not at all: 1	**2**	4.3%
2	**3**	6.4%
3	**10**	21.3%
4	**15**	31.9%
Very much: 5	**17**	36.2%

The amount of material presented was:



Too much	**13**	27.7%
Just the right amount	**33**	70.2%
Not enough	**0**	0%
No opinion	**1**	2.1%

Additional comments on the topic presentation and organization

The first week on Harmonic Analysis was excellent! The second week was much more difficult, but even when the technical details were too much, I learned nice ideas and intuition.

A lot of material! (Huge props to Simon and Jose Luis for giving lectures with less than 24 hours notice.)

more time to individually work on problems before the discussion sessions would have been helpful

Playing catch up with the less experienced students was not efficient. Either you were well versed in Harmonic Analysis or your spent most of your time studying on your own to learn that material.

I wish we could have had more time to review the topics treated during the lectures and for personal study. Expecially during the afternoon sessions.

The topic presentation was well done. The TA sessions weren't particularly helpful, as they seemed to just be extra lecture sessions.

It was such a great experience at MSRI. Materials presented were very helpful and useful. Organization part was outstanding.

It will be nice to have more time for problems in the afternoon. Maybe organize problems into an assignment?

It was fairly specialized and it was a little rushed. Overall, I am still happy with the experience and would love to do it again.

It was difficult to digest the vast amount of material within only a few hours, especially during the second week.

The organization of the topics presented was very appropriate. It was clear that the speakers have a deep understanding of all the material and ideas presented.

It was great!

It will be better to have discussion session as a discussion not just additional lectures.

Just great.

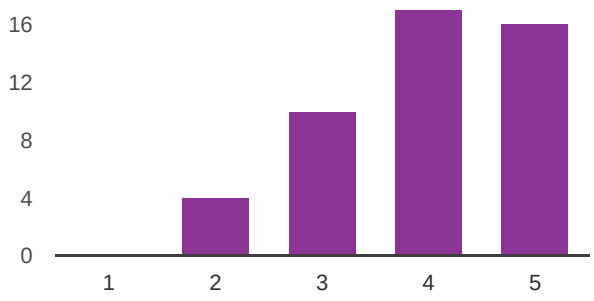
I enjoyed the summer school on harmonic analysis and elliptic PDEs very much. I knew very little harmonic analysis before this school, so I had to learn a lot of the topics from scratch. Prof. Hoffman was very well organized; he even numbered each result he mentioned during the lecture, which was for the most part useful. Prof. Martell was also equally organized but with a different style. His lectures were very consistent and not too hard to follow. The TA sessions were helpful, but more often than not were lectures meant to cover what had not been covered during the morning lectures. Personally, I think that it would have been very useful if at least one of the TA lectures was an actual problem session. This might have resulted in increased time to work on the problems assigned and would have helped me digest the material covered with more ease.

It was quite ambitious to present such a topics in two weeks. I think definitely need more time, as I would love to see more on how the three things come together.

The TA's should have reviewed material from lecture instead of the long, tedious presentations. For example, nobody wanted to see all the Sobolev theorems proved - simply stating them and talking about their use would have been more beneficial, or even mentioning that they can be proved with different tools than Evans (i.e. dyadic cube decomposition instead of polar coordinates). It also would have been useful to have handouts with notes (I know this takes a long time and maybe isn't feasible)- it was quite difficult to take notes and pay attention, especially from the back row seats.

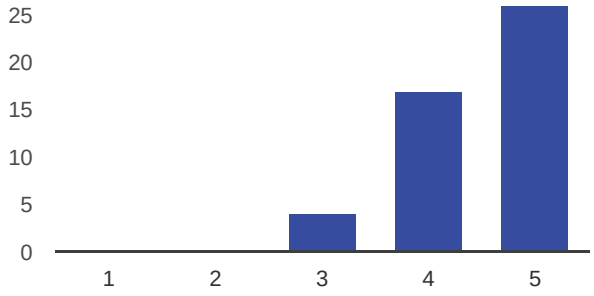
Personal assessment

I was well prepared to benefit from the school



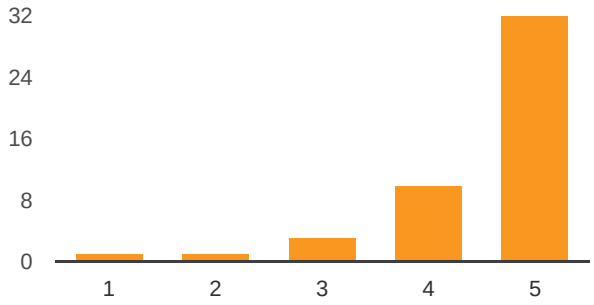
Not at all:	1	**0**	0%
	2	**4**	8.5%
	3	**10**	21.3%
	4	**17**	36.2%
Very:	5	**16**	34%

My interest in the subject matter was increased by the school

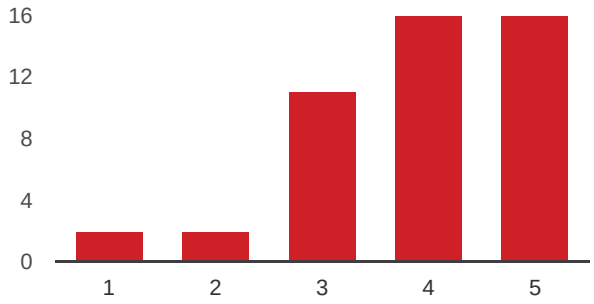


Not at all:	1	**0**	0%
	2	**0**	0%
	3	**4**	8.5%
	4	**17**	36.2%
Very much:	5	**26**	55.3%

The school helped me meet people with similar scientific interests

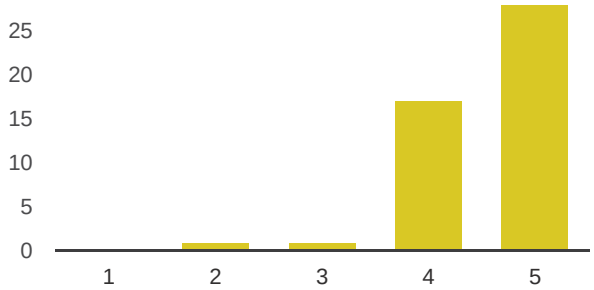


It is likely that I will work in the area of the school subject in the future



Not at all:	1	**2**	4.3%
	2	**2**	4.3%
	3	**11**	23.4%
	4	**16**	34%
Very:	5	**16**	34%

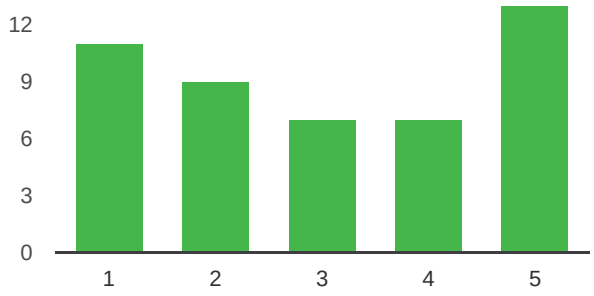
How would you evaluate your interaction with other participants?



not satisfactory:	1	**0**	0%
	2	**1**	2.1%
	3	**1**	2.1%

	4	**17**	36.2%
above satisfactory:	5	**28**	59.6%

Did you find the library session useful?



not satisfactory:	1	**11**	23.4%
	2	**9**	19.1%
	3	**7**	14.9%
	4	**7**	14.9%
above satisfactory:	5	**13**	27.7%

Additional Comments on personal assessment

Would definitely attend another school in the future.

For a few groups of students, the library orientation eats up some class time (around 5 to 10 minutes), which I think should be avoided. I find some of the topics covered in the library session useful, but others are unnecessary. For example most people can easily figure out by themselves how the printer works (if they haven't already done so), and how the books and journals are arranged.

I wish the library will be open for longer time in the evening.

All good. Great opportunity to collaborate with other young people starting off in the field.

The library session went over the lecture and it was almost completely useless. The librarian is a very sweet and helpful person, but the way the session is organized is a complete waste of time. I've learned nothing new from it. (Locations of the book and access to the computer is pretty straightforward anyway) The fact that people had to miss even half hour of lecture is especially bad.

The problem with the library session is that it was almost all information graduate students either know (stuff about arxiv, mathscinet, etc) or is irrelevant (e.g. how to choose a grad school, how to survive first year of grad school, etc.) It also took too long and made people miss the start of sessions. I think this would have been very helpful if I was an undergrad.

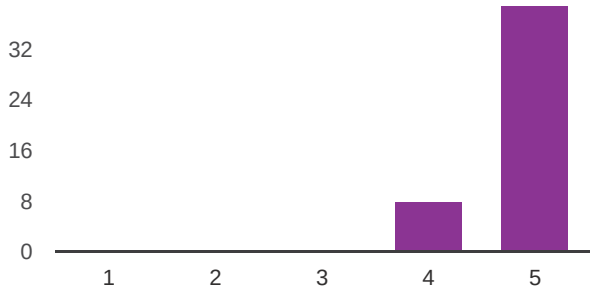
The library session would have been helpful for me in earlier years. By this point in my graduate student career, all the information presented was more or less known to me.

I just love the friendly environment at msri. The tea time and lunch break allow me to talk to more people.

I personally hadn't seen any of the material past the first day... I was able to follow through the first week, but the second week, I was totally lost

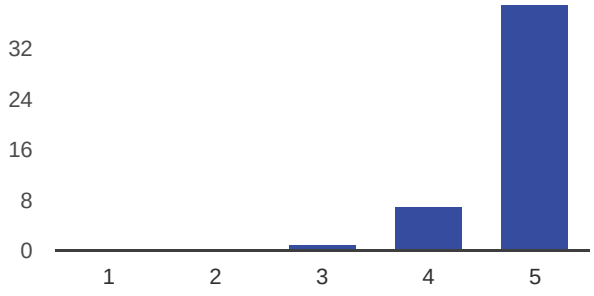
MSRI Venue

I found the MSRI staff helpful



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**8**	17%
Very:	5	**39**	83%

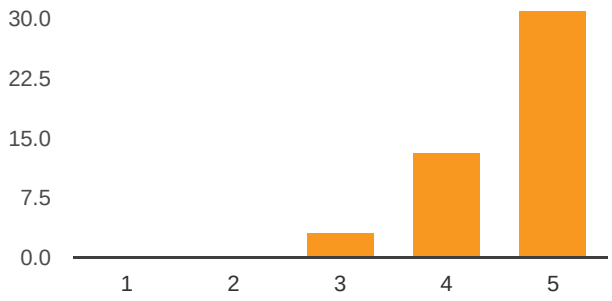
The MSRI physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**1**	2.1%
	4	**7**	14.9%

Very: 5	**39**	83%

The MSRI computer facilities were adequate for such a school



Not at all: 1	**0**	0%
2	**0**	0%
3	**3**	6.4%
4	**13**	27.7%
Very: 5	**31**	66%

Additional comments on the MSRI venue

Absolutely wonderful library!

MSRI is a very nice place!!

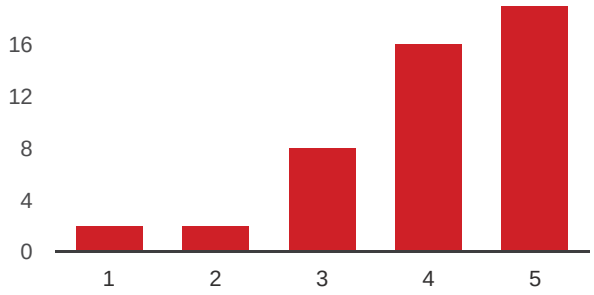
Outstanding !!

It wasn't super clear to me coming in that getting up to the MSRI from the dorms on campus needed the bus. Looking at a map it seemed walkable (not catching topography). This may have been in emails, and I just missed it, but it would be helpful to highlight where the shuttle bus leaves from and how hard it is to get to the location otherwise.

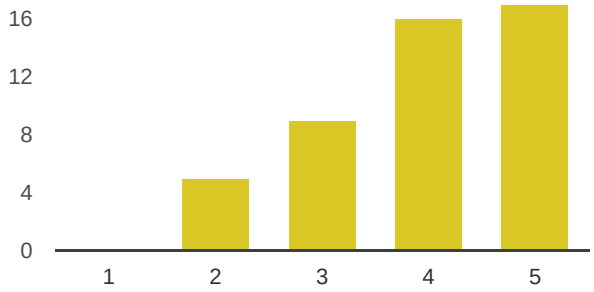
One of the most beautiful places I've been!

Accommodation and Food

The summer school accommodation

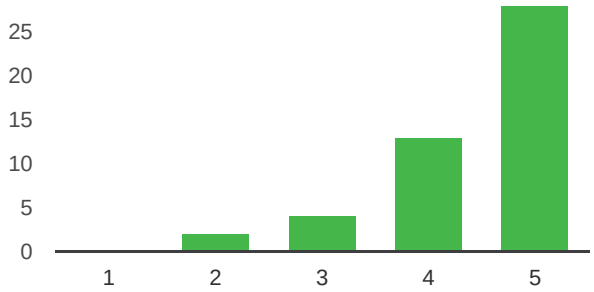


The food at the dormitories



not satisfactory:	1	**0**	0%
	2	**5**	10.6%
	3	**9**	19.1%
	4	**16**	34%
above satisfactory:	5	**17**	36.2%

The food provided at MSRI



not satisfactory:	1	**0**	0%
	2	**2**	4.3%
	3	**4**	8.5%

	4	**13**	27.7%
above satisfactory:	5	**28**	59.6%

Additional comments on accommodation and food

the staff at lunch were doing a very good job accommodating dietary restrictions

Great cook! He deserves an award. The bread pudding was so good tho

Some people around me complained that the food provided for lunch at MSRI is not enough.

The dormitory was not very well-kept. There were many spiders. Many many.

Everything was good so far. Food at dormitories was great !! I have a small comment though: I was said in my email that we will be provided a bar of soap. That is way I came without soap. Which was not actually there. I had to struggle to find a place to buy it in this new area. I will request you to remove it form the list so that everybody will come with their proper arrangement. It was not a big deal but I had to wait hours to take shower.

I'd rather have a per diem to buy my own meals than have the cafeteria meals in the dormitory.

It would be great to have hot eggs at the dormitory's dining place. They also mix juices with water a lot.

The vegetarian option was not at all sufficient for me. I found myself having to bring additional food, so that I wouldn't be too famished to pay attention during the lectures.

The Foothill accommodations were not really appropriate for adults, and would've been a freshman level dorm at most universities I've seen, as evidenced by the crowds of middle schoolers staying in the same facility. The lack of AC and uncomfortable heat necessitated constantly open windows so I suffered from terrible allergies the whole second week. There was also a full blown concert going on not 30 yards away from my room the last night I was there. This was made worse by the fact that I had to wake up very early the next morning and my walls were literally shaking with the noise. The food was mostly fine if you could beat the swarms of children to the dining hall, but I was served very pink chicken on two occasions and there was a severe lack of variety in the food served from day to day.

A small per diem would be preferred to food at dormitories. The dorm rooms have bad mattresses and sharing a room for two weeks might be very inconvenient especially considering the tight schedule of the school. Food at the MSRI is very good and the cooks are lovely.

The lunches served at MSRI were amazing! Compliments to the chef!

Very satisfying vegetarian food at msri! Better pillows please!

The Dorms we stayed at had bugs everywhere. There were spiders in spider webs all over the lights in the hallways of our suites. They didn't provide soap like they said they would. Towels were only changed once instead of every two days like we were told.

Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

I think some different accommodation should be made for the transportation from the dorm to the msri. The walk up was hard and the busses were almost always crowded.

Is there a way to require attendance? I noticed that some students stopped attending as early as the middle of the first week. It bothers me that they are taking the spots of students who would benefit much more from the program.

Long live MSRI. Incredibly worthy institution in wonderful place!!

Overall a great experience.

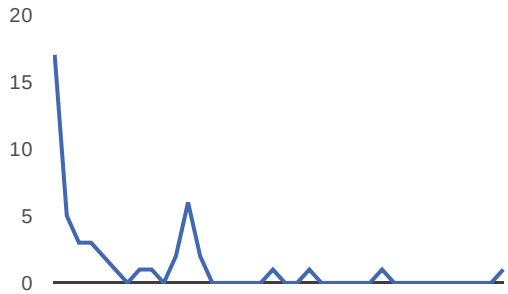
I overall was very happy with the experience.

My MSRI experience was excellent, the organizers and TA's were very insightful and energetic in their teaching. However, the dorms were very uncomfortable for adults and I believe changing accommodations from Foothill to a nicer dorm would help students maintain focus and motivation for the entire two weeks in the future.

Very good overall

I really enjoyed the summer school. It was well organized and the lectures were extremely interesting. On top of that, MSRI is in a wonderful location.

Number of daily responses



Mathematical Sciences Research Institute

Summer Graduate School
Chip Firing and Tropical Curves

July 25, 2016 - August 05, 2016

MSRI, Berkeley, CA, USA

Organizers:

Matthew Baker (Georgia Institute of Technology)

David Jensen (University of Kentucky)

Sam Payne (Yale University)

PROPOSAL FOR A 2016 MSRI SUMMER SCHOOL ON CHIP FIRING AND TROPICAL CURVES

MATTHEW BAKER, DAVID JENSEN, AND SAM PAYNE

1. Introduction

The goal of this summer school was to introduce a diverse group of students to chip firing and tropical curves, a topic of significant recent interest in combinatorics, algebraic geometry, and tropical geometry. To accomplish this, we had:

(1) **two lectures per day**, for all but the last day of the workshop. Taught by the three organizers, these lectures formed a coherent narrative, covering such topics as the combinatorics of chip-firing, the geometry of specialization, and the structure of Berkovich analytic spaces.
(2) **one TA session per day**, taught by the teaching assistants, Yoav Len and Dhruv Ranganthan. These informal sessions, which were not attended by the lecturers, provided a comfortable environment for students to ask questions and discuss ideas. The purpose of the sessions was to reinforce and deepen students' understanding of the material from the lectures, and in certain cases, to discuss material relevant to future lectures.
(3) **one problem session per day**, in which the students broke up into groups to work on problem sets. The problem sets covered a wide range of material, including topics of combinatorial, algebraic, and geometric flavor. Students were free to choose which problem sets to work on, and were encouraged to work at their own pace, some spending the entire two weeks on one or two problem sets, and others finishing a new one almost every day.
(4) **five research talks**, one for each of the lecturers and each of the TAs, on the final two days of the summer school. These introduced students to current research topics in the divisor theory of tropical curves. The talks covered Clifford's theorem for tropical curves, the tropical Hurwitz space, specialization of theta characteristics to tropical curves, the topology of the moduli space of tropical curves, and bounding the number of rational points on curves over number fields.

In addition, there were several activities planned to foster interaction and comraderie among the students, including a short hike and picnic on each of the two Wednesday afternoons, and a magic show at the end of the program.

2. Evaluation of the components of the program

Most of the students appeared to learn a lot from the lectures. They remained interested and engaged throughout both weeks, and their energy did not fade. We received many comments from students praising the overall development of the lectures, with each one building on those that came before, but covering a wide variety of topics, providing ample material for students with diverse backgrounds or tastes. The lectures also exposed students to a large number of open problems in the divisor theory of tropical curves, suggesting future directions for discussion and research.

The teaching assistants report that they received quite a few questions during the TA sessions, and they were often able to supplement or clarify the lectures by working through explicit, concrete examples. This was a valuable resource for many of the students.

The afternoon problem sessions were possibly the most valuable experience for students attending the summer school. The problem sets were designed to lead students step-by-step from basic material to significant results in the field. By working on these problems, students learned a lot of mathematics, developing knowledge and intuition that cannot be obtained by attending a lecture. The problem sessions also gave students an opportunity to meet and interact with one another. Many of the students commented that the problem sessions were among the workshop's most memorable activities, a chance for them to really learn the material.

The research talks provided students a chance to learn of recent developments in the field. Students were well prepared to follow these talks by the end of the two weeks, and many expressed interest in open problems and future directions.

3. Students

The students in the program had very diverse backgrounds. Prior to the workshop, we asked students to complete a survey indicating their familiarity with various terms that we were planning to discuss. While a few of the students were already familiar with all of the terms, most indicated either a strong background in combinatorics without much algebraic geometry, or a strong background in algebraic geometry without much combinatorics. The workshop attracted students from all areas of the country and many different institutions, including a number of female students and students from underrepresented minority groups.

Most of the students reported learning quite a bit from the workshop, despite the large variance in student's backgrounds and experiences. This was due in no small part to the workshop's emphasis on student-run activities, including the TA sessions and problem sessions in which students were encouraged to work on problems of their own choosing at their own pace. Because they worked on the problems in groups, students also benefited from the varied interests and expertise of their peers.

4. Details on lectures

The subject of chip-firing and tropical curves was particularly well-suited to an MSRI summer school, because very little formal background is needed. The combinatorial aspects of the subject, which are quite beautiful and lead to cutting-edge research problems, are almost entirely self-contained.

The lectures began with some discussion of the more combinatorial aspects of chip-firing and tropical geometry. Tropical geometry uses a combination of techniques from algebraic geometry, combinatorics, and convex polyhedral geometry to study degenerations of algebraic varieties. The simplest tropical objects are tropical curves, which one can think of as combinatorial analogues, or more suggestively "shadows", of algebraic curves. An abstract tropical curve is essentially just a metric graph. That is, a finite graph with a positive length attached to each edge. Linear equivalence of divisors on an abstract tropical curve Γ is determined by a simple but rich combinatorial process called chip firing, which was discovered independently in the (non-metric) discrete setting by several different groups of mathematicians. The Jacobian of a tropical curve is a g-dimensional real torus, where $g = \dim H_1(\Gamma, \mathbb{R})$ is the *genus* of Γ. The discrete analogue of this group is sometimes called the *critical group* of a graph, or the *sandpile group*; its order is the number of spanning trees of the graph and there are several interesting

combinatorial bijections between spanning trees and degree-zero divisor classes on graphs. Divisors on tropical curves obey a Riemann-Roch theorem $r(D) - r(K - D) = \deg(D) + 1 - g$ analogous to the classical result; the proof relies on the theory of *reduced divisors*, whose discrete analogues are variously known as G-parking functions or critical configurations. There are some important non-obvious compatibilities between the discrete and tropical divisor theories, such as Luo's theorem on rank-determining sets.

The next few lectures focused on the analogy between tropical and algebraic geometry, and how techniques from the former subject can be used to derive results in the latter. From a pedagogical point of view, one can view tropical curves and their Jacobians as a "hands-on" combinatorial model for the highly analogous but more abstract theory of algebraic curves and their Jacobians. However, there is much more to the story than this: one can in fact use reduced divisors and tropical Riemann-Roch to prove interesting theorems in algebraic geometry and number theory. For example, in complex algebraic geometry, the celebrated Brill-Noether Theorem of Griffiths and Harris says that the naive expected dimension of the space of divisor classes of degree d that move in a linear series of dimension at least r is correct for the general curve of genus g. This theorem and the companion Gieseker-Petri theorem have recently been given a new proofs by tropical methods. As another example, tropical Riemann-Roch can be used in conjunction with the method of Chabauty-Coleman to give new bounds on the number of rational points on algebraic curves of genus at least 2.

By the end of the first week, the lectures turned to more technical aspects of tropicalization. The connection between the classical and tropical worlds, in these contexts, comes from specialization of divisors from curves to graphs. More concretely, given a curve X over a non-archimedean field K, one can construct a *skeleton* Γ associated to X, which is naturally a tropical curve. There is also a natural specialization map from divisors on X to divisors on Γ which respects linear equivalence. The *specialization lemma* asserts that the rank of a divisor cannot go down under specialization. The most natural way to understand the construction of the skeleton Γ and the specialization map $\mathrm{Div}(X) \to \mathrm{Div}(\Gamma)$ is through Berkovich's theory of analytic spaces. (Fortunately, only a small part of Berkovich's general theory is needed to work with and appreciate this theoretical framework.)

The field of tropical geometry and its relation to chip firing and Berkovich spaces is relatively new, so participants had the opportunity to start from scratch and still get a glimpse of the cutting edge in this active research area. By the end of the workshop, students were prepared to follow talks on current research in the divisor theory of tropical curves. They were introduced to open problems and some of the most promising areas of active research within the subject.

5. Conclusion

The feedback we heard from students, both direct and indirect, was both positive and enthusiastic. This workshop appears to have been highly successful.

MSRI Mathematical Sciences Research Institute

Chip Firing and Tropical Curves

July 25, 2016 - August 05, 2016

Schedule

Monday July 25, 2016			
9:15 AM - 9:30 AM	Simons Auditorium		Welcome to MSRI
9:30 AM - 10:30 AM	Simons Auditorium	Matthew Baker	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Matthew Baker	Lecture
12:00PM - 2:00 PM	Atrium		Lunch
2:00 PM- 3:00PM	Simons Auditorium		TA Session
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium		Problem Sets

Tuesday July 26, 2016			
9:30 AM - 10:30AM	Simons Auditorium	David Jensen	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	David Jensen	Lecture
12:00 PM - 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:00PM - 3:15 PM	Atrium		Tea
3:30PM -4:30 PM	Simons Auditorium		Problem Sets

Wednesday July 27, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Sam Payne	Lecture
10:30 AM -11:00 PM	Atrium		Break
11:00 PM - 11:30 PM	Simons Auditorium	Sam Payne	Lecture
11:30 PM - 2:00 PM	Tilden Park		BBQ Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium		Problem Sets

Thursday July 28, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Matthew Baker	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Matthew Baker	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:00 PM - 3:30 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Sets

Friday July 29, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	David Jensen	Lecture
10:30AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	David Jensen	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:15PM - 3:45 PM	Atrium		Tea Break
3:30 PM - 4:30 PM	Simons Auditorium		Problem Sets

Monday Aug 1, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Sam Payne	Lecture
10:30AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Sam Payne	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:30 PM - 4:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium		Problem Sets

Tuesday Aug 2, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Matthew Baker	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Matthew Baker	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 3:00 PM	Simons Auditorium		TA Session
3:00 PM - 3:30 PM	Atrium		Tea
3:30 PM - 4:30 PM	Simons Auditorium		Discussion Session 2

Wednesday Aug 3, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	David Jensen	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	David Jensen	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 03:00 PM	Simons Auditorium		TA Session
3:00 PM - 03:30 PM	Atrium		Tea
3:30 PM - 04:30 PM	Simons Auditorium		Problem Sets

Thursday Aug 4, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Sam Payne	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Sam Payne	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 03:00 PM	Simons Auditorium		Lecture
3:00 PM - 03:30 PM	Atrium		Tea
3:30 PM - 04:30 PM	Simons Auditorium		Problem Sets

Friday Aug 5, 2016			
9:30 AM - 10:30 AM	Simons Auditorium	Yoav Len	Lecture
10:30 AM - 11:00 AM	Atrium		Break
11:00 AM - 12:00 PM	Simons Auditorium	Dhruv Ranganathan	Lecture
12:00 PM- 2:00 PM	Atrium		Lunch
2:00 PM - 03:00 PM	Simons Auditorium		David Jensen
3:00 PM - 03:30 PM	Atrium		Tea
3:30 PM - 04:30 PM	Simons Auditorium	Sam Payne	Lecture

Organizers		
First Name	**Last Name**	**Institution**
Matthew	Baker	Georgia Institute of Technology
David	Jensen	University of Kentucky
Sam	Payne	Yale University
Speakers		
First Name	**Last Name**	**Institution**
Matthew	Baker	Georgia Institute of Technology
David	Jensen	University of Kentucky
Yoav	Len	Fields Institute for Research in Mathematical Sciences
Sam	Payne	Yale University
Dhruv	Ranganathan	Massachusetts Institute of Technology

MSRI Supported Students

First Name	Last Name	Institution
Yang	An	Columbia University
Demara	Austin	Kansas State University
Samuel	Backlund	University of Vermont
Matthew	Baker	Georgia Institute of Technology
Roberto	Barrera	Texas A & M University
Daniel	Bernstein	North Carolina State University
Madeline	Brandt	University of California, Berkeley
Charles	Camacho	Oregon State University
Javier	Carvajal	University of Utah
Swee Hong	Chan	Cornell University
Yan	Chu	Duke University
Chad	Duna	University of Kansas
Christopher	Eur	University of California, Berkeley
Elijah	Fender	University of California, Santa Cruz
Andrew	Fry	Colorado State University
Joseph	Gunther	CUNY, Graduate Center
John	Guo	San Francisco State University
Yunlin	He	Indiana University
Natalie	Hobson	University of Georgia
Sam	Hopkins	Massachusetts Institute of Technology
David	Jensen	University of Kentucky
Ayush	Khaitan	Central Michigan University
Jordan	Kostiuk	University of Alberta
Max	Kutler	University of Oregon
Alexander	Lazar	University of Miami
Yoav	Len	Fields Institute for Research in Mathematical Sciences
Pak Hin	Li	Cornell University
Hiram	Lopez Valdez	Centro de Investigacion y de Estudios Avanzados del IPN
Marie	Meyer	University of Kentucky
Cara	Monical	University of Illinois at Urbana-Champaign
Leonid	Monin	University of Toronto
Jackson	Morrow	Emory University
Evan	Nash	Ohio State University
Ignacio	Otero	Centro de Investigacion y Estudios Avanzados (CINVESTAV)
Sam	Payne	Yale University
Michael	Perlman	University of Notre Dame
Michelle	Pinharry	University of Minnesota, Twin Cities
Rohini	Ramadas	University of Michigan
Dhruv	Ranganathan	Massachusetts Institute of Technology
Lisa	Sauermann	Stanford University
Anna	Schindler	San Francisco State University
Jifeng	Shen	Yale University
Ola	Sobieska	Texas A & M University
Padmavathi	Srinivasan	Massachusetts Institute of Technology
Caitlin	Stanton	Stanford University
Matthew	Stevenson	University of Michigan

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Do	Tran	Duke University
Ryan	Vitale	Indiana University
Robert	Walker	University of Michigan
Anna	Weigandt	University of Illinois at Urbana-Champaign
Keyvan	Yaghmayi	University of Utah
Jinhe	Ye	University of Notre Dame
Chi Ho	Yuen	Georgia Institute of Technology
Zhongyi	Zhang	Columbia University
Xiao	Zheng	Boston University

Officially Registered Student Information

Participants		55

Gender		55
Male	74.55%	41
Female	25.45%	14
Declined to state	0.00%	0

Ethnicity*		63
White	52.38%	33
Asian	26.98%	17
Hispanic	7.94%	5
Pacific Islander	0.00%	0
Black	3.17%	2
Native American	1.59%	1
Mixed	6.35%	4
Declined to state	1.59%	1

* ethnicity specifications are not exclusive

Edit this form

46 responses

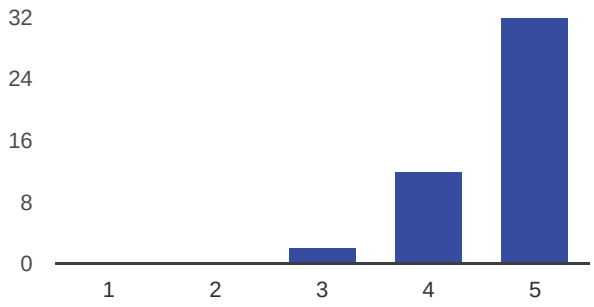
46 responses out of 55 participants = 84% response rate

View all responses Publish analytics

Summary

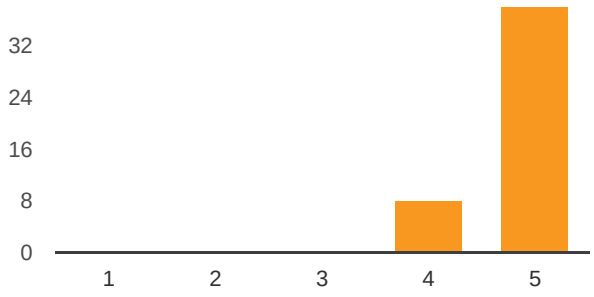
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**2**	4.3%
	4	**12**	26.1%
Very much:	5	**32**	69.6%

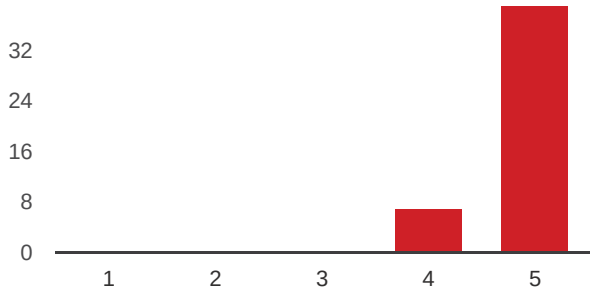
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**0**	0%

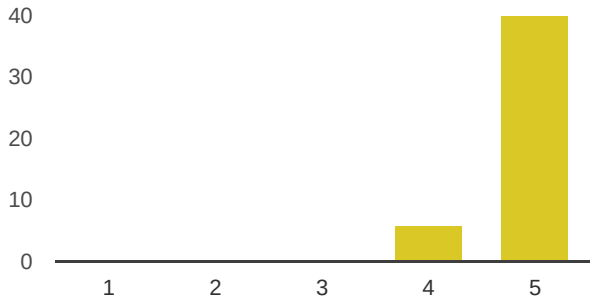
3	**0**	0%
4	**8**	17.4%
Very much: 5	**38**	82.6%

The school was intellectually stimulating



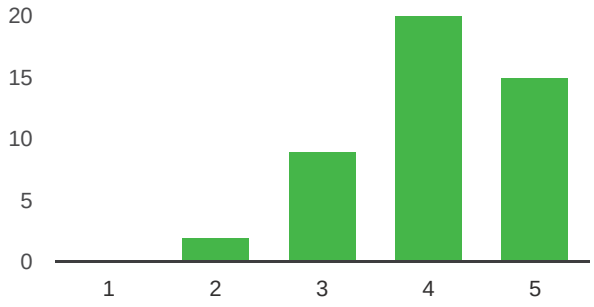
Not at all: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**7**	15.2%
Very: 5	**39**	84.8%

The overall experience of the school was worthwhile



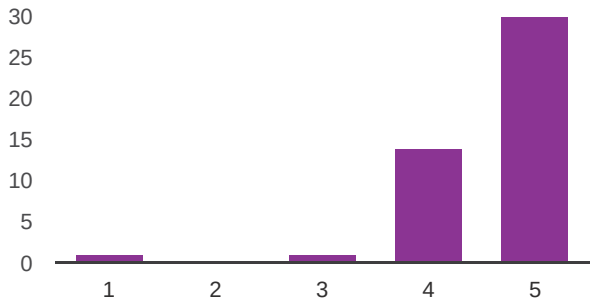
Not at all: 1	**0**	0%
2	**0**	0%
3	**0**	0%
4	**6**	13%
Very: 5	**40**	87%

The TA sessions were helpful



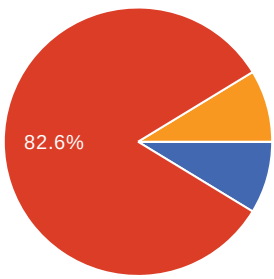
Not at all:	1	**0**	0%
	2	**2**	4.3%
	3	**9**	19.6%
	4	**20**	43.5%
Very much:	5	**15**	32.6%

The problems sessions were helpful



Not at all:	1	**1**	2.2%
	2	**0**	0%
	3	**1**	2.2%
	4	**14**	30.4%
Very much:	5	**30**	65.2%

The amount of material presented was:



Too much	**4**	8.7%
Just the right amount	**38**	82.6%
Not enough	**4**	8.7%
No opinion	**0**	0%

Additional comments on the topic presentation and organization

The presentation was amazing.

My only complaint with the material is that the material covered during the lectures essentially encapsulated the information from the suggested reading before the workshop.I would have liked to go into some more advanced topics earlier in the lecture series. It was very nice to get the opinions and impressions of mathematicians outside of my area. I found that very enlightening!

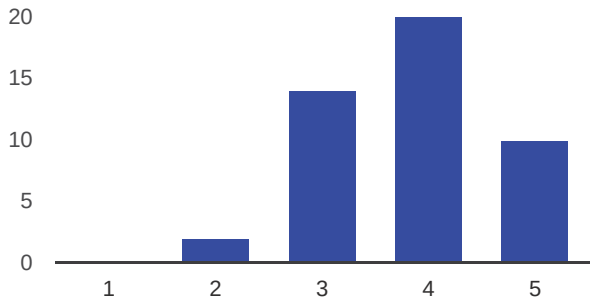
The organizers designed a wonderful course, which covered an impressive amount of material yet never felt overwhelming. The problem sets were a perfect compliment to the lectures.

It was awesome! I've never had a TA session in a summer school like this. It was a great idea.

The summer school was an amazing experience! I learned a lot and met many researchers in the area. I am excited to learn more and do research in this topic.

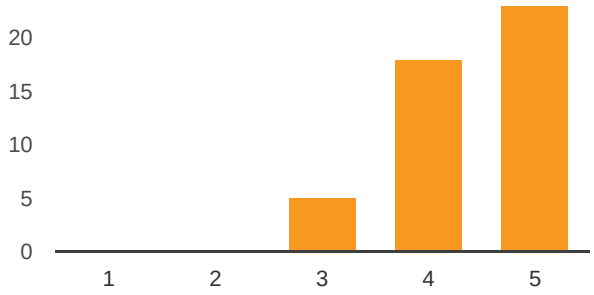
Personal assessment

I was well prepared to benefit from the school



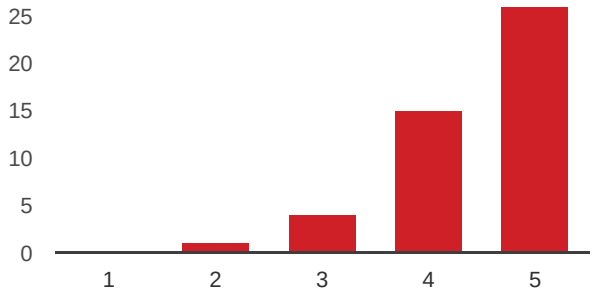
Not at all: 1	**0**	0%
2	**2**	4.3%
3	**14**	30.4%
4	**20**	43.5%
Very: 5	**10**	21.7%

My interest in the subject matter was increased by the school



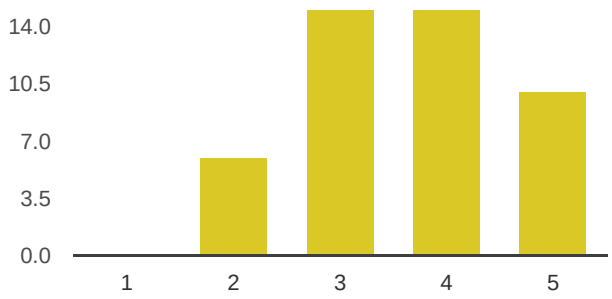
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**5**	10.9%
	4	**18**	39.1%
Very much:	5	**23**	50%

The school helped me meet people with similar scientific interests

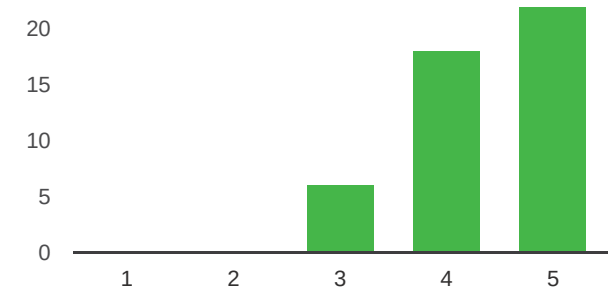


Not at all:	1	**0**	0%
	2	**1**	2.2%
	3	**4**	8.7%
	4	**15**	32.6%
Very much:	5	**26**	56.5%

It is likely that I will work in the area of the school subject in the future



How would you evaluate your interaction with other participants?



not satisfactory:	1	**0**	0%
	2	**0**	0%
	3	**6**	13%
	4	**18**	39.1%
above satisfactory:	5	**22**	47.8%

Additional Comments on personal assessment

Really excellent summer school. Organizers were very encouraging and helpful. I learned a lot and started a new research project with other attendees.

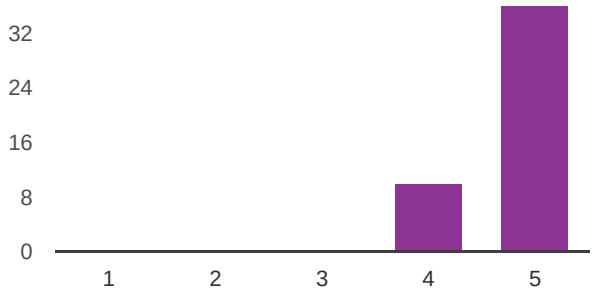
I found a wonderful community of young mathematicians at this summer school. Everyone was supportive and collegial, and differences in age and experience with the topic were no barrier to fruitful conversations and friendly interaction.

Everyone interacted just fine. Perhaps there could have been some ice breaker even the first evening but not necessary.

Problem sessions provided great experience for learning the topics.

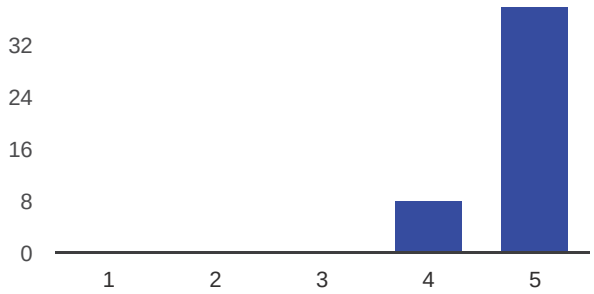
MSRI Venue

I found the MSRI staff helpful



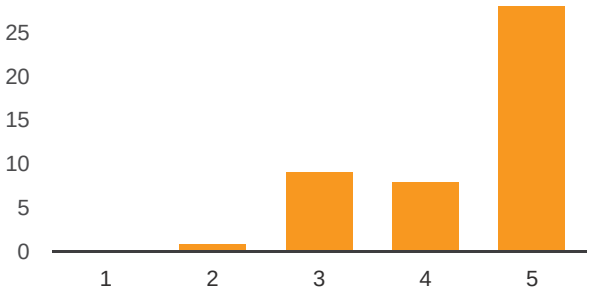
Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**10**	21.7%
Very:	5	**36**	78.3%

The MSRI physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**0**	0%
	4	**8**	17.4%
Very:	5	**38**	82.6%

The MSRI computer facilities were adequate for such a school



Additional comments on the MSRI venue

somewhat frustrating that Dropbox was blocked from the MSRI network as I use it to collaborate with my advisor

I often use Dropbox to collaborate and it appears to have been blocked by the MSRI firewall.

A beautiful venue.

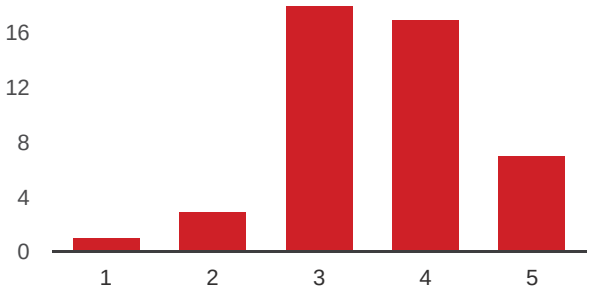
I didn't use the computer facilities so I cannot rate them.

I was very happy with the MSRI facilities and location. Looking down on Berkeley and across the bay, I found it easy to put the chaos of the world aside and focus on the mathematics and the people around me. I loved walking down the hill each afternoon--a great way to cap off a day of heavy thinking--and occasionally walking up in the morning.

MSRI staff was amazing! Staff was helpful and answered questions and were always friendly and nice.

Accommodation and Food

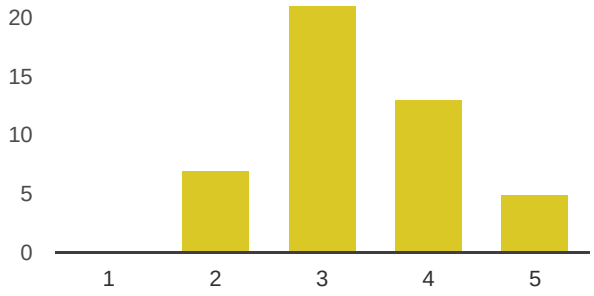
The summer school accommodation



not satisfactory:	1	**1**	2.2%
	2	**3**	6.5%
	3	**18**	39.1%

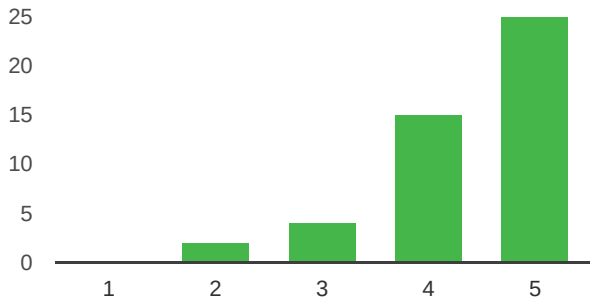
	4	**17**	37%
above satisfactory:	5	**7**	15.2%

The food at the dormitories



not satisfactory:	1	**0**	0%
	2	**7**	15.2%
	3	**21**	45.7%
	4	**13**	28.3%
above satisfactory:	5	**5**	10.9%

The food provided at MSRI



not satisfactory:	1	**0**	0%
	2	**2**	4.3%
	3	**4**	8.7%
	4	**15**	32.6%
above satisfactory:	5	**25**	54.3%

Additional comments on accommodation and food

I did not stay in the dorms

The dorms were not great, but passable for as short a span as it was.

Food was very good, and there was always plenty of vegetarian food

The dormitory was disappointing. The showers were clogged for the first week.

The dorms were dorms--nothing special, but about what I expected.

Food and chefs at MSRI were awesome!

Food at MSRI was delicious. Snacks and lunch were always very filling. Dorm food was good for dorm food :)

Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

It would have been nice to have been made aware in advance of the plan for a picnic on the second Wednesday. I know some people didn't bring proper footwear for the hike and had to stay behind.

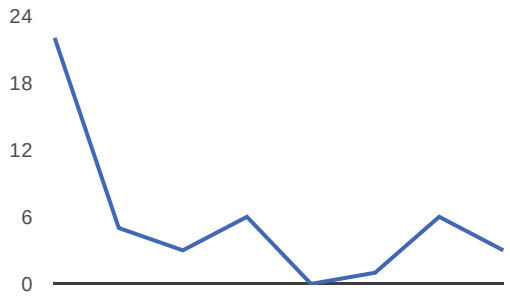
Out of the three organizers and two teaching assistants, there were no women. It is well studied that this adversely affects women in the program: "But most strikingly, among symposia the proportion of female participants differs dramatically by the gender of the organizer. Male-organized symposia have half the number of female first authors (29%) that symposia organized by women (64%) or by both men and women (58%) have, and half that of female participation in talks and posters (65%)." L. A. Isbell, T. P. Young, and A. H. Harcourt, Stag parties linger: continued gender bias in a female-rich scientific discipline, PLOS ONE 7 (2012), no. 11, e49682.

On some mornings there was not enough space on the bus. I think several institutions have programs during the summer that start around 9am. I realize this is probably outside of MSRI's control, but between 8-9am it would be best if the bus ran every 15 minutes.

I am overall very satisfied with my experience at MSRI. I will definitely make an effort to return in the future!

Information about first day travel to MSRI would be helpful, which bus and where. If it was already sent out and I missed then ignore this.

Number of daily responses



Summer Graduate School
Electronic Structure Theory

July 18, 2016 - July 29, 2016

Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Organizers:

Lin Lin (University of California, Berkeley)

Jianfeng Lu (Duke University)

James Sethian (University of California, Berkeley)

Final Report

MSRI-LBNL Summer School on Electronic Structure Theory

July 18 - July 29, 2016

Organizers:
Lin Lin (University of California, Berkeley)
Jianfeng Lu (Duke University)
James Sethian (University of California, Berkeley)

The goal of this workshop was to provide a mathematical introduction to the area of electronic structure theory to a diverse group of students, to help the students cross the language barrier between applied mathematics and computational chemistry and materials science and to prepare them for research in related areas. To accomplish this, we had

1. A two week long course taught together by Lin Lin (UC Berkeley) and Jianfeng Lu (Duke) (2.5 hour each day) starting from basic quantum mechanics, to many-body systems, to density functional theory (DFT), and to more advanced topics in electronic structure theory (e.g., efficient numerical methods based on density matrices, response theory for time-independent and time-dependent problems, correlation energy from random phase approximation).
2. Problem sessions lead by TAs Anil Damle (UC Berkeley) and Kyle Thicke (Duke) where students work on codes in Matlab for a few concrete examples of electronic structure calculations from scratch, including Rabi oscillation, hydrogen atom, DFT calculation for Helium atom, 1D periodic solids, etc. Students also have the chance to ask questions about the lectures or the programming.
3. Four one hour talks to give brief introduction to application of electronic structure theory in chemistry and materials science and other related topics. The talks are “Large scale quantum mechanical simulations of nanosystems” by Lin-Wang Wang (Materials Science Division, LBNL), “Numerical methods for solving the Kohn-Sham problem” by Chao Yang (Computational Research Division, LBNL), “NWChem: Pushing the scientific envelope” by Bert de Jong (Computational Research Division, LBNL), “Beyond DFT: predictng excited-state properties of materials using Green’s function formalisms” by Felipe H. da Jornada (Department of Physics, UC Berkeley). The two TAs also present a half hour talk on their research: “Fast algorithms for localization of Kohn-Sham orbitals” by Anil Damle and “Orbital Minimization Method” by Kyle Thicke.
4. Two one hour tours (20 people for each group) to the Advanced Light Source (ALS), lead by Michael Banda (Deputy Division Director at ALS). He introduced the various facilities and experiments performed at ALS, and motivated the students to connect electronic structure theories to real world experiments.
5. A poster session at the very end of the program, where students present their own research or results of the course projects. Students are encouraged to further explore the area of electronic structure theory by working on a list of course projects, prepared and distributed in the beginning of the program.

Evaluation of the components of the program

Despite the widely variable backgrounds of the students, most students seem to get quite a bit out of the lectures. The interest in the course materials stayed high throughout the two weeks of the program. There were comments from the students concerning the difficulty and pace of more advanced topics during the beginning of the second week. This was addressed immediately by adjusting the content and layout of the lectures. Several students expressed that they have benefited a lot from the lectures.

Many students commented that the afternoon session on programming and questions are extremely helpful. They very much like the opportunity to try themselves to solve electronic structure problems in simple settings. The informal interactions during the coffee breaks and excursions (BBQ lunch and tours of the Advanced Light Source (ALS) at LBNL) are also highly appreciated.

The one hour talks further exposed the students to more frontier topics and the variety of applications of electronic structure theory, which greatly enriched the workshop. In particular, the students find useful to see how the mathematical formulation they learned can be used for real materials applications and to connect to experimental investigation at ALS.

Students

The students of the program had very diverse backgrounds. The combination of domestic and international students (about one third of the students came from abroad from 9 countries) created a productive environment to exchange ideas and expertise. Students formed groups to work on course projects and also discussed with each other on the content of the course and their own research projects.

While most students do not have any prior experience on electronic structure theory, the lectures were designed to start from scratch (the summer school started from basic quantum mechanics). This turns out to be a very good strategy for students with less prepared background in physics. For students with stronger backgrounds, having the opportunity to work on course projects (some of them go beyond the level of the lectures) turns out to be rather useful.

Details on the lecture series

The two-week lectures co-taught by Lin Lin and Jianfeng Lu gives a mathematical introduction to the field of electronic structure theory, in particular the density functional theory. The lectures cover spin-1/2 particle, Schrodinger equations for spin systems and in the real space, hydrogen atom and identical particles, many-body Hamiltonian, Hartree-Fock theory, Kohn-Sham density functional theory, self-consistent field iteration, density matrix and Green’s function, density matrix algorithms, crystal and k-point sampling, localization of Green’s function, perturbation

theory and density functional perturbation theory, time-dependent density functional theory, time-dependent perturbation theory, and RPA correlation energy.

The first week lecture starts from the basic quantum mechanics, and provide a self-contained introduction to the density functional theory for many-electron quantum systems. The second week lecture focuses on two aspects of mathematical study of electronic structure theory: Analysis and algorithms based on the density matrix formulation of DFT and the linear response theory on time-independent and time-dependent systems.

The lectures are also videotaped by MSRI and are available online.

Conclusion

Both organizers thought the graduate summer school worked out very well and was quite successful. The direct and indirect feedback the organizers heard from both students and guest speakers were uniformly positive.

Overall Schedule

08:30-09:00	Registration (**first day only**)
09:00-09:15	Welcoming remarks (**first day only**)
09:15-10:30	Lecture 1 (CRT-3101)
10:30-10:45	Break
10:45-12:00	Lecture 2 (CRT-3101)
12:00-14:00	Lunch Break (LBNL Cafeteria, Bldg 54)
14:00-15:00	Problem session 1 / Talk by guest speaker (CRT-3101)
15:00-15:30	Tea Break
15:30-16:30	Problem session 2 (CRT-3101)

Daily Schedule (updated every day)

7/18 Monday

09:00-09:15	Welcoming remarks by David Eisenbud and James Sethian
09:15-10:30	Lecture. Spin
10:45-12:00	Lecture. Schrodinger equation
14:00-15:00	Problem session. Spin.
15:30-16:30	Problem session. (MATLAB) Rabi oscillation.

7/19 Tuesday

09:15-10:30	Lecture. Two spin-1/2 particles
10:45-12:00	Lecture. Schrodinger equation in the real space
14:00-15:00	Problem session. Examples of Schrodinger equation
15:30-16:30	Problem session. (MATLAB) Harmonic oscillator

7/20 Wednesday

09:15-10:30	Lecture. Hydrogen atom
10:45-12:00	Lecture. Identical particles
14:00-15:00	Guest lecture by Lin-Wang Wang
15:30-16:30	Problem session. (MATLAB) 3D hydrogen atom

7/21 Thursday

09:15-10:30	Lecture. Many-body Hamiltonian
10:45-12:00	Lecture. Hartree-Fock equation
12:00-15:00	BBQ, MSRI Visit, Group photo

7/22 Friday

09:15-10:30	Lecture. Kohn-Sham density functional theory
10:45-12:00	Lecture. Self-consistent field iteration
14:00-15:00	Guest lecture by Chao Yang
15:30-16:30	Problem session. Contour integral formulation

7/25 Monday

09:15-10:30 Lecture. Density matrix representation.
10:45-12:00 Lecture. Green's function
14:00-15:00 Guest lecture by Bert de Jong
15:30-16:30 Problem session. (MATLAB) Hellium

7/26 Tuesday

09:15-10:30 Lecture. Density matrix algorithm
10:45-12:00 Lecture. Crystal. K-point sampling.
13:30-14:30 Problem session. (MATLAB) Solids
15:00-17:00 Visit at Advanced Light Source

7/27 Wednesday

09:15-10:30 Lecture. Localization
10:45-12:00 Lecture. Time independent perturbation
14:00-15:00 Guest lecture by Felipe da Jornada
15:30-16:30 Project

7/28 Thursday

09:15-10:30 Lecture. Density functional perturbation theory
10:45-12:00 Lecture. Time dependent density functional theory
14:00-15:00 Talks by Anil Damle and Kyle Thicke
15:30-16:30 Project

7/29 Friday

09:15-10:30 Lecture. Time dependent response
10:45-12:00 Lecture. RPA correlation energy
14:00-15:00 Poster session
15:00 Summer school adjourn

Organizers		
First Name	**Last Name**	**Institution**
Lin	Lin	University of California, Berkeley
Jianfeng	Lu	Duke University
James	Sethian	University of California, Berkeley

Speakers		
First Name	**Last Name**	**Institution**
Lin	Lin	University of California, Berkeley
Jianfeng	Lu	Duke University
James	Sethian	University of California, Berkeley

LBNL Supported Students		
First Name	**Last Name**	**Institution**
Abhishek	Bagusetty	University of Pittsburgh
Kisung	Chae	Korea Institute for Advanced Study (KIAS)
Fabian	Faulstich	TU Berlin
swarnava	ghosh	Georgia Institute of Technology
Felix	Henneke	TU München
Jiban	Kangsabanik	Indian Institute of Technology Bombay
Jason	Kaye	New York University, Courant Institute
Mykhailo	Kuian	Kent State University
Huan	Lei	Battelle Pacific Northwest Laboratories
Tianyi	Liu	University of California, Berkeley
Fei	Lu	University of California, Berkeley
Martin	Mrovec	Technical University of Ostrava (VSB)
Anh Thai	Nhan	Ohlone College
Hajar	Nsiri	University of bergen
Xinran	Ruan	National University of Singapore
Abhishek	Sharan	University of Delaware
Roel	Van Beeumen	Katholieke Universiteit Leuven
Yangshuai	Wang	Shanghai Jiaotong University
Zhe	Wang	Duke University
Xiaojie	Wu	Pennsylvania State University
Ze	Xu	University of California, Berkeley
Xinshuo	Yang	University of Colorado at Boulder
Jia	Yin	National University of Singapore
Cindy	Zheng	University of California, Berkeley

Officially Registered Student Information

Participants		24

Gender		24
Male	95.00%	21
Female	5.00%	3
Declined to state	0.00%	0

Ethnicity*		24
White	45.45%	5
Asian	36.36%	17
Hispanic	4.55%	0
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	4.55%	0
Declined to state	9.09%	2

* ethnicity specifications are not exclusive

MSRI Supported Students		
First Name	**Last Name**	**Institution**
Pablo	Baldivieso	Portland State University
Dangxing	Chen	University of North Carolina
Jimmy	Corbin	Texas A & M University
Anil	Damle	Stanford University
Michael	Donders	Rutgers University
Brian	Fernandes	University of Waterloo
Tingyue	Gan	University of Maryland
Minh	Kha	Texas A & M University
Yezheng	Li	University of Pennsylvania
Lin	Lin	University of California, Berkeley
Tyson	Loudon	University of Minnesota Twin Cities
Jianfeng	Lu	Duke University
Daniel	Rehn	Stanford University
Lewis	Sears	Washington and Lee University
James	Sethian	University of California, Berkeley
Kyle	Thicke	Duke University
Joseph	Umhoefer	Oregon State University
Yingwei	Wang	Purdue University
Jerome	Weston	Louisiana State University
Leighton	Wilson	University of Michigan

Officially Registered Student Information

Participants		20

Gender		20
Male	95.00%	19
Female	5.00%	1
Declined to state	0.00%	0

Ethnicity*		22
White	45.45%	10
Asian	36.36%	8
Hispanic	4.55%	1
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	4.55%	1
Declined to state	9.09%	2

* ethnicity specifications are not exclusive

Edit this form

22 responses

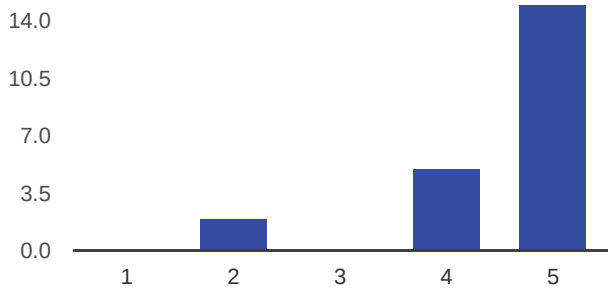
responses out of 44 participants = 5 % response rate

View all responses Publish analytics

Summary

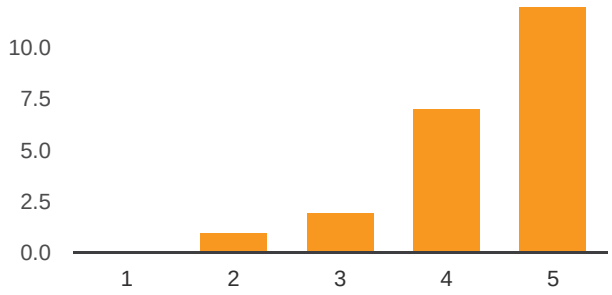
Topic presentation and organization

The various topics within the summer school integrated into a coherent picture



Not at all:	1	**0**	0%
	2	**2**	9.1%
	3	**0**	0%
	4	**5**	22.7%
Very much:	5	**15**	68.2%

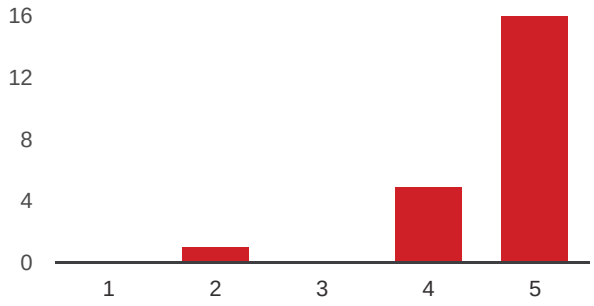
The faculty speakers were generally clear and well organized in their presentation



Not at all:	1	**0**	0%
	2	**1**	4.5%

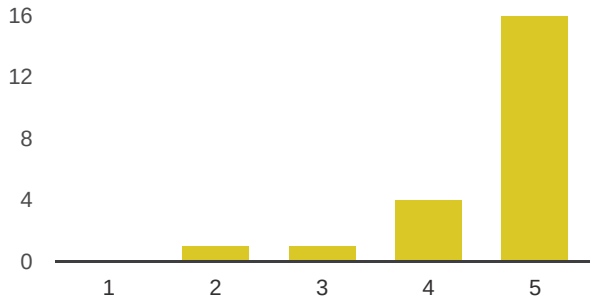
3	**2**	9.1%
4	**7**	31.8%
Very much: 5	**12**	54.5%

The school was intellectually stimulating



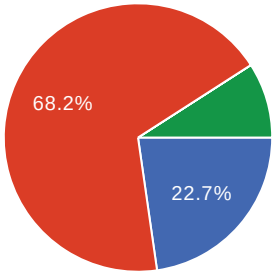
Not at all: 1	**0**	0%
2	**1**	4.5%
3	**0**	0%
4	**5**	22.7%
Very: 5	**16**	72.7%

The overall experience of the school was worthwhile



Not at all: 1	**0**	0%
2	**1**	4.5%
3	**1**	4.5%
4	**4**	18.2%
Very: 5	**16**	72.7%

The amount of material presented was:



Too much	**5**	22.7%
Just the right amount	**15**	68.2%
Not enough	**0**	0%
No opinion	**2**	9.1%

Additional comments on the topic presentation and organization

I really enjoyed the summer school and thought it was a very valuable experience. I think that it would be good to tell students that the course assumes a decent mathematics background (more details in next comment area).

No.

The speed was a little too slow in the first week, and a little too fast in the second week.

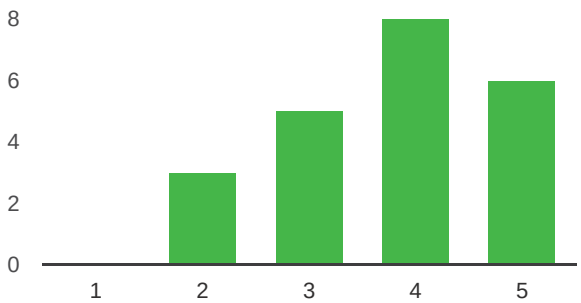
The summer school was great; would love to have seen more code and numerical implementations

The choice of topics and guest talks are all very good.

Felt I was a bit haphazard. Sort or jumped around without giving a clear picture beforehand of what we were going to be doing.

Personal assessment

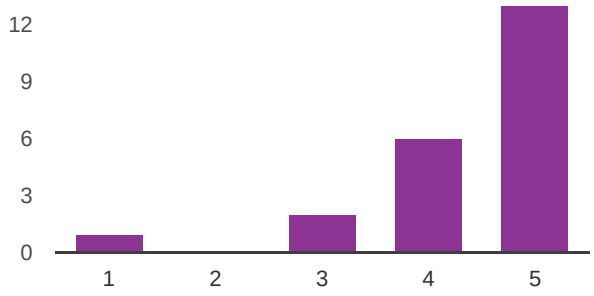
I was well prepared to benefit from the school



Not at all: 1	**0**	0%
2	**3**	13.6%

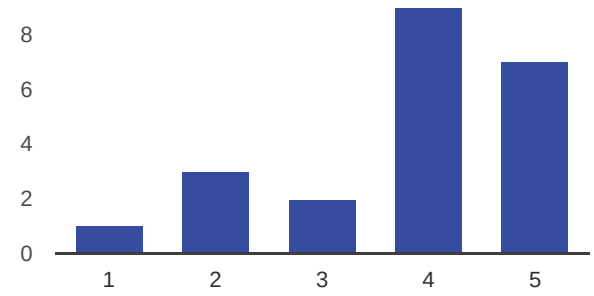
3	**5**	22.7%
4	**8**	36.4%
Very: 5	**6**	27.3%

My interest in the subject matter was increased by the school



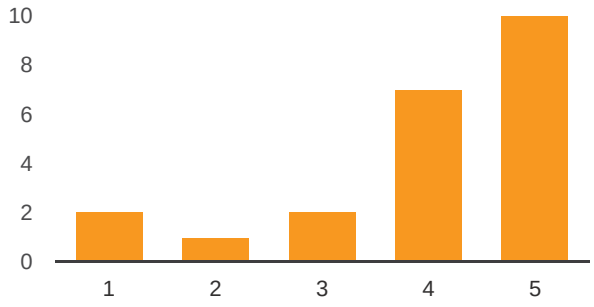
Not at all: 1	**1**	4.5%
2	**0**	0%
3	**2**	9.1%
4	**6**	27.3%
Very much: 5	**13**	59.1%

The school helped me meet people with similar scientific interests



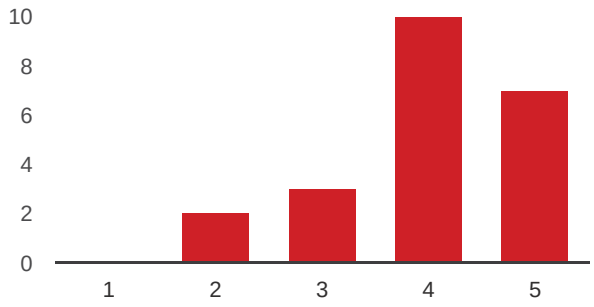
Not at all: 1	**1**	4.5%
2	**3**	13.6%
3	**2**	9.1%
4	**9**	40.9%
Very much: 5	**7**	31.8%

It is likely that I will work in the area of the school subject in the future



Not at all:	1	**2**	9.1%
	2	**1**	4.5%
	3	**2**	9.1%
	4	**7**	31.8%
Very:	5	**10**	45.5%

How would you evaluate your interaction with other participants?



not satisfactory:	1	**0**	0%
	2	**2**	9.1%
	3	**3**	13.6%
	4	**10**	45.5%
above satisfactory:	5	**7**	31.8%

Additional comments on your personal assessment

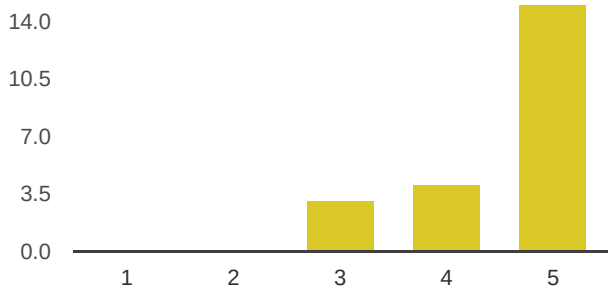
I had done a Master's in applied math and could follow almost everything, but if I had taken this class finishing my Bachelor's in physics, much of it would have been difficult to follow. I believe people with an undergrad math major would be well-prepared, but perhaps new grad students with a physics or engineering background would find the mathematical presentation difficult to follow at times.

No

Was nice but sold as quite a bit broader than it actually turned out to be.

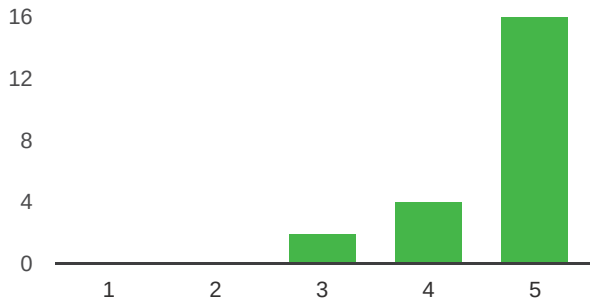
Venue

I found the onsite staff helpful



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**3**	13.6%
	4	**4**	18.2%
Very:	5	**15**	68.2%

The physical facilities were conducive for such a school



Not at all:	1	**0**	0%
	2	**0**	0%
	3	**2**	9.1%
	4	**4**	18.2%
Very:	5	**16**	72.7%

Additional comments on the venue

The location and venue was excellent. I appreciate the fact that it was held at the lab.

No

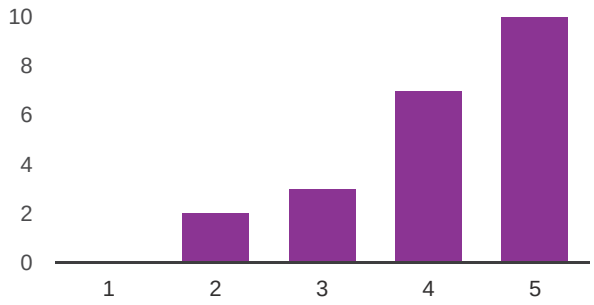
Nice morning exercise to get to the lab ;)

...the hills.....

Perfect

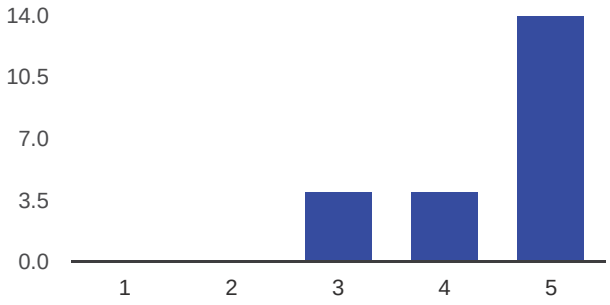
Accommodation and Food

The summer school accommodation



not satisfactory:	1	**0**	0%
	2	**2**	9.1%
	3	**3**	13.6%
	4	**7**	31.8%
above satisfactory:	5	**10**	45.5%

The food provided



not satisfactory:	1	**0**	0%
	2	**0**	0%
	3	**4**	18.2%
	4	**4**	18.2%
above satisfactory:	5	**14**	63.6%

Additional comments on accommodation and food

Sharing a room with a stranger is something I feel like I'm too old for.

No

The vegan options were amazing!! I don't like to share a bedroom.

Apparently vegans took over California.....

We have to move to another dorm on the second night. The keys of our second room cannot open the room easily.

Thank you for completing this survey

We welcome any additonal comments or suggestions you may have to improve the overall experience for future participants.

Thank you for all of organizers and staffs. I had a very good time and learn a lot from Berkeley.

Number of daily responses