



Mathematical Sciences Research Institute

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**Final Report  
on the  
Mathematical Sciences Research Institute  
2018-19 Activities  
supported by  
NSA Grant H98230-18-1-0269  
Support of Advanced Graduate Students  
As Pre-doctoral Members at MSRI  
6/01/18 – 5/31/19**

**July 2019**

**Mathematical Sciences Research Institute  
NSA Final Report for H98230-18-1-0269**

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## I. INTRODUCTION

The main scientific activities of MSRI are its Programs and Workshops. MSRI hosts two to four semester-long programs each year. Each program has about forty mathematicians in residence at any given time, including seven to eight graduate students.

Generally, each semester-long program features three workshops. A program begins with a *Connections for Women Workshop*, which is designed to encourage the participation of women in the research activities of the program. If the area of mathematics is one that traditionally has a large number of women, then the workshop can be used to highlight and to showcase their individual work. However, if the number of women in the field is low, then the workshop is marketed to a wider female audience in an effort to stimulate interest in the area. In addition, another goal is to encourage new connections among the women early in the program as a catalyst for eventual collaborations. This workshop is then followed by an *Introductory Workshop*, the purpose of which is to introduce the subject to the broader mathematical community. Later during the program, there is a *Topical Workshop*, which is designed to explore some of the themes of the program in greater depth.

In addition to the scientific workshops that run parallel with the programs, MSRI hosts a Hot Topics workshop. These workshops are intended to explore emerging topics in mathematics. (See Section II.B for a brief summary)

MSRI also hosts and co-hosts Education & Outreach Workshops. These workshops focus on improving the skills of K–12 math teachers. Their descriptions, as well as lists of speakers, talks and participants, can be found on the MSRI web site at <http://www.msri.org/web/msri/education/for-k-12-educators>.

Another essential activity at MSRI is its series of Summer Graduate Schools, which target advanced graduate students in mathematics. During the summer of 2018, MSRI hosted four on-site and four off-site Summer Graduate Schools, with themes ranging from derived geometry to representations of high dimensional data. A complete description can be found at:

<http://www.msri.org/web/msri/scientific/workshops/summer-graduate-school>.

Each summer since 2007, MSRI has hosted a summer research experience (MSRI-UP) for undergraduate students with the aim of increasing the number of Ph.D.’s among members of under-represented groups. These summer schools are co-funded by the NSA and the NSF. The 2018 MSRI-UP, *Mathematics of Data Science*, was a successful and popular school, with 18 undergraduate participants. Since MSRI-UP is funded by an independent NSA grant, its report will be filed separately. More information about MSRI-UP can be found at:

<http://www.msri.org/web/msri/education/for-undergraduates/msri-up>.

The MSRI project, *Summer Research for Women in Mathematics* (SWiM), is part of MSRI’s overall activities aimed at strengthening the mathematical sciences by facilitating

research and professional activities leading to or enhancing successful, productive careers. The SWiM project provides space and funds for groups of 2-6 women researchers to work on a research project for 2-3 weeks at MSRI during the summer. These are research projects that have already been started, perhaps at a conference such as *Women in ...* or could be freestanding activities. Originally started in the summer of 2017, the 2018 SWiM program received applications from 22 groups (totaling 88 women) and was able to accept 20 women forming 6 groups ranging in size from 2 to 5. More information concerning SWiM can be found at  
<http://www.msri.org/web/msri/scientific/summer-research-for-women-in-mathematics>

## II. OVERVIEW OF ACTIVITIES 2018-19

The year 2018-19 was an exciting one. In fall 2018, we held a jumbo program: *Hamiltonian Systems, from Topology to Applications through Analysis*, with lead organizer Albert Fathi (Georgia Institute of Technology). In spring 2019, we held two programs, *Derived Algebraic Geometry*, led by Bhargav Bhatt (University of Michigan), and *Birational Geometry and Moduli Spaces*, led by Christopher Hacon (University of Utah). MSRI also hosted a small Complementary Program for mathematicians whose interests were not closely related to the three programs. All programs are briefly summarized in Section II.A.

There were 260 researchers who participated in these programs. Of those members, there were 31 Postdoctoral Fellows, 63 Organizers & Research Professors, 130 Research Members, and 36 Program Associates (Graduate Students).

The NSA grant H98230-18-1-0269 funded nine Program Associates (Graduate Students): five participated in the fall jumbo program, *Hamiltonian Systems: From Topology to Applications Through Analysis* and two participated in each of the spring programs, *Birational Geometry and Moduli Spaces* and *Derived Algebraic Geometry*.

### A. Major Programs and their Associated Workshops

In the list of organizers of each activity, an asterisk (\*) denotes lead organizer(s).

#### **Program 1: Hamiltonian Systems, From Topology to Applications through Analysis (HST)**

August 13, 2018 - December 14, 2018

*Organizers:* Rafael de la Llave (Georgia Institute of Technology), \*Albert Fathi (Georgia Institute of Technology; École Normale Supérieure de Lyon), Vadim Kalsomine (University of Maryland), Robert Littlejohn (University of California, Berkeley), Philip Morrison (University of Texas, Austin), Tere Seara (Polytechnical University of Cataluña (Barcelona)), Sergei Tabachnikov (Pennsylvania State University), Amie Wilkinson (University of Chicago)

The interdisciplinary nature of Hamiltonian systems is deeply ingrained in its history. This program brought together the communities of mathematicians with the community of practitioners, mainly engineers, physicists, and theoretical chemists who use Hamiltonian systems daily. The program covered not only the mathematical aspects of Hamiltonian systems but also their applications, mainly in space mechanics, physics and chemistry.

The mathematical aspects comprise celestial mechanics, variational methods, relations with PDE, Arnold diffusion and computation. The applications concern celestial mechanics, astrodynamics, motion of satellites, plasma physics, accelerator physics, theoretical chemistry, and atomic physics.

The goal of the program was to bring to the forefront both the theoretical aspects and the applications, by making available for applications the latest theoretical developments, and also by nurturing the theoretical mathematical aspects with new problems that come from concrete problems of applications.

Workshops associated with the *Hamiltonian Systems* program:

**Workshop 1: Connections for Women: Hamiltonian Systems, From Topology to Applications Through Analysis**

August 16, 2018 - August 17, 2018

*Organizers: Marie-Claude Arnaud (Université d'Avignon), \*Basak Gurel (University of Central Florida), Tere Seara (Polytechnical University of Cataluña (Barcelona))*

This workshop featured lectures on a variety of topics in Hamiltonian dynamics given by leading researchers in the area. The talks focused on recent developments in subjects closely related to the program such as Arnold diffusion, celestial mechanics, Hamilton-Jacobi equations, KAM methods, Aubry-Mather theory and symplectic topological techniques, and on applications. The workshop was open to all mathematicians in areas related to the program.

**Workshop 2: Introductory Workshop: Hamiltonian Systems, From Topology to Applications Through Analysis**

August 20, 2018 - August 24, 2018

*Organizers: Marie-Claude Arnaud (Université d'Avignon), Wilfrid Gangbo (University of California, Los Angeles), \*Vadim Kaloshin (University of Maryland), Robert Littlejohn (University of California, Berkeley), Philip Morrison (University of Texas, Austin)*

The introductory workshop covered the large variety of topics of the semester: weak KAM theory, Mather theory, Hamilton-Jacobi equations, integrable systems and integrable planar billiards, instability formation for nearly integrable systems, celestial mechanics, billiards, spectral rigidity, Astrodynamics, motion of satellites, Plasma Physics, Accelerator Physics, Theoretical Chemistry, and Atomic Physics.

The workshop consisted of approximately 18 lectures which introduced the main topics relevant to the semester. That left time for discussions and exchange between the participants.

### **Workshop 3: Hamiltonian Systems, From Topology to Applications through Analysis I**

October 08, 2018 – October 12, 2018

*Organizers: Alessandra Celletti (Seconda Università di Roma "Tor Vergata"), Rafael de la Llave (Georgia Institute of Technology), Diego del-Castillo-Negrete (Oak Ridge National Laboratory), Lawrence Evans (University of California, Berkeley), \*Philip Morrison (University of Texas, Austin), Sergei Tabachnikov (Pennsylvania State University), Amie Wilkinson (University of Chicago)*

This was a main workshop of the program “Hamiltonian Systems, From Topology to Applications through Analysis” and was a companion to the workshop in November 26-30. Both workshops featured current developments pertaining to finite and infinite-dimensional Hamiltonian systems, with a mix of rigorous theory and applications. A broad range of topics was included, e.g., existence of and transport about invariant sets (Arnold diffusion, KAM, etc.), techniques for projection/reduction of infinite to finite systems, and the role of topological invariants in applications.

### **Workshop 4: Hamiltonian Systems, From Topology to Applications through Analysis II**

November 26, 2018 – November 30, 2018

*Alessandra Celletti (Seconda Università di Roma "Tor Vergata"), Rafael de la Llave (Georgia Institute of Technology), Diego del-Castillo-Negrete (Oak Ridge National Laboratory), Lawrence Evans (University of California, Berkeley), \*Philip Morrison (University of Texas, Austin), Sergei Tabachnikov (Pennsylvania State University), Amie Wilkinson (University of Chicago)*

This was a main workshop of the program “Hamiltonian Systems, From Topology to Applications through Analysis.” It featured current developments pertaining to finite and infinite-dimensional Hamiltonian systems, with a mix of rigorous theory and applications. A broad range of topics was included, e.g., existence of and transport about invariant sets (Arnold diffusion, KAM, etc.), techniques for projection/reduction of infinite to finite systems, and the role of topological invariants in applications.

### **Program 2: Birational Geometry and Moduli Spaces (BGMS)**

January 22, 2019 – May 24, 2019

*Organizers: Antonella Grassi (University of Pennsylvania), \*Christopher Hacon (University of Utah), Sándor Kovács (University of Washington), Mircea Mustață (University of Michigan), Martin Olsson (University of California, Berkeley)*

Birational Geometry and Moduli Spaces are two important areas of Algebraic Geometry that have recently witnessed a flurry of activity and substantial progress on many

fundamental open questions. In this program we aimed to bring together key researchers in these and related areas to highlight the recent exciting progress and to explore future avenues of research.

This program focused on the following themes: Geometry and Derived Categories, Birational Algebraic Geometry, Moduli Spaces of Stable Varieties, Geometry in Characteristic  $p > 0$ , and Applications of Algebraic Geometry: Elliptic Fibrations of Calabi-Yau Varieties in Geometry, Arithmetic and the Physics of String Theory

Workshops associated with the *Birational Geometry and Moduli Spaces* program:

**Workshop 1: Connections for Women: Derived Algebraic Geometry, Birational Geometry and Moduli Spaces**

January 28, 2019 – January 30, 2019

*Organizers: Julie Bergner (University of Virginia), \*Antonella Grassi (University of Pennsylvania), Bianca Viray (University of Washington), Kirsten Wickelgren (Georgia Institute of Technology)*

This workshop covered different aspects of Algebraic Geometry relating Derived Algebraic Geometry and Birational Geometry. In particular, the workshop focused on connections to other branches of mathematics and open problems. There were several colloquium style lectures as well as shorter research talks. The workshop was open to all.

**Workshop 2: Introductory Workshop: Derived Algebraic Geometry and Birational Geometry and Moduli Spaces**

January 31, 2019 – February 08, 2019

*Organizers: Julie Bergner (University of Virginia), Bhargav Bhatt (University of Michigan), Christopher Hacon (University of Utah), \*Mircea Mustață (University of Michigan), Gabriele Vezzosi (Università di Firenze)*

The workshop surveyed several areas of algebraic geometry, providing an introduction to the two main programs hosted by MSRI in spring 2019. It consisted of 7 expository mini-courses and 7 separate lectures, each given by top experts in the field. The workshop focused on the recent progress in derived algebraic geometry, birational geometry and moduli spaces. The lectures were aimed at a wide audience including advanced graduate students and postdocs with a background in algebraic geometry.

**Workshop 3: Recent Progress in Moduli Theory**

May 06, 2019 – May 10, 2019

*Organizers: Lucia Caporaso (Roma Tre University), \*Sándor Kovács (University of Washington), Martin Olsson (University of California, Berkeley)*

This workshop focused on presenting the latest developments in moduli theory, including (but not restricted to) recent advances in compactifications of moduli spaces of higher dimensional varieties, the birational geometry of moduli spaces, abstract methods including stacks, stability criteria, and applications in other disciplines.

### **Program 3: Derived Algebraic Geometry (DAG)**

January 22, 2019 – May 24, 2019

*Organizers: Julie Bergner (University of Virginia), \*Bhargav Bhatt (University of Michigan), Dennis Gaitsgory (Harvard University), David Nadler (University of California, Berkeley), Nick Rozenblyum (University of Chicago), Peter Scholze (Universität Bonn), Gabriele Vezzosi (Università di Firenze)*

Derived algebraic geometry is an extension of algebraic geometry that provides a convenient framework for directly treating non-generic geometric situations (such as non-transverse intersections in intersection theory), in lieu of the more traditional perturbative approaches (such as the “moving” lemma). This direct approach, in addition to being conceptually satisfying, has the distinct advantage of preserving the symmetries of the situation, which makes it much more applicable. In particular, in recent years, such techniques have found applications in diverse areas of mathematics, ranging from arithmetic geometry, mathematical physics, geometric representation theory, and homotopy theory. This semester long program was dedicated to exploring these directions further, and finding new connections.

Workshops associated with the *Derived Algebraic Geometry* program:

#### **Workshop 1: Connections for Women: Derived Algebraic Geometry, Birational Geometry and Moduli Spaces**

January 28, 2019 – January 30, 2019

*Organizers: Julie Bergner (University of Virginia), \*Antonella Grassi (University of Pennsylvania), Bianca Viray (University of Washington), Kirsten Wickelgren (Georgia Institute of Technology)*

This workshop covered different aspects of Algebraic Geometry relating Derived Algebraic Geometry and Birational Geometry. In particular the workshop focused on connections to other branches of mathematics and open problems. There were several colloquium style lectures as well as shorter research talks. The workshop was open to all.

#### **Workshop 2: Introductory Workshop: Derived Algebraic Geometry and Birational Geometry and Moduli Spaces**

January 31, 2019 – February 8, 2019

*Organizers: Julie Bergner (University of Virginia), Bhargav Bhatt (University of Michigan), Christopher Hacon (University of Utah), \*Mircea Mustață (University of Michigan), Gabriele Vezzosi (Università di Firenze)*

The workshop surveyed several areas of algebraic geometry, providing an introduction to the two main programs hosted by MSRI in spring 2019. It consisted of 7 expository mini-courses and 7 separate lectures, each given by top experts in the field.

The workshop focused on the recent progress in derived algebraic geometry, birational geometry and moduli spaces. The lectures were aimed at a wide audience including advanced graduate students and postdocs with a background in algebraic geometry.

### **Workshop 3: Derived Algebraic Geometry and Its Applications**

March 25, 2019 – May 29, 2019

*Organizers: Dennis Gaitsgory (Harvard University), David Nadler (University of California, Berkeley), \*Nick Rozenblyum (University of Chicago), Peter Scholze (Universität Bonn), Brooke Shipley (University of Illinois at Chicago)*

This workshop brought together researchers at various frontiers, including arithmetic geometry, representation theory, mathematical physics, and homotopy theory, where derived algebraic geometry has had recent impact. The aim was to explain the ideas and tools behind recent progress and to advertise appealing questions. A focus was on moduli spaces, for example, principal bundles with decorations that arise in many settings, and their natural structures.

### **Program 4: Complementary Program (2018-19)**

The Complementary Program had a limited number of memberships that were open to mathematicians whose interests were not closely related to the core programs; special consideration was given to mathematicians who were partners of an invited member of a core program.

## **B. Hot Topics Workshop**

### **Hot Topics: Shape and Structure of Materials**

October 1, 2018 – October 5, 2018

*Organizers: Myfanwy Evans (TU Berlin), \*Frank Lutz (TU Berlin), Dmitriy Morozov (Lawrence Berkeley National Laboratory), James Sethian (University of California, Berkeley), Ileana Streinu (Smith College)*

The fascinating and complicated microstructures of materials that are now visible through advanced imaging techniques challenge the frontiers of characterization and understanding. At the same time, developments in modern geometric and topological techniques are beginning to illuminate important features of material structures, while the microstructures themselves and the analysis and prediction of their macroscopic properties are inspiring new directions in pure and applied mathematics. In a collaboration with the Lawrence Berkeley National Laboratory (LBNL), this workshop aimed at intensifying the interaction of mathematicians with material scientists, physicists and chemists on the structural description and design of materials.

## **Hot Topics: Recent Progress in Langlands Program**

April 8, 2019 – April 12, 2019

*Organizers: Mark Kisin (Harvard University), Elena Mantovan (California Institute of Technology), \*Xinwen Zhu (California Institute of Technology)*

The purpose of the workshop was to explain Vincent Lafforgue's ground breaking work, constructing the automorphic to Galois direction of the Langlands correspondence for function fields. There were also a number of talks on more recent developments and related results.

### **III. PARTICIPATION SUMMARY**

#### **A. All MSRI Members**

The table below indicates the number of participants for the major programs and workshops that took place at MSRI during the 2018-19 academic year.

DATES	ACTIVITY TYPE	TITLE	PARTICIPANTS
6/11/18 – 8/3/18	Summer Research	Summer Research for Women in Mathematics	20
6/16/18 – 7/29/18	MSRI-UP	MSRI-UP 2018: The Mathematics of Data Science	18
6/11/18 – 6/22/18	Summer Graduate School	The $\partial$ -Problem in the Twenty-First Century	35
6/11/18 – 6/22/18	Summer Graduate School	Séminaire de Mathématiques Supérieures 2018: Derived Geometry and Higher Categorical Structures in Geometry	34
6/17/18 – 6/30/18	Summer Graduate School	Mathematical Analysis of Behavior	24
6/25/18 – 7/6/18	Summer Graduate School	Derived Categories	56
6/25/18 – 7/6/18	Summer Graduate School	H-principle	15
7/1/18 – 7/21/18	Summer Graduate School	IAS/PCMI 2018: Harmonic Analysis	36
7/3/18 – 7/20/18	Summer Graduate School	Representations of High Dimensional Data	53
7/23/18 – 8/3/18	Summer Graduate School	From Symplectic Geometry to Chaos	33

<b>Fall 2018</b>	<b>Scientific Program</b>	<b>Hamiltonian systems, from topology to applications through analysis (HST)</b>	<b>107</b>
8/16/18 – 8/17/18	Programmatic Workshop	Connections for Women: Hamiltonian systems, from topology to applications through analysis	57
8/20/18 – 8/24/18	Programmatic Workshop	Introductory Workshop: Hamiltonian systems, from topology to applications through analysis	111
10/8/18 – 10/12/18	Programmatic Workshop	Hamiltonian systems, from topology to applications through analysis I	123
10/1/18 – 10/5/18	Hot Topics Workshop	Hot Topics: Shape and Structure of Materials	55
11/26/18 – 11/30/18	Programmatic Workshop	Hamiltonian systems, from topology to applications through analysis II	95
<b>Spring 2019</b>	<b>Scientific Program</b>	<b>Birational Geometry and Moduli Spaces (BGMS)</b>	<b>67</b>
<b>Spring 2019</b>	<b>Scientific Program</b>	<b>Derived Algebraic Geometry (DAG)</b>	<b>69</b>
1/28/19 – 1/30/19	Programmatic Workshop	Joint Connections for Women: Derived Algebraic Geometry, Birational Geometry and Moduli Spaces	115
1/31/19 – 2/8/19	Programmatic Workshop	Joint Introductory Workshop: Derived Algebraic Geometry and Birational Geometry and Moduli Spaces	209
3/25/19 – 3/29/19	Programmatic Workshop	Derived Algebraic Geometry and Its Applications	150
4/8/19 – 4/12/19	Hot Topics Workshop	Hot Topics: Recent Progress in Langlands Program	89
5/6/19 – 5/10/19	Programmatic Workshop	Recent Progress in Moduli Theory	147
<b>8/13/18 – 5/24/19</b>	<b>Scientific Program</b>	<b>Complementary Program 2018-19</b>	<b>17</b>

## B. NSA supported Program Associates

There were 36 Program Associates (Graduate Students) who participated in the 2018-19 programs. The NSA grant, H98230-18-1-0269, funded nine out of the 36 graduate students, five graduate students in the fall and four in the spring semester. The funded graduate students had their living expenses reimbursed at the rate of \$2,000 per month,

prorated for the time that they were in residence at MSRI. Since the provisional Indirect Cost rate decreased from the proposed 21.48% to 20.32%, we were able to fund a little bit more person-months of stipends to the Program Associates. Detailed financial information can be found in Section IV.

Below is more information on the nine graduate students supported by this grant:

### **HAMILTONIAN SYSTEMS, FROM TOPOLOGY TO APPLICATIONS THROUGH ANALYSIS (HST)**



**Gasiorek,  
Sean**

**Name: Sean Gasiorek**

Year of Ph.D: 2019

Institution of Ph.D: UC Santa Cruz

Dissertation title:

Billiards Inside, Circles Outside: Dynamics of a Charged Particle in a Piecewise Constant Magnetic Field

Ph.D. advisor: Richard Montgomery

Mentor while at MSRI: Richard Montgomery

Dates at MSRI: 8/13/18 – 12/14/18

**Program Associate's comments:**

Generally I worked on my dissertation research. Often this meant working alone, but I had about half a dozen very productive meetings with other researchers here at MSRI who were either in residence or were only visiting for a week or two. I often attended the colloquia and seminars, and would regularly socialize at lunch and tea times.

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

Absolutely. This gave me the chance to focus on my research in an environment whose only goal was to help me succeed. I made significantly more progress on my research here than I would have at my home institution (partially due to not being a TA this quarter).



**Heninger,  
Jeffrey**

**Name: Jeffrey Heninger**

Year of expected Ph.D: 2020

Institution of expected Ph.D: University of Texas at Austin

Ph.D. advisor: Phil Morrison

Mentor while at MSRI: Phil Morrison

Dates at MSRI: 8/15/18 – 12/14/18

**Program Associate's comments:**

With Phil Morrison: We submitted a paper about the non-Hamiltonian nature of magnetic monopoles to the arxiv. We received commentary, incorporated it into the paper, and submitted it to a peer reviewed journal.

With Robert Littlejohn: We exactly solved the motion of an electron in a radial magnetic field with constant (nonzero) divergence and determined the asymptotic direction it travels in.

With George Miloshevich and Emanuele Tassi: We worked on writing the equations of movement and Hamiltonian structure for a relativistic fluid whose constituent particles have zero charge but nonzero magnetic moment. This kind of fluid exists during neutron star mergers, after the neutron stars have been broken up by tidal forces into a slurry of chunks of neutrons.

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

Yes. Gained a broader understanding of the work being done for Hamiltonian systems. Learned about some topics that my adviser is not involved in.

Met a lot of new people. This is useful not just for exchanging ideas but also for finding something to do after I finish my Ph.D.

Research progress (see above).



**Hughes,  
Alexander**

**Name: Alexander Hughes**

Year of expected Ph.D: 2020

Institution of expected Ph.D: University of Missouri at Columbia

Ph.D. advisor: Statmatis Dostoglou

Mentor while at MSRI: Stamatis Dostoglou

Dates at MSRI: 8/13/18 – 12/14/18

**Program Associate's comments:**

Studying relationship between information and thermodynamic entropy. Minimizing information entropy requires solving a Lagrange multiplier problem. It has been shown previously that information entropy converges to thermodynamic entropy. Using the idea of epiconvergence, we have shown that

Alexander Hughs (cont'd):

the parameters involved in the Lagrange multiplier problem converge to their corresponding physical parameters (for example, inverse temperature) in the thermodynamic entropy setting. All of the above work was done in an equilibrium setting. We hope in the future to expand to the setting of local equilibrium. This semester I also began work on applying the ideas in information geometry to the above problems. This work is only in its beginning stages.

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

Yes my time here was beneficial. My residency at MSRI gave me plenty of time to work uninterrupted and exposed me to several new ideas that gave new perspective on the work described above. This includes field of information geometry, which will likely make up a significant portion of my thesis. Having the opportunity to talk to people at MSRI with experience in fields I am interested in, or even tangentially related to areas that hold my interest, was invaluable.



Katz, Ori

**Name: Ori Katz**

Year of expected Ph.D: 2022

Institution of expected Ph.D: Weizmann Institute of Science, Rehovot, Israel

Dissertation title (if available): The kinematics and fluid dynamics of transport and mixing in the ocean.

Ph.D. advisor: Vered Rom Kedar

Mentor at MSRI: Vered Rom Kedar

Dates at MSRI: 10/1/18 – 10/31/18

**Program Associate's comments:**

I continued my research, developing a 3D kinematic mixing model for the Atlantic Ocean.

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

My experience at MSRI was extremely beneficial. I met many people that conduct research that is relevant to my work, and learned many new mathematical topics that can be used in my research. Also, it was an excellent work environment, quiet and serious with all the required facilities, the leading experts in the field, great colleagues and all with a wonderful view. In short, it was my privilege to be a Program Associate at MSRI.



**Suder, Mark**

**Name: Mark Suder**

Year of expected Ph.D: 2021

Institution of expected Ph.D: West Virginia University

Ph.D. advisor: Dr. Adrian Tudorascu

Mentor while at MSRI: Dr. Adrian Tudorascu

Dates at MSRI: 8/13/18 – 12/14/18

**Program Associate's comments:**

Exposure to mathematical research, Hamiltonian Systems, and Dr. Wilfrid Gangbo's lectures on Optimal Transport and Wasserstein metrics. Also, collaboration with Dr. Adrian Tudorascu on research problems.

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

Yes, it gave me exposure to mathematical research and an opportunity for focused effort.

## **DERIVED ALGEBRAIC GEOMETRY (DAG)**



**Harnois, John**

**Name: John Harnois**

Year of Ph.D: 2021

Institution of Ph.D: University of Virginia, Charlottesville

Dissertation title:

Ph.D. advisor: Julie Bergner

Mentor while at MSRI: Julie Bergner

Dates at MSRI: 1/22/19 - 2/1/19

**Program Associate's comments:**

John Harnois was accepted into MSRI's Derived Algebraic Geometry program in the spring of 2019, but he was only in residence at MSRI for 8 days and left early due to a family emergency. The following description is based on a letter nominating him to the program by his Ph.D. advisor, Dr. Bergner.

John has been studying algebraic topology and homotopy theory, such as model categories and simplicial methods. As a second year Ph.D student, he will benefit from the program – he is someone who will be inspired and motivated by interacting with more experienced students and researchers and will be deciding on a specific research project by next fall. He is also developing homotopy-theoretic skills which are related to the “derived” aspect of the program.

## **BIORATIONAL GEOMETRY AND MODULI SPACES (BGMS)**



**Friedenberg,  
Netanel**

**Name: Netanel Friedenberg**

Year of Expected Ph.D: 2020

Institution of Expected Ph.D: Yale University

Ph.D. advisor: Sam Payne

Mentor while at MSRI: Sam Payne

Dates at MSRI: 1/22/19 – 5/24/19

### **Program Associate's comments:**

While at MSRI I worked on three projects. First, I worked on writing up *Work on Normal Equivariant Completions of Normal Toric Varieties Over Valuation Rings*. I also continued joint work with Kalina Mincheva on putting an analytic structure on the set of prime congruences of a Laurent polynomial semiring. Finally, I started working on extending Sumihiro's equivariant completion theorem to the case of non-normal varieties.

My experience at MSRI was very beneficial. MSRI provided ideal conditions for writing up my work. Also, being at MSRI gave me the opportunity to get to know some of my colleagues, and to learn how my work relates to other ongoing research.



**Godfrey, Charles**

**Name: Charles Godfrey**

Year of expected Ph.D: 2020

Institution of expected Ph.D: University of Washington

Dissertation title: Rational pairs in positive characteristic.

Ph.D. advisor: Sándor Kovács

Mentor while at MSRI: Sándor Kovács

Dates at MSRI: 4/2/19 – 5/24/19

### **Program Associate's comments:**

Researched and wrote a substantial portion of my thesis. Attended BGMS seminars regularly and participated in the Introductory and Recent Progress in Moduli workshops. For the Recent Progress workshop I was the grad student note-taker. Gave a talk in the graduate student seminar (“Logarithmic Chow-to-Hodge cycle maps”).

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

Very much so. Perhaps the most beneficial part was the opportunity to meet with so many researchers whose work either inspired my research or is used directly as an essential input in my work. Some of these meetings were planned, and others just happened over tea. These conversations left me with both answers to pressing questions and interesting open questions that I hope to investigate in the future. Thanks so much!



Shrieve, Michael

**Name: Michael Shrieve**

Year of expected Ph.D: 2020

Institution of Ph.D: University of Washington

Ph.D. advisor: Sandor Kovacs

Mentor while at MSRI: Sándor Kovács

Dates at MSRI: 4/2/19 – 5/24/19

**Program Associate's comments:**

During my participation in the BGMS program, I collaborated with Charles Godfrey and Sandor Kovacs. I felt that the talks were very good, and I learned new ideas/techniques which I could apply to my problems and had opportunities to present my work to new audiences. Also, in my exit survey, I gave the highest possible rating for the support I received from the administration and IT staff.

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

I felt that my research benefited from access to MSRI's extensive library, the opportunity to communicate with other students and professors, access to daily talks and the good research environment.