**Annual Report
on the
Mathematical Sciences Research Institute
2012–13 Activities
supported by
NSA Practical and Intellectual Grant
H98230-12-1-0269
May 2013**

Mathematical Sciences Research Institute
NSA Annual Report for 2012–13

I.   INTRODUCTION

The main scientific activities of MSRI are its Programs and Workshops. Typically, MSRI will host one year-long program and two semester-long programs or four semester-long programs each year. Each program has about forty mathematicians in residence at any given time, including seven to eight graduate students. Each year, MSRI also runs a one-year Complementary Program, with five to ten researchers coming for various period. The purpose of the Complementary Program is to host mathematicians whose research expertise, while not directly in the area of the main programs held at MSRI that year, remains sufficiently close to it so as to promote interdisciplinary interactions among researchers.

During the 2012–13 academic year, aside from the Complementary Program, MSRI hosted a total of three programs. Two semester-long programs *Cluster Algebras* took place in the Fall 2012*,* and *Noncommutative Algebraic Geometry and Representation Theory* took place in the Spring 2013 and one year-long program *Commutative Algebra*.

Approximately 240 researchers participated in these programs for period of one month or longer. Of those, six were funded either entirely or partially by NSA Practical and Intellectual (P&I) Grant H98230-12-1-0269. Among those six members, two of them were postdoctoral fellows: Christine Berkesch in the *Commutative Algebra* and Max Glick in the *Cluster Algebras* program. More information about these two postdocs can be found in Section III.

Generally, each semester-long program features three workshops that are held at MSRI during the program. The 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 depth. A total of ten of these programmatic workshops took place at MSRI during the 2012–13 academic year. Six of those workshops were partially funded by separate NSA grants independent of the Practical and Intellectual one and their reports will be filed separately.

In addition to the scientific workshops that run parallel with the programs, MSRI hosted a Hot Topics workshop on surface subgroups and cube complexes. (Every year MSRI holds a Hot Topics workshop in an area of intense mathematical activity). Scientific workshops are briefly summarized in Section II, B.

MSRI also hosts Education & Outreach Workshops. These workshops focus on improving the skills of K–12 math teachers. Eight Education & Outreach Workshops took place during the 2012–13 academic year. 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. They are also briefly summarized in Section II, C.

Another essential activity at MSRI is its series of Summer Graduate Workshops which target advanced graduate students in mathematics. During the summer of 2012, MSRI hosted three on-site and two off-site Summer Graduate Workshops, with themes ranging from noncommutative algebraic geometry topics to model theory. A complete description can be found at the URL http://www.msri.org/web/msri/scientific/workshops/summer-graduate-school with a summary in Section II, D.

Last but not least, each summer since 2007, MSRI has hosted a summer school (MSRI-UP) for undergraduate students with the aim of increasing the number of PhDs among members of under-represented groups. These summer schools are co-funded by the NSA and the NSF. The 2013 MSRI-UP workshop in Algebraic Combinatorics is a successful and popular workshop, with 18 anticipated undergraduate participants. (See Section II, E, for a brief summary). Since MSRI-UP is funded by an NSA grant independent of the Practical and Intellectual one, its report will be filed separately.

For a comprehensive view of the entire year's activities, we have listed all of MSRI scientific and educational activities even those not funded by the NSA Practical and Intellectual grant, H98230-12-1-0269. Detailed expenditures for this grant can be found in Section V, Financial Funding Summary.

II.   OVERVIEW OF ACTIVITIES 2012–13

A. Major Programs and their Associated Workshops

Note: The description of each activity is provided to MSRI by the organizers prior to the beginning of each activity; therefore, the verbs are in future tense. In the list of organizers of each activity, an asterisk (*) denotes lead organizer(s).

Program 1: Commutative Algebra
August 20, 2012 to May 24, 2013
Organized by David Eisenbud* (University of California, Berkeley), Srikanth Iyengar (University of Nebraska), Ezra Miller (Duke University), Anurag Singh (University of Utah), and Karen Smith (University of Michigan)

Commutative algebra was born in the 19th century from algebraic geometry, invariant theory, and number theory. Today it is a mature field with activity on many fronts.

The year-long program will highlight exciting recent developments in core areas such as free resolutions, homological and representation theoretic aspects, Rees algebras and

integral closure, tight closure and singularities, and birational geometry. In addition, it will feature the important links to other areas such as algebraic topology, combinatorics, mathematical physics, noncommutative geometry, representation theory, singularity theory, and statistics. The program will reflect the wealth of interconnections suggested by these fields, and will introduce young researchers to these diverse areas.

New connections will be fostered through collaboration with the concurrent MSRI programs in Cluster Algebras (Fall 2012) and Noncommutative Algebraic Geometry and Representation Theory (Spring 2013).

Workshops associated with the Commutative Algebra Program:

Workshop 1: Connections For Women: Joint Workshop on Commutative Algebra and Cluster Algebras
August 22, 2012 to August 24, 2012
Organized by Claudia Polini (University of Notre Dame), Idun Reiten (Norwegian University of Science and Technology), Karen Smith (University of Michigan), and Lauren Williams* (University of California, Berkeley)

This workshop will present basic notions from Commutative Algebra and Cluster Algebras, with a particular focus on providing background material. Additionally, the workshop aims to encourage and facilitate the exchange of ideas between researchers in Commutative Algebra and researchers in Cluster Algebras.

Workshop 2: Joint Introductory Workshop: Cluster Algebras and Commutative Algebra
August 27, 2012 to September 7, 2012
Organized by David Eisenbud* (University of California, Berkeley), Bernhard Keller (Universit´e Paris VII, France), Karen Smith (University of Michigan), and Alexander Vainshtein* (University of Haifa, Israel)

This workshop will take place at the opening of the MSRI special programs on Commutative Algebra and on Cluster Algebras. It will feature lecture series at different levels, to appeal to a wide variety of participants. There will be minicourses on the basics of cluster algebras, and others developing particular aspects of cluster algebras and commutative algebra.

Workshop 3: Combinatorial Commutative Algebra and Applications
December 3, 2012 to December 7, 2012
Organized by Winfried Bruns (Universität Osnabrück), Alicia Dickenstein (University of Buenos Aires, Argentina), Takayuki Hibi (Osaka University), Allen Knutson* (Cornell University), and Bernd Sturmfels (University of California, Berkeley)

This workshop on Combinatorial Commutative Algebra aims to bring together researchers studying toric algebra and degenerations, simplicial objects such as monomial

ideals and Stanley-Reisner rings, and their connections to tropical geometry, algebraic statistics, Hilbert schemes, D-modules, and hypergeometric functions.

Workshop 4: Representation Theory, Homological Algebra, and Free Resolutions
February 11, 2013 to February 15, 2013
Organized by Luchezar Avramov (University of Nebraska), David Eisenbud (University of California, Berkeley), and Irena Peeva* (Cornell University))

Workshop 5: The Commutative Algebra of Singularities in Birational Geometry: Multiplier Ideals, Jets, Valuations, and Positive Characteristic Methods
May 6, 2013 to May 10, 2013
Organized by Craig Huneke* (Kansas University), Yujiro Kawamata (University of Tokyo), Mircea Mustata (University of Michigan), Karen Smith (University of Michigan), and Kei-ichi Watanabe (Nihon University)

The workshop will examine the interplay between measures of singularities coming both from characteristic p methods of commutative algebra, and invariants of singularities coming from birational algebraic geometry. There is a long history of this interaction which arises via the "reduction to characteristic p" procedure. It is only in the last few years, however, that very concrete objects from both areas, namely generalized test ideals from commutative algebra and multiplier ideals from birational geometry, have been shown to be intimately connected. This workshop will explore this connection, as well as other topics used to study singularities such as jets schemes and valuations.

<u>**Program 2: Cluster Algebras**</u>
August 20, 2012 to December 21, 2012
Organized by Sergey Fomin (University of Michigan), Bernhard Keller (Université Paris Diderot - Paris 7, France), Bernard Leclerc (Université de Caen Basse-Normandie, France), Alexander Vainshtein* (University of Haifa, Israel), and Lauren Williams (University of California, Berkeley)

Cluster algebras were conceived in the Spring of 2000 as a tool for studying dual canonical bases and total positivity in semisimple Lie groups. They are constructively defined commutative algebras with a distinguished set of generators (cluster variables) grouped into overlapping subsets (clusters) of fixed cardinality. Both the generators and the relations among them are not given from the outset, but are produced by an iterative process of successive mutations. Although this procedure appears counter-intuitive at first, it turns out to encode a surprisingly widespread range of phenomena, which might explain the explosive development of the subject in recent years.

Cluster algebras provide a unifying algebraic/combinatorial framework for a wide variety of phenomena in settings as diverse as quiver representations, Teichmueller theory, invariant theory, tropical calculus, Poisson geometry, Lie theory, and polyhedral combinatorics.

Workshops associated with the Cluster Algebras Program:

Workshop 1: Connections For Women: Joint Workshop on Commutative Algebra and Cluster Algebras

August 22, 2012 to August 24, 2012

Organized by Claudia Polini (University of Notre Dame), Idun Reiten (Norwegian University of Science and Technology), Karen Smith (University of Michigan), and Lauren Williams* (University of California, Berkeley)

This workshop will present basic notions from Commutative Algebra and Cluster Algebras, with a particular focus on providing background material. Additionally, the workshop aims to encourage and facilitate the exchange of ideas between researchers in Commutative Algebra and researchers in Cluster Algebras.

Workshop 2: Joint Introductory Workshop: Cluster Algebras and Commutative Algebra

August 27, 2012 to September 7, 2012

Organized by David Eisenbud* (University of California, Berkeley), Bernhard Keller (Universit´e Paris VII, France), Karen Smith (University of Michigan), and Alexander Vainshtein* (University of Haifa, Israel)

This workshop will take place at the opening of the MSRI special programs on Commutative Algebra and on Cluster Algebras. It will feature lecture series at different levels, to appeal to a wide variety of participants. There will be minicourses on the basics of cluster algebras, and others developing particular aspects of cluster algebras and commutative algebra.

Workshop 3: Cluster Algebras in Combinatorics, Algebra, and Geometry

October 29, 2012 to November 2, 2012

Organized by Claire Amiot (Université de Strasbourg), Sergey Fomin (University of Michigan), Bernard Leclerc (Université de Caen), and Andrei Zelevinsky* (Northeastern University)

Cluster algebras provide a unifying algebraic/combinatorial framework for a wide variety of phenomena in settings as diverse as quiver representations, Teichmuller theory, Poisson geometry, Lie theory, discrete integrable systems, and polyhedral combinatorics.

The workshop aims at presenting a broad view of the state-of-the-art understanding of the role of cluster algebras in all these areas, and their interactions with each other.

<u>Program 3: Noncommutative Algebraic Geometry and Representation Theory</u>

January 14, 2013 to May 24, 2013

Organized by Mike Artin (Massachusetts Institute of Technology), Viktor Ginzburg (University of Chicago), Catharina Stroppel (Universität Bonn , Germany), Toby Stafford* (University of Manchester, United Kingdom), Michel Van den Bergh (Universiteit Hasselt, Belgium), and Efim Zelmanov (University of California, San Diego)

Over the last few decades noncommutative algebraic geometry (in its many forms) has become increasingly important, both within noncommutative algebra/representation theory, as well as having significant applications to algebraic geometry and other neighbouring areas. The goal of this program is to explore and expand upon these subjects and their interactions. Topics of particular interest include noncommutative projective algebraic geometry, noncommutative resolutions of (commutative or noncommutative) singularities,Calabi-Yau algebras, deformation theory and Poisson structures, as well as the interplay of these subjects with the algebras appearing in representation theory--like enveloping algebras, symplectic reflection algebras and the many guises of Hecke algebras.

Workshops associated with the Noncommutative Algebraic Geometry and Representation Theory Program:

Workshop 1: Connections for Women: Noncommutative Algebraic Geometry and Representation Theory
January 24, 2013 to January 25, 2013
Organized by Georgia Benkart (University of Wisconsin), Ellen Kirkman* (Wake Forest University), and Susan Sierra (Princeton University & University of Edinburgh)

The Connections for Women workshop associated to the MSRI program in noncommutative algebraic geometry and representation theory is intended to bring together women who are working in these areas in all stages of their careers.

As the first event in the semester, this workshop will feature a "tapas menu" of current research and open questions: light but intriguing tastes, designed to encourage further exploration and interest. Talks will be aimed at a fairly general audience and will cover diverse topics within the theme of the program. In addition, there will be a poster session for graduate students and recent PhD recipients and a panel discussion on career issues, as well as free time for informal discussion.

Workshop 2: Introductory Workshop: Noncommutative Algebraic Geometry and Representation Theory
January 28, 2013 to February 1, 2013
Organized by Michael Artin (Massachusetts Institute of Technology - MIT), Michel Van den Bergh* (Vrije Universiteit Brussel), and Toby Stafford (University of Manchester)

This workshop will provide several short lecture series consisting two or three lectures each to introduce postdocs, graduate students and non-experts to some of the major themes of the conference. While the precise topics may change to reflect developments in the area, it is likely that we will run mini-series in the following subjects:

Noncommutative algebraic geometry; D-Module Theory; Derived Categories; Noncommutative Resolutions of Singularities; Deformation-Quantization; Symplectic Reflection Algebras; Growth Functions of Infinite Dimensional Algebras.

Workshop 3: Interactions between Noncommutative Algebra, Representation Theory, and Algebraic Geometry
April 8, 2013 to April 12, 2013
Organized by Victor Ginzburg (University of Chicago), Iain Gordon (University of Edinburgh, UK), Markus Reineke (Bergische Universität Wuppertal, Germany), Catharina Stroppel* (University of Bonn, Germany), and James Zhang (University of Washington)

In recent years there have been increasing interactions between noncommutative algebra/representation theory on the one hand and algebraic geometry on the other. This workshop would aim to examine these interactions and, as importantly, to encourage the interactions between the three areas. The precise topics will become more precise nearer the time, but will certainly include:

Noncommutative algebraic geometry; Noncommutative resolutions of singularities and Calabi-Yau algebras; Symplectic reflection and related algebras; D-module theory; Deformation-quantization

Program 4: Complementary Program
August 20, 2012 to May 24, 2013

MSRI had a small Complementary Program comprised of four researchers, Valerio Capraro (Université de Neuchâtel), Carolyn Dean (Manchester University), Peter Selinger (Dalhousie University), and Eric Zaslow (Northwestern University).

B.   Other Scientific Workshops

Workshop 1: Pacific Rim Mathematical Association (PRIMA) Congress 2013
Location: Shanghai Jiao Tong University, China
June 24, 2013 to June 28, 2013
Organized by Alejandro Adem (University of British Columbia, Canada), Federico Ardila (San Francisco State University, USA), Marston Conder (University of Auckland, New Zealand), David Eisenbud (UC Berkeley, USA), Yasha Eliashberg (Stanford University, USA), Nassif Ghoussoub (University of British Columbia, Canada), Tony Guttmann (University of Melbourne, Australia), Le Minh Ha (Vietnam National University, Vietnam), Shi Jin (Shanghai Jiao Tong University and University of Wisconsin-Madison, China/USA), Alejandro Jofre (Universidad de Chile, Chile), Yujiro Kawamata (University of Tokyo, Japan), JongHae Keum (Korea Institute for Advanced Study, Korea), Doug Lind (University of Washington, USA), Kyewon Koh Park (Ajou University, Korea), Shige Peng (Shandong University, China), Jose Seade (Universidad Nacional Autónoma de México, México), Gang Tian (Princeton University and Peking University, USA/China), and Tatiana Toro (University of Washington, USA)

The Second Pacific Rim Mathematical Association (PRIMA) Congress will be held at Shanghai Jiao Tong University in China, on June 24-28, 2013.

PRIMA is an association of mathematical sciences institutes, departments and societies from around the Pacific Rim, established in 2005 with the aim of promoting and facilitating the development of the mathematical sciences throughout the Pacific Rim region.

Workshop 2: Bay Area Differential Geometry Seminar (BADGS) 2012–13
Location: Berkeley, Santa Cruz and Stanford, California
June 2, 2012, October 6, 2012 and March 9, 2013
Organized by David Bao (San Francisco State University), Robert Bryant (Mathematical Sciences Research Institute), Joel Hass (University of California, Davis), David Hoffman* (Stanford University), Rafe Mazzeo (Stanford University), and Richard Montgomery (University of California, Santa Cruz)

The Bay Area Differential Geometry Seminar meets three times per year and is a one-day seminar on recent developments in differential geometry and geometric analysis, broadly interpreted. Typically, it runs from mid-morning until late afternoon with three to four speakers. Lunch will be available at MSRI (participants will be asked to make a donation to help defray their lunch expenses), and the final talk will be followed by dinner.

Workshop 3: Hot Topics: Surface subgroups and cube complexes
March 18, 2013 to March 22, 2013
Organized by Ian Agol* (University of California, Berkeley), Danny Calegari (University of Chicago), Ursula Hamenstädt (University Bonn), Vlad Markovic (California Institute of Technology)

Recently there has been substantial progress in our understanding of the related questions of which hyperbolic groups are cubulated on the one hand, and which contain a surface subgroup on the other. The most spectacular combination of these two ideas has been in 3-manifold topology, which has seen the resolution of many long-standing conjectures. In turn, the resolution of these conjectures has led to a new point of view in geometric group theory, and the introduction of powerful new tools and structures. The goal of this conference will be to explore the further potential of these new tools and perspectives, and to encourage communication between researchers working in various related fields.

C. Education & Outreach Workshops

Workshop 1: Bay Area Circle for Teachers (BACT) Summer 2012
June 18, 2012 to June 22, 2012
Organized by Sage Moore and BACT Director

The core of the summer workshop will consist of the morning and afternoon sessions held from Monday through Friday. This time will be devoted to discovery, problem solving, and interactive learning. During the earlier part of the week teachers will gain experience with a variety of problem solving techniques such as symmetry, mathematical patterns, and parity. Subsequent sessions will focus on particular topics such as geometry,

sequences, counting, and number theory. Traditionally relegated to the high school curriculum or beyond, these topics actually provide a natural starting point for exploring and appreciating interesting mathematics at the middle school level. All the sessions will be led by exceptional educators and mathematicians from the San Francisco Bay area. We are grateful to the Firedoll, Simons and Bechtel Foundations as well as MSRI for supporting our summer instructors.

A major theme throughout the week will be finding creative answers to the question of how to incorporate a problem-solving approach to math education into the existing curriculum. To this end leaders will supply participants with handouts or short modules based on the material covered during their sessions. They will also work with teachers to share ideas for enlivening any math class and to develop lesson plans. Focused discussions will be held regularly to determine what obstacles exist to incorporating this style of teaching into the present curriculum, what resources would be most helpful to teachers, and other related topics.

Workshop 2: Bay Area Circle for Teachers (BACT) Winter 2013
January 26, 2013
Organized by Sage Moore and BACT Director

The aim of the Circle for Teachers is to equip educators with an effective problem-solving approach to teaching mathematics. This style of learning is based on the math circle environment that has proven to be successful for students around the world. The program will immerse a group of interested middle and high school math teachers in engaging mathematics and expose them to a dynamic style of classroom presentation. Participants will come away with a variety of resources, lesson modules, and a renewed sense of appreciation for the fascinating world of mathematics. Teacher will also be eligible for contnuing education credit, professional development units or college course credits. A major theme throughout the program will be creatively answering the question of how to incorporate a problem-solving approach to math education into the existing curriculum. To this end, leaders will supply participants with handouts or short modules based on the material covered during their sessions. They will also work with teachers to share ideas for enlivening any math class and to develop lesson plans. Focused discussions will be held regularly to determine what obstacles exist to incorporating this style of teaching into the present curriculum, what resources would be most helpful to teachers, and other related topics.

For more information, please visit the Bay Area Circle for Teachers Winter Workshop 2013 page at: http://bact.mathcircles.org/winter_2013

Workshop 3: Mathematics Professional Development Institute 2012 (Wu Summer Institute)
July 9, 2012 to July 27, 2012
Organized by Hung-Hsi Wu (University of California, Berkeley)

This is a three-week institute on the mathematics of grades 6-8 in direct response to the recent adoption of the Common Core Mathematics Standards (CCMS) by California.

Workshop 4: UC Berkeley Julia Robinson Mathematics Festival
January 27, 2013

The UC Berkeley Julia Robinson Mathematics Festival will be held in the Chevron Auditorium of the International House from 8:30 - 11:30 am.

Workshop 5: Circle on the Road Spring 2013
Location: University of Puerto Rico, Mayaguez
March 8, 2013 to March 10, 2013
Organized by Amanda Serenevy (Riverbend Community Math Center), Dave Auckly (Kansas State University), Jonathan Farley (Research Institute for Mathematics), Hector Rosario (University of Puerto Rico, Mayaguez), Mark Saul (John Templeton Foundation), Diana White (University of Colorado Denver)

This workshop will bring together new and experienced leaders of math circles for students and teachers. We welcome anyone who is interested in learning more about math circles, especially teachers. Workshop activities will include discussions, presentations, and a mathematics festival.

Participants will begin collaborating before the workshop to develop sample math circle sessions that they will present during the festival. These activities will be collaboratively evaluated and refined during the workshop.

Workshop 6: Critical Issues in Mathematics Education 2013: Assessment of Mathematcial Proficiencies in the Age of the Common Core
April 3, 2013 to April 5, 2013
Organized by Mark Thames* (University of Michigan), Kristin Umland* (University of New Mexico), Noah Heller (Math for America) and Alan Schoenfeld (University of California, Berkeley)

This workshop will explore the fundamental problems of trying to assess students' mathematical proficiency, seeking to take a more comprehensive perspective on what it is to learn, know, and use mathematics. The advent of the Common Core State Standards both increases the demand and broadens the conception of what it is to be mathematically skillful, and opens new opportunities and challenges to improving our ability to assess what students understand and can do.

Workshop 7: Mathematics Institutes' Modern Math Workshop at SACNAS
Location: Seattle, Washington
October 10, 2012 to October 11, 2012
Organized by NIMBioS and Jeff Brock (ICERM), Ricardo Cortez (Tulane University), Ruth Crane (ICERM), Suzanne Lenhart (University of Tennessee and NIMBioS), Ivelisse Rubio (University of Puerto Rico, Computer Science), Kelly Sturner (NIMBioS)

Overview The eight [NSF mathematics institutes](#) and [NIMBioS](#) are pleased to offer three concurrent sessions immediately preceding the [SACNAS](#) annual meeting – one for graduate students and recent PhDs, and two for undergraduate students – to invigorate the research careers of minority mathematicians and mathematics faculty at minority-serving institutions. The "Modern Math Workshop" is one of the workshops in the *Mathematical Sciences Collaborative Diversity Initiative*. See the [full schedule here](#). This workshop will highlight presentations on topics drawn from the institutes' upcoming programs, a keynote speaker, and an informative panel presentation on the 2013-14 programs and workshops. The two undergraduate sessions (applicants will choose one) are appropriate for students of any major interested in learning how mathematics contributes to our understanding of various scientific topics. Activities will include lectures and group work.

All sessions will begin with lunch on Wed. Oct. 10 and include an evening reception. The sessions will continue on Thursday morning and will end at 12:30 pm prior to the SACNAS conference lunch. All participants will come together for a keynote lecture and panel discussion.

Modern Math Workshop: The workshop features presentations by eight speakers, one on behalf of each institute. Speakers are typically chosen from among the organizers of upcoming programs at those institutes and will give an accessible presentation on exciting and current research topics associated with the upcoming institute programs. In addition there will be an informational panel of institute representatives, which will describe upcoming programs and other opportunities offered by the institutes and how to participate in them. Also, representatives from sponsoring agencies will present.

Undergraduate Minicourses in Mathematics: Two minicourses for an undergraduate audience will be offered during the Modern Math Workshop. Undergraduate applicants will choose one.

- Mini-Course 1: *Sage software workshop*. [Dr. William Stein](#), professor of mathematics at the University of Washington, Seattle, started [Sage](#) in 2005 and continues to direct this project. Sage is a freely available and freely modifiable mathematics software. Sage has become a very popular alternative to expensive commercial software such as Magma, Maple, Matlab and Mathematica. Students and faculty can plot and perform all sorts of calculations from calculus to number theory.
- Mini-Course 2: *Inferring gene regulatory networks: an algebraic geometry - systems biology connection*, presented by [Dr. Brandilyn Stigler](#), professor of mathematics at Southern Methodist University, Dallas, TX. Gene regulatory networks are ubiquitous in molecular systems biology and contribute to the control of major biological processes including metabolism and development. Given the abundance of gene data sets, the ability to reconstruct the regulatory network underlying the data has become one of the prime objectives in systems biology research. We will introduce various methods for inferring the structure of gene regulatory networks. These methods use techniques from algebraic geometry to build models of polynomial dynamical systems, which provide a rich backdrop

within which to perform network analyses. We will demonstrate the use of the methods with a Macaulay 2 based web application.

Keynote Speaker: Mariel Vazquez, Associate Professor of Mathematics, San Francisco State University

Workshop 8: Blackwell-Tapia Conference 2012
Location: ICERM
November 9, 2012 to November 10, 2012
Organized by ICERM and Alejandro Aceves (Southern Methodist University), Edray Goins (Purdue University), Trachette Jackson (University of Michigan), Juan Meza (University of California at Merced), Jill Pipher (ICERM), Bjorn Sandstede (ICERM)

This is the seventh in a series of biennial conferences honoring David Blackwell and Richard Tapia, two seminal figures who inspired a generation of African-American, Native American and Latino/Latina students to pursue careers in mathematics. Carrying forward their work, this one and a half day conference will

- *Recognize and showcase mathematical excellence by minority researchers*
- *Recognize and disseminate successful efforts to address under-representation*
- *Inform students and mathematicians about career opportunities in mathematics, especially outside academia*
- *Provide networking opportunities for mathematical researchers at all points in the higher education/career trajectory*

The conference includes a mix of activities including scientific talks, poster presentations, panel discussions, ample opportunities for discussion and interaction, and the awarding of the 2012 Blackwell-Tapia Prize.

This event is supported in part by a grant from the Alfred P. Sloan Foundation.

D. Summer Graduate Schools 2012

SGS 1: Noncommutative Algebraic Geometry
June 18, 2012 to June 29, 2012
Organized by Dan Rogalski* (University of California, San Diego), Travis Schedler (Massachusetts Institute of Technology), and Michael Wemyss (The University of Edinburgh, United Kingdom)

This workshop will introduce some of the major themes of the MSRI program "Interactions between Noncommutative Algebra, Representation Theory, and Algebraic Geometry" to be held in the spring of 2013. There will be four mini-courses on the topics of noncommutative projective geometry, deformation theory, noncommutative resolutions of singularities, and symplectic reflection algebras. As well as providing theoretical background, the workshop will aim to equip participants with some intuition

for the many open problems in this area through worked examples and experimental computer calculations.

SGS 2: Mathematical General Relativity
July 9, 2012 to July 20, 2012
Organized by Justin Corvino* (Lafayette College) and Pengzi Miao (University of Miami)

Mathematical general relativity is the study of mathematical problems related to Einstein's theory of gravitation. There are interesting connections between the physical theory and problems in differential geometry and partial differential equations.

The purpose of the workshop is to introduce graduate students to some fundamental aspects of mathematical general relativity, with particular emphasis on the geometry of the Einstein constraint equations and the Positive Mass Theorem. These topics will comprise a component of the upcoming semester program at MSRI in Fall 2013.

There will be mini-courses, as well as several research lectures. Students are expected to have had courses in graduate real analysis and Riemannian geometry, while a course in graduate-level partial differential equations is recommended.

SGS 3: Model Theory
July 23, 2012 to August 3, 2012
Organized by David Marker* (University of Illinois, Chicago), Thomas Scanlon (University of California, Berkeley), and Carol Wood (Wesleyan University)

The workshop will consist of two minicourses, together with a selection of topical lectures.

In the model theory course, o-minimality, and specifically the concrete example of the semi-algebraic sets of real numbers will provide the setting in which we introduce various fundamental results from model theory.
The algebraic dynamics course will allow the introduction of concepts and proof techniques from number theory and algebraic geometryin the context of applications involving model theory.

Toward the end of the workshop, the two minicourses will converge on the Pila-Wilkie theorem concerning points on analytic varieties, a result crucial in recent applications of o-minimality to diophantine geometry.

SGS 4: Séminaire de Mathématiques Supérieures 2012: Probabilistic Combinatorics
Location: Montréal, Canada
June 25, 2012 to July 6, 2012
Organized by Louigi Addario-Berry* (McGill University), Luc Devroye (McGill University), and Bruce Reed (McGill University)

One of the cornerstones of the probabilistic approach to solving combinatorial problems is the following guiding principle: information about global structure can be obtained through local analysis. This principle is ubiquitous in probabilistic combinatorics. It arises in problems ranging from graph colouring, to Markov chain mixing times, to Szemerédi's regularity lemma and its applications, to the theory of influences. The 2012 Séminaire de Mathématiques Supérieures brings together experts in probabilistic combinatorics from around the world, to explain cutting edge research which in one way or another exhibits this principle.

SGS 5: IAS/PCMI Summer 2012: Geometric Group Theory
Location: Park City, Utah
July 1, 2012 to July 21, 2012
Organized by Mladen Bestvina (University of Utah), Michah Sageev (Technion – Israel Institute of Technology), and Karen Vogtmann (Cornell University)

This workshop takes place at the Institute for Advanced Study – Park City Mathematics Institute and is reported independently by the organizers.

The Graduate Summer School bridges the gap between a general graduate education in mathematics and the specific preparation necessary to do research on problems of current interest. In general, these students will have completed their first year, and in some cases, may already be working on a thesis. While a majority of the participants will be graduate students, some postdoctoral scholars and researchers may also be interested in attending.

We strongly recommend that graduate students have already had the equivalent of rigorous first year graduate-level courses in topology, algebra and analysis.

The main activity of the Graduate Summer School will be a set of intensive short lectures offered by leaders in the field, designed to introduce students to exciting, current research in mathematics. These lectures will not duplicate standard courses available elsewhere. Each course will consist of lectures with problem sessions. Course assistants will be available for each lecture series. The participants of the Graduate Summer School meet three times each day for lectures, with one or two problem sessions scheduled each day as well.

E. Undergraduate Program: MSRI-UP 2013: Algebraic Combinatorics
June 15, 2013 to July 28, 2013
Organized by Duane Cooper (Morehouse College), Ricardo Cortez (Tulane University), Herbert Medina (Loyola Marymount University), Ivelisse Rubio (University of Puerto Rico, Rio Piedras Campus), and Suzanne Weekes* (Worcester Polytechnic Institute)

The academic and research portion of the 2013 MSRI-UP will be led by Prof. Rosa Orellana from Dartmouth College. Professor Orellana has supervised over 30 undergraduate student research projects, several of which resulted in senior thesis containing original research. Many of her students have continued their mathematical education in PhD programs.

Algebraic combinatorics is an area of mathematics that studies objects that have combinatorial and algebraic properties. An example of such object is the ring of symmetric functions. In algebraic combinatorics, we use algebraic methods to answer combinatorial questions, and conversely, apply combinatorial techniques to problems in algebra.

Let $x_1, \ldots, x_n$ be commuting variables, a polynomial $f(x_1, \ldots, x_n)$ is *symmetric* if $f(x_{\sigma_1}, \ldots, x_{\sigma_n}) = f(x_1, \ldots, x_n)$ for all permutations σ. The space of all symmetric polynomials forms a ring, $\Gamma(x_1, \ldots, x_n)$. This simply says that if we multiply two symmetric functions we get another symmetric function. $\Gamma(x_1, \ldots, x_n)$ has several distinguished bases that are indexed by partitions. One of the most important bases is Schur's basis: $\{s_\lambda \mid \lambda \text{ is a partition}\}$. The objective of the summer is to learn about and work on open problems involving symmetric polynomials.

Sample research project I. In 1995 Stanley described a symmetric polynomial associated to a graph. This polynomial is called the *symmetric chromatic polynomial*. Here the variables represent distinct colors and the monomials in the polynomial correspond to proper colorings. To obtain the symmetric polynomial we sum all monomials corresponding to proper colorings. A hard open problem is a conjecture of Stanley that says that the symmetric polynomial is an invariant of trees. Until recently it was not known if the chromatic symmetric polynomial was also an invariant of unicyclic graphs. Geofrey Scott (Ph.D. student at the Univ. of Michigan) found a method to construct non-isomorphic graphs containing a triangle that have the same chromatic polynomial. Students in this research project will generalize Scott's results to unicylic graphs containing larger cycles and discover properties under which two unicyclic graphs will have the same chromatic polynomial.

Sample research project II. A symmetric polynomial $f(x_1, \ldots, x_n)$ is called *Schur positive* if when written as a linear combination of Schur polynomials all the coefficients are nonnegative. Students will study examples of symmetric polynomials of the form $s_\alpha s_\beta - s_\lambda s_\mu$ and determine conditions so that such a product is Schur positive.

III.   PARTICIPATION SUMMARY

a. NSA supported members

The table below lists the participants supported (fully/partially) by the Practical and Intellectual grant in each activity that took place at MSRI during the 2012–13 academic year. Note that these participants are all US citizen or US permanent resident.

Activities	Member Names
Commutative Algebra	Postdoc: Christine Berkesch
	Researcher: Iyengar Srinkath
Cluster Algebras	Postdoc: Glick Max
	Researcher: Andrei Zelevinsky
Noncommutative Algebraic Geometry and Representation Theory	Researcher: Sarah Witherspoon
	Researcher: Matilde Marcolli

b. All MSRI members

The table on the next three pages indicates the number of participants for each activity that took place at MSRI during the 2012–13 academic year.

Time	Activity Type	Activity Title	No. of Participants	MSRI Postdocs	PD/RMs
Whole Year 2012-13	Scientific Program	Commutative Algebra	111	Christine Berkesch (NSA), Emilie Dufresne, Alexander Fink, Daniel Hernandez, Manoj Neelakandhan Kummini, Jason McCullough, Daniel Murfet, Claudiu Raicu, Steven Sam, Gregory Stevenson, Matteo Varbaro, Emily Witt, Yi Zhang, Wenliang Zhang	Eleanor Faber, Florian Geiss, Thomas Kahle, Paolo Mantero, Alexandra Seceleanu
08/22/12 to 08/24/12	Programmatic Workshop	Joint Connections for Women: Cluster Algebras and Communtative Algebra	104		
08/27/12 to 09/07/12	Programmatic Workshop	Joint Introductory Workshop: Cluster Algebras and Communtative Algebra	150		
12/03/12 to 12/07/12	Programmatic Workshop	Combinatorial Commutative Algebra and Applications	125		
02/11/13 to 02/15/13	Programmatic Workshop	Representation Theory, Homological Algebra, and Free Resolutions	168		
05/06/13 to 05/10/13	Programmatic Workshop	Multiplier Ideals, Jets, Valuations, and Positive Characteristic Methods	125		
Fall 2012	Scientific Program	Cluster Algebras	48	Bruce Fontaine, Max Glick (NSA), Pierre-Guy Plamondon, Fan Qin, Dylan Rupel, Sarah Scherotzke, Kaisa Taipale	N/A
08/22/12 to 08/24/12	Programmatic Workshop	Joint Connections for Women: Cluster Algebras and Communtative Algebra	104		
08/27/12 to 09/07/12	Programmatic Workshop	Joint Introductory Workshop: Cluster Algebras and Communtative Algebra	150		
10/29/12 to 11/02/12	Programmatic Workshop	Cluster Algebras in Combinatorics, Algebra, and Geometry	90		

Date	Type	Program/Workshop	Participants	Organizers	
Spring 2013	Scientific Program	Noncommutative Algebraic Geometry and Representation Theory	74	Kenneth Chan, Maria Chlouveraki, Andrew Morrison, Jeremy Pecharich, Alice Rizzardo, Ian Shipman (NSF), Theodore Stadnik Jr., Adam-Christiaan van Roosmalen, Chelsea Walton (NSF), Alexander Young (NSF)	Michael Ehrig
01/24/13 to 01/25/13	Programmatic Workshop	Connections for Women: Noncommutative Algebraic Geometry and Representation Theory	74		
01/28/13 to 02/01/13	Programmatic Workshop	Introductory Workshop: Noncommutative Algebraic Geometry and Representation Theory	118		
04/08/13 to 04/12/13	Programmatic Workshop	Interactions between Noncommutative Algebra, Representation Theory, and Algebraic Geometry	124		

Whole Year 2012-13	Scientific Program	Complementary Program 2012-13	4	

06/15/13 to 07/28/13	Scientific Activities Directed at Underrepresented Groups in Mathematics	MSRI-UP 2013: Algebraic Combinatorics	has not occurred yet	
10/10/12 to 10/11/2012	Scientific Activities Directed at Underrepresented Groups in Mathematics	Modern Math Workshop (SACNAS)	off site	
11/09/12 to 11/10/12	Scientific Activities Directed at Underrepresented Groups in Mathematics	Blackwell-Tapia Conference	off site	

06/18/12 to 06/29/12	Summer Graduate School (2012)	Noncommutative Algebraic Geometry (MSRI)	53	
07/09/12 to 07/20/12	Summer Graduate School (2012)	Mathematical General Relativity (MSRI)	45	
07/23/12 to 08/03/12	Summer Graduate School (2012)	Model Theory (MSRI)	40	
06/25/12 to 07/06/12	Summer Graduate School (2012)	Seminaire de Mathematiques Superieures 2012: Probabilistic Combinatorics	18	
07/01/12 to 07/21/12	Summer Graduate School (2012)	IAS/PCMI Summer 2012: Geometric Group Theory	17	

06/24/13 to 06/28/13	Other Scientific Workshop	Pacific Rim Mathematical Association (PRIMA) Congress 2013	55	
03/18/13 to 03/22/13	Other Scientific Workshop	Hot Topics: Surface subgroups and cube complexes	62	
6/2/2012	Other Scientific Workshop	Bay Area Differential Geometry Seminar (BADGS) Summer 2012	off site	
10/6/2012	Other Scientific Workshop	Bay Area Differential Geometry Seminar (BADGS) Fall 2012	off site	
3/9/2013	Other Scientific Workshop	Bay Area Differential Geometry Seminar (BADGS) Spring 2013	off site	

06/18/12 to 06/22/12	Education & Outreach Workshop	Bay Area Circle for Teachers Summer 2012	off site	
1/26/2013	Education & Outreach Workshop	Bay Area Circle for Teachers Winter 2013	off site	
07/09/12 to 07/27/12	Education & Outreach Workshop	Mathematics Professional Development Institute 2012 (Wu Summer Institute)	28	
1/27/2013	Education & Outreach Workshop	UC Berkeley Julia Robinson Mathematics Festival	off site	
03/08/13 to 03/10/13	Education & Outreach Workshop	Circle on the Road Spring 2013	49	
04/03/13 to 04/05/13	Education & Outreach Workshop	Critical Issues in Mathematics Education 2013: Assessment of Mathematical Proficiencies in the Age of the Common Core	150	

c. NSA supported Postdoctoral Fellows

MSRI allocated NSF, NSA and private funding to financially support 27 postdoctoral fellows during the 2012–13 academic year. Of those 27 postdoctoral fellows, two were financially supported by the NSA Practical and Intellectual grant, H98230-12-1-0269. Detailed financial information can be found in Section V.

Christine Berkesch was given a stipend (plus fringe benefits) for five months for her participation in *Commutative Algebra* Program.
Below is the information regarding her work during her stay at MSRI:

Berkesch, Christine

Name: Christine Berkesch
Year of Ph.D: 2010
Institution of Ph.D.: Purdue University
Dissertation title: Euler--Koszul homology in algebra and geometry
Ph.D. advisor: Uli Walther

Institution prior to obtaining the MSRI PD fellowship:
Duke University
Position at that institution: Assistant Research Professor

Institution (or company) where you are going after the MSRI PD fellowship: same as above
Anticipated length (if it is a tenure track position just write tenure-track): 1 more semester

Postdoctoral Fellow's comments:

I worked on the following publications:

(with Jens Forsgard and Mikael Passare)
Euler--Mellin integrals and A-hypergeometric functions,
19 pages. arXiv:math.CV/1103.6273

(with Stephen Griffeth and Ezra Miller)
Systems of parameters and holonomicity of A-hypergeometric systems,
4 pages. arXiv:math.AG/1302.0048

(with Laura Felicia Matusevich and Uli Walther)
Torus equivariant D-modules and hypergeometric systems, 37 pages.

(with Laura Felicia Matusevich and Uli Walther)
Singularities and binomial D-modules, 10 pages.

I also considered various aspects of toric Boij--Soederberg theory.

Was your experience at MSRI beneficial?
 Yes, this experience of focused research and collaboration was

21

'''gz vtgo gn{ 'dgpghekcn0'

Max Glick was given a stipend (plus fringe benefits) for five months
for his participation in the *Cluster Algebras* Program. Below is the information regarding
his work during his stay at MSRI:

Glick, Max

Name: Max Glick
Year of Ph.D: 2012
Institution of Ph.D. : University of Michigan
Dissertation title: The pentagram map: combinatorial and geometric
perspectives
Ph.D. advisor: Sergey Fomin

Institution prior to obtaining the MSRI PD fellowship: University of
Michigan
Position at that institution: Graduate student
Mentor (if applicable): Sergey Fomin

Institution (or company) where you are going after the MSRI PD fellowship:
UC Berkeley
Position: Visiting postdoc
Anticipated length: (if it is a tenure track position just write tenure-track) 1
semester
Mentor (if applicable): Lauren Williams

Postdoctoral Fellow's comments:

I worked on trying to better understand how geometrically defined discrete
dynamical systems can be understood in terms of cluster algebras. Towards
the end of the semester, I started a related project, consulting with Pavlo
Pylyavskyy, which I am hopeful will lead to a publication eventually. My
time at MSRI was quite beneficial. I plan to continue working in the field of
cluster algebras, and I am sure the people I met and the new ideas I
encountered will help to this end.

IV.   PUBLICATIONS SUMMARY

Six research members (including two postdoctoral fellows) were funded either entirely or partially by NSA Practical and Intellectual grant, H98230-12-1-0269. These members worked on a total of 23 papers during their stay at MSRI. The 23 papers are summarized as follows:

Manuscript Status	*Number of paper*
Submitted	5
Posted	2
Rough/Draft	12
Notes	4
Total	**23**

The table below provides complete details of the 23 papers:

Member Name	Title	Co-author(s)	Paper Status
Christine Berkesch	Euler--Mellin integrals and A-hypergeometric functions	Jens Forsgard and Mikael Passare	Submitted
Christine Berkesch	Systems of parameters and holonomicity of A-hypergeometric systems	Stephen Griffeth and Ezra Miller	Posted
Christine Berkesch	Quotients of torus equivariant D-modules and hypergeometric systems	Laura Felicia Matusevich and Uli Walther	Rough/Draft
Christine Berkesch	Hypergeometric holonomicity via the singular locus	Laura Felicia Matusevich and Uli Walther	Rough/Draft
Christine Berkesch	Splendid resolutions for toric varieties	Daniel Erman and Gregory G. Smith	Working Notes
Srikanth Iyengar	Relation between two twisted inverse image pseudofunctors in duality theory	Ammon Neeman and Joseph Lipman	Rough/Draft
Srikanth Iyengar	SUBADDITIVITY OF SYZYGIES OF KOSZUL ALGEBRAS	Lucheza Avramov, Aldo Conca	Rough/Draft
Srikanth Iyengar	Torsion in tensor products, and tensor powers, of modules	Olgur Celikbas, Greg Piepmeyer, Roger Wiegand	Submitted
Srikanth Iyengar	A local-global principle for small triangulated categories	Dave Benson, Henning Krause	Posted
Matilde Marcolli	Moduli Operad over F1	Yuri I. Manin	Submitted

Matilde Marcolli	Dyson-Schwinger equations in the theory of computation	Colleen Delaney	Submitted
Matilde Marcolli	Gauge networks in noncommutative geometry	Walter D. van Suijlekom	Submitted
Matilde Marcolli	Type III sigma-spectral triples and quantum statistical mechanical systems	Mark Greenfield, Kevin Teh	Rough/Draft
Matilde Marcolli	Positive mass Feynman integrals in configuration spaces	Ozgur Ceyhan	Rough/Draft
Sarah Witherspoon	Untitled	Dave Benson	Working Notes
Sarah Witherspoon	Untitled	Van Nguyen	Working Notes
Sarah Witherspoon	Tensor ideals and varieties for modules of quantum elementary abelian groups	Julia Pevtsova	Rough/Draft
Sarah Witherspoon	Deformations of skew groups algebras in positive characteristic	Anne Shepler	Rough/Draft
Sarah Witherspoon	Poincare-Birkhoff-Witt Theorems	Anne Shepler	Rough/Draft
Sarah Witherspoon	Drinfeld orbifold algebras for Hopf action	Chelsea Walton	Rough/Draft
Sarah Witherspoon	Gerstenhaber algebra structure of Hocschild cohomology of quantum symmetric algebras and group extensions	Guodong Zhou	Rough/Draft
Andrei Zelevinsky	Quantum greedy lements in rank 2 cluster algebras	K.Lee, L.Li, D.Rupel	Working Notes
Andrei Zelevinsky	Primitive species with potentials and their mutations	D. Labardini Fragoso	Rough/Draft