

**Final Report
on the
Mathematical Sciences Research Institute
2015–16 Activities
supported by
NSA Grant H98230-15-1-0038
Support of Distinguished Researchers at MSRI
8/01/2015-5/31/2016**

July 2016

**Mathematical Sciences Research Institute
NSA Final Report for H98230-15-1-0038**

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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 2015, MSRI hosted three on-site and three off-site Summer Graduate Schools, with themes ranging from algebraic topology topics to geometry and analysis. A complete description can be found at the URL <http://www.msri.org/web/msri/scientific/workshops/summer-graduate-school>.

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 2015 MSRI-UP, *Geometric Combinatorics Motivated by the Social Sciences*, was a successful and popular school, with 17 undergraduate participants. (See Section II.B, for a brief summary). Since MSRI-UP is funded by an independent NSA grant, its report is filed separately.

II. OVERVIEW OF ACTIVITIES 2015–16

During the 2015–16 academic year, MSRI hosted two jumbo programs: *New Challenges in PDE: Deterministic Dynamics and Infinite Dimensional Systems* took place in the fall of 2015 and *Differential Geometry* took place in the spring of 2016. MSRI also hosted a small Complementary Program for mathematicians whose interests are not closely related to the two jumbo programs. They are briefly summarized in Section II. A

There were 242 researchers who participated in these programs for a period of one month or longer. Of those members, there were 35 Postdoctoral Fellows, 47 Research Professors, 123 Research Members, and 37 Program Associates (Graduate Students).

The NSA grant H98230-15-1-0038 funded nine members. During the year, Amir Dembo, Jonathan Mattingly, Andrea Nahmod, and Gigliola Staffilani participated in the fall program: *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*. Sun-Yung Chang, Christine Breiner, James Isenberg, and Tobias Colding participated in the spring program: *Differential Geometry*. Curtis Greene participated in the year-long Complementary Program. Their full reports can be found in Section III.

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: New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems

August 17, 2015 - December 18, 2015

*Organizers: Kay Kirkpatrick (University of Illinois at Urbana-Champaign), Yvan Martel (École Polytechnique), Jonathan Mattingly (Duke University), Andrea Nahmod (University of Massachusetts, Amherst), Pierre Raphael (Université Nice Sophia-Antipolis), Luc Rey-Bellet (University of Massachusetts, Amherst), *Gigliola Staffilani (Massachusetts Institute of Technology), Daniel Tataru (University of California, Berkeley)*

The fundamental aim of this program is to bring together a core group of mathematicians from the general communities of nonlinear dispersive and stochastic partial differential equations whose research contains an underlying and unifying problem: quantitatively analyzing the dynamics of solutions arising from the flows generated by deterministic and non-deterministic evolution differential equations, or dynamical evolution of large physical systems, and in various regimes.

In recent years there has been spectacular progress within both communities in the understanding of this common problem. The main efforts exercised have generated an incredible number of deep results, that are not just beautiful mathematically, but are also important to understand the complex natural phenomena around us. Yet, many open

questions and challenges remain ahead of us. Hosting the proposed program at MSRI would be the most effective venue to explore the specific questions at the core of the unifying theme and to have a focused and open exchange of ideas, connections and mathematical tools leading to potential new paradigms. This special program will undoubtedly produce new and fundamental results in both areas, and possibly be the start of a new generation of researchers comfortable on both languages.

Workshops associated with the *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*:

Workshop 1: Connections for Women: Dispersive and Stochastic PDE

August 19, 2015 - August 21, 2015

*Organizers: *Kay Kirkpatrick (University of Illinois at Urbana-Champaign), Andrea Nahmod (University of Massachusetts, Amherst)*

This workshop will consist of various talks given by prominent female mathematicians whose research lies in and interfaces with the fields of nonlinear evolution dispersive PDE, wave phenomena and stochastic processes. These talks will be appropriate for graduate students, post-docs, and researchers in areas above mentioned. The workshop will allocate ample time for group discussions and will include a professional development session.

Workshop 2: Introductory Workshop: Randomness and long time dynamics in nonlinear evolution differential equations

August 24, 2015 - August 28, 2015

*Organizers: Kay Kirkpatrick (University of Illinois at Urbana-Champaign), *Yvan Martel (École Polytechnique), *Luc Rey-Bellet (University of Massachusetts, Amherst), Gigliola Staffilani (Massachusetts Institute of Technology)*

The purpose of the program *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems* is to bring together a core group of mathematicians from the dispersive PDE and the SPDE communities whose research contains an underlying and unifying problem: analyzing high or infinite dimensional dynamics, where dynamics is understood in a broad sense and arising from the flows generated by either deterministic or stochastic partial differential equations, or from dynamical evolution of large physical systems.

The introductory workshop will serve as an overview to the program. It aims at familiarizing graduate students, postdocs, and other researchers to the major topics of the program through short courses and discussions.

Workshop 3: New challenges in PDE: Deterministic dynamics and randomness in high and infinite dimensional systems

October 19, 2015 - October 30, 2015

*Organizers: Jonathan Mattingly (Duke University), *Andrea Nahmod (University of Massachusetts, Amherst), Pierre Raphael (Université Nice Sophia-Antipolis), Luc Rey-Bellet (University of Massachusetts, Amherst), Daniel Tataru (University of California, Berkeley)*

This workshop serves to bring into focus the fundamental aim of the jumbo program by both a) showcasing the spectacular progress in recent years in the study of both nonlinear dispersive as well as stochastic partial differential equations and b) bringing to the fore the key challenges for the future in quantitatively analyzing the dynamics of solutions arising from the flows generated by deterministic and non-deterministic evolution differential equations, or dynamical evolution of large physical systems.

During the two weeks long workshop, we intertwine talks on a wide array of topics by some of the key researchers in both communities and aim at highlighting the most salient ideas, proofs and questions which are important and fertile for ‘cross-pollination’ between PDE and SPDE. Topics include: Global dynamics and singularity formation for geometric and physical nonlinear wave and dispersive models (critical and supercritical regimes); dynamics of infinite dimensional systems (critical phenomena, multi scale dynamics and metastability); symplectic structures of infinite dimensional dynamical systems; randomization and long time dynamics, invariant Gibbs and weighted Wiener measures; derivation of effective dynamics in quantum systems; weak turbulence phenomena; optimization and learning algorithms: distributed, stochastic and parallel.

Program 2: Differential Geometry

January 11, 2016 – May 20, 2016

*Organizers: Tobias Colding (Massachusetts Institute of Technology), Simon Donaldson (Imperial College, London), John Lott (University of California, Berkeley), Natasa Sesum (Rutgers University), Gang Tian (Princeton University), *Jeff Viaclovsky (University of Wisconsin-Madison)*

Differential geometry is a subject with both deep roots and recent advances. Many old problems in the field have recently been solved, such as the Poincaré and geometrization conjectures by Perelman, the quarter pinching conjecture by Brendle-Schoen, the Lawson Conjecture by Brendle, and the Willmore Conjecture by Marques-Neves. The solutions of these problems have introduced a wealth of new techniques into the field. This semester-long program will focus on the following main themes:

- (1) Einstein metrics and generalizations,
- (2) Complex differential geometry,
- (3) Spaces with curvature bounded from below,
- (4) Geometric flows, and particularly on the deep connections between these areas.

Workshops associated with the *Differential Geometry* program:

Workshop 1: Connections for Women: Differential Geometry

January 14, 2016 – January 15, 2016

*Christine Breiner (Fordham University), *Natasa Sesum (Rutgers University)*

The purpose of this meeting is to help junior female researchers to become familiar with the focus topics of the main MSRI program, and also for the junior researchers to have an opportunity to get acquainted with more senior women researchers in differential geometry. This workshop is open to *all* mathematicians.

Workshop 2: Introductory Workshop: Modern Riemannian Geometry

January 18, 2016 – January 22, 2016

**Tobias Colding (Massachusetts Institute of Technology), John Lott (University of California, Berkeley), Jeff Viaclovsky (University of Wisconsin-Madison)*

The week will be devoted to an introduction to modern techniques in Riemannian geometry. This is intended to help graduate students and younger researchers get a headstart, in order to increase their participation during the main semester programs and research lectures. To increase outreach, the week will focus on Riemannian geometry and should be largely accessible. Some minicourses on topics of recent interest will be included. The workshop will also have semi-expository lectures dealing with aspects of spaces with curvature bounded from below, since such spaces will occur throughout the semester. We expect that many Berkeley mathematicians and students will participate in the introductory workshop.

Workshop 3: Kähler Geometry, Einstein Metrics, and Generalizations

March 21, 2016 – March 25, 2016

*Olivier Biquard (École Normale Supérieure), Simon Donaldson (Imperial College, London), Gang Tian (Princeton University), *Jeff Viaclovsky (University of Wisconsin-Madison)*

The workshop will integrate elements from complex differential geometry with Einstein metrics and their generalizations. The topics will include

- Existence of Kähler-Einstein metrics and extremal Kähler metrics. Notions of stability in algebraic geometry such as Chow stability, K-stability, b-stability, and polytope stability. Kähler-Einstein metrics with conical singularities along a divisor.
- Calabi-Yau metrics and collapsed limit spaces. Connections with physics and mirror symmetry.
- Einstein metrics and their moduli spaces, ϵ -regularity, noncompact examples such as ALE, ALF, and Poincaré -Einstein metrics. Generalizations of the Einstein condition, such as Bach-flat metrics and Ricci solitons.
- Sasaki-Einstein metrics and metrics with special holonomy. New examples and classification problems

Organized in partnership with Clay Mathematics Institute.

Workshop 4: Geometric Flows in Riemannian and Complex Geometry

May 02, 2016 – May 06, 2016

*Tobias Colding (Massachusetts Institute of Technology), *John Lott (University of California, Berkeley), Natasa Sesum (Rutgers University)*

The workshop will concentrate on parabolic methods in both Riemannian and complex geometry. The topics will include

- Ricci flow. Analytic questions about Ricci flow in three dimensions. Possible applications of Ricci flow to 4-manifold topology. Ricci flow in higher dimensions under curvature assumptions.
- Kähler-Ricci Flow. Applications to the Kähler-Einstein problem. Connections to the minimal model program. Study of Kähler-Ricci solitons and limits of Kähler-Ricci flow.
- Mean curvature flow. Singularity analysis. Generic mean curvature flow.
- Other geometric flows such as Calabi flow and pluriclosed flow.

Organized in partnership with Clay Mathematics Institute.

Program 3: Complementary Program (2015-16)

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

B. Hot Topics Workshop

Hot Topics: Cluster algebras and wall crossing

March 28, 2016 - April 01, 2016

*Organizers: *Mark Gross (University of Cambridge), Paul Hacking (University of Massachusetts, Amherst), Sean Keel (University of Texas), Lauren Williams (University of California, Berkeley)*

Cluster algebras were introduced in 2001 by Fomin and Zelevinsky to capture the combinatorics of canonical bases and total positivity in semisimple Lie groups. Since then they have revealed a rich combinatorial and group-theoretic structure, and have had significant impact beyond these initial subjects, including string theory, algebraic geometry, and mirror symmetry. Recently Gross, Hacking, Keel and Kontsevich released a preprint introducing mirror symmetry techniques into the subject which resolved several long-standing conjectures, including the construction of canonical bases for cluster algebras and positivity of the Laurent phenomenon. This preprint reformulates the basic construction of cluster algebras in terms of scattering diagrams (or wall-crossing structures). This leads to the proofs of the conjectures and to new constructions of elements of cluster algebras. But fundamentally they provide a new tool for thinking about cluster algebras.

The workshop will bring together many of the different users of cluster algebras to

achieve a synthesis of these new techniques with many of the different aspects of the subject. There will be lecture series on the new techniques, and other lecture series on connections with Lie theory, quiver representation theory, mirror symmetry, string theory, and stability conditions.

III. PARTICIPATION SUMMARY

a. All MSRI members

The table on the next two pages indicates the number of participants for each activity that took place at MSRI during the 2015–16 academic year.

Time	Activity Type	Activity Title	No. of participants
Fall 2015	Scientific Program	New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems	109
August 19, 2015 - August 21, 2015	Programmatic Workshop	Connections for Women: Dispersive and Stochastic PDE	62
August 24, 2015 - August 28, 2015	Programmatic Workshop	Introductory Workshop: Randomness and long time dynamics in nonlinear evolution differential equations	111
October 19, 2015 - October 30, 2015	Programmatic Workshop	New challenges in PDE: Deterministic dynamics and randomness in high and infinite dimensional systems	156
Spring 2016	Scientific Program	Differential Geometry	122
January 14, 2016 - January 15, 2016	Programmatic Workshop	Connections for Women: Differential Geometry	49
January 18, 2016 - January 22, 2016	Programmatic Workshop	Introductory Workshop: Modern Riemannian Geometry	128
March 21, 2016 - March 25, 2016	Programmatic Workshop	Kähler Geometry, Einstein Metrics, and Generalizations	134
May 02, 2016 - May 06, 2016	Programmatic Workshop	Geometric Flows in Riemannian and Complex Geometry	135
Academic Year 2015-16	Scientific Program	Complementary Program 2015-16	11

Time	Activity Type	Activity Title	No. of participants
June 13, 2015 – July 26, 2015	MSRI-UP 2015	Geometric Combinatorics Motivated by the Social Sciences	18
June 15, 2015 - June 26, 2015	Summer Graduate School (2015)	Seminaire de Mathematiques Superieures 2015: Geometric and Computational Spectral Theory	18
June 15, 2015 - July 11, 2015	Summer Graduate School (2015)	CRM-PIMS Summer School in Probability	18
June 15, 2015 - June 26, 2015	Summer Graduate School (2015)	Geometric Group Theory	59
June 29, 2015 - July 10, 2015	Summer Graduate School (2015)	NIMS Summer School on Random Matrix Theory	15
June 29, 2015 - July 10, 2015	Summer Graduate School (2015)	Mathematical Topics in Systems Biology	25
July 6, 2015 - July 17, 2015	Summer Graduate School (2015)	Berkeley summer course in mining and modeling of neuroscience data	6
July 13, 2015 – July 24, 2015	Summer Graduate School (2015)	Gaps between Primes and Analytic Number Theory	47
July 27, 2015 – August 7, 2015	Summer Graduate School (2015)	Incompressible Fluid Flows at High Reynolds Number	51
December 5, 2015	Other Scientific Workshop	Bay Area Differential Geometry Seminar (BADGS) Winter 2015	30
April 30, 2016	Other Scientific Workshop	Bay Area Differential Geometry Seminar (BADGS) Spring 2016	30
March 28, 2016 - April 01, 2016	Other Scientific Workshop	Hot Topics: Cluster algebras and wall-crossing	73
February 10, 2016 - February 12, 2016	Education & Outreach Workshop	Critical Issues in Mathematics Education 2016: Observing, Evaluating and Improving Mathematics Teaching from the Early Grades through the University	112

b. NSA supported researchers

MSRI allocated NSF, NSA and private funding to financially support 47 Research Professors and 123 Research Members during the 2015–16 academic year. Of the nine researchers supported by the NSA, four were Organizers, two were Research Professors and three were Research Members.

Amir Dembo participated in the fall 2015 program, *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*



Dembo, Amir

Name: Amir Dembo
Year of Ph.D: 1986
Institution of Ph.D.: Technion University, Haifa, Israel

Current Position:

Professor, Stanford University, 1996-present.

Award, Honors, and Distinctions:

- 1) 2000 & 2004 & 2007 & 2011 NSF research grants (Statistics and Probability program).
- 1) 2008 NSF (Probability program) grant for the 2009 seminar in stochastic processes conference at Stanford.
- 2) 2005 & 2008 NSF VIGRE program in Statistics at Stanford.
- 3) 2003 NSF Focused Research Group (jointly with D. Aldous, Y. Peres and A. Sinclair).
- 4) 2002 Lady Davis Visiting Professorship. Technion University.

Publications:

Books

- 1) A. Dembo and O. Zeitouni, *Large Deviations Techniques and Applications*, Jones and Bartlett, Boston, 1993; Second edition, Springer, New York, 1998.
- 2) A. Dembo "High Density Associative Memories", contributed chapter in the book *Associative Neural Memories: Theory and Implementation*, M. H. Hassoun, editor, Oxford University Press, New York, NY, 1993.
- 3) A. Dembo and O. Zeitouni, "Large Deviations and Applications", contributed chapter in the *Handbook of Stochastic Analysis and Applications*, D. Kannan and Lakshmikantham, editors, Marcel Dekker, 2002.
- 4) A. Dembo "Favorite points, cover times and fractals", 33rd St. Flour probability summer school, in *Lecture Notes in Mathematics*, 1869, Springer, 2005.

Jonathan Mattingly participated in the fall 2015 program, *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*



Mattingly, Jonathan

Name: Jonathan Mattingly
Year of Ph.D: 1998
Institution of Ph.D.: Princeton University

Current Position:

Professor of Mathematics and Statistical Science, Duke University

Awards, Honors, and Distinctions:

- 1) Simons Visiting Professors at MSRI, August, 2015
Fellow of the American Mathematical Society, American Mathematical Society
- 2) Collaboration Grants for Mathematicians, Simons Foundation
Institute of Mathematical Statistics Fellow, Institute of Mathematical Statistics, June, 2012
- 3) Sloan Research Fellowship-Mathematics, Alfred P. Sloan Foundation
- 4) School of Mathematics/ Members, Institute for Advanced Study
NSF Post-Doctoral Fellow, NSF, 1999-2002

Publications:

- 1) NE Glatt-Holtz, JC Mattingly and G Richards, *On Unique Ergodicity in Nonlinear Stochastic Partial Differential Equations*, arxiv (December, 2015) [[1512.04126v1](#)] [[abs](#)]
- 2) JE Johndrow, JC Mattingly, S Mukherjee and D Dunson, *Approximations of Markov Chains and Bayesian Inference*, arxiv (August, 2015) [[1508.03387v2](#)] [[abs](#)]
- 3) DP Herzog and JC Mattingly, *A practical criterion for positivity of transition densities*, *Nonlinearity*, vol. 28 no. 8 (August, 2015), pp. 2823-2845, ISSN 0951-7715 [[repository](#)], [[doi](#)]
- 4) S Luo and JC Mattingly, *Scaling limits of a model for selection at two scales*, arxiv (July, 2015) [[1507.00397v1](#)] [[abs](#)]
- 5) S Huckemann, J Mattingly, E Miller and J Nolen, *Sticky central limit theorems at isolated hyperbolic planar singularities*, *Electronic Journal of Probability*, vol. 20 (January, 2015) [[repository](#)], [[doi](#)]

Andrea Nahmod participated in the fall 2015 program, *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*



Nahmod, Andrea

Name: Andrea Nahmod
Year of Ph.D: 1991
Institution of Ph.D.: Yale University

Positions Held:

- 1) Professor, Univ. of Massachusetts, Amherst, MA Sept. 2008 -- Present
Sargent-Faulk Fellow, Radcliffe Institute for Advanced Study at Harvard, 2009-2010.
- 2) Associate Professor, Univ. of Massachusetts, Amherst, MA Sept. 2002--present

Award, Honors, and Distinctions:

- 1) Fellow of the American Mathematical Society (Elected in the 2015 Class)
- 2) Simons Foundation Fellow 2013-2014.
- 3) Radcliffe Institute for Advanced Study Fellow 2009-2010.
- 4) N.S.F. Grant DMS-- 1201443, July 2012-2015; Principal PI.
- 5) N.S.F. Grant DMS-- 0803160, July 2008-2012; Principal PI.
- 6) N.S.F. Grant DMS-- 0503542, July 2005-2008; Principal PI.
- 7) N.S.F. Grant DMS--0202139, July 2002-2005; Principal PI.
- 8) N.S.F. Grant DMS--9971159, July 1999-2002; Principal PI.
- 9) NSF-REU Supplement to DMS--9971159, Summer 2001; Principal PI.

Publications:

- 1) (with G. Staffilani) Long-time existence of the periodic nonlinear Schrödinger equation with randomized infinite energy data. In preparation (2014).
- 2) (with G. Staffilani) Almost sure well-posedness for the periodic 3D quintic NLS below the energy space. To appear in J. Eur. Math. Soc. (JEMS) 80 pages, (2014).
- 3) (with N. Lu and C. Zeng) Equivariant and self-similar standing waves for a Hamiltonian hyperbolic-hyperbolic spin-field system

Gigliola Staffilani participated in the fall 2015 program, *New Challenges in PDE: Deterministic Dynamics and Randomness in High and Infinite Dimensional Systems*



Staffilani, Gigliola

Name: Gigliola Staffilani

Year of Ph.D: 1995

Institution of Ph.D.: University of Chicago

Positions Held:

- 1) Co-organizer of the Clay Mathematics Institute 2008 Summer School on Evolution Equations Eidgenössische Technische Hochschule, Zürich, Switzerland June 23 – July 18, 2008.
- 2) Co-organizer of the MIT Women in Mathematics Conference: A Celebration MIT, Cambridge, April 12–13, 2008.
- 3) Organizer of a semester at MSRI, Berkeley, on Dispersive Equations, Autumn 2005.
- 4) Organizer of the Workshop on Nonlinear Dispersive Equations, Stanford, February 12–13, 2000.

Award, Honors, and Distinctions:

- 1) NSF Grant 2006-2010
- 2) NSF Grant 2000-2003
- 3) Alfred P. Sloan Research Fellowship 2000-2002
- 4) NSF Grant 1998-2001
- 5) Terman Award 1998-2001
- 6) Borsa di Studio C.N.R. per l'estero, 1993-1995
- 7) University of Chicago fellowship, 1990-1995

Publications:

- 1) Flows on Hyperbolic Spaces: Scattering in H^1 . Preprint, 2008. (With A. Ionescu)
- 2) Resonant decompositions and the I-method for cubic nonlinear Schrödinger on \mathbb{R}^2 . To appear in DCDS-A, 2008. (With J. Colliander, M. Keel, H. Takaoka and T. Tao).
- 3) Weighted low-regularity solutions of the KP-I initial-value problem. *Discrete Contin. Dyn. Syst.* 20 (2008), no. 2, 219–258. (With J. Colliander, A. Ionescu, and C. Kenig.)
- 4) Regularity of solutions to the Navier-Stokes equations evolving from small data in BMO–1. *Int. Math. Res. Not. IMRN* 2007, no. 21, Art. ID rnm087, 35 pp. 76D03. (With P. Germain and N. Pavlović.)

Christine Breiner participated in the spring 2016 program, *Differential Geometry*



Breiner, Christine

Name: Christine Breiner

Year of Ph.D: 2009

Institution of Ph.D.: Massachusetts Institute of Technology

Current Position:

CLE Moore Instructor Massachusetts Institute of Technology

2009-present

Award, Honors, and Distinctions:

- 1) National Science Foundation Postdoctoral Research Fellow, MIT, 2009-2010, 2011-2013.
- 2) Mathematics Department Excellence in Teaching Award, Johns Hopkins University, 2007.
- 3) William Kelso Morrill Award for Excellence in the Teaching of Mathematics, Johns Hopkins University, 2005.
- 4) Apgar Teaching Award, Roland Park Country School, Baltimore, MD, 2003.
- 5) Elmer A. Graham Endowed Scholarship Fund, Kenyon College, 1998-1999.
- 6) Reginald B. Allen Prize in Mathematics, Kenyon College, 1997, 1998.
- 7) Phi Beta Kappa, Kenyon College, 1998-present.

Publications:

- 1) Symmetries of Embedded Genus One Helicoids, joint with J. Bernstein, To appear. Duke Math J.
<http://arxiv.org/abs/1011.3769>. Conformal Structure of Minimal Surfaces with Finite Topology, joint with J. Bernstein, To appear. Comment. Math. Helv.
<http://arxiv.org/abs/0810.4478>.
- 2) Helicoid-like Minimal Disks and Uniqueness, joint with J. Bernstein, To appear. J. Reine Angew. Math. (Crelle's Journal) <http://arxiv.org/abs/0802.1497>.
- 3) Distortions of the Helicoid, joint with J. Bernstein. Geometriae Dedicata. 137(1) 143-147 (2008).
<http://arxiv.org/abs/0805.4775>.

Alice Chang participated in the spring 2016 program, *Differential Geometry*



Chang, Alice(Sun-Yung)

Name: Alice (Sun-Yung) Chang

Year of Ph.D: 1974

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

Positions Held:

- 1) Assistant Professor, State University New York, Buffalo.
- 2) Hedrick Assistant Professor, University of California, Los Angeles.
- 3) Professor, University of California, Berkeley
- 4) Professor, Princeton University.
- 5) Distinguished Visiting Professor, Institute for Advanced Study, Princeton.

Award, Honors, and Distinctions:

- 1) Invited 45 Minutes Speaker, International Congress of Mathematicians, Berkeley, 1986.
- 2) Outstanding Women of Science Award, UCLA, 1989.
- 3) Satter Prize, American Mathematical Society, 1995.
- 4) Emmy Noether Lecture, American Women in Mathematic, January 2001.

Publications:

- 1) Sun-Yung A. Chang, Hao Fang, and C. Robin Graham, "A Note on Renormalized Volume Functionals" *Differential Geometry and its Applications*: to appear (pdf)
- 2) Sun-Yung A. Chang and Yi Wang, "Inequalities for Quermassintegrals on k -Convex Domains", preprint 2011, to appear *Advances in Math.* (pdf)
- 3) Sun-Yung A. Chang and Yi Wang, "Some higher order isoperimetric inequalities via the method of optimal transport", preprint, to appear in *IMRN*.
- 4) Sun-Yung A. Chang, Jiakun Liu and Paul Yang, "Optimal transportation on the hemisphere", preprint 2013. (pdf)
- 5) Jeffrey Case, Sun-Yung A. Chang, "On fractional GJMS operator", preprint, 2014, to appear in *CPAM*.

James Isenberg participated in the spring 2016 program, *Differential Geometry*



Isenberg, James

Name: James Isenberg
Year of Ph.D: 1979
Institution of Ph.D.: University of Maryland

Positions Held:

- 1) 1993-present Professor, Department of Mathematics, University of Oregon.
- 2) 1987-1993 Associate Professor, Department of Mathematics, University of Oregon.
- 3) 1982-87 Assistant Professor, Department of Mathematics, University of Oregon.

Award, Honors, and Distinctions:

- 1) 2013 Eisenbud Professorship, MSRI 2009 Research Innovation Award (Oregon)
- 2) 2001 Fellow of the American Physical Society
- 3) 1996 Distinguished Professor (France)
- 4) 1992 Professor of the Month (Jan. 1992, University of Oregon) 1986 CNRS Fellowship
- 5) 1981 Fifth Place, Gravity Essay Award
- 6) 1980 Fourth Place, Gravity Essay Award
- 7) 1979 Chaim Weizmann Fellowship
- 8) 1974 Outstanding First Year Student (Physics, University of Maryland)
- 9) 1974 NSF Fellowship

Publications:

- 1) Effect of Temperature on Light Absorption by Crystalline Cadmium Sulfide. *Chemistry*, Vol. 42, No. 6 pp. 26-28 (1969).
- 2) Initial Value Problem of General Relativity. III. Coupled Fields and the Scalar Tensor Theory. *Physical Review D.*, Vol. 13, No. 6, pp. 1532-1537, (1976) with J. York and N. O'Murchadha.
- 3) Torsion Singularities. *Physical Review D*. Vol. 15, No. 8, pp. 2078-2087, (1976) with J. Nester.
- 4) The Effect of Gravitational Interaction on Classical Fields: A Hamilton Dirac Analysis. *Annals of Physics*, Vol. 107, Nos. 1-2, pp. 56-81, (1977) with J. Nester.
- 5) Extension of the York Field Decomposition to General Gravitationally Coupled Fields. *Annals of Physics*, Vol. 108, No. 2, pp. 368-386, (1977) with J. Nester.

Tobias Colding participated in the spring 2016 program, *Differential Geometry*



Colding, Tobias

Name: Tobias Colding

Year of Ph.D: 1992

Institution of Ph.D.: University of Pennsylvania

Positions held:

- 1) Spring 2016: Eisenbud Visiting Professor, MSRI.
- 2) 2013-: Cecil and Ida Green Distinguished Professor, MIT.
- 3) 2010-13: Norman Levinson Professor, MIT.
- 4) 1999-08: Professor, New York University.

Award, Honors, and Distinctions:

- 1) 2015-2016: Clay Senior Scholar.
- 2) 2013-: Cecil and Ida B. Green Distinguished Professor of Mathematics, MIT
- 3) 2011-2012: Clay Senior Scholar.
- 4) 2010 Oswald Veblen prize

Publications:

- 1) T.H. Colding and W.P. Minicozzi II, Committee ranking, submitted.
- 2) T.H. Colding, D. Gabai and D. Ketover, On the classification of Heegaard splittings, submitted.
- 3) T.H. Colding and W.P. Minicozzi II, Differentiability of the arrival time, *Comm. Pure and Appl. Math*, to appear.
- 4) T.H. Colding and D. Gabai, Effective Finiteness of irreducible Heegaard splittings of non Haken 3-manifolds, submitted.
- 5) T.H. Colding and W.P. Minicozzi II, The singular set of mean curvature flow with generic singularities, *Inventiones Math.*, to appear.

Curtis Greene participated in the year-long Complimentary Program:



Greene, Curtis

Name: Curtis Greene
Year of Ph.D: 1969
Institution of Ph.D.: California Institute of Technology

Positions held:

Massachusetts Institute of Technology
University of Pennsylvania

Award, Honors, and Distinctions:

Member, American Mathematical Society

Publications

- 1) Words avoiding a reflexive acyclic relation (with John Dollhopf and Ian Goulden), *Electronic Jour. Combinatorics* **11(2)** (2006), #R28.
- 2) Closed form summation of C-finite sequences (with Herbert Wilf) *Transactions Amer. Math. Soc.*, 359 (2007), 1161-1189.
- 3) Inequalities for symmetric means (with Allison Cuttler and Mark Skandera), in preparation.
- 4) *Greene, Curtis; Kleitman, Daniel J. (1976), "The structure of Sperner k-families", Journal of Combinatorial Theory, Series A 20 (1): 41–68, doi:10.1016/0097-3165(76)90077-7, MR 0398844.*
- 5) *Greene, Curtis; Kleitman, Daniel J. (1976), "Strong versions of Sperner's theorem", Journal of Combinatorial Theory, Series A 20 (1): 80–88, doi:10.1016/0097-3165(76)90079-0, MR 0389608.*

IV. PUBLICATIONS SUMMARY

Nine researchers funded by this NSA grant wrote 10 papers:

Member Name	Paper Title	Co-author(s)	Paper Status
Christine Breiner	Regularity of Harmonic maps to CAT(1) spaces	Fraser, Huang, Mese, Sargent, Zhang	Rough/Draft
Christine Breiner	Harmonic replacement into CAT(1) spaces	Fraser, Huang, Mese, Sargent, Zhang	Rough/Draft
Christine Breiner	Quantitative Stratification for Yang Mills Connections	Petrache	Working Notes
Christine Breiner	Extremal metrics in Kaehler geometry	Sena-Dias	Working Notes
Jonathan Mattingly	On Ergodicity of SPDEs	Nathan Glad-Hotlz, Geordie Richards	Submitted
Jonathan Mattingly	Ergodicity of rough SPDEs	Martin Hairer	Rough/Draft
Jonathan Mattingly	Hybrid Monte Carlo	oleg Bukovsky, Andrew Stuart	Working Notes
Jonathan Mattingly	MCMC and kinetic equations	Kay Kirkpatrick, Jeremy Marzula	Working Notes
Jonathan Mattingly	Stochastically Forced Szego Equations	Patrick Gérard	Working Notes
Jonathan Mattingly	Random Hankel matrices	Amir Dembo	Working Notes