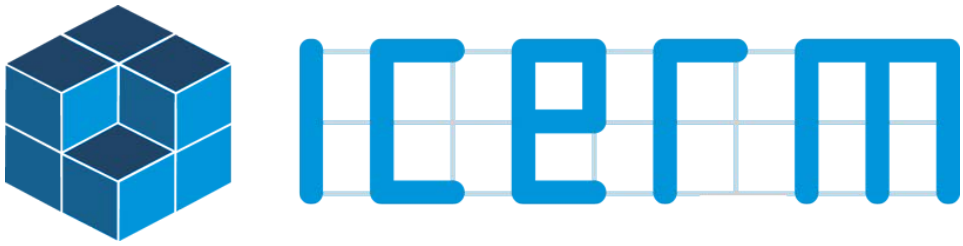

Institute for Computational and Experimental Research in Mathematics

Annual Report
February 1, 2016 – May 10, 2016

Jill Pipher, Director
Jeffrey Hoffstein, Consulting Associate Director
Sinai Robins, Deputy Director
Bjorn Sandstede, Associate Director
Homer Walker, Deputy Director
Ulrica Wilson, Associate Director for Diversity and Outreach

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ICERM Reporting Dates

ICERM received its NSF renewal grant for years 2015-2020 in the fall of 2015. ICERM began utilizing funds from this *new* grant starting February 1, 2016. Note that ICERM has submitted a separate abbreviated report for the programs and events that were funded by the remaining funds in the original 2010-2015 grant, starting May 1, 2015 and running through January 31, 2016. Since ICERM typically reports on its programs and events annually from May to the following May, *this* abbreviated report details programs and events that ran at ICERM from February 1, 2016 through May 10, 2016, and were funded with the 2015-2020 renewal grant funds.

Mission

"The mission of the Institute for Computational and Experimental Research in Mathematics ICERM is to support and broaden the relationship between mathematics and computation: specifically, to expand the use of computational and experimental methods in mathematics, to support theoretical advances related to computation, and address problems posed by the existence and use of the computer through mathematical tools, research and innovation."

Core Programs and Events

ICERM's programs and events from February 1, 2016 through May 10, 2016

TYPE	TITLE	DATE	# ATTENDED
Semester Program	Dimension and Dynamics	Feb 1, 2016 - May 6, 2016	72
Program Workshop 1	Ergodic, Algebraic and Combinatorial Methods in Dimension Theory	Feb 15 - 19, 2016	78
Public Lecture	"The Beautiful Mathematically Ordered Colors of Birds", featuring Rodolfo Torres	February 17, 2016	65
Program Workshop 2	Fractal Geometry, Hyperbolic Dynamics and Thermodynamical Formalism	Mar 7 - 11, 2016	87
Program Workshop 3	Computation in Dynamics	Apr 4 - 8, 2016	70
Public Lecture	"Inverse Problems and Harry Potter's Cloak", featuring Gunther Uhlmann	April 20, 2016	250

Virtual Institute of Mathematical and Statistical Sciences VI-MSS

ICERM's supplemental proposal for the two-year pilot program "Virtual Institute of Mathematical and Statistical Sciences VI-MSS" was awarded in August 2011, creating a partnership that formally connects two US mathematical sciences institutes ICERM and SAMSI with several mathematics and statistics institutes in India. ICERM was granted a no-cost extension through 2016, which allowed the program to expand further on its original mission. ICERM presently includes jointly funded international collaborations with institutes and institutions in Brazil, Israel, Japan, and South Africa. These collaborations create a thriving "virtual" institute in the mathematical and statistical sciences.

VI-MSS Goals

1. Collaborative workshops held in US and other contributing international Institutes

2. Research visits by international faculty, postdocs and students to ICERM semester programs and workshops funded by their home institution.
3. Satellite workshops funded by international institutions associated with long programs at ICERM held abroad.
4. Graduate/postdoc joint training events.
5. Research visits abroad to participating international institutions.

Participating Institutions and Organizations

In US
- Institute for Computational and Experimental Research in Mathematics ICERM, Providence, RI

In Brazil:
- Instituto Nacional de Matemática Pura e Aplicada IMPA

In Israel:
- School of Mathematical Sciences at the Tel Aviv University

In Japan:
- Kobe University

No international team-based programs were run during this reporting period.

Participant Summaries by Program Type

For this reporting term **February 1, 2016 to May 1, 2016** 175 unique participants were enrolled in one semester long program and/or 3 workshops. Of the 175, 152 received some sort of funding to attend an ICERM program. ICERM actively seeks women and members of underrepresented ethnic groups to participate in its programs as speakers and participants. While most participants choose to report their gender and ethnicity, some choose not to do so. All data below includes all organizers and is as of May 1, 2016.

ICERM Funded Participants

			Gender and Ethnicity							Geographical Point of Origin									
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US - Midwest	US - Northeast	US - South	US - West	Africa	Asia	Canada	Europe	Latin & South America	Oceania
Spring Semester '16	Semester Program	70	10	54	0	0	13	0	43	6	6	4	4	0	10	5	27	8	0
	Workshop 1	70	11	53	0	0	19	0	43	9	9	1	6	0	14	6	18	7	0
	Workshop 2	72	12	58	0	0	13	0	49	9	13	3	5	0	5	5	24	8	0
	Workshop 3	67	15	50	0	0	11	0	40	6	11	5	2	0	4	7	25	6	1
	Total	279	48	215	0	0	56	0	175	30	39	13	17	0	33	23	94	29	1
	% of # Reporting		22%		0%	0%	32%	0%		11%	14%	5%	6%	0%	12%	8%	34%	10%	0%

All Participants ICERM funded and Non-ICERM funded

			Gender and Ethnicity							Geographical Point of Origin	
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US Based	Foreign Based
Spring Semester '16	Semester Program	72	10	56	0	0	13	0	43	21	51
	Workshop 1	78	13	61	0	0	21	0	47	28	50
	Workshop 2	87	13	71	0	0	15	0	56	38	49
	Workshop 3	70	16	53	0	0	12	0	42	26	43
	Total	307	52	241	0	0	61	0	188	113	193
	% of # Reporting		22%		0%	0%	32%	0%		37%	63%

ICERM Funded Speakers

			Gender and Ethnicity							Geographical Point of Origin									
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US - Midwest	US - Northeast	US - South	US - West	Africa	Asia	Canada	Europe	Latin & South America	Oceania
Spring Semester '16	Semester Program	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Workshop 1	20	3	13	0	0	5	0	9	4	2	0	4	0	3	2	5	0	0
	Workshop 2	23	3	19	0	0	2	0	14	2	3	1	2	0	1	1	7	5	0
	Workshop 3	28	3	20	0	0	1	0	14	1	4	4	0	0	1	2	11	4	1
	Total	71	9	52	0	0	8	0	37	7	9	5	6	0	5	5	23	9	1
	% of # Reporting		17%		0%	0%	5%	0%		3%	3%	2%	2%	0%	2%	2%	8%	3%	0 %

All Speakers ICERM funded and Non-ICERM funded

			Gender and Ethnicity							Geographical Point of Origin	
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US Based	Foreign Based
Spring Semester '16	Semester Program	0	0	0	0	0	0	0	0	0	0
	Workshop 1	21	3	13	0	0	4	0	8	10	11
	Workshop 2	24	3	20	0	0	3	0	15	8	15
	Workshop 3	28	3	20	0	0	1	0	14	9	19
	Total	73	9	53	0	0	8	0	37	27	45
	% of # Reporting		17%		0%	0%	4%	0%		9%	15%

ICERM Funded Postdoctoral Fellows and Postdoctoral Visitors

			Gender and Ethnicity							Geographical Point of Origin									
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US - Midwest	US - Northeast	US - South	US - West	Africa	Asia	Canada	Europe	Latin & South America	Oceania
Spring Semester '16	Semester Program	14	3	11	0	0	3	0	10	1	0	0	0	0	1	1	5	1	0
	Workshop 1	13	3	9	0	0	3	0	9	4	0	0	0	0	1	1	3	1	0
	Workshop 2	13	3	10	0	0	3	0	9	2	1	0	0	0	0	1	4	1	0
	Workshop 3	9	2	6	0	0	0	0	6	0	1	0	0	0	0	1	3	0	0
	Total	49	11	36	0	0	9	0	34	7	2	0	0	0	2	4	15	3	0
	% of # Reporting		31%		0%	0%	5%	0%		3%	1%	0%	0%	0%	1%	1%	5%	1%	0%

5 postdocs received a stipend from ICERM during this reporting period: 3 males, 2 Females.

All Postdocs ICERM funded and Non-ICERM funded

			Gender and Ethnicity							Geographical Point of Origin	
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US Based	Foreign Based
Spring Semester '16	Semester Program	14	3	10	0	0	3	0	9	1	8
	Workshop 1	14	4	10	0	0	3	0	10	4	7
	Workshop 2	14	3	10	0	0	3	0	9	4	6
	Workshop 3	10	2	6	0	0	0	0	6	2	4
	Total	52	12	36	0	0	9	0	34	11	25
	% of # Reporting		33%		0%	0%	5%	0%		4%	8%

5 postdocs received a stipend from ICERM during this reporting period: 3 males, 2 Females.

ICERM Funded Graduate Students

			Gender and Ethnicity							Geographical Point of Origin									
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US - Midwest	US - Northeast	US - South	US - West	Africa	Asia	Canada	Europe	Latin & South America	Oceania
Spring Semester '16	Semester Program	15	4	12	0	0	4	0	13	2	2	0	2	0	1	2	6	0	0
	Workshop 1	18	4	15	0	0	5	0	16	2	3	0	2	0	3	2	6	0	0
	Workshop 2	19	5	16	0	0	5	0	17	2	4	0	3	0	1	2	7	0	0
	Workshop 3	15	5	11	0	0	5	0	12	3	2	0	2	0	0	3	5	0	0
	Total	67	18	54	0	0	19	0	58	9	11	0	9	0	5	9	24	0	0
	% of # Reporting		33 %		0%	0%	11%	0%		3%	4%	0%	3%	0%	2%	3%	9%	0%	0%

All Graduate Students ICERM funded and Non-ICERM funded

			Gender and Ethnicity							Geographical Point of Origin	
	Program Type	Total Participants	Female	# Reporting Gender	African American	American Indian	Asian	Hispanic	# Reporting Ethnicity	US Based	Foreign Based
Spring Semester '16	Semester Program	15	4	12	0	0	4	0	13	6	9
	Workshop 1	21	4	17	0	0	6	1	17	8	13
	Workshop 2	25	6	20	0	0	4	0	15	12	13
	Workshop 3	15	5	11	0	0	5	0	10	7	8
	Total	76	19	60	0	0	19	1	55	33	43
	% of # Reporting		32%		0%	0%	10%	1%		11%	14%

Semester Programs

Since its inaugural semester program in September 2011, a large portion of the Institute's activity has taken place in the context of semester long thematic programs together with their associated workshops.

Semester Program Process

ICERM's Scientific Advisory Board SAB meets annually in November, and schedules conference calls as needed throughout the year. The 2015 annual meeting and a subsequent conference call in June resulted in the selection of semester programs and topical workshops through Fall 2018.

The semester program selection process follows these steps:

1. Solicitation of Proposals

ICERM hosts two semester programs per year. Each has 5-10 organizers and typically incorporates three week-long associated workshops. Semester program proposers are asked to contact the ICERM Director to discuss program ideas prior to starting a pre-proposal.

Pre-Proposal Requirements

A 2-3 page document which describes the scientific goals, lists the organizers of the program, and identifies the key participants.

Pre-Proposal Target Deadline

All pre-proposals should be submitted to the ICERM Director. Target deadlines are early September and mid-April. The ICERM directors and a subcommittee of the Scientific Advisory Board SAB review all pre-proposals. Proposers receive feedback within a few weeks of their submission.

Semester Program Full Proposal Requirements

Full Proposals for semester programs consist of 6-10 pages containing:

- A description of the program area/theme written with a general mathematical audience in mind,
- A description of the central scientific challenges to be addressed by the program,
- A list of organizers normally around 5-10, most of whom will be in residence for the semester program,
- A list of 8-10 high priority senior scientists who are likely to visit ICERM as long-term participants for a month or more,
- An additional ranked list of up to 20 or more potential long-term participants the organizing committee feels will help form a critical mass for the scientific program,
- A main contact chair of organizing committee,
- A description of the three proposed workshops including potential organizers if possible,
- A discussion of the experimental and computational aspects of the program,
- Concrete plans for involving and mentoring graduate students, postdocs, and early-career mathematicians in the program tutorials at the beginning of the program and/or before workshops, weekly student/postdoc seminars, advising and other structured mentoring activities from the senior participants,
- An assigned organizer responsible for coordination of mentoring,
- Plans for ensuring the participation of underrepresented groups organizers are expected to work with ICERM directors on diversity issues.

Semester Program Full Proposal Deadline

All full proposals should be submitted to the ICERM Director. Target deadlines are October 1st and May 1st. The ICERM directors and the Scientific Advisory Board SAB review all proposals. Proposers receive feedback within a few weeks of their submission.

2. Proposal Selection

The Science Advisory Board SAB approves the semester programs. The deadline for proposals is at least a week prior to the annual November SAB meeting typically the end of the month. Proposals are usually sent out for review. Once a proposal is accepted, an ICERM Director and members of a SAB subcommittee are assigned to assist the organizers and the organizers are provided with a semester program planning timeline. The "high priority" list of senior scientists are contacted and invited to participate immediately upon approval of the program and this list by the SAB. Program dates are scheduled with details posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes, and Conference Service Mandl. Program and/or workshop ads are placed in appropriate publications if recommended by the organizers and directors. In addition, ICERM reserves some funds for applicants to the program.

From this point on, organizers are involved in making decisions on the following: ICERM postdoc selection; applications for long-term visitors, graduate students, and workshop participants; mentoring of students and postdocs an institute Director assists organizers with mentor coordination. The Directors make the final decision on all invitations. `The chair of the organizing committee or other designated organizer assists ICERM staff by providing appropriate program images for web and print ads, and may be asked to review marketing materials.

3. Selection of Long-term Visitors/Research Fellows

The organizers propose a ranked list of 15 to 20 research fellows. ICERM Directors approve and/or suggest additions or re-rankings in consultation with assigned SAB members. The standard model for long-term participation for senior faculty is through paid leaves such as sabbatical.

4. Offers to Research Fellows

Once the list of research fellows has been finalized and funding determined, an invitation is sent to each. The invitation describes the program and outlines the support to be provided. Using its Discovery database, ICERM tracks demographic information about, and all interactions with, research fellows.

5. Semester Workshops

The semester program proposal should include a list of organizers for each of its three workshops. The organizers propose an initial ranked list of 20-25 possible speakers and a list of 10 alternates. The ICERM Directors approve and/or suggest additions or re-rankings in consultation with assigned SAB members. Formal invitations are sent by ICERM staff describing the program and outlining the support to be provided to those who indicate an interest.

The chair of each workshop's organizing committee or other designated organizer assists ICERM staff by providing appropriate program images for the workshop's web and print ads, and may be asked to review marketing materials.

6. Application Process

Once the organizers and Directors agree there is enough critical mass in terms of confirmed long-term visitors and/or workshop speakers, the on-line application for that particular program is opened on the ICERM website. All applications are stored in the institute's Application database. The ICERM postdoctoral fellow applicants who were not hired are either automatically entered into the online applicant pool, or they are alerted that these positions have closed and that they should apply online for partial support to attend if they are still interested.

7. Applicant Selection

The Application database allows program organizers, ICERM Directors and staff to view each candidate's application. Every two weeks or so, the organizers are asked to recommend a ranking of

applicants for their program graduate students, participants. ICERM Directors review the ranked list, re-rank as appropriate and make the final selections, taking into consideration the remaining budget for the program, diversity, participant support requested, and whether or not the applicant if a young researcher has an advisor already participating in the program. ICERM staff then updates the applicant about their status, and any support they are eligible for, as appropriate. This process continues until funds for the program run out.

Financial Decisions for Semester Programs

Financial decisions are made by ICERM Directors based on discussions with organizers. On average, the institute provides stipends for 5 postdoctoral fellows and 1 institute postdoctoral fellow each semester, with support for travel and shared housing for 12-15 graduate students per program. There is support for housing and travel for around 15-20 long-term visitors including organizers who stay for 4 months, and up to 60 additional shorter term visitors who stay for 1-4 weeks. In addition, there is support for workshop attendees. The institute has very limited funds for stipends and buyout of teaching for key participants. Some funds are reserved for support for applicants to the program. In general, ICERM will aim to help participants negotiate sabbatical leaves and teaching release from their departments to participate in institute programs.

Opening, "Middle" and Closing Events

Semester program opening and closing events are tailored to each program. Here are some examples of planned events during semester programs.

Opening event

Lasts about 1-2 days, beginning on first day of program and includes:

- 10-15 minute introductory presentations by the postdocs and grad students, designed to get everyone acquainted
- Opening reception on first day of program
- Talks related to upcoming workshops
- IT tutorial led by ICERM's IT staff

Weekly Seminar non workshop weeks

- The weekly seminar includes talks by visitors in residence at ICERM. Program organizers are provided with names and dates to facilitate scheduling.

Mini-Series Optional

- Mini-courses or other multi-session events are encouraged.

Research Clusters Optional

A Research Cluster takes place during a semester program and is an independently organized research group activity in a focused subfield of that semester program.

A typical Research Cluster lasts at least 10 days, and as long as 4-6 weeks, and focuses on immediate progress on a major problem or on several problems of significance in the field of the program. In addition to the invited participants, interested faculty, postdocs or graduate students in residence at ICERM may participate in the research cluster.

The activity period begins with a collection of tutorials or a short possibly two day workshop. The research activities, planned by the organizers, may consist of teamwork, daily/weekly seminars, and closing presentations. In collaboration with an ICERM director, Research Cluster organizers develop a list of 6-15 key scientists to form the core cohort of the cluster.

Prior to each of semester workshops

- Full-day tutorials the Thursday and Friday the week before each workshop.
- Tutorials are given by long term visitors to the program

During Semester Workshops

- Workshops last 1 week and consist of 50-minute talks with 10 minutes of Q&A.
- Typically one afternoon is left "open" for collaborations and small groups
- A poster session is scheduled midweek, usually in the early evening with refreshments
- Workshops include a "wrap-up" session to discuss ideas and new directions among all of the workshop participants together

Non-workshop weeks

- Lectures occur through either mini courses, research seminars, special talks, and/or computational working group meetings
- Young Researcher Seminar, where graduate students and postdocs meet sans faculty and discuss scientific questions
- Postdocs and grad students are mentored throughout the program, both informally and with formal professional development seminars and meetings

Final Event

During the first week of the program a 1-day closing event is planned with input from the organizing committee. Some possible models include:

- Short talks from all long term visitors who are still in residence
- Special Colloquium to close out the event on the last day of the program
- Time set aside for takeaways
- Closing reception

Note: Sample schedules and organizer timeline can be found in Appendix A

Spring 2016 Semester Program

Spring Semester 2016: Dimension and Dynamics

February 1-May 6, 2016

Organizing Committee

Dmitry Dolgopyat, University of Maryland
Mike Hochman, Hebrew University of Jerusalem
Izabella Laba, University of British Columbia
Stefano Luzzatto, ITCP-Trieste
Yakov Pesin, Penn State University
Mark Pollicott, Warwick University
Joerg Schmeling, Lund University
Boris Solomyak, Bar-Ilan University
Warwick Tucker, Uppsala University

Program Description

Since its introduction by Felix Hausdorff in 1919, the concept of the Hausdorff dimension of sets and measures has been a versatile and powerful tool in classical analysis, geometry and geometric measure theory, mathematical physics and their numerous applications. However, there has been a particularly important symbiosis between dynamical systems and dimension theory. This connection arises both from

application of dimension theory to the classification and geometric analysis of dynamical systems and their invariant sets and measures, and the fact that many classical objects of study in mathematics arise from sometimes implicit dynamical systems, which often play a role in the dimension theory of said objects.

Recently, there has been substantial progress on a number of central problems in dimension theory, and while many old problems remain, many new ones have also presented themselves. These include a deeper understanding of the relationship between dimension, entropy and Lyapunov exponents; the recent strengthenings of the Marstrand projection theorem and its implications for dimensions of sums of Cantor sets and the connections with number theory; multifractal analysis of ergodic averages, particularly the recent advances for multiple ergodic averages; and improved computational methods for obtaining effective bounds on Hausdorff dimension. This proposed program aims to set the stage for further progress on the many open problems in the field.

It is a challenging classical problem to compute numerically dimensions of given fractals. In recent years, computer-aided proofs in mathematical analysis have gained an increasing presence in mathematical research. One reason for this field's growing impact is due to its ability to produce high-quality quantitative information about global, nonlinear problems. As a consequence, solutions to a large class of previously intractable problems are now within reach and recently several long-standing conjectures have been verified using rigorous computations.

During the semester we will focus on three specific aspects of the interaction between these two areas: i Ergodic, algebraic and combinatorial methods in dimension theory ii Computations in fractal geometry in dynamical systems; and iii Fractal geometry and hyperbolic dynamics.

Mini Courses

A class of random Cantor measures, with applications
Speaker: Pablo Shmerkin, Universidad Torcuato Di Tella
February 10, 2016 and February 12, 2016

Schmidt games and fractals in dynamics and number theory
Speakers: Dmitry Kleinbock, Brandeis University, and Barak Weiss,
Tel Aviv University
February 10, 2016 and February 11, 2016

Equidistribution and dimension via additive combinatorics
Speaker: Elon Lindenstrauss, The Hebrew University of Jerusalem
February 11, 2016 and February 12, 2016

Symbolic dynamics for hyperbolic systems
Speaker: Yuri Lima, University of Paris
March 2, 2016

Microlocal techniques for hyperbolic dynamics
Speaker: Semyon Dyatlov, MIT
March 3, 2016

Multifractal analysis, large deviations and Fourier transforms for countable branch expanding maps
Speaker: Thomas Jordan, University of Bristol
March 4, 2016

Workshop 1: Ergodic, Algebraic and Combinatorial Methods in Dimension Theory

February 15-19, 2016

Organizing Committee

Mike Hochman, Hebrew University
Izabella Laba, University of British Columbia
Pablo Shmerkin, Torcuato Di Tella University
Barak Weiss, Tel Aviv University

Workshop Description

here are natural interactions between dimension theory, ergodic theory, additive combinatorics, metric number theory and analysis. Each of these fields provides different perspectives on, and complementary approaches to, the hierarchical structures which appear in fractal geometry.

The workshop will focus on recent advances at the interfaces of these fields, including:

- Classical fractals self-similar and self-affine sets, random fractals.
- Dimension theory and additive combinatorics.
- Diophantine approximation and equidistribution.
- Schmidt games.
- Rigidity phenomena.
- Scenery flow methods.
- Projection and slice theorems

Speakers

Balázs Bárány, University of Warwick
Jon Chaika, University of Utah
Xianghong Chen, University of Wisconsin-Milwaukee
Yitwah Cheung, San Francisco State University
Marianna Csörnyei, University of Chicago
Kenneth Falconer, University of St. Andrews
De-Jun Feng, The Chinese University of Hong Kong
Michael Hochman, The Hebrew University of Jerusalem
Alex Iosevich, University of Rochester
Esa Järvenpää, University of Oulu
Dong Han Kim, Dongguk University
Henna Koivusalo, University of York
Ben Krause, UCLA
Izabella Laba, University of British Columbia
András Máthé, University of Warwick
Yuval Peres, Microsoft Research
Yakov Pesin, Penn State University
Malabika Pramanik, University of British Columbia
David Simmons, Ohio State University
Karoly Simon, Budapest University of Technology and Economics
Boris Solomyak, Bar-Ilan University
Krystal Taylor, The Ohio State University
Joshua Zahl, MIT

Some Workshop Participant Comments for "Please describe how ICERM has or has not added to your knowledge of experimental/computational methodologies and/or theoretical developments within this field":

- *"I was not aware that people do research on Fourier analysis on fractals. Through this workshop, I learned that much has been done on Fourier analysis on fractals in conjunction with number theory and combinatorics. This was very educational."*
- *"During the workshop, I learned new tool to study dynamical systems, such as Schmidt games."*

Some Workshop Organizer Comments for "Briefly describe workshop highlights":

- *"I thought there was a good mix of talks, and people from different fields interacted with each other; there were many lively discussions which hopefully spurred future collaborations."*
- *"The participants interacted very well and there was significant interaction between different mathematical communities. I was hoping to be able to attract a stronger representative contingent in diophantine approximation but many of the relevant experts declined invitations unfortunately."*
- *"The goal of bringing together researchers from diverse areas connected to dimension theory was very successfully met."*
- *"I liked the lectures which were not in my immediate area, but had some interesting connections with it, in particular, those by M. Csornyei, I. Laba, M. Pramanik, and J. Zahl.*
- *"Talk of Hochman in workshop and talks of Lindenstrauss and Shmerkin in minicourse."*
- *"Diversity of areas represented, high quality research presented, opportunities for informal talks with leading researchers in many areas."*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *"The highlight of this workshop is the opportunity to listen to talk by and talk with people on various levels, from graduate students and postdocs, to well renowned professors, on topics related to my research."*
- *"I attended many inspiring talks on dimension theory in dynamical systems."*
- *"Interesting talks. Many specialists to ask questions and to discuss with. Allowing me meet many old and new friends."*

Workshop 2: Fractal Geometry, Hyperbolic Dynamics and Thermodynamical Formalism

March 7-11, 2016

Organizing Committee

Lorenzo Diaz, Pontifical Catholic University of Rio de Janeiro
Dmitry Dolgopyat, University of Maryland
Maarit Jarvenpaa, University of Oulu
Joerg Schmeling, Lund Institute of Technology
Masato Tsujii, Kyushu University
Amie Wilkinson, University of Chicago

Workshop Description

A surprising discovery of 20th century mathematics is that many deterministic systems exhibit random behavior. One early example of a chaotic system was Lorenz equation used by meteorologist Edward Lorenz as a simplified model of atmospheric convection. One of the most common mechanisms of stochasticity is the Smale horseshoe appearing near a homoclinic intersection.

The Lorentz attractor and Smale horseshoe are typical examples of fractal invariant sets for dynamical systems. Fractal objects are ubiquitous in dynamics, including invariant sets, invariant measures, invariant foliations et cetera.

Thermodynamical formalism is a powerful tool for studying dimensions of fractal objects. It originated in statistical mechanics, but currently it has applications to many areas of mathematics including spectral theory, hyperbolic geometry and probability theory.

The goal of this conference is to bring together experts studying fractal objects in dynamics in order to review recent progress in the field and catalyze further research.

Speakers
Yong Moo Chung, Hiroshima University
Vaughn Climenhaga, University of Houston
Sylvain Crovisier, University of Paris - Sud
Jacopo de Simoi, University of Toronto
Lorenzo Diaz, Pontifical Catholic University of Rio de Janeiro
Dmitry Dolgopyat, Uppsala University
Semyon Dyatlov, MIT
Ai-Hua Fan, Université de Picardie Jules Verne
Todd Fisher, Brigham Young University
Jonathan Fraser, University of Manchester
Katrin Gelfert, Universidade Federal do Rio de Janerio
Anton Gorodetski, University of California Irvine
Thomas Jordan, University of Bristol
Sarah Koch, University of Michigan, Ann Arbor
Francois Ledrappier, CNRS in France
Carlos Moreira, Instituto Nacional de Matemática Pura e Aplicada IMPA
Stéphane Nonnenmacher, Université Paris-sud
Hee Oh, Yale University
Mark Pollicott, Warwick University
Federico Rodriguez, Hertz PSU
Pablo Shmerkin, Torcuato Di Tella University
Karoly Simon, Budapest University of Technology and Economics
Giulio Tiozzo, Yale University
Masato Tsujii, Kyushu University

Some Workshop Participant Comments for "Please describe how ICERM has or has not added to your knowledge of experimental/computational methodologies and/or theoretical developments within this field":

- *"I have had the opportunity to attend talks of colleagues announcing new developments in my area, that are connected to my research. Also, I have had the opportunity to listen to talks that are not exactly in my current field, but that made me broaden my scope."*
- *"Workshop was aimed at theoretical developments, for which great speakers were invited, who presented their latest results, giving a good overview on the topic. Also there was plenty of free time to collaborate with others."*
- *"The list of participants included the names of world leading experts in dynamics, and the atmosphere of the conference was perfect for informal interactions and discussions. I learned a lot during these 5 days!"*

Some Workshop Organizer Comments for "Briefly describe workshop highlights":

- *"From my point of view this workshop was an excellent opportunity to put in contact researched working in different related fields of dynamics, the common point being thermodicamical formalism."*
- *"Many connections between differentiable dynamics my field and symbolic aspects of dynamics, it opens many perspectives."*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *"1. Relevance and treatment of systems with different time scales 2. Wide applicability of Markov methods, in particular that of standard pairs."*
- *"Opportunities to chat with excellent researchers in the field."*
- *"The great environment ICERM had to offer to do research."*
- *One of my co-authors whom I never encountered before in person was there. It was a great opportunity to finally meet him and talk about so many different projects!..."*
- *"Good balance between presentation and collaboration time, well-planned program, excellent working facilities both formal and informal.."*

Workshop 3: Computation in Dynamics

April 4-8, 2016

Organizing Committee

Denis Gaidashev, Uppsala University
Stefano Galatolo, University of Pisa
Stefano Luzzatto, ICTP
Warwick Tucker, Uppsala University
Michael Yampolsky, University of Toronto

Workshop Description

Numerical computations have always played an important role in the development of the theory of Differential Equations and Dynamical Systems, more and more so as the availability and power of computers has increased dramatically over the last few decades. At the same time, the limitations of computer-assisted numerical calculations have also become increasingly apparent. Notwithstanding their enormous power, the intrinsic finite resolution of computers can lead to significant errors, especially as a result of a large number of calculations through which small errors can accumulate.

An important and growing approach to certain mathematical problems consists of developing rigorous numerical techniques in combination with more classical analytic methods in order to obtain rigorous qualitative and quantitative results. In some cases this leads to the proof of deep mathematical theorems and in other cases to quantitative, and thus more concrete and applicable, versions of abstract existence results.

This workshop will bring together experts in Dynamical Systems and experts in the theory of Computability to exchange ideas and results, and promote collaborations in view of significant developments in the field over the next few years.

The workshop will include four main streams of research:

- Approximation of Dynamical Quantities
- Regular and Stochastic Properties
- Renormalization
- Computability in Dynamics

Speakers
Zin Arai, Hokkaido University
Jeremy Avigad, Carnegie Mellon University
Wael Bahsoun, Loughborough University
Ilia Binder, University of Toronto
Sarah Day, College of William and Mary
Rafael de la Llave, Georgia Tech
Artem Dudko, Stony Brook University
Jordi-Lluís Figueras, University of Uppsala
Gary Froyland, University of New South Wales
Denis Gaidashev, Uppsala University
Stefano Galatolo, University of Pisa
Zbigniew Galias, AGH University of Science & Technology
Vadim Kaloshin, University of Maryland
Hans Koch, University of Texas at Austin
Jean-Philippe Lessard, Université Laval
Suzanne Lynch Boyd, University of Wisconsin-Milwaukee
Giorgio Mantica, Universita' dell'Insubria
Konstantin Mischaikow, Rutgers University
Irina Mitrea, Temple University
Maurizio Monge, Federal University of Rio de Janeiro UFRJ
Isaia Nisoli, Federal University of Rio de Janeiro UFRJ
Kathrin Padberg-Gehle, Technische Universitat Dresden
Pawel Pilarczyk, IST Austria
Cristóbel Rojas, Universidad Andrés Bello Santiago
Pablo Roldán González, Instituto Tecnológico Autónomo de México
Dalia Terhesiu, University of Exeter
Daniel Wilczak, Jagiellonian University
Piotr Zgliczynski, Jagiellonian University

Some Workshop Participant Comments for "Please describe how ICERM has or has not added to your knowledge of experimental/computational methodologies and/or theoretical developments within this field":

- *"I was an outsider to the conference -- my goal was to present some new computational methods to people working in dynamical systems, and learn more about what goes on in the field. I am very happy to have had an opportunity for this."*
- *"I had a very positive interaction with colleagues, some of whom I knew already, many I did not. Certainly I did see new ideas and techniques and yet it will need a longer stay to put these at work. But this is not at all a fault of the workshop, that was perfectly organized. It is the fact that I could just come for a short week."*
- *"I learned many new more numerical and computational approaches to a topic that I had worked on, generally speaking, more theoretically, in the past."*

Some Workshop Organizer Comments for "Briefly describe workshop highlights":

- *"This turned out to be a really good workshop with a wide but not too wide scope of the talks. There were quite a few junior participants which also is nice. I think that all participants learned some new techniques and results that were slightly out of their own expertise, which I think is very valuable."*
- *"The blend and core - bringing together a wide variety of topics with the same area: rigorous computations."*

Some Workshop Participant Comments for "Briefly describe workshop highlights":

- *"Learning about contemporary research in dynamical systems, and thinking about how interactive and automated theorem proving can contribute."*
- *"* New techniques of rigorous evaluation of Perron Frobenius operators * Functional analytic framework for stability of the computation of invariant measures * Newton-Kantorovich type algorithms."*
- *"The workshop gave me the direction I needed in crafting a graduate program which we will be instituting in our college UP Cebu."*

All Visitors to Spring 2016 Semester Program

Gray highlight represents anyone staying over 9 days

Name	Organization	Time spent at ICERM in Days
Algom, Amir	The Hebrew University of Jerusalem	7
Almocera, Lorna	University of the Philippines Cebu	4
Arai, Zin	Hokkaido University	69
Avigad, Jeremy	Carnegie Mellon University	4
Bahsoun, Wael	Loughborough University	6
Bank, Efrat	University of Michigan	4
Barany, Balazs	University of Warwick	6
Belova, Anna	Uppsala University	9
Ben-Ovadia, Snir	Weizmann Institute	4
Benedicks, Michael	KTH (Royal Institute of Technology)	31
Binder, Ilia	University of Toronto	3
Bonatti, Christian	CNRS	4
Bradonjic, Milan	Bell Labs	4
Bray, Sarah	Tufts University	4
Bunimovich, Leonid	GA Tech	5
Canadell, Marta	Georgia Institute of Technology	105
Cao, Yongluo	Suzhou University China	20
Chaika, Jon	University of Utah	8
Chandgotia, Nishant	University of British Columbia	120
Chen, Jianyu	Michigan State University	4
Chen, Xianghong	U Wisconsin - Milwaukee	6
Cheung, Yitwah	San Francisco State University	4
Chung, Yong Moo	Hiroshima University	4
Cladek, Laura	University of Wisconsin - Madison	95
Climenhaga, Vaughn	University of Houston	11
Crovisier, Sylvain	University of Paris	4
Csörnyei, Marianna	University of Chicago	4
Cyranka, Jacek	Rutgers University	4
Day, Sarah	College of William and Mary	6
de la Llave, Rafael	Georgia Institute of Technology	4
de Simoi, Jacopo	University of Toronto	4
Demers, Mark	Fairfield University	4
Diaz, Lorenzo	University of Rio de Janeiro	40

Dolgopyat, Dmitry	University of Maryland	31
Dudko, Artem	Stony Brook University	4
Dungca, Jason	University of Bristol	4
Dyatlov, Semyon	MIT	4
Ekström, Fredrik	Lund University	6
Fan, Ai-Hua	Universite de Picardie Jules Verne	4
Farkas, Abel	Mathematical Institute, North Haugh	120
Feng, De-Jun	The Chinese University of Hong Kong	6
Figueras, Jordi-Lluis	Uppsala University	35
Fisher, Todd	Brigham Young University	4
Fraser, Jon	University of Manchester	30
Froyland, Gary	University of New South Wales	6
Furstenberg, Hillel	Hebrew University of Jerusalem	4
Gaidashev, Denis	Uppsala University	38
Galatolo, Stefano	University of Pisa	22
Galias, Zbigniew	AGH University of Science & Technology	7
Gelfert, Katrin G.	Universidade Federal do Rio de Janerio	87
Golmakani, Ali	Federal University of Alaguas	95
Hasselblatt, Boris	Tufts	8
Hazard , Peter	University of Toronto	98
Hempel, Maria	WPI	4
Hochman, Mike	Hebrew University of Jerusalem	37
Hooper, Patrick	City College of New York	4
Hu, Huyi	Michigan State University	4
Humi, Mayer	WPI	95
Iosevich, Alex	University of Rochester	4
Jordan, Thomas	University of Bristol	14
Jurga, Natalia	University of Warwick	39
Järvenpää, Maarit	University of Oulu	4
Järvenpää Esa	University of Oulu	31
Kaloshin, Vadim	University of Maryland	4
Kao, Lien-Yung	University of Notre Dame	95
Katz, Nets	California Insitute of Technology	4
Kempton, Tom	University of St Andrews	39
Kim, Dong Han	Dongguk University	6
Kleinbock, Dmitry	Brandeis University	4
Koch, Hans	University of Texas at Austin	5
Koch, Sarah	University of Michigan Ann Arbor	4
Koivusalo, Henna	University of York	19
Kolossvary, Istvan	Budapest University of Technology and Economics	4
Kra, Bryna	Northwestern University	
Krause, Ben	UCLA	88
Laba, Izabella	University of British Columbia	44
Lai, Chun Kit	San Francisco State University	4
LeCrone, Jeremy	Kansas State University	6
Ledrappier, Francois	CNRS in France	32
Lessard, Jean-Philippe	Universite Laval	4
Li, Zhiqiang	University of California, Los Angeles	120

Liao, Lingmin	University of Paris	4
Lima, Yuri	University of Paris-Sud	40
Lin, Yan	China University of Mining and Technology	4
Lindenstrauss, Elon	Hebrew University of Jerusalem	2
Liu, Bochen	University of Rochester	4
Lu, Guozhen	Wayne State University	69
Luo, Yusheng	Harvard University	4
Luzzatto, Stefano	ITCP-Trieste	47
Lynch Boyd, Suzanne	University of Wisconsin-Milwaukee	6
Mansfield, Daniel	University of New South Wales	4
Mantica, Giorgio	Universita' dell'Insubria	6
Marcinek, Jake	Harvard University	4
Mathe, Andras	University of Warwick	4
Medvedovsky, Anna	Brandeis University	120
Mihailescu, Eugen	Institute of Mathematics of the Romanian Academy	7
Mijovic, Vuksan	University of St Andrews	59
Mischaikow, Konstantin	Rutgers University	5
Mitrea , Irina	Temple University	5
Molontay, Roland	Budapest University	95
Molter, Ursula	Universidad de Buenos Aires	4
Monge, Maurizio	Federal University of Rio de Janeiro (UFRJ)	6
Moreira, Carlos Gustavo	IMPA	25
Nesharim, Erez	Tel Aviv University	60
Nisoli, Isaia	Federal University of Rio de Janeiro (UFRJ)	4
Nonnenmacher, Stephane	Université Paris-Sud	4
Nowak, Magdalena	Jan Kochanowski University	4
Oh, Hee	Yale University	4
Padberg-Gehle, Kathrin	Technische Universitat Dresden	6
Peres, Yuval	UC Berkeley	4
Pesin, Yakov	Penn State University	59
Pham, Lam	Yale	4
Pilarczyk, Pawel	IST Austria	6
Pollicott, Mark	Warwick University	88
Prager, Amy	Saudi Research Science Institute	6
Pramanik, Malabika	University of British Columbia	4
Radu, Remus	Stony Brook University	4
Rappaport, Ariel	The Hebrew University of Jerusalem	5
Rodriguez Hertz, Jana	IMERL	41
Rojas, Cristobel	Universidad Andres Bello (Santiago)	3
Roldan Gonzalez, Pablo	Instituto Tecnologico Autonomo de Mexico	6
Ruggiero, Rafael	University of Rio de Janeiro	4
Ruziboev, Marks	International School of Advanced Studies	89
Sahlsten, Tuomas	Einstein Institute of Mathematics	4
Senti, Samuel	Universidade Federal do Rio de Janerio	95
Shahidi, Farruh	Penn State University	4
Shmerkin, Pablo	Torcuato Di Tella University	33
Shu, Lin	Peking University	63
Simmons, David	Ohio State University	4

Simon, Karoly	Budapest University of Technology and Economics	97
Solomyak, Boris	Bar-Ilan University	56
Stenflo, Orjan	Uppsala University	40
Sun, Peng	Central University of Finance and Economics	4
Szasz, Domokos	Budapest University of Technology and Economics	14
Takahashi, Hiroki	Keio University	4
Takahashi, Yuki	University of California Irvine	4
Tanaka, Ryokichi	AIMR	6
Taylor, Krystal	IMA	32
Terhesiu , Dalia	University of Exeter	5
Thompson, Daniel	Ohio State University	4
Tiozzo, Giulio	Yale University	1
Todd, Michael	University of St. Andrews	59
Trevino, Rodrigo	Courant Institute NYU	95
Troscheit, Sascha	University of St. Andrews	47
Tsujii, Masato	Kyushu University	7
Tu, Siming	University of Chile	42
Tucker, Warwick	Uppsala University	14
Urbanski , Marius	University of North Texas	4
Ures, Raul	IMERL	41
Vytnova, Polina	Queen Mary, University of London	116
Wang, Zhiren	Penn State University	11
War, Khadim	International Center for Theoretical physics	127
Weiss, Barak	(Tel Aviv University)	11
Whitaker, Nathaniel	University of Massachusetts Amherst	3
Wilczak, Daniel	Jagiellonian University	4
Wilkinson, Amie	University of Chicago	4
Winter, Dale	IAS	4
Wolf, Christian	CUNY	25
Wu, Wen	University of Oulu	32
Xiao, Yayuan	Ball State University	6
Yampolsky, Michael	University of Toronto	95
Yang, Jonguk	University of Toronto	95
Yavicoli, Alexia	University of Buenos Aires	25
Yi, Ren	Brown University	4
Zabzina, Natalia	Uppsala University	9
Zaehle, Martina	Friedrich-Schiller-UniversitÃ¤t	37
Zahl , Joshua	MIT	4
Zelerowicz, Agnieszka	Penn State University	95
Zgliczynski, Piotr	Jagiellonian University	6
Zhang, Lu	Wayne State University	4
Zhang, Ruifeng	Hefei University of Technology China	4
Zhao, Yun	Suzhou University	39

Here follows a sample of the most substantive comments from our long-term visitors:

Some Semester Program Participant Comments for "Please describe how ICERM has or has not added to your knowledge of experimental/computational methodologies and/or theoretical developments within this field":

- *"The courses and conferences provided new insights and techniques for the theoretical development in particular the courses around the first two events contributed in numerous aspects."*
- *"The semester program at ICERM presented me with an opportunity to dedicate myself to research, to make connections with new colleagues and strengthen connections with existing colleagues, and to learn about the cutting edge results in the field of Geometric Measure Theory and Fractal analysis. The lectures and time spend one-on-one where very beneficial to adding to my knowledge of theoretical developments and computational methods."*
- *"Before coming to ICERM I knew very little about the computational methods used in the theory of dynamical systems. I met here some of the leading experts of the field. I decided to enter in this topic, motivated by some of the talks on the conference in April in ICERM."*
- *"The contact with many experts in these topics has improved my research work. Indeed, I have obtained some new results inspired by discussion and talks I attended during the activity"*

Semester Organizer Comments for "Briefly describe program highlights":

- *"The first two workshops were extremely important with many great talks and discussions. Some of the mini-courses were very interesting and informative as were some talks at the seminars."*
- *"The working atmosphere at ICERM."*

Some Semester Organizer Comments for "What, if any, specific projects or collaborations did you pursue during this program?":

- *"1. The study of Sinai-Ruelle-Bowen measures; the paper has been completed during the program and a second paper is being written. 2. A geometric approach for constructing equilibrium measures; the project has been originated during the program. 3. Scaled dimension-like characteristics of dynamical systems; the project has been originated during the program."*
- *"1) There were several POTENTIAL new projects, which I have been thinking about, which arose as a result of the program, but whether they will grow into actual projects is not clear yet. 2) I continued working on several projects while attending the program: (i) a joint project with P. Shmerkin and S. Saglietti on absolute continuity of non-homogeneous self-similar measures on the line; (ii) a joint project with M. Hochman on dimensions of Furstenberg measures, (iii) a joint book project with K. Simon (tentative book title "Self-similar and self-affine sets and measures"), (iv) a joint project with A. Bufetov on Hoelder continuity of spectral measures for generic translation flows in genus 2 (Bufetov didn't attend the program, but I discussed this project with many participants, including J. Chaika, R. Trevino, and B. Weiss."*

Some Long-Term Participant Comments for "Briefly describe program highlights":

- *"I enjoyed interactions with postdocs and PhD students - usually semester programmes (at least outside the US) don't allow for such long-term interactions."*
- *"This program provided an exceptionally friendly atmosphere, and very good circumstances for research. I met many of the world leading experts of the topic of the conferences and also I met many young students whom I have never met before."*
- *"The topics, as well as the courses around, the first two conferences covered a very interesting range of topics the choice of speakers was were well done."*
- *"Many of the leading experts coming together for a longer period than a typical conference, so plenty of opportunities for interaction."*

- *"Having a great number of specialists together produces the ideal ambience for scientific production. In my opinion the minicourses and seminars were more useful than the great number of talks given during the workshops."*

Some Long-Term Participant Comments for "What, if any, specific projects or collaborations did you pursue during this program?":

- *"Wrote most of this paper: http://arxiv.org/abs/1604.03572 And discussed with several people (B. Solomyak, B Weiss, N. Chandgotia) about problems related to that topic."*
- *"1. The study of Sinai-Ruelle-Bowen measures; the paper has been completed during the program and a second paper is being written. 2. A geometric approach for constructing equilibrium measures; the project has been originated during the program. 3. Scaled dimension-like characteristics of dynamical systems; the project has been originated during the program."*
- *"We started a collaboration with Kristal Taylor that we will continue after the conference. This project requires the skills of Kristal about harmonic analysis and my expertise on the theory of fractals. Also I found very interesting a question by Mark Pollicott that may also lead to a collaboration."*
- *"Karoly Simon and I began investigating the existence of interior points in the Minkowski sum of a circle with a fractal subset of the plane: S^1 + A. We are using the transversality method (a more generalized projection theory) and techniques from Harmonic analysis. This project lies in the intersection of our interests and expertise. It has given me the opportunity to learn more projection theory and given him the opportunity to learn more Harmonic analysis."*

Some Postdoc Comments for "Briefly describe program highlights":

- *"There were several talks on Thermodynamic formalism, decay of correlations and limit theorems from which I learned new application of the construction I have learned during my PhD."*

Some Postdoc Comments for "What, if any, specific projects or collaborations did you pursue during this program?":

- *"Continued working with D Gaidashev on the study of renormalization for conservative maps in dimension 2. Discussed a possible future project with M Benedicks on optimal regularity for infinite topological entropy."*
- *"Now, I have started random dynamical systems (RDS), which can be represented by skew product systems. RDS is completely new are for me."*

Some Graduate Student Comments for "Briefly describe program highlights":

- *"The location (ICERM building) was absolutely fantastic and very conducive to a research atmosphere. The length of the program was also nice, as it allowed the participants to get to know each other better."*

Some Graduate Student Comments for "What, if any, specific projects or collaborations did you pursue during this program?":

- *"There is a plan to study and understand the rigidity problem for Siegel Henon maps."*

Topical Workshops

ICERM hosts several topical workshops each year. These workshops typically last 5 days and focus on a timely and exciting theme of interest that aligns with ICERM's mission of supporting and broadening the relationship between mathematics and computation.

Pre-Proposal Requirements
A 1-2 page pre-proposal document which describes the scientific goals, lists the organizers of the program, and identifies the key participants.

Pre-Proposal Deadline
All pre-proposals should be submitted to the ICERM Director. The target deadlines for submissions are early September and mid-April. The ICERM directors and a subcommittee of the Scientific Advisory Board SAB will review all pre-proposals. Proposers will receive feedback within a few weeks of their submission.

Topical Workshop Full Proposal Deadline
All full proposals should be submitted to the ICERM Director. Target deadlines are October 1st and May 1st. All full proposals are considered by the Scientific Advisory Board SAB potentially after an external review. Decisions are typically reached within one-to-two months of the target deadlines.

1. Solicitation of Topical Workshop Proposals
A topical workshop proposal should be of 2-4 pages length and contain the following:

- A description of the program area/theme written with a general mathematical audience in mind,
- A list of organizers normally around 3-6,
- The main contact chair of the organizing committee,
- A discussion of the experimental and computational aspects of the program,
- Plans for ensuring the participation of underrepresented groups organizers are expected to work with ICERM directors on diversity issues.

2. Proposal Selection
The Science Advisory Board SAB approves the topical workshops. The deadlines for proposals is mid-October, prior to the annual November SAB meeting, and mi May, prior to an annual conference call. Approved program dates will be scheduled with details posted on the ICERM website and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes.

From this point on, applications for graduate students and workshop participants will be considered; the chair of the workshop organizing committee or other designated organizer will assist ICERM staff by providing appropriate program images for web and print ads, and may be asked to review marketing materials.

3. Recommendation of Speakers
The organizers will propose a ranked list of 20-25 speakers, which the ICERM Directors will approve and/or suggest additions or re-rankings in consultation with SAB members.

4. Invitations to Speakers
Once the list of workshop speakers has been finalized and funding determined, an invitation will be sent to each. The invitation will describe the workshop and outline the support to be provided. Using its Discovery database, ICERM will track demographic information about, and all interactions with, speakers.

5. Application Process
Once the organizers and Directors agree there is enough critical mass in terms of confirmed speakers, the on-line application for that particular workshop will be opened on the ICERM website. All applications will automatically be synced with ICERM's Discovery database.

6. Applicant Selection

The Discovery database allows workshop organizers, ICERM Directors and staff to view each candidate's application. Every two weeks or so, the organizers will be asked to recommend a ranking of applicants for their program graduate students, participants. ICERM Directors will review the ranked list, re-rank as appropriate and make the final selections, taking into consideration the remaining budget for the program, diversity, participant support requested. ICERM staff will then update the applicant about their status, and any support they are eligible for, as appropriate. This process continues until funds for the program run out.

Financial Decisions for Topical Workshops

Financial decisions are made by ICERM Directors based on discussions with organizers. There is support for housing and travel support for around 20-25 speakers including organizers, who stay for 1 week. The institute reserves some funds to support uninvited applicants.

Topical Workshops

No topical workshops were run during this reporting period.

Note: for upcoming programs please see Appendix B.

Collaborate@ICERM

Collaborate@ICERM is ICERM's newest program. It offers teams of 3-6 researchers the opportunity to spend five days at the institute during the summer (May-August) or in the month of January. The team research project should have a computational or experimental component. ICERM provides access to a variety of software packages as well as to high performance computing through Brown's Center for Computation and Visualization.

Proposals should specify the research project, the members of the team, the case for convening at ICERM, and possible dates. The proposal narrative should be no longer than 2-3 pages. Supporting materials should include short CVs of team members. This program provides funding for travel to the institute and local accommodations for six nights. International travel is partially supported. The entire team should be present for the week at ICERM, and are required to write a 2-page follow-up report within a month of being at ICERM. Proposals involving research projects that continue a collaboration fostered at one of the past ICERM semester programs are encouraged.

Collaborate@ICERM Process

The Collaborate@ICERM selection process follows these steps:

1. Solicitation of Proposals

ICERM solicits and recruits proposals from faculty nationally.

2. Future Proposal Selection

Programs are selected from proposals submitted to ICERM in an open competition. Proposals are reviewed by the ICERM Science Board during their November annual meeting and spring conference call.

The first Collaborate@ICERM programs will be run during the summer of 2016, and will be reported on in ICERM's 2016-2017 annual report.

Note: for upcoming programs please see Appendix B.

VI-MSS International Programs

VI-MSS has sponsored joint workshops, research visits and graduate educational activities with support from the US National Science Foundation, the Indo-US Science and Technology Forum, and the Indian Department of Science and Technology. VI-MSS presently includes jointly funded international collaborations with institutes and institutions in Brazil, Israel, Japan, and South Africa

Graduate Student Team Based Research

ICERM's international VI-MSS research training program provides graduate students with the opportunity to work in small teams on research projects, while also engaging with a diverse group of graduate students from different countries with different cultural backgrounds. Each program is held in collaboration with a foreign university or institution, typically involving six students from US universities and six students from the international partner institution. Students work in small teams of 3-4 participants on different research projects. Each team is be led by an advanced graduate student; two faculty mentors supply the projects, provide general guidance, and facilitate the research work. Each research program lasts for 3 weeks with half of the time being spent at ICERM and the other half at the international partner institution: this ensures that students are exposed not only to research collaborations within an international group of students but also experience the cultural differences of working in different countries.

No international programs were run during this reporting period.

Note: for upcoming programs please see Appendix B.

Program Promotions

ICERM programs and events are marketed through a variety of outlets: its website, dedicated Facebook page and Twitter account, targeted blast emails, posters mailed to purchased targeted university and college lists, placement of advertisements in mathematical journals and newsletters, Director participation in conferences and exhibits, upcoming program fliers and announcements provided to all ICERM participants, and various on-line math organization calendars SIAM, AMS, European Mathematical Society, National Math Institutes, and Conference Service Mandl, etc..

ICERM's email database is made up of former and future participants, ICERM board members, academic and corporate sponsors, and the department managers from higher education math departments in both the US and overseas. It currently has over 4,000 contact emails. Posters for ICERM's summer undergraduate research program Summer@ICERM are target mailed to institutions known to have undergraduate programs in mathematics, applied math, and computer science.

During this reporting cycle, ICERM has had a speaker, a booth and/or joint representation with other institutions at the following locations and national events:

- Underrepresented Students in Topology and Algebra Research Symposium, Spring 2016
- Spring Opportunities for Women Mathematical Sciences, Spring 2016

All program advertising emphasizes diverse participation and uses language encouraging minority and under-represented students to apply. More details about this can be found in the "Outreach/Diversity" section of this report.

Organization/Infrastructure

ICERM's governing body is a Board of Trustees BOT. The Scientific Advisory Board SAB oversees all scientific activities of the Institute and selects the scientific programs. The Education Advisory Board, or EAB coordinates the oversight of educational activities at all levels at ICERM.

Board of Trustees (BOT)

The Board of Trustees (BOT) oversees all institute activities. This includes being responsible for reviewing the budget for the coming year, developing policies and procedures, approving the appointment of the Director, and taking a leadership role in fundraising and public awareness. The Board of Trustees has a face-to-face meeting at ICERM for one day each year usually in late spring, and one or two conference-call meetings if needed.

Board member appointments are for four years. Chairs from the Scientific Advisory Board SAB and the Education Advisory Board EAB, as well as the ICERM Directors, act as ex officio members. The board meets in person once a year. There may be additional conferences and consultation.

ICERM Board of Trustees

Name	Institution
Douglas Arnold	University of Minnesota
Sir John Ball	University of Oxford
Jennifer Chayes	Microsoft Research
Peter Jones (interim Chair)	Yale University
David Keyes	Columbia University/KAUST
Barbara Keyfitz	Ohio State University
Yann LeCun	NYU and Director of Research, Facebook
Yvon Maday	Université Pierre et Marie Curie
Bin Yu	University of California at Berkeley

Scientific Advisory Board (SAB)

The Scientific Advisory Board (SAB) is responsible for approving the programs and scientific activities of the Institute. In addition, through direct communication with the Directors, Science Board members will be involved in shaping the direction of the scientific enterprise through specific suggestions of thematic programs, program organizers and participants.

Terms are three years. Three of the seats on this Board are reserved for senior representatives of Google Research, IBM, and Microsoft Research. The ICERM Directors act as ex officio members of this committee.

ICERM Scientific Advisory Board

Name	Institution
Henry Cohn	Microsoft Research
Qiang Du (new member)	Columbia University
Charles Epstein	University of Pennsylvania
Anna Gilbert, Chair	University of Michigan
Sally Goldman	Google
Ricardo Nochetto (new member)	University of Maryland
Guillermo Sapiro	Duke University
Anne Schilling	University of California, Davis
Richard Schwartz	Brown University
Cosma Shalizi	Carnegie Mellon University

Robert S. Sutor	IBM

Note: see Appendix C for the minutes of the SAB conference call on May 26, 2016.

Education Advisory Board (EAB)

The Education Advisory Board (EAB) is charged with 1) oversight of the mentoring mechanisms and professional development of both graduate students and postdoctoral candidates, 2) oversight of undergraduate research programs, and helping to develop and identify successful proposals, and 3) developing proposals for K-12 outreach programs, including student internships and teacher education, and identifying alternative sources of funding.

Principally, the focus of the EAB will be the educational activities pertaining to Undergraduates, Secondary and Primary school students, Teachers in STEM fields, and the community at large. Subcommittees will have oversight over the following activities:

- **Summer Undergraduate Research Programs**: Oversight includes the task of reviewing and rank-ordering proposals for summer undergraduate research programs from faculty.

- **Outreach Activities:** Oversight includes proposing and reviewing all projects and programs involving the interaction between ICERM and the communities listed above. Review of such programs will include advice on assessment and evaluation.

- **External Funding:** The EAB will explore opportunities for external funding for outreach activities, and, where possible, facilitate and pursue such funding opportunities.

- **Public Outreach:** The EAB will identify potential speakers and topics for public lectures to the community at large.

- **Dissemination and Evaluation:** This subcommittee will recommend external evaluators and review evaluation processes.

Terms are three years. The ICERM Directors act as ex officio members of this committee.

ICERM Education Advisory Board

Name	Institution
John Ewing (new member)	Math for America
Karen Haberstroh	Brown University
Irina Mitrea	Institute for Mathematics and its Applications
Katharine Ott	Bates College
Allison Pacelli	Williams College
Lynn Rakatansky	RI Math Teachers Association Executive Board
Tatiana Shubin	San Jose University
Sergei Tabachnikov, Chair	Brown University
Ulrica Wilson	Morehouse College

Mathematics Institute Directors Meeting MIDs

The minutes for the 2015 MIDs meeting were included in ICERM's annual report dated May 1, 2015-January 31, 2016.

ICERM's Early Career Training and Mentorship

A special focus of the operations of the institute is the training and mentorship of younger and early career mathematicians, through specific outreach programs and directed opportunities for connections between mathematicians at different stages in their career. This includes ICERM's postdoctoral program, integration and support of graduate students in the context of semester programs, and our summer research programs for undergraduates (Summer@ICERM).

Caroline Klivans, a Lecturer for Brown University's Applied Mathematics and Computer Science Departments, is also ICERM's newest Associate Director. Carly provides leadership for the institute's graduate student and postdoc mentoring program, including the Professional Development seminar series.

Postdoctoral Program

ICERM's postdoctoral program brings early career mathematicians to the institute in order to support and expand their research and to create lasting career collaborations and connections. ICERM supports postdoctoral researchers in two different ways: postdoctoral fellows, who participate in a single semester program and are supported by a stipend plus health insurance benefits and a $750 travel stipend, and a smaller number of institute fellows, who stay at ICERM for 9 months and who receive a salary plus health insurance benefit with the possibility of summer support. In addition, $1,500 in research travel funding is made available with pre-approval from ICERM. All ICERM postdocs are matched with a faculty mentor for the duration of their institute appointment.

Recruiting and Selection of ICERM-Funded Postdocs

ICERM's postdoctoral positions are widely advertised using MathJobs.org, print and online publications of the Society for Industrial and Applied Mathematics News, Notices of the American Mathematical Society, the Association of Women in Mathematics, the Society for the Advancement of Chicanos and Native Americans in Science, and on the ICERM website. These positions are also advertised at the NSF Institute Reception at the joint meetings of the AMS/MAA. ICERM collects applications via Mathjobs.org, an online job application service provided by the American Mathematical Society.

In all written material sent out, it is emphasized that Brown is an EEO/AA Employer and that ICERM encourages applications from women and minority candidates.

ICERM sets a mid-January deadline for postdoctoral applications. Application review begins immediately and continues until the positions are filled.

The Postdoctoral Fellow Search Committee consists of the ICERM Semester Program organizers for the upcoming programs and the ICERM Director and Deputy Directors.

The program organizers review all of the applications and provide a rank-ordered list to the ICERM Directors for each of the two types of positions (Institute and Semester postdocs). Directors review the total applicant pool and the ranked lists, and may suggest changes. The directors approve all offers, and Brown University's Dean of the Faculty generates the appointment paperwork.

Typically, ICERM postdoctoral fellows come to ICERM after taking a leave from, or have deferred the start of, another position.

Spring 2016 ICERM Postdoctoral Cohort

ICERM Postdoctoral Semester Fellows: 4 months w/; funds for travel to and from institute

Name	Previous Institution	Semester
Nishant	University of British Columbia	Spring 2016 D&D

Chandgotia		
Abel Farkas	University of St Andrews	Spring 2016 D&D
Zhiqiang Li	UCLA	Spring 2016 D&D
Polina Vytnova	Imperial College London	Spring 2016 D&D

Institute Fellow: 9 months w/benefits; summer support may be available

Name	Previous Institution	Semester
Marta Canadell	Georgia Institute of Technology	2015-16: focus Spring D&D

Based on available information, the ICERM supported postdocs for Spring 2016 break down as follows:

	Male		Female	
Black	0		0	
Hispanic	0		0	
American Indian/Alaskan Native	0		0	
Asian/Pacific Islands	2		0	
White	1		2	
Other specify	0	+	0	
	3		2	= 5 Total

Keeping Track of Former Postdocs Institute and Semester

The institute makes every effort to keep in touch with its postdoctoral alums in order to track their professional growth.

ICERM-funded postdocs ***to date***	**Period of Stay**	**Current Position**
Emre Esenturk	Fall 2011	Warwick Mathematics Institute
Jeffrey Haack	Fall 2011	RTG Instructor, University of Texas/Austin
Andong He	***Fall 2011***- Spring 2012	Passed Away in 2016
Ahmed Kaffel	Fall 2011	Research Associate University of WI
Daniela Tonon	Fall 2011	Maître de Conférence, Université Paris Dauphine
Dongming Wei	Fall 2011	Associate Dir at RBC Capital Markets
Cecile Armana	Spring 2012	Maître de Conférence, University of Franche-Comté
Anupam Bhatnagar	Spring 2012	Data Scientist at Chartboost
Alon Levy	Fall 2011 – ***Spring 2012***	Postdoc at KTH
Bianca Viray	Spring 2012	University of Washington
Xiaoguang Wang	Spring 2012	Tenure track at Zhejiang University
Daniel Cargill	Fall 2012	Visiting Assistant Professor, Southern Methodist University
Arnab Ganguly	Fall 2012	Tenure track at University of Louisville
Peng Hu	Fall 2012	Oxford-Man University

Hao Ni	Fall 2012	Oxford-Man University
Aaron Smith	***Fall 2012*** - Spring 2013	Tenure Track at University of Waterloo
Julio Andrade	Fall 2012 - ***Spring 2013***	Senior Researcher at Oxford
Kwangho Choiy	Spring 2013	Tenure track at Southern Illinois University
Zajj Daugherty	Spring 2013	Tenure track CCNY
Martina Lanini	Spring 2013	Tenure track University of Edinburgh
Ben Salisbury	Spring 2013	Tenure track Central Michigan University
BoGwang Jeon	Fall 2013	Tenure track at Columbia University
Rodolfo Rios-Zertuche	Fall 2013	Max Planck Institute
Ryan Greene	Fall 2013	Lecturer at Ohio State
Giulio Tiozzo	***Fall 2013*** – Spring 2014	Tenure track at Yale University
Anastasiia Tsvietkova	Fall 2013	Tenure track at UC-Davis
Danupon Nanongkai	Spring 2014	Tenure track KTH Royal Institute of Technology
Amanda Redlich	Spring 2014	Tenure track at Bowdoin College
Kyle Fox	Spring 2014	Duke University
Charalampos Tsourakakis	Spring 2014	Harvard School of Engineering and Applied Sciences
Grigory Yaroslavtsev	Fall 2013 - ***Spring 2014***	University of Pennsylvania
Ali Ahmed	Fall 2014	MIT
Ulas Ayaz	**Fall 2014** – Spring 2015	MIT
Jacqueline Davis	Fall 2014	Arizona State University
Pawel Siedlecki	Fall 2014	University of Warsaw, Faculty
Li Wang	Fall 2014	University of Illinois, Research Asst. Prof non tenure track
Tyler Helmuth	Spring 2015	UC Berkeley
Marcin Lis	Spring 2015	University of Gothenburg
Xuan Wang	Spring 2015	Georgia Institute of Technology, Visiting Assistant Professor
Emily Russell	Fall 2014 – ***Spring 2015***	Google Software Engineer
Samuel Watson	Spring 2015	Brown University
Olga Balkanova	Fall 2015	University of Turku, Finland
Sandro Bettin	Fall 2015	University of Genova
Edgar Costa	Fall 2015	Instructor, Dartmouth College
Anna Medvedovsky	***Fall 2015***- Spring 16	Max Planck Institute
James Weingandt	***Fall 2015*** – Spring 16	Purdue University
Marta Canadell	Fall 2015- ***Spring 16***	Barcelona
Nishant Chandgotia	Spring 2016	Tel Aviv University
Abel Farkas	Spring 2016	Hebrew University of

		Jerusalem
Zhiqiang Li	Spring 2016	Lecturer, Stony Brook University
Polina Vytnova	Spring 2016	Queen Mary University of London

ICERM funded 2 ICERM Institute Postdocs in 2015-2016.

Graduate Students

Support for Graduate Students

The research semester program budget includes partial support for a cohort of graduate students. A housing allowance $750/month and travel to the institute is provided to about 10-14 graduate students each of whom applies to be in residence for the entire semester. Applicants include graduate students working with visitors to the program, as well as students who intend to come without an advisor. Graduate students must arrange for a letter of recommendation from their advisor to be sent separately. The graduate student applications are rank-ordered by the semester program organizing committee, and subsequently reviewed by the Deputy Director overseeing the development of that particular program. Final decisions are made by the directors. The ability to provide a mentor for each graduate student in residence is a factor in the decision.

Training and Mentoring Programs

Before an ICERM semester program starts, all postdocs and graduate students are assigned a mentor. The institute provides all senior mentors with written guidelines that spell out their responsibilities and the responsibilities of mentees. The institute also provided mentors and mentees with the AAMC Compact and the FASEB Individual Development Plan IDP to help them clarify mutual expectation and guide them in developing and setting goals for the mentees. Currently, Associate Director Caroline Klivans coordinates these efforts and works with the members of the Program Organizing Committee assigned to be responsible for mentorship.

In addition, at the beginning of each semester program, directors hold mentor/mentee introductory meetings. These meetings emphasize that mentors should help mentees start to build a research cohort, and help them create contacts and resources which will persist beyond the program.

The mentoring program for the Institute Postdoctoral Fellows necessarily includes a plan for the "off semester" when these postdocs are in residence at ICERM while there is no active research program in their area. So far, all such postdocs have been matched with mentors at Brown in Math, Applied Math, or Computer Science. However, we envision the possibility of different arrangements, including mentorship from faculty at local institutions or even arranging travel or extended visits to more distant locations.

ICERM Postdoctoral Participant and Mentor list, Spring 2016 Semester

Postdoc	Mentor	Program
Marta Canadell	Jordi-Luis Figueras	Spring 2016 ICERM Institute Postdoc
Nishant Chandgotia	Pablo Shmerkin	Spring 2016 ICERM Postdoctoral Fellow
Abel Farkas	Mike Hochman	Spring 2016 ICERM Postdoctoral Fellow
Peter Hazard	Denis Gaidashev	Spring 2016 ICERM/Independent
Tom Kempton	Mark Pollicott	Spring 2016 ICERM/Independent
Ben Krause	Izabella Laba	Spring 2016 ICERM/Independent
Zhiqiang Li	Katrin Gelfert	Spring 2016 ICERM Postdoctoral Fellow
Siming Tu	Orjan Steflo	Spring 2016 ICERM/Independent
Polina Vytnova	Mark Pollicott	Spring 2016 ICERM Postdoctoral Fellow

Meng Wu	Joerg Schmeling	Spring 2016 ICERM/Independent
Wen Wu	Joerg Schmeling	Spring 2016 ICERM/Independent

Graduate Student Mentoring, Spring 2016 Semester

Graduate Student	Mentor	Program
Laura Cladek	Izabella Laba	Spring 2016
Natalia Jurga*	Mark Pollicott	Spring 2016
Cao Lien-Yung*	Francois Ledrappier	Spring 2016
Roland Molontay*	Karoly Simon	Spring 2016
Vuksan Mijovic*	Mike Todd	Spring 2016
Erez Nesharim	Boris Solomyak	Spring 2016
Marks Ruziboev*	Stefano Luzzatto	Spring 2016
Sascha Troscheit*	Mike Todd	Spring 2016
Khadim War*	Stefano Luzzatto	Spring 2016
Jonguk Yang*	Mike Yampolsky	Spring 2016
Agnieszka Zelerowicz*	Yakov Pesin	Spring 2016

*Advisor also attended program/acted as mentor. Other graduate students attended the program, but may not have been at the institute long enough to warrant a mentor assignment.

Roundtable Discussions

To prepare graduate students and postdocs better for their future careers, the institute also organizes regular roundtable discussions with long-term visitors, Brown faculty, and directors, that in the course of each semester, cover the following topics:

- Preparing job applications
- Writing and submitting papers
- Writing grant proposals
- Ethics in research as required by NSF – mandatory, attendance is taken
- Job opportunities in industry and government labs

Peer-to-Peer Discussions

During semester programs, there are regularly scheduled postdoc-graduate student seminars, expressly limited to junior researchers. This gives participating postdocs and graduate students an opportunity to discuss research topics and any other issues openly, without senior people present. The format is completely flexible. For example, it could feature talks by postdocs or graduate students on their current research, or provide an opportunity to read and report on papers, or give an introduction to upcoming talks in other seminars. The group could even ask a senior participant to give a tutorial lecture and then follow up with a discussion session afterwards.

Integration with Summer@ICERM undergraduate research program.

Ideally, our summer undergraduate research program has scientific connections to the themes of one of the surrounding semester program, and will attract applications from participating postdocs and graduate students to assist the summer faculty leaders.

Graduate Students and Postdocs as Mentors

It is expected that some of the graduate students and postdocs may play an integral part in the Summer Undergraduate programs by supporting faculty in working with the undergraduate participants.

Summer Undergraduate Research Program

Details for the 2015 Summer Undergraduate Research Program (Summer@ICERM) were included in ICERM's annual report dated May 1, 2015-January 31, 2016.

Current Program Evaluation

ICERM has expanded its evaluation and measurement efforts to gain a better understanding of program impact on participant research and scholarly success over time. Additionally, ICERM has begun to incorporate more in-depth data analysis procedures in its current evaluation efforts in order to understand the impact of its programs on different subgroups of participants e.g., early career versus tenured faculty. The following is summary of the goals set last year

1. Hire an external evaluator (completed)
2. Ensure all ICERM surveys are consistent and capture all relevant indicators (completed)
3. Transition to a more sophisticated survey tool (completed)
4. Embed unique identifiers in every survey (completed)
5. Measure impact of programs across subgroups
6. Measure long-term outcomes

External evaluator

ICERM continues to work with SRG, an external evaluation company, to improve its survey process.

More consistent surveys

Based on SRG's feedback, the following improvements were made to the surveys in order to streamline the reporting-out and analysis of results:

- all institute surveys are now created and stored securely in the cloud using the Qualtrics Research Suite
- all are similar in length and style
- all include some identical questions and unique identifier markers, all of which were identified as necessary for tracking ICERM's impact on research and career growth over time

The goal in the coming year is to have all survey reports automated to display particular variables of interest across participants and over time. In this way, ICERM can start to more easily recognize a pattern of program strengths in certain areas and may be able to tailor aspects of its programs to successfully equip individuals for a thriving and influential research career.

ICERM now successfully creates surveys that are customized to a single participant instead of distributing a broad and generalized survey to all participants. An example of how customized surveys are being used at the institute is the generation of publication lists for each participant. When the survey is sent, Qualtrics reads the unique identification number of the participant stored in the panel database and generates a list of publications previously collected by ICERM staff and assigned to that specific identification number. Then, the surveyed participant is able to identify the publications that can be attributed to his or her time at ICERM. This novel incorporation of a participant-specific generated publication list has been useful in understanding how influential ICERM programs are to one's research career long-term.

Survey response rates

ICERM strives to get the highest response rate for its surveys. The director informs participants that they will receive a survey during her welcoming remarks. In addition, the institute works to explain how it handles responses confidentially and why it collects gender and ethnicity data. Reminders are sent one or two weeks after each survey is first sent out. This year, ICERM averaged a 65% response rate on all of its

exit surveys.

Every survey ICERM sends to participants includes the following statements:
Why ICERM asks for demographic information: *ICERM receives support from the National Science Foundation (NSF), which is an agency of the Federal Government. The Federal Government has a continuing commitment to monitor the operation of its grant and award processes to identify and address any inequities based on gender, race, ethnicity or disability.*

Your voluntary responses to our demographic questions are made available to ICERM and reported only in aggregate. They are not linked to your other survey responses. This data allows us to measure our objective to ensure the participation of a representative sample of the population, hence it is important to get this information from everyone.

ICERM maintains the strictest standard of confidentiality with all information provided by our participants. Responses are not shared or reported in any way outside of ICERM that is personally identifiable. All results are reported at the aggregate level.

Measure impact across subgroups

Qualtrics not only aids in creating customizable surveys for participants, but also can serve as a platform for analyzing data according to different subgroups of participants e.g., gender, job title, race/ethnicity.

SRG will be assisting ICERM with using the Qualtrics data analysis tools to better understand how the institute's programs impact different subgroups of researchers in both the immediate i.e., program exit surveys and intermediate-/long-term i.e., two- and five-years after program participation. ICERM is now positioned to conduct appropriate analyses of categorical data i.e., Chi-square analysis and t-tests within the survey website. Qualtrics also provides the opportunity to analyze longitudinal data, which will be helpful in the analysis of certain programs over time. Ultimately, these analyses will provide information as to how ICERM can alter programs to benefit different types of participants who may be at various points in their research career.

Measure long-term outcomes

Since 2014, ICERM has been administering an intermediate - i.e., two-year follow-up survey to past semester program participants (see Appendix D). Using the unique identification numbers and in-survey data analyses as outlined above, these surveys measure the attributable impact of participation in ICERM research programs by gathering data on published papers, invited talks, and funded or pending grant proposals. These follow-up surveys will help us understand the far-reaching impact of ICERM's research programs over time. A first five-year follow-up surveys will be administered to program participants during the coming reporting cycle.

ICERM continues to play a large role in gathering and updating participant information for the two year surveys. Specifically, one question provides participants with a list of their papers, pre-prints, or reports published since their participation at ICERM; participants then have the opportunity to include which publications resulted from their participation at an ICERM program or event. ICERM is responsible for finding and compiling these publications for each participant. Additionally, before implementing each survey, ICERM continues to be involved in editing and testing the survey in order to have an end product that will most effectively provide data aligned with its goals.

It is important to note here that although ICERM has hired SRG as its external evaluation company to aid in reaching their evaluation goals, the institute still plays a vital role in the data collection and survey distribution process. In addition, at weekly management meetings, survey results are reviewed and discussed so that improvements can be made as appropriate.

Note: Appendix D shows links to exit survey summaries for programs run during this reporting cycle (February 2016-May, 2016). It also includes the 2-year follow-up reports for Fall 2012 and Spring 2013.

Reported Scientific Outcomes/Projects Initiated

In the past years, the Director sent a request to all long-term participants asking for updates on their research projects and/or publications that arose during, or were enhanced by, participation in an ICERM program. With the advent of ICERM's 2-year and soon to be added 5-year follow-up survey for each of its semester programs, scientific outcomes have begun to be collected much more systematically and consistently; ICERM can now report scientific outcomes for past programs in a standardized report. For the purposes of this report, we have summarized "projects initiated" that were reported on the Spring 2016 semester program exit surveys. Participants answered the question, "What, if any, specific projects did you initiate or continue while attending this semester program?" Using unique IDs, ICERM will be able to track the advancement of these initial projects through the subsequent standardized 2-year and 5-year follow-up surveys.

Note: see Appendix E for a list of research projects initiated at ICERM during the spring 2016 semester program.

Corporate and Academic Sponsorship

Several math institutes currently funded by the NSF employ corporate and university sponsored programs with tiered memberships. ICERM launched its own unique corporate and academic sponsorship programs in 2011.

The Corporate Sponsorship program has a $5,000 annual membership fee. To date, ICERM has received $27,500 in corporate sponsorship funds.

Annual Corporate sponsors include:

- Google
- Mathematical Association of America
- Microsoft Research
- Schlumberger Limited

The Academic Sponsorship has an annual membership fee of $1,500 for domestic memberships with small graduate student programs, $3,000 for domestic membership with large graduate student programs, and $5,000 for international membership. To date, ICERM has received $60,875 in academic sponsorship funds.

Academic sponsors include:

- Cornell University, Department of Mathematics
- Georgia Tech, School of Mathematics
- Indiana University, Bloomington, Department of Mathematics
- Iowa State University, Department of Mathematics
- Korea University, Department of Mathematics
- Michigan State University, Department of Mathematics
- Michigan Tech, Department of Mathematical Sciences
- Tufts University, Department of Mathematics
- UMASS Amherst, Department of Mathematics and Statistics
- Worcester Polytechnic Institute, Mathematical Sciences Department

External Support

The institute staff will continue to aggressively work to develop new sources of support for its programs. Financial Manager Juliet Duyster, has duties which include managing both public and private grants, managing the proposal process and ensuring that follow-up reporting is completed. Assistant Director Ruth Crane manages relations with the institute's sponsoring corporations and serves as a liaison to Brown's Division of Advancement, which unites Alumni Relations, Development, and International Advancement in a single, focused organization.

In addition to the funding provided by the NSF, ICERM receives substantial in-kind financial support from Brown University. The Director is released from teaching, and two Deputy Directors are released from half of their teaching responsibilities. In addition, ICERM is not charged for the use of its building or for custodial care which Brown values at $670,500 annually. During the 2015-2016 academic year Brown gave ICERM over $80,000 in funding, $75K of which is the university operating budget.

Other Funding Support received from February 1, 2016 to May 10, 2016

University Funding Support	
University Resource Committee	$20,312.50
Supplemental Administrative Costs	$38,565.56
Sub-total	$58,878.06
Sponsor Support	
Academic Sponsors	$ 6,000.00
Corporate Sponsors	$ 5,000.00
Sub-total	$11,000.00
TOTAL	$69,878.06

Outreach/Diversity

Ulrica Wilson, an Associate Professor of Mathematics at Morehouse College, is also ICERM's Associate Director of Diversity and Outreach. Ulrica continues to provide leadership in meeting institutional diversity goals: ensuring diversity throughout ICERM's programs, assisting in the development of policies and procedures, participating in national meetings and conferences, and helping to identify and obtain funding for programs and activities. Ulrica currently chairs the overarching diversity committee of the Math Institutes Diversity Committee.

ICERM strongly supports the National Science Foundation's goals of expanding the numbers and diversity of individuals engaged in mathematical sciences through increased participation. Through its membership in the Math Institutes Diversity Committee, the institute actively seeks best practices for securing the participation of women and under-represented minorities in ICERM's governing bodies and in all scientific programs, workshops and events. Specifically, ICERM policy includes the following:

ICERM's Board of Trustees and Science Advisory Board work to ensure participation of women and under-represented minorities on all ICERM boards and in all scientific programs, respectively. The Director, Deputy, and Associate Directors are proactive in seeking representation of women and minorities in its undergraduate, graduate and postdoctoral programs and on organizing committees of programs and workshops, and work to liaise closely with organizing committees to increase diversity

among funded participants. All past and future activities that support these goals and achievements in this area are documented on this page.

ICERM hosts or co-sponsors special events or conferences that serve women and under-represented minorities in the mathematical sciences, including diversity workshops, Blackwell-Tapia conferences, Society for Advancement of Chicanos and Native Americans in Science SACNAS conferences, Association for Women in Mathematics AWM workshops and events, and is building relationships with academic institutions that serve large minority populations.

ICERM states its commitment to diversity on all informational and promotional materials, and broadly advertises its activities and opportunities for funding.

ICERM sends diversity guides to all semester program and workshop organizers. They are available for review later in this tab section.

Diversity Events (February 2016 to May 2016)

- Participated in Underrepresented Students in Topology and Algebra Research Symposium, Spring 2016
- Participated in Spring Opportunities for Women Mathematical Sciences, Spring 2016

Other Activities

- ICERM is a member of the NSF Institute-wide diversity committee
- ICERM co-supporter the AWM mentor network

EPSCoR

ICERM supports the National Science Foundation's EPSCoR mission: "to assist the NSF in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." EPSCoR goals are:

1. to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness;
2. to advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

Accepted ICERM participants by EPSCoR States for the period May 2015-May 2016:

EPSCoR State	# of ICERM Participants
Alabama	4
Alaska	0
Arkansas	2
Delaware	2
Guam	0
Hawaii	0
Idaho	5
Iowa	3
Kansas	0
Kentucky	1
Louisiana	7

Maine	1
Mississippi	1
Missouri	2
Montana	0
Nevada	0
New Hampshire	19
New Mexico	11
North Dakota	0
Oklahoma	16
Puerto Rico	0
Rhode Island	64
South Carolina	5
South Dakota	0
Tennessee	14
US Virgin Islands	0
Utah	5
Vermont	0
West Virginia	0
Wyoming	0
TOTAL	**162**

Administration and Staff

ICERM Directors funded by the grant are: Jeffrey Brock, Jill Pipher, and Bjorn Sandstede (all Brown University). Jeff Brock and Bjorn Sandstede have committed one half summer month of effort to the institute as Associate Directors, Jill Pipher commits 100% time. Jeff Hoffstein (Brown University) is the fourth PI on the grant receives no financial support from the grant and volunteers his time for special projects at ICERM. Homer Walker (WPI) and Sinai Robbins (University of Sao Paulo) serve as Deputy Directors, each at 50% time, with appointments starting July 2013 and July 2015, respectively.

ICERM Staff

Mathew Borton, Director of IT hired in December 2011: reports to the Director. Responsible for all daily IT/technology related operational activities in the institute; oversees all technical development and IT related service offerings; oversees IT staff management, ensures operational security and stability, provides service development, and continuity of the institute activities; acts as liaison to the institutional IT community, provides assistance with longer-term planning and resource development, and has continued awareness of external activities and resources of relevance to the mission of ICERM. Besides support of the scientific activities in the institute, the responsibilities include support of administrative IT and A/V equipment, and development and support of web interfaces and databases.

Ruth Crane, Assistant Director hired in November 2010: reports to the Director. Responsibilities include overseeing the coordination and administrative aspects of all research programs of the institute; supervision of institute staff; development and implementation of policies and procedures; external communications with various academic units, companies, and individuals; coordination of fundraising activities and grant proposals including proposal writing; organization of board meetings; assistance with reporting functions; oversight of web content; advertising management; oversight of functional aspects of undergraduate programs; and coordination of community outreach activities.

Juliet Duyster, Financial Manager, hired in August 2011: reports to the Assistant Director. Provides high-level administrative support and financial management; sets policy and creates spending guidelines in accordance with Brown's Office of Sponsored Projects OSP and the Brown Accounting Office;

oversees financial processes and administration; Prepares budget for multiple programs and workshops of ICERM; works with Director and Assistant Director to prepare contract and grant proposal budgets; provides data trend analysis for budget projection and prepare monthly and annual financial reports on multiple funding sources; approves high volume of Travel Express vouchers, purchase orders, subcontract agreements, intra-departmental, intercampus fund transfers and other financial transactions endowment, gift funds, etc..; provides financial analyses and various reports on the status of the institute's operating funds required.

Heather Forand, Program Coordinator hired in July 2015: reports to the Program Manager. Major responsibilities include securing housing for all visitors (long and short term), assisting with sending and tracking invitations, and general event/visitor and administrative support.

Brian Lavall, Technical Support Coordinator, hired April 2014: reports to the Director of IT. The Technical Support Coordinator supports and facilitates the technological needs of ICERM staff, visiting researchers, postdocs and guests 50-100 end-users. Responsibilities include support of administrative IT and A/V equipment. Provides A/V support for the institute's workshops and events. Monitors and actively controls the Echo 360 lecture capture system and provides first level support for technical issues such as wireless connectivity and printing.

Meghan Lopes, Administrative Assistant, hired February 2016: reports to the Program Manager. Is the first point of contact for ICERM visitors. Acts as receptionist/concierge. Assists with updating and posting schedules, tracking invitations, visitor data entry, all event prep and set-up. Assists with marketing.

Bernadette McHugh, Web Content Editor, hired in September 2012: reports to the Senior Application Developer. Updates and maintain website content and web-based applications used to support and promote ICERM and its activities, including semester programs, workshops, and special events. Assists with quality assurance testing of web content and data systems and routine maintenance and support as needed.

Jenna Sousa, Program Manager hired May 2014: reports to the Assistant Director. Responsible for the implementation of the entire portfolio of ICERM's scientific research programs; manages a program timeline and program guide for each program, adhering to all programmatic deadlines and budgets. Major responsibilities include coordinating the housing, coordinating all communications regarding the arrival and orientation of long-term and short-term visitors; sending and tracking invitations and applications, assisting with creating a program schedule; assisting with creating marketing materials for distribution; coordinating special events; hiring and training student employees as needed to assist with event prep and administrative support.

Nina Succi, Financial Office Assistant, hired February 2016: reports to the Financial Manager. Serves as primary point of contact for ICERM staff, program organizers, visitors, postdocs, students, vendors, and sponsor agencies for all financial transactions and related issues; reconciles the day-to-day financial activity for expenses supported by sponsored projects and University appropriated budgets.

Shaun Wallace, Senior Application Developer hired in March 2011: reports to the Director of IT. The Web Application Developer designs, implements and maintains websites, web based applications, and ICERM's proprietary databases used to support and promote ICERM and its activities. The Web Application Developer assists the IT support team in routine maintenance and support as needed.

ICERM PI and Director Biographies

Jill Pipher is the Elisha Benjamin Andrews Professor of Mathematics at Brown University, and founding Director of the Institute for Computational and Experimental Research in Mathematics ICERM. She served as Chair of the Mathematics Department 2005-2008. Pipher received her Ph.D. from UCLA in 1985, and came to Brown as an Associate Professor in 1990 from the University of Chicago. Her research interests include harmonic analysis, partial differential equations and cryptography. She jointly holds four patents for the NTRU encryption and digital signature algorithms and was a co-founder of Ntru Cryptosystems, Inc, now owned by Security Innovation, Inc. Her awards include an NSF Postdoctoral Fellowship, Presidential Young Investigator Award, Mathematical Sciences Research Institute Fellowship, and an Alfred P. Sloan Foundation Fellowship. She served as President of the Association for Women in Mathematics in 2011-2013 and was a National Women's History Month 2013 Honoree. She was honored to deliver the 2016 Brown University Presidential Faculty Award lecture. Pipher is a Fellow of the American Mathematical Society and a member of the American Academy of Arts and Sciences.

Jeffrey Brock is Professor and Chair of mathematics at Brown University, and an ICERM Associate Director. Brock's research focuses on low-dimensional geometry and topology, particularly on spaces with hyperbolic geometry. He received his undergraduate degree in mathematics at Yale University and his Ph.D. in mathematics from U.C. Berkeley, where he studied under Curtis McMullen. After holding postdoctoral positions at Stanford University and the University of Chicago, he came to Brown as an Associate Professor. He was awarded the Donald D. Harrington Faculty Fellowship to visit the University of Texas, and has had continuous National Science Foundation support since receiving his Ph.D. He was recently awarded a John S. Guggenheim Foundation Fellowship. Brock is the incoming Director of Brown University's new Data Science Initiative.

Jeffrey Hoffstein is a Professor at Brown University, and an ICERM Associate Director. He received his PhD in mathematics from MIT in 1978. After holding postdoctoral positions at the Institute for Advanced Study, Cambridge University, and Brown University, Hoffstein was an Assistant and Associate Professor at University of Rochester. He came to Brown as a full professor in 1989. His research interests are number theory, automorphic forms, and cryptography. Hoffstein has written over sixty papers in these fields, co-authored an undergraduate textbook in cryptography, and jointly holds seven patents for his cryptographic inventions. He was a co-founder of Ntru Cryptosystems, Inc., now merged with Security Innovation, Inc.

Caroline Klivans is the newest ICERM Associate Director. Her focus is on the Institute's mentoring and professional development programs for students and postdoctoral fellows. In particular she leads the Round-Table discussion sessions building community and career foundations. Caroline received a BA degree in mathematics from Cornell University and a PhD in applied mathematics from the Massachusetts Institute of Technology. Currently, she is a Lecturer in the Division of Applied Math and Department of Computer Science at Brown University. Before coming to Brown she held positions at MSRI and the University of Chicago. Her research is in algebraic, geometric and topological combinatorics.

Sinai Robins is a deputy director at ICERM, and a Professor of computer science at the University of Sao Paulo, Brasil. He enjoys doing research in discrete and computational geometry, combinatorics, and number theory. His work has revealed interactions between polytopes and lattices, and some of his current research focuses on computing various different forms of discrete volumes for polytopes, often using Harmonic analysis. Professor Robins has contributed to the modern field of the geometry of numbers by coauthoring the Springer UTM book "Computing the continuous discretely: integer point enumeration in polyhedra". His research has been funded by the National Science Foundation, the NSA, the Sloan Foundation, the London Mathematical Society, and the Singapore Ministry of Education. Professor Robins received his PhD from UCLA in 1991, and has had numerous research visiting positions, including the CNRS/LAAS lab for architecture of systems (Toulouse, France), the Alfred Renyi research institute (Budapest, Hungary), the Technion institute (Haifa, Israel), MSRI (Berkeley, California), the Institute for Defense Analysis (La Jolla, California), and the Distinguished Visiting Professorship at Brown University in 2014.

Bjorn Sandstede is Professor and Chair of applied mathematics at Brown University, and an ICERM Associate Director. He studied mathematics at the University of Heidelberg and received his PhD in 1993 from the University of Stuttgart. After holding postdoctoral positions at the Weierstrass Institute in Berlin and at Brown University, he was a faculty member at the Ohio State University from 1997-2004, before moving in 2004 to the University of Surrey in England. In 2008, he joined the Division of Applied Mathematics at Brown University. Sandstede received an Alfred P Sloan Research Fellowship in 2000, was awarded the first JD Crawford Prize of the SIAM Activity Group on Dynamical Systems in 2001, and received a Royal Society Wolfson Research Merit Award in 2004. He is currently the editor-in-chief of the SIAM Journal on Applied Dynamical Systems. Sandstede is a Fellow of the Society for Industrial and Applied Mathematics.

Homer Walker joined ICERM as a Deputy Director in July 2013. He has been a professor of mathematics at Worcester Polytechnic Institute since 1997 and previously held faculty appointments at Utah State University, the University of Houston, and Texas Tech University. He has also held visiting appointments at a number of institutions, including Cornell, Yale, and Rice Universities and Lawrence Livermore and Sandia National Laboratories. His previous administrative experience includes service as department head at WPI 1997-2002 and as program manager for the US Department of Energy Office of Science Applied Mathematics Program 2007-2008. Walker's research interests are in numerical analysis and computational mathematics, especially iterative methods for large-scale linear and nonlinear systems, implementations for high-performance computing, and applications. He has been an associate editor of SIAM Journal on Numerical Analysis and has served as a guest editor for ten special sections in SIAM Journal on Scientific Computing. He has also served on program committees for a number of national and international conferences and workshops, notably the biennial Copper Mountain Conferences on Iterative Methods, as well as on many review panels and site-visit teams for funding agencies in the US and abroad.

Ulrica Wilson is an Associate Professor of Mathematics at Morehouse College. Director of Diversity and Outreach she provides leadership in meeting institutional diversity goals: ensuring diversity throughout ICERM's programs, assisting in the development of policies and procedures, participating in national meetings and conferences, and helping to identify and obtain funding for programs and activities. Ulrica's primary research has been in noncommutative ring theory and combinatorial matrix theory. Throughout her career, she has integrated opportunities to

address diversity issues in the mathematical workforce. A decade of experience includes directing the Enhancing Diversity in Graduate Education EDGE Program and organizing the Research Experience for Undergraduate Faculty REUF workshops at the American Institute of Mathematics AIM.

Facilities

ICERM is located on the 10th and 11th floors of 121 S. Main Street, in a Brown owned building in downtown Providence, RI. Visitors to ICERM are within a 10-minute walking distance of the Brown campus, the train station, major hotels, and a variety of restaurants and historic sites.

The space includes a 100-seat lecture hall, a 20-seat seminar room, a 20-seat conference room, an administrative suite, office space for 40-45 visitors, a kitchen, and three large collaborative areas.

IT Resources

ICERM's information technology group's mission is to provide the necessary tools for research, collaboration, and information dissemination required by the institute's participants and to support the administrative staff. This is accomplished by providing flexible systems that can be quickly reconfigured to meet research needs and efficient administrative tools that allow the institute's staff to maintain operational excellence.

Work Stations

ICERM provides virtual desktop systems to all semester program participants using Virtual Bridges on Redhat Linux systems. The host operating system is Redhat Linux Server, the guests use Redhat Linux workstation or Windows 8, and the client machines are thin clients using a thin version of Linux. Applications are distributed as needed. Application needs differ from program to program and researcher to researcher. Individuals have administrative control over their own virtual desktops. Researchers are also free to provide their own equipment use their own laptop. The majority of the applications provided to users will leverage existing Brown license agreements.

Web Based Tools

ICERM provides web-based tools for collaboration and to assist research. All previous talks and papers generated in the course of semester programs are archived and available for download and review via the website.

Multimedia Resources

ICERM has state of the art audio/visual capabilities. The 120-seat lecture hall features dual projection screens, a centrally controlled AV system capable of displaying multiple media types, and a lecture capture system for recording presentations and streaming to the web. A smaller meeting room is equipped with a video conferencing system and includes a digital media projection system. The video conferencing system can also be leveraged to communicate with the lecture hall. A seminar room on the 10th floor provides basic multimedia presentation capability and contains a smart-board system. Digital signage screens throughout the institute are used to display important information to visitors and can be independently used as a peripheral display from a laptop.

Live Streaming

ICERM provides live, real-time video streaming of all Workshop talks, special events, and tutorial sessions given in the lecture hall.

Video Archives

ICERM digitally records semester and topical workshop talks and special lectures in High Definition using the Panopto lecture capture system. Presentations are then archived and made available for viewing on our website along with a PDF copy of the presenter's slides, when available.

Data Collection and Reporting
ICERM has developed a new database, called CUBE to collect and report on participant data. This system will become a central point of data management for both staff and participants as new feature sets are added.

Brown Computing Resources
ICERM participants are encouraged to use other IT resources available at Brown. Chief among these is the high-performance computing cluster HPC hosted by the Center for Computation and Visualization CCV. ICERM provides premium access accounts upon request to all long-term participants and to workshop participants on an as needed basis with approval from the Director. To date, thirty researchers from various programs have taken advantage of this resource.

Participants are also welcome to use the Digital Scholarship Lab at the Rockefeller Library. This room incorporates a high-definition video wall for large-scale visualization and collaboration.

CCV makes other services available to ICERM participants, including access to consultants for code creation and optimization and an immersive display environment.

APPENDIX:
Appendix A: Sample Semester Schedule & Organizer Timeline
Appendix B: Upcoming Programs and Events
Appendix C: Minutes from Scientific Advisory Board Meeting Conference Call
Appendix D: Survey Summaries (February 1, 2016 to May 10, 2016)
Appendix E: Research Projects Initiated at ICERM (February 1, 2016 to May 10, 2016)

NSF Required Materials Available in the Appendix
Appendix F: ICERM Participant List and Summary Table (May 1, 2015 to May 10, 2016)
Appendix G: ICERM Financial Support List (May 1, 2015 to May 10, 2016)
Appendix H: ICERM Income and Expenditure Report (May 1, 2015 to May 10, 2016)
Appendix I: VI-MSS Income and Expenditure Report (May 1, 2015 to May 10, 2016)