Pacific Institute *for the* Mathematical Sciences

Year in Review 2013

Simon Fraser University • University of Alberta • University of British Columbia • University of Calgary
University of Regina • University of Saskatchewan • University of Victoria • University of Washington
University of Lethbridge • Portland State University • University of Northern British Columbia

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Cover Image: Trumpeter Swans in Flight (Saskatchewan)

From the Director

The year 2013 saw intense scientific activity at PIMS as well as a variety of notable achievements in education and outreach. In April we launched a Collaborative Research Group in Geometry and Physics, under the leadership of Charles Doran (UAlberta) and Jim Bryan (UBC). In November they organized a joint meeting with the Fields Institute on *Hodge Theory in String Theory* and in 2014 will have a Focus Period with a variety of large-scale activities in Edmonton and Vancouver. The CRGs in Quantum Information Theory, Optimization and Applied Harmonic Analysis wrapped up this year, with a variety of thematic activities throughout Western Canada.

This summer PIMS sponsored an impressive succession of world class events on topics as varied as automata theory and symbolic dynamics, biological invasions, Hodge theory, optimization, quantum information, probability, complex fluids and flows, partial differential equations and algebraic topology. Particular highlights were the conferences that honored the mathematical acheivements of Nassif Ghoussoub, Ed Perkins, Martin Barlow and Bud Homsy. At the University of Calgary PIMS hosted a meeting on numerical methods for seismic inverse problems, with significant participation from industry. We again partnered with the Institute for Mathematics and its Applications (IMA) on the *Mathematical Modeling in Industry Workshop*, which next year, will take place in Vancouver for the first time.

In April, PIMS-UBC hosted the exhibit *The Unravelers: Mathematical Snapshots* (see p. 10) with unique photographs of mathematicians of the Institut des Hautes Études Scientifiques (IHÉS) in France. The opening was a memorable occasion for Canadian mathematics, as it included the Directors of BIRS, CRM and Fields as well as the Consul-General of France in Vancouver. The guest of honour, Jean-Pierre Bourguignon (then Director of IHÉS), received a well-deserved tribute from his Canadian colleagues.

Our distinguished lectures continued to bring in a variety of excellent speakers (see p. 11), including (among others) Avi Wigderson (IAS), Bruce Reed (McGill), Ulrike Tillmann (Oxford), Yuval Peres (Microsoft), Yann Brenier (École Polytechnique) and Peter Constantin (Princeton). In September PIMS sponsored a lecture by Trevor Hastie (Stanford) and in November, hosted the third Hugh Morris Lecture at UBC, delivered by Phil Holmes (Princeton) (see p. 12).

Under the leadership of Dan Coombs, the IGTC in Mathematical Biology continued its excellent work. This program has trained some truly outstanding students and is scheduled to wrap up in 2014, but there are plans to develop a national initiative building on their program. Meanwhile, the PIMS postdoctoral program continues to attract top level talent to PIMS universities and in 2013, funded 49 postdoctoral fellows.

In July, PIMS hosted a special retreat to review existing programs and brainstorm for new initiatives. These ideas and improvements have been crystallized in a proposal to NSERC for renewal of PIMS funding for the period 2014-2019. It contains a variety of exciting plans for scientific and training activities for the next five years and beyond.

Our educational programs focused on enhancing the mathematical training of Aboriginal students and teachers attracted substantial funding from public and private sources, including grants from the Governments of British Columbia and Saskatchewan, the Royal Bank of Canada, VanCity, the Actuarial Foundation of Canada and the Vancouver Foundation, as well as generous private donors. Let me conclude by expressing our gratitude to all of them, with particular thanks to Darell Duffie, Haig Farris, Ahmad Jawad, Vaho Rebassoo, Brian Russell, Ken Spencer and Andy Wright.

Alejandro Adem
Director

About PIMS

The Pacific Institute for the Mathematical Sciences was founded in 1996; it is a consortium of universities in the Pacific Northwest and Western Canada.

Member universities: Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Lethbridge, University of Regina, University of Saskatchewan , University of Victoria and University of Washington.

Affiliates: University of Northern British Columbia and Portland State University.

The PIMS mandate is to promote research and applications of the mathematical sciences of the highest international caliber; to facilitate the training of highly-qualified personnel at the graduate and postdoctoral level; to enrich public awareness of mathematics through outreach; to enhance mathematical training for teachers and students in K-12; and to create mathematical partnerships with similar organizations in other countries, with a particular focus on Latin America and the Pacific Rim.

The central office is at the University of British Columbia, with a PIMS site office and a Site Director local to each of the nine member universities. The Site Director facilitates local opportunities and synergies, while the PIMS site offices provide administrative assistance for organizing local events. This distributed structure renders it quite unique, involving strong local site offices and activities, and allowing a broad impact across Western Canada and beyond.

The Board of Directors oversees the administration of PIMS, with membership consisting of the V. P. of Research from each of the member universities, as well as distinguished scientists and representatives from industry. An independent Scientific Review Panel composed of internationally renowned mathematical scientists assesses proposals for scientific events and programs.

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2013 Activity Overview

PIMS is a leading mathematical institute in North America, with worldwide impact on the mathematical sciences and their applications. PIMS has established innovative programs which have had a transformative effect on mathematical research and training of students and postdoctoral fellows.

In 2013, PIMS helped to support approximately 100 scientific activities. These involved more than 4,800 participants who spent over 20,000 days at PIMS activities.

Conferences and Workshops: 2013 was an incredibly busy summer in terms of workshops and conferences, with participants attending nearly 40 events being held around PIMS sites and at other locations. Some of the more notable events included the *Automata Theory and Symbolic Dynamics Workshop* (see p.12), the *Analysis and Partial Differential Equations* conference and the *Recent Trends in Stochastic Analysis* conference.

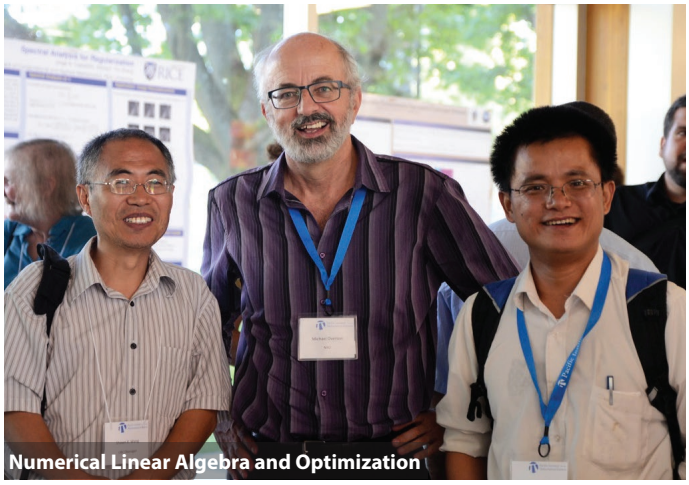
Summer Schools: PIMS hosted and helped sponsor seven summer schools in 2013 at locations spanning from British Columbia to Montreal to Oregon. These included the *Summer School on Optimization* in Calgary, *Recent Advances in Hodge Theory* at UBC, and the *West Coast Algebraic Topology Summer School* at the University of Oregon.

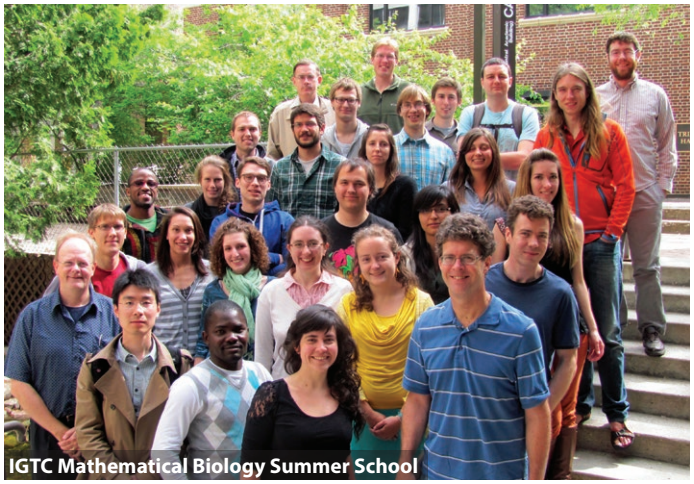
Lecture and Seminar Series: PIMS supports 28 seminar series at member universities each year. In 2013, these included the *PIMS/UBC Distinguished Colloquium*, which featured speakers such as Béla Bollobás and Yuval Peres, the *PIMS UNBC Distinguished Speaker Series*, as well as the *IAM-PIMS Distinguished Colloquium Series*. PIMS hosts two high profile series which occur annually, the *Hugh C. Morris Lecture Series* and the *Marsden Memorial Lecture Series*.

Industrial and Applied Activities: PIMS was pleased to continue its support of the *IMA/PIMS Mathematical Modeling in Industry workshop*, held this year at the University of Minnesota, as well as continuing the popular PIMS/Shell Lunchbox lecture series in Calgary. The workshop, *Complex Fluids and Flows in Industry and Nature* was held at the University of British Columbia and brought together a select group of researchers in this area.

Training of Highly Qualified Personnel: PIMS hosts dozens of postdoctoral fellows at its nine sites. The International Graduate Training Centre in Mathematical Biology (see p.6 for further details) is an innovative PIMS program that trains students in a focused, interdisciplinary area.


Analysis and Partial Differential Equations


Numerical Linear Algebra and Optimization


IGTC Mathematical Biology Summer School

Collaborative Research Groups

PIMS Collaborative Research Groups (CRGs) develop research and training networks, establishing lasting interdisciplinary links between geographically dispersed groups of researchers at member universities. CRGs organize thematic activities, such as workshops, summer schools and seminars, make joint postdoctoral fellowship (PDF) appointments, and/or develop joint graduate training programs. PIMS has developed 25 CRGs since its inception in areas ranging across all the mathematical sciences. These have served as catalysts for producing mathematical research of the highest quality in Western Canada and attracting outstanding faculty to PIMS universities.

PIMS had five CRGs operating in 2013: Applied and Computational Harmonic Analysis (2011-2014); Mathematics of Quantum Information (2010-2013); Optimization: Theory, Algorithms and Applications (2012-2015); Algorithmic Theory of Networks (2012-2015) and Geometry and Physics (2013-2016), which started this year.

Notably, in the summer of 2013, the Optimization: Theory, Algorithms and Applications CRG held three major events: *Women Optimize in the West* (UCalgary); a five-day conference on *Geometric Aspects of Optimization* (UCalgary) and the *Workshop on Numerical Linear Algebra and Optimization* (UBC), while Mathematics of Quantum Information hosted the *13th Canadian Summer School on Quantum Information* (UCalgary), the Canadian Quantum Information Students' Conference (UCalgary) and the *Workshop on Quantum Information and Foundations of Quantum Mechanics* (UBC).

Geometry and Physics (2013-2016)

Pure mathematics and fundamental physics, historic partners for centuries, grew apart during the first half of the 20th century. This changed with the emergence of gauge theory in particle physics and, still more strikingly, the string-theoretic approach to quantum gravity. Thus far in the 21st century, many of the great insights into geometry have come from physical models formulated in geometric terms.

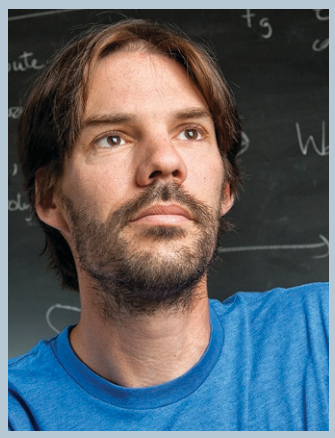
During 2013-2015, the PIMS CRG in Geometry and Physics will bring hundreds of the world's best researchers in geometry and physics to Western Canada to continue to develop this rich interface.

In 2013, the CRG organized the Geometry and Physics Seminar Series, hosting seminars at both UAlberta and UBC as well as cohosting *Hodge Theory in String Theory* at The Fields Institute, November 11-15. In 2014, they will host the *String-Math Summer School* at UBC, an international conference on *Calabi-Yau Manifolds and Moduli* at UAlberta and the *String-Math Conference*, to be held at UAlberta's new Centennial Centre for Interdisciplinary Science.

CRG Leaders

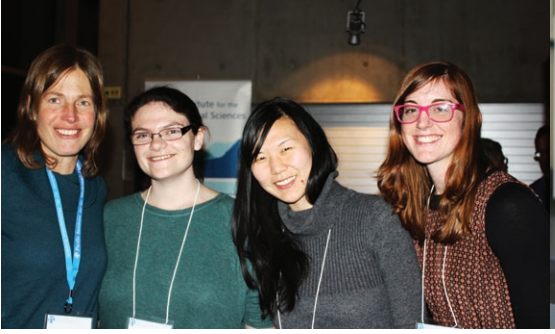
Chuck Doran
(UAlberta)

Kai Behrend
(UBC)



Vincent Bouchard
(UAlberta)

Jim Bryan
(UBC)



Disease Dynamics

Mathematics and the Planet Earth: a Long Life Together

The Mathematics of Planet Earth (MPE) 2013

In 2013, PIMS joined the world's mathematics community in celebrating in a special year of broadly based programs on the Mathematics of Planet Earth. MPE2013 provided a showcase for the essential relevance of mathematics to planetary problems and created a context for the mathematical developments necessary to meet global challenges.

PIMS/MPE 2013 Events (selected):

January 17-19, 2013 *Disease Dynamics: Immunization, a True Multi-Scale Problem* (UBC)

February 7, 2013 *The Language of Life: When Mathematics Speaks to Biology: Gerda de Vries* (URegina)

March 1, 2013 *Advice for Statisticians in an Academic Medical Setting: Rhonda J. Rosychuk* (UNBC)

March 14, 2013 *Mathematical Models for Territorial Interactions: Mark Lewis* (UVic)

May 27-June 14, 2013 *PIMS IGTC Mathematical Biology Summer School* (UAlberta)

July 15 & 17, 2013 *Mathematics and the Planet Earth: a Long Life Together (I & II): Ivar Ekeland* (UBC)

October 24, 2013 *Harnessing Math to Understand Tipping Points with Applications to Climate and Biology: Mary Lou Zeeman* (UVic)

To see videos and other content visit the MPE2013 mathtube.org page at www.mathtube.org/conference/mathematics-planet-earth-2013.

Hugh C. Morris Lecture Series

On November 1, Philip Holmes (Princeton) delivered the 2013 Hugh Morris Lecture to a packed audience in the Earth Sciences Building at UBC. His lecture, entitled *Can We Choose Optimally? The Neural Dynamics of Decisions*, explored the process by which people make everyday choices, often under time pressure and with incomplete or noisy information. "The basic electro-chemistry of individual neurons and synapses in our brains is fairly well understood. The key problem is one of scale: how do almost a trillion neurons and many more synapses interact to sift noisy evidence and weigh it against prior knowledge?" Holmes described how mathematical models, coupled with human and animal experiments, illuminate the neural mechanisms responsible for some simple decisions and actions.

This lecture is available on mathtube.org at:
www.mathtube.org/lecture/video/can-we-choose-optimally-neural-dynamics-decisions

The Hugh C. Morris Lecture Series was generously endowed by Dr. Hugh Morris (1932-2012), former Chair of the PIMS Board of Directors, and long-time friend of the mathematical sciences.

International Graduate Training Centre in Mathematical Biology

2013 IGTC Summit

PIMS' vision for the International Graduate Training Centres (IGTC) is to "seize scientific leadership on the world stage and to launch strategic training programs in emerging areas in mathematics." This is to be achieved through training a generation of researchers in the application of new mathematics to present-day global problems. To these ends, PIMS created the IGTC in Mathematical Biology in 2007, which is directed by Dan Coombs of the University of British Columbia.

IGTC supported a range of events in 2013, the first of which was the *Disease Dynamics: Immunization, a True Multi-Scale Problem* workshop, which showcased new research at the interface between experimental biology, epidemiology and applied mathematics with considerable emphasis on the translation of research into practical outcomes in treatment and public policy. Graduate students from across the continent attended.

Frontiers in Biophysics, an annual event held jointly by SFU and UBC, featured excellent student talks as well as a poster session and an address, *What Can Computational Modelling Tell us About Cell Motility?* by invited speaker, Charles Wolgemuth (University of Arizona).

This was followed by IGTC's most important event, the graduate summer school on *Biological Invasions*, at the University of Alberta, organized by Thomas Hillen and Mark Lewis and featuring distinguished lecturers Alan Hastings (UC Davis), Jonathan Sherratt (Heriot-Watt) and Sergei Petrovskii (Leicester).

Finally, the *IGTC Student Summit*, held at the Banff International Research Station, focussed on Career Transitions and Development in Math Biology. Academic and government-agency professionals provided perspectives on the challenges and opportunities of a career in mathematical modelling, from the graduate level, through postdoctoral positions, to permanent positions in different areas.

PIMS is proud to support IGTC student Stilianos Louca (UBC)

"As a naturalist by ideology, a physicist by methodology and a biologist by heart, I am trying to get a fundamental understanding of complex biological systems through mathematical models and numerical simulations. I am currently interested in the ecology of microbial communities and the metabolic networks they define. I also work on models of community-level host-parasite interactions as well as cyclic population dynamics. I am fascinated and motivated by the beauty and richness of the living world, which keeps me stumbling over new exciting phenomena yet to be understood every day.

I am grateful to the IGTC for making me part of a great community driven by leading experts in mathematical biology. The summer schools and workshops organized by the IGTC have been a great opportunity to stay at the forefront of current research, and have given me plenty of new ideas and perspectives."

Education

An integral part of the PIMS mandate is to enrich public awareness of mathematics through outreach and to enhance mathematical training for teachers and students in K-12. PIMS is nurturing the pipeline of younger generations in Western Canada, including those with First Nations backgrounds. PIMS promotes numeracy as an integral part of development and learning.

Some of the 2013 education activities included:

Math Mania

An event for elementary and middle schools in BC that presents a variety of interactive demonstrations, puzzles, games and art designed to demonstrate fun ways of learning math. participants in 2012. At UVic, 5 events reached 550 students.

ELMACON

A yearly event for Grades 5 to 7 students from Lower Mainland BC and Victoria-area schools. ELMACON provides an opportunity to experience mathematics as an exciting sport. 323 students participated in 2013.

Math on the Move

Visited thirteen communities in Saskatchewan with inquiry-based mathematics activities for grades 9 and 10 students delivering sessions, to nearly 500 students. The team travelled over 3,000 kilometres.

Math Central

Math Central is a successful tool for teachers, attracting answer submissions from around the world including Italy, Romania, Turkey and Indonesia. The site is maintained by PIMS Education Coordinator Harley Weston and faculty and students at the University of Regina.

Changing the Culture

A yearly one-day meeting that brings together mathematicians, mathematics educators and school teachers from all levels to improve teaching. 100 participants in 2013.

Aboriginal Scholarship

Summer camps, scholarships, mentorship programs, math manias and math clubs provide a students with math skills that prepare them for a post-secondary education. In 2013 these programs received funding from RBC, The Governments of British Columbia and Saskatchewan, Vancity and others.

Postdoctoral Fellows

Every year PIMS sponsors numerous postdoctoral fellows (PDFs), attracting outstanding young scientists who contribute to PIMS research programs, many of whom later become faculty members at Canadian universities. PDFs are distributed throughout PIMS sites on a competitive basis. In addition, each CRG is allocated a number of PDFs, the selection of which is determined by an assessment panel. In 2013 PIMS supported a total of 49 PDFs distributed among all its sites.

2013 incoming postdocs:

Andrew Berget (UWashington)
Robin Michael John Koytcheff (UVic)
Jan Hubicka (UCalgary)
Timur Hulshof (UBC)
Martijn Kool (UBC)
Koushik Pal (USaskatchewan)
James W.A Parks (ULethbridge)
Ting Kei Pong (UBC)
Jonathan Potts (UAlberta)
Callum Quigley (UAlberta)
Alan M. Thompson (UAlberta)
Ryan. M Tifenbach (URegina)
Nghia T.A Tran (UBC)
Adrien Saumard (UWashington)
Pierre Youssef (UAlberta)
Hehui Wu (SFU)
Changlong Zhong (UAlberta)

Featured Postdoctoral Fellow: Emil Weidemann

"Having completed my undergraduate studies at the Universities of Munich and Cambridge, I obtained my doctoral degree in 2012 from the University of Bonn under the supervision of László Székelyhidi. My thesis was concerned with the Euler equations, which have been known as a model for the motion of an incompressible fluid for more than two centuries, yet are still not well understood. Using and expanding novel techniques that were developed in the last few years, I was able to prove global existence of weak solutions for these equations and to describe the relationship between various deterministic and statistical notions of solution.

I have been a PIMS Postdoc with the Partial Differential Equations Group at UBC since 2012 and have found Vancouver to be an excellent place to deepen and broaden my mathematical interests. While at PIMS, I have made further progress on the Euler equations and have also employed the techniques I learned in the context of fluid equations in order to study problems in the calculus of variations. Jointly with two colleagues in England, I thus obtained surprising results about variational integrals with non-convex integrands, which have intriguing applications to nonlinear elasticity theory and to the analysis of Sobolev spaces of orientation- and volume-preserving maps."

2013 Prizes & Awards

CRM - Fields - PIMS Prize

Bruce Reed (McGill)

The CRM-Fields-PIMS Prize is the premier Canadian award for research achievements in the mathematical sciences. Professor Reed has played a leading role in a broad range of research areas in discrete mathematics and theoretical computer science, and is best known for his work on graph theory. He was cited "for his profound contributions to difficult and important problems in the areas of graph minors, graph colouring, algorithmic graph theory, random graphs and the probabilistic analysis of algorithms."

He currently holds the Canada Research Chair in Graph Theory and was elected as a Fellow of the Royal Society of Canada in 2009.

CAIMS/PIMS Early Career Award in Applied Mathematics

Serdar Yuksel (Queen's University)

Professor Yuksel is cited for his contributions to the areas of information and control theory, and the interface between these. He has made fundamental contributions to the study of control of systems under information constraints and has developed a framework in which the factors that govern the feasibility of control systems with unreliability in data transfer are laid bare, and has designed effective control laws that can be shown to work. He has also contributed greatly to research in decentralized control, i.e. situations in which one has many agents whose behaviour one is trying to control, but in which agents do not communicate fully with one another, and/or some do not communicate at all. In this instance, Professor Yuksel has provided a framework for evaluating the extent and type of information that must be transmitted in order that the desired group behaviour can be achieved.

PIMS Education Prize

Natalia Kouzniak (SFU)

Dr. Natalia Kouzniak is a Senior Lecturer in the Department of Mathematics at Simon Fraser University. She has been an inspiration to her colleagues through her dedication to her students and tireless efforts for improving the instruction of mathematics and developing young people's interest in the subject. In recognition, she was awarded the 2012 SFU Excellence in Teaching Award. For over ten years Dr. Kouzniak has organized and hosted many outreach activities in the Vancouver area and is well known and respected among local high school mathematics teachers. She has organized the annual CMS Math Camps for high school students which always receive rave reviews by the students.

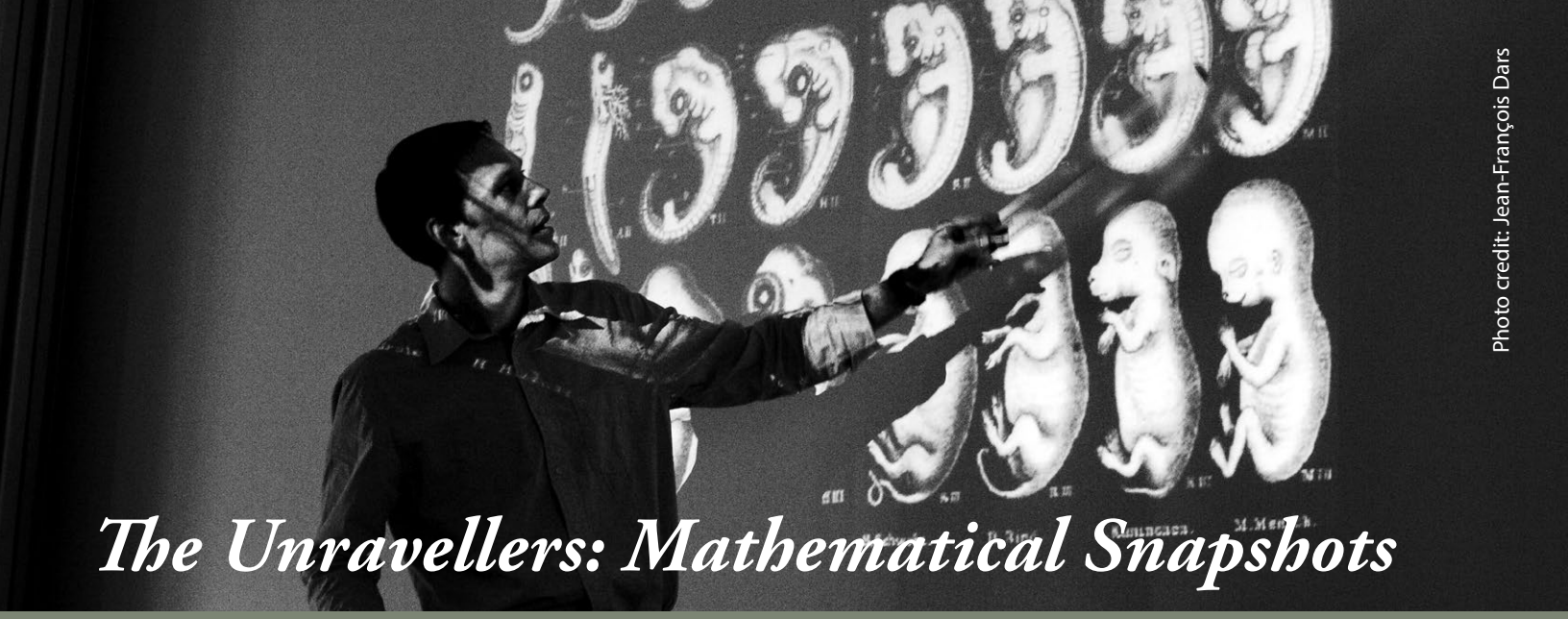


Photo credit: Jean-François Dars

The Unravellers: Mathematical Snapshots

On April 5, PIMS held a reception to announce the opening of The Unravelers: Mathematical Snapshots, an original exhibit by photographer Jean-François Dars, based on the book with the same title, co-edited with Annick Lesne and Anne Papillault. Through photos and accompanying text, the book and exhibit provide an intense and remarkable glimpse into the culture, experiences and people of the Institut des Hautes Études Scientifiques (IHÉS), a world-class centre for scientific research in France.

The nearly 100 attendees included the Directors of PIMS (Alejandro Adem), BIRS (Nassif Ghoussoub), CRM (François Lalonde), Fields (Edward Bierstone) and IHÉS (Jean-Pierre Bourguignon), the Consul General of France in Vancouver (Mme Évelyne Decorps) and the French scientific attaché (Didier Marty-Dessus), as well as faculty, students and staff from local instutions.

Bourguignon led a tour of the exhibit, revealing the story behind each photograph and explaining how the idea was conceived. He described the fascinating story of the making of the exhibit and said of Jean-Francois, "After time, [he] became completely unnoticed by the scientists. He could catch intimate moments of exchange between people and would have the patience to wait and capture the perfect moment."

A collection of thousands of pictures developed and the best ones formed the book. It has since been published in French, Chinese, English, Japanese, and soon, Korean. More than 7000 copies have been sold in France, as well as sold out printings in Japan, and China. The book's great success spawned the idea for the exhibit, which showcases 27 individual panels of images, accompanied by several panels with descriptive text.

The exhibit was displayed for the first time in Canada, on display for two weeks at the Pacific Museum of the Earth Gallery at UBC before journeying to San Francisco and then New York.

PIMS Distinguished & Public Lectures

Trevor Hastie

Numerous high profile public lectures are held each year at PIMS sites. In September, Trevor Hastie spoke on *Sparse Linear Models* in a lecture that celebrated the International Year of Statistics. Hastie is noted for his many contributions to the statistical toolbox of flexible data analysis methods, beginning with his co-development of the software *S*, precursor of *R*. His recent contributions centre on machine learning and the analysis of high-dimensional data. He has written three research-level books, all widely used by both statisticians and users of statistics. His lecture brought ideas in statistics and computer science togther in the midst of an audience that ranged from mathematical scientists to health scientists.

In March, Prof. Avi Wigderson (Institute for Advanced Study, Princeton) delivered the lecture, *Cryptography: Secrets and Lies, Knowledge and Trust*. Wigderson is a leader in theoretical computer science whose accomplishments include winning the Nevalinna and Gödel Prizes and membership in the US National Academy of Science.

The talk, which was attended by numerous faculty, postdoctoral fellows and graduate and undergraduate students in Computer Science, Engineering, Mathematics and Statistics, introduced cryptography and focused on cryptographic methods at the foundation of the ongoing e-commerce revolution.

Other highlights from 2013:

January 14 - Margot Gerritsen (Stanford) on *How does Google google? The Math Behind the Internet* at UCalgary

May 27 - Yann Brenier (École Polytechnique) on *Fluids and optimal transport: from Euler to Kantorovich* at UBC

June 10 - PIMS Marsden Memorial Lecture - Peter Constantin (Princeton) on *Nonlocal Evolution Equations* at the Isaac Newton Institute for Mathematical Sciences

July 18 - CRM-Fields-PIMS Prize Lecture: Bruce Reed (McGill) on *Some 21st Century Results in Graph Theory* at SFU

September 6 - Yuval Peres (Microsoft) on *Search Games and Optimal Kakeya Sets* at UBC

September 20 - Ulrike Tillman (Oxford) on *Cobordisms: Old and New* at UBC

Featured Workshop: Automata Theory and Symbolic Dynamics

From June 3-7, 2013 at UBC, the PIMS/EQINOCS Workshop on Automata Theory and Symbolic Dynamics brought together computer scientists working in automata theory and mathematicians working in symbolic dynamics. The two subjects originated in the first half of the twentieth century, but it wasn't until the 1980's that it was recognized that finite-state machines, studied in automata theory, could be used to implement conjugacies between symbolic dynamical systems, and vice versa. While many of the fundamental problems of interest were different, it soon became apparent that techniques in one field could be applied to the other. Since then, there has been a great deal of interplay, which this workshop served to further.

Workshop participants consisted of approximately half graduate students and postdoctoral fellows, and a majority of the participants came from outside of North America.

The formal part of the workshop consisted of approximately thirty lectures, with roughly one-third given by graduate students and postdoctoral fellows. Each day was primarily devoted to a different sub-topic, leading off with a tutorial lecture. These tutorials were particularly important since the workshop brought together two groups, working in related areas with somewhat different viewpoints and terminology. The focus of the first day was the role of computation theory in symbolic dynamics. This is a major recent development, which has generated breakthrough results and raised new questions in multi-dimensional symbolic dynamics.

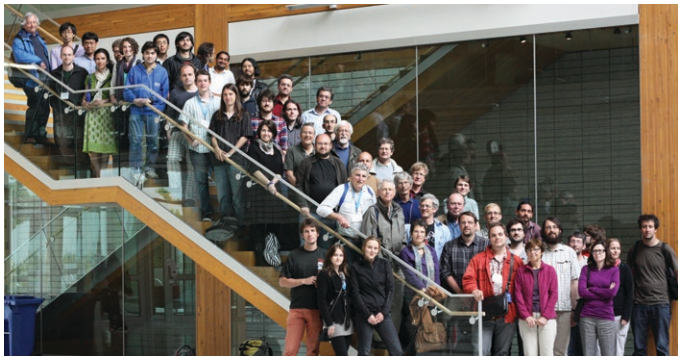
Two open problem sessions provided a major highlight, with a great deal of discussion on many problems of interest to both groups. While it is far too early to assess the impact of the workshop, one problem was solved by a graduate student shortly after the workshop. This student is now developing a new and intriguing body of theory based on his solution.

Most lectures and reports of the open problem sessions can be found at *http://mathtube.org/conference/automata-theory-and-symbolic-dynamics*

Scientific Highlight

Of fundamental importance in symbolic dynamics is the class of shifts of finite type (SFTs), which are collections of arrays on a d-dimensional lattice defined by finitely many forbidden patterns. Perhaps the most prominent invariant of an SFT its entropy.

For d = 1, the numbers that can occur as entropies of an SFT were characterized long ago as logs of certain algebraic numbers. A few years ago, it was discovered that the range of entropies in higher dimensions can be characterized in a completely different way, namely by computability properties. A highlight of this workshop was an exposition of the breakthrough result and talks on ensuing results that have completely changed our understanding of higher dimensional SFTs.



2014 Event Highlights

EVENTS, CONFERENCES AND WORKSHOPS

28 Feb - 1 Mar	**14th Colloquiumfest** University of Saskatchewan
19-27 April	**Alberta Number Theory Days VI** Banff, Alberta
1-2 May	**Alberta Mathematics Dialogue (AMD)** University of Alberta
3 May	**ELMACON** University of British Columbia
6-9 May	**TRUe Games** Thompson Rivers University
10-11 May	**Western Canada Linear Algebra Meeting (WCLAM)** University of Regina
13-16 May	**International Conference: Symmetry Methods, Applications and Related Fields** University of British Columbia
16 May	**Changing the Culture** Simon Fraser University
17-18 May	**Pacific Northwest Number Theory Conference** Simon Fraser University
26-30 May	**Algebraic Topology- Methods, Computation and Science 6 (ATMCS6)** University of British Columbia
29-31 May	**Geometry and Physics Workshop** University of British Columbia
2-5 June	**11th PIMS Young Researchers Conference in Mathematics and Statistics** University of British Columbia

SUMMER SCHOOLS

May-August	**Software Carpentry Bootcamps** Various PIMS Sites
2-27 June	**PIMS Summer School in Probability** University of British Columbia
2-6 June	**String Math Summer School** University of British Columbia
23 June – 4 July	**Séminaire de Mathématiques Supérieures** CRM Montreal
7-12 July	**West Coast Algebraic Topology Summer School** University of British Columbia
7 July - 1 August	**PIMS-SFU Undergraduate Summer School on Multiple Zeta Values** Simon Fraser University
21-25 July	**PIMS Summer School on Economics and Math of Systemic Risk** University of British Columbia
10-23 August	**Two weeks at Waterloo: A summer school for Women in Math** University of Waterloo
18-22 August	**Randomized Techniques for Combinatorial Algorithms** Simon Fraser University

For more information and updates, visit www.pims.math.ca

9-13 June	**String Math Conference** University of Alberta
21-27 June	**Satellite conference to CAIMS 2014: Combinatorial applications to biology, chemistry and physics.** University of Saskatchewan
8-11 July	**Workshop on Algebraic Design Theory and Hadamard Matrices** University of Lethbridge
14-25 July	**Pan-American Advanced Study Institute in Spatio-temporal Modeling** Búzios, RJ, Brazil
15-20 July	**Int'l Congress for the Psychology of Mathematics Education** Vancouver, British Columbia
28-30 July	**PIMS Workshop on Economics and Math of Systemic Risk** University of British Columbia
5-15 August	**Math Modelling in Industry Workshop** University of British Columbia
7-8 October	**Workshop on Big Data in Networks and Distributed Systems** Simon Fraser University
TBA December	**PIMS-IISER Pune Mathematical Biology Conference** IISER-Pune, India

PUBLIC & DISTINGUISHED LECTURES

10 January	**David Levermore** Simon Fraser University
3 February	**Russel Caflisch** University of British Columbia
28 February	**Jaroslav Nesetril** University of British Columbia
14 March	**Robert Guralnick** University of British Columbia
28 March	**Linda Petzold** University of British Columbia
25 April	**L. Mahadevan** Simon Fraser University
TBD April	**Mathieu Desbrun** Instituto Nacional de Matematica Pura e Aplicada, Rio de Janeiro
26 May	**Bjorn Poonen** University of British Columbia

COLLABORATIVE RESEARCH GROUPS

2014 - 2017	**Applied Combinatorics**
2014 - 2018	**Applied, Algebraic and Geometric Topology**
2013 – 2016	**Geometry and Physics**
2012 - 2015	**Algorithmic Theory of Networks**
2012 - 2015	**Optimization: Theory, Algorithms and Applications**
2011 - 2014	**Applied and Computational Harmonic Analysis**

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