# Pacific Institute *for the* Mathematical Sciences

## Year in Review 2010

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

# Table of Contents



# Organization



Cover photo: Sunrise over Rocky Mountains, Alberta.

# *From the Director*

**It is a pleasure for me to write these lines in our Year in Review 2010**, which is a publication containing an overview of the multiple activities held at PIMS during the year.

I think it is safe to say that 2010 was the "Year of Alberta" at PIMS, thanks to the remarkable scientific activities that were launched in that province. As readers may know, one of the major scientific offerings at PIMS is the Collaborative Research Group (CRG), which brings together faculty at PIMS universities to organize international thematic events such as workshops and summer schools, recruit postdoctoral fellows, and attract distinguished visitors. In 2010 PIMS launched two impressive new CRGs based primarily in Alberta, on the respective topics of "Mathematics of Quantum Information" and "*L*-functions and Number Theory". Both of these groups will build on traditional strengths in Western Canada and attract multiple activities to PIMS universities. We are grateful to Barry Sanders and Matt Greenberg from the University of Calgary for their leadership on these projects.

Moreover, activities in Alberta will undoubtedly benefit from the significant funding ($1.2 million) that was obtained from the Alberta Ministry of Advanced Education and Technology (AAET) to fund PIMS activities for the period 2010-2014, providing a major boost to our colleagues in that province.

Perhaps the most important development at PIMS in 2010 was the establishment of the endowed Hugh C. Morris Lecture Series thanks to a very generous gift by the former Chair of the PIMS Board of Directors, Hugh Morris. We are enormously grateful to Hugh for his generosity and vision in support of the mathematical sciences. His contributions to PIMS and science in Canada are truly outstanding. In addition he has provided valuable advice to PIMS Directors over the years and it has been a real privilege to count on his friendship and counsel. This endowment is the first of its kind for PIMS and is a testimony to the lasting quality and impact of our programs across a broad spectrum of the mathematical sciences.

On the industrial side I want to mention the very fruitful collaboration between PIMS, the IMA in Minneapolis and the CIMAT in Mexico which led to the first ever CIMAT-IMA-PIMS Math Modelling in Industry Workshop in Mexico last August (see page 12 for more details). This is a great example of the collaborative efforts that have greatly enhanced the quality and diversity of PIMS activities over the past few years.

During 2010 PIMS also hosted a dizzying array of educational and outreach activities for K-12, which are too numerous for me to list here. Recently we welcomed our colleagues from Saskatchewan to the PIMS fold and we are now proud sponsors of their signature activities, Math Central and Math on the Move.

Let me conclude this introduction to the Year in Review 2010 by expressing our gratitude to all of our generous donors, with particular thanks to Fernando Aguilar, Darrell Duffie, Haig Farris, Hugh Morris, Vaho Rebassoo, Brian Russell, Ken Spencer and Andy Wright.

Warmest regards,

Alejandro Adem
Director

# *About PIMS*

**The Pacific Institute for the Mathematical Sciences (PIMS)** was founded in 1996 by a consortium of five universities in Alberta and British Columbia (University of Alberta, University of Calgary, the University of British Columbia, Simon Fraser University and University of Victoria). The University of Washington (USA), the University of Regina, and the University of Saskatchewan have since joined as full members and the University of Lethbridge and Portland State University as affiliated universities.

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 eight major 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. The PIMS annual budget is approximately $3.5 million.

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# *Conferences, Workshops, Summer Schools, and Short Courses*

**During 2010 PIMS helped to support over 60 scientific activities.** These involved a total of nearly 3,000 attendees who spent nearly 13,000 attendee days at PIMS activities. The charts give the demographics of the attendees. As can be seen, they represent a broad cross-section of the community and come from a variety of locations to attend PIMS events.

**Conferences and Workshops:** These range from small one-day workshops to multi-week conferences with hundreds of participants.

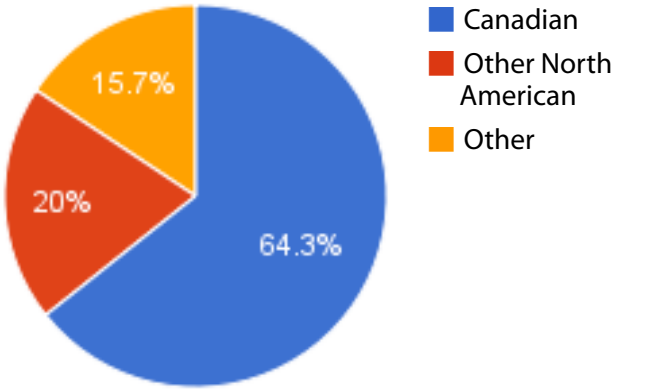
**Summer Schools:** Eight summer schools/short courses were held in 2010 on topics including risk management and risk sharing, modelling and computation for social networks and probability. See page 10 for more.

**Lecture and Seminar Series:** PIMS supported 19 ongoing seminar series at member universities and industrial centres in 2010.

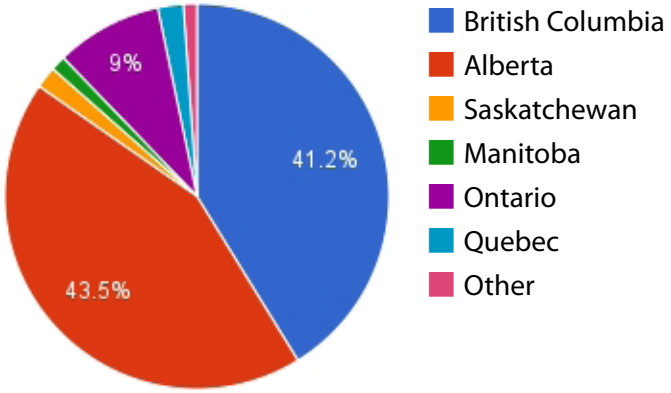
**Industrial Activities:** As described on page 12, PIMS fosters collaborations with industry through a variety of industrial workshops, short courses, mini-courses, summer schools and seminar series organized by PIMS researchers.

**Thematic Programs:** These intensive activities cover a specific area of research of current importance, with participants ranging from students to world experts in the mathematical sciences. Summer Thematic Programs are special events that take place every 2-3 years, depending on exceptional opportunities. For 2011 thematic programs are planned in Applied Mathematics and in Number Theory.

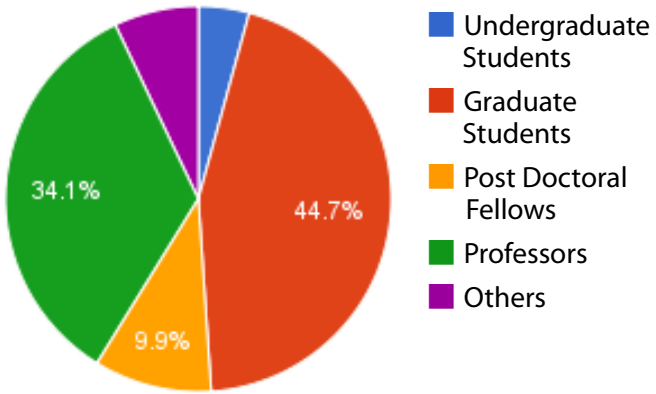
**Attendee Institutions**




**Canadian Distribution**




**Academic Attendee Demographics**



# *Collaborative Research Groups*

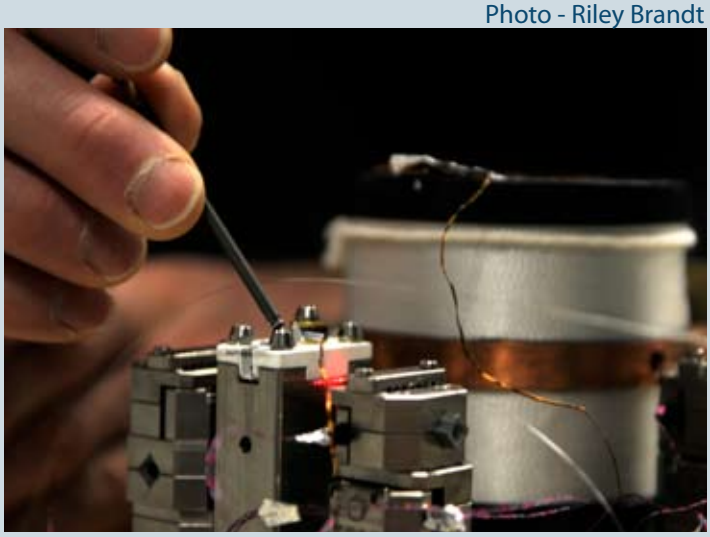
**PIMS Collaborative Research Groups (CRGs)** develop permanent research and training networks, establishing lasting interdisciplinary links between geographically separate groups of researchers at member universities. Groups organize thematic activities, such as workshops, summer schools and seminars, make joint postdoctoral fellowship (PDF) appointments, and/or develop joint graduate training programs. CRGs are designed to promote and support longer term, multi-event, multi-site coordinated activities. During its period of operation, typically 3-4 years, a CRG can take advantage of the full gamut of PIMS resources. PIMS has developed 22 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.

## CRG in Mathematics of Quantum Information (2010–2013)

Quantum information science is an interdisciplinary research endeavour that brings together computer scientists, mathematicians, physicists, chemists, and engineers to develop revolutionary information processing and communication technologies that are infeasible without exploiting the principles of quantum mechanics. The importance of quantum information was first widely recognized in 1982 when Feynman conjectured that a quantum computer would efficiently simulate quantum systems, and a universal Turing machine ("classical computer") could not.

Members of this CRG have expertise in many areas of quantum information including these three important topics: models of quantum computing, research in error correction, and algorithms. The CRG will pursue these areas by bringing together their complementary expertise and holding workshops with the world's leading scientists in the field.

Photo - Riley Brandt



This CRG is led by Barry Sanders (U. of Calgary), Robert Raussendorf (U. of BC), Petr Lisonek (SFU) and Dave Bacon (U. of Washington)

Sanders' Group

# *Collaborative Research Groups*

$$\sum_{n=1}^{\infty} n^{-s} = \prod_{p} \left(1 - p^{-s}\right)^{-1} \qquad \sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{p} \left(1 - \frac{1}{p^s}\right)^{-1}$$

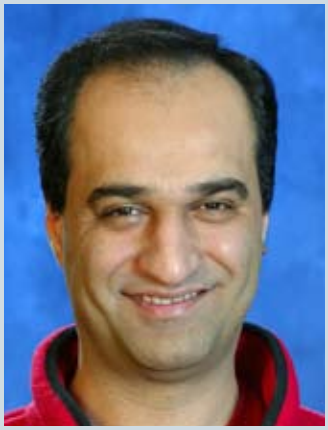
## CRG in Number Theory (2010–2013)

Number theory is a subject as diverse as it is ancient, and this diversity is well represented in the mathematics departments of PIMS universities. These universities are home to academics with expertise in algebraic and analytic number theory, arithmetic algebraic geometry, computational number theory, number theoretic cryptography and information security, and representation theory, and have long-held reputations for producing cutting-edge research in these fields. Much has changed, though, in the arithmetic landscape of Western Canada since PIMS last funded a CRG in number theory during the period 2003-2005. An influx of new, young researchers into PIMS universities, particularly in Alberta, has added to the region's already impressive list of accomplished number theorists. This CRG brings all these mathematicians together to encourage the development of promising young faculty and their work while continuing to promote the number theoretic excellence for which Western Canada is acknowledged worldwide.

The Coordinator of this CRG is Matthew Greenberg, University of Calgary, with eight Principal Investigators and 19 participating faculty. Event highlights have included the Alberta Number Theory Days in April-May 2010 with two more similar events and many others planned for 2011 and 2012, including a thematic program which runs from May-July and October-November 2011.

Postdoctoral fellows associated with this CRG will also be recruited in 2011.

Coordinator:
Matthew Greenberg
(U Calgary).



Leader:
Amir Akbary (U Lethbridge).

Leader:
Greg Martin (UA).

Leader:
Clifton Cunningham
(U Calgary).

# *International Graduate Training Centre in Mathematical Biology*

2010 IGTC Annual Research summit

**The PIMS vision for creating the International Graduate Training Centres is to "Seize the scientific leadership on the world stage and to launch a strategic training program 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 Prof. Mark Lewis of the University of Alberta.

**New IGTC Fellowships Awarded for 2010-2011:**

Sheehan Khan

Stephanie Peacock

Deniz Yorukoglu

Eric Foxall

Ben Wilson

Phuong Dao

Monica Itzuri Delgado Carillo

Anastasia Lukyanova

Lyudmila Korobenko

This IGTC is uniquely positioned to play a role central to the national and international development of mathematical biology. The program has both the breadth and depth needed to train interdisciplinary researchers whose core discipline is mathematical and statistical science. The proposed breadth of the training, which includes model formulation, mathematical, computational and statistical analysis, and scientific communication, is unmatched by other programs.

The 2010 IGTC Annual Research summit was held in Naramata, BC from October 1–3. There were talks given by Sebastian Schreiber from the Department of Evolution & Ecology at the University of California at Davis and Dan Coombs from the Department of Mathematics at UBC on grant proposal writing.

In addition to summits, the IGTC offers annual 2–4 week graduate courses which rotate according to interests of local organizers. The courses which are coming up are Mathematical Ecology (January–March 2011) and Models in Evolution (July–August 2011).

PIMS is proud to support IGTC student **Shaun Strohm** who was awarded a Vanier Scholarship in 2010.

"My research is focused on the dispersal of the Mountain Pine Beetle and the impact of management activities. My model is spatially-explicit and incorporates beetle dispersal and reproduction as well as the density of susceptible trees. It is composed of reaction-diffusion-chemotaxis PDEs for the beetle flight period and discrete equations for the overwintering stage.

The PIMS IGTC in Math Biology has been invaluable in my graduate training and growth as a researcher, in particular through the attendance of PIMS summer schools, annual summits, and an academic visit to the U of Alberta. The financial support of PIMS and a Vanier scholarship has allowed me to focus exclusively on my research."

# *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 proud to provide the elements that are necessary for success for current and future generations of teachers, scientists and engineers.

**Math Mania** is a popular alternative math education event for elementary and middle schools in BC. Math Mania presents a variety of interactive demonstrations, puzzles, games and art. These activities are designed to demonstrate to students—and their parents—fun ways of learning both math and computer science concepts. 6 Math Manias were held in 2010.

**SNAP** is a non-traditional Student-centered, Non-competitive, All-inclusive, and Problem-based math fair based in Alberta. The purpose of a SNAP math fair is to provide a meaningful problem-solving experience for all students. 11 SNAP fairs were held in 2010. In 2010 this program expanded to BC where 7 SNAP fairs were held.

**Changing the Culture** is a yearly one-day meeting that brings together mathematicians and mathematics educators from all levels to work together towards improving the teaching of mathematics.

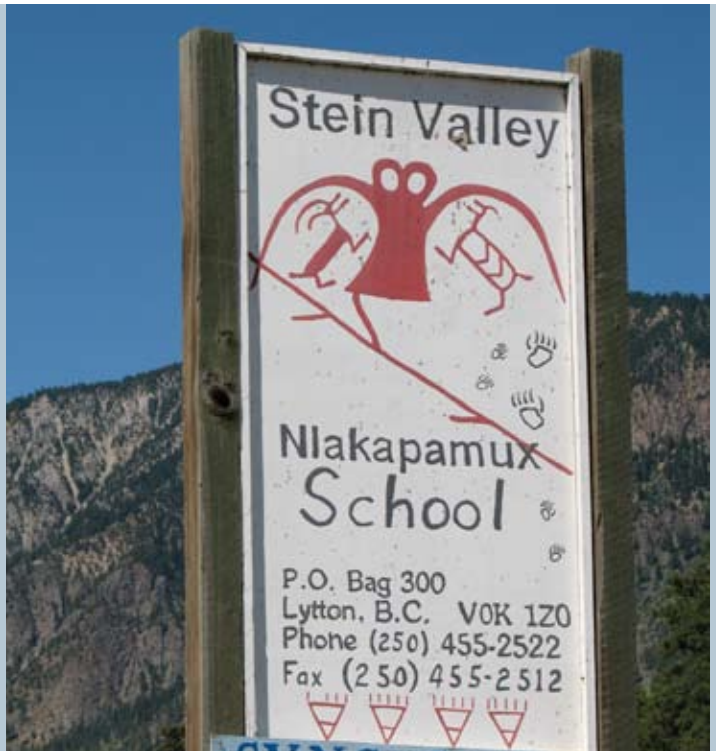
**ELMACON** is an annual Elementary Mathematics Contest held at UBC which gives students from Grades 5-7 the chance to experience mathematics as an exciting sport. There were almost 300 participants in April, 2010.

**PIMS Math Workshops for Teachers** are conducted to help elementary school teachers build their math skills.

**Pi in the Sky,** a high school level periodical produced by PIMS for students in Canada and the United States. This resource aims to establish direct contact with teachers and students, to involve high school students in mathematical activities and promote careers in mathematical sciences.

**Math Central**, mathcentral.uregina.ca, a website for mathematics students and teachers. Maintained by faculty and students in Mathematics and Statistics and Mathematics Education at the University of Regina.

**A Taste of Pi**, a workshop designed to provide students who have demonstrated a talent and strong interest for mathematics with enrichment activities in a fun and rewarding environment.




## First Nations Outreach

First Nations outreach is a special focus within our educational program. PIMS has developed partnerships with the First Nations Education Steering Committee and First Nations schools in British Columbia. In November 2009, PIMS co-sponsored the third First Nations Math Education Workshop which brought together a group of Elders, mathematicians and math educators, with the goal of improving mathematics education among aboriginals while simultaneously acknowledging the importance of traditional culture. Throughout 2010, members of these groups worked together in creating resources to honor the spirit of each student as an individual and as part of a community. This way of thinking is an integral part of many aboriginal cultures as well as a successful way of learning mathematics in any culture.

# *Postdoctoral Fellows*

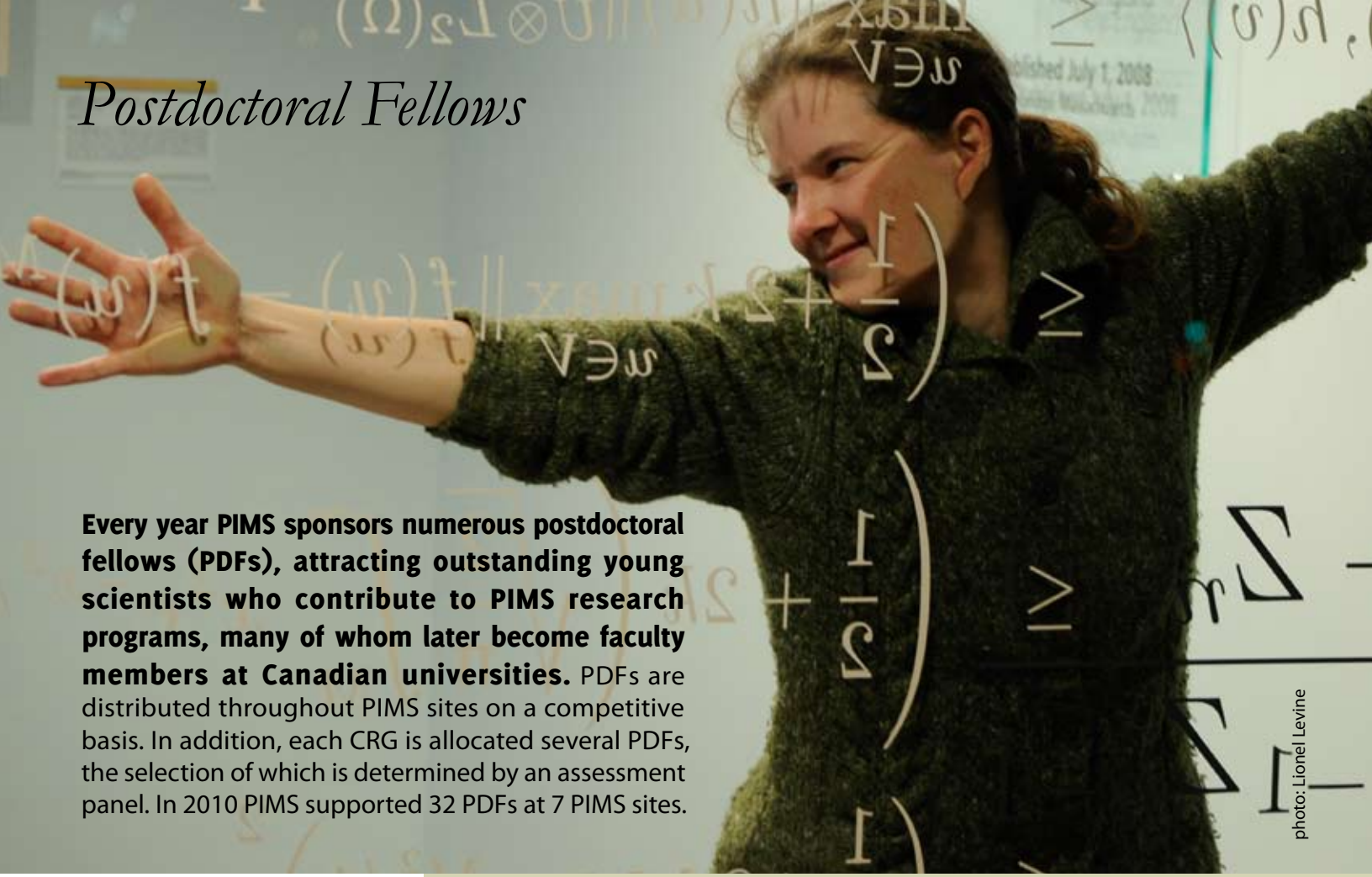


photo: Lionel Levine

**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 several PDFs, the selection of which is determined by an assessment panel. In 2010 PIMS supported 32 PDFs at 7 PIMS sites.

**2010 incoming PDFs**

Benjamin Adcock (SFU)

Vianney Combet (UBC)

Felix Fontein (UC)

Pavel Hrubes (UC)

Johnson Jia (UBC)

Antoine Julien (UVic)

Xiaoguang Ma (UA)

Benjamin Marlin (UBC)

Tom Meyerovitch (UBC)

Pavel Semukhin (UR)

Cecilia Tokman (UVic)

Kirsten Valkenburg (USask)

Tsuyoshi Yoneda (UVic)

Ian Zwiers (UBC)

**Featured Post-Doctoral Fellow: Katherine Stange**

My Ph.D. supervisor, Joseph H. Silverman, got me hooked on elliptic curves. There's so much structure in elliptic curves, and yet we don't know the answers to so many fundamental questions. After my Ph.D. at Brown University, in 2008, I spent a year at Harvard University before coming to Vancouver.

Here, PIMS has given me the resources to get a lot of really interesting projects going. A long-term project is to generalise elliptic nets to abelian varieties. But research always takes you down interesting side roads along the way: one research surprise came in the form of a question that fell out of joint work with Silverman. We asked, for a given elliptic curve, how many pairs of primes p and q have the property that the curve has p points modulo q and q points modulo p. Another fun project has been a game theory investigation with Lionel Levine into how to share dinner at an Ethiopian restaurant. I've even wandered into the field of arithmetic dynamics.

I've been really impressed with PIMS' work in outreach programs, so it was an honour to be invited to give a lecture in the Taste of Pi series for high school students. To get a sense of what mathematicians actually do, the students investigated modular arithmetic, gathering patterns and conjectures and trying to prove them. My own "taste of pi"—the overwhelming enthusiasm and curiosity in the room (and in my inbox the weeks following!)—has gotten me addicted.

This spring, I'm headed to Stanford University for a final year of postdoc. I expect I'll be thinking about number theory for many years to come, and I hope I'll still be exploring it with students, too.

# *Prizes & Awards*

## 2010 CRM - Fields - PIMS Prize
## Gordon Slade, University of British Columbia

This award recognizes Gordon Slade's outstanding work in rigorous statistical mechanics and probability. He is renowned for developing a technique known as the lace expansion into a systematic calculus which he has applied to diverse and famous problems including self-avoiding walk, percolation, branched polymers, random graphs, and numerical techniques for the exact enumeration of self-avoiding walks.

## 2010 CAIMS/PIMS Early Career Award in Applied Mathematics
## Daniel Coombs, University of British Columbia

This new award recognizes exceptional research in any branch of applied mathematics where the recipient is less than ten years past the date of Ph.D. at the time of nomination. In 2010, Daniel Coombs was selected as the inaugural recipient and cited for his creativity, productivity, and ever-growing impact in mathematics applied to problems in biology. He works in the field of computational immunology, addressing a wide range of problems in viral disease dynamics and HIV modelling, and in the dynamics of receptors on cell surfaces.

## 2010 PIMS Education Prize
## Andy Liu, University of Alberta

This prize is intended to recognize individuals from the PIMS universities, or other educational institutions in Alberta, British Columbia, and Saskatchewan who have played a major role in encouraging activities which have enhanced public awareness and appreciation of mathematics. Andy Liu is an outstanding mathematical educator who has been internationally recognized for his tireless work in education and outreach over a period of many years. Liu, a professor of mathematics, has been highly influential through his popular courses for school teachers and students alike.

*PIMS is grateful to CGG Veritas & Hampson-Russell for sponsoring this award.*

# *PIMS in the Summer*

**Every year, PIMS runs a number of topical summer schools.** They are intended to educate graduate students and early career researchers on current developments. In 2010, PIMS ran 8 different summer schools.

**First Montreal Spring School in Graph Theory, McGill University, June 7-29.**

**Summer School in Risk Management and Risk Sharing, University of British Columbia, June 7-July 9.**

**Summer School on Operator Algebras and Non-commutative Geometry, University of Victoria, June 14-25.**

**Modelling and Computation for Social Networks, Whistler, BC, June 21-25.**

**PIMS Summer School in Probability 2010, University of Washington, June 21-July 10.**

**10th Canadian Summer School on Quantum Information, University of British Columbia, July 17-30.**

**Summer School on Computer Models and Geophysical Risk Analysis, University of British Columbia, August 6-10.**

**West Coast Algebraic Topology Graduate Summer School, University of Oregon, August 9-14.**


Summer school in Risk Management

(PIMS in the Summer cont.) These summer schools attract international and Canadian speakers, explore cutting edge issues and bridge gaps between people from different backgrounds. In 2010 PIMS summer schools attracted almost 500 participants from all around Canada and the world.

Here's what the students said:

"[this school] offered a series of lectures of the best graph theory experts in the world lecturing on current trends and new developments. One would have to spend a semester at Princeton, another at Columbia and another one at McGill to be able to attend these courses. This School allowed this to be achieved in 4 weeks at a single place! These 4 weeks were tough, full of content and new knowledge, but they were exciting at the same time."

"The highlight for me was learning how to work with other people outside of my area and learning that they can offer solutions to geological problems. Building connections and strengthening collaboration between different academic groups."

"The courses were really well given and the subjects motivated. It was definitely an event for young researchers."

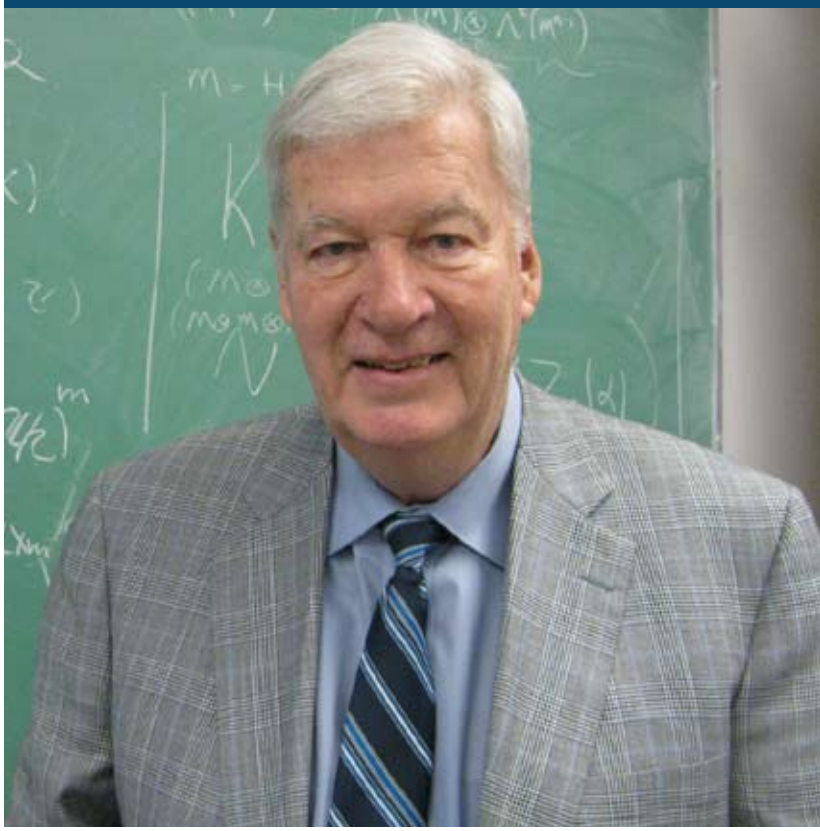
"Considering the qualification of the lecturers, who talked about arguably the most fundamental and important results of recent graph theoretical developments, the lectures by Bruce Reed, Paul Seymour and Maria Chudnovsky on the proofs of Wagner's Conjecture, the SPGT and various results on hereditary classes were all scientific highlights, so it is hard to select one as THE highlight of the event. From my own subjective point of view, the lectures on various minor results on induced subgraphs were most likely to have a positive impact on my own research."

"This was a terrific conference, far exceeding my expectations. I am very grateful to Adrian, Kevin, Raphael, and the other organizers. The speakers were well chosen and provided great insight. I especially appreciated it when speakers could make direct reference to a previous talk."

"I hope such an event will be organized again. I thank the organizers for all your time and effort!"

"Fantastic networking opportunity for future (inter-disciplinary) collaborations."

# *Hugh C. Morris Lecture Series*



**PIMS would like to thank Dr Hugh Morris, longtime friend of PIMS and the mathematical sciences who generously endowed a yearly lecture series to begin in 2011.** The Hugh C. Morris Lecture series will attract the world's top mathematical scientists to deliver presentations on current research topics to PIMS sites in Western Canada and Washington State.

"Mathematicians have always pursued their craft and nurtured their science and their research with wide-spread communication and abundant collaboration. The success of PIMS is an example.

I would hope that this lecture series will contribute additional capacity for scientific interaction amongst the PIMS family." says Dr Morris.

The first speaker is George Papanicolaou from Stanford University, who will deliver the inaugural lecture in Vancouver.

# *Industrial Collaborations*

**In 2010, PIMS continued to foster collaborations with industry** through a variety of industrial workshops, short courses, mini-courses, summer schools and seminar series organized by PIMS researchers with topics of interest to both industry and academia.

In August 2010, PIMS, together with the IMA and the Centro de Investigation en Matematicas (CIMAT) held a 10-day workshop on Mathematical Modelling in Industry at CIMAT in Guanajuato, México.

The workshop was designed to provide graduate students and qualified advanced undergraduates with first hand experience in industrial research, and was the first such joint workshop held by the three Institutes. PIMS Deputy Director, George M. Homsy attended this workshop and judged it a great success. PIMS, IMA and CIMAT have agreed to repeat the joint workshop in the future.

Other Industrial Activities in 2010 included the PIMS/Shell Canada lunchbox lectures held in Calgary. These lectures, 6 in total, are given by experts from the PIMS universities and focus on mathematical techniques and applications relevant to the oil and gas industry and demonstrate the utility and beauty of applied mathematics.

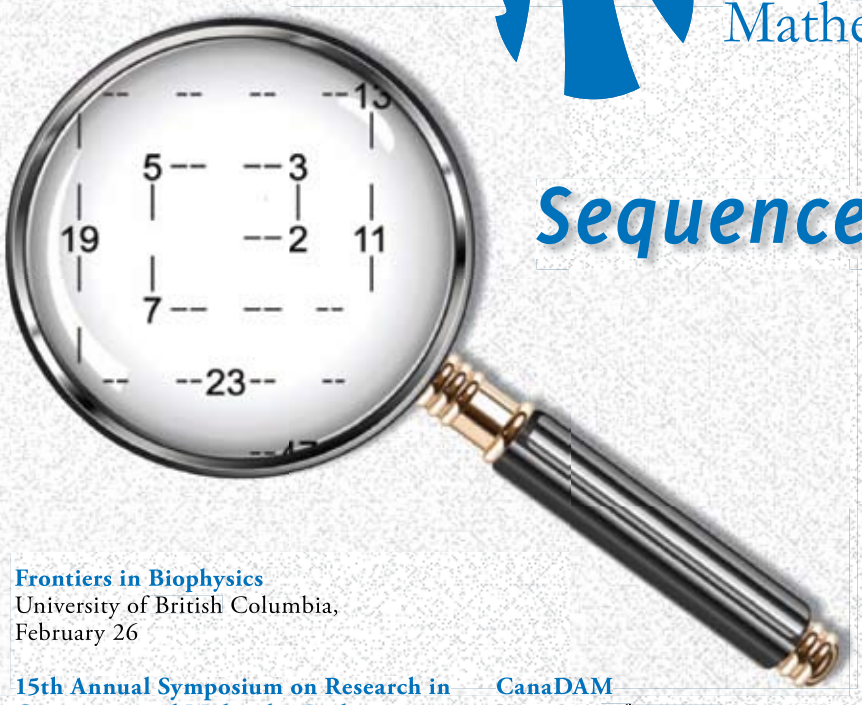
Mathematical Modelling in Industry, Guanajuato, Mexico.

# *International Agreements*

**PIMS has taken a leadership role in both national and international mathematical communities.** In 2010 PIMS signed a collaborative agreement with the Yangtze Center of Mathematics at Sichuan University in Chengdu, China. In late 2010, PIMS partnered with the Sociedad Matemática Méxicana (SMM), Society for Industrial and Applied Mathematics (SIAM) and CAIMS (Canadian Applied and Industrial Mathematics Society) to sponsor the highly successful First Joint North American Meeting on Industrial and Applied Mathematics, an event that brought together the Mexican, American and Canadian scientific communities in Huatulco, México, helping to establish new links between researchers.

PIMS is affiliated with the Centre National de la Recherche Scientifique (CNRS), the French national agency for scientific research, as an "Unité Mixte Internationale", thus allowing PIMS to host French researchers throughout its different sites. In 2010 the following researchers were in residence at PIMS sites: Pierre Guillot (UBC), Sylvain Rubenthaler (UBC) and Emmanuel Goddard (SFU).

Pacific Institute *for the* Mathematical Sciences



# *Sequence* of Events *2011*

**Frontiers in Biophysics**
University of British Columbia,
February 26

**15th Annual Symposium on Research in Computational Molecular Biology**
Vancouver, March 28-31

**Joint UBC/SFU Graduate Student Workshop in Statistics**
University of British Columbia, April 5

**Cascade Topology Seminar**
University of Victoria, April 22-23

**PIMS Young Researchers Conference in Mathematics**
University of British Columbia, May 2-5

**Pacific Northwest Number Theory Conference**
Western Washington University, May 7-8

**Eleventh International Conference on Logic Programming and Nonmonotonic Reasoning**
Simon Fraser University, May 16-19

**Computational and Analytical Mathematics**
Simon Fraser University, May 16-20

**The 2011 Canadian Workshop on Information Theory**
University of British Columbia – Okanagan
May 18-20

**Canadian Operator Symposium**
University of Victoria, May 24-28

**Alberta Number Theory Days**
Banff, May 28-29

**Workshop on Analytic Aspects of *L*-functions and Applications to Number Theory**
University of Calgary, May 29-June 3

**CanaDAM**
University of Victoria, May 31-June 3

**CMS Special Session in Number Theory**
University of Alberta, June 3-5

**CMS Summer Meeting**
Edmonton, June 3-5

**Statistical Society of Canada Annual Meeting**
Wolfville, NS, June 12-15

**35th Conference on Stochastic Processes and their Applications**
Oaxaca, México, June 19-24

**L-Packets**
Banff, June 26-July 1

**Séminaire de Mathématiques Supérieures: Metric-Measure Spaces**
Université de Montréal, June 27-July 8

**Gene Golub SIAM Summer School**
University of British Columbia, July 4-15

**Groups, Rings and Group Rings**
University of Alberta, July 11-15

**Applied Mathematics Perspectives: ICIAM Satellite Meetings**
University of British Columbia &
University of Victoria, July 12-17

**CT2011 International Category Theory Conference**
University of British Columbia,
July 17-23

**Graphs, Designs and Algebraic Combinatorics**
University of Regina, July 18-21

**2011 Prairie Discrete Math Workshop**
University of Regina, July 22-23

**International Conference on Applied Harmonic Analysis and Multiscale Computing**
University of Alberta, July 25-28

**WAVES 2011**
Simon Fraser University, July 25-29

**The 5th G.J. Butler Memorial Conference on Differential Equations and Population Biology**
University of Alberta, July 25-30

**Computational Harmonic Analysis Summer School**
University of Alberta, July 29-31

**Hyperplane Arrangements and Applications**
University of British Columbia, August 8-12

**West Coast Optimization Meeting**
University of British Columbia – Okanagan
August 27

**3rd Pacific Northwest Meeting on Computational Neuroscience**
University of Washington,
September 30-October 1

**GEOMED 2011**
University of Victoria, October 20-21

**Workshop on Cycles on Modular Varieties**
Banff, October 30-November 4

**WIN 2: Women in Numbers**
Banff, November 6-11

**PIMS Collaborative Research Groups:**

- Applied and Computational Harmonic Analysis (2011-2014)
- Operator Algebras and Non-commutative Geometry (2009-2012)
- Number Theory (2010-2013)
- Mathematics of Quantum Information (2010-2013)

# Pacific Institute *for the* Mathematical Sciences

Thank you to:

NSERC CRSNG

Alberta Advanced Education and Technology

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British Columbia The Best Place on Earth

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