



NEWSLETTER

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NEW COLLABORATIVE RESEARCH GROUPS

Optimization: Theory, Algorithms and Applications: 2012-2015

Optimization has become ubiquitous to numerous theoretical and applied research directions of modern mathematics. Yet, despite recent theoretical breakthroughs and the dramatic increase in computational capacities, there is an urgent need to push the boundaries of knowledge even further.

$$\arg \min_{x \in (-\infty, -1)} r^2 + 1,$$
$$\arg \min_{x \in (\infty, -1)} r^2 + 1,$$

The past decade has seen a substantial turnover in Western Canada's optimization community. In particular, two new campuses in BC feature optimization prominently: SFU-Surrey has established a Centre for Operations Research and Decision Sciences (CORDS), while UBC-Okanagan has obtained CFI funding to build the Optimization, Convex Analysis and Nonsmooth Analysis (OCANA) CoLab.

This new cohort of researchers and established facilities provide an ideal opportunity to build strong new collaborations and to substantially extend the activities of researchers in this area.
Continued on page 3.

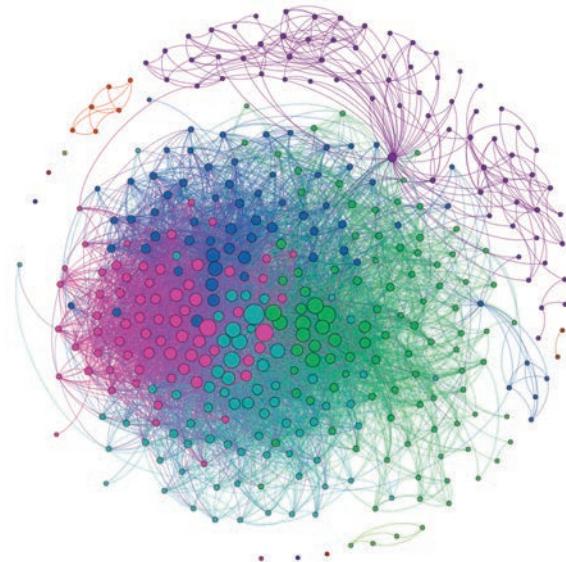


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Algorithmic Theory of Networks: 2012-2015

The technology revolution of the 1990s and 2000s owes much of its existence to the advances in computer networking technologies. These advances have made profound changes in how users and researchers model, construct/modify, maintain, use and ultimately, view networks, in terms of scale, structure and functionality. *Continued on page 3.*



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Director's Message



What could be more natural and important for our society than the study of networks and the science of optimization? Indeed these two themes pervade human activity. The mathematical sciences have a big role to play in these endeavours. I am delighted to report that PIMS has recently launched two new Collaborative Research Groups (CRGs) to address these important topics. The CRG, Optimization: Theory, Algorithms and Applications, is based at U.Calgary, UBC-Okanagan and UBC-Vancouver and will support mathematical activity leading to better decision-making, seeking to establish a permanent collaborative network of optimizers in Western Canada and the Pacific Northwest. The Algorithmic Theory of Networks CRG is based at SFU, U.Victoria, UBC and U.Calgary and will focus on the theoretical foundations for new generation networks. I was also pleased to observe that this is the first PIMS CRG where the main organizers are all women. As women have unfortunately been an underrepresented group in the mathematical sciences, this is a truly encouraging sign.

Our recently concluded postdoctoral competition resulted in the appointment of twelve highly qualified PIMS PDFs spread throughout our member universities. Their interests cover a broad array of topics including: computer science; partial differential equations; algebra; number theory; optimization and topology. These remarkable young scientists will provide a burst of energy across the PIMS sites.

I want to take this opportunity to recognize the recipients of recent PIMS prizes: Stevo Todorcevic from the University of Toronto (CRM-Fields-PIMS Prize), Theodore Kolokolnikov from Dalhousie (CAIMS/PIMS Early Career Award in Applied Mathematics) and Mark MacLean from UBC (PIMS Education Award). Their accomplishments are truly amazing!

This June, PIMS and the Institute for Mathematics and its Applications (IMA) will be partnering to organize the Mathematical Modeling in Industry Workshop at the University of Calgary, which will provide a valuable opportunity for students from Canada, the United States and Mexico to learn first-hand about industrial applications of mathematics.

As usual, our educational activities are in full swing, including Math Manias, ELMACON and summer camps for students at various levels. In particular we will be running Aboriginal summer camps for students in Vancouver and the interior of British Columbia. I want to thank David Leeming for his valuable work as PIMS Education Coordinator at the University of Victoria. He has decided to step down this summer after many years of remarkable service to the community. Fortunately, he will still be involved with our educational/outreach activities on Vancouver Island.

In our next issue we will report on our move to the new headquarters of PIMS' UBC site, a state-of-the-art, centrally located facility. This is undoubtedly an exciting development for PIMS as it will allow us to host events and visitors in an improved location and facility. We will, of course, miss the old West Mall Annex, given all the wonderful memories attached to it.

Warmest regards,

A handwritten signature in black ink, appearing to read "Alejandro Adem".

Alejandro Adem
Director, PIMS



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OPTIMIZATION... (CONTINUED FROM COVER)

This CRG's goal is to facilitate the creation of new mathematics that ultimately supports better decision making by creating a truly collaborative and permanent network of optimizers in the Pacific Northwest.

The collaborative network will allow the optimization community to organize and integrate itself, to enhance existing largely informal collaborations, to better identify new promising research projects and teams and to provide graduate students and postdoctoral fellows with rich and productive work environments and research experiences.

Led by Heinz Bauschke (UBC–Okanagan); Michael Friedlander (UBC); and Yuriy Zinchenko (U of Calgary), the CRG is planning a variety of scientific activities including the West Coast Optimization Meetings, a workshop on Robust Optimization, a conference on Geometric Aspects of Optimization, and Women Optimize in the West (WOW), a mentor-mentee international workshop. Ongoing events will include a shared Optimization Seminar Series with remote access and participation capabilities, and at least one team-taught graduate course per academic year.

The group intends to host multiple distinguished visitors, who will give lectures at PIMS sites. They will also host three postdoctoral fellows who, due to interdisciplinary and collaborative aspects of the research proposal, are expected to spend time at no fewer than two separate PIMS sites.

ALGORITHMIC THEORY...(CONTINUED FROM COVER)

Now, the scientific and technical communities are faced with new networking paradigms which are complex, heterogeneous and data-intensive, where existing algorithmic techniques are insufficient. The resulting theoretical and practical problems are multifaceted, requiring a wide range of expertise.

This CRG brings together researchers from four major universities in Western Canada: Petra Berenbrink and Funda Ergun (SFU) and Valerie King (UVic) as the lead investigators, as well as Will Evans, Nick Harvey, and David Kirkpatrick (UBC), Bruce Kapron and Venkatesh Srinivasan (UVic) and Lisa Higham and Philipp Woelfel (U of Calgary). The researchers will tackle algorithmic problems related to next generation networks.

The group will organize a major event on "Massive Scale Modeling and Algorithms for Networks" at SFU Harbour Centre, as well as a workshop on "Randomization in Networks" at UVic, in addition to hosting a distinguished speaker series, postdoctoral fellows, summer schools and research visits.

For more info on these and other PIMS CRGs visit:
www.pims.math.ca/scientific/collaborative-research-groups

Pacific Rim Mathematical Association (PRIMA) 2013 Congress

June 24-28, 2013 – Shanghai Jiaotong University, Shanghai, China

Plenary Speakers:

- Martin Barlow (University of British Columbia, Canada)
- Andrea Bertozzi (University of California, Los Angeles, USA)
- Weinan E (Princeton University and Peking University, USA/China)
- Jun-Muk Hwang (Korea Institute for Advanced Study, Korea)
- Vaughan Jones (University of California, Berkeley, USA)
- Zhi-Ming Ma (Chinese Academy of Sciences, China)
- Matilde Marcolli (California Institute of Technology, USA)
- Maryam Mirzakhani (Stanford University, USA)
- Arun Ram (University of Melbourne, Australia)
- Shuji Saito (University of Tokyo, Japan)
- Weiping Zhang (Nankai University, China)

Public Lecturers:

- Ronald Graham (University of California, San Diego, USA)
- Cedric Villani (Université de Lyon and Institut Henri Poincaré, France)

Visit the PRIMA 2013 Congress website:
www.primath.org/prima2013 for more details



Around the Sites

University of British Columbia BUD HOMSY

At the UBC site we've been busy with a number of exciting events in the recent months. These include: the West Coast Optimization Meeting held at UBC-Okanagan; the Hugh C. Morris Distinguished Lecture by George Papanicolaou; the PIMS/UBC Distinguished Colloquium Series featuring Dusa McDuff (Barnard College), Emmanuel Candès (Stanford University), Gregory Margulis (Yale University) and Karl Sigmund (Universität Wien); the 26th Automorphic Forms Workshop – an L-Functions and Number Theory (CRG) event; PIMS Public lectures by both Ken Golden, Stevo Todorcevic and Robert J. Lang; as well as PIMS Distinguished Lecturer, Thomas Scanlon.



AN EXAMPLE OF ROBERT LANG'S ORIGAMI: BULL MOOSE

University of Calgary CLIFTON CUNNINGHAM

The Calgary Site has been very active over the past year, mainly with activities related to the two Collaborative Research Groups with leaders here: L-functions and Number Theory (LNT), and the Mathematics of Quantum Information (MQI). The LNT CRG held a huge conference in Calgary coordinated with four workshops in BIRS while the MQI CRG brought three visitors to Calgary: Netanel Lindner (California Institute of Technology), Fernando G.S.L. Brandão (Universidade Federal de Minas Gerais, Belo Horizonte, Brazil) and Shmuel Friedland (U of Illinois at Chicago). Other activities at the Calgary Site include six talks in the Lunchbox Lecture Series and four Voyageur Colloquia.

University of Washington PETER HOFF

This past fall, the UW, with support from PIMS and Microsoft, hosted the Pacific Northwest Probability Seminar. An exciting feature of this mini-conference was the Birnbaum Lecture, delivered by Steven Evans of UC Berkeley. Other ongoing PIMS-supported activities include the MathAcrossCampus colloquium series – showcasing applications of mathematics, with special emphasis on discrete methods – and the UW-PIMS math colloquium. A memorable highlight of this latter colloquium was Fields Medalist Edward Witten's seminar. Videos of both Professor Witten's and Professor Evans' seminars are available on mathtube.org – PIMS' multimedia resource website.

University of Regina DONALD STANLEY

In the last few months PIMS Regina site has hosted an array of Distinguished Lectures. Marcelo Laca (University of Victoria) spoke to the topic of "Broken Symmetries", Volker Runde (University of Alberta) gave a lecture entitled "Big Things Are Rarely Amenable" and Vern Paulsen (University of Houston) joined us to discuss the "The Kadison-Singer Problem". In April Pascal Lambrechts (Louvain-la-Neuve, Belgium) visited both PIMS Regina and PIMS UBC as a Distinguished Visitor.



PASCAL LAMBRÉCHTS

University of Saskatchewan RAJ SRINIVASAN

At the University of Saskatchewan, we were honoured to welcome Melania Alvarez, PIMS' BC Education Coordinator, who provided a "Bar Model Workshop" to education students from the College of Education, Indian Teacher Education Program and Saskatchewan Urban Native Teacher Education Program, as well as other interested students, teachers, staff and faculty. Melania also presented this well-received workshop at the Saskatoon Tribal Council Professional Community Event which was held at the One Arrow Nation School, Saskatchewan.



MELANIA ALVAREZ

Simon Fraser University NILS BRUIN

At SFU, our PIMS/CSC applied and PIMS/SFU discrete seminars are running regularly and in January, we welcomed PIMS/CSC Distinguished Speaker, Dr. Nigel Goldenfeld (U of Illinois).

This summer brings another installment of Computational Math Day and flurry of activity on the new CRG, Algorithmic Theory of Networks. We will run the month-long PIMS-MITACS Summer School for Undergraduates and are in the middle of the ninth year of our Taste of Pi lecture series for high school students.

The Math Catcher program – which develops resources for math education focused on aboriginal communities – has been approved by the First Nations Schools Association as an out-of-curriculum activity and will be visiting the member schools this spring. In May we'll have the 15th "Changing the Culture" conference on math education and in July we will host the PIMS-CMS Summer Math Camp.

University of Alberta CHARLES DORAN

In addition to ongoing PIMS activities such as the Interdisciplinary Seminar Series on Theoretical and Applied Mechanics, the Public Health Seminar, and the PIMS/Applied Mathematics Institute Seminar Series, the UAlberta PIMS Site is gearing up for a particularly event-filled Spring and Summer 2012. Highlights include the 2nd PIMS-Mprime-CDM Summer School on Mathematical Modeling of Infectious Diseases (May), the Fluid Dynamics Summer School (July), and the 3rd Alberta Summer Mathematics Institute for High School Students (July and August).

In addition, we are happy to report that U of A faculty member, Mark Lewis (the 2011 CRM/Fields/PIMS Prize winner and former Director of the International Graduate Training Centre in Mathematical Biology) received a 2012 Killam Fellowship.

University of Victoria IAN PUTNAM

PIMS UVic welcomed two PIMS Distinguished Speakers this April: Dr. Timothy Johnson of the University of Michigan (Biostatistics); and Dr. Philip Maini of Oxford University (Mathematical Biology). In June we will be sponsoring a one-day event to celebrate the 100th anniversary of the birth of Alan Turing that will feature a number of lectures by UVic faculty on Turing's many contributions to theoretical computing science as well as a screening of the film, "Breaking the Code".

The International Graduate Training Centre program in Mathematical Biology has grown since its inception in 2007, supporting graduate training in the development of new mathematics and applications to problems across the biological sciences. Originally intended as a five-year program, the IGTC has recently secured significant additional funding from Mprime that will allow us to continue our most important activities until 2014. We continue to seek new sources of support for our program and anticipate a strong future in student training and research.

We were pleased to welcome five new student fellows in September 2011: Jia Guo, Bernhard Konrad and Cory Simon (all at UBC) and Michael Akinwumi and Silogini Tharajah (both at Alberta). These students received two-year fellowships and will join other program members and existing fellows at this year's IGTC Summit in Naramata, BC, from October 12th to 14th – organized by Rebecca Tyson (UBC-Okanagan).

The IGTC is supporting two special summer courses this year. The first is "Models in Ecology" at Bamfield Marine Station, from April 30th to May 18th, presented by past IGTC Director, Mark Lewis (Alberta). Simultaneously at PIMS-UBC, Leah Edelstein-Keshet will teach "Mathematical Cell Biology" from May 1st to 31st. This course will also be offered online to students at other PIMS sites and worldwide via mathtube.org.

IGTC faculty and students will also play a big role in next year's pan-Canadian thematic year on "Models and Methods in Ecology, Epidemiology and Public Health", part of Mathematics of Planet Earth 2013. This large-scale program will include conferences and summer schools across the country throughout the year. In particular, PIMS will host a major summer school at Alberta, "The Mathematics Behind Biological Invasions," organized by Mark Lewis.



Multidimensional Symbolic Systems: Growth, Entropy and Computability

BY PIMS POSTDOCTORAL FELLOW, TOM MEYEROVITCH (UBC)

Suppose you are to tile the plane by placing colored square tiles on a grid. Each of the tiles has a color, which we number from 1 to n . You are given some local adjacency constraints on placing colored tiles: There are pairs of colors i and j so that a tile of color i can not be placed directly to the left of a tile of color j , and other pairs l and m so l can not be placed directly below a tile with color m . A tiling is called admissible if it doesn't violate the constraints. The collection of admissible tilings for a given set of constraints is a two-dimensional symbolic system or a subshift of finite type. Models of this type arise as in a wide range of scientific and engineering applications such as statistical mechanics and data encoding. The study of systems of this kind is a part of the mathematical field known as symbolic dynamics.

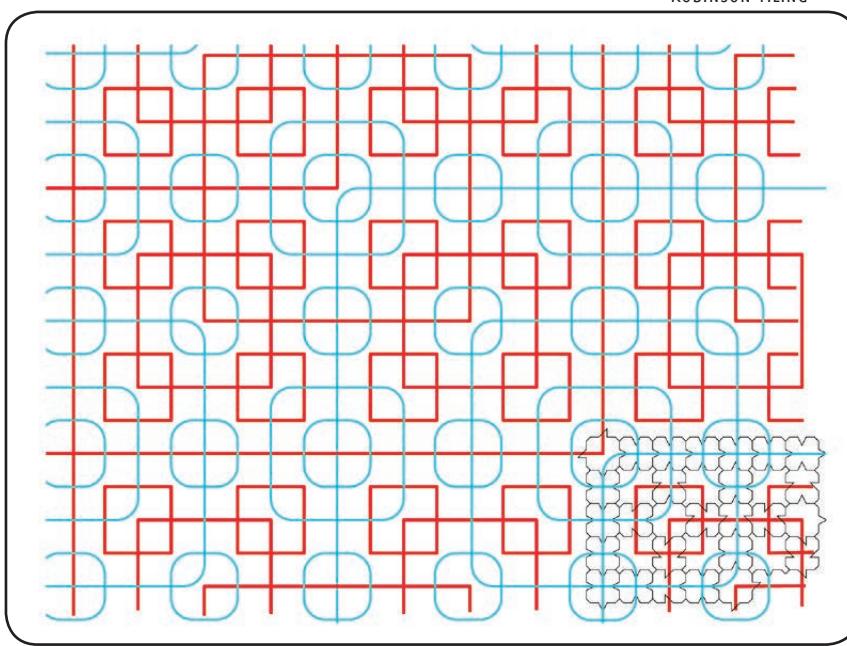
There is much interest, both theoretical and practical, in analyzing the number of admissible tilings of a finite region, and its growth rate as a function of the area of that region. A central notion in symbolic dynamics is the topological entropy of a subshift X : This is the exponential growth rate of the number admissible tilings of a finite region, normalized by the area of the region. Getting closed-form expressions for the entropy of a system has been attempted for many models. There are a few examples for such “exactly solved models”, and these are often remarkable mathematical derivations, as in E. Lieb’s celebrated computation for the entropy of the “square ice” model [Lieb, 1967].

A result of Hochman and Meyerovitch [Hochman & Meyerovitch, 2010] states that any non-negative real number for which there is a computable sequence of numbers approximating it from above is the entropy of some two-dimensional subshift of finite type. The converse is also true, by a result of S. Friedland [Friedland, 1997]: For any subshift of finite type there exists an approximation sequence. It has been demonstrated in [Meyerovitch, 2011] that for some subshifts of finite type the number of admissible tilings of a finite region can grow sub-exponentially in the volume of the region. The normalizing constant which is the exponent of the volume is called the entropy dimension. Any non-negative

number satisfying some explicit recursive-theoretic properties can be obtained as the entropy dimension of a multi-dimensional subshift.

The above results are manifestations of the richness of this class of models, and of connections between multi-dimensional symbolic dynamics and the theory of computability. A remarkable result in this direction was obtained by Hochman [Hochman, 2009]: Under mild technical conditions,

ROBINSON TILING



any computable dynamics can be represented by some multi-dimensional subshift of finite type.

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Math Mania in Sooke

BY DAVID LEEMING

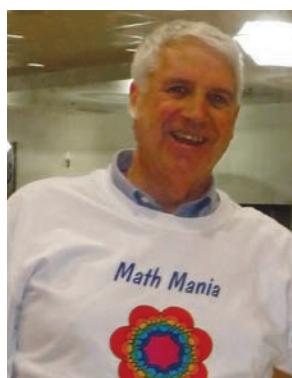
Math Mania went on the road – to Edward Milne Community School (EMCS) in Sooke on the evening of Tuesday, February 13th. The MM event was opened with a prayer and drumming by T'Sou-ke Nation Chief Gordon Planes assisted by an Elder.

An estimated 100+ parents and kids attended the ninety-minute Math Mania, with some travelling from as far away as Port Renfrew. Volunteers, who consisted of the school's senior students and two parents, did an outstanding job; they were enthusiastic and learned their tasks very quickly! Among the activities presented in Sooke were the Sorting Network (tarp), goats and gold, the set game, the penny game, balancing blocks, error correcting code and the aboriginal game of lahal.

The event was jointly sponsored by PIMS and the T'Sou-ke Nation – a first for Math Mania. Melania Alvarez (PIMS-UBC), Heather Walsh, Community School Coordinator for EMCS and Kathleen King-Hunt, District Principal for Aboriginal Education (SD 62), assisted with the organization. Everyone was delighted with the event and the large turnout of parents and students!

David Leeming Retires as Education Coordinator

BY IAN PUTNAM



David Leeming, who has served as the University of Victoria PIMS Education Coordinator for more than ten years, will be stepping down this year.

Embracing the role even before the position was created, in 1997 David took activities developed for school-age children and expanded them to create Math Mania. Over the past fifteen years in the Victoria area, an estimated twenty-six events have hosted over 4000 student and parent participants to discover and enjoy mathematics.

David served as editor of Pi in the Sky between 2004 and 2010 and has been very active in PIMS' programs for aboriginal students. He has regularly participated in First Nations Math Education Workshops at BIRS and has helped in workshops for both students and teachers around BC. Last fall he even took Math Mania on the road to Haahuupayak School in Port Alberni. David received the 2005 PIMS Education Prize in recognition of his many contributions.

As he leaves this position, we acknowledge the tremendous impact of David's educational activities in Victoria and across PIMS and show our appreciation for his tireless energy and determination.

PIMS and Mathematics Education in British Columbia

BY MALGORZATA DUBIEL

PIMS is interested in K-12 mathematical education because it impacts the culture and appreciation of science in our society and moulds students enrolled in postsecondary education.

Research and anecdotal evidence confirm that the majority of children develop (or lose) their interest in math and science by the time they finish grade five. Therefore, to improve math and science literacy and to have more students prepared for math, science and technology careers, we must focus on our elementary, middle and high schools.

The Fields Institute for the Mathematical Sciences has been involved in high school curriculum issues in Ontario since 1997. It is unfortunate that the BC Ministry of Education is not interested in similar cooperation with PIMS.

Consultations with postsecondary institutions have not meaningfully involved mathematicians in discussions about, or design of, curriculum. Mathematicians - possibly through PIMS - need to be involved in curriculum design in a more fundamental way, and for all grades from K to 12.

Many problems with the curriculum arise not from content, but from the way curriculum documents are written. In some instances the language is not mathematically correct. More seriously, it focuses on skills and fails to provide a sense that there are important ideas in mathematics. Poorly written curriculum documents can (and do) lead to serious problems in textbooks. It should be noted that mathematicians have not been involved in writing or reviewing the textbooks.

The only way to correct many of the problems is first, to acknowledge that the problem exists, and second, to include mathematicians as partners in discussions on curriculum, textbooks, and education of teachers.

Summary of the report, PIMS and Mathematics Education in British Columbia, which was submitted to the BC Ministry of Education to address the shortcomings of the K-12 school system. To request the full report contact: reception@pims.math.ca

Dr Malgorzata Dubiel is a senior lecturer in the SFU Department of Mathematics and PIMS education coordinator. She has earned many awards including the 2011 CMS Adrian Pouliot Award, 2011 YMCA Women of Distinction Award in the Education, Training & Development category, the 3M National Teaching Fellowship, the 2005 PIMS Education Prize and the 2003 SFU Excellence in Teaching Award.

The Vancouver Sun interviewed Dubiel for a story on this topic, which can be found at: <http://ow.ly/aDK3m>

Report on the visit of the PIMS Distinguished Lecturer: Thomas Scanlon

BY DRAGOS GHIOCA



Professor Thomas Scanlon visited Vancouver in January 2012 as a PIMS-BC Distinguished Lecturer. Scanlon is a Professor of Mathematics and Chair of the Group in Logic and the Methodology of Science at UC Berkeley. His research is at the conjunction of model theory with various other areas such as: algebraic geometry, differential algebra, number theory, and differential geometry.

Prof. Scanlon gave three talks during his visit: a Colloquium talk in the UBC Math Department and two specialized talks in the PIMS SFU-UBC Number Theory Seminar. He surveyed the most important applications of model theoretic techniques in arithmetic geometry and algebraic dynamics and, in particular, described the new and exciting applications of o -minimality found by Pila in his proof of the André-Oort Conjecture. He also discussed the problems around the Dynamical Mordell-Lang Conjecture, including the description of periodic sub varieties of $(\mathbb{P}^1)^N$ under the coordinatewise-action of N rational functions, which is obtained using the trichotomy theorem for the theory of difference fields.

In his Colloquium talk, Scanlon introduced the basic concepts of mathematical logic (definability, compactness theorem, Gödel's Incompleteness Theorem, etc.) and gave a comprehensive overview of their applications to diophantine geometry. The main topics surveyed by Prof. Scanlon were as follows:

- Matiyasevich's theorem, which shows that there is no algorithm to decide given a polynomial $P \in \mathbb{Z}[x_1, \dots, x_n]$ whether there is an n -tuple of integers $\bar{a} \in \mathbb{Z}^n$ such that $P(\bar{a}) = 0$.**

2. Skolem's method, extended to algebraic dynamics and in particular, the applications of Skolem's p -adic method to the Dynamical Mordell-Lang problem.

3. o -minimal structures. Scanlon discussed a real-analytic approach to the Dynamical Mordell-Lang problem which uses the o -minimality of the theory of restricted analytic functions together with the global real exponential function. He then described the breakthrough results of Pila and Wilkie who used ideas from both diophantine geometry and o -minimal geometry in order to prove that real-analytic sets contain few rational points. Using the Pila-Wilkie theorem, Pila and Zannier reproved the Manin-Mumford conjecture, with Pila later proving unconditionally the André-Oort Conjecture about algebraic relations on the j -invariant of CM-elliptic curves.

4. The trichotomy theorem for difference fields. This powerful result of Chatzidakis and Hrushovski for fields of characteristic zero allowed Medvedev and Scanlon to obtain a complete description of all periodic subvarieties of $(\mathbb{P}^1)^N$ under the coordinatewise-action of N rational functions defined over \mathbb{C} . Their result is important in understanding the *special* subvarieties which appear in the Dynamical Mordell-Lang Conjecture.

In his two talks in the PIMS SFU-UBC Number Theory Seminar, Scanlon presented the latest results on the classical Mordell-Lang Conjecture in characteristic p . The classical Mordell-Lang Conjecture in characteristic zero, now a theorem of Faltings, asserts that if A is an abelian variety over \mathbb{C} , $\Gamma \subset A(\mathbb{C})$ is a finitely generated subgroup, and $X \subseteq A$ is a closed subvariety, then $X(\mathbb{C}) \cap \Gamma$ is a finite union of cosets of subgroups of Γ . If one were to ask instead that A be defined over a field K of positive characteristic, then such a conclusion cannot hold in general as if A were defined over a finite field, $F: A \rightarrow A$ were the associated Frobenius morphism, $X \subseteq A$ were defined over the same finite field, and $P \in X(K) \cap \Gamma$, then

$$\{F^n(P) : n \in \mathbb{N}\} \subseteq X(K) \cap \Gamma.$$

Other anomalous intersections may arise as sums of such orbits. Moosa and Scanlon showed that these are essentially the only counterexamples to a naive translation of the Mordell-Lang conjecture to semiabelian varieties defined over a finite field. In his two lectures, Prof. Scanlon described their proof, and then explained how to deduce characteristic independent bounds from a differential algebraic argument using arc spaces.

The Pivotal Impact of Percolating Brine

Ken Golden's basic area of mathematical research is composite materials – materials made from two or more constituent materials of significantly different physical or chemical properties, combined to form a new material such as human bone, lungs or the carbon fibre structures used in cars and aircraft. But for Golden, the most fascinating example of a composite material is sea ice.

"What's particularly interesting about sea ice" says Golden, "is that small changes in the temperature of the sea ice can induce significant changes in its microstructure and properties. It plays a fundamental role in the earth's climate as a leading indicator of climate change and an active player in the climate system." Golden's research aims to develop the mathematics and physics to understand the processes that can be incorporated into the next generation of global climate models.



KEN GOLDEN CORING SEA ICE SAMPLES

The path to sea ice began for Golden in the summer after 11th grade. He attended an NSF science training program at the Institute for Arctic and Alpine Research near Boulder and studied the distribution of ancient pollen in peat bogs as an indicator of climate changes. On his own, he was also studying how a permanent snow bank melts.

"When I returned home I started studying satellite images of Antarctic sea ice at NASA with my mentor, Jay Zwally." Zwally sparked his interest in sea ice and encouraged him to pursue a math major at Dartmouth. While there, Golden started working at the US Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), trying to develop electromagnetic techniques for measuring the thickness of sea ice – still incredibly relevant due to its implications for gauging global warming's impact.

At university, Golden was falling in love with the interplay between mathematics and physics. And at CRREL, he was studying radar propagation to measure ice thickness, treating sea ice as a composite material and trying to theoretically and numerically calculate its effective electromagnetic properties.

Golden was at a crossroads: mathematics and physics, or sea ice? As he prepared to begin his PhD in Mathematics, he had yet to realize that the two would blend together and that sea ice would become his career's passion.

When he arrived at Courant Institute of Mathematical Sciences, he met Professor George Papanicolaou who was developing advanced mathematical approaches to understanding the effective properties of composite materials. "This led me into some very sophisticated mathematics and physics that were directly applicable to sea ice, but in a completely new way."

"And then, as an assistant professor of mathematics at Princeton, I started delving into percolation theory. The very first time I had encountered this concept in graduate school I immediately thought of the brine inclusions in sea ice. That the brine phase in sea ice exhibits a percolation threshold became one of my biggest discoveries 15 years later, but only after I'd been to the Antarctic and seen it for myself."

This discovery occurred when Golden became part of the Antarctic Zone Flux Experiment (ANZFLUX), to measure sea ice processes and the heat flux through the air-sea-ice interface. The study region was the location of a massive hole in the ice pack, hundreds of miles across, that occurred yearly in the late 1970's, known as the Weddell Polynya. "Instead of a massive hole, we saw a seemingly stable 50 cm thick ice pack that was actually melting rapidly from the bottom. In the middle of a storm, I was out on the ice at the right moment and witnessed the phenomenon I had spent ten years of my life proving theorems about: percolation – where idealized models exhibit a threshold of connectedness and at some critical point there is an infinite connected pathway. In sea ice, under certain conditions the sea water would percolate up and form a slushy mix which would then freeze into sea ice on the surface, thus balancing the bottom melting."



Ken Golden (cont'd)

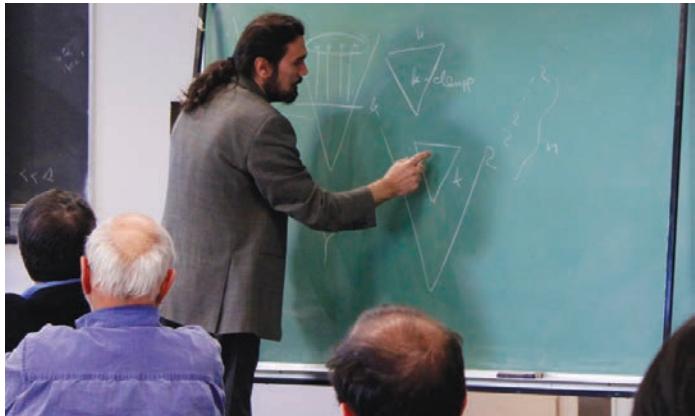
Recognizing this threshold, Golden's next big step was to use this information to theoretically predict fluid flow. "It is that kind of precise information that you need to program into global climate models to be able to improve predictions. The next phase is to try to electromagnetically monitor these processes and the changes in the microstructure."

Kenneth M. Golden is a Professor of Mathematics and Adjunct Professor of Bioengineering at the University of Utah. He has travelled to Antarctica six times and the Arctic seven times to study sea ice and its relationship to the shifting global climate. He has collaborated with numerous institutions and universities and supported a large number of postdoctoral associates, graduate students, and undergraduates to assist with his research.

On March 30, 2012, Ken Golden delivered the PIMS Public Lecture, "Mathematics and the Melting Polar Ice Caps" at the UBC site.

PIMSBits

- **Recent PIMS award recipients:** Mark MacLean (UBC), PIMS Education Prize – sponsored by CGGVeritas/Hampson-Russell; Stevo Todorcevic (U of Toronto), Fields-CRM-PIMS Prize; Theodore Kolokolnikov (Dalhousie), CAIMS/PIMS Early Career Award in Applied Mathematics.

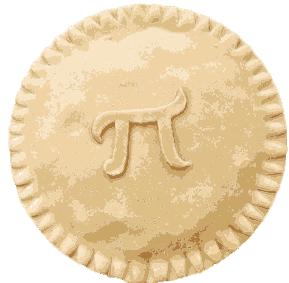


STEVO TODORCEVIC (U OF TORONTO)

- **In August 2012,** PIMS Central will be moving to a new facility on the 4th floor of the brand new Earth Sciences Building at UBC. The new space includes a reception area, offices for administration, up to 24 visitors and postdoctoral fellows and lab workspace for ten graduate students. We look forward to welcoming you to our new site! More details to come in the next edition.

- **PIMS postdoctoral fellow,** David Roe, played on the winning team at the 2012 MIT Mystery Hunt, a huge annual puzzle competition held at MIT.

- **The Vancouver Sun featured** SFU's observation of Pi Day: "On the Burnaby campus, math professor Nils Bruin will today deliver the annual Pi Day lecture entitled 'The Other Pi' on a separate but related mathematical concept related to circles also denoted by the Greek letter pi. Just to keep things fresh... The lecture will be followed by a selection of berry pies."



- **We are pleased to report** that Professor Henri Darmon (McGill) has agreed to deliver the 2nd Hugh Morris Lecture at the University of Calgary on Thursday, November 1, 2012.

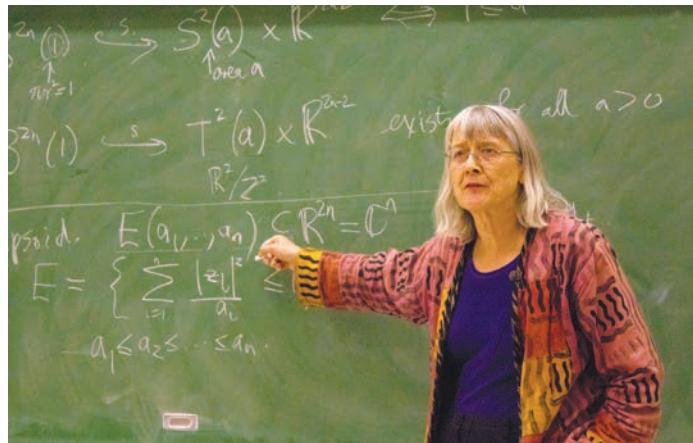
- **The 2012 PIMS Marsden Memorial Lecturer** has been announced. Richard Montgomery, University of California, Santa Cruz will deliver a talk entitled, "An Octahedral Gem Hidden in Newton's Three Body Problem." The lecture will take place on July 25 at the Fields Institute (time and location TBA).



NEW PIMS-UBC SITE UNDER CONSTRUCTION

The Pursuit of Success

Professor Dusa McDuff has always loved mathematics. Her first memories of the discipline are of her grandfather explaining the multiplication tables to her when she was four years old, "He showed me the times tables up to 10x10, with its various symmetries" she says. "I loved doing sums; it was just something that I could always understand."



She recalls a schoolteacher who was instrumental in helping develop her interest. "She really understood mathematics. When she first introduced us to calculus, she would explain things, break it all down and prove things right in front of us."

McDuff sees community as being essential to the field. "Mathematics is done by the community, and while there are always people who prefer to work on their own, at some level you always need to be associated to the community in some way."

Likewise, creativity is also key. "It's one of the critical components" she says. "People have very different kinds of imaginations and contribute in very different ways."

She admits that being a female mathematician has sometimes been hard. "I felt pretty isolated. In Britain I was always the first woman in the department." When she moved to America the isolation continued, because she didn't understand the country and culture. However, she was raised to believe that women could pursue careers, and in that sense sees herself as way ahead of most women of her generation. Her mother was an architect and set the standard for McDuff's pursuit of success.

"There used to be a lot of prejudice and stigmatization against women, many people thought women weren't clever enough to do mathematics. Even I was pretty prejudiced against women when I was younger" she says. "It's easier for [women] now, there are even special events for women in math. I think a lot of women are nervous about them, but we see women who are similar or very different to us and they are all people doing mathematics who we can relate to on some level."

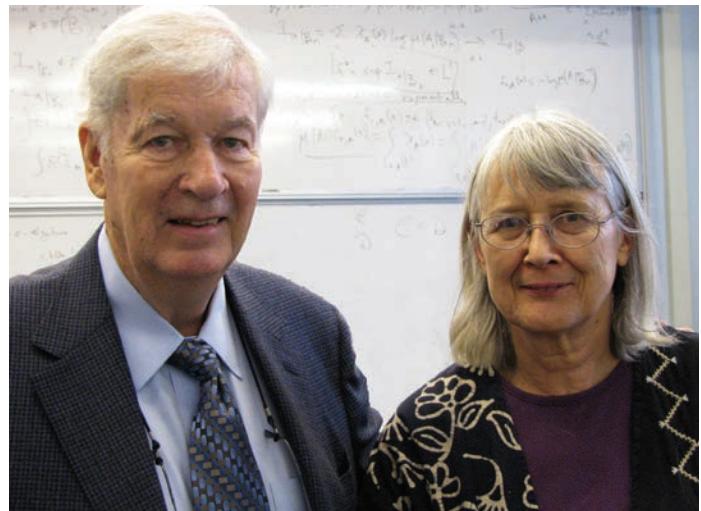
Looking back on her career, she recalls several turning points.

"One was going to Moscow. I was accompanying my husband who was completing a PhD in Russian Literature, and my advisor luckily advised me to get a scholarship so I could study there too. I studied with Gelfand; which was really eye-opening and prompted me to completely switch subjects." And the other, she continues, was due to Gelfand's influence, "I was invited to MIT as a visiting assistant professor a few years later; going to MIT really opened my eyes."

McDuff is often an invited speaker and lecturer, and thoroughly enjoys her visits to locations such as Vancouver and PIMS-UBC. "I enjoy giving talks and meeting new people and getting their perspectives. The last trip I took, someone asked a question which really got me thinking and helped move along an idea I had. You can get bogged down sometimes and talking to people can really move you out of that."

Dusa McDuff was a visitor as part of the PIMS/UBC Distinguished Colloquium series. Her lecture entitled "Embedding questions in symplectic geometry" can be seen on mathtube.org.

She holds the Helen Lyttle Kimmel Chair at Barnard College (Columbia University) and is a Fellow of the Royal Society, a Noether Lecturer and a member of the United States National Academy of Sciences. In 2010, she was awarded the Senior Berwick Prize of the London Mathematical Society.



DUSA McDUFF AND HUGH MORRIS, FORMER CHAIR OF THE PIMS BOARD OF DIRECTORS.



Summer Event Highlights

Scientific Events

May 3-4, 2012 - Alberta Colleges Mathematics Conference and North South Dialogue in Mathematics (U of Alberta)

May 4-5, 2012 - Prairie Discrete Math Workshop (U of Calgary)

May 5-6, 2012 - Pacific Northwest Geometry Seminar (UBC)

May 14-16, 2012 - International Symposium on Multiple-Valued Logic (UVic)

May 17-27, 2012- PIMS-Mprime-CDM Summer School on Mathematical Modeling of Infectious Diseases (U of Alberta)

May 24, 2012 - Niven Lecture: On growth and form: geometry, physics and biology.
Speaker: Lakshminarayanan Mahadevan (UBC)

May 28, 2012 - PIMS Voyageur Colloquium: Henry Wolkowicz (U of Calgary)

May 29 - June 1, 2012 - Connections between Algebra and Geometry (U of Regina)

May 31 - June 1, 2012 - Workshop on Representation Theory of Groups, Lie Algebras, and Hopf Algebras (U of Regina)

June 4-29, 2012 - PIMS-Mprime Summer School in Probability 2012 (UBC)

June 7-9, 2012 - Theory Canada 7 (U of Lethbridge)

June 11-12, 2012 - Stability Workshop (U of Washington)

June 17-22, 2012 - Canadian Number Theory Association XII Meeting (CNTA XII) (U of Lethbridge)

June 22, 2012 - Celebration of the 100th Birthday of Alan Turing (UVic)

June 25 - July 6, 2012 - Séminaire de Mathématiques Supérieures: Probabilistic Combinatorics (U de Montréal)

June 25-28, 2012 - 9th PIMS Young Researchers Conference (U of Calgary)

July 2-13, 2012 - AMSI/ANU/UQ Australian Winter School (U of Queensland, Australia)

July 2-27, 2012 - Mitacs/PIMS/SFU Summer School for Undergraduates in Algebraic Graph Theory (SFU)

July 11-15, 2012 - Canadian Undergraduate Mathematics Conference 2012 (UBC- Okanagan)

July 16-21, 2012 - West Coast Algebraic Topology Summer School (Stanford U)

July 23-27, 2012 - Fluid Dynamics Summer School (U of Alberta)

July 25, 2012 - PIMS Marsden Memorial Lecture: An Octahedral Gem Hidden in Newton's Three Body Problem. Speaker: Richard Montgomery (Fields Institute)

July 27 - August 5, 2012 - Summer School and Conference in Cohomology and Support in Representation Theory and Related Topics (U of Washington)

August 8-10, 2012 - 24th Canadian Conference on Computational Geometry (CCCG) (Charlottetown, Prince Edward Island)

August 8-10, 2012 - W-CLAM: Western Canada Linear Algebra Meeting (U of Lethbridge)

September 19-21, 2012 - PIMS Hot Topics Workshop on Computational Criminology (SFU)

Education Events

May 5, 2012 - ELMACON (UBC)

May 18, 2012 - Changing the Culture 2012 (SFU)