NEWSLETTER

University of Manitoba Joins PIMS

The University of Manitoba joined PIMS as a full member in May of 2015. With its incorporation the PIMS consortium now has ten full members, including all the major research universities in Alberta, British Columbia, Manitoba, Saskatchewan and Washington State. This new partnership will expand PIMS' reach across western Canada and provide new opportunities for researchers in Manitoba to participate in PIMS activities.

"PIMS is excited to be welcoming Manitoba to the PIMS consortium; they have valuable strengths in a number of areas in the mathematical sciences – combinatorics is a good example. Through our collaborative research groups (CRGs), summer schools, postdoctoral opportunities, broadcast seminars and educational activities, Manitoba faculty and students will be important contributors to PIMS activities," remarked PIMS Interim Director, Martin Barlow.

Dr. Stefi Baum, Dean of Science and Professor of Physics and Astronomy at the University of Manitoba said, "The University of Manitoba is delighted to be joining the PIMS network. This is an important step in our program of enhancing research, education and outreach in the mathematical, statistical and computational sciences. The extension of PIMS to the province of Manitoba will bring dedicated and active scientists and educators under the PIMS umbrella to share their expertise, accomplishments and insight with the other members of the consortium. We look forward to a fruitful partnership between PIMS and the University of Manitoba."

What's Inside

Director's Message

We are delighted to welcome the University of Manitoba as the newest member of PIMS. Earlier this month I visited Winnipeg and met with senior administrators and faculty members, as well as five new assistant professors in the mathematics department. It was encouraging to see the enthusiasm at UManitoba for their PIMS connection, and how they are gearing up to participate in PIMS' research networking, education and innovation programs.

I also visited URegina and was very pleased to hear of a PIMS success story from their Associate Dean of Research, Dr. Cory Butz; he told me how he first met a long-term collaborator through a PIMS-funded seminar series on Algorithms in Bayesian Networks.

Our new Deputy Director, James Colliander, began officially on July 1, and I wish to welcome him to the PIMS team.

As mentioned in the previous issue, Michael Lamoureux started as Innovation Coordinator this past January. He has since helped to ensure a successful summer for our innovation program. PIMS organised two conferences: the Industrial problem Solving Workshop at USaskatchewan in June and the Mathematical Modeling in Industry (MMI) workshop in August, which was run jointly with the IMA in Minneapolis. Before I joined PIMS I paid little attention to these programs. I thought that my students and postdocs were working in areas of mathematics far from the needs of industry and that they would have little to contribute to these events. However, as you can see from the description on page 6, the problems come in many areas of mathematics and one does not have to be a specialised applied mathematician to participate. In today's economy many of our HQP will go on to work outside the academic world, and these workshops can provide them with a valuable introduction to the way industrial mathematicians think and work. The benefits can be direct and immediate: one of UBC's postdocs has already found a position via the contacts made through the MMI.

With best wishes,

Martin Barlow
Interim Director, PIMS

Pacific Institute *for the* Mathematical Sciences

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Connections in Discrete Mathematics | A conference to celebrate the life and work of Ron Graham
June 15-19, Simon Fraser University

This conference was held on the Burnaby campus of SFU and attracted an impressive 200 participants. It was, in part, to celebrate the mathematical work of Ron Graham (who turned 80 in 2015) and brought together many of his friends and collaborators, as well as a large number of young mathematicians, providing them with the opportunity to connect with leaders in the discrete mathematics field. The variety of mathematicians ranged from undergraduate students to emeritus professors, and the mathematics presented included a broad array of topics in discrete mathematics such as Ramsey theory, number theory, combinatorial game theory and combinatorial matrix theory.

The conference had the premiere presentation of "Something new every day" a short documentary about Ron Graham, by George Csicesry. Additionally, there were many wonderful plenary, invited and contributed talks, which included Persi Diaconis on loop switching, Carl Pomerance on number theory, Joel Spencer on Ramsey theory, Peter Frankl on vector spaces, Jeffrey Lagarias on the $3x+1$ problem and Erik Demaine on mathematical fonts (which included a performance of nine jugglers at the conference). On the final evening of the conference there was a special banquet during which Donald Knuth delivered some "orthogonal remarks."

The conference was organized by Steve Butler (Iowa State University), Josh Cooper (University South Carolina), Glenn Hurlbert (Virginia Commonwealth University), Veselin Jungic (SFU/IRMACS), Jozsef Solymosi (UBC), Jacques Verstraete (University of California, San Diego), and Pam Borghardt (IRMACS). The IRMACS Centre played a tremendous role in the conference in helping with the local organization and many additional funding agencies, including PIMS, helped contribute funds to the conference that went largely to participant support.

Cover page continued...

Faculty and researchers at UManitoba have an established track record in various key areas of mathematical sciences. The principal areas of research in the Departments of Mathematics and Statistics are algebra and algebraic geometry, analysis, approximation theory, combinatorics, logic and set theory, geometry and topology, mathematical biology, numerical and computational mathematics, as well as theoretical and applied probability and statistics. Areas of research in mathematical sciences in the Department of Computer Science include computational geometry, geometric optimization, computational complexity, combinatorial designs, combinatorial optimization, graph algorithms and data visualization. The departments are also committed to enhancing the quality of education in mathematical sciences that K-12, post-secondary and graduate students in Manitoba are receiving, and are offering numerous educational programs that aim to enhance student experience and inspire learning.

Kirill Kopotun
PIMS' UofM Site Director

Dr. Baum will represent the university on the PIMS Board of Directors, Dr. Kirill Kopotun has been appointed as the PIMS Site Director beginning July 1, 2015 and Darja Kalajdzievska has been appointed as the site's Education Coordinator.

Around the Sites

University of British Columbia James Colliander

As the academic year starts back up, so do the numerous PIMS-sponsored seminar series at UBC, including those in math biology, topology and probability. Over the summer session, the site hosted a number of events, including *Building a Bioanalytical Theory for Analysis of Marine Mammal Movements*, *Big Data in Environmental Science*, the *2015 Niven Lecture,* with speaker Ingrid Daubechies (Duke University), on "Surfing With Wavelets," the *Western International Workshop on Harmonic Analysis and PDE*, the *PIMS Symposium on the Geometry and Topology of Manifolds* and a *Summer School for In-Service Teachers*.
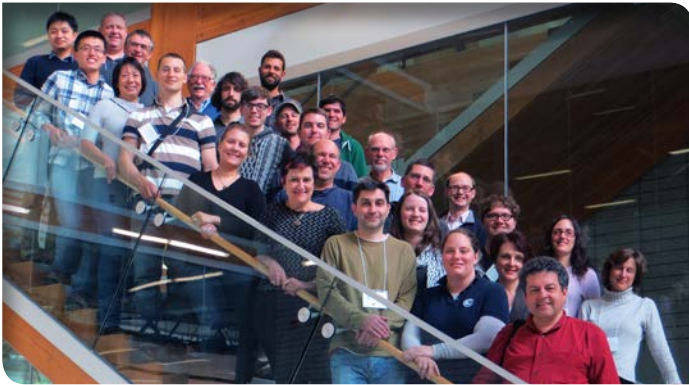
Building a Bioanalytical Theory for Analysis of Marine Mammal Movements

University of Regina Donald Stanley

The *PIMS Distinguished Lecture Series* continued at URegina with a lecture in August by Alexandru Suciu, (Northeastern University) on "Hyperplane arrangements: at the crossroads of Topology and Combinatorics." Also in August, the CRG in Applied Algebraic and Geometric Topology organized the *Combinatorial Constructions in Topology* workshop.

Hugh Thomas, Combinatorial Constructions in Topology workshop speaker

University of Calgary Clifton Cunningham

UCalgary continued to be busy throughout the spring and summer with a number of events including *Spectral Graph Theory* in March, the *Elementary Math Contest* in April, the *12th Annual Young Researchers Conference* and *Theory Canada 10* in May, the *CMS Regional Math Camp* in July, and the *ICSA-Canada Chapter 2015 Symposium* in August. A new CRG, Explicit Methods for Abelian Varieties, launched with a successful week-long workshop in May and welcomed a visitor, Emmanuel Thomé (University of Lorraine), in July. The CRG, Optimization: Theory, Algorithms and Applications, wrapped up on a high note with a distinguished visitor, Vali Alexandru Asimit (City University London), and wind-up workshop in May. UCalgary was very fortunate to welcome Ronald Graham (Chief Scientist at the California Institute for Telecommunications and Information Technology and the Irwin and Joan Jacobs Professor in Computer Science and Engineering at UCSD), as the speaker for the *10th Annual Richard and Louise Guy Lecture Series*. His lecture, "Juggling Mathematics and Magic", is available on *mathtube. org*. The popular *PIMS Lunchbox Lecture Series* continues this fall with its first lecture in October, "Valuing and Operating Infrastructure: A quantitative approach using a real options lens," by Matthew Davison (University of Western Ontario).

University of Victoria Anthony Quas

At UVic, in August, we hosted a PIMS summer school and workshop on *Applied Topology and High-Dimensional Data Analysis* (part of the PIMS CRG on Applied, Algebraic and Geometric Topology), with support from NSF for US-based participants. Additional events included the *3rd BC Combinatorics Day* and the *Cascade Topology Seminar* in April. Claire Mathieu (École Normale Supérieure) visited Valerie King in Computer Science as a PIMS Distinguished Visitor.

University of Saskatchewan Raj Srinivasan

In addition to three summer conferences and workshops we ran – *The Industrial Problem Solving Workshop*, *Canadian Discrete and Algorithmic Mathematics* and the *PIMS-USASK Graduate Summer School in Applied Combinatorics* – Stavros Stavrou, the Math Outreach Coordinator for the Department of Mathematics and Statistics at USaskatchewan, was selected to give a talk about the math outreach program at the *TEDxSaskatoon* event on October 24, 2015.

University of Washington Christoper Hoffman

This spring, UWashington witnessed many exciting lectures in colloquia sponsored by PIMS. Some of the highlights include the *UW/PIMS Mathematics Department Colloquium* featuring Catherine Williams (Chief Data Scientist at AppNexus). She spoke on "The Mathematical Monetization of the Internet: How Theory + Data Ads Up." The *CORE Seminar Series in Optimization* hosted several lectures including "Learning about Shape" by Andrew Fitzgibbon (Microsoft Research).

University of Lethbridge Amir Akbary

In April, we had two lectures as part of *PIMS Distinguished Speakers Series* delivered by Heydar Radjavi (University of Waterloo) and Kumar Murty (University of Toronto). *The Alberta Mathematics Dialogue*, May 8 to 9, was the main spring event at ULethbridge. This conference hosted a number theory session (six lectures) and a session in statistics (three lectures) focusing on recent developments in robustness of designs. On the education front there was a session on undergraduate teaching and outreach and two discussion sessions: one on calculus sequence in Alberta and the other on exploring the Alberta K-12 mathematics curriculum. The conference also included a public lecture by Ram Murty (Queen's University) entitled "Measurement, Mathematics and Information Technology."


Richard Guy, Alberta Mathematics Dialogue Speaker

Our weekly *PIMS Lethbridge Number Theory and Combinatorics Seminar* continued; speakers included: Tristan Freiberg (University of Missouri); Ram Murty (Queen's University); Adam Felix (KTH Royal Institute of Technology); Darcy Best (Monash University); Anders Södergren (University of Copenhagen) and Daniel Fiorilli (University of Ottawa). In August we welcomed Alia Hamieh, our new PIMS postdoctoral fellow. Alia's research explores special values of *L*-functions from both analytic and algebraic point of views.

University of Alberta Vakhtang Putkaradze

Distinguished Visitors: we continued our *Distinguished Lecture Series* with visitor Cliff Frolich (Associate Director of the Institute of Geosciences at the University of Texas at Austin). A lecture and a public panel discussion on the possibility of human-induced earthquakes resulting from hydraulic fracturing were held on September 10, with an audience of approximately 300 members, followed by lively discussion and feedback.
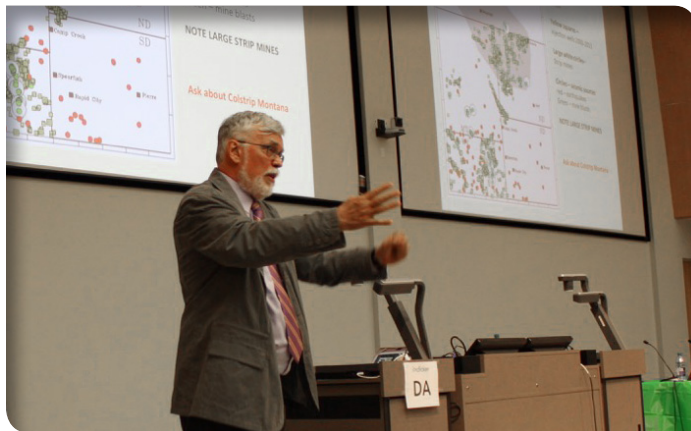
Cliff Frolich

Research highlights: several focused workshops occurred, including the *MSI-PIMS Workshop on Conformal Field Theory and Related Topics* at the Australian University in Canberra in July, as well as the *Lie Theory Workshop* at UAlberta in May and the kick-off meeting for the PIMS CRG in Applied Partial Differential Equations ran in Banff, Alberta, in August.

Outreach highlights: the *Alberta Summer Math Institute (ASMI)* ran from July 6 to 31, and brought together local and international students from Edmonton, rural Alberta and even Taiwan. Ryan Morrill (a UAlberta graduate student) ran another term of the *JAMES (Junior Alberta Mathematics for Eager Students)* mathematics circle. Two of the circle's attendees were chosen to represent Alberta at the *CIMC (China International Mathematics Competition)* in Changchun, China. The team ranked third in the team competition; one member, Richard Kang (of Calgary), earned a silver medal in the individual competition. Vincent Bouchard was involved in the organization of the annual two-week math summer camp at the Maskwacis Cree reserve, which enabled approximately fifty grades 5-8 students from the Ermineskin Cree Nation to focus on improving and expanding math skills.

Industrial Problem Solving Workshop

This workshop was held at the University of Saskatchewan in June. With 35 academic and industry participants, five teams worked on mathematical and statistical challenges presented in real industrial problems, ranging from optimal operations of a potash mining network to monitoring advertisement effectiveness to the design of quantum computer gates.

Many thanks to the local faculty and staff at the University of Saskatoon, the students and professors from across the country who participated and especially, to our application partners from Potash Corp, Insightrix, Ag Exchange, Fotech Solutions and the Institute for Quantum Science and Technology!

Mathematical Modeling in Industry XIX | A Workshop for Graduate Students

The IMA/PIMS Graduate Math Modeling in Industry workshop focuses on the training of graduate students by working on real industrial problems with mentors from industry. This year's event in Minneapolis brought together seven mentors and more than 40 students from across North America to work on problems in optical scanning of precision electronic assemblies, seismic imaging, design and modeling of power tools, among others. Industrial mentors included researchers from CGG, Corning, CyberOptics, Hilti Corp, IBM, Target Corp and 1Qbit Technologies. After ten days on the projects, each team presented a report on their progress; final reports are being submitted for publication.
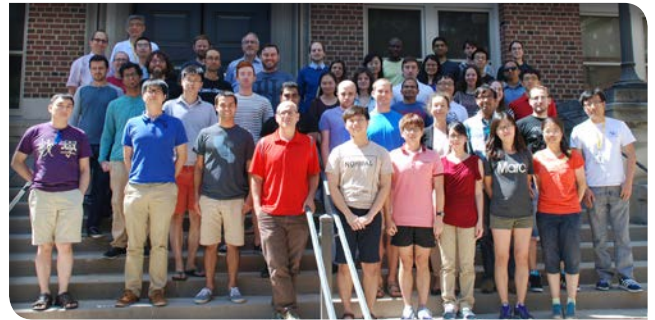
Students worked in teams of six or seven under the guidance of an industry mentor who helped them model, analyze, and perform computational work associated with a real-world industrial problem. The 2015 teams and their cooresponding industry mentors are listed below.

Team 1: *Approximate Mapping of Temperatures from Coarser to Finer Grid using Temporal Derivatives* (Corning Incorporated)

Team 2: *Is This a Compressed Sensing Application?* (CyberOptics)

Team 3: *Simulation-driven Design in the Development of High-performance Tools* (Hilti Corporation)

Team 4: *Fast and Somewhat Accurate Algorithms* (IBM)

Team 5: *Deep Learning for Image Anomaly Detection* (Target Corporation)

Team 6: *Deducing Rock Properties from Spectral Seismic Data* (CCG)

Team 7: *Sparse Recovery Using Quantum Annealing* (1QB Information Technologies)

- PIMS' founder, **Nassif Ghoussoub, received an honorary degree** from the University of Victoria at their convocation ceremonies on June 12, 2015. Ghoussoub is a world-leading mathematician who has played a critical role in building Canadian networks for the support of education and research in the mathematical sciences.

- In 2015, PIMS introduced a new position at our Central Office at UBC. Michael Lamoureux, our new Innovation Coordinator, invites you to **submit your proposals for innovation activities**. Visit *www.pims.math.ca/news/pia* for more information.

- Nominations are being accepted for outstanding young researchers in the mathematical sciences for **Postdoctoral Fellowships for the year 2016-2017**. Candidates must be nominated by a scientist or department affiliated with PIMS. The fellowships are intended to supplement support provided by the sponsor, and are tenable at any of the PIMS Canadian member universities. Complete applications must be submitted by December 1, 2015. More info at *www.pims.math.ca/news/pdf16-17*.

- PIMS and the Centre National de la Recherche Scientifique (CNRS) are calling for applications from French researchers to spend the 2016-17 academic year at one of PIMS' member universities and to participate in PIMS' research activities. The applicants should be "fonctionnaires titulaires" either at the CNRS or at a French university, and priority will be given to junior researchers: "chargés de recherche" or "maîtres de conférences." Application deadline is December 18, 2015. More info at *www.pims.math.ca/news/pims-cnrs16-17*.

- PIMS announces the new **UBC Mathematics and Pacific Institute for the Mathematical Sciences Faculty Award**. This prize was created by two founding donors, Anton Kuipers and Darrell Duffie, to recognize young UBC researchers for their leading edge work in mathematics or its applications in the sciences. Sadly, Kuipers passed away earlier this year. He was a member of the UBC Faculty of Science Development and Alumni Engagement team and an enthusiastic supporter of the PIMS mission. More information on the award may be found at *www.pims.math.ca/news/msfa*.

Around the Sites continued...

Simon Fraser University Nils Bruin

This summer at SFU was a busy one. The highest profile event was the large *Connections in Discrete Mathematics* conference, with the world leaders of the field in attendance. In addition we had the CANSSI sponsored workshop, *Statistical Inference for Large Scale Data*, the *Symposium on Math and Computation* and distinguished visitor Samir Siksek giving a colloquium lecture. We also hosted the *PIMS-SFU Undergraduate Summer School on Rigorous Computing*.

On the educational front we hosted the *SFU Academic Summer Camp for Aboriginal Students* (featured on page 10), as well as the annual *Changing the Culture* conference for mathematics educators in BC, at which PIMS distinguished visitor Chris Budd contributed a plenary lecture. In September, we hosted a conference on *The Mathematics of Sea Ice* at our Downtown Campus.

Working in teams at Changing the Culture

Conference on the Mathematics of Sea Ice

This conference was held at the Harbour Centre Campus of SFU from September 24 to 26. It brought together many of the world's leading sea ice theorists, as well as interdisciplinary students, postdocs and early-career investigators, to focus on the mathematical aspects of research on sea ice and its role in Earth's climate system.

A broad range of powerful methods and tools spanning many different areas of mathematics and theoretical physics can be applied to sea ice. These mathematical techniques can help improve our understanding of sea ice structures and processes, advance how sea ice is represented in global climate models, and ultimately improve projections of climate change and the fate of Earth's ice packs.

The major goals of this conference were to explore how these many areas of mathematics can, and are, being applied to sea ice, and to spur new advances through the sharing of different ideas, approaches and perspectives. This was accomplished by bringing together researchers – all with an interest in sea ice – from different mathematical and scientific backgrounds, including partial differential equations, numerical analysis, large scale models, dynamical systems and bifurcation theory, fractal geometry, diffusion processes and statistical physics.


Over an intensive three-day schedule a wide variety of relevant subjects were explored, ranging from small scale processes and the fundamental physics of sea ice to large scale processes and the role of sea ice in global climate. Lunchtime and evening discussions on new research ideas were common amongst the attendees. A mix of well-established and early-career speakers ensured that a vibrant array of new ideas and perspectives were shared, fostering new professional relationships and developments in the field. By the end of the conference, perspectives were broadened, interesting new questions emerged and a new community in the mathematics of sea ice was solidified.

Applied Combinatorics | A Summer School for Graduate Students

The PIMS CRG in Applied Combinatorics ran this school from May 18 to 29 at the USaskatchewan. The timing took advantage of the CanaDAM meeting, one of the major combinatorics meetings in Canada, which was held the following week on the same campus.

In the first week of the summer school Éric Fusy (École Polytechnique and former PIMS postdoctoral fellow) gave a series of lectures on random generation of combinatorial structures and organizer Andrew Rechnitzer (UBC) lectured on rare event sampling algorithms.
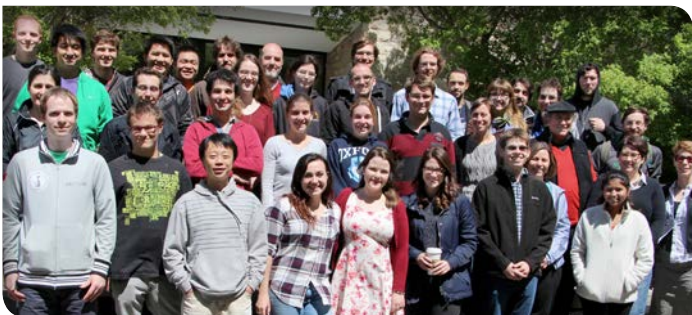
In the second week, Erik Panzer (Institut des Hautes Études Scientifiques) gave a series of lectures on combinatorial

Hopf algebras in particle physics and Christine Heitsch (Georgia Technical Institute) gave a series of lectures on the combinatorics of RNA secondary structure.

Both weeks devoted substantial time to working problems. The students were engaged in the work and came away with both practical and theoretical skills to match their new knowledge on these topics. Participants also learned to program using SageMath – an open-source mathematical software system.

The participating students had a variety of backgrounds and came from across Canada, the United States and Europe. There were 23 out of town graduate students and three out of town undergraduate students, along with local students. The ambiance was notably supportive. Students shared details of their own research and also worked in groups to solve problems and prepare presentations. Those who stayed for CanaDAM made an organized effort to attend each other's talks.

Following the summer school, four participants have planned or conducted research visits to Vancouver to visit CRG members. Two others are continuing to work with the Saskatoon group.

PIMS Symposium on the Geometry and Topology of Manifolds

From June 29 to July 9 at UBC, 127 mathematicians (including 64 graduate students and postdocs) from around the world came together to exchange ideas related to manifolds and their geometry. The attendees included diverse groups who have overlapping interests, but do not usually meet together, including specialists in high- and low-dimensional manifolds, geometric group theory and differential geometry.

Highlights included the recent striking results on the spectacular applications of curvature flows that were explained by Gang Tian, and Marco Gualtieri's presentation of a new approach to the generalized complex structures on manifolds. The interplay with symplectic geometry was featured in the lecture of Gil Cavalcanti, Daniel Ruberman reported on joint work with Tom Mrowka, and Nikolai Saveliev extending the Atiyah-Patodi-Singer eta-invariant on manifolds with periodic ends.

The latest developments in geometric group theory were identified, with Ruth Charney presenting new boundary theory for $CAT(0)$ spaces and Mike Davis describing striking estimates for the action dimension of a right-angled Artin group. Martin Bridson gave a broad overview of decision problems and the connections between curvature, topology and algorithms.

In high-dimensional manifolds, Oscar Randal-Williams reported on joint work with Boris Botvinnik and Johannes Ebert on the topology of moduli spaces of positive scalar curvature metrics, followed by joint work with Soren Galatius on the cohomology of the spaces of manifolds in a fixed even dimension. Galatius also gave lectures, on several homological stability results and their applications to describing topology of classifying spaces $B\mathrm{Diff}(M)$ for even-dimensional manifolds.

Soren Galatius

Several lectures linked latest developments in topology and geometry. Benson Farb explained a remarkable bridge – built by Weil, Grothendieck, Deligne and others – between topology and number theory, and Tom Farrell gave two beautiful lectures: one on spaces of constrained Riemannian metrics and their associated Teichmueller spaces and the other on bundles of negatively-curved manifolds. Wolfang Lück highlighted new developments in studying L^2-acyclic manifolds with torsion free fundamental group and the latest results on the Farrell-Jones Conjecture.

The symposium was generously supported by PIMS, UBC, the Canadian Natural Sciences and Engineering Research Council, the US National Science Foundation and the PIMS CRG in Applied, Algebraic and Geometric Topology.

PIMS Marsden Memorial Lecture | Yann Brenier

On June 10 at the École Polytechnique Fédérale de Lausanne, Switzerland, Yann Brenier delivered the 5th annual Marsden Memorial Lecture.

In the words of Professor Darryl Holm (Imperial College London), "Yann Brenier gave one of the best lectures I have ever heard!" The lecture, entitled "From Euler to Born and Infeld, Fluids and Electromagnetism," was given to a packed lecture hall.

The lecture was delivered as part of the Centre Interfacultaire Bernoulli Workshop on Classic and Stochastic Geometric Mechanics (June 8 to 12, 2015).

The Marsden Memorial Lecture Series is dedicated to the memory of Jerrold E Marsden (1942-2010), a world-renowned Canadian applied mathematician.

Yann Brenier

PIMS Education Associates in BC | By David Leeming, PIMS UVic Education Coordinator

There are ten PIMS Education Associate campuses in British Columbia: Camosun College; Capilano University; College of the Rockies; Douglas College; Langara College; Okanagan College; Selkirk College; Thompson Rivers University; University of the Fraser Valley and Vancouver Island University. Since PIMS provides some financial and other support for their outreach activities, I was curious to learn about their range and extent. Here's what I found out!

Seven of the associates participated in the BC Secondary School Mathematics Contest (BCSSMC). There are two rounds held at each of two levels: grades 8-10 and grades 11-12. The Preliminary Round is held within the students' own schools. About 1300 juniors and 750 seniors participated. The Final Round is held with the top performers (and a teacher) spending a day at a regional college or university.

Camosun and Okanagan Colleges hosted the BC Math Challengers event in February; this is a half-day competition with both written and face-off elements to it. Math Challengers is sponsored by the provincial engineers association, APEGBC.

Douglas College, University of the Fraser Valley and Thompson Rivers University presented Math Mania events at local elementary schools.

Other outreach included celebration of Pi Day (March 14), math fair-type events (Capilano University and Langara College) as well as numerous classroom visits by most associates.

So, math outreach by our BC PIMS Associates is extensive and varied. We should be proud of their efforts to make math fun and interesting for so many school children in British Columbia. Well done, associates!

SFU Academic Summer Camp for Aboriginal Students | By Veselin Jungic, SFU

The 2015 SFU Academic Summer Camp for Aboriginal Students took place at SFU's Burnaby Campus from July 2 to 31. The camp was organized and supported by PIMS, the SFU Faculty of Science, the SFU Office for Aboriginal Peoples, the IRMACS Centre and the SFU Department of Mathematics. The NSERC PromoScience Program provided partial financial support for the camp.

The main goals of the camp included:

- increasing Aboriginal student participation, retention and high school graduation rates by providing a more solid foundation in mathematics, science and English in preparation for admission and success in post-secondary institutions and

- helping Aboriginal students realize that Universities are a place for them and to feel empowered while they are here.

The camp was extremely successful in many respects, as was evident through the responses of students, teachers, organizers and parents at the graduation ceremony on July 31 at the IRMACS Centre. A strong sense of community formed in the month-long school and a reciprocal appreciation was shown by all for the efforts put into making the camp a success. Twenty-six high school students from Burnaby, Coquitlam, Maple Ridge, Pitt Meadows, Port Coquitlam, Port Hardy, Richmond, Surrey and Vancouver attended the camp. We proudly report that all of them completed the program.

STUDENT PRESENTATION AT GRADUATION CEREMONY, JULY 31, 2015

In the words of one participant:

"My summer at SFU was one of my best summers. It felt cool attending a University. At first I felt so out of place like an 8th Grader going into high school for the first time. After about day four it felt like I attended SFU, like a Freshman studying sciences I can't pronounce. SFU is such a welcoming environment, everyone has a mutual respect for each other and a kind positive attitude toward others and the program. I have made many friends and I thank the program for bring us kids together. I would recommend the program and have encouraged a Metis friend to join next summer."

More information about the camp is available at *www. mathcatcher.irmacs.sfu.ca/math-camps/2015*.

Summer School for In-Service Teachers | By Melania Alvarez, PIMS BC Education Coordinator

The UBC Mathematics Department, together with PIMS, organizes multiple outreach events and activities (workshops, contests, summer camps, public lectures, etc.) each year to enhance mathematical opportunities throughout British Columbia. As mathematical scientists we are very aware of the challenges faced by teachers and students in the dissemination and acquisition of mathematical knowledge.

Developing the Summer School

The reality is that many teachers, especially in elementary schools, do not have the necessary math knowledge or experience to feel comfortable teaching mathematics. Therefore, it is important to provide further teacher training.

To this end, we developed a summer school for in-service teachers and delivered the first session this summer (June 29 to July 24). Twenty teachers attended – teams of three teachers from each of six schools, as well as two teachers who teach remedial students in elementary and secondary schools. It was critical to have a group of three teachers per school so that they could further support each other and bring a positive change to the mathematical environment at their schools.

Goals

Our hope is that these teams of teachers will foster a cultural and academic shift with respect to the learning and enjoyment of mathematics by:

- increasing teachers' capability, confidence and attitude with regard to math
- educating teachers to strive for and expect success for all their students
- incorporating meta-cognition strategies so that teachers will understand their own learning processes for math, as well as that of their students
- making these teachers PIMS' ambassadors for institutional change by transforming their attitudes toward the teaching and learning of math at their schools
- familiarizing other teachers with PIMS' educational resources so that they can them to develop a variety of their own mathematical activities

The Curriculum

The training touched on the following:

- how to go from the concrete to pictorial to abstract
- how to explain mathematics in the simplest and clearest way
- how to choose, and build, word problems to teach a variety of mathematical ideas
- how to use a variety of algorithms and heuristics for problem solving

The program overview contained three main themes: geometry, numeracy and patterns, with a broad range of topics covered related to different grades.

Measuring Success

The participants were not assessed with tests, but an analysis of the lessons they prepared provided insight into how much they had learned and how they will use that new knowledge. Currently we are analyzing over 200 lessons prepared by the teachers, some of which will be uploaded to a website that will be linked to the new curriculum for other teachers to use and comment on.

We will also measure success by following the level of mathematical activity and academic success at the participants' schools by monitoring:

- the establishment and continuity of a math club
- students' success based on grade 4 and 7 standardized tests
- whether math achievement is improved at the school
- how students are performing in math contests
- to what extent students participate in activities with a mathematical content

We are currently scheduling a variety of activities with three of the schools. We aim to extend this to teachers in all of the participating schools throughout the current academic year.

Testimonial

"I have learned so many different teaching strategies, ways of thinking… In the future, I plan on collaborating with other instructors to come up with ideas."

Pacific Institute *for the* **Mathematical Sciences**

Celebrating 20 Years!

Please join PIMS in celebrating our 20th year of promoting research in and applications of the mathematical sciences, facilitating the training of highly qualified personnel, enriching public awareness of and education in the mathematical sciences, and creating robust mathematical partnerships.

Visit *www.pims.math.ca/20years* for information!