Pacific Institute for the Mathematical Sciences

NEWSLETTER

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Spring 2013

The Unravelers: Mathematical Snapshots

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

IHÉS Director, Jean-Pierre Bourguignon, is presented with an appreciation gift

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

A brief speaking program recognized the contributions of IHÉS Director, Jean-Pierre Bourguignon, to mathematics and to the development of mathematical institutes in Canada, as well as partnerships between French and Canadian mathematicians and mathematical institutions.

Bourguignon led a tour of the exhibit, revealing the story behind each photograph and telling how the idea was conceived. He described the making of the exhibit as an unbelievable story that started in the most unlikely way. He had known the photographers, Anne Papillault and Jean-François Dars, for many years as the professional filmmakers for CNRS, and had helped them make two movies on the well-known mathematicians Jacques Tits and Henri Cartan.

The studio they occupied became unavailable and they needed a new location. "I invited them to come to IHÉS. During their stay, they interacted with people at the institute. Jean-Francois likes very much to take pictures, and the consequence of them being around for several years was that after time, they became completely unnoticed by the scientists. He could catch intimate moments of exchange between people and would have the patience to wait and capture the perfect moment."

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

The exhibit was displayed for the first time in Canada at UBC, in the Pacific Museum of the Earth Gallery for two weeks before it journeyed to San Francisco and then New York. See pages 6-7 for highlights of the reception and exhibit.

What's Inside

Director's Message

Dear Colleagues,

Recently, PIMS had the opportunity to host the first visit to Canada of the exhibit, *The Unravelers*, based on photographs of mathematicians taken at IHÉS in Bures-sur-Yvette, France. For this remarkable event we had the pleasure of welcoming the illustrious IHÉS Director, Jean-Pierre Bourguignon, who was personally involved in setting up the display. The opening event included a heartfelt homage to JPB (as he is affectionately known) for his remarkable service to the Canadian mathematics community. The French Consul in Vancouver was also in attendance, and the excitement was such that a senior colleague referred to the exhibit and its opening "as the most exciting thing to happen in mathematics at UBC in 50 years." You will find some beautiful images from the event in this newsletter.

Another noteworthy fact was the attendance by the Directors of BIRS, CRM, Fields and of course PIMS. This is the first time we have all been together at PIMS and I would like to take the opportunity to wish both Ed Bierstone (Fields) and Francois Lalonde (CRM) the very best, as they will soon be stepping down as fellow directors.

This April saw the launch of our Collaborative Research Group in Geometry and Physics, spearheaded by Chuck Doran at UAlberta and Jim Bryan at UBC. The cross-fertilization between geometry and physics has led to some remarkable developments related to string theory, and PIMS will be hosting a variety of world class events on that topic, including the String-Math meeting which will be held in Edmonton in 2014. This exciting level of activity has been reinforced by the recent cluster of excellent faculty appointments at UAlberta in geometry and physics.

Our educational outreach continues with great success. Recently, our Aboriginal mathematics initiatives have received support from both the Governments of British Columbia and Saskatchewan, in addition to funding from Vancity and private donors.

This summer will see some intense activity at PIMS in a variety of areas including mathematical biology, algebraic geometry, automata and symbolic dynamics, optimization, environmental science, discrete mathematics, quantum information and quantum mechanics, low dimensional topology, reversible computation, partial differential equations, stochastic analysis, statistics, complex fluids, celestial dynamics, numerical linear algebra and cryptography. Events will take place at our sites in Calgary, Edmonton, Saskatoon, Seattle, Vancouver and Victoria. I hope to see many of you at our events.

Warmest regards,

Alejandro Adem
Director, PIMS

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Proofs in Prime

Ben Green recalls his involvement in high school math competitions, "That's when a lot of people realize they are interested in, and good at, mathematics. Once you make the realization that it's possible to be paid to do mathematics, if you love doing it, then [becoming a mathematician] is really a very natural career choice."

In 2003, after completing his PhD at Cambridge University, he came to PIMS as a post-doctoral fellow. "It's a good idea to see different places mathematically, both for your CV and because it's valuable to talk to different people." PIMS-UBC and Vancouver seemed like a great opportunity to Green, he was able to enjoy the outdoors and learn to ski while developing his career. Recollecting, he says, "It was a fantastic time, I did some of my very best work that year."

"The turning point in my career was the work I did while I was here at PIMS," says Green. He wrote a number of papers during his time at PIMS, including one with Terence Tao (UCLA) on arithmetic progressions of prime numbers. While prime numbers have fascinated mathematicians for thousands of years and are extremely simple and natural to define, it is often very difficult or impossible to prove facts about them. "There are a lot of conjectures, but people don't often succeed in actually proving anything about them," says Green. In his paper with Tao, they proved that any set consisting of a positive proportion of S contains arbitrarily long arithmetic progressions of primes.

Green's work spans many diverse areas of mathematics, which he sees joined by a common thread of "finding structure in places where you wouldn't expect it to exist." Such findings, he explains, "are interesting in their own right and often have applications to other parts of mathematics". This philosophy has provided him many valuable lessons and experiences and helped shape his remarkable career.

Recalling his first year as a PhD student he says, "I had the idea that I shouldn't tell anybody about what I was working on because they would steal it… I was having a drink with a mathematician and he asked me what I was working on. I didn't want to tell him, and he said 'I may have been a bit like that when I was your age, but when you get to my age, you'll be desperate for people to take an interest in things that you're working on.' And he was entirely right. Be open and talk to people about your ideas. The huge majority of mathematicians do not steal others' ideas. If they do, they get a very bad reputation."

For students thinking about pursuing a career in math, Green offers more advice, "The key is to work hard and keep an open mind. And don't take it too seriously when someone questions the importance of a problem you are working on. Sometimes students come to me wanting to work on the Goldbach conjecture (an unsolved problem about prime numbers). I have to break it to them that, to begin with at least, they need to work on something a little less notorious." Working on smaller, less significant problems, he explains, provides a means of getting used to the idea of thinking about mathematics and then developing techniques.

"I can certainly think of papers that I wrote early in my career (and indeed now) that people might ask why I cared, but I think 99% of mathematics is like that. But you keep working at it, because you can never tell which bits are going to turn out to be the really good stuff."

Ben Green is the Herchel Smith Professor of Pure Mathematics at the University of Cambridge and a Fellow of Trinity College. His work in demonstrating that every set of primes of positive relative upper density contains an arithmetic progression of length three led to his breakthrough 2004 work with mathematician Terence Tao now known as the Green–Tao theorem.

On October 10, 2012, Ben Green delivered the PIMS Distinguished Colloquium lecture, On the Sylvester-Gallai Theorem*, at the UBC site.*

Around the Sites

University of British Columbia Bud Homsy

The UBC site has kicked off 2013 with a number of high profile speakers, including: Béla Bollobás (Cambridge & Memphis); Avi Wigderson (Institute for Advanced Study, Princeton); François Lalonde (CRM and UMontreal) and Jean-Pierre Bourguignon (CNRS-IHÉS). In January, we hosted the successful IGTC event, Disease Dynamics and in April, in collaboration with the UBC Department of Earth and Ocean Sciences, we hosted the IHÉS exhibit The Unravelers: Mathematical Snapshots.

University of Washington Peter Hoff

This past fall, the UW, along with Microsoft Research, UBC, Oregon State University and the University of Oregon, organized the Pacific Northwest Probability Seminar, supported by PIMS and Microsoft. This one day mini-conference included over 60 participants and five keynote speakers. A highlight of the conference was the Birnbaum Lecture, delivered by Jeff Steif (Chalmers University).

Simon Fraser University Nils Bruin

This past fall featured a workshop (November 2- 3) on the interdisciplinary aspects of the Riemann zeta function, with main speakers Michael Berry and Richard Crandall (who sadly passed away on December 20th, 2012).

Also in November, SFU hosted the Combinatorial Potlatch, a yearly focal point of the region's combinatorial community, which featured Ron Graham (UCSD).

This spring brings PIMS/CSC distinguished lecturers Mark Newman (Michigan) and Tao Tang (Hong Kong Baptist University), PIMS distinguished visitor Frits Beukers (Utrecht) and on April 6, the 100th edition of our Taste of Pi lecture series for high school students.

University of Victoria Marcelo Laca

March was a very busy month for the UVic site, with the Dispersive Partial Differential Equations II seminar, two talks by Mark Lewis (UAlberta) — one on the *Mathematics Behind Stream Population Dynamics* and an MPE2013 talk on *Mathematical Models for Territorial Interactions* — and distinguished speaker Alexander E. Holroyd (Microsoft Research) giving a talk on *Random Matching*. The PIMS annual board meeting was also held at our site in March.

On May 4, we hosted The 3rd Pacific Northwest Theory Day, a conference in computer science.

University of Saskatchewan Chris Soteros

The Applied Mathematics Seminar series has continued this year with two speakers: Dr. Michael Lamoureux (UCalgary), speaking on Applications of Harmonic Analysis to Seismic Imaging and Dr. Roberto Camassa (University of North Carolina-Chapel Hill), speaking on *Spinning Rods, Microfluidics, and Propulsion by Cilia in Biological Systems*. We look forward to the Mathematics of Planet Earth Symposium as part of the CMOS/CGU/CWRA Joint Scientific Congress held May 26-30, 2013 at TCU Place in Saskatoon. We are also very busy developing and delivering outreach activities around the newly funded joint PIMS/Government of Saskatchewan proposal: *New Initiatives in Mathematics Education for FNIM Teachers and Students in the Province of Saskatchewan*.

University of Regina Donald Stanley

The third Saskatchewan Analysis Day was held on March 16. This one-day conference aims to bring people in analysis from Regina and Saskatoon together. As well, a distinguished lecture by Ejaz Ahmed was given on March 22.

The 2013 Saskatchewan Math Challenge was held on Saturday March 2 and attended by 180 Grade 7-10 students from across the province. The event was made possible through the collaboration of members of the Department of Mathematics and Statistics, Faculty of Education, Saskatchewan Math Teachers Society, elementary and high school teachers, and many more.

Funding has been secured to hire two students for Math on the Move, we are collaborating with First Nations University on a summer camp, and are in the early stages of planning another summer camp for FNMI transitioning with the Regina Public School Board.

University of Calgary Clifton Cunningham

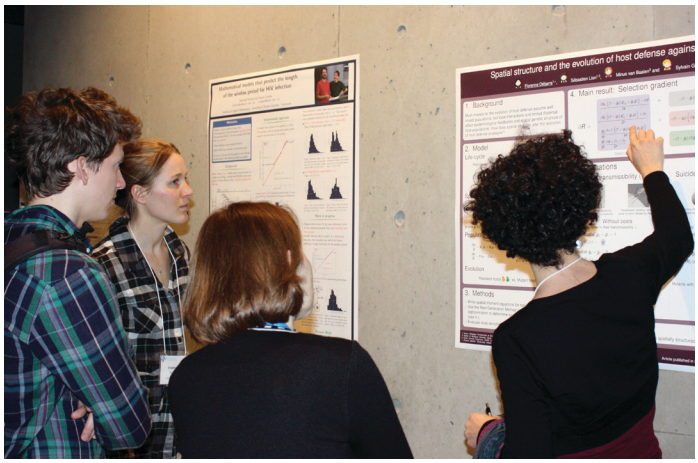
The CRG on the Mathematics of Quantum Information has been busy with five guests hailing from Canada, the UK, Singapore and the US. Meanwhile, the CRG on Optimization is gearing up for its Focus Period, including a workshop at Lehigh University and a conference and summer school at UCalgary. While the CRG on L-functions and Number Theory has now completed its programming, the West End Number Theory seminar continues. We also enjoyed a talk in the PIMS/Shell Lunchbox Lecture Series; two more talks are planned for the spring. Now we are firmly focused on other upcoming activities, such as the North-South Dialogue, a larger-than-ever CMS mathcamp, and four conferences. This will be a very busy summer! Continued on page 5.

IGTC Update

The PIMS International Graduate Training Centre (IGTC) program supports graduate student research training and career development in the broad area of mathematical biology. Our activities and student fellows (currently 11 students) are generously supported by PIMS and Mprime and we continue to seek new sources of funding.

Since the last newsletter, the IGTC has supported three workshops in mathematical biology. The first was the PIMS symposium on immune cell modelling held on November 8, 2012. This symposium featured researchers from mathematics and experimental immunology, from Oxford University, UC Davis and UBC, including two IGTC alumni: Omer Dushek (now faculty in Pathology at Oxford University) and Jun Allard (currently a postdoctoral researcher in the Mogilner lab at UC Davis).

The second major event was the three-day workshop, *Disease Dynamics 2013: Immunization, a true multi-scale problem*, held in January. This workshop showcased new research at the interface between experimental biology, epidemiology and applied mathematics. There was a considerable emphasis on the translation of research into practical outcomes in treatment and public policy. The participants were drawn from academic institutions, government laboratories and industrial companies. Graduate students from across the continent attended to learn about recent developments and present their own work at a lively poster session held "under the whale" at the UBC Beaty Biodiversity Museum. This event was also the start of PIMS' participation in the Mathematics of Planet Earth 2013 events.



GRADUATE STUDENT PARTICIPANTS AT 2013 DISEASE DYNAMICS

The third IGTC-sponsored event was Frontiers in Biophysics, an annual event held jointly between SFU and UBC. Held at PIMS-UBC on March 2nd, this year's Frontiers featured a dozen excellent student talks as well as a poster session and an address "What can computational modelling tell us about cell motility?" by guest, Charles Wolgemuth (University of Arizona). Thanks to Mark Zajac, Alejandra Herrera, Hildur Knutsdottir, Laura Liao, Meghan Dutot and May Anne Mata for organizing.

In the next few months we look forward to the most important IGTC event of the year, the graduate summer school on Biological Invasions to be held at the University of Alberta. We are all familiar with human introductions of invasive species, which can change habitats and ecosystem processes, crowd out native species or damage human activities. The ultimate cost to the global economy has been estimated at $1.4 trillion per year. The dramatic progression of an invasion involves a series of complex dynamical processes that requires sophisticated mathematical language to describe, quantify and investigate. This course will focus on development and analysis of mathematical models that can be applied to these processes. The main organizer for this event is Thomas Hillen, and distinguished lecturers in the summer school will be Alan Hastings (UC Davis), Mark Lewis (Alberta, co-organizer), Jonathan Sherratt (Heriot-Watt) and Sergei Petrovskii (Leicester).

Around the Sites cont'd

University of Alberta CHARLES DORAN

The big news at UAlberta is the April inauguration of the new CRG in Geometry and Physics (joint with UBC and UW). The CRG will bring hundreds of the world's best researchers in geometry and physics to Western Canada for events such as the international String-Math conference, previously held at UPenn, Bonn and Stony Brook. UAlberta principal CRG faculty Vincent Bouchard and Chuck Doran will be joined this summer by three new Geometry and Physics faculty: Thomas Creutzig, Emanuel Diaconescu and David Favero.

University of Lethbridge AMIR AKBARY

The last several months have featured lectures in our PIMS Distinguished Speakers Series: Chris Godsil (Waterloo), Heinz Bauschke (UBC Okanagan), Nassif Ghoussoub (UBC) and Alejandro Adem (UBC).

In Education activities, we have had weekly problem-solving sessions for high school students called Fun With Math, which is organized by Abbas Momeni and Soroosh Yazdani. The sessions will continue until the end of semester.

In January we welcomed Adam Felix, a PIMS postdoctoral fellow who will work with our number theory group.

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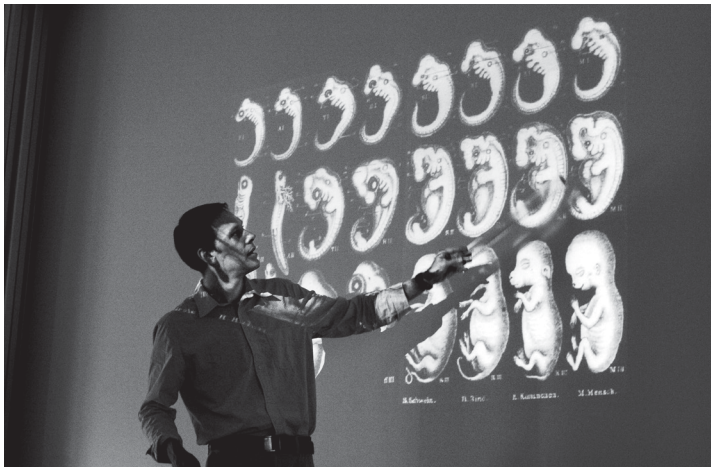


PIMS Director, Alejandro Adem welcomes guests to reception

Jean-Piere Bourguignon explains the story behind a photograph

RAVELERS SNAPSHOTS

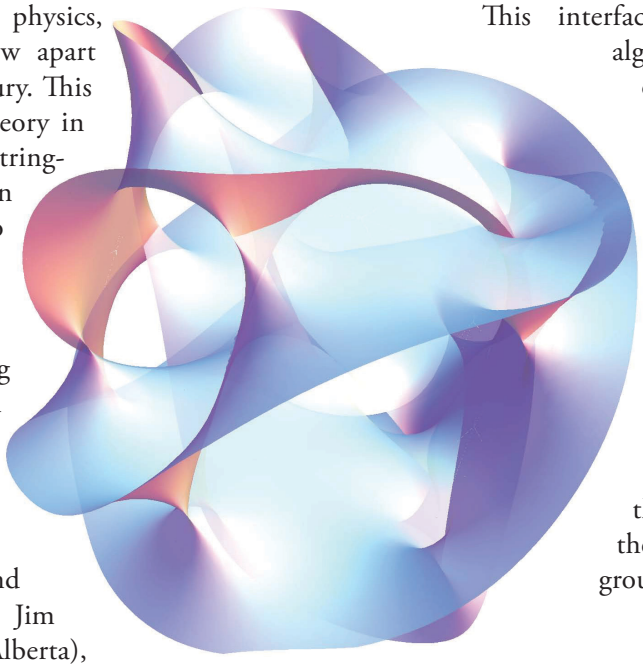
(L-R) Directors of PIMS (Alejandro Adem), FIELDS (Edward Bierstone), CRM (François Lalonde) and BIRS (Nassif Ghoussoub)

(L-R) Edward Bierstone, Nassif Ghoussoub, Jean-Pierre Bourguignon (Director IHÉS), Evelyne Decorps (Consul General of France), François Lalonde, Alejandro Adem and Didier Marty-Dessus (Attaché scientifique Consulat Général de France)

New Collaborative Research Group (CRG)

Geometry and Physics (2013-2016)

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



During 2013-2016, this CRG will bring hundreds of the world's best researchers in geometry and physics to Western Canada to continue to develop this rich interface.

Led by Chuck Doran (UAlberta), the principal CRG faculty are Kai Behrend (UBC), Vincent Bouchard (UAlberta), Jim Bryan (UBC), Thomas Creutzig (UAlberta), Emanuel Diaconescu (UAlberta), David Favero (UAlberta), Robin Graham (UWashington) and Andreas Karch (UWashington). The CRG Scientific Committee consists of distinguished geometers and physicists: Ron Donagi (UPenn), Jim Gates (UMaryland), Sheldon Katz (UIUC) and Yongbin Ruan (UMichigan).

An international conference, *Calabi-Yau Manifolds and Moduli,* will be held in June 2014 at UAlberta, immediately followed by the premier international conference in the field, the String-Math Conference, at UAlberta's new Centennial Centre for Interdisciplinary Science. Previously held at UPenn, the Hausdorff Center, and the Simons Center for Geometry and Physics, the conference represents a significant "coming of age" for the UAlberta geometry and physics group.

In the weeks preceding these events, a three-day Geometry and Physics Workshop will take place at UBC, followed by a String-Math Summer School at the new PIMS site at UBC. Other planned activities include a joint geometry and physics seminar at UAlberta and UBC. This cross-province merger will take advantage of the newly operational NSERC-RTI funded PIMS-UA Collaborative Research Environment (CoRE) at the PIMS-UAlberta office and the new Westgrid facilities at the PIMS-UBC site. Graduate courses at UBC and UAlberta will involve students and faculty at both universities, some courses being designated as PIMS "Hot Topics."

This interface between geometry – algebraic, arithmetic and differential – and string theory is fruitful, timely and of great relevance for the CRG groups at UAlberta, UBC and UWashington. This period of concentration will help each site develop the talents of their students and postdocs, aid in both retention and recruitment of faculty in this area and strengthen the interactions among these groups of researchers.

PIMSBits

- **Recent award recipients:** Natalia Kouzniak (SFU), PIMS Education Prize; Serdar Yuksel (Queen's), CAIMS/PIMS Early Career Award in Applied Mathematics; Bruce Reed (McGill), CRM/Fields/PIMS Prize; PIMS Founding Director Nassif Ghoussoub (UBC), Queen Elizabeth II Diamond Jubilee Medal.

- **Paper results from MMIW workshop:** Six students from the project: Touch Sensing, Silhouettes, and "Polygons-of-Uncertainty" achieved illuminating results, both on theoretical level and simulation, which led to a published paper, *Optical Touch Sensing: Practical Bounds for Design and Performance*.

- **Announcing PIMS' four new Board Members:** Samuel Gray (Chief Scientist, CGG, Calgary); Yuval Peres (Principal Researcher, Microsoft Research); John F.H. Thompson (Consultant, PetraScience Consultants Inc. and Professor, Cornell University) and Nicole Tomczak-Jaegermann (Professor of Mathematics and Canada Research Chair in Geometric Analysis, University of Alberta).

- **How does Google Google?:** As part of PIMS' MPE2013 activities, Margot Gerritsen (Stanford) gave talks at both Calgary and UBC entitled *How Does Google Google? The Math Behind the Internet.* View this talk on mathtube.org!

Calculus for Functions That Don't Have Derivatives

PIMS CRG Optimization: Theory, Algorithms, and Applications

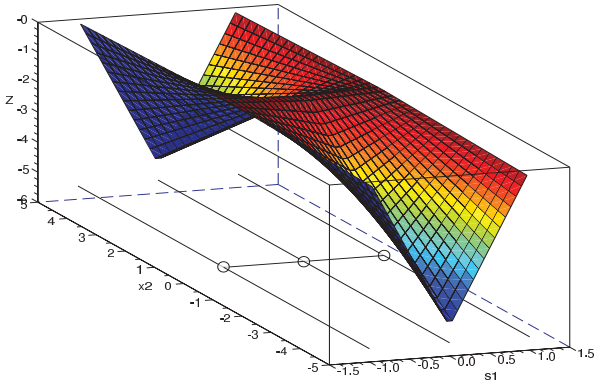
Heinz H. Bauschke, Warren L. Hare†, Yves Lucet and XianfuWang

The elliptic Monge-Ampere equation is a fully nonlinear partial differential equation that originated in geometric surface theory and has been applied in dynamic meteorology, elasticity, geometric optics, image processing and image registration. Solutions can be singular, in which case standard numerical approaches fail.

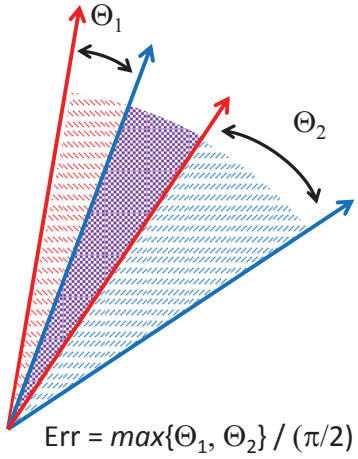
One of the most successful mathematical discoveries of all time is the differential calculus by Newton and Leibniz. It is an indispensable tool in applied mathematics. For example, in optimization — which aims to solve mathematically optimal allocation of resources — one of the key techniques is finding critical points via derivatives.

Unfortunately, many important functions encountered in optimization do not possess classical derivatives. In this case, one creates generalized derivatives that capture the "first order calculus" of the function without requiring traditional differentiability. Most widely studied in this field is the notion of convex functions, which leads to generalized derivatives that are monotone operators [1]. Another important example is the case when the function represents inclusion in a set, which leads to normal cones and set-valued calculus.

At the Centre for Optimization, Convex and Nonsmooth Analysis (COCANA) at the University of British Columbia, researchers are particularly interested in generalized derivatives and their applications. Recent research topics include exploring connections between generalized derivatives and *the method of alternating projections* [2], building sophisticated *computer-aided convex analysis* tools to increase researchers' productivity [3], and designing new techniques to *approximate normal cones without calculus* [4]. These advancements of knowledge are paving the way for new applications in Optimization worldwide.



Partial conjugate of the max-norm



Evaluating Error for Conic Approximations

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Onward and Upward

Jean-Pierre Bourguignon, the current Director of Institut des Hautes Études Scientifiques (IHÉS) in France, discovered mathematics in high school. At the end of his studies, "confronted with a mathematics teacher who was known as an inefficient teacher, but an outstanding mathematician," his interest piqued. "It was an unusual situation for me, as, when I had a good teacher, with almost no effort I could achieve good marks. Now I had a teacher who was clearly saying something interesting, but I didn't understand him. My first grade in this class was half a point out of twenty, when I was used to having 20/20. I was suffering, but very motivated."

He was admitted to École polytechnique, a leading engineering school in France, and decided to become a mathematician. It was just before 1968 and the spectacular social unrest with the longest general strike in French history. "At that time, the school was in very bad shape. Aside from the math and some physics professors, the teaching was very poor." When the courses were inadequate, Bourguignon and his colleagues would boycott them and develop their own material to teach and study, which turned out to be a very good training to do research later in his career.

Bourguignon Delivers a lecture at PIMS-UBC: *The Work of Misha Gromov, a Truly Original Thinker*

Upon graduating and, as he was beginning to work on his thesis, a paper appeared in a major math journal solving the very problem he was considering. "The method used was exactly the one I had thought of using." It was disheartening, because his program was already solved, but also encouraging because he had contrived the idea on his own, and was on the right path to the solution. The techniques he intended to use to solve the problem became the standard for solving geometric problems in the 70s and 80s.

He was hired by CNRS at the unusually young age of 21, and at 25, gave a lecture in Paris that was attended by Jim Simons, a well-known mathematician, who on the spot, offered him a job at the State University of New York at Stony Brook, opening the way to a most memorable year. The next summer, while visiting Stanford University, he was invited for lunch by Shiing-Shen Chern, an indisputable leader in differential geometry, "It was just unthinkable! I didn't even have a PhD. It gave me the feeling that what I was doing could be quite significant. A feeling I didn't have in France, where, at that time, if you weren't doing algebraic geometry, you were not really a mathematician."

"Returning to France, my view on my own work had changed and also I was networked. I had known I was technically solid, but realized that what I was interested in was found relevant by others." His field, global analysis, was becoming very important not only to mathematics, but also to the interface with theoretical physics, and, unlike other mathematicians, he had received a thorough basic training in quantum physics and looked upon physics with interest.

1979 was a pivotal year. "One day, I was talking with Blaine Lawson, who was visiting IHÉS, and mentioned that I could solve part of a problem of interest to him. I remember this moment very vividly, he asked, 'can you really do this part? I know exactly how to do the other part,' so just by mentioning this to him, we had a very sought after theorem. Within a few hours we had solved a conjecture that physicists had been considering for quite some time." From this experience, he learned that having the right contacts is critical, but also not to be shy about your work. This was also an opportunity to thank Jim Simons through a joint publication. He had indeed inspired part of the work, but had left mathematics for business at the time.

Bourguignon became Director of IHÉS in 1994, at 47, a young age compared to those who preceded him. His name had been put forward by a famous physicist and professor at IHÉS. "Our paths crossed when I was 33. He was representing the theoretical physicists' community at the national level in CNRS and defending it bitterly while I was representing the mathematics community. He was very senior to me, but, as I realized later, he appreciated the way I was fighting for my discipline."

Bourguignon knew that at that time at IHÉS the appetite for innovation was low. "When I took the position I became very aggressive in restoring the balance between math and physics, and immediately initiated a postdoctoral program to attract young people. Continued on page 11.

PIMS Public Lecture by Avi Wigderson

By Lior Silberman

Prof. Avi Wigderson (Institute for Advanced Study, Princeton) is a leader in theoretical computer science whose research spans the gamut of the field. His accomplishments include winning the Nevalinna and Gödel Prizes and he has given several ICM addresses.

Wigderson visited PIMS-UBC on March 8 to deliver the public lecture, *Cryptography: Secrets and Lies, Knowledge and Trust*, which was attended by numerous faculty, postdoctoral fellows and graduate and undergraduate students in Computer Science, Engineering, Mathematics and Statistics. Wigderson introduced cryptography, the science of hiding (and uncovering) information, and focused on cryptographic methods at the foundation of the ongoing e-commerce revolution. A goal of modern cryptography is to allow parties who have never met to send messages to each other without eavesdroppers obtaining the information.

A method for this can be called a "digital envelope", and ought to only allow the intended recipient to "open the envelope" and read the message it contains. Solving the problem "calculate the message given the sealed envelope" must be easy for the recipient and hard for everyone else. In the most popular implementation on the world-wide-web (through algorithms embedded in every browser and server), opening the envelope roughly requires the prime factors of a large integer which are known to the intended recipient. Others who only know the large integer itself cannot open the envelope. Note that while the factorization problem is generally believed to be difficult, that belief is not a theorem and in principle, tomorrow someone could devise an efficient factorization algorithm and e-commerce would grind to a halt.

Beyond simple communication, digital envelopes can be incorporated into other protocols. Perhaps the most striking application Wigderson described is "the zero-knowledge proof," whereby "Alice" can convince "Bob" that she knows something, without leaking any of the knowledge itself. For example, Alice can convince Bob that she has followed an agreed-upon protocol while keeping her actual information private.

Many of the protocols described above inherently depend on tossing coins. Independently, the best-known algorithms solving computational problems also often make decisions by tossing coins. Randomness in computation was explored in Wigderson's colloquium lecture. In addition to coin-tossing algorithms, he discussed the problem of producing the coin tosses -- in practice computers don't have access to sufficient true randomness, and must suffice with simulated ("pseudo-random") coin tosses. It turns out that computationally difficult problems (for example, those used in cryptography) make such simulation possible.

PIMS Chats with Bourguignon cont'd

I also brought to an end some permanent invitations - it was not the quality of people that was in question, but the fact that room should be left for new areas and styles."

IHÉS has a very specific role, "to create special moments for people in which they are free from the normal constraints of professional life. If you don't have some extended period of time during which you can concentrate on thinking strictly on your research and being completely open to non-programmed interactions, then you are in trouble" says Bourguignon. "IHÉS works at creating conditions under which for example people can realize that they are looking at the same questions, though their work may belong to different areas of math, biology or physics."

The special atmosphere at IHÉS is created by the permanent scientific staff and the visitors, as well as by the technical staff and the physical conditions of the institute. A housing complex with 60 apartments accommodates both individuals and families. In the Bois-Marie scientific campus there are many meeting spaces of all sizes, lecture theatres and a conference centre. Upon arrival, visitors are given the keys to everything so that they can access the facilities at any time.

Under Bourguignon's leadership, IHÉS has grown and strengthened. After hard work with the scientific council, he hired two permanent professors of mathematics both of whom received the Fields Medal as well as a very renowned physicist. Under his leadership, the variety of visitors has evolved; the percentage of young people has grown to 40-50% and every year the institute hosts researchers from more than 30 countries. Using the Institute's network as well as the one Bourguignon established throughout his career, the Institute led two fundraising campaigns at his initiative. The first exceeded its initial target of 10 million euro and raised 13 million and the second (the 50th Anniversary Campaign) has raised 23 million euro to date and continues to expand.

Governments of BC and Saskatchewan Support PIMS

On April 9, the Government of British Columbia announced an investment of $350,000 in programs and research to promote Aboriginal students' education success. Of these funds, $100,000 were delegated to PIMS for the purpose of delivering high-quality education in mathematics and to provide programs to increase the success of Aboriginal learners in math and science throughout BC.

"Support from the BC government will allow PIMS to enhance the mathematical opportunities for Aboriginal teachers and learners throughout British Columbia by offering summer math camps, teacher training workshops and peer mentorships. Mathematical skills are a basic component in technical careers and these programs seek to provide critical support to enable Aboriginal students to successfully pursue them" said Alejandro Adem, PIMS' Director.

The Government of Saskatchewan Ministry of Education has also committed to an investment of $100,000 in PIMS to join with First Nations, Inuit and Métis communities to enhance opportunities for students and teachers in the mathematical sciences.

PIMS also thanks the Vancity Community Grant program, which has awarded PIMS a $6,000 Community Project Grant to establish peer mentoring programs in Vancouver East Side Schools. For just $1,000, our peer mentorship programs reach four to five students for an entire school year.

To find out about more about how to support PIMS' education activities, please visit: *www.pims.math.ca/fundraising.*

BRITISH COLUMBIA

Government of Saskatchewan
Ministry of Education

Vancity

Math Mania at KELSET Elementary

By David Leeming

The popular Math Mania program, sponsored by PIMS UVic, visited KELSET Elementary School in North Saanich in October, 2012. KELSET is a public school with 376 students (K-5) of which about one-third are first nations. A record number of volunteers (26) participated in this event including UVic faculty, grad students and students from the Math 161 (Math for Elementary Teachers) class. This meant we were able to present many different games and activities – some of them new.

We estimate that over 150 parents and students attended the ninety minutes of Math Mania. Among the favourite activities were the Sorting Network, goats and gold, pig, straw constructions, the set game and kaleidocycles. We received a dozen 'thank you' cards written by kids who attended Math Mania that evening and KELSET is eager for us to do a return engagement.