Pacific Institute *for the* Mathematical Sciences

Annual Report *2012*
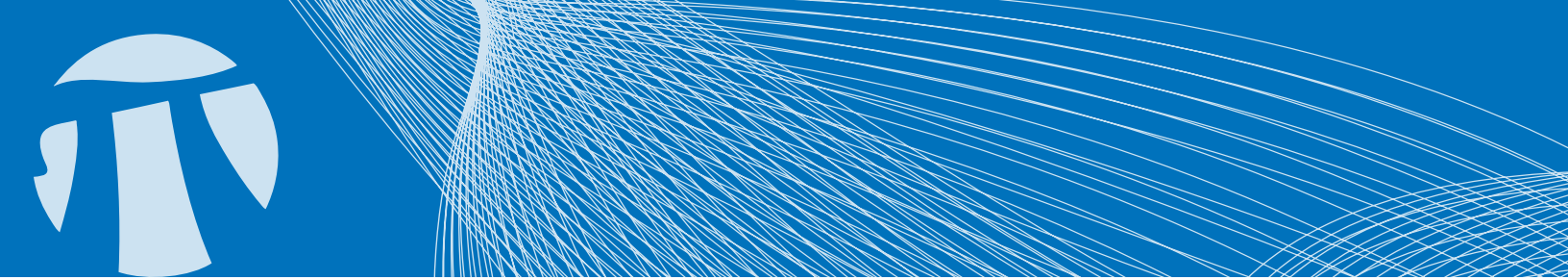
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1. BACKGROUND

The Pacific Institute for the Mathematical Sciences (PIMS) was founded in 1996 by a consortium of five universities in Alberta and British Columbia (the University of Alberta, the University of Calgary, the University of British Columbia, Simon Fraser University and the University of Victoria). Later the University of Washington in the United States, and more recently the Universities of Regina, Saskatchewan, and Lethbridge joined PIMS as full members, and Portland State University in Oregon and the University of Northern British Columbia joined as affiliates. The mandate of PIMS is to:

- Promote research in and application of the mathematical sciences of the highest international calibre,
- Facilitate the training of highly-qualified personnel at the graduate and postdoctoral levels,
- Enrich public awareness of mathematics through outreach,
- Enhance the mathematical training of teachers and students in K-12, and
- Establish partnerships with similar organizations in other countries, with a particular focus on Latin America and the Pacific Rim.
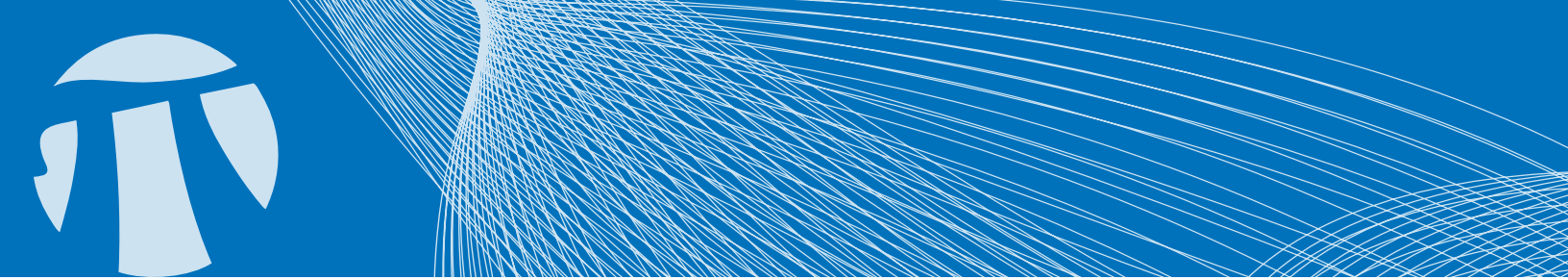
2. UNIQUE STRUCTURE OF PIMS

PIMS is unique in several ways, most fundamentally because of its distributed structure. Most institutes organize activities at a central location where international scientists are brought in residence; PIMS, on the other hand, has a site at each of nine major universities in Alberta, British Columbia, Saskatchewan and Washington State. PIMS events and programs are organized at each of these sites and PIMS researchers are distributed throughout the network. PIMS is institutionally bi-national (the University of Washington is a full member, and Portland State University is an affiliate) and it is the only institute of this kind in mathematics. This unique structure projects PIMS beyond the boundaries of Canada, notably towards the Pacific Rim, to allow Canada to benefit from international scientific and economic developments.

3. SCIENTIFIC HIGHLIGHTS IN 2012

PIMS has built an international reputation for excellence and has transformed the conditions of mathematical research in Canada. PIMS funds Collaborative Research Groups, Postdoctoral Fellowships, the International Graduate Training Centre in Mathematical Biology as well as individual events and special focused periods on a competitive basis. The following is a partial list of current scientific achievements:

- The innovative PIMS *Collaborative Research Groups* (CRGs) and their training and focused activities over a multi-year period aim to develop permanent research networks, establishing lasting interdisciplinary links between geographically separate groups of researchers at member universities. PIMS has developed 25 CRGs since its inception, in areas ranging across all the mathematical sciences. This has served as a catalyst for producing mathematical research of the highest quality in Canada and attracting outstanding faculty to PIMS universities.

    Two new CRGs on the Algorithmic Theory of Networks and Optimization: Theory, Methods and Applications were launched in 2012, with a full slate of activities for the former to commence in 2013. The Optimization CRG began with a flurry of activity, holding two conferences, a workshop and a meeting to introduce the field to UBC-

Okanagan undergraduates. Noteworthy results thus far include (i) the introduction of the new notion of the restricted Mordukhovich normal cone, which is important in the nonconvex case, (ii) a study of the variational properties of value functions for convex functions and a derivation of explicit subgradient expressions for a large family of inverse problems, and (iii) the first series of computational validations of the newly proposed moment-based relaxation of the DVH constraints for radiotherapy treatment.

In 2012 the CRG on Applied and Computational Harmonic Analysis held a major event: the Joint Alberta-British Columbia Seminar. The main objective of this workshop was to serve as a platform where CRG members can present their recent research, interact, and start new collaborations. At this meeting, collaborators O. Yilmaz (UBC), and PIMS PDF E. Au-Yeung (UBC) presented an important result on recovery guarantees in compressed sensing when "jitter sampling"-based Fourier sampler matrices are used for collecting measurements.

Several breakthroughs came from the Mathematics of Quantum Information CRG. At SFU more than 20 efficient algorithms have been developed that deliver new quantum stabilizer codes that are superior to existing codes. Given a set of quantum states with bounded pairwise fidelities, the UW group found a bound on how many copies are required for to distinguish between them reliably. Researchers at UC developed a theoretical framework for treating photon coincidence probabilities with single photons entering each input port with controllable relative delays in the entry time. The coincidence rates sample the immanants of the special unitary matrix describing the interferometric transformation.

The L-functions and Number Theory CRG hosted its premiere event—the 12th Meeting of the Canadian Number Theory Association—at UL in June. This conference welcomed 175 participants and featured 120 talks including 10 plenary, 34 invited, and 1 prize lecture.

Future CRGs on Geometry and Physics and Applied Combinatorics are under development for 2013 and beyond.

- Every year PIMS sponsors numerous *postdoctoral fellows* (PDFs) – 47 in 2012 – attracting outstanding young scientists who contribute to PIMS research programs, many of whom later become faculty members at leading Canadian universities. They are distributed throughout PIMS sites on a competitive basis. This year one of our 2003-2004 PDFs, Ben Green, the Herchel Smith Professor of Mathematics at Cambridge, returned to Canada to present a PIMS/UBC Distinguished Colloquium. Green, who is a Fellow of the Royal Society, has won numerous major awards.

- In 2007, PIMS launched the *International Graduate Training Centre* (IGTC) *in Mathematical Biology.* This program focuses on strategic topics of great current interest such as the mathematical modelling of ecosystems, disease spread and intracellular dynamics. Special fellowships are awarded to students and there are conferences and research summits connected to the program. This involves a coordination of resources and ideas from several PIMS sites, emphasizing contact between the student community and the frontiers of scientific research. This year's highlight was the IGTC Summit in Naramata, BC. The IGTC also sponsored a streamed summer course on mathematical cell biology at UBC.

Notably, IGTC student Deniz Yorukoglu with C. Sahinalp (SFU) developed the Dissect (DIScovery of Structural Alteration Event Containing Transcripts) gene alignment tool. This year, Deniz won the Ian Lawson Van Toch Memorial Award for Outstanding Student Paper at ISMB (Intelligent Systems for Molecular Biology) 2012. Deniz is now a PhD student at the MIT Computer Science and Artificial Intelligence Laboratory (cSAIL).

- Of note are *Special Focused Periods* that are non-CRG events that occur every couple of years, depending on exceptional opportunities. They often take place in the summer and duration varies according to the discipline. Currently, PIMS is co-organizing two special focus period for 2013: a pan-Canadian program on *Epidemiology, Ecology and Public Health*, and an international *Celestial Mechanics* program. Both are part of *Mathematics of Planet Earth* – a worldwide thematic effort.

- PIMS organizes international summer schools to train the new generation of scientists in emerging areas of mathematics and its applications as diverse as seismic imaging, the mathematics of sustainability, string theory, environmetrics, finance, atmospheric modelling and climate change, quantum information, and cryptography. This year's offerings included algebraic graph theory, probability, mathematical modelling of infectious diseases, geometric PDE, and fluid dynamics. An in-depth overview of the probability summer school can be found at the end of Section II.1.B.

- PIMS has a lively program in industrial mathematics, and runs *Mathematical Modeling in Industry Workshops* (MMIW) as well as *Industrial Problem Solving Workshops* (IPSW) for students, faculty and industry. The 2012 edition (the 16th) of the MMIW, held in Calgary, was the third dual effort of PIMS and the Institute for Mathematics and its Applications (IMA). It also is summarized at the end of Section II.1.B. Continuing in this direction in 2012, PIMS co-sponsored the *Gene Golub Summer School* in Monterey, CA, and presented the short course *Monte Carlo Methods for Quantitative Finance* at SFU-V.

- PIMS sponsors conferences and workshops throughout Canada and the world on a wide range of topics. This year's events took place in Australia, California, Idaho, Ontario, Prince Edward Island, and Quebec, as well as PIMS' 'home' provinces and states, and covered fields such as biophysics, computer science, criminology, medicine, physics, and statistics, in addition to almost every area of applied and abstract mathematics.

- This year's speaker in the *Hugh C. Morris Lecture Series* was Henri Darmon from McGill. The talk was on *Numbers and Shapes*, and provided a non-technical sampler of some of the rich, fascinating interactions between arithmetic questions and topological insights. Dr. Hugh Morris (1932-2012), former Chair of the PIMS Board of Directors and a longtime friend of the mathematical sciences, generously endowed this yearly lecture series at PIMS. The objective is to attract top mathematical scientists in the world to deliver presentations on current research topics to PIMS universities.

- The 2012 PIMS *Marsden Memorial Lecturer* was Richard Montgomery of UC Santa Cruz. He spoke about his celebrated work on the 3-body problem at the focus program on *Geometry, Mechanics and Dynamics: The Legacy of Jerry Marsden* hosted by the Fields Institute in July. Jerrold E. Marsden (1942-2010) was a world-renowned Canadian applied mathematician who did extensive research in the areas of geometric mechanics, dynamical systems and control theory.

- PIMS sponsored seven Distinguished Visitors this year: four at UBC (T. Scanlon, R. McCann, M. Overton and P. Schneider), two at UR (P. Lambrects and V. Paulson) and one at UV (Turing Award Winner L. Valiant).

- R. Lang (Los Alamos) and K. Golden (U Utah) anchored PIMS' Public Lecture Series at UBC this year, giving well-attended talks on *From Flapping Birds to Space Telescopes: The Modern Science of Origami* and *Mathematics and the Melting Polar Ice Caps*, respectively. PIMS' 2013 lineup includes A. Wigderson (IAS) and T. Hastie (Stanford).

- Our distinguished colloquia continue to bring first-rate speakers to PIMS; in 2012 these included G. Margulis (Yale), E. Candès (Stanford), E. Witten (IAS), L. Mahadevan (Harvard), B. Green (Cambridge), and K. Sigmund (Vienna).

- Each year PIMS awards several prestigious prizes. The 2012 *CRM-Fields-PIMS Prize* went to S. Todorcevic of U Toronto, and M. MacLean of UBC was the recipient of the 2012 *PIMS Education Prize*. In 2010 the Canadian Applied and Industrial Mathematics Society (CAIMS) and PIMS created the *Early Career Award in Applied Mathematics* to recognize exceptional research in any branch of applied mathematics; the 2012 awardee was T. Kolokolnikov of Dalhousie U.

4. NATIONAL AND INTERNATIONAL COLLABORATIONS

National: PIMS has a national mandate to support the mathematical sciences in Canada. To this end, in partnership with the Fields Institute and the Centre de Recherches Mathématiques (CRM), it has created major national programs such as Mprime (formerly known as Mathematics of Information Technology and Complex Systems) and the Atlantic Association of Research in the Mathematical Sciences (AARMS). Together with the Mathematical Sciences Research Institute (MSRI) in Berkeley, PIMS created the Banff International Research Station (BIRS), which is now the premier mathematical research station in North America.

PIMS coordinates with AARMS, BIRS, CRM and Fields to support a number of Canadian activities such as meetings of the societies (CAIMS, CMS and SSC), the Séminaire de Mathématiques Superieres in Montréal, and the regularly scheduled CanaDAM and CNTA meetings. Recently, we have agreed on a yearly national rotation for the *Industrial Problem Solving Workshops*, which were created by PIMS and then emulated by CRM and Fields. PIMS funding for activities in Atlantic Canada through AARMS is an important link to another region of the country. The statistics community has proposed a national initiative through the three institutes and PIMS will be an active participant; it is already working together with CANSSI to present a series of public lectures in statistics. In 2013, the three institutes and BIRS will sponsor focused programs on epidemiology, ecology and public health, and also celestial mechanics, as part of the *Mathematics of Planet Earth* initiative.
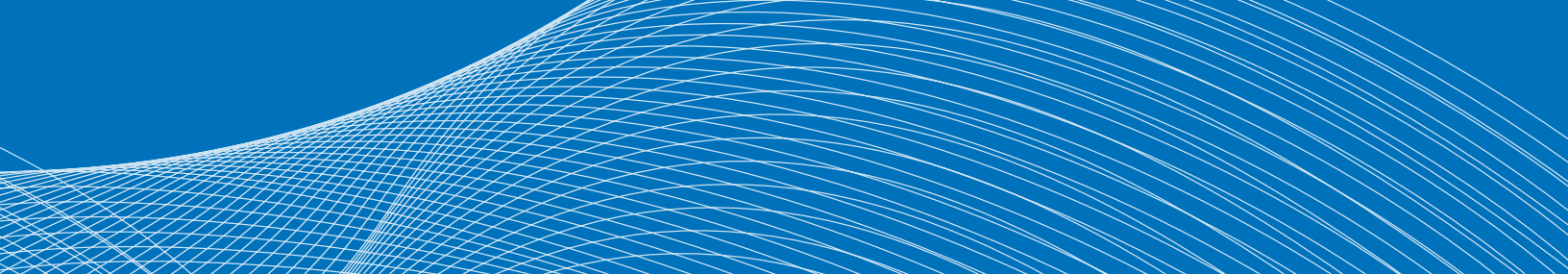
International: Part of the PIMS mandate is to establish international partnerships in order to provide mechanisms for Canadian researchers to participate in activities outside Canada and attract visitors from abroad, especially beyond the United States. The establishment of the Centre National de la Recherche Scientifique (CNRS), *Unité Mixte Internationale,* at PIMS (the first in mathematics in North America) has led to year-long visits by 22 researchers from France since 2007, fully funded by CNRS. Similarly the leadership role played by PIMS in establishing the Pacific Rim Mathematical Associa-tion (PRIMA) has provided ample opportunities for Canadian exchanges with countries in this huge region; in 2013, we expect to have about 1000 participants at the PRIMA Congress in Shanghai. Our partnership with IMA (USA) has allowed us to provide new opportunities in industrial mathematics for students via the annual Mathematical Modelling in Industry Workshops, which are advertised throughout Canada. Our connections with Latin America have led to joint events (Canada-México meetings), as well facilitating the existing North American partnership at BIRS, to the benefit of the entire community.

5. ADMINISTRATIVE STRUCTURE AND FUNDING FOR PIMS

The central office and the Director of PIMS are based at UBC, and each of the other eight universities has a site office and a site director (see *www.pims.math.ca/contact*). The role of the site directors is to look for local opportunities and synergies, while the site offices provide administrative assistance for organizing on-site PIMS activities. The distributed structure has allowed the Institute to support and energize departments of mathematical sciences across Western Canada.

The strong presence of PIMS at the university level gives it access to a vast reservoir of scientists from all disciplines. Over the years, PIMS has been able to lower disciplinary barriers, and create innovative research teams, making a sustained effort to extend the PIMS community beyond mathematics and statistics departments so as to include scientists in areas such as physics, biology, engineering, informatics, operations research and economics.

The day-to-day scientific administration of PIMS is carried out by **Alejandro Adem** (Director), **George Homsy** (Deputy Director) and **Mark J. Gotay** (Assistant Director), who are located at PIMS Central at UBC. PIMS operations

are overseen by its *Board of Directors*, which includes a senior academic administrator from each of the founding universities and representatives from the business, industry and resource sectors and professional societies. Board members are listed at *www.pims.math.ca/pims-glance/board-directors*. Scientific events are adjudicated by an independent *Scientific Review Panel* (SRP) composed of internationally renowned mathematical scientists. For biographies of Panel members, see *www.pims.math.ca/pims-glance/scientific-review-panel*. PIMS Site Directors are N. Bruin (SFU), C. Doran (UA), G. Homsy (UBC), C. Cunningham (UC), A. Akbary (UL), D. Stanley (UR), R. Srinivasan (US), M. Laca (UV) and P. Hoff (UW).

PIMS receives funding from NSERC, its member universities, and provincial governments. It also receives contributions from industry and private donors for specific events such as the Hugh C. Morris Lecture Series and Summer Math Camps for Aboriginal Students. Its events are co-sponsored by funding agencies such as the U.S. National Science Foundation (NSF), the U.S. National Security Agency, the U.S. Army, Alberta Advanced Education and Technology (AAET), and other Canadian institutes such as AARMS, the Canadian Institute for Advanced Research (CIFAR), the Canadian Institute for Theoretical Astrophysics, Centre de Recherches Mathématiques (CRM), Fields Institute, Mitacs, Mprime, the Pacific Institute for Theoretical Physics (PiTP), the Perimeter Institute and the Winnipeg Institute for Theoretical Physics, by professional societies such as the American Mathematical Society (AMS), American Statistical Association (ASA), Association for Logic Programming, CAIMS, Canadian Association of Physicists, CMS, Canadian Number Theory Association, The Canadian Society for History and Philosophy of Mathematics, International Association for Cryptologic Research (IACR), International Linear Algebra Society, International Mathematical Union (IMU), Mathematical Association of America (MAA), Society of Actuaries, Society for Industrial and Applied Mathematics (SIAM), SMM, Society for Mathematical Biology (SMB), and Statistical Society of Canada (SSC), and by international partner institutions such as the CNRS, IMA, MSI, PRIMA, Research Institute for Mathematical Sciences (RIMS), and Universidad Nacional Autónoma de México. Other partners include the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems (Australia), Australian Mathematical Sciences Institute (AMSI), Australian Mathematical Society, Bishop's U, BC Centre for Disease Control, BC Oil and Gas, BIRS, Boise State U, Center for Analysis and Modelling of Security, CIBC, Capital One, Center for Analysis and Modeling of Security, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS), Central Michigan U., Centre for Experimental and Constructive Mathematics (CECM), Centre International de Mathématiques Pures et Appliquées, Centro de Investigación en Matemáticas (CIMAT), Centro de Modeliamiento Matematico, CERTICOM, Clay Mathematics Institute, D-Wave Systems, ENCORA, Federal Interlocutor for Métis and Non-status Indians, FP Innovations, Golden Key, Gouvernement de Benin, Grant MacEwan U., Hokkaido U., H.R. MacMillan Space Centre, Institute of Electrical and Electronic Engineers (IEEE), Institut des Hautes Études Scientifiques, Institute for Canadian Urban Research Studies, Institute for Pure and Applied Mathematics, Institute of Industrial Mathematics, Interdisciplinary Research in the Mathematical and Computational Sciences Centre (IRMACS), International Centre for Theoretical Physics, Ion Torrent, JackTek System Ltd., JMP, J. Templeton Foundation (USA), Kyoto U. Global COE Program, Luther College, Mathematical Sciences Research Institute (MSRI), MapleSoft, Microsoft Research, Modelling of Complex Social Systems, Mount Royal U, National Institute for Mathematical and Biological Synthesis (NIMBioS), Nelson Education, North Dakota State U, the Number Theory Foundation, the (U.S.) Office for Naval Research, Okanagan College, Pacific Bioscience, Pearson, the Prairie Network for Research in the Mathematical Sciences (PNRMS), Quantum Works, Quest 4D, Reed College, RFEC Americas, SAS, Schlumberger, Science World (Vancouver), SEAMOCS, Seoul U., Shell Canada, Springer-Verlag, Stanford U., StataCorp, Statistical and Applied Mathematics Institute (SAMSI), Swedish Foundation for International Cooperation in Research (STINT), SYREON Corp., TD Bank, Telus Spark, Tutte Institute, U Abomey Calavi, U Bourgogne, U California (Santa Barbara), U Guelph, U Manitoba, U Montréal, U New South Wales, U Oregon, W.H. Freeman & Co., Wiley and York U.

The PIMS annual budget is approximately $3.4 million, with roughly one-third of this amount coming from NSERC.

6. PIMS EDUCATIONAL AND OUTREACH ACTIVITIES

PIMS has a mandate to promote mathematics vigorously in Canada, and takes upon itself the mission to help provide the elements for success that are necessary for current and future generations of teachers, scientists and engineers. In addition, the educational programs at PIMS advocate strongly for, and find models and activities to facilitate, the participation of people of all backgrounds in mathematics. PIMS is actively involved in promoting mathematical outreach events in schools throughout Western Canada, either directly or through mechanisms such as regional science fairs. These involve students, teachers and parents and seek to convey the excitement of discovery and learning that underlies mathematics and its applications.

PIMS has developed a partnership with First Nations schools in BC that has been supported by the provincial government as well as by private donors. The activities under this program include summer camps for students, teacher training sessions, and a coordinated mentoring program where undergraduate students from universities work with local teachers and students to provide support in mathematics.

Colleges and universities within the BC and Alberta post-secondary systems that do not qualify for regular membership in PIMS may become *PIMS Education Associates*. The PIMS educational network allows for the exchange of successful practices in outreach, teaching, and professional development amongst its members. Currently PIMS has nine educational associates in Alberta and British Columbia.

7. PIMS NEWS IN 2012

- In August PIMS Central moved to a new home. We now have a 20% larger facility on the 4th floor of the brand new Earth Sciences Building on the Main Mall at UBC. Our new space includes a reception area, offices for administration, offices for up to 24 visitors and postdoctoral fellows, and workspace for 10 students in our graduate student lab. We have meeting rooms, workrooms and a state of the art videoconferencing centre. Our site also includes a library and lounge, and we have access to classroom facilities and larger meeting areas one floor above us. The building also features a large atrium and a café.
- The University of Lethbridge officially became a full member of PIMS on July 1st, with A. Akbary as the first site director. PIMS now has all the major research universities in Alberta, BC, Saskatchewan and Washington State as full members of its consortium.
- Under Director Daniel Coombs the PIMS IGTC in Mathematical Biology continues to flourish, attracting outstanding local and international graduate students, as well as world-class visitors and speakers. In particular the training centre has been extremely successful in fostering student research (with over 75 papers published since 2008, including several in top scientific journals) and career development (centre alumni are moving into excellent positions in academia and elsewhere). A top priority is to continue seeking expanded and diversified funding sources for the program, to allow the program to increase student funding and compete for the most exceptional graduate students. In this goal they have already seen success, having secured external funding which allowed further awarding of IGTC Fellowships in 2012. §II.2.B contains more reporting on the IGTC.
- Former director of the PIMS IGTC, Professor Mark Lewis (UA) was awarded a prestigious Killam Fellowship. Lewis' research focuses on the 'Mathematics Behind Biological Invasions'. This work will have an impact on Canada's ability to proactively combat invasive species with early detection and rapid response. Professor Lewis plans to develop mathematical model structures to better detect and fight against harmful species such as weeds, insect

pests, and aquatic pests that threaten ecosystems.

- Grégory Miermont (U Paris-Sud) received a European Mathematical Society Prize at the 6th European Congress of Mathematics in Krakow, Poland. He was awarded the prize "for his outstanding work on scaling limits of random structures such as trees and random planar maps, and his highly innovative insight in the treatment of random metrics." Miermont visited PIMS and the Mathematics Department at UBC during the 2011-12 academic year, funded by the French CNRS through the Unité Mixte Internationale established at PIMS in 2007.

- The Canadian Mathematical Society (CMS) awarded Melania Alvarez of PIMS/UBC the 2012 Adrien Pouliot Award in recognition of her sustained contributions to mathematics education in Canada. Although much of her focus is on working with First Nations students, Alvarez also plays an active role in promoting mathematics amongst the general population. Alvarez›s work was featured in the Globe and Mail in December 2012. This is the second year in a row that a PIMS Education Coordinator was awarded this prize; Malgorzata Dubiel of SFU won it in 2011.

- The robustness of PIMS educational efforts is reflected by its funding successes this past year: PIMS was awarded (i) $60,000 from the Vancouver Foundation for First Nations and K-12 Inner City Outreach, and (ii) $100,000 from the Government of Saskatchewan for First Nations, Inuit and Métis mathematical education, including Math on the Move, Math Central, teacher workshops and mentorship programs, and extended math summer camps (to start in 2013).

- The Milner Foundation awarded a $3 million Fundamental Physics Prize to A. Kitaev of Caltech, who was recognized for transformative advances in fundamental physics. He was a PIMS Distinguished Chair at UBC in October 2006, as part of the CRG on Quantum Topology sponsored by PIMS during 2005-2007.

- After many years of service, PIMS UV Educational Coordinator D. Leeming has retired. He has been replaced by A. Gracia-Saz. This summer PIMS welcomed a new site director: M. Laca at UV; he replaced I. Putnam on July 1. At US, R. Srinivasan has taken a sabbatical; his duties have been assumed by C. Soteros.

- Finally, A. Adem (UBC) has been appointed to a second 5-year term as Director of PIMS beginning July 1, 2013.

- More information about PIMS can be obtained under "PIMS News/Press" at *www.pims.math.ca* and in "Year in Review" at *www.pims.math.ca/resources/publications/pims-year-review.*

PIMS efforts are focused in several overlapping directions: scientific, postdoctoral training, and educational. We discuss actual and planned activities as well as accomplishments in these areas below.

1. SCIENTIFIC EVENTS

PIMS enables and funds Collaborative Research Groups (CRGs) and their thematic activities, the International Graduate Training Centre (IGTC) in Mathematical Biology and its training events, and occasional Special Focused Periods. PIMS also sponsors and facilitates stand-alone conferences and workshops, runs summer schools for graduate students, finances lecture and seminar series, and cultivates interactions between academia and industry via various industrial activities. These activities typically take place at PIMS institutions around the Pacific Northwest and Prairie Provinces, but PIMS also has an international presence.

A. Numbers and Types of Activities

Collaborative Research Groups: *Collaborative Research Groups* (CRGs) consist of researchers with a common interest, and with a desire to collaborate in developing aspects of their research programs. Groups organize focused periods, including workshops and summer schools as well as seminars, make joint postdoctoral fellowship (PDF) appointments, or develop joint graduate training programs. CRGs are designed to promote and support long term, multi-event, multi-site coordinated activities. During its period of operation, typically 3-4 years, a CRG can expect to receive priority access to the full gamut of PIMS resources and benefit from collaborations with other institutes or funding agencies. CRGs will sometimes concentrate their activities in a focused period, but more often their events are spread out over 2-3 years. See *www.pims.math.ca/scientific/collaborative-research-groups* for more information.

International Graduate Training Centre: Recognizing the importance of mathematics in biology, PIMS created the IGTC in Mathematical Biology in 2007. This has served as the core of a specialized graduate program shared between several PIMS universities. PIMS serves as a catalyst by supporting the program with summits, workshops, and summer schools; bringing international students to them, arranging for distinguished visitors to teach in the program, and awarding fellowships. See *www.pims.math.ca/scientific/graduate-training-igtc.*

Conferences and Workshops: PIMS organizes and/or funds a variety of meetings around North America and the Pacific Rim each year. These range from small one-day workshops to multi-week conferences involving hundreds of participants. The larger meetings are selected each year on a competitive basis by the SRP. Smaller events are often funded at the discretion of the Director and Deputy Director.

PIMS also hosts or cosponsors several meetings by professional societies such as the CMS, CAIMS, CNTA, IEEE and SSC.

Summer Schools: Every year PIMS runs a number of topical summer schools. They are intended to educate graduate students and early career researchers on current developments.

Special Focused Periods: These intensive non-CRG activities each cover a specific but substantial area of research of current importance to Canada, with participants ranging from students to world experts in the mathematical sciences. Special Focused Periods are special opportunity events depending on current mathematical trends and collaborative prospects. They often take place in the summer and vary in length depending on the discipline. Proposals are evaluated

by the PIMS SRP to ensure the highest scientific quality and appropriateness of the subject.

Lecture and Seminar Series: PIMS supports various ongoing seminar series at member universities and industrial centers throughout the year. Some of these are for specialists, while others are geared towards the general public, with the goal of inculcating in the citizenry the importance of mathematical research and its applications.

Industrial Activities: PIMS also fosters collaborations with industry. *Industrial Problem Solving Workshops* (IPSW) are based on the Oxford Study Group Model, in which problems of interest to participating industrial companies are posed to the workshop attendees. Participating graduate students and faculty spend five days working on the problems, and the results are published. The advantages for participating students and academics are: (i) the challenge of applying one's skills to new and relevant problems directly applicable to industry, (ii) the opportunity for continued collaboration with the workshop's academic and industrial participants, and (iii) advancing mathematics by demonstrating to businesses and governments the tangible benefits of supporting the mathematical sciences. The IPSW are held annually, rotating between PIMS, Fields and CRM. PIMS' next opportunity to host an IPSW will be in 2014.

Mathematical Modelling in Industry Workshops (MMIW) enable graduate students from North American universities to learn various aspects of high-level techniques for solving industrial mathematics problems. Since 2010, these camps have been co-sponsored by the IMA and rotate between the two countries; the 2013 MMIW will be held in Minneapolis.
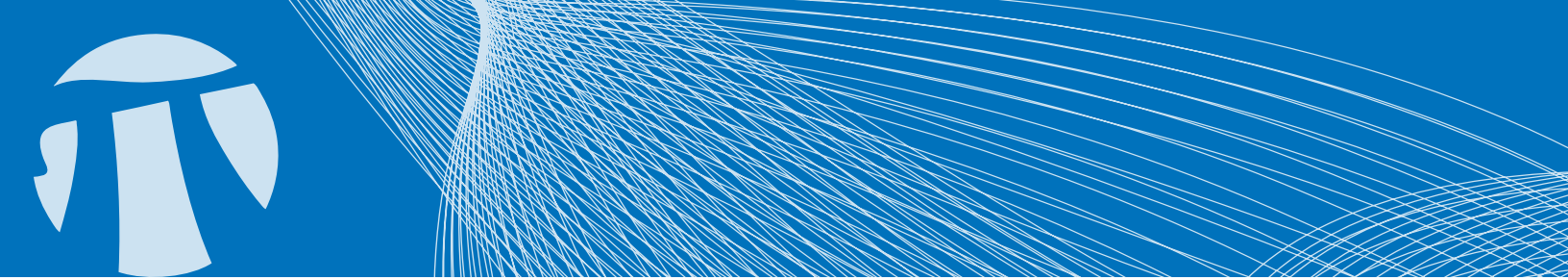
As well, industrial workshops, short courses, mini-courses, summer schools, and seminar series are organized by PIMS researchers, with topics of interest to both industry and academia, which serve to disseminate newly developed mathematical tools that can be of use in industry. For instance, with the sponsorship of Shell Canada Limited, PIMS presents a series of lunch hour lectures at Calgary Place Tower 1. These lectures, given by experts from the PIMS universities, focus on mathematical techniques and applications relevant to the oil and gas industry and demonstrate the utility and beauty of applied mathematics. The talks (3 in 2012) are aimed at a general audience. *www.pims.math.ca/industrial* has more information.

Figure 1: Numbers of each type of activity supported by PIMS by year.

Activity	2011	2012	2013
Conferences/Workshops	44	39	34
Summer Schools	4	9	6
Collaborative Research Groups	5	6	6
Lecture and Seminar Series	20	24	27
Industrial Activities	5	4	7
Other	24	20	12

Note: The category "Conferences/Workshops" includes CRG events, Special Focused Period activities as well as IGTC events. Activities to be co-sponsored by AARMS in 2013 are not known at this writing. We expect there will be 4-5 of these that we have listed under "Other."

All activities are listed individually below, along with *selected* highlights, as well as expanded summaries of two showcase events, so as to give a taste of what PIMS does. The sheer number of PIMS endeavors precludes us from doing much more than merely mentioning them here; however, details about specific activities can be obtained at *www.pims.math.ca* or by request. Such details typically include lists of organizers and plenary speakers, titles and abstracts of

talks, scientific background and summaries, schedules, etc. Because of their importance, more detail is given on the CRGs, PIMS support for AARMS and the IGTC in §§II.1.D–E and II.2.B following.

B. Listing of Activities: 2012

Conferences and Workshops

1. *The Eleventh Colloquiumfest,* US, February 3-4.
2. *Frontiers in Biophysics 2012,* SFU, February 11.
3. *Dispersive PDE,* UV, February 25.
   - ➢ Progress was made in understanding of non-compactness of Sobolev embeddings, which may prove useful is solving global well-posedness problems for 2D energy-critical PDEs.
4. *UBC/SFU Graduate Student Workshop in Statistics,* SFU-Vancouver, March 17.
5. *26th Automorphic Forms Workshop*, UBC, April 26-29.
6. *Cascade Topology Seminar*, UBC, April 28-29.
   - ➢ Two highlights were the talks by Ian Hambleton (McMaster) on "Finite Group Actions on Kervaire Manifolds" & Jack Morava (Johns Hopkins) on "Theories of Anything".
   - ➢ This meeting was dedicated to the 70th birthday of Dale Rolfsen.
7. *North-South Dialogue in Mathematics,* UA– St. Jean, May 3-4.
   - ➢ Jean-Marie De Koninck (U Laval) spoke on "The Secret Life of Mathematics" while Robert McCann (U Toronto) discussed "Geometric Variational Problems in Economics."
8. *2012 Prairie Discrete Math Workshop* (PDMW), UC, May 4-5.
9. *Pacific Northwest Geometry Seminar,* UBC, May 5-6.
10. *West Canada Linear Algebra Meeting 2012*, UL, May 12-13.
    - ➢ Talks ranged from the purely theoretical "Local-to-Global Properties of Semigroups of Matrices" to the most practical "Randomized Spectral Divide-and-Conquer: a Communication-Optimal Approach to the Non-symmetric Eigenproblem."
11. *2012 International Symposium on Multiple-Valued Logic*, UV, May 14-16.
12. *Connections Between Algebra and Geometry*, UR, May 29-June 1.
13. *Workshop on Representation Theory of Groups, Lie Algebras, and Hopf Algebras*, UR, May 31-June 1.
    - ➢ R. Srinivasan's lecture brought participants up to date on progress on the modular representations of the finite general linear groups.
    - ➢ M. Lau and L. Cagliero's lectures on the representation theory of Lie algebras gave a fresh perspective to the modern constructions of modules and the study of affine Lie algebras.
14. *Theory Canada 7*, UL, June 7-9.
    - ➢ Gordon Semenoff talked on using holography and string-theoretic techniques to understand graphene.
15. *The Stability of Coherent Structures and Patterns*, UW, June 11-12.
16. *Canadian Number Theory Association Conference* (CNTA XII), UL, June 17-22.
    - ➢ "There were some great breakthroughs, none more so than the great new results of M. Bhargava and of T. Wooley."
    - ➢ "[There were] a lot of significant advances of young number theorists."
    - ➢ Helfgott's announcement that the ternary Goldbach conjecture was within reach was a highlight.

17. *Celebration of the 100th Birthday of Alan Turing,* UV, June 22.
    - ➢ Educational and inspirational lectures brought attention to the mathematical underpinnings of computer science and the significance of the contributions of Alan Turing, including one presentation by a cryptanalyst who worked with him at Bletchley Park.
18. *Differential Schemes and Differential Cohomology*, UC, June 25-26.
19. *PIMS Young Researchers Conference*, UC, June 25-28.
    - ➢ 3 mini-workshops focused on mathematical software (R, SAGE, MATLAB), and a panel discussion on employability and careers in math and stats attracted industry representatives from MITACS, Corning, Boeing, CGG Veritas, CSEC, and Alberta Health.
20. *Optimization Workshop,* UBC-O, July 9-11.
    - ➢ This free workshop for UBC-O undergraduates featured two real-world applications of optimization: "Robust Methods for Awesome Geophysical Inverse Problems" and "Operations Research in Industry and Finance."
21. *Canadian Undergraduate Mathematics Conference*, UBC-O, July 11-15.
22. *Workshop on Cohomology and Support in Representation Theory and Related Topics,* UW, August 1-5.
23. *Joint Alberta-British Columbia 4-day Harmonic Analysis Seminar*, UBC, August 7-10.
24. *Computational Math Day 2012*, SFU, August 8.
25. *Canadian Conference on Computational Geometry*, UPEI, August 8-10.°
    - ➢ G. G. Ziegler gave an overview of how a seemingly simple problem was resolved using only very sophisticated results from several different branches of mathematics.
26. *Miniconference on Combinatorial Models*, SFU, August 13
27. *3rd conference of the Canadian Prairie Theoretical Physics Network,* First Nations University/UR, August 21-22.
    - ➢ Leroy Little Bear, a physicist from UL, gave the keynote address on philosophical topics in theoretical physics from a First Nations perspective.
28. *PIMS Hot Topics Workshop on Computational Criminology*, SFU, September 19-21.
    - ➢ Main themes were data analysis in criminology, PDE models for crime hotspots and game theory and agent-based models.
    - ➢ This was a workshop based on computational criminology, an emerging field that takes the growing need for improved ways to use mathematics and computational techniques in understanding crime patterns and in developing methods for predicting and forecasting crime.
    - ➢ A highlight was the use of game theory to deploy resources for airport security.
29. *Mathematical Biology Workshop* and *IGTC Summit*, Naramata, BC, October 12-14.
30. *Canadian Undergraduate Physics Conference,* Vancouver, October 25-29.
    - ➢ The CUPC is the largest undergraduate physics conference in North America.
    - ➢ Plenary lectures were given by Jocelyn Bell Burnett, FRS (the discoverer, as a graduate student, of pulsars) and Erich Vogt, OC (the founder of TRIUMF).
31. *UBC/SFU Graduate Student Workshops in Statistics*, SFU-Vancouver, September 29.
32. *West Coast Optimization Meeting*, UBC, October 6.
33. *Northwest Probability Seminar*, Microsoft Research, October 13.
    - ➢ The Birnbaum Lecture in Probability was given by Jeff Steif (Chalmers U of Technology) on "Boolean Functions, Noise Sensitivity, Influences and Percolation."
34. *Pacific Northwest Numerical Analysis Seminar*, Boise State U., October 27.
35. *Interdisciplinary aspects of the Riemann Zeta Function,* SFU, November 1-2.
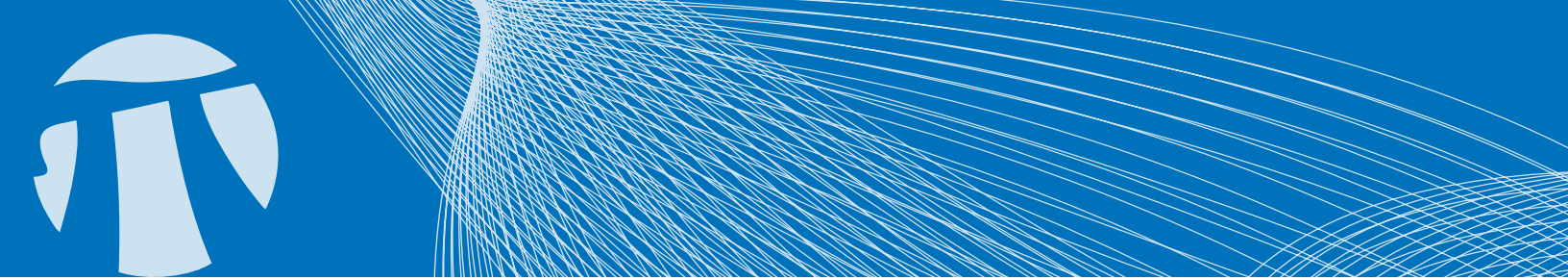
- ➢ This event went beyond traditional treatments, and explored computer applications, conjectures across various fields, and recent, perhaps surprising developments that involve the Riemann zeta function.
- ➢ The keynote speakers were Richard E. Crandell (Reed College) and Sir Michael Berry, FRS (Bristol).

36. *Bellingham Algebraic Geometry Seminar*, Western Washington U, November 10.
37. *Combinatorial Potlatch,* SFU, November 17
    - ➢ Ron Graham (UCSD) spoke on "The Combinatorics of Solving Linear Equations.
38. *Cascade Topology Seminar*, U Oregon, December 1.
39. *2012 Symposium on Immune Cell Modeling*, UBC, November 8.

Summer Schools

1. *The Second PIMS-Mprime-CDM Summer School on Mathematical Modeling of Infectious Diseases*, UA, May 17-27.
2. *PIMS-Mprime Summer School in Probability 2012,* UBC, June 4-29.
3. *SMS Probabilistic Combinatorics*, U Montreal, June 25-July 6.
    - ➢ The focus was on discrete Markov Chains and new techniques for understanding structural properties of deterministic and random graphs.
4. *PIMS-SFU Undergraduate Summer School in Algebraic Graph Theory*, SFU, July 2-27.
    - ➢ Concentrated on gathering experimental and theoretical evidence surrounding Graham's Conjecture on tree reconstruction; Graham's Conjecture has now been verified by computer for trees up to a certain size and for certain special families of graphs.
5. *Winter School on Geometric PDEs*, U Queensland, Brisbane, July 2-13.
6. *West Coast Algebraic Topology Summer School,* Stanford U, July 16-21.
7. *Fluid Dynamics Summer School*, UA, July 23-27.
    - ➢ This Summer School was highlighted in an invited talk in the Educational Session at the annual meeting of the American Physical Society Division of Fluid Dynamics.
8. *Summer School on Cohomology and Support in Representation Theory and Related Topics,* UW, July 27-30.
9. *Two Weeks at Waterloo - A Summer School for Women in Math*, U Waterloo, August 12-25.
    - ➢ 16 outstanding female undergraduate math students took part.
    - ➢ Two mini-courses were offered, "Introduction to Elliptic Curves," by M. Lalin (U Montreal) and "Introduction to Math Biology," by G Wolkowicz (McMaster U).
    - ➢ Three guest lectures by prominent women mathematicians were given, including one public lecture, and one lecture was given by a pair of women working in industry. Tours were made to meet with female mathematicians in industry at IBM, Manulife and Maplesoft. The students also visited the Fields Institute.

Collaborative Research Groups†

1. CRG 20 - *Operator Algebras and Non-commutative Geometry,* 2009-2012.
2. CRG 21 - *L-functions and Number Theory,* 2010-2013.
3. CRG 22 - *Mathematics of Quantum Information,* 2010-2013.
4. CRG 23 - *Applied and Computational Harmonic Analysis,* 2011-2014.
5. CRG 24 – *Optimization: Theory, Algorithms and Applications*, 2012-2015.
6. CRG 25 – *Algorithmic Theory of Networks*, 2012-2015.

Lecture and Seminar Series

1. *Math of Planet Earth Public Lectures*, Fields Institute, June 24-25.*
   - Three talks on "*Motility: Molecules, Mechanics, Mathematics and Machines," "Puzzles in the Patterns of Plagues"* and *"Using Mathematics to Combat Climate Change"* were presented by L. Mahadevan (Harvard U), D. Earn (McMaster U) and R. Dembo (Zerofootprint), respectively.
2. *PIMS Number Theory CRG Seminar Series,* UC, ongoing.
3. *UW-PIMS Colloquium,* UW, ongoing.
   - Fields Medalist Edward Witten spoke on "Gauge Theory and Khovanov Homology" in February.
4. *PIMS/UBC Distinguished Colloquium Series,* UBC, ongoing.
   - Fields Medalist Fields Medalist and Wolf Prize Recipient Gregory Margulis spoke on "Homogeneous Dynamics and Number Theory" in March..
5. *PIMS Distinguished Lecture Series,* UR, ongoing.
6. *The AMI Seminar Series,* UA, ongoing.
7. *Niven Lecture,* UBC, May 24.
   - L. Mahadevan (Harvard U) spoke "On Growth and Form: Geometry, Physics and Biology."
8. *PIMS Voyageur Colloquium,* UC, ongoing.
9. *CS Distinguished Colloquium Series*, UBC, ongoing.
   - Turing Award Winner, Judea Pearl, lectured.
10. *The PIMS Marsden Memorial Lecture,* Fields Institute, July 25.
    - Richard Montgomery (UCSC) found "An Octahedral Gem Hidden Inside Newton's Three Body Problem."
11. *Applied Mathematics Seminar,* US, ongoing.
12. *PIMS/CSC Distinguished Lecture Series*, SFU, ongoing.
13. *CRM-Fields-PIMS Prize Lecture,* UBC, April 4.
    - Stevo Todorcevic (U Toronto) delivered a lecture on "Structure Theory of Ramsey Spaces and Some of its Applications."
14. *SFU Discrete Math Seminar,* Simon Fraser University, ongoing.
15. *SCAIM Seminar Series,* UBC, September 2011 – August 2012.
16. *IAM-PIMS-MITACS Distinguished Colloquium Series,* UBC, ongoing.
17. *PIMS Postdoctoral Colloquium Series,* UBC, ongoing.
18. *Hugh C. Morris Distinguished Lecture,* UC, November 1.
19. *MITACS/PIMS Mathematical Biology Seminars,* UBC, ongoing.
20. *MathAcrossCampus Colloquium Series*, UW, ongoing.
21. *PIMS Mathematics of Quantum Information Seminar Series,* UC, ongoing.
22. *PIMS_VanBUG Seminar*, Vancouver, September 13.
23. *R&L Guy Public Lecture Series,* UC, ongoing.
    - Ravi Vakil of Stanford spoke on "The Mathematics of Doodling."
24. *PIMS Public Lecture Series,* UBC, ongoing.
    - K. Golden and R. Lang spoke on the melting polar icecaps and origami.

International Graduate Training Centre in Mathematical Biology

1. *Mathematical Cell Biology Summer Course*, UBC, May 1-31.

2. *Mathematical Biology Workshop* and *IGTC Summit*, Naramata, BC, October 12-14.
3. *2012 Symposium on Immune Cell Modeling*, UBC, November 8.

Industrial Activities
1. *PIMS/Shell Lunchbox Lecture Series*, Calgary.
2. *Monte Carlo Methods for Quantitative Finance*, SFU-Vancouver, February 22-24.
3. *Mathematical Modeling in Industry Workshop*, UC, June 18-27.
4. *Gene Golub SIAM Summer School,* Monterey, CA, July 29-August 10.
   ➢ There were 3 main focus areas: Tsunami and Storm-Surge Simulation, Numerical Methods for Wave Propagation, and Supercomputing: From Multi- to Many-Core Platforms.

Other: PIMS provided administrative, financial and/or travel support for a number of activities and organizations, including:
1. *Centennial Celebration at the University of Alberta,* May 1, 2011-April 30, 2012.
2. *PIMS Distinguished Lecturer* (Thomas Scanlon), UBC, January 6-12.
   ➢ He gave "A Logician's View of Diophantine Geometry."
3. *PIMS Distinguished Lecturer* (Vern Paulson), UR, March 2-6.
4. *Fifth Northwest Functional Analysis Symposium,* Banff, March 30-April 1.
5. *PIMS Distinguished Lecturer* (Pascal Lambrechts), UR, April 3-25.
6. *CMS Summer Meeting,* Edmonton, June 2–4.
7. *SSC Annual Meeting,* U Guelph, June 3-6.
8. *AARMS Summer School,* Memorial U, July 16-August 10.º
9. *CAIMS Annual Meeting,* Toronto, June 24-28.
10. *PIMS Distinguished Lecturer* (Michael Overton), UBC, July-August.
11. *Groups, Rings and Lie and Hopf Algebras III,* Bonne Bay Marine Station, NL, August 12-18.º
12. *PIMS Distinguished Lecturer* (Robert McCann), UBC, August.
    ➢ He presented a series of lectures on optimal transportation.
13. *PIMS Distinguished Lecturer* (Peter Schneider), UBC, fall semester.
    ➢ He taught a graduate course on *p*-adic Hodge theory at UBC.
14. *CRG 25 Organizational Meeting,* Victoria, October 9.
15. *Turing Award Winner Les Valiant,* UV, October 10.
    ➢ Explained how biological evolution can be viewed as a form of learning.
16. *34 Annual Meeting of Alberta Statisticians,* UA, October 20.
17. *PIMS/UBC Grad Student/Postdoc Job Forum,* UBC, October 22.
18. *Open Problems in Mathematical Epidemiology,* UBC, December 5-6.
19. *CMS Winter Meeting,* Montreal, December 7-10.
20. *American Women in Mathematics* Mentor Network.

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* Starred events are part of *The Mathematics of Planet Earth 2013 Program.*

º Circled events are co-sponsored with and organized by AARMS.

† Although it formally ended in 2011, CRG 19 on *Partial Differential Equations* still had two active postdocs in 2012.

In the following section, we highlight two of our 2012 events in depth, so as to illustrate the types of activities that PIMS sponsors.

PIMS-Mprime Summer School in Probability 2012, UBC, June 4-29. This major training event attracted over 80 registered participants from India, China, Japan, Israel, Poland, Germany, France, United Kingdom, Netherlands, Brazil, Mexico, and of course from the U.S. and Canada. The Summer School was organized by O. Angel, E. Perkins, and G. Slade. Past PIMS Summer Schools in Probability have been held at UBC in 2004, 2005, 2008, 2009 (the latter joint with the CRM), and at UW in 2010.

The format of the PIMS Summer School is unique. The core of the Summer School consisted of two full-length courses, given by O. Angel (UBC) and G. Miermont (CNRS-PIMS), each comprising 24 hours of lectures. This was supplemented by 30 lectures given by Summer School participants themselves; for many their first lecture in an international conference. The two courses were official UBC graduate courses and were taken for academic credit by graduate students. Five keynote lectures were also given, by A. Holroyd (Microsoft), R. Kenyon (Brown), Y. Peres (Microsoft), G. Slade (UBC), and B. Virág (Toronto).

O. Angel's course Interacting Particle Systems focused on the many incarnations of totally asymmetric exclusion processes, and included a presentation of his work with Holroyd et al. on random sorting networks. This is a spectacular example of order coming from complete randomness and although fascinating results have been proved, they remain far away from capturing what the simulations are showing. The resulting conjectures are amazing. Take a randomly chosen sequence of n choose 2 nearest-neighbour swaps which take $1, \ldots, n$ to $n, \ldots, 1$. The rescaled trajectory of a randomly chosen particle will converge to a random sine curve (the amplitude and phase are random). The rescaled halfway permutation matrix (put a 1 in the ith column at the location of the original i) "will" converge to the distribution on the disc obtained by projecting surface area on the 2-sphere. The buzz in the room when these simulations were playing and the conjectures were being made was clearly audible. At the breaks Angel was dealing with crowds of students wanting more.
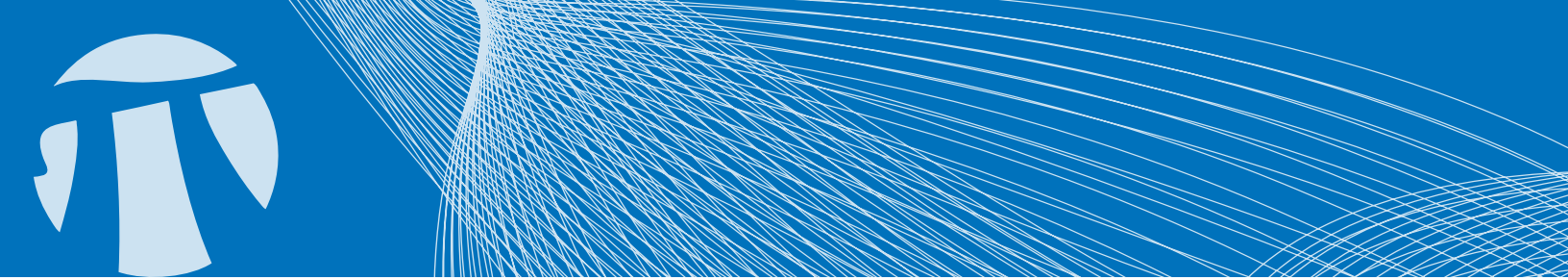
G. Miermont's course on Random Maps focused on a major recent result on scaling limits of random maps that was announced in 2011. Take a randomly chosen graph with n vertices on the 2-sphere with each face bounded by q edges, e.g,. if $q = 3$, this is a triangulation. Equip the resulting graph with the graph distance and rescale by $n^{1/4}$. The resulting random metric spaces then converge in distribution as $n \to \infty$ (i.e., their random statistics converge) to a universal limiting metric space called the Brownian map. The result was the culmination of over ten years of work by many mathematicians, in a marvellous blend of combinatorics, geometry, and probability.

The calibre of the attending students was very impressive. In particular, the large Probability Group at UBC benefitted greatly from all the activities of the Summer School, as did many students from UW.

Mathematical Modeling in Industry Workshop, UC, June 18-27. The workshop brought industrial researchers, mathematicians and graduate students and PDFs together in an intensive workshop devoted to the development and solution of mathematical models of pressing industrial problems. There were 40 students total – 19 from Canadian institutions, one from Mexico and the remainder from the USA.

The workshop consisted of seven projects, with approximately six students per project. They were:

- o Touch Sensing, Silhouettes, and "Polygons-of-Uncertainty" (Corning Incorporated)
- o Validation of Service Concepts for Oil Drilling by Simulation (Siemens)
- o Azimuthal Elastic Inversion for Fracture Characterization (CGGVeritas)
- o Identifying Sugars (National Institute of Standards and Technology)
- o Multi-Objective Design of a Fuel Tank (Boeing)
- o Interactive Treatment Planning in Cancer Radiotherapy (University of California, San Diego)
- o Valuation of Over-the-Counter Derivatives with Collateralization (Royal Bank of Canada)

Further details on the projects and team members is available on the IMA website.

Notable outcomes of this event included an almost 100% level of participant satisfaction (measured by an exit survey) and a significant increase (19% to 58%) in students' interest in industry and industrial mathematics. As well, one of the teams went on to win a prize at the annual SPIE Conference in the SF Bay Area where they presented their work.

C. Listing of Planned Activities: 2013

Conferences and Workshops

1. *Frontiers in Biophysics,* UBC, March 2.
2. *Second Seminar on Dispersive PDEs,* UV, March 9.
3. *UBC/SFU Graduate Student Workshops in Statistics*, SFU-Vancouver, March 16.
4. *Cascade Topology Seminar*, Spring.
5. *Alberta Number Theory Days 2013*, Banff, May.
6. *Pacific Northwest Geometry Seminar,* Portland State U, May.
7. *North-South Dialogue in Math*, UC, May 2-3.
8. *2013 Canadian Undergraduate Mathematics Conference* (CUMC), UC, May 2-3.
9. *2013 Prairie Discrete Mathematics Workshop*, Thompson Rivers University, May 3-4.
10. *10th Annual PIMS Young Researchers Conference in Mathematics and Statistics*, UA, May 21-24.
11. *International Workshop on Perspectives on High Dimensional Data Analysis, III*, UBC, May 23-25.
12. *PIMS/CWOS/CGU/CRWA Math of Planet Earth Joint Meeting*, US, May 26-30.*
13. *Automata Theory and Symbolic Dynamics*, UBC, June 3-7.
14. *CANADAM 2013*, St. John's, NL, June 10-13.°
15. *Workshop on Recent Advances in Hodge Theory: Period Domains, Algebraic Cycles, and Arithmetic*, UBC, June 14-20.
16. *Workshop on Curves and Applications*, UC, June 19-21.
17. *Canadian Quantum Information Students' Conference*, UC, June 24-28.
18. *PRIMA 2013*, Shanghai Jiaotong U, June 24-28.
19. *Rolfsenfest: Low dimensional topology, knots, and orderable groups*, Luminy, France, July 1-5.
20. *Conference on Reversible Computation,* UV, July 4-5.
21. *Analysis and Partial Differential Equations: A Conference in Honour of the 60th Birthday of Nassif Ghoussoub*, UBC, July 7-12.
22. *Recent Trends in Stochastic Analysis*, UBC, July 22-26.
23. *Celestial, Molecular, and Atomic Dynamics* (CEMAD-2013), UV, July 29-August 2.*
24. *Quantum Information and Foundations of Quantum Mechanics*, UBC, July.
25. *Mathematical Congress of the Americas*, Guanajuato, México, August 5-9.
26. *Workshop on Numerical Linear Algebra and Optimization*, UBC, August 8-10.
27. *Selected Areas in Cryptography (SAC),* SFU, August 14-16.
28. *Alberta-British Columbia Seminar in Harmonic Analysis*, UC, Summer.
29. *Northwest Probability Seminar*, Microsoft Research, Fall.
30. *UBC/SFU Graduate Student Workshops in Statistics*, SFU-Vancouver, Fall.

31. *Pacific Northwest Numerical Analysis Seminar, Fall.*
32. *Bellingham Algebraic Geometry Seminar*, Western Washington U, Fall.
33. *Workshop on Hodge Theory in String Theory,* Fields, November 18-22.
34. *Cascade Topology Seminar*, Fall.

Summer Schools

1. *Summer School on Mathematics Behind Biological Invasions,* UA, May 27-June 14.
2. *Summer School on Recent Advances in Hodge Theory: Period Domains, Algebraic Cycles, and Arithmetic*, UBC, June 10-13
3. *Canadian Summer School on Quantum Information 2013*, UC June 17-21.
4. *AARMS Summer School,* MUN, Summer.
5. *Seminaire de Mathématiques Superieures-2013*, CRM-U Montréal, June 24-July 5.
6. *Pan-American Advanced Study Institute in Spatio-temporal Modelling,* Brazil, July 14-25.
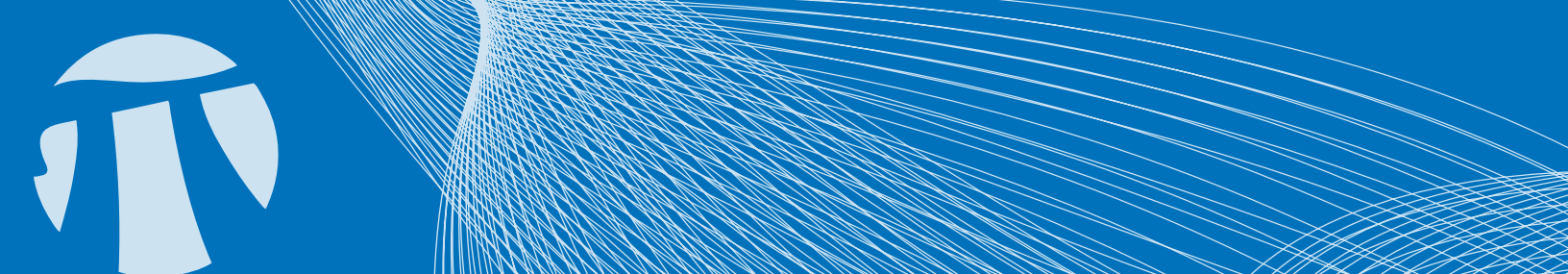
Collaborative Research Groups

1. CRG 21 - *L-functions and Number Theory,* 2010-2013.
2. CRG 22 - *Mathematics of Quantum Information,* 2010-2013.
3. CRG 23 - *Applied and Computational Harmonic Analysis,* 2011-2014.
4. CRG 24 – *Optimization: Theory, Algorithms and Applications*, 2012-2015.
5. CRG 25 – *Algorithmic Theory of Networks*, 2012-2015.
6. CRG 26 – *Geometry and Physics,* 2013-2016.

Special Focused Periods

1. *Celestial Mechanics*, January 1-November 30.*
2. *Models and Methods in Epidemiology, Ecology and Public Health*, January 1-September 30.*

Lecture and Seminar Series

1. *UW-PIMS Colloquium,* U Washington, ongoing.
2. *PIMS-Lethbridge Seminar in Optimization*, UL, ongoing.
3. *Seminar Series on Analysis Of Genetic Data,* UC, May 1-December 31.
4. *PIMS/UBC Distinguished Colloquium Series,* UBC, ongoing.
5. *PIMS Distinguished Lecture Series,* UR, ongoing.
6. *The AMI Seminar Series,* UA, ongoing.
7. *Niven Lecture,* UBC, May.
8. *The PIMS Marsden Memorial Lecture,* the Newton Institute, Summer.
9. *Applied Mathematics Seminar,* US, ongoing.
10. *CS Distinguished Colloquium Series*, UBC, ongoing.
11. *Lethbridge Number Theory and Combinatorics Seminar,* UL, ongoing.

12. *Lectures on the occasion of the year of Mathematics of Planet Earth and the International Year of Statistics,* UNBC, October 1, 2012- April 3, 2013.*
13. *PIMS Voyageur Colloquium,* U Calgary, ongoing.
14. *Anabelian Geometry and Arithmetic Geometry,* UL, UBC, UC, October 1, 2012- October 1, 2013.
15. *PIMS/CSC Distinguished Lecture Series,* SFU, ongoing.
16. *SFU Discrete Math Seminar,* SFU, ongoing.
17. *SCIAM Seminar Series,* UBC, September 2011 – August 2012.
18. *IAM-PIMS-MITACS Distinguished Colloquium Series,* UBC.
19. *PIMS Postdoctoral Colloquium Series,* UBC, ongoing.
20. *CRM-Fields-PIMS Prize Lecture,* SFU, July 18.
21. *Hugh C. Morris Distinguished Lecture Series,* Fall.
22. *MITACS/PIMS Mathematical Biology Seminars,* UBC, ongoing.
23. *MathAcrossCampus Colloquium Series,* U Washington, ongoing.
24. *Quantum Information Seminar Series,* U Calgary, ongoing.
25. *PIMS Public Lecture Series,* UBC, ongoing.
26. *PIMS VanBUG Seminar,* Vancouver, Fall.
27. *R&L Guy Public Lecture Series,* UC, ongoing.

International Graduate Training Centre in Mathematical Biology
1. *Summer School on Mathematics Behind Biological Invasions,* UA, May 27-June 14.

Industrial Activities
1. *Disease Dynamics 2013: Immunization, a True Multi-scale Problem,* UBC, January 17-19.*
2. *UBC Shale Gas and LNG Industry Symposium,* UBC, February 22.
3. *11th International Conference on Applied Cryptography and Network Security 2013,* Banff, June 25-28.
4. *Recent Developments in Numerical Methods for Seismic Inverse Problems and Applications,* UC, July 16-18.
5. *Complex Fluids and Flows in Industry and Nature II,* UBC, July 24-26.
6. *Mathematical Modeling in Industry Workshop 17,* IMA, August 7-16.
7. *PIMS/Shell Lunchbox Lecture Series,* Calgary, ongoing.

Other: PIMS will provide administrative, financial and/or travel support for a number of activities and organizations, including:
1. *2013 Mathematical Institutes Open House & Mathematics of Planet Earth 2013 US Launch,* San Diego, January 9.*
2. *PIMS Distinguished Lecturer:* Frits Beukers, SFU, April 28-May 10.
3. *CANSSI Annual Meeting,* UA, May 25.
4. *Statistical Society of Canada Annual Meeting,* UA, May 26-29.
5. *CMS Summer Meeting,* Halifax, June 4-7.
6. *CAIMS Annual Meeting,* Québec City, June 16-20.
7. *PIMS Distinguished Lecturer:* Ivar Ekelund, UBC, July.

* Starred events are part of *The Mathematics of Planet Earth 2013 Program.*

º Circled events are co-sponsored with and organized by AARMS.

D. CRG Status Reports

PIMS had 6 active CRGs in 2012; below we briefly summarize current and upcoming activities and list their PDFs. In 2013 PIMS inaugurated two new CRGs, #24 on *Optimization: Theory, Algorithms and Applications,* which is based at UBC-O, with nodes at UBC, UC and UV, and #25 on *Algorithmic Theory of Networks* based at SFU with nodes at UV and UBC. CRG #26 on *Geometry and Physics* will kick-off in 2013, and PIMS is currently considering letters of intent for new CRGs in following years.

CRG 20: Operator Algebras and Non-commutative Geometry (2009–2012)

Leaders: D. Farenick (UR), M. Laca (UV), A. Lau (UA), I. Putnam (UV).

2012 Activities:
- PIMS Distinguished Lecturer V. Paulson (U Houston), March.
- Visitors: C. Skau (Trondheim), Spring and K. Thomsen (Aarhus), Spring.
- This CRG is winding down; however, several PDFs remain active.

2013 Activities: This CRG ended in 2012.

PDFs: Antoine Julien (UV, 2010-2012).

CRG 21: L-functions and Number Theory (2010–2013)

Leader: Matthew Greenberg (UC).

2012 Activities:
- *PIMS CRGs Seminar Series.*
- *West End Number Theory Seminars.*
- *12th Meeting of the Canadian Number Theory Association* (CNTA 12), UL, June 17-22.
- The CRG was also deeply involved in the planning and execution of *Sage Days 36*. This workshop took place February 19-23 at UCSD and focused on *p*-adic numbers and associated structures in Sage.

2013 Activities (Planned): This CRG completed its main thematic activity in 2012, although several postdocs remain active.

PDFs: J. Jia (UBC, 2010-2012), C. Marks (UA, 2011-2013), B. Ce (UC, 2011-2013), D. Roe (UC, 2011-2013).

Highlights: During the first two weeks in July 2011, at the Mathematisches Forschungsinstitut Oberwolfach, a CRG focused research group worked on a geometric approach to the local Langlands correspondence as it pertains to algebraic groups over *p*-adic fields. This research group met for one week in May 2012 at (BIRS) to continue this

project.

CRG 22: The Mathematics of Quantum Information (2010–2013)

Leaders: Barry Sanders (UC), Robert Raussendorf (UBC), Petr Lisonek (SFU), Aram Harrow (UW).

2012 Activities:

- *Quantum Information Seminar Series.*
- Joint UBC-SFU course on topological methods in quantum error correction, January- April.
- Visitors: L.C. Kwek (U Singapore) visited UBC (18 -20 July) and UC (23-27 July); C. Brell (U Sydney) visited UBC (27 August – 1 September); D. Browne (U College London) visited UBC (27 August – 1 September); N. Schuch (U Aachen) visited UW (10-14 September) and UBC (18-20 September 2012); J. Eisert (Freie U) visited UBC (11-12 September); M. Grassl (National U Singapore) visited SFU (4 October), UBC (9 October) and UC (10 October).
- Inter-node collaboration: M. Amin (IQC, DWave Systems) visited UC (25 January), V. Gheorghiu (UC) visited SFU (6-8 February) and UBC (8-10 February), R. Choi (UC) visited SFU (6-8 February) and UBC (8-10 February), G. Gour (UC) visited UBC (22 February), P. Barclay (UC) visited UBC (12 September) and UW (13 November), P. Pham (UW) visited UBC (14-20 September), and K. Michnicki (UW) visited UC (26 September).

Future Activities (Planned):

- *Canadian Summer School on Quantum Information 2013*, UC June 17-21.
- *Canadian Quantum Information Students' Conference*, UC, June 24-28.
- *Quantum Information and Foundations of Quantum Mechanics*, UBC, July.

PDFs: R. Dridi (UC), V. Gheorghiu (UC), Maritza Hernandez (UBC), N. Lovett (UC), V. Singh (SFU), C. Trail (UC), Y. Wang (UC).

Graduate Students: UBC-3, UC-9, UW-7.

Highlights:

- *Quantum Codes:* All four nodes are working on quantum codes now and the CRG has enabled valuable dialogue and exchange between the various nodes, as well bringing in quantum coding experts as visitors, to enable high-quality research in this area within the CRG. Quantum codes are valuable to protect quantum information in efficient ways.
- *Models of Quantum Computing:* UBC and UC are working on models of quantum computing, i.e., on different ways to realize universal quantum computation.
- *Open Quantum Systems:* In the UC group, quantum simulation has been commenced for open quantum systems. The idea of quantum simulation is to employ quantum computers to compute properties of dynamically changing systems. Preliminary results show that open quantum systems are indeed efficiently simulatable on a quantum computer under the assumption that individual particles interact with separate environments.

CRG 23: Applied and Computational Harmonic Analysis (2011-2014)

Leaders: Bin Han (UA), Rong-Qing Jia (UA), Elena Braverman (UC), Ozgur Yilmaz (UBC).

2012 Activities:

- *Alberta-British Columbia Seminar in Harmonic Analysis*, UBC, August 7-10.
- Visitors: A. Ron (U Wisconsin-Madison, April 3-6), X. Wang (Shanghai U, May-August), Y. Wang (Michigan State U, August 6-9), R. Saab (Duke U, August 6-11), S. Gunturk (Courant Institute., August

6-11), Q. Mo (Zhejiang U, September 14-November 30), Y. He (Xi'an Jiaotong U), L. Cao (Chinese Acad. Sci., July 29-August 25), R. Chan (Hong Kong Chinese U., August 21-28), and S. Li (Zhejiang U., July 29-August 20), Ben-qi Guo (U Manitoba), H. Jiang (Bell Labs), C.-K. Lin (Nat. Chiao-Tung U), K. Nandakumar (LSU).

Future Activities (Planned):
- *Alberta-British Columbia Seminar in Harmonic Analysis*, UC, Summer, 2013.
- Visitors: 1 planned for February.

PDFs: E. Au-Yeung (UBC, 2011-2013), K. Wang (UA, 2012-2013), Yi Shen (UA, 2012), X. Zhuang (UA, 2012), M. Ghavi (UA, 2012).

Students: 7 Ph.D. and 8 M.S., at UA, UBC, UV and UC.

Highlights:
- The UV research group has been working on triangle-mesh representations of images.
- During the past year the UC group obtained some important results in the area of elliptic PDE's.
- Researchers at UW are studying manifold-valued subdivision schemes, with particular attention to their smoothness properties.
- Wavelets, framelets and shearlets were intensively investigated at UA.
- The main thrust of research at UBC has been directed towards the development of numerical algorithms in scientific computing based on spectral methods with grids defined by nonclassical polynomials, as well as with Fourier series, splines and wavelets.

CRG 24: Optimization: Theory, Algorithms and Applications (2012-2015)

Leaders: Heinz H. Bauschke (UBC-O), Michael Friedlander (UBC), Yuriy Zinchenko (UC).

2012 Activities:
- *West Coast Optimization Meeting,* UW, May 4-5.
- *Optimization Workshop,* UBC-O, July 9-11.
- *West Coast Optimization Meeting,* UBC, October 6.
- Visitors: A. Aravkin (UBC, July 10–11), J. Eaton, (UW-Tacoma, November 21–22), V. Koch (Autodesk, Inc., July 11), P. Marechal (U Toulouse, June 4–6), J. Nelson (UBC, June 20), M. Nguyen (PSU, November 14–16), D. Noll (U Paul Sabatier, Toulouse, July), A. Park (Thompson Rivers U, June 13).
- Seminars & Colloquia Talks: UC-4, SFU-1, UBC-4, UBC-O-19, UW-6, UV-3.
- Related Activity: *Workshop on Robust Optimization*, Banff, May 25-27.

Future Activities (Planned):
- *West Coast Optimization Meeting,* Spring 2013.
- *Workshop on Numerical Linear Algebra and Optimization,* August 8-10, 2013.
- *West Coast Optimization Meeting,* Fall 2013.
- Visitors: D. Noll (U Paul Sabatier, Toulouse) will be a CNRS/PIMS visitor to UBC-O.

PDFs: H. Phan (UBC-O, 2011-2012), A. Aravkin (UBC, 2010-12), N. Krislock (UBC, 2012-13), I. Rahmanian (UBC-O, 2012).

Students: UBC-O-19, UBC-3, UC-2.

Highlights: The CRG has led the study of:
- pathological cases of the method of alternating projections for nonconvex sets,

- a derivative–free comirror algorithm,
- the variational properties of value functions for convex programs, including applications to inverse problems, and
- moment-based approximation schemes for a particular class of MIP constraints arising in optimal radiotherapy treatment planning for cancer treatment.

CRG 25: Algorithmic Theory of Networks (2012-2015)

Leaders: Funda Ergun & Petra Berenbrink (SFU), Valerie King (UV).

2012 Activities:
- *CRG Kick-off Meeting,* UV, October 9.
- Visitors: F. Ellen (UT, December 3-10).
- Research Meeting and Inaugural Distinguished Lecture, Vancouver, December 4-5.
- Related Activity: *Streaming Algorithms Workshop,* U Dortmund, July 16-20

Future Activities (Planned):
- *Workshop on Network Theory,* UV, May, 2013.
- Visitors: Morteza Monemizadeh (Karlsruhe I. T., April 5-May 30, 2013).
- Related Activity: *Workshop on Communication Complexity,* Banff, August 24-29, 2014.

Students & PDFs: Zahed Rahmati (UV), Erfan Sadeqi Azer (SFU), Hoda Akbari (SFU).

Highlights: CRG leader Valerie King (UV) won the Best Paper Award at SODA 2013 for "Dynamic Graph Connectivity in Polylogarithmic Worst Case Time" with B. Kapron and B. Mountjoy.

E. AARMS Report

As part of a national mandate, PIMS has been supporting mathematical activities in the Maritime Provinces in conjunction with the Atlantic Association of Research in the Mathematical Sciences (AARMS). Together they co-sponsored the following activities in 2012; PIMS' financial contribution to each event is listed in parentheses:

- *AARMS Summer School,* Memorial U, July 16-August 10: Every summer highly regarded faculty from around the world deliver graduate courses in the mathematical sciences. In 2012 these were *Combinatorial Designs and Graph Decompositions, Probabilistic Method and Random Graphs, Lie Theory,* and *Hopf Algebras and Applications* ($2,775).
- *Groups, Rings, Lie and Hopf Algebras III,* Bonne Bay, NL, August 12-18 ($4,725).
- 24th Canadian Conference on Computational Geometry ($5,000).

PIMS also partially supported two PDFs at MUN (Alexei Gordienko and Rui Peng).
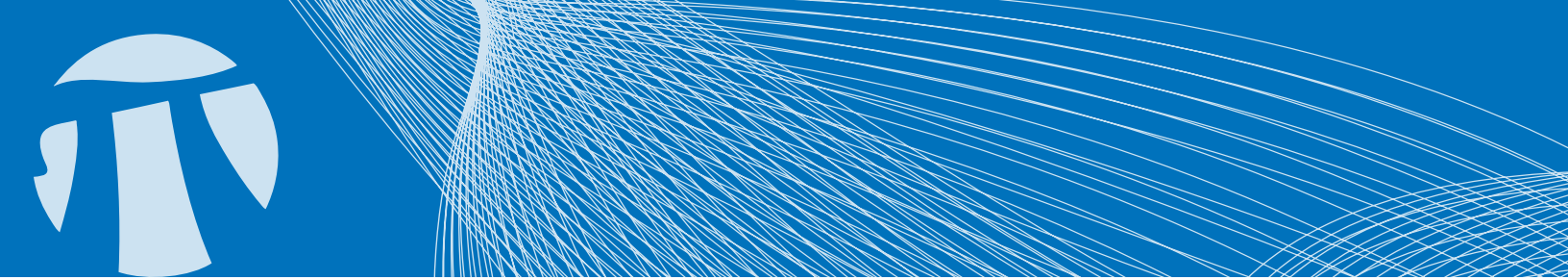
F. Evaluation of PIMS Activities

In 2010 PIMS began collecting evaluations of all its scientific events of at least three days duration. Participants are asked to fill in an online survey rating various aspects of their events; approximately 427 responded in 2012. The results were passed on to event organizers and scrutinized at PIMS Central. Below are charts summarizing responses to

questions of particular interest to PIMS; here "1" represents the worst score (very dissatisfied/low/poor) and "5" the best score (very satisfied/high/excellent):
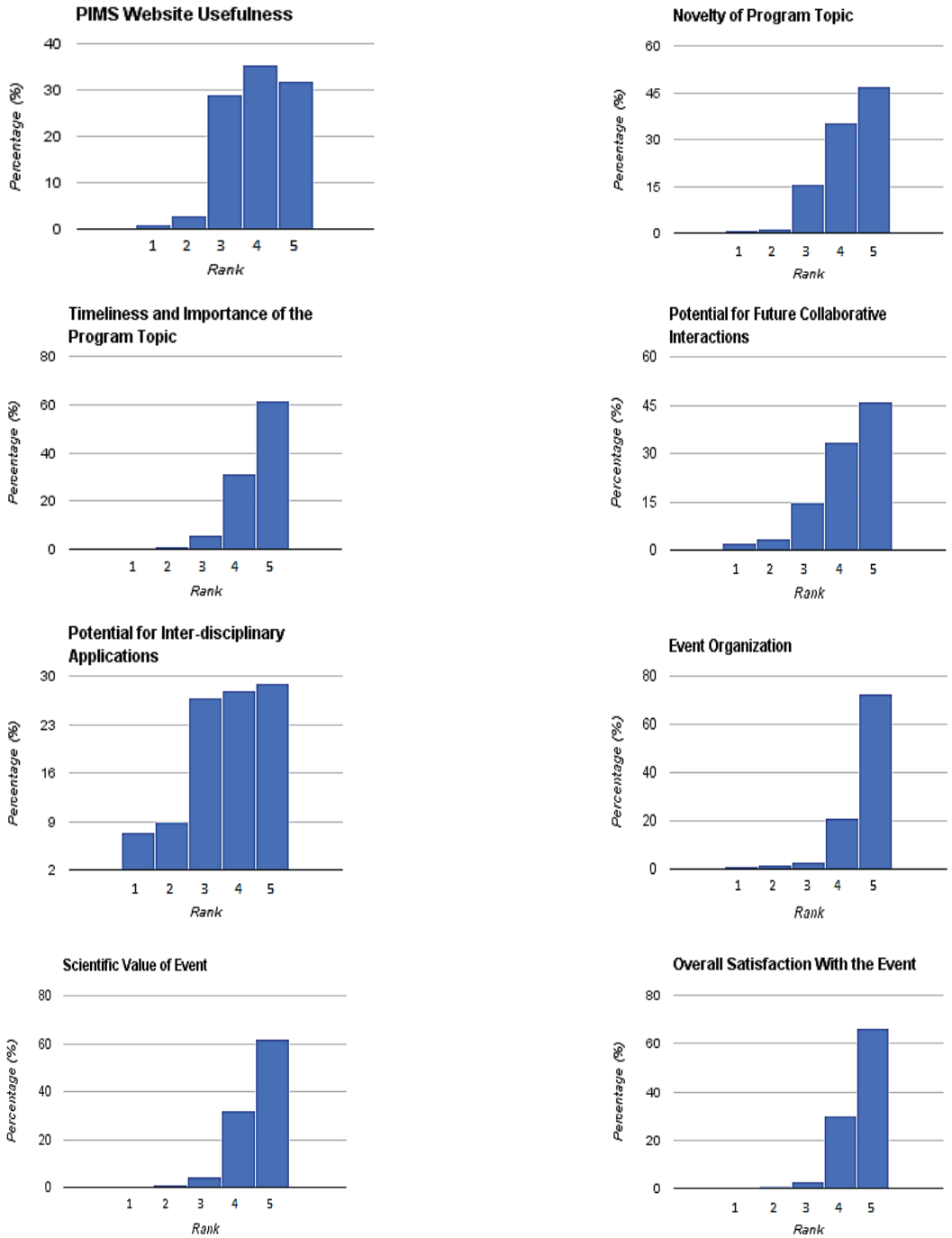
The results were broadly similar to those in 2011, except for a substantial gain in event organization, whereas the

usefulness of PIMS' website and the novelty of program topics dipped slightly.

Individual comments regarding PIMS' events included:

- "I think that PIMS is entirely on the right track in its efforts. Program choices are good."
- "It has been a long time since I have been at such a pleasant, well-organized and scientifically significant event. The scheduling, social events, chances for interactions were spectacular. Speakers were exceptional."
- "There were many excellent talks, but as a highlight I would mention the useful scientific discussions with some colleagues, which helped me to make progress in some mathematical problems I was stuck with for some time, and also the potential for future collaborations."
- "As a whole the workshop helped me realize that I indeed want to be an industrial mathematician."
- "It was a wonderful workshop with great importance to my research and career. I can only be grateful for… PIMS for the support."
- "This conference was incredibly helpful to me. I made many new contacts and discussed my research with lots of people - I am pretty sure that one of these discussions will lead to a postdoc opportunity."
- "The plenary talks were uniformly good in quality, and I appreciated that the organizers chose speakers who made an effort to aim their talk at a wider audience."
- This is one of my favorite scientific events because of the quality and originality of the works presented, and the very productive interactions with other participants.
- "This summer program has been a terrific experience mathematically. Both of the main courses were very well taught and had very interesting subject matter. I had many interesting conversations with students, post docs, and professors, some of which led directly to progress in my research. I started working on a new project with one of the students I met here, and we plan to continue collaborating in the future. I learned about several areas that are very appealing to work on in the future. Also, it's been a really fun few weeks--Vancouver is beautiful and the hikes and other activities have been great."
- "Personally, [the highlight] was spending 2 hours talking with two people who I had not met before and setting in motion international collaborations."
- "The organizers… have done a fantastic and outstanding job!! I rate this one of the best conferences in our field. "The conference brought together a remarkable group of mathematical scientists, with applications to a wonderful variety of applied problems. It was extremely well organized in every way. PIMS can feel very pleased -- it deserved support, it received strong support, and the result was a success for applied mathematics."
- "An amazing conference … above and beyond."
- "I had several important conversations with important researchers in my field … who expanded my thinking… I could not ask for more!"
- "This is certainly one of the most impressive and high quality conferences that I have been [to] in the past couple of year[s]. The organizers had done excellent work making it very smooth and enjoyable. Most importantly, the quality of the talks is very high."
- "The scientific content of the conference was excellent - interesting topics, good speakers, great interdisciplinary talks."
- "For me the highlight was the range of new problems and ideas -- exceptional."
- "The organizers put together a truly brilliant program that gave the participants a broad and varied look at many topics in the field. A truly wonderful week."
- "Outstanding mathematicians in general… Extremely excellent!"
- "A well-organized conference which attracted several big names in the field and which was of considerable instructional value to the many graduate students and which stimulated a good deal of research."
- "Spectacular survey ... outlining a number of interesting research directions that will help my PhD student."
- "Unexpected interactions between several distinct areas of mathematics."
- "The set-up of the workshop was excellent. 4 days was the perfect length of time … Also, all of the speakers were great and the organizers were approachable and friendly. Overall, an excellent workshop."
- "Attending … has been very rewarding. It will certainly help in scientific collaboration."
- "Underscored how mathematics is a foundation upon which technological breakthroughs are enabled."
- "The workshop has exceeded my expectations. The program was carefully thought out, balanced current results with some background material and was of exceptionally high level altogether. A mixture of current results and recent work were reported which informed me and broadened my understanding of the current state of the field. I returned home inspired by the great

mathematics I have learned."

- ➢ "It was also great to get problems to work on and company to work with."
- ➢ "The workshop was really excellent, with a focus that was narrow enough to provide real opportunities for research synergy but broad enough that one was not seeing 'the same people, one always sees.'"
- ➢
- ➢ "The talks were wonderful and thought provoking. I am still working on some problems I learned at the meeting."
- ➢ "An unforgettable experience."
- ➢ "I found the event both fascinating and informative. The presenters were able to cover a variety of .topics... The lectures were clear and concise. Furthermore, the labs showcased the theory nicely and the instructors were approachable and helpful throughout the week. The funding made a big difference for myself as well as other students as without it I don't think the week could have been as outstanding as it was. Overall it was an excellent experience and I am motivated to apply for future PIMS events…"
- ➢ "The most valuable aspect was getting to do group collaboration and to see what working for a company is like.. It helped give me clearer direction for the future."
- ➢ "… the level of work and diversity was impressive."
- ➢ "Perhaps it's cliché, but this will be one of the defining moments in my life, probably. It was an amazing conference, in a wonderful locale, with stellar organization, and featuring amazing talks by both students and professors."
- ➢ "…the summer school was a huge success. The event surpassed my expectations on all accounts."
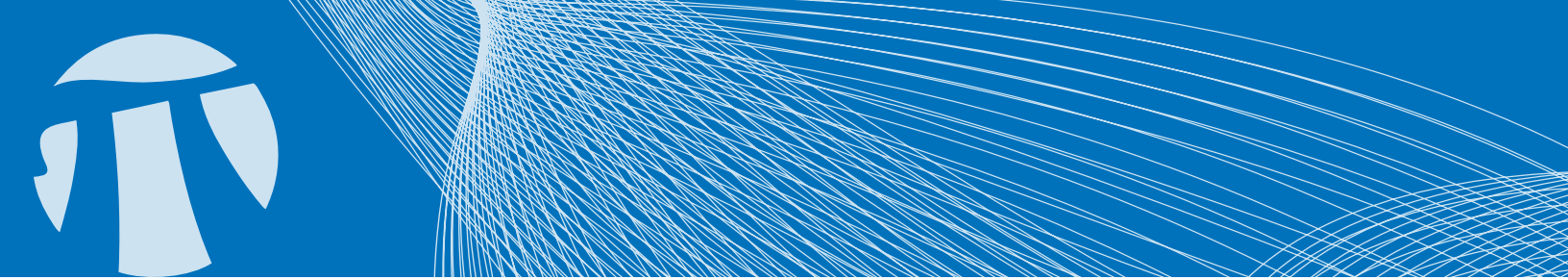
G. Demographics

Here we provide some demographics of participants in PIMS scientific events and programs. For all PIMS-sponsored or co-sponsored conferences/workshops, summer schools, IGTC, industrial and selected educational and 'other' activities, we:

1. Summarize the total number of attendees and the number of attendee-days.
2. Sort the attendees into academics, educators, industrial scientists, and others. We further sort academics into professors, postdoctoral fellows, graduate students, undergrads and others, and broadly classify them by field.
3. List the number of males/females.
4. Classify the attendees as to whether they belong to Canadian institutions, other North American institutions, or institutions located elsewhere. As well, we break down the Canadian participants by province.

In what follows, data from the two previous years are placed in brackets.

During the 2012 [2011/2010] reporting period, PIMS helped to support 81 [74/61] scientific activities of the types listed above. We have data on 73 activities – a remarkable 90% return rate (Compare to the 62% response rate for the Math and Physical Sciences Directorate of NSF in 2011). Of these,
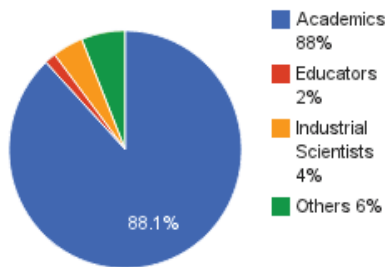
- ▪ The total number of attendees: 5,472 [4,166/2,702]
- ▪ Attendee-days spent at PIMS activities: 17,611 [15,573/12,823]
- ▪ Average attendees/activity: 75 [60/52]
- ▪ Average attendee-days/activity: 241 [254/247]
- ▪ Average activity duration: 3.9 [3.7/5.7] days

Of all identifiable attendees,

- 88% [83/77]% were **academics**, and of these:
- 34% [38/34]% were **professors**,
- 9% [10/13]% were **PDFs**,
- 45% [43/45]% were **graduate students**,
- 10% [4/5]% were **undergraduate students**, and
- 2% [5/7]% were **other academics**.
- 2% [5/2]% were **educators**,
- 4% [11/18]% were **industrial**, and
- 6% [1/3]% were **others** (this includes programs aimed at secondary and elementary school students).
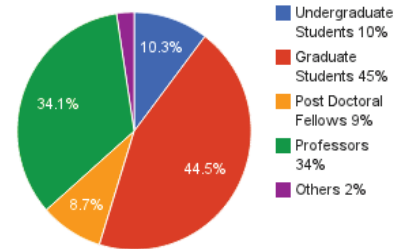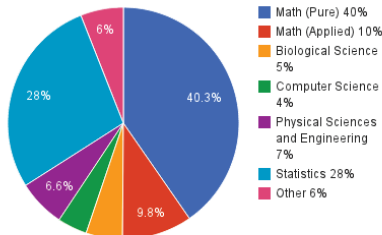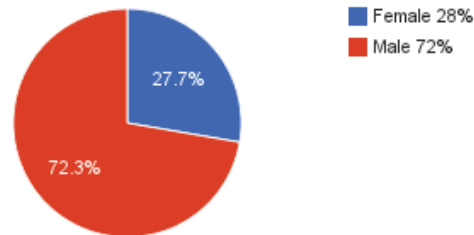

Some respondents also supplied their fields of expertise. They consisted of:

- 40% pure mathematicians
- 10% applied mathematicians
- 5% biological scientists
- 4% computer scientists
- 7% physical sciences and engineering
- 28% statisticians
- 6% others.

Of those attendees who stated their gender,

- 72% [76/77]% were male, and

- 28% [24/23]% were female.

Also,
- 83% [66/63]% were from **Canadian** institutions, of which:
- 61% [41/41]% were from British Columbia,
- 15% [35/43]% were from Alberta,
- 2% [4/2]% were from Saskatchewan,
- 1% [1/1]% were from Manitoba,
- 18% [10/12]% were from Ontario and Quebec, and
- 3% [9/1]% were from the Atlantic Provinces.
- 9% [18/20]% were from **other North American** institutions, and
- 8% [16/20]% were from elsewhere

We have also computed the geographical distribution of PIMS events and programs, including Lecture & Seminar Series, during 2012. Of the activities with well-defined geographic locations,
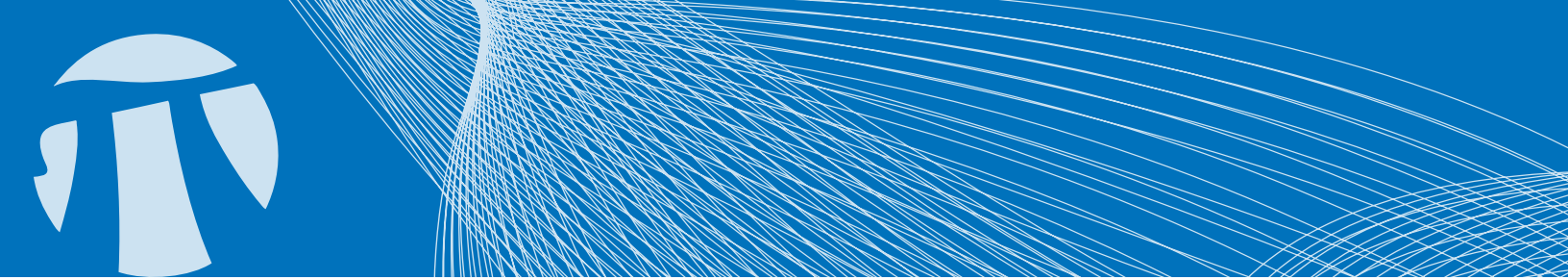- 88% [86/81]% were held in **Canada**, of which:
- 54% [61/60]% were held in British Columbia,
- 26% [26/25]% were held in Alberta,
- 8% [6/9]% were held in Saskatchewan,
- 3% [5/3]% were held in the Atlantic Provinces,
- 8% [4/3]] were held in Quebec and Ontario,
- 12% [13/14]% were held in the **United States** (7 events in Washington, 2 in California and 1 each in Idaho and Oregon), and
- 1% [2/5]% was held **overseas** (1 event in Australia).

Of course, some programs such as CRGs are spread over several provinces and states.

H. Publications

PIMS CRG activities, PDFs and CNRS Researchers produced over 300 publications in 2012, many of which were in top journals, such as the *Ann. Math., SIAM J. Math. Anal., Math. Proc. Cambridge Phil. Soc., J. Algebra, Commun. Pure Appl. Anal., Phys. Rev., Quart. J. Math., Acta Arith., Adv. Appl. Math., J. Amer. Chem. Soc., Compositio Math., J. Comp. Anal., Commun. Math. Sci., SIAM J. Num. Anal., Trans. A.M.S., Int. Math. Res. Not., Comm. Math. Phys., J. Funct. Anal., Nature, Math. Annalen, J. Math. Bio., J. Geom. Anal., Amer. Naturalist, Indiana U. Math. J., Arch. Rational Mechanics Anal., Inventiones Mathematicae, Ramanujan J., Commun. PDE, Biophys. J., Proc. Nat. Acad. Sci. (USA),* and the *Duke Math. J.* A list is at: *www. pims.math.ca/resources/publications/pims-scientific-publication-lists.*

2. TRAINING OF HIGHLY QUALIFIED PERSONNEL (HQP)

A. Postdoctoral Fellows & CNRS/PIMS Scientists

PIMS has created a large number of postdoctoral opportunities for young researchers in the mathematical sciences. The regular PIMS Postdoctoral Fellow (PDF) competition takes place each January. Postdoctoral candidates from institutions in France are eligible for CNRS/PIMS fellowships. In addition, there are several PIMS-supported PDFs that are associated with Collaborative Research Groups and/or Special Focused Periods; these go through the same rigorous review process. Candidates must be nominated by a scientist or group of scientists affiliated with PIMS. The two-year fellowships are tenable at any one of the member or affiliated universities.

In 2011 PIMS supported 39 PDFs, and 47 in 2012. They were distributed as follows: SFU – 4, UA – 11, UBC – 10, UC – 11, UL – 1, UR – 2, US – 3, UV – 3, and UW – 2. Below we list the 2012 PDFs and their university affiliations:

Adcock, Benjamin (SFU)	Akhunov, Timur (UC)	Au-Yeung, Enrico (UBC)
Biasse, Jean-François (UC)	Buckingham, Paul (UA)	Ce, Bian (UC)
Chan, Kenneth (UW)	Felix, Adam Tyler (UL)	Gheorghiu, Vlad (UC)
Giakkoupis, George (UC)	Giladi, Ohad (UA)	Gurel-Gurevich, Ori (UBC)
Hamilton, Ryan John (UC)	Hernandez, Maritza (UBC)	Hrubes, Pavel (UC)
Huruguen, Matieu (UBC)	Jia, Johnson (UBC)	Julien, Antoine (UV)
King, Andrew (SFU)	Kitagawa, Jun (UBC)	Krislock, Nathan (UBC)
Lammersen, Christiane (SFU)	Lundell, Benjamin (UW)	Ma, Xiaoguang (UA)
Madariaga, Sara (US)	Marks, Christopher (UA)	Meyerovich, Tom (UBC)
Mitchell Nenna, Vanessa (UC)	Nasserasr, Shahla (UR)	Oluwaseun, Sharomi (US)
Phan, Hung Minh (UV)	Potts, Jonathan (UA)	Roe, David (UC)
Semukhin, Pavel (UR)	Shen, Yi (UA)	Singh, Vijaykumar (SFU)
Tokman, Cecilia Gonzalez (UV)	Trail, Collin (UC)	Valkenburg, Kirsten (US)
Wang, Kun (UA)	Warnick, Claude (UA)	Wiedemann, Emil (UBC)
Wilcox, Stewart (UA)	Zhang, Tong (UA)	Zhuang, Xiaosheng (UA)
Zubov, Vladimir (UC)	Zwiers, Ian (UBC)	

For a complete list of PDF appointments over the years, see *www.pims.math.ca/scientific/postdoctoral/postdoctoral-fellowships*.

PIMS PDFs are closely mentored by sponsoring faculty at PIMS host institutions. In the case of CRG and Special Focused Period PDFs, they are inducted into appropriate research groups. PIMS Central also monitors PDF progress, and follows up on PDFs after their tenures have ended. All PDFs are given exit interviews and fill out anonymous surveys that are used to assess and improve programs. The average ratings terminal 2012 (2011) PDFs gave to selected questions are listed below (1 = worst score, 5 = best score):

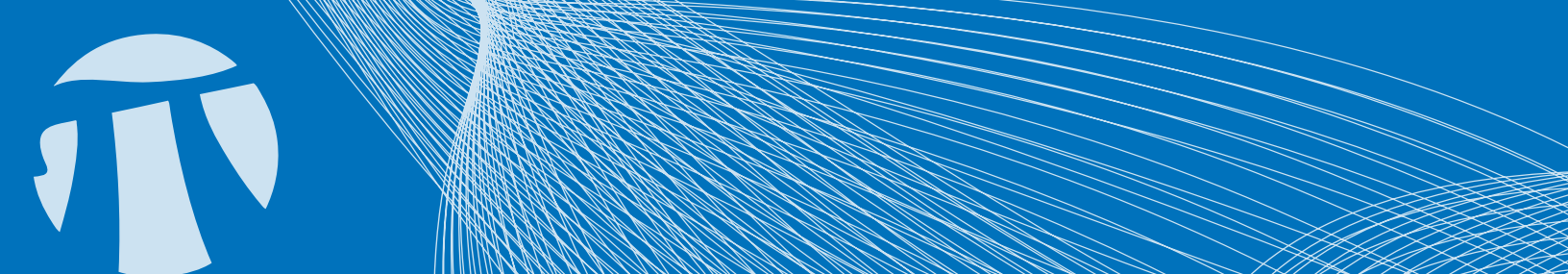|	PDF SURVEY	Score
1	How well were you mentored in your department?	4.3 (3.8)
2	How suited to your academic interests was your department?	4.0 (4.3)
3	How suited to your academic interests was your mentor?	4.4 (4.2)
4	How was the intellectual life in your department?	4.3 (4.3)

5	How well were you looked after (in a practical sense) in your department?	4.4 (4.7)
6	Were there opportunities for collaborative interactions?	3.6 (3.7)
7	Amount of travel support:	3.7 (3.8)
8	Do you feel that your PIMS PDF has prepared you for your professional career?	4.1 (4.4)
9	Overall satisfaction with your postdoctoral experience:	4.6 (4.2)

PDFs move on professionally to a range of positions and activities at top places, including: Johns Hopkins U., City U. Hong Kong, Haverford College, Lancaster U. (England), U. Paul Cézanne (Aix-Marseille, France), Champlain College (QC), UCLA, Max Planck Institute for Informatics (Saarbrücken, Germany), UW, Hong Kong U. of Science and Technology (China), US, U. Algarve (Faro, Portugal), U. Waterloo, U. Chile (Santiago, Chile), U. Massachusetts (Boston), Brno U. of Technology (Czech Republic), U. Manitoba, U. Blaise Pascal de Clermont-Ferrand (France), U. Ottawa, Harvard U, Indian Institute of Science Education and Research (Kolkata, India), McMaster U., U. Frankfurt (Germany), Rice U., Laboratoire de Probabilité et Modèles Aléatoires (Paris, France), Columbia U., INRIA Bordeaux Sud Ouest & Rennes (France), Princeton U., Nat. Acad. Sci. (Ukraine), U. Toronto, École normale supérieure (Paris, France), U. California (Berkeley), U. Karlova v Praze (Prague, Czech Republic), U. Kentucky, Laboratoire Écologie et Sciences Phytosanitaires (Renne, France), Purdue U., SAP AG (Walldorf, Germany, Victoria U. (Wellington, NZ), U. Gottingen (Germany), UA, U. Warsaw (Poland), École Polytechnique (Palaiseau, France), U. London (UK), University of Zurich, U. N. Carolina (Chapel Hill), Institut Joseph Fourier (Grenoble, France), Carnegie-Mellon U., Austrian Acad. Sci., Munich American Reassurance Company (WA), Institute for Advanced Study, CNRS (Montpellier, France), UBC, Max Planck Institute for Mathematics (Bonn, Germany), U. Oregon, Ben-Gurion University, UR, Moscow State U. (Russia), Southern Illinois U. and Cambridge U.

At UBC, the PIMS Assistant Director is responsible for ensuring that the PIMS PDFS are looked after intellectually, professionally, and socially. A PIMS Postdoctoral Colloquium Series runs monthly, in which PDFs hone speaking skills for professional presentations as well as job interviews. All PIMS/UBC PDFs are encouraged to participate and present talks. This series is also useful as an opportunity for PDFs to interact with each other, learn about others' research, and share ideas. As well, PIMS Central holds one-day workshops on professional development topics such as *Information Session on Grant Opportunities* and *Postdoc/Grad Student Job Forum,* and the PIMS Workshop on Automorphic Forms included a discussion on "Postdoctoral life in different kinds of institutions – research, teaching and industrial." The Assistant Director also hosts various social activities so as to reduce postdoc isolation and promote formation of long-term friendships and contacts.

Some verbatim comments from PDF exit interviews:

➢ "My overall impression of the PIMS Postdoctoral Fellowship program is very good. The straight-forward nature of the application process, the freedom of choice of research areas, and the number of fellowships available annually ranks it, in my opinion, as the best of those offered by the mathematical research institutes in Canada…"

➢ "My postdoctoral research is a departure - and an evolution, I think - from my doctoral thesis."

➢ "I was very happy with my supervisor and have managed to make research connections outside of the department… On the whole, the department has been very welcoming."

➢ "The PIMS PDF has been a great experience."

➢ "My PIMS post-doc has provided me with the opportunity to gain research experience and to make connections in an area outside of my PhD work. This will certainly help in my future research work."

➢ "I did receive a $1000 travel supplement, and this was a great bonus. I greatly enjoyed my time in the Department... I got along with my mentor very well, was well taken care of, and made friends with many of the faculty, students, and the few other post-docs in the department. I learnt a lot during my stay, and I would certainly have done this again."

➢ "At first I felt social isolation. This was one of the issues PIMS worked on and I must say that things changed for the better. I recommend that the social activities keep running."

PIMS also hosts more senior researchers from France as part of its cooperative agreement with the CNRS. In 2012 N. Boussaid (UV, Lab. Math. de Besançon), P. Marechal (UV, U. Toulouse), G. Miermont (UBC, U. Paris Sud 11) and Frédéric Havet (SFU, U. Nice-Sophia-Antipolis) took part in this program.

In addition to PDFs and PIMS/CNRS scientists, PIMS sites host many long- and short-term: approximately 74 in 2012 alone.

B. IGTC in Mathematical Biology Report

Although life sciences and mathematics have historically been separate, the application of mathematical and statistical methods to solving scientific problems in the life sciences and systems biology is now experiencing dramatic success. To meet the need to train new researchers in this area, PIMS established the first IGTC in 2007 in the area of mathematical biology. This IGTC is designed to develop distributed training by building, in particular, on graduate programs in mathematical biology at PIMS universities. The IGTC counts 26 faculty from PIMS universities along with dozens of yearly visitors.

The key component of the IGTC is its Fellowships, which are awarded to graduate students at Canadian PIMS member or affiliate universities. These Fellowships are generously funded in part by Mprime, which provided $100,000 for the period Sept, 2011 to Aug, 2013. There are currently 9 students with fellowships (4 for 2011-13 and 5 for 2012-14). During the lifetime of the program, IGTC students have been located at UA, UBC, UC, UV and SFU. The number of applicants increased every year from 2008-2012, allowing us to raise the quality of students obtaining IGTC fellowships. Based on feedback from the IGTC Evaluation Committee, the current level of excellence of IGTC students compares favorably to those of NSERC scholarship applicants. Recent IGTC students have been successful, obtaining positions as a junior faculty member in Pathology at Oxford U, an Asst. Professor at St. Francis Xavier U, a postdoctoral Science Teaching and Learning Fellow at UBC, and as a scientist for Alberta Environment.

Students supported by fellowships as of Sept 1, 2012 are: Bernhard Konrad (UBC), Michael Akinwumi (UA), Jia Gou (UBC), Silogini Tharanajah (UA), Stilianos Louca (UBC), Alejandra Herrera (UBC), Michael Bryniarksi (UA), Ashok Rajaraman (SFU) and Susan Fassnacht (UBC). We also congratulate the record crop of graduating IGTC students for 2012: Monica Delgado-Carrillo (UBC), Sheehan Khan (UA), Douglas Friesen (UA), Katrina Williams (UBC-O), Eric Foxall (UV), Stephanie Peacock (UA), Josh Zukewich (UBC), Iman Hajirasouliha (SFU), Deniz Yorukoglu (SFU), Ben Wilson (UVic), Phuong Dao (SFU), Carly Rozins (UBC-O), Alison Muscat (UA) and Anastasia Lukyanova (UA).

The annual IGTC summit (Oct 12-14, in Naramata, BC) was attended by nearly 40 students from UV, UBC, UBC-O, SFU, UA, Venezuela and Mexico. This event featured Prof. Steven Krone (University of Idaho) who gave an interactive workshop on biological modelling with interacting particle systems and a detailed research seminar on spatial pattern formation in bacteria-phage experimental systems.

During May, L. Edelstein-Keshet taught a summer course in Mathematical Cell Biology for graduate students. This course was taught live at UBC but lectures and materials were shared to IGTC students and others at UA, McGill, the U.S., Russia and elsewhere via the internet. This was a pilot web-based course facilitated by PIMS and we plan to offer similar courses in the future, to share expertise between the region's universities and continue to develop our regional mathematical biology community. This content is publicly available on mathtube as a resource for all with interests in

math biology.

Looking forward, the IGTC will be a major participant in the Mathematics of Planet Earth thematic year, through the pan-Canadian program "Models and Methods in Ecology, Epidemiology and Public Health". The centre will support the conference "Immunization - a true multi-scale problem" (January 17-19, 2013 at UBC) and the major IGTC summer school "Mathematics Behind Biological Invasions" (May 27-June 14, 2013 at UA). Both events will feature leading biological and mathematical scientists from around the world.

Further information about the IGTC is at *www.pims.math.ca/scientific/graduate-training-igtc/mathematical-biology*, and a recent assessment of the program as well as a list of IGTC publication can be obtained by clicking on *www.pims.math.ca/files/IGTCreport2011.pdf* and *www.pims.math.ca/files/IGTC_Publications-_2008-_2012_0.pdf* respectively.

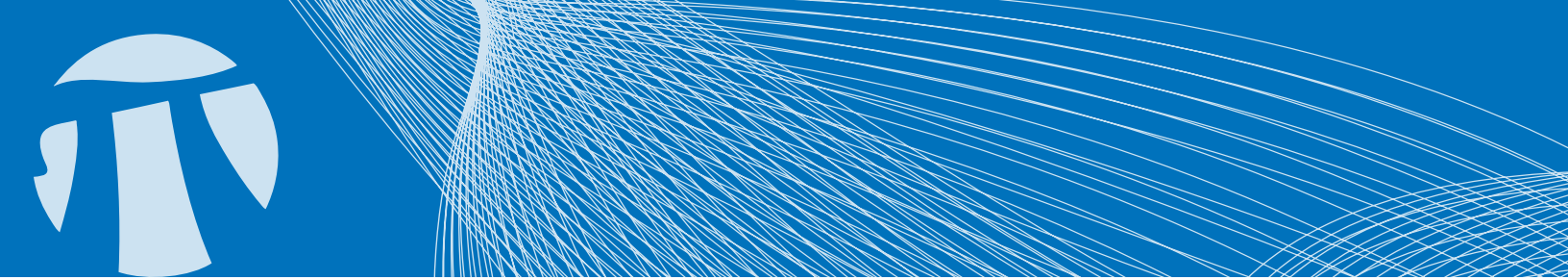Feedback on the IGTC includes the following verbatim comments:

➢ "I am at a smaller campus, UBC Okanagan, and therefore there is not access to many professors in the field of mathematical biology. Thus, the opportunities that I have had from the IGTC program have shaped my PhD education."

➢ "My decision to enroll for grad studies at the U of A was influenced by the fact that the U of A is a part of PIMS and hence participates in the IGTC program. I had read about the IGTC program and realized it would provide me with great opportunities for learning and networking. So far, in fact, it has given me the opportunity to attend the grad summit where I met colleagues from other universities and during which I learnt a lot about math bio."

➢ "The IGTC was an excellent way to meet students from across western Canada working on problems in mathematical biology. Without it, I may never have discovered those working on similar projects - even in my back yard! … Thanks to the IGTC, I have learned of a group of students and profs in mathematics at UVic working on interesting models in biology, and have collaborated with them during time I have spent on the coast of British Columbia for field work…"

➢ "IGTC Funding and workshops were of great assistance to my research and to writing my master's thesis. In particular, these enabled me to pursue research and to communicate and share ideas with others in the same field, or in related fields of mathematical biology."

➢ "The IGTC has opened up so many opportunities for me to attend courses, conferences, and the IGTC summit. Without the IGTC I would not have met my current supervisors and not known the work that they do – I have no idea where I'd be!"

➢ "It was wonderful to be part of this research community. IGTC made me feel that my work was acknowledged and valued, and also put my research into prospective [sic] as I could relate it to work of others."

➢ "The program has a large impact on the students here at UVic, which has a relatively small math biology program. It enables the students to have an enriched program, to make excellent connections, and to enhance their research interests. The program is just up and running, and is beginning to reach its full potential."

➢ "[This event] was an amazing success with excellent student posters, talks, discussions and group presentations. The students are well-informed, eager to learn, and have lots of good ideas and energy. Thank you PIMS!"

➢ "On the how-to-find-a-research-topic: I love how you experiment with these ideas, and how you really want students to take something useful away."

➢ "[Highlights were] Meeting with other students and getting to hear about research happening at other universities. The PIMS IGTC in Math Bio has been amazing for connecting me to other math biologists in Pacific Canada. "

3. EDUCATIONAL

A. K-12 Educational Activities:

PIMS is dedicated to increasing public awareness of the importance of mathematics in the world around us. PIMS encourages young people to see that mathematics is a subject that opens doors to more than just careers in science. Many different and exciting fields in industry are eager to recruit people that are well prepared in this subject. From its inception, PIMS has supported a series of educational initiatives for the K-12 level, including:

▪ Organization of interesting, fun and challenging math events for children of all ages.

- Facilitation of access to information (newsletters, workshops, conferences, special publications, etc.) about math education matters to parents, teachers and university faculty.
- Coordination of workshops to create communication links between parents, mathematicians and educators.
- Publishing *Pi in the Sky*, a math magazine for high school students.
- Holding workshops to improve teachers' math and teaching skills.
- Hosting the annual *Changing the Culture* conferences for schoolteachers.
- Sponsoring regional and Canada-wide *Science Fairs*.

1. General

Math Mania: This is a popular alternative math education event that has been presented in elementary and (more recently) middle schools of greater Victoria and the Lower Mainland since 1997. All age levels are welcome, although it is particularly suited to students in grades 4-7. *Math Mania* presents a variety of interactive demonstrations, puzzles, games and art. These activities are designed to demonstrate to students – and their parents – fun ways of learning both math and computer science concepts. On average over two hundred students, parents and teachers participate in *Math Mania* events. This year *Math Manias* were held in the remote communities of Sointula and Alert Bay on Vancouver Island, as well as around the greater Victoria area. Further details are available at *www.pims.math.ca/educational/math-mania*.

One BC school principal wrote: "… a great evening! You don't know how much this means to our students and parents. I heard so many positive comments from parents and it was amazing how thrilled they were that we were doing this for the kids. Many of them had never looked at math as being very fun or exciting... Hopefully this will inspire them to take a real interest in math and develop a greater appreciation for its application to everyday life."

SNAP Math Fairs: PIMS sponsors these non-traditional **S**tudent-centered, **N**on-competitive, **A**ll-inclusive, and **P**roblem-based math fairs based in Alberta. The purpose of a SNAP math fair is to provide a meaningful problem-solving experience for all students. Several SNAP fairs were held the Edmonton and Vancouver areas this past year. Visit mathfair.com for more information.

Changing the Culture: This is a yearly one-day meeting organized and sponsored by PIMS, bringing together mathematicians, mathematics educators and school teachers from all levels to work together towards improving the teaching of mathematics. This year's conference attracted about 125 participants, and discussed the question: Should we change what we do in the calculus classroom?

ELMACON: The **El**ementary **Ma**thematics **Con**test is a yearly event held at UBC (and in 2011 at UV) and is open to students in Grades 5 to 7 from Lower Mainland schools and Victoria-area schools. ELMACON gives them the chance to experience mathematics as an exciting sport. This PIMS-sponsored event attracts close to 300 participants.

UBC/PIMS Math Workshops: These workshops in Lower Mainland schools aim to excite Grade 6-12 students about mathematics by exposing them to interesting and challenging problems and interesting mathematics personalities. In the case of Grade 12 students, careers and university programs in the mathematical sciences are also discussed. The workshops are conducted by faculty and student volunteers from the UBC Mathematics Department, and are coordinated by the PIMS-BC Education Coordinator. Over 80 workshops are conducted each year.

Teacher Workshops: A variety of workshops designed to help elementary school teachers build their math skills for the classroom are supported by our institution. Twelve workshops to teach problem solving were held all around the province. Six additional workshops to support the teaching of JUMP math were held at PIMS-UBC.

Math On the Move: This is a mobile version of the UR Math Camp that was initiated in 2003. With support from PIMS, two UR faculty and four math education students deliver inquiry-based mathematical activities to high school

students in rural Saskatchewan.

Pi in the Sky: The widely distributed (estimated circulation is 2,500) high school level periodical produced by PIMS for students in Canada and the United States, aims to establish direct contact with teachers and students, to involve high school students in mathematical activities, as well as to promote careers in mathematical sciences. Go to *www.pims.math.ca/resources/publications/pi-sky* for current and back issues.

Lesson Studies for Teachers: Lesson Study is a form of professional development in which teachers jointly plan, implement, observe, analyze, and refine actual classroom lessons called "research lessons", and then revise and report on the results so that other teachers can benefit. For the last three years PIMS has been offering series of workshops closely modelled on the highly successful Lesson Studies conducted by the Galileo Educational Network of Calgary. Teachers meet six Saturdays a year to develop lessons on a variety of mathematical concepts.

In addition, PIMS supports the **Math Circles Coaching Program**, the **Vancouver Free Math Mentorship Program,** the **BC Math Challengers**, the **Forever Annual Math Exhibition**, and the **No Homework Club**, along with other local initiatives.

Math Central: Beginning its 17th year, Math Central (*www.mathcentral.uregina.ca*) continues to be a successful tool for teachers. The site currently gets in excess of 5 million hits per month from approximately 450,000 visitors. Math Central attracts answer submissions from keen mathematicians from all over the world including Italy, Romania, Turkey and Indonesia. The site is maintained by PIMS Education Coordinator Harley Weston and faculty and students in the Mathematics and Statistics and Mathematics Education Departments of the University of Regina.
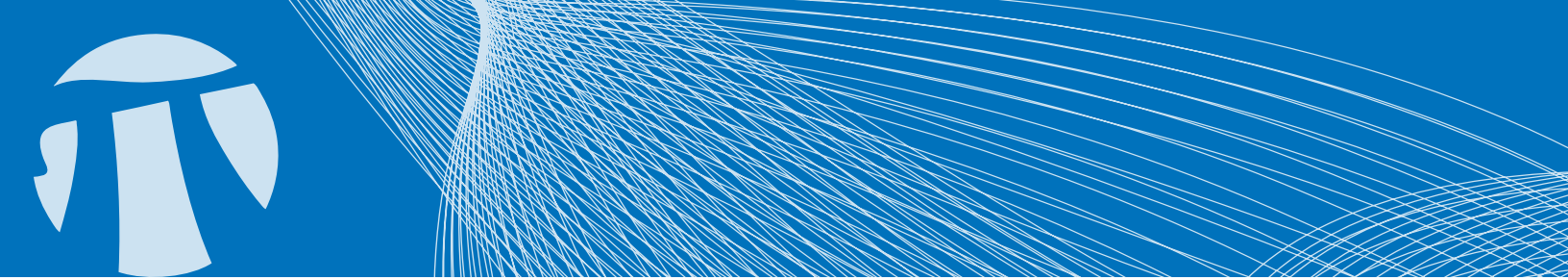
Math Kangaroo Contest Workshop

Alberta Summer Mathematics Institute (ASMI): PIMS and UA sponsored this day-camp style lecture and project based event for mathematically talented high school students. From July 3-August 10 the UA campus welcomed 10 local students to work on projects including Mathematical Objects in Interaction, Group Theory and Geometry, and Mathematical Physics. These students attended several lecture series by distinguished faculty, supplemented with computer classes on mathematical typesetting (LaTeX) and computation (Sage). This was followed by two weeks of directed mathematical research. ASMI 2012 was entirely funded through the PIMS-AAET grant.

2. Aboriginal/First Nations

PIMS has shown its leadership in bringing together various people, resources and institutions in working together towards the improvement of aboriginal mathematics education. In particular, under the auspices of the First Nations Education Steering Committee (FNESC), PIMS has developed a partnership with First Nations schools in British Columbia, which has received funding from private donors, Vancouver City, the Vancouver Foundation, the Kinder Foundation as well as provincial and federal agencies. Activities under this program include:

Teacher training/math development sessions during the summer, where mathematicians and educators provide lessons for teachers to help them assimilate teaching material for their mathematics courses. Sessions have been held in Kamloops, Lytton, Barriere, Port Alberni, Vernon and Merritt. Partner schools in the interior of British Columbia include: Sk'elep School of Excellence in Kamloops, Lelawagila Primary School in Kingcome Inlet, Stein Valley Nlakapamux School in Lytton, Neqweyqwelsten School in Barriere, Bonaparte School north of Lytton, First Nations elementary and secondary schools in Bella Bella, First Nations elementary school in Port Alberni (Vancouver Island), Lower Nicola Band School in Merritt, Haisla Community School in Kitimat, Seabird Island Indian Band School in Agassiz, the Gitanyou, Kispiox, Holly Smith and Anspayaxw Schools in Smithers and Houston, the Wilpe School in Gitwangak and the Xit'olacw Community School in Mount Currie.

A coordinated mentorship program where undergraduate students from universities work with local teachers and students to provide support in mathematics.

Assistance in choosing and implementing mathematics curricula at First Nations Schools, where the PIMS BC Education Coordinator serves as a permanent resource for teachers and administrators.

Math summer camps, which PIMS has organized in Kamloops, Lytton, Merritt and Mount Currie for the past 5 years. More than 150 children have attended these camps. This summer, 24 First Nations students in grades 10-12 attended the 5 weeklong *Emerging Aboriginal Scholars* summer camp jointly run by PIMS and the UBC First Nations House of Learning and 21 in the transitional summer camp for students entering high school. As part of these camps, students took math and English classes each morning and three afternoons per week they attended an internship program which placed each student with university of affiliated faculty and staff. Other afternoons were spent meeting with members of the aboriginal community who are successfully working in various fields.

Providing in-depth assessment of the mathematical skills for students at our partner schools, measuring the impact of their programs and suggesting adjustments along the way. FNESC has commissioned an assessment tool from PIMS to evaluate third grade students in First Nation schools.
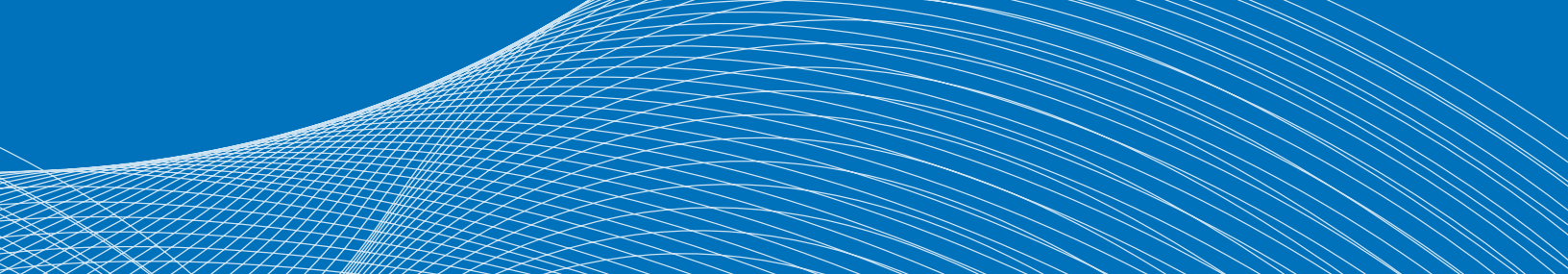
School partnerships: During the last five years, PIMS has developed a partnership with the Britannia, Templeton, Windermere and Point Grey secondary schools and the MacDonald elementary school in Vancouver, which have large numbers of aboriginal students. In recent summers PIMS organized a math summer camp for a group of these students. Together with the math department at UBC, PIMS has been coordinating mentorship programs at several elementary schools in Vancouver. PIMS is also coordinating a scholarship program to support the neediest of their aboriginal students. This program has been funded both by the federal government and private donors.

The fourth **First Nations Math Education Workshop** co-sponsored by PIMS was held in Banff in November. PIMS brought together a group of Elders, mathematicians, math educators and teachers, with the goal of improving mathematics education among aboriginals while at the same time acknowledging the importance of traditional culture. This year math story booklets for elementary level students were unveiled; the booklets are bilingual, e.g., written in English and Blackfoot. In Saskatchewan, PIMS supports the **Aboriginal Perspectives** web site *www.AboriginalPerspectives.uregina.ca*, which serves as a means for delivering lesson ideas with an Aboriginal focus to K-12 teachers. Support from PIMS has been used to help hire the students who write the lessons and facilitate the workshops. PIMS also partially funds the ongoing *Aboriginal Perspectives Workshop*.

B. Post-Secondary Educational Activities

Colleges and universities wishing to enjoy an affiliation with PIMS (but not otherwise eligible for regular PIMS membership) may engage as *PIMS Education Associates*. Membership is for a period of three years and is renewable. An annual membership fee of $500 is paid by the college or university. Members are entitled to apply for PIMS funding to engage in appropriate education, outreach, and professional development activities in their region. Examples of approved activities are the support of a guest speaker, support for a regional math competition and for the purchase of mathematical models and demonstration materials for use in the classroom. Currently 5 colleges in BC and 4 in Alberta are PIMS Education Associates: Okanagan College (BC), U. of the Fraser Valley (BC), Langara College (BC), Red Deer College (AB), Thompson Rivers U. (BC), Concordia U. College (AB), Douglas College (BC), Grant McEwan U. (AB), and Mount Royal U. (AB). PIMS hopes to enroll more Education Associates in 2013.

PIMS also directly sponsors high-level undergraduate activities at its affiliated universities, such as: the biannual *Joint UBC/SFU Graduate Student Workshop in Statistics,* the *Young Researchers Conference in Mathematics* at UC, the *Alberta Colleges Mathematics Conference* at UA-St. Jean, the *Optimization Workshop* and the *Canadian Undergraduate Mathematics Conference* at UBC-O, and the *Canadian Undergraduate Physics Conference* in Vancouver, as well as various summer schools including the

AARMS Summer School at Memorial U and *Two Weeks at Waterloo - A Summer School for Women in Math* at U Waterloo. PIMS also sponsors an ongoing series of public lectures as part of the *MathAcrossCampus* program at UW.

In addition, PIMS provides travel support for Canadian students to attend educational activities, e.g., the *Canadian Undergraduate Mathematics Conference 2012* and the joint PIMS-IMA *Mathematical Modeling in Industry Workshop,* both held at UC.

PIMS also uses its facilities for teaching; in 2012 PIMS-UBC hosted three mathematics courses, one mathematical biology course, numerous seminar series, and streamed several video-conferenced courses from UC and UBC.

Every year the *PIMS Education Prize* is awarded to outstanding mathematical educators in Alberta, British Columbia, Saskatchewan or Washington State. A cash award is attached to the prize, which has considerable prestige, and receives widespread publicity in the mathematical community and beyond. See *www.pims.math.ca/pims-glance/prizes-awards* for details about past prizewinners. In 2012 this prize was sponsored by CGG Veritas/Hampson-Russell.

1. COMMUNICATIONS PLAN

This plan identifies communication objectives, key messages, identifies stakeholders and sets out the strategies and tools that will be used.

Objectives and communication priorities:
- Build a consistent communications framework to raise the profile of PIMS in the global scientific community.
- Demonstrate to existing and potential new sponsors and the global scientific community that PIMS has given thought and priority to communicating with them, with the view that we are here to stay.
- Build the PIMS community through regular, consistent and targeted formal and informal communications.

- Place education as a top priority in terms of gathering funding, program organization and awareness-raising.

Key messages:

- PIMS is a leading mathematical institute in North America, with worldwide influence on research and industry. PIMS has established innovative programs which have had a transformative impact on the mathematical sciences and the training of HQP.
- The PIMS community is inclusive; from K-12 to research faculty. PIMS' distributed structure throughout the Pacific Northwest enables all who are engaged to do so locally, while still benefitting from all of PIMS' resources.
- PIMS is nurturing the pipeline of younger generations in Western Canada, including those with First Nations backgrounds. PIMS promotes numeracy as an integral part of development and learning.

Strategies:

- Create consistency, clarity and regularity of communications.
- Respond to the needs of stakeholders as to how they would like to receive information.
- Add a more human touch, include photos, personal stories and testimonials.
- Become more proactive and opportunistic in promoting PIMS to stakeholders.
- Increase internal and external community building opportunities

Tools:

- Websites and electronic
  - **PIMS website** The PIMS website (*www.pims.math.ca*) offers easy global access to information on all PIMS activities, recent news and resources. A new feature is the Research Impacts section on PIMS home page that shows results from PIMS researchers.
  - **Mathtube.org** A dedicated site that will eventually archive all of PIMS written, video and audio media. mathtube.org was created to meet the increasing demand of requests to see footage of past PIMS lectures. It provides global exposure to PIMS events and gives those who attend our events the chance to review and those who don't, a chance to see what they've missed. This resource also gives added value to conference organizers and participants, as well as a forum to see world-class speakers from all areas of the mathematical sciences. These materials are an important resource and include contributions from some of the world's most distinguished contemporary mathematicians. mathtube.org is for those interested and engaged in the mathematical sciences; whether one is a student, a researcher, an industry professional or a mathematics teacher, mathtube.org includes useful content that will help advance one in their field.
  - **PIMS Connection, monthly e-newsletter,** was introduced in 2011. This brief email includes URL links to event updates and news items. Its circulation is over 3200.
  - **Social Media** in 2012, PIMS began using Twitter and Facebook allowing us to connect with and provide all of our updates and news to our community more frequently and through a single channel (the same content is provided on both Twitter and Facebook).
- **Hardcopy publications**
  - **Year in Review** this booklet is designed to summarize the range of PIMS activities. The 2009–2012 Years in Review can be downloaded from pims.math.ca/resources/publications/pims-year-review.

- ➢ **PIMS Newsletter** is produced twice yearly. It contains reports on the recent activities at PIMS, announcements of upcoming scientific, industrial and educational events, accolades and breakthroughs within the PIMS community; and upcoming opportunities and how to apply. The latest issue can be found at *www.pims.math.ca/resources/publications/pims-newsletter*. It has a circulation of 800.
- ➢ **Pi in the Sky** is primarily aimed at high-school students and teachers, with the main goal of providing a cultural landscape for mathematics. It has a natural extension to junior high school students and undergraduates, with articles that put curriculum topics in a different context. *Pi in the Sky* accepts material on any subject related to mathematics and its applications, including: articles, problems, cartoons, statements, jokes, etc. Pi in the Sky is produced once a year and mailed to various institutes and private subscriptions throughout Canada and the world, (estimated circulation is 2,500) and can be downloaded from the PIMS website: *www.pims.math.ca/resources/publications/pi-sky*.
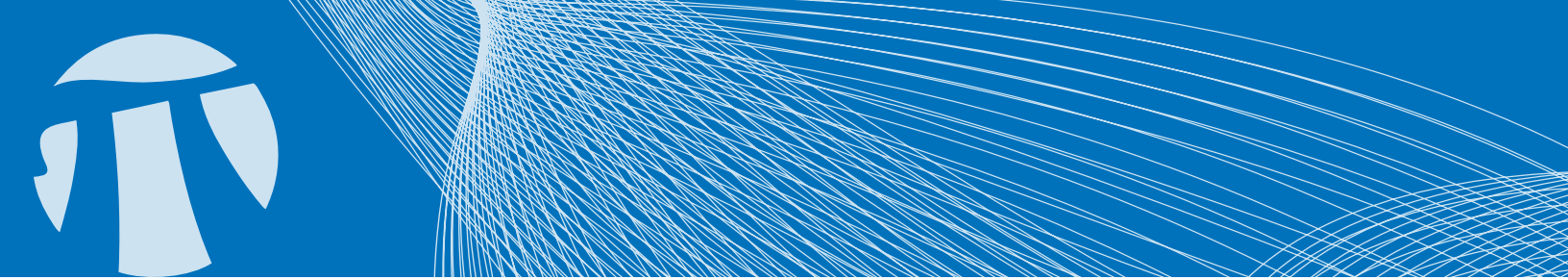
- ▪ **Other**
  - ➢ **Advertising** PIMS-funded events and opportunities are advertised both electronically and in print. We advertise through websites and publications at institutions such as Mprime, IMS, CMS, SIAM and AMS, and by offering custom-designed event posters that are distributed to over 200 of the top scientific institutions worldwide.
  - ➢ **Reports** Conference proceedings, abstracts, lecture notes, websites and final event reports are all made available for download from the PIMS website in .pdf or .html format. (See *www.pims.math.ca*). Conference materials are attached to the corresponding event, which are listed chronologically and are searchable by keyword for ease of access. PIMS also produces an annual report that is sent to sponsors, administrators at PIMS-affiliated universities, representatives from the business, industry and resource sectors as well as the major professional societies. Past annual reports (1997-2011) can be viewed at *www.pims.math.ca/resources/publications/annual-reports*.

An annual evaluation of communications activities will take place each January. Communications surveys will be sent out annually.

2. AUDIO/VIDEO FACILITIES

PIMS-funded event coordinators are offered a wide range of audio-visual services to facilitate the global nature of collaborative scientific work. PIMS' current video-conferencing facilities at UBC underwent upgrades and modernization recently as part of our move to the new Earth Sciences Building. We are now able to offer full, high-definition video-conferencing service to users, along with a wide variety of software video-conferencing technologies. In addition, thanks to PIMS' financial support, UC was able to outfit a videoconferencing center in their mathematics department.

These improvements have tightened the integration between PIMS sites as well as fostered the development of distance learning courses and remote collaborations. PIMS is building upon recent successful remote events such as an ongoing seminar series in number theory hosted jointly between UBC, SFU and UC. Two statistics graduate courses and a course on p-adic Hodge Theory by P. Schneider at UBC, a number theory course at UC and a multi-site working group on the ABC conjecture utilized these facilities this academic year. The Eluminate web conferencing system was used to live-stream a summer school in mathematical biology with participants from Canada, the United States and Russia. (Videos and other materials from this school are now publicly available through our media portal at www.mathtube.org.) The Bluejeans system is currently being used to allow PIMS researchers to participate in a seminar series hosted by the

Mathematical Biosciences Institute at Ohio State U. Additionally, UL and UC joined in via 2-way video conferencing during the 2012 Riemann Day meeting at SFU.

PIMS Central continues to participate in the Compute Canada seminar series. This series features a different mathematical or technical theme each term and brings together 30-40 remote sites from across Canada. Together with the WestGrid seminar series (that focuses on training researchers in the use of high performance computing) these events have helped raise awareness of PIMS among new groups and departments at UBC while also providing valuable training to PIMS researchers.

Our facilities continue to be used by researchers to fulfill their academic responsibilities while at PIMS. Examples include participation in the thesis examination of a PhD candidate in México and PIMS PDFs interviewing for faculty positions at remote institutions.

PIMS' online educational forum utilizes video-conferencing to bring together all the PIMS education coordinators from BC, Alberta and Saskatchewan in meetings to examine successful math educational programs and techniques and to plan new ones. Additional events in this series as well as a program to support math teachers at isolated aboriginal schools are planned for next year.

The Scientific Review Panel is responsible for the scientific leadership at PIMS. Through their continuing efforts, PIMS keeps abreast of activities in the mathematical community and seeks to develop programs in new areas. The process that the SRP follows can be briefly described as follows:

1. Identify research topics,
2. Discuss at length the value, impact and feasibility of running scientific activities in these areas at the annual SRP meeting and through email discussion,
3. Serve as liaisons between experts in a particular area and the PIMS Director and Deputy Director thus providing crucial scientific expertise,
4. Once an important theme has been identified, the SRP will work with potential organizers to develop a proposal that encompasses the required depth and breadth to ensure a high quality event of international calibre.

Aside from the role played by the SRP, the PIMS Directors regularly attend research conferences and meetings of professional societies, and consult with leading experts to obtain/solicit information on recent advances in the

IV. ACTIVITIES TO KEEP ABREAST OF SCIENTIFIC ADVANCES

mathematical sciences. This also involves establishing regular channels of communication with the PIMS community and encouraging researchers to use PIMS as a platform for the development of their ideas. In addition, through a systematic scanning of web-based literature (such as preprints on the arXiv) and announcements of scientific breakthroughs in bulletin boards and journals, PIMS maintains a pro-active involvement in learning about and enhancing the impact of new developments.

IV. FINANCIAL REPORTS

PIMS MRS NSERC Activity Report January 1 to December 31 2012

Resource Expenditures	Use of the resource (i.e. PIMS) Paid from ALL revenue sources January 1 to December 31 2012	Planned use of MRS funds January 1 to March 31 2013	Planned use of MRS funds April 1 2013 - March 31 2014
1) Salaries & Benefits			
a) Administrative Staff	312,705	0	0
b) Directors & Site Directors Teaching Releases/Stipends	147,100	0.00	0.00
c) Scientific Support Personnel	162,805	40,700	128,845
d) Postdoctoral Fellows (inc. CRG PDFs)	672,435	115,600	397,501
e) Technical/Professional Assistants (inc. Education)	56,764	0	0
f) IGTC students	115,448	28,900	42,334
2) Equipment or Facility			
a) Purchase or Rental	24,224	0	0
b) Operation and Maintenance Costs	17,979	0	0
3) Materials & Supplies			
a) Refreshments	10,044	0	0
b) Office Supplies	19,044	0	0
4) Meetings/Collaborations/Staff Travel			
a) PIMS Meetings (SRP, PDF, Board, Admin, Exec)	32,957	0	0
b) Staff/PDF Travel	6,671	0	0
c) Director Research Support and Scientific Consultation	51,305	0	0
5) Dissemination Costs			
a) Publication Costs	24,761	0	0
b) Advertising & Networking	1,861	0	0
6) Scientific Activities (inc. CRGs and IGTC)			
a) Conferences/Symposia	203,735	25,000	188,300
b) Summer Schools	173,007	0	145,000
c) Workshops/Seminars/Colloquia (inc. MMIW)	232,245	51,650	121,900
d) Distinguished Visitors/Chairs/Speakers	50,841	18,200	46,120
7) Education Initiatives	133,961	0	0
8) AARMS Activities			30,000
a) AARMS Summer School	2,775		
b) Groups, Rings, Lie and Hopf Algebras III	4,725		
c) 24th Canadian Conference on Computational Geometry	5,000		
d) Partial support of 2 Post Doctoral Fellows	17,500		
TOTAL EXPENDITURES	**2,479,892**	**280,050**	**1,100,000**

<u>Resource Revenues</u> *(collected during the period January 1 to December 31 2012)*

a)	User Fees (Registration Fees collected)	36,462
b)	Contributions from Partner Universities	
	UBC	192,125
	Simon Fraser University	80,000
	University of Alberta	77,700
	University of Calgary	67,710
	University of Victoria	66,600
	University of Saskatchewan	50,000
	University of Regina	35,000
	University of Washington	11,210
	University of Lethbridge	35,000
	Portland State University	3,947
	UNBC	5,000
c)	Contributions from MITACS/Mprime	
	Mitacs - Algebraic Graph Theory	13,500
	Mitacs-Applied Math Perspectives	5,000
	Mitacs-Summer School in Probability 2009	2,500
	Mitacs-Disease Dynamics	11,250
	Mprime-Summer School in Probability 2012	26,000
	Mprime-IGTC Student Salary	100,000
	Mprime-Math Modeling in Industry Workshop	20,000
d)	Private Donations	30,926
e)	Other Contributions	
	US Army-Hot Topics in Computational Criminology	14,596
	Vancouver Foundation-Education	20,000
	Other Miscellaneous	28,468
	NSF -Summer School in Probability 2012	19,001
	NSERC Regional-Math Modeling in Industry	9,722
	BC Oil and Gas	135,000
	Number Theory Foundation-Automorphic Forms	4,901
	UBC Math Dept	50,479
	Education Associates	3,000
	AMS re travel by Alejandro Adem for meetings	3,983
	Hugh C. Morris Endowment Interest	2,779
f)	AAET Grant	400,000
g)	NSERC Grant	1,100,000
h)	Carried Forward from December 31 2011	757,519
TOTAL REVENUES (January 1 to December 31 2012)		**3,419,378**

	Revenue less Expenses	939,486

GLOSSARY OF ACRONYMS

PIMS	Pacific Institute for the Mathematical Sciences
AARMS	Atlantic Association of Research in the Mathematical Sciences
AMS	American Mathematical Society
BIRS	Banff International Research Station
CAIMS	Canadian Applied and Industrial Mathematics Society
CANSII	Canadian Statistical Sciences Institute
CMS	Canadian Mathematical Society
CNRS	Centre National de la Recherche Scientifique
CNTA	Canadian Number Theory Association
CRG	Collaborative Research Group
CRM	Centre de Recherches Mathématiques
IGTC	International Graduate Training Centre in Mathematical Biology
IMA	Institute for Mathematics and its Applications
IPAM	Institute for Pure and Applied Mathematics
IPSW	Industrial Problem Solving Workshop
Mitacs	Mathematics of Information Technology and Complex Systems
MMIW	Mathematical Modeling in Industry Workshops
MSI	Mathematical Sciences Institute
MSRI	Mathematical Sciences Research Institute
MUN	Memorial University of Newfoundland
NSERC	National Sciences and Engineering Research Council
PDF	Postdoctoral Fellow
PNRMS	Prairie Network for Research in the Mathematical Sciences
PRIMA	Pacific Rim Mathematical Association
PSU	Portland State University
SAS	Standards Aligned System
SFU	Simon Fraser University
SFU-V	Simon Fraser University-Vancouver
SIAM	Society for Industrial and Applied Mathematics
SMB	Society for Mathematical Biology
SMM	Sociedad Matemática Mexicana
SRP	Scientific Review Panel
SNAP	Student-centered, Non-competitive, All-inclusive, and Problem-based
SSC	Statistical Society of Canada
STINT	Swedish Foundation for International Cooperation in Research
UA	University of Alberta
UBC	University of British Columbia
UBC-O	University of British Columbia–Okanagan
UC	University of Calgary
UL	University of Lethbridge
UR	University of Regina
US	University of Saskatchewan
UV	University of Victoria
UW	University of Washington