Pacific Institute *for the*
Mathematical Sciences

2011
Annual Report

I. Overview

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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 and Saskatchewan joined PIMS as full members, and the University of Lethbridge, 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 ac-tivities at a central location where international scientists are brought in residence; PIMS, on the other hand, has a site at each of eight major universities in Alberta, British Columbia, Saskatchewan and Washington State. PIMS events and programs are organized at each of the eight 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

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 23 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.

In 2011 a new CRG on *Applied and Computational Harmonic Analysis* began. One of its highly regarded events, the *Computational Harmonic Analysis Summer School* held in July in Edmonton, featured a tutorial on learning theory by Fields Medalist Steve Smale (University of California at Berkeley and City University of Hong Kong).

Two key breakthroughs came from the *Mathematics of Quantum Information* CRG. One, due to B. Sanders and collaborators of UC, elucidated the metabolic process of electron transfer between proteins and was published in the *Proceedings of the National Academy of Sciences*. On the experimental side, long-distance quantum communication took a leap forward with W. Tittel's group's demonstration of entangled light storage and release using solid state systems. This work was published in *Nature*. To top things off, A. Lvovsky, one of the CRG faculty members, was given the *International Quantum Communication Award*.

The *L-functions and Number Theory* CRG had a full slate of focused activities this year, coordinating workshops at Calgary with previously scheduled workshops at BIRS, as well as a special session in the Canadian Mathematical Society (CMS) Summer Meeting in Edmonton. The Calgary meeting featured lecture series by three top number theorists: B. Conrey (AIM), R. Murty (Queens), and K. Soundararajan (Stanford). The workshop on *L-Packets* featured several invited lec-tures by J. Arthur, who took this opportunity to announce a new major result in the full local Langlands correspondence.

The *Operator Algebras* CRG has led to a great increase in activity around C*-algebras from number theoretic systems. In particular it motivated a focused workshop which took place in Münster in December, 2011, an Oberwolfach work-shop on the subject to be held in April, 2012, and a workshop at BIRS to take place in November, 2013.

New CRGS on *Optimization Theory: Algorithms and Applications* and *Algorithmic Theory of Networks* will be launched in 2012, and CRGs on *Geometry and Physics* and *Applied Combinatorics* are under development for 2013 and beyond.

• Every year PIMS sponsors numerous *postdoctoral fellows* (PDFs) – around 40 in 2011 – 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 past summer one of our PDFs, Ben Adcock of SFU, won second place in the Leslie Fox Prize competition for his postdoctoral research. (This biennial award is one of the highest honors a young numerical analyst may receive

from their community.) As well, Tom Meyerovich of UBC published papers in the *Annals of Mathematics* in 2010 and in *Inventiones Mathematicae* in 2011.

• 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. 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.

Of special note is a project carried out by PIMS IGTC PhD student R. Lukeman and his co-supervisors (L. Edelstein-Keshet and Y. Li) that studied mathematical models for schools and flocks. Quantifying the interactions in moving social animals is notoriously challenging and this project represents one of the first to track individuals within a flock numbering tens to hundreds of members. The results revealed very interesting aspects of flocking behavior, and were published in the *Proc. of the Nat. Acad. Sci.* (USA) (http://www.pnas.org/content/107/28/12576.full), were the subject of a cover story in the April 2011 AMS *Notices* and was also featured in an editorial in *Nature* 466: 163. Lukeman has since graduated with a PhD from UBC and is now an assistant professor in mathematics at St. Francis Xavier University in the Maritimes.

• *Special Focused Periods* are special non-CRG events that occur every couple of years, depending on exceptional opportunities. They take place in the summer and duration varies according to the discipline. In 2011 PIMS organized the program *Applied Mathematics Perspectives*, built around the ICIAM 2011 meeting in Vancouver. It successfully showcased the excellence and breadth of the applied mathematics community in Canada and was organized in partnership with CAIMS, MITACS and BIRS, with additional funding from the NSF. The highlights are recapped in §II.1.E. Currently PIMS is planning a special focused period for 2013: a Canada-wide program on *Epidemiology, Ecology and Public Health*, as part of *Mathematics of Planet Earth* – a North America-wide 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, atmospheric modelling and climate change, quantum information and cryptography, environmetrics and finance. This year's offerings included metric-measure spaces, waves and imaging, computational harmonic analysis and algebraic topology.

• 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. This year's edition (the 15th) of the MMIW, held in Minneapolis, was the second tripartite effort of PIMS and the Institute for Mathematics and its Applications (IMA) and the Center for Mathematical Research (CIMAT). Continuing in this direction, in July of 2011, PIMS cosponsored and hosted the *Gene Golub Summer School* in Vancouver, which addressed the interdisciplinary mathematics underlying different modalities of to-mographic imaging such as radar, medical CT, and seismic. As well, PIMS sponsored three events in 2011 with medical applications: the *3rd Pacific Northwest Computational Neuroscience Connection, GEOMED 2011* and the *Medical and Seismic Imaging*, held at UW, UV and UBC.

• The inaugural speaker in the *Hugh C. Morris Lecture Series* was G. Papanicolaou from Stanford University. Papanicolaou is a highly regarded applied mathematician, a member of the U.S. National Academy of Sciences, winner of the SIAM von Neumann Prize (2006) and the William Benter Prize in Applied Mathematics (2010). Dr. Hugh Morris, 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.

• Each year PIMS awards several prestigious prizes. The 2011 *CRM-Fields-PIMS Prize* went to Mark Lewis of UA, and Veselin Jungic of SFU was the recipient of the 2011 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 2011 awardee was Adam Oberman of SFU.

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 Mitacs (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 in the country. Recently the statistics community has proposed a national initiative through the three institutes and PIMS will be an active participant. In 2013 the three institutes and BIRS will sponsor a pan-Canadian thematic program on epidemiology, ecology and public health 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 also 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 18 researchers from France since 2007, fully funded by CNRS. As part of our agreement with CNRS, PIMS has hired 11 excellent young French scientists as PDFs. Similarly the leadership role played by PIMS in establishing the Pacific Rim Mathematical Association (PRIMA) has provided ample opportunities for Canadian exchanges with countries in this huge region; indeed in 2013 we expect to have about 1000 participants at the PRIMA Congress in Shanghai. Our partnership with IMA (USA) and CIMAT (México) 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 seven universities has a site office and a site director (see http://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 onsite 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 governing structure of PIMS consists of **Alejandro Adem** (Director), **George Homsy** (Deputy Director) and **Mark J. Gotay** (Assistant Director), who are located at PIMS Central at the University of British Columbia. 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 http://www.pims.math.ca/pims-glance/board-directors. Scientific events are adjudicated by an independent *Scientific Review Panel* composed of internationally renowned mathematical scientists. For biographies of Panel members, see http://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), D. Stanley (UR), R. Srinivasan (US), I. Putnam (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 and Alberta Advanced Education and Technology (AAET), by other Canadian institutes such as AARMS, the Canadian Institute for Advanced Research (CIFAR), Centre de Recherches Mathématiques (CRM), Fields Institute, Mitacs, mprime and the Pacific Institute for Theoretical Physics (PiTP), by pro-fessional societies such as the American Mathematical Society (AMS), American Statistical Association (ASA), Association for Logic Programming, CAIMS, CMS, International Association for Cryptologic Research (IACR), International Mathe-matical Union (IMU), Mathematical Association of America (MAA), Society of Actuaries, Society for Industrial and Ap-plied 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, BC Centre for Disease Control, BIRS, CIBC, Capital One, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS), Centre for Experimental and Constructive Mathematics (CECM), Centre International de Mathématiques Pures et Appliquées (CIMPA), Centro de Investigación en Matemáticas (CIMAT), CERTI-COM, Clay Mathematics Institute, D-Wave Systems, ENCORA, Federal Interlocutor for Métis and Non-status Indians, FP Innovations, 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 (IHES), Institute for Pure and Applied Mathematics (IPAM), Institute of Industrial Mathematics (IIMS), Interdisciplinary Research in the Mathematical and Computational Sciences Centre (IRMACS), International Centre for Theoretical Physics (ICTP), Ion Torrent, JackTek System Ltd., JMP, J. Templeton Foundation (USA), Kyoto U. Global COE Program, Luther College, Mathematical Sci-ences Research Institute (MSRI), MapleSoft, Microsoft Research, Mount Royal U., National Institute for Mathematical and Biological Synthesis (NIMBioS), Nelson Education, the Number Theory Foundation, Pacific Bioscience, Pearson, the (U.S.) Office for Naval Research, the Prairie Network for Research in the Mathematical Sciences (PNRMS), Quantum Works, Quest 4D, 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, U. of Abomey Calavi, U. of California (Santa Barbara), U. of Manitoba, U. of New South Wales, U. of Oregon, W.H. Freeman & Co., Wiley and York U.

The PIMS annual budget is approximately $3.3 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 the mathematical endeavour. PIMS is actively involved in promoting mathematical out-reach 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 is supported by the provincial and local governments 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 eleven educational associates in Alberta and British Columbia.

7. PIMS NEWS IN 2011:

• In August 2012 PIMS Central will be moving to a new home. We will 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 and offices for up to 24 visitors and postdoctoral fellows, and workspace for 10 students in our graduate student lab. We will have meeting rooms, workrooms and a state of the art videoconferencing centre. Our site will also include a library and lounge, and we will have access to classroom facilities and larger meeting areas one floor above us. The building will feature a large atrium and a café.

• PIMS renewed its "Unité Mixte Internationale" affiliation with the CNRS this year, incorporating UR and US. PIMS was the first North American mathematics institute to receive this recognition in 2007.

• In October PIMS unveiled http://www.mathtube.org, a new multimedia source that gives users easy access to mathematical seminar and lecture materials including videos, notes and slides. It is unique in that it allows users to view slides and video at the same time, but also independently from one another, so that watchers may follow a lecture at their own pace and have time to review anything that they missed. See §III.1 for more details about mathtube.

• The PIMS IGTC in Mathematical Biology underwent a significant change this summer. As of August 1, 2011, Dan Coombs of UBC took over the position of director from Mark Lewis of UA, who has directed this specialized graduate program since its beginnings in 2007. During Lewis' tenure the IGTC flourished, 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 50 papers published since 2008, including several in top scien-tific journals) and career development (centre alumni are moving into excellent positions in academia and elsewhere). A top priority for incoming Director Coombs is to seek 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 he has already seen success, securing external funding which will allow further awarding of IGTC Fellowships in 2012. §II.2.B con-tains more reporting on the IGTC.

• The University of Northern British Columbia officially became an affiliate member of PIMS.

• The British Columbia government awarded $100,000 to PIMS in legacy funding from the 2010-2011 Year of Science in BC. (Only Science World and PIMS were singled out for this special funding.) The funds will be used on our First Nations/Aboriginal Program throughout the province.

• This year PIMS established the *Marsden Memorial Lecture Series*. 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. In view of Marsden's seminal academic contributions and close ties to Canada in general and British Columbia in particular, it is appropriate for PIMS to remember him with a named lecture series. A Lecture will be given annually in a venue of special significance to Marsden or his work and/or at selected professional meetings. The series will return to Canada at least every third year, following up on the inaugural Lecture given in July 2011 by A. Weinstein (U. of California at Berkeley) at ICIAM in Vancouver.

• Malgorzata Dubiel, the PIMS Education Coordinator at SFU, was awarded the 2011 Adrien Pouliot Award from the CMS in recognition of her outstanding contributions to mathematics education in Canada.

• This summer PIMS welcomed two new site directors: N. Bruin at SFU and P. Hoff at UW; they replaced S. Ruuth and G. Uhlmann, respectively. K. Bauer was the interim site director at UC while C. Cunningham was on sabbatical during fall 2011.

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

II. PIMS Current Activites

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

PIMS enables and funds Collaborative Research Groups (CRGs) and their focused 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 post-doctoral fellowship (PDF) appointments, or develop joint graduate training programs. CRGs are designed to promote and support longer term, multi-event, multi-site coordinated activities. During its period of operation, typically 3-4 years, a CRG can 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 http://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 http://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 PIMS Scientific Review Panel. 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, 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 usually take place in the summer and vary in length depending on the discipline. Proposals are evalu-ated by the PIMS Scientific Review Panel 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 be-tween PIMS, Fields and CRM.

Mathematical Modelling in Industry Workshops (MMIW) enable graduate students from North American universities learn various aspects of high-level techniques for solving industrial mathematics problems. Since 2010, these camps have been co-sponsored by the IMA and CIMAT and rotate among the three countries; the one in 2012 will be in Calgary.

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 (7 in 2011) are aimed at a general audience. http://www. pims.math.ca/industrial has more information.

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

Activity	2010	2011	2012
Conferences/Workshops	33	44	31
Summer schools	8	4	9
Collaborative Research Groups	7	5	7
Lecture and seminar series	19	20	21
Industrial Activities	6	5	4
Other	20	24	20 (est.)

Note: The category "Conferences/Worskhops" includes CRG events and Special Focused Period events as well as IGTC events. Activities to be co-sponsored by AARMS are not known at this writing. We expect there will be 5-6 of these that we have listed under "Other".

All activities are listed individually below, along with selected scientific highlights. 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 http://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, and so forth. Because of their importance, more detail is given on the CRGs, Special and CRG Focused Periods, PIMS support for AARMS and the IGTC in §§II.1.D–F and II.2.B following.

B. Listing of Activities: 2011

Conferences and Workshops

1. *Frontiers in Biophysics*, UBC, February 26.
2. *Joint UBC/SFU Graduate Student Workshop in Statistics*, UBC, February 26.
3. *Bellingham Algebraic Geometry Seminar*, Western Washington University, March 5.
4. *Pacific Permutation Pattern Workshop* (PPPW), Simon Fraser University, March 31-April 1.
5. *Cascade Topology Seminar*, U Victoria, April 16-17.
   - J. Johnson spoke on Heegaard splittings of 3-manifolds; his result – first announced here – has been de scribed by some as "the holy grail" for the subject.
6. *PIMS Workshop on Geometric Analysis*, UBC, April 26.
7. *5th Annual Meeting of the PNRMS*, U Regina, April 29-May 2.
8. *PIMS Young Researchers Conference in Mathematics*, UBC, May 2-5.
9. *North-South Dialog in Mathematics*, Mt. Royal University, May 5-6.
10. *Pacific Northwest Number Theory Conference,* Western Washington University, May 7-8.
11. *Pacific Northwest Geometry Seminar*, U Washington, May 7-8.
12. *Eleventh International Conference on Logic Programming and Nonmonotonic Reasoning*, Simon Fraser University, May 16-20.
13. *Computational and Analytical Mathematics*, Simon Fraser University, May 16-20.
    - Variational analysis, optimization algorithms, high performance computing, number theory, and experi-

mental mathematics were explored at this workshop, which was dedicated to J. Borwein in honour of his 60th birthday.

14. *The 2011 Canadian Workshop on Information Theory,* UBC–Okanagan, May 17-20.
    - The first CSIT School of Information Theory focused on Optimizing Wireless Network Resource Al location and Interference Align-ment.
15. *Canadian Operator Symposium*, U Victoria, May 24-28.
    - N. Higson (Penn State) lectured on his recent work providing an approach to the "quantization com mutes with reduction" problem through K-homology of C*-algebras.
    - M. Khalkhali (Western) presented work generalizing the Gauss-Bonnet Theorem to noncommutative tori.
16. *Workshop on Analytic Aspects of L-functions and Applications to Number Theory*, U Calgary, May 29-June 3.*
17. *CanaDAM 2011*, U Victoria, May 31-June 3.
18. *Special Session on L-functions and Number Theory*, U Alberta, June 3–5.*
19. *Alberta Topology Seminar*, U Calgary, June 7-8.
20. *International Workshop on Combinatorial Algorithms*, U Victoria, June 20-22.
21. *Groups, Rings and Group Rings*, U Alberta, July 11-15.
    - A highlight was the talk of R. Boltj; he and his collaborators are opening the new and exciting of "biset functors," replacing the old and more complicated Mackey functors.
22. *Applied Analysis & Applied PDEs,* U Victoria, July 12-July 15.†
23. *Reproducible Research: Tools and Strategies for Scientific Computing*, UBC, July 13-16. †
24. *Delay Differential Equations in Applications: Common Themes and Methods*, UBC, July 14-16. †
25. *Numerical Methods for Incompressible Fluid Flow*, UBC, July 14-16. †
26. *Mathematical Biology Workshop* and *IGTC Summit*, U Victoria, July 14-16. †
27. *Advances in the Numerical Solution of Constrained Differential Equations,* UBC, July 15-17. †
28. *Numerical Ricci Flow in Computer Science, Geometry, and Physics*, UBC, July 14-16. †
29. *CT2011 International Category Theory Conference*, UBC, July 17-23.
30. *Graphs, Designs and Algebraic Combinatorics*, U Regina, July 18-21.
31. *2011 Prairie Discrete Math Workshop*, U Regina, July 22-23.
32. *WAVES 2011*, Simon Fraser University, July 25-29.
    - This meeting highlighted emerging areas (random media, nano-scale phenomena, the use of Bayesian methods for large-scale inverse problems), and also had a focus on nonlinear and water waves. It pro vided the first serious mathematical simulation of a grand piano, and dissipative solitons in femtosec ond lasers.
33. *International Conference on Applied Harmonic Analysis and Multiscale Computing*, U Alberta, July 25-28.
34. *The 5th G.J. Butler Memorial Conference on Differential Equations and Population Biology*, U Alberta, July 25-30.
    - J. Wu of York University gave three Butler Memorial Lectures, titled "Insights from nonlinear dynamics of delay differential equations on disease spread and pattern recognition."
35. *Hyperplane Arrangements and Applications*, UBC, August 8-12.
36. *Computational Math Day*, Simon Fraser University, August 12.

37. *PRIMA-PARC-PIMS Meeting on PDEs*, Seoul National University, August 25-27.
38. *Joint SFU/UBC Seminar in Statistics*, Simon Fraser University, September 17.
39. *Pacific Northwest Numerical Analysis Seminar*, Vancouver Island University, October 1.
40. *West Coast Optimization Meeting,* UBC–Okanagan, October 1.
41. *Pacific Northwest Statistics Seminar,* U Victoria, October 14.
42. *Pacific Northwest Probability Seminar*, U Washington, October 15.
    - S. Evans (Berkeley) gave an overview of his striking work on aging and mortality, while J. Miller (Microsoft Research) spoke on his major result with S. Sheffield establishing the long-conjectured duality between SLE(k) and SLE(16/k).
43. *Alberta Statisticians Meeting*, U Calgary, October 22.
44. *Cascade Topology Seminar*, Portland State University, November 19-20.
    - A beautiful confluence of hyperbolic geometry, Coxeter groups, and number theory was used to con struct the first known examples of orientable hyperbolic 6-manifolds having the smallest possible volume.

Summer Schools

1. *Séminaire de Mathématiques Supérieures: Metric-Measure Spaces*, U Montréal, June 27-July 8.
2. *Gene Golub SIAM Summer School*, UBC, July 4-15.
3. *Computational Harmonic Analysis Summer School,* U Alberta, July 29-31.
4. *West Coast Algebraic Topology Summer School,* U Washington, August 26-28.

Collaborative Research Groups

1. CRG 19 - *Partial Differential Equations*, 2008-2013.
2. CRG 20 - *Operator Algebras and Non-commutative Geometry*, 2009-2012.
3. CRG 21 - *L-functions and Number Theory*, 2010-2013.
4. CRG 22 - *Mathematics of Quantum Information*, 2010-2013.
5. CRG 23 - *Applied and Computational Harmonic Analysis*, 2011-2014.

Special and CRG Focused Periods

1. *L-functions and Number Theory*, June-July & November.
2. *Applied Mathematics Perspectives 2011*, mid-July.

Lecture and Seminar Series

1. *PIMS Voyageur Colloquium,* U Calgary.
2. *IAM-PIMS-MITACS Distinguished Colloquium Series*, UBC.
3. *PIMS Postdoctoral Colloquium Series*, UBC.
4. *2011 CRM-Fields-PIMS Prize Lecture*, U Alberta, April 11.
5. *The AMI Seminar Series*, U Alberta.
6. *PIMS Distinguished Lecture Series*, U Regina.
7. *Niven Lecture,* UBC, May 30.
   - Ravi Vakil (Stanford University) was the 2011 Niven Lecturer.
8. *PIMS/CSC Distinguished Lecture Series*, Simon Fraser University.

9. *Hugh C. Morris Distinguished Lecture*, UBC, November 7.
10. *UW-PIMS Colloquium*, U Washington.
11. *Seminars and Colloquia at the University of Victoria*, U Victoria.
12. *MathAcrossCampus Colloquium Series*, U Washington.
    - J. Lowengrub of UC Irvine spoke on the latest results regarding "Feedback, Lineages and Cancer."
13. *Applied Mathematics Seminar*, U Saskatchewan.
14. *Quantum Information Seminar Series*, U Calgary.
15. *PIMS-UBC Distinguished Lecture Series*, UBC.
    - Lecturers included J.-P. Bismut (Prix Ampere winner), Dusa McDuff (Senior Berwick Prize winner) and Gregory Margulis (Fields Medalist and Wolf Prize recipient).
16. *SCAIM Seminars*, UBC.
17. *MITACS/PIMS Mathematical Biology Seminars,* UBC.
18. *PIMS VanBUG Seminar*, British Columbia Cancer Agency (Vancouver).
19. *SFU Discrete Mathematics Seminar,* Simon Fraser University.
20. *PIMS Number Theory CRG Seminar Series*, U Calgary.

International Graduate Training Centre in Mathematical Biology

1. *Mathematical Biology Workshop and IGTC Summit,* U Victoria, July 14-16. †

Industrial Activities

1. *PIMS/Shell Lunchbox Lecture Series*, Calgary.
2. *Complex Fluids and Flows in Industry and Nature,* UBC, July 13-16. †
3. *Medical and Seismic Imaging*, UBC, July 14-16. †
    - A notable discovery was the wide commonality of state-of-the-art mathematical methods that can be used equally effectively in diverse imaging applications: from CAT scans in medicine to deconvolution/ migration in seismic imaging, to radar imag-ing in military environments.
4. *3rd Pacific Northwest Computational Neuroscience Connection*, U Washington, September 30-October 1.
5. *GEOMED 2011*, U Victoria, October 20-21.

Other: PIMS provided administrative, financial and/or travel support for a number of activities and organizations, including:

1. *PIMS Distinguished Lecturer* (Noam Elkies - Harvard), UC, January.
2. *Mathematical Institutes Open House Reception,* 2011 Joint Mathematics Meetings, New Orleans, January 6.
3. *15th Annual Symposium on Research in Computational Molecular Biology,* Vancouver, March 28-31.
4. *Centennial Celebration at the University of Alberta*, May 1, 2011-April 30, 2012.
5. *AARMS Summer School, Memorial University,* June 2-June 29.º
6. *CMS Summer Meeting*, Edmonton, June 3–5.
7. *Theory Canada 6 and Atlantic General Relativity Meeting*, Memorial University (Corner Brook), June 10-12.º
    - Key talks concerned the potential to discover new physics in searches for exotic muon decays and a new approach to rigid body motion in relativity.
    - A public lecture entitled "From GPS to Nanotechnology – Applied Mathematics and Theoretical

Physics in the Real World," emphasized the relevance of fundamental theory on the development of everyday technology.

8. *SSC Annual Meeting*, Acadia University, June 12-15.º
   - The former Chief Statistician of Canada, Ivan Fellegi, spoke on lessons from the 2011 census.
9. *Canadian Undergraduate Mathematics Conference 2011*, Laval University, June 16-19.
10. *Alberta Number Theory Days*, Banff, June 17-19.*
    - T. Trudgian spoke on the latest bounds on Skewes' Number, while H. Kadiri discussed an explicit esti mation on the error term in the celebrated Prime Number Theorem.
11. *35th Conference on Stochastic Processes and their Applications*, Oaxaca, Mexico, June 19-24.
12. *L-Packets*, Banff, June 26-July 1.*
    - A major announcement, by J. Arthur, was that the full local Langlands correspondence for SO(2n + 1) and Sp(2n) is now proved, as is a slightly weaker form of the correspondence for the SO(2n).
13. *PIMS Distinguished Lecturer* (Thomas Erneux), UBC, July 10-31.
    - The Université Libre, Bruxelles, researcher visited UBC for collaboration in applications of delay differ ential equations and asymptotics of biochemical reaction-diffusion systems. Several new projects were identified.
14. *Applied Mathematics Perspectives Receptions*, Simon Fraser University, July 19.
15. *AWM Embedded Meeting at ICIAM*, Vancouver, July 18-22.
16. *Mathematical Modeling in Industry Workshop*, IMA, U Minnesota, August 3-12.
17. *Polynomial Identities in Algebras II*, Memorial University, September 2-6.º
18. *PIMS Hot Topic Course on Distribution of prime numbers and zeros of Dirichlet L-functions*, UBC, winter term.
19. *PIMS Hot Topic Course on Mathematical Ecology*, UA, winter term.
20. *PIMS/UBC Grad Student/Postdoc Job Forum*, UBC, October 6.
21. *Workshop on Cycles on Modular Varieties*, BIRS, October 30-November 4.*
22. *WIN 2: Women in Numbers*, BIRS, November 6-11.*
23. *CMS Winter Meeting*, Toronto, December 10-12.
24. *American Women in Mathematics* Mentor Network.

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* Starred events belong to CRG Focused Period on L-Functions and Number Theory.

† Daggered events belong to the Special Focused Period on Applied Mathematics Perspectives.

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

C. LISTING OF Planned 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.
4. *UBC/SFU Graduate Student Workshops in Statistics*, SFU-Vancouver, March 17.
5. *26th Automorphic Forms Workshop*, UBC, April 26-29.
6. *Cascade Topology Seminar*, UBC, April 28-29.
7. *PIMS Young Researchers Conference*, U Calgary, May 2-5.

8. *North-South Dialogue in Mathematics*, U Alberta, May 3-4.
9. *2012 Prairie Discrete Math Workshop (PDMW)*, U Calgary, May 4-5.
10. *Connections Between Algebra and Geometry*, U Regina, May 29-June 1.
11. *Bellingham Algebraic Geometry Seminar*, UBC, Spring.
12. *The Stability of Coherent Structures and Patterns*, U Washington, June 11-12.
13. *Canadian Number Theory Association Conference (CNTA XII)*, U Lethbridge, June 17-22.
14. *Joint Alberta-British Columbia 4-day Harmonic Analysis Seminar*, UBC, July.
15. *Canadian Undergraduate Mathematics Conference*, UBC-Okanagan, July 11-15.
16. *Workshop on Cohomology and Support in Representation Theory and Related Topics*, U Washington, August 1-5.
17. *West Coast Linear Algebra Meeting 2012*, U Lethbridge, August 8-10.
18. *Cascade Topology Seminar*, Fall.
19. *UBC/SFU Graduate Student Workshop in Statistics*, Fall.
20. *Pacific Northwest Geometry Seminar*, Fall.
21. *Pacific Northwest Number Theory Conference,* Fall.
22. *6th Annual Meeting of the PNRMS*, TBA.
23. *CanaDAM 2012*, TBA.
24. *Alberta Topology Seminar*, TBA.
25. *Alberta Number Theory Days*, TBA.
26. *Pacific Northwest Numerical Analysis Seminar*, TBA.
27. *West Coast Optimization Meeting*, TBA.
28. *Pacific Northwest Statistics Seminar*, TBA.
29. *Pacific Northwest Probability Seminar*, TBA.
30. *Mathematical Biology Workshop* and *IGTC Summit,* Naramata, BC, October 12-14.
31. *Combinatorial Potlatch,* SFU, November 17.

Summer Schools

1. *The Second PIMS-Mprime-CDM Summer School on Mathematical Modeling of Infectious Diseases*, U Alberta, May 3-13.
2. *PIMS-Mprime Summer School in Probability 2012*, UBC, June 4-29.
3. *SMS Probabilistic Combinatorics*, U Montreal, June 25-July 6.
4. *PIMS-SFU Undergraduate Summer School in Algebraic Graph Theory*, Simon Fraser University, July 1-28.
5. *Winter School on Geometric PDEs*, U Queensland, Brisbane, July 2-13.
6. *West Coast Algebraic Topology Summer School,* Stanford University, July 16-21.
7. *Fluid Dynamics Summer School*, U Alberta, July 23-27.
8. *Cohomology and Support in Representation Theory and Related Topics*, U Washington, July 27-30.
9. *Two Weeks at Waterloo - A Summer School for Women in Math*, U Waterloo, August 12-25.

Collaborative Research Groups

1. CRG 19 - *Partial Differential Equations,* 2008–2013.
2. CRG 20 - *Operator Algebras and Non-commutative Geometry*, 2009-2012.
3. CRG 21 – *L-functions and Number Theory*, 2010-2013.
4. CRG 22 - *Mathematics of Quantum Information*, 2010-2013.

5. CRG 23 - *Applied and Computational Harmonic Analysis*, 2011-2014.
6. CRG 24 – *Optimization: Theory, Algorithms and Applications,* 2012-2015.
7. CRG 25 – *Algorithmic Theory of Networks*, 2012-2015.

Lecture and Seminar Series

1. *PIMS Number Theory CRG Seminar Series*, U Calgary, ongoing.
2. *UW-PIMS Colloquium*, U Washington, ongoing.
3. *PIMS/UBC Distinguished Colloquium Series*, UBC, ongoing.
4. *PIMS Distinguished Lecture Series*, U Regina, January 1 – December 31.
5. *The AMI Seminar Series*, U Alberta, ongoing.
6. *Niven Lecture,* UBC, May.
7. *The PIMS Marsden Memorial Lecture*, the Fields Institute, July.
8. *Applied Mathematics Seminar,* U Saskatchewan, ongoing.
9. *PIMS Voyageur Colloquium,* U Calgary, ongoing.
10. *PIMS/CSC Distinguished Lecture Series*, Simon Fraser University, ongoing.
11. *p-Adic Galois Representations,* UBC, September 1-November 30.
12. *SFU Discrete Math Seminar*, Simon Fraser University, September 2010 – August 2012.
13. *SCIAM Seminar Series*, UBC, September 2011 – August 2012.
14. *IAM-PIMS-MITACS Distinguished Colloquium Series*, UBC.
15. *PIMS Postdoctoral Colloquium Series*, UBC, ongoing.
16. *CRM-Fields-PIMS Prize Lecture*, UBC, April 4.
17. *Hugh C. Morris Distinguished Lecture Series,* U Calgary, Fall.
18. *MITACS/PIMS Mathematical Biology Seminars,* UBC, ongoing.
19. *MathAcrossCampus Colloquium Series*, U Washington, ongoing.
20. *Quantum Information Seminar Series*, U Calgary, ongoing.
21. *PIMS Public Lecture Series*, UBC, ongoing.

International Graduate Training Centre in Mathematical Biology

1. *Mathematical Biology Workshop and IGTC Summit*, Naramata, BC, October 12-14.

Industrial Activities

1. *Monte Carlo Methods for Quantitative Finance*, Industrial Short Course, SFU-Vancouver, February 22-24.
2. *Mathematical Modeling in Industry Workshop*, U Calgary, June 18-27.
3. *Gene Golub SIAM Summer School*, Monterey, CA, July 29-August 10.
4. *Disease Dynamics 2012: Immunization*, a True Multi-scale Problem, UBC, September 26-28.
5. *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. *PIMS Distinguished Lecturer: Thomas Scanlon*, UBC, January 6-12.
2. *PIMS Distinguished Lecturer: Pascal Lambrechts*, U Regina, April 3-25.
3. *Northwest Functional Analysis Symposium*, BIRS, April/May

4. *Centennial Celebration at the U of A*, U Alberta, May 1, 2011-May 1, 2012.
5. *CMS Summer Meeting*, UR, June 2-4.
6. *Statistical Society of Canada Annual Meeting,* U Guelph, June 3-6.
7. *PIMS Distinguished Lecturer: Michael Overton*, UBC, July.
8. *PIMS Distinguished Lecturer: Robert McCann*, UBC, August 1-31.
9. *PIMS Postdoc Day*, UBC, Fall.
10. *PIMS Distinguished Lecturer: Vern Paulsen*, U Regina.
11. *PIMS Distinguished Lecturer: Peter Schneider*, UBC, one semester.
12. *CMS Winter Meeting*
13. *5-6 AARMS events,* Atlantic Canada.
14. *American Women in Mathematics* Mentor Network.
15. *CAIMS Annual Meeting*.

D. CRG Status Reports

PIMS had 5 active CRGs in 2011; below we briefly summarize current and upcoming activities and list their PDFs. In 2012 PIMS will inaugurate two new CRGs, #24 on *Optimization: Theory, Algorithms and Applications*, which will be based at UC, with nodes at UBC and UBC-O, and #25 on *Algorithmic Theory of Networks* based at SFU. PIMS is also currently considering several letters of intent for new CRGs in coming years.

CRG 19: Partial Differential Equations (2008–2013)

- **Leader:** N. Ghoussoub (UBC).
- **2011 Activities:** *Second PRIMA-PARC-PIMS Meeting on PDEs*, Seoul National University, Korea, August 25-27.
- **2012 Activities:** This CRG has wound down; however, several PDFs remain active.
- **PDFs**: Ian Zwiers (UBC, 2010-2012), Vianny Combet (UBC, 2010-2011), Jun Kitigawa (UBC, 2011-2013).

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

- **Leaders:** D. Farenick (UR), M. Laca (UV), A. Lau (UA), I. Putnam (UV).
- **2011 Activities:**
  1. *Canadian Operator Symposium*, University of Victoria, May 24-28.
  2. PIMS Distinguished Lecturer: Jean Bellissard (Georgia Institute of Technology, October).
  3. Visitors: A. an Huef & I. Raeburn (U of Otago, September), J. Kellendonk (U de Lyon, October), J. Savinien (Georgia Institute of Technology, October), M. Ramirez-Solano (U of Copenhagen, January-August).
- **2012 Activities (Planned):**
  1. PIMS Distinguished Lecturer Vern Paulsen (U of Houston), March.
  2. Visitors: Chris Skau (Trondheim), Spring and Klaus Thomsen (Aarhus), Spring.
  3. This CRG is winding down; however, several PDFs remain active.
- **PDFs:** Antoine Julien (UV, 2010-2012), Bogdan Nica (UV, 2009-2011).
- **Students:** 8 PhD, 5 MSc, 1 USRA.
- **Highlights:** A paper by D. Farenick and V. Paulsen offers potential new approaches to the Connes

Embedding Problem. Research by J. Cuntz, C. Deninger, and M. Laca has already had a significant impact and has sparked research in several directions in the area of C*-algebras of Toeplitz type.

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

- **Leader:** Matthew Greenberg (UC).
- **2011 Activities:**
  1. *Analytic Aspects of L-functions and Applications to Number Theory*, University of Calgary, May 29–June 3.
  2. *Special Session on L-functions and Number Theory*, CMS Summer Meeting, Edmonton, June 3–5.
  3. *Alberta Number Theory Days*, BIRS, June 17–19.
  4. *L-packets*, BIRS, June 26–July 1.
  5. *Workshop on Cycles on Modular Varieties*, BIRS, October 30–November 4.
  6. *WIN 2: Women in Numbers,* BIRS, November 6–11.
  7. *PIMS CRGs Seminar Series.*
  8. *West End Number Theory Seminars.*
  9. Visitors: Hugo Chapdelaine (U. Laval, December 14-19).
  10. Two Focused Periods, one in spring/summer and the other in October, are described in detail in §II.1.E.
- **2012 Activities (Planned):**
  1. *12th Canadian Number Theory Association Conference* (CNTA XII), U Lethbridge, June 17-22.
  2. *PIMS CRGs Seminar Series.*
  3. *West End Number Theory Seminars.*
  4. Visitors: N. Elkies (Harvard), P. Charollois (Jussieu), C. Franc (McGill), P. Mezo (Ottawa), H. Salmasian (Ottawa), P. Achar (LSU), S. Dasgupta (UCSC).
- **PDFs:** J. Jia (UBC, 2010-2012), C. Marks (UA, 2011-2013), B. Ce (UC, 2011-2013), D. Roe (UC, 2011-2013).

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

- **Leaders:** Barry Sanders (UC), Robert Raussendorf (UBC), Petr Lisonek (SFU), Aram Harrow (UW).
- **2011 Activities:**
  1. *Quantum Information Seminar Series.*
  2. Visitors: F. Brandão (U Federal de Minas Gerais, Brazil, July 10-23), P. Hayden (McGill U, March 9-20), N. Lindner (Caltech, March 6-17), and S. Friedland (U of Illinois at Chicago, 7-12 November).
- **Future Activities (Planned):**
  1. *Workshop on Quantum Methods Applied Outside of Quantum Information,* (Summer 2013).
  2. Inter-node collaboration in 2012 -- Ran Choi (UC MSc student) and V. Gheorghiu (UC PIMS PDF) will visit SFU and UBC for one week in February, and M. Amin (D-Wave Systems in Vancouver) will visit UC in January. Y. Wang (UC PDF) is planning visits to SFU and UBC in 2012.
- **PDFs:** M. Hernandez (UBC, 2011-13), V. Singh (SFU, 2011-13), C. Trail & V. Gheorghiu (UC, 2011-13).
- **Students:** Ran Hee Choi (UC, MSc).
- **Highlights**: The CRG works at the forefront of mathematical quantum information and has obtained several significant results. These advances include the non-randomized construction of highly entangled subspaces, a proof that the Affleck-Kennedy-Lieb-Tasaki states in condensed matter physics are a universal

resource for quantum computation by local measurement, a closed formula for relative entropy of entanglement in all dimensions, and an efficient algorithm for optimizing adaptive quantum metrology processes. Major efforts are underway on quantum error control codes especially concerning the LU-LC conjecture.

- The CRG helped attract new faculty in experimental quantum information to UW (K. Fu) and UC (P. Barclay).

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

- **Leaders:** Bin Han (UA), Rong-Qing Jia (UA), Elena Braverman (UC), Ozgur Yilmaz (UBC).
- **2011 Activities:**
  1. *International Conference on Applied Harmonic Analysis and Multiscale Computing,* University of Alberta, July 25-28.
  2. *Computational Harmonic Analysis Summer School,* University of Alberta, July 29-31.
- **Future Activities (Planned):**
  1. *Alberta-British Columbia Seminar in Harmonic Analysis*, July 2012.
  2. Visitors: A. Averbuch (Tel Aviv U., July 17-29), Q. Mo (Zhejiang University, July 25-August 28), Y. Xu (Syracuse U., August 21-25), X. Zhuang (Osnabruck U., July 23-August 13). 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).
- **PDFs:** Enrico Au-Yeung (UBC, 2011-2013), Kun Wang (UA, 2012-2013), Srinath Madhavan, (Goodyear R&D Centre, Akron, 2011).
- **Students:** 7 Ph.D. and 3 M.S., at UA, UBC and UV.
- **Highlights:** The above conference and its summer school afterward enabled the CRG to attract the interest of and establish connections with the research groups on machine learning at the Department of Computing Sciences and signal processing at the Department of Physics at UA. In addition to Fields Medalist S. Smale's lectures on the theory of learning, D. Zhou presented tutorial lectures on the current-state-of-art research in the area of learning theory. Z. Shen gave tutorial talks on the theory of wavelet analysis and its applications to image processing. Finally there were two tutorial lectures by B. Han on the algorithmic aspects of wavelets and framelets.

E. Special and CRG Focused Periods

Special Focused Period: Applied Mathematics Perspectives (AMP). Approximately 250 people from around the world attended the AMP workshops on the UBC campus in July 2011. Seven workshops targeted diverse areas of applied mathematics including imaging, fluid mechanics, differential equations, Ricci flows and reproducible research. Two further workshops on mathematical biology were held at University of Victoria and an additional two at BIRS. These workshops took place just before the ICIAM Vancouver meeting, so as to enhance the attendance at ICIAM and allow for a deeper investigation into these selected areas. PIMS, MITACS, BIRS and CAIMS/SCMAI were co-organizers of the events, with additional travel support from NSF.

The Local Organising Committee consisted of: I. Frigaard (UBC), T. Hillen (UA), B. Khouider (UV), M. Lamoureux (UC), R. LeVeque (UW), N. Nigam (SFU), R. Russell (SFU), R. Spiteri (US), and M. Ward (UBC).

In the workshop, *Advances in the Numerical Solution of Constrained Differential Equations*, speakers from 10 countries gave lively and informative talks on the theory, computation, and software for solving differential equations subject to constraints. Applications include multi-body systems with collisions, virtual reality, robotics, image reconstruction, and data inversion in geophysics. The workshop on Reproducible Research presented tools and techniques for improving reproducibil-ity in the computational sciences. In *Applied Analysis and Applied PDEs*, three mini-courses were given on optimal transportation theory, Navier-Stokes-type equations, and PDEs and waves for the atmosphere and oceans. Several new lines of inquiry arose from connections between researchers of the different focus areas. For instance, the ideas of optimal trans-portation theory may provide new techniques for ensemble climate prediction, and the lectures on the "hurricane embryo" provided new fluid dynamics PDEs that are deserving of rigorous analysis. Also, recent works revealed that optimal transportation theory is useful for the analysis of fluid mechanics equations. *Medical and Seismic Imaging* brought together researchers and practitioners in academia and industry to discuss advances in mathematical methods used to produce reliable, accurate, and useful images for both medical and geophysical applications. Attendees included geophysicists from Shell Oil in the Netherlands, medical scientists from England and Oregon, and mathematicians from MIT, Rochester, Corvallis, and across Canada. *Complex Fluids and Flows in Industry and Nature* discussed problems with origins in the engineering, physical and biological sciences. In the *Numerical Methods for Incompressible Fluid Flow* workshop, the focus was on the exact imposition of incompressibility, new stabilization techniques, fast and massively parallelizable algorithms, and new exciting families of discrete spaces based on B-splines. Key applications include atmospheric and ocean flows, as well as biological flows and pharmacology. *Delay Differential Equations* occur in models of physical and biological systems, ranging from laser physics through traffic flow to disease processes; this workshop discussed the most recent advances in the subject. *Numerical Ricci Flow in Computer Science, Geometry and Physics* was the first-ever workshop to bring together researchers from these disciplines who are exploring applications of (numerical) Ricci flow. The AMP *Mathematical Biology Workshop and IGTC Summit* is described below in §II.2.B.

As well as diversity in subject and application, coordination of the workshops to run simultaneously allowed cross-pollination of ideas over communal lunches, coffee breaks and social events.

CRG Focused Period: L-functions and Number Theory. The CRG by this name organized two focused periods in 2011. The CRG coordinated its efforts with the organizers of BIRS workshops in related topics in number theory, making use of its geographic proximity to Calgary. This resulted in substantial joint activity.

From May 29-June 3, UC hosted the PIMS workshop *Analytic Aspects of L-Functions*, one of the CRG's flagship events. This well-received workshop gathered 75 participants from North America, Europe, and Asia, from advanced undergraduates through senior faculty. The workshop featured three lecture series by top number theorists: Random matrix theory by B. Conrey (AIM), Artin L-functions by R. Murty (Queens), and Moments of zeta functions by K. Soundararajan (Stanford). These lecture series were complemented by invited talks by many researchers with international reputation; there were also contributed talks as well as a sequence of informal early evening lectures aimed at graduate students.

Immediately following the Calgary workshop the CRG organized a special session at the CMS Summer Meeting at UA, appropriately titled *L-functions and Number Theory*. This session brought together postdocs and young faculty in order to make professional connections, foster future collaboration, and share their latest research.

The fourth installment of the *Alberta Number Theory Days* was held in BIRS on the weekend of June 17 to 19. There were 29 participants, including 12 faculty members, 13 graduate students, and 4 postdocs. Nine lectures covered a wide variety of areas in number theory: analytic number theory, algebraic number theory, Diophantine approximation, computational number theory, and representation theory of p-adic groups.

The BIRS Workshop on *L-packets* attracted 40 participants from 6 countries for 16 high-level lectures reflecting the best information available regarding L-packets as they appear in the arithmetic Langlands Program. The workshop was tightly focused on the following objectives: (1) to review the current status of Arthur's conjectures as they pertain to the structure, stability and parametrization of L-packets; (2) to examine examples to gather evidence to support (or refute) the conjectures; (3) to think about arithmetic implications; and (4) to develop strategies that might lead to progress on the conjectures. To that end J. Arthur provided participants with an advance copy of his forthcoming book "The Endoscopic Classification of Representations: Orthogonal and Symplectic Groups" and gave four lectures on its contents. A recording of these lectures is available online.

The *Cycles on Modular Varieties* workshop, which attracted 44 participants, explored a variety of state-of-the art modu-larity-based techniques for studying the solutions of diophantine equations. The meeting began with a pair of lectures by V. Rotger and H. Darmon on the connections between the de Rham fundamental group of the modular curve, the triple product L-function, and diagonal cycles. Put together, these objects yield explicitly computable points on elliptic curves, as well as new cases of the Birch and Swinnerton-Dyer conjecture in ranks zero and one. Much of Tuesday was concerned with the zeta and L-functions, and the day ended with an open problem session. Wednesday began with a step back and looked at the variety of cycle constructions that arise in different parts of the subject. Thursday morning was highlighted by a lecture of Bertolini, who presented a p-adic Beilinson formula and made a connection between Kato's Euler system and the results of Darmon and Rotger presented earlier. Kato's Euler system was taken up again on Friday morning.

Finally WIN2 *(Women in Numbers 2)* addressed the fact that, in social terms, the growth in number theory has been uneven: the representation and visibility of women in the area is poor. This workshop gathered female number theorists at various stages of their careers with the goal of providing a nurturing environment for research projects while facilitating collaborations, mentorship, networking, and empowerment of women in number theory in general. By all accounts, these goals were met and even exceeded. Well before the workshop, participants subdivided themselves into six vertically inte-grated research teams, each led by acknowledged leaders in their fields. Each group came to the conference with a specific research goal in mind, and worked at it collaboratively throughout the week. At the end of the conference, each group shared its findings. This format worked well and the results are currently being written up for publication.

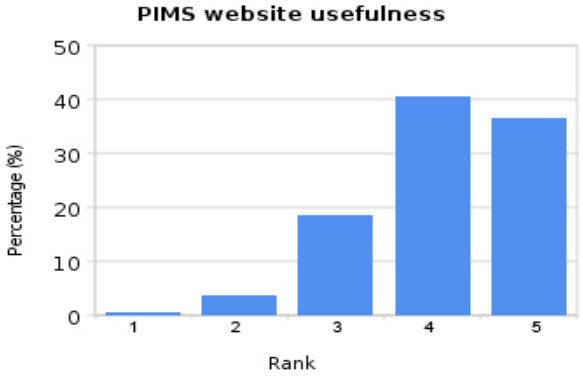
F. AARMS Report

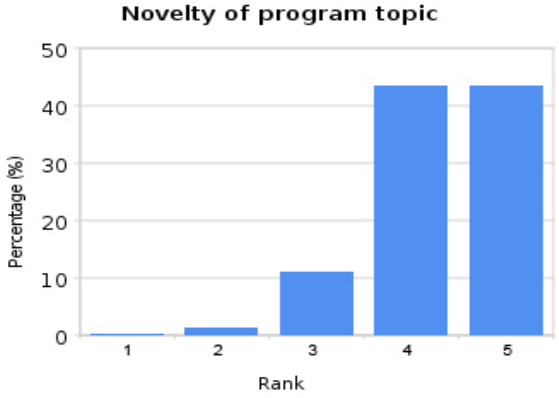
As part of a national mandate, PIMS has been supporting mathematical activities in the Maritime Provinces in conjunction with the Atlantic Association of Research in the Mathematical Sciences (AARMS). Together they co-sponsored the following activities in 2011; PIMS' financial contribution to each event is listed in parentheses:

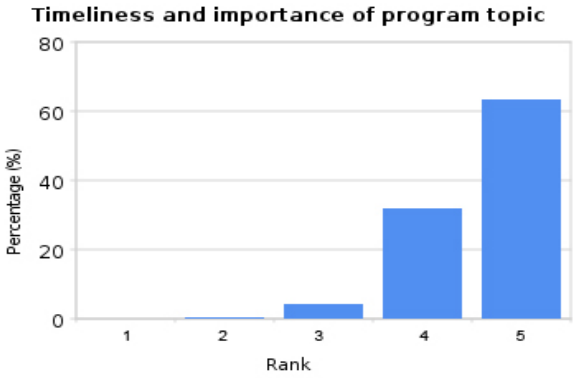
- *Canadian Mathematics Education Study Group Meeting*, St. John's, NL, May 10-14, 2011: Notably, six talks were given by new Ph.D.s who defended their theses is in a Canadian university during past year. ($4,000)
- *W. J. Blundon Seminar*, Memorial University, May 19, 2011: World-class presenters gave talks on "hot topics" in contemporary mathematics at the level appropriate to high school students in order to provide valuable enrichment for our junior participants, engage them into the discipline and outline possible applications and bright ideas. ($2,000)
- *Theory Canada 6 and Atlantic General Relativity Meeting*, Memorial University (Corner Brook), June 10-12, 2011: This is the premier theoretical physics meeting in Atlantic Canada. ($2,599)
- *SSC Annual Meeting*, Acadia University, June 12-15. ($2,000)
- *AARMS Summer School*, Memorial University, June 2-29, 2011: Every summer highly regarded faculty from around the world deliver graduate courses in the mathematical sciences. In 2011 the courses given were "Analysis and Geometry of PDE," "Harmonic Analysis," "Numerical Solution to PDE" and "Mathematical Biology." ($14,401)
- *Polynomial Identities in Algebras II,* Memorial University, September 2-6. ($5,000)

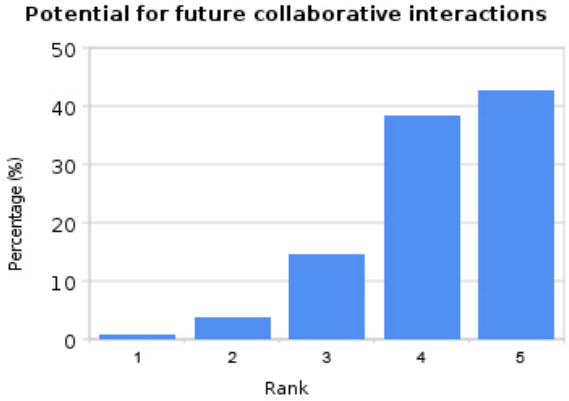
G. Evaluation of PIMS Activities

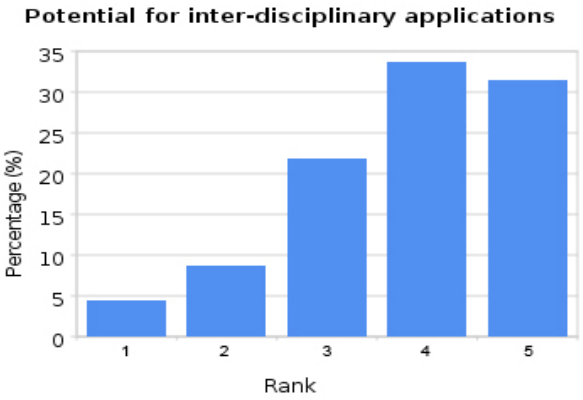
In 2010 PIMS began collecting evaluations of all its scientific events of at least three days duration. Participants are asked to fill in an online survey rating various aspects of their events; approximately 575 responded in 2011. The results were passed on to event organizers and were scrutinized at 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 2010, except for small gains in the potentials for both interdisciplinary and future collaborative interactions, whereas the usefulness of PIMS' website and the timeliness and importance 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."
- "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."
- "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."
- "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."
- "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."
- "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 back-ground 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."
- "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.'"

H. Demographics

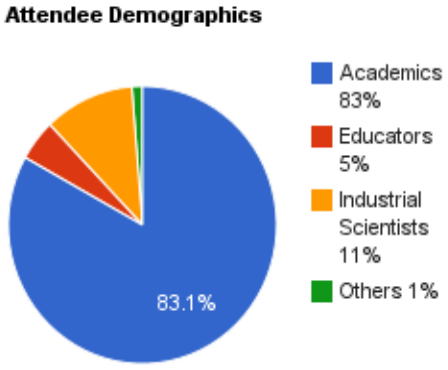
Here we provide some demographics of participants in PIMS scientific events and programs. For all PIMS-sponsored or co-sponsored conferences/workshops, summer schools, IGTC, industrial and selected 'other' activities, we:

i. Summarize the total number of attendees and the number of attendee-days.
ii. 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.
iii. List the number of males/females.
iv. 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.

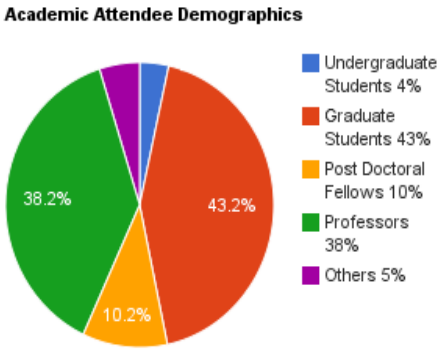
During the 2011 [2010/2009] reporting period, PIMS helped to support 74 [61/58] scientific activities of the types listed above. We have data on 70 activities – a remarkable 95% return rate (Compare to the 62% response rate for the Math and Physical Sciences Directorate of NSF). Of these,

- The total number of attendees: 4,166 [2,702/3,470]
- Attendee-days spent at PIMS activities: 15,573 [12,823/13,965]
- Average attendees/activity: 60 [52/67]
- Average attendee-days/activity: 254 [247/269]
- Average activity duration: 3.7 [5.7/4.2] days



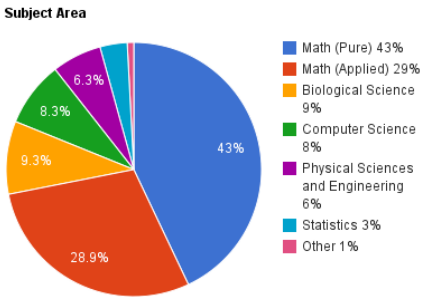
Of all identifiable attendees,

- 83% [77/83]% were **academics**, and of these:
- 38% [34/45]% were **professors,**
- 10% [10/13]% were **PDFs**,
- 43% [45/37]% were **graduate students**,
- 4% [5/3]% were **undergraduate students**, and
- 5% [7/2]% were **other academics**.
- 5% [2/1]% were **educators**,
- 11% [18/15]% were **industrial,** and
- 1% [3/1]% were **others.**



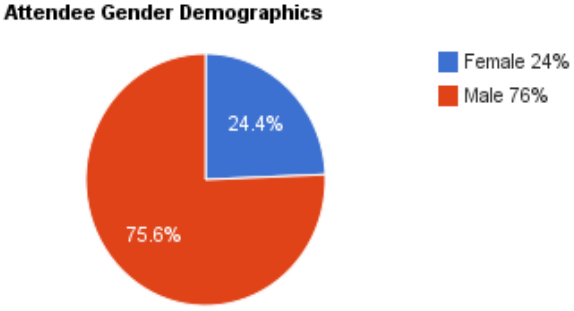
This year some respondents also supplied their fields of expertise. They consisted of:

- 43% pure mathematicians
- 29% applied mathematicians
- 9% biological scientists
- 8% computer scientists
- 6% physical sciences and engineering
- 3% statisticians
- 1% others.



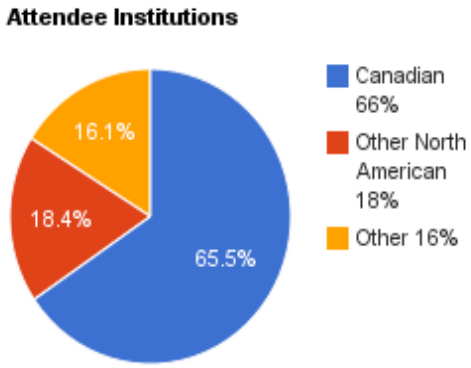
Of those attendees who stated their gender,

- 76% [77/75]% were male, and
- 24% [23/24]% were female



Also,

- 66% [63/61]% were from **Canadian** institutions, of which,
  - 41% [41/38]% were from British Columbia,
  - 35% [43/21]% were from Alberta,
  - 4% [2/3]% were from Saskatchewan,
  - 1% [1/3]% were from Manitoba,
  - 10% [12/31]% were from Ontario and Quebec, and
  - 9% [1/4]% were from the Atlantic Provinces.
- 18% [20/19]% were from **other North American** institutions, and
- 16% [16/20]% were from elsewhere.



We have also computed the geographical distribution of PIMS events and programs, including Lecture & Seminar Series, during 2011. Of the activities with well-defined geographic loci,

- 86% [81/77]% were held in **Canada**, of which:
  - 61% [60/60]% were held in British Columbia,
  - 26% [25/27]% were held in Alberta,
  - 6% [9/6]% were held in Saskatchewan,
  - 5% [3/3]% were held in the Atlantic Provinces,
  - 4% [3/1]] were held in Quebec and Ontario,
- 13% [14/8]% were held in the **United States** (11 events in Washington and 1 in Oregon), and
- 2% [5/5]% were held **overseas** (1 event each in Korea and México).

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

I. Publications

PIMS CRG activities, PDFs and CNRS Researchers produced over 250 publications in 2011, many of which were in top journals, such as the *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., 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.*

For a list please visit: http://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 re-view process. Candidates must be nominated by a scientist or group of scientists affiliated with PIMS. The two-year fel-lowships are tenable at any one of the member or affiliated universities.

In 2010 PIMS supported 32 PDFs, and 39 in 2011. The were distributed as follows: SFU – 2, UA – 6, UBC – 11, UBC-O – 1, UC - 8, UR – 4, US – 3, and UV – 4. Below we list the 2011 PDFs and their university affiliations:

Adcock, Benjamin (SFU)
Bailey, Robert (UR)
Buckingham, Paul (UA)
Gheorghiu, Vlad (UC)
Hernandez, Maritza (UBC)
Julien, Antoine (UV)
Lammersen, Christiane (SFU)
Marlin, Benjamin (UBC)
Nasserasr, Shahla (UR)
Phan, Hung Minh (UBC-O)
Stange, Katherine (UBC)
Tvalavadze, Marina (US)
Wilcox, Stewart (UA)

Akhunov, Timur (UC)
Biasse, Jean-François (UC)
Combet, Vianney (UBC)
Giakkoupis, George (UC)
Hrubes, Pavel (UC)
Kitagawa, Jun (UBC)
Ma, Xiaoguang (UA)
Meyerovich, Tom (UBC)
Nica, Bogdan (UV)
Semukhin, Pavel (UR)
Tokman, Cecilia Gonzalez (UV)
Valkenburg, Kirsten (US)
Yoneda, Tsuyoshi (UV)

Au-Yeung, Enrico (UBC)
Bonner, Simon (UBC)
Fortescue, Benjamin (UC)
Gurel-Gurevich, Ori (UBC)
Jia, Johnson (UBC)
Kunduri, Hari (UA)
Marks, Christopher (UA)
Mitchell, Vanessa (UC)
Oluwaseun, Sharomi (US)
Singh, Vijaykumar (UR)
Trail, Collin (UC)
Warnick, Claude (UA)
Zwiers, Ian (UBC)

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

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 2011(2010) PDFs gave to selected questions are listed below (1 = worst score, 5 = best score):

	PDF SURVEY	
1	How well were you mentored in your department?	3.8 (4.4)
2	How suited to your academic interests was your department?	4.3 (4.0)
3	How suited to your academic interests was your mentor?	4.2 (4.2)
4	Did you feel intellectually isolated in your department?	4.3 (3.8)
5	How well were you looked after (in a practical sense) in your department?	4.7 (4.4)
6	Were there opportunities for collaborative interactions?	3.7 (3.8)
7	Amount of travel support:	3.8 (3.0)
8	Do you feel that your PIMS PDF has prepared you for your professional career?	4.3 (4.4)
9	Overall satisfaction with your postdoctoral experience	4.2 (4.5)

PDFs move on professionally to a range of positions and activities at top places, including: 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 University, 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 (France), Princeton U., Nat. Acad. Sci. (Ukraine), U. Toronto, École normale supérieure (Paris, France), U. California (Berkeley), Univerzita Karlova v Praze (Prague, Czech Republic), U. Kentucky, Laboratoire Écologie et Sciences Phytosanitaires (Renne, France), Victoria U. (Wellington, NZ), U. Gottingen (Germany), UA, U. Warsaw (Po-land), École Polytechnique (Palaiseau, France), U. London (UK), University of Zurich, U. N. Carolina (Chapel Hill), Institut Joseph Fourier (Grenoble, France), Carnegie-Mellon U., Munich American Reassurance Company (WA), Institute for Ad-vanced Study, CNRS (Montpellier, France), UBC, Max Planck Institute for Mathematics (Bonn, Germany), U. Oregon, UR, Moscow State U. (Russia) and Southern Illinois 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 a vehicle for PDFs to interact with each other and learn about others' research and share ideas. As well, PIMS Central holds one-day workshops on profes-

sional development topics such as *Information Session on Grant Opportunities and Postdoc/Grad Student Job Forum*. The Assistant Director also hosts various social activities so as to reduce post-doc 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."
- "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 recom-mend that the social activities keep running."
- "My only substantial suggestion for improvement is that the funds allocated by PIMS to each PDF could be organized so that they include a dedicated budget for travel, so that PDFs are not required to seek out institutional and/or other sources of funding for this. This is a matter of particular concern at the smaller PIMS member institutions…"
- "I have to say that overall I had a very good opportunity to collaborate with the people here at PIMS..."

PIMS also hosts more senior researchers from France as part of its cooperative agreement with the CNRS. In 2011, the following scientists took part in this program: P. Guillot (UBC, U. Strasbourg), G. Miermont (UBC, U. Paris Sud 11) and S. Rubenthaler (UBC, U. Nice - Sophia Antipolis).

In addition to PDFs and PIMS/CNRS scientists, PIMS sites host a many long- and short-term visitors: approximately 50 in 2011 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 visitors every year. The key component of the IGTC is its Fellowships, which are awarded to graduate students at Canadian PIMS member or affiliate universities. There were 18 Fellows in 2010-2011 and 19 in 2011-2012. In addition, the IGTC enrolled 9 non-fellowship students in 2010-2011 and 7 in 2011-2012. IGTC

students were located at UA, UBC, UC, UV and SFU. The number of applicants is increasing every year, allowing us to raise the quality of students who obtain IGTC fellowships. The applicant admittance rate started out in 2007-8 at 60% but has decreased to 30% this year and, 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 Newton Fellow 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 in 2011 are: Jun Allard (UBC), Romain Richard (UC), Ulrike Schlagel (UA), William Carlquist (UBC), Marie Varughese (UA), Johnathan Martin (UA), Kelly Paton (UBC), Lyudmila Korobenko (UC), Anastasia Lukyanova (UA), Phuong Dao (SFU), Deniz Yorukoglu (SFU), Ben Wilson (UV), Eric Foxall (UV), Mónica Carrillo (UBC), Sheehan Khan (UA), Bernhard Konrad (UBC), Cory Simon (UBC), Jia Gou (UBC), Silogini Thanarajah (UA) and Michael Akinwumi (UA). Other enrolled students were: Katrina Williams (UBC-O), Oksana Chkrebtii (SFU), Alison Muscat (UA), Iman Hajirasouliha (SFU), Diana White (UA), Douglas Friesen (UA), Miranda Gray (UBC-O), and Joshua Zukewich (UBC).

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."

Noteworthy in 2011 was the publication in Nature of *Mapping Copy Number Variation by Population-scale Genome Sequencing* via 1000 Genomes Project, including contributions by IGTC fellow I. Hajirasouliha. Currently in development is an online IGTC course that will span May 2012 and will feature both lectures and course content

that will be available on Mathtube for students at participating PIMS universities. This content will be publicly available as a resource for all with interests in math biology.

As a part of PIMS' Applied Mathematics Perspectives special focused period and the 2011 ICIAM Satellite Meetings, this summer saw the *Fifth Graduate Research Summit and Workshop* take place at UV from July 14–16. 72 attendees came from across Canada and as far away as France, Italy, Japan, India and Australia. The program focused on mathematical physiology (especially gene and neural networks) and structured population dynamics. Highlights included a focus on "Developing In-terdisciplinary Research Collaborations, with talks from L. Glass (McGill), S. Levin (Princeton) and L. Edelstein-Keshet (UBC). In 2012 the *Sixth Graduate Research Summit and Workshop* will be held at Naramata, BC during October. Further in-formation about the IGTC is at http://www.pims.math.ca/scientific/graduate-training-igtc/mathematical-biology, and a recent assess-ment of the program as well as a list of IGTC publication can be obtained by clicking on http://www.pims.math.ca/files/IGTCreport2011.pdf.

3. EDUCATIONAL ACTIVITIES

A. K-12 Educational Activities

PIMS is dedicated to increasing public awareness of the importance of mathematics in the world around us. PIMS en-courages 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 com-puter science concepts. On average over two hundred students, parents and teachers participate in Math Mania events. This year 7 Math Manias were held in Burnaby, Port Coquitlam, Victoria, Port Alberni and Sooke in British Columbia. Further details are available at http://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 area this past year, and there were about 10 math fairs held at various schools in the Lower Mainland. Visit http://www.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 100 participants.

- **ELMACON:** The **E**lementary **M**athematics **C**ontest 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 work-shops 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 http://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** and the **No Homework Club**, along with other local initiatives.

• **Math Central:** Beginning its 17th year, Math Central (http://www. mathcentral.uregina.ca) continues to be a successful tool for teachers. The site currently gets in excess of 3.5 million hits per month from approximately 250,000 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.

• **Canadian Mathematics Education Study Group Meeting:** PIMS teamed up with AARMS to sponsor this conference, held in St. John's, NL.

2. Aboriginal/First Nations

PIMS has shown its leadership in bringing together various people, resources and institutions in working together to-wards 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. Ac-tivities 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. For example, FNESC commissioned an assessment tool from PIMS to evaluate third grade students in First Nation schools.

• **Math summer camps**, which PIMS has organized in Kamloops, Lytton, Merritt and Mount Currie for the past 4 years. More than 150 children have attended these camps. This summer, 20 First Nations students in grades 10 and 11 attended the month-long *Emerging Aboriginal Scholars* summer camp jointly run by PIMS and the UBC First Nations House of Learning. As part of the camp, these 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 recently 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 School in Vancouver, which has a large number 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.

• **Math Club**s: PIMS together with UBC organizes a math club at the Musqueam Reserve. This program has been expanded to include a math mentorship program and a math club that meets at the Vancouver Aboriginal Friendship Center; this program is led by faculty and students from SFU.

• **The third First Nations Math Education Workshop** co-sponsored by PIMS was held in Banff in November 2009. 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. Throughout 2011, members of these groups worked together in creating resources to honor the spirit of each student as an individual and as part of a community. This way of thinking is an integral part of many aboriginal cultures as well as a successful way of learning mathematics in any culture.

• In Saskatchewan, PIMS supports the **Aboriginal Perspectives** web site http://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 member-ship) may engage as PIMS *Education Associates*. Membership is for a period of three years and is renewable. An annual mem-bership fee of $500 is paid by the college or university. Members are entitled to apply for PIMS funding to engage in appro-priate 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 dem-onstration materials for use in the classroom. To date, 7 colleges in BC and 4 in Alberta have become PIMS Education Associates: Camosun College (BC), Vancouver Island U. (BC), 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 2012.

PIMS also directly sponsors high-level educational activities at its affiliated universities, such as: the biannual *Joint UBC/SFU Graduate Student Workshop in Statistics*, the *Young Researchers Conference in Mathematics at UBC*, the *Alberta Colleges Mathematics Conference* at Mt. Royal U. as well as various summer schools, including the *AARMS Summer School* at Memorial U. PIMS is also sponsoring a series of public lectures as part of the *MathAcrossCampus* program at UW during 2011-2012.

From July 11-August 12 the UA welcomed 20 mathematically talented Albertan high school students to campus to attend the second annual *Alberta Summer Mathematics Institute* (ASMI). These students attended several lecture series by distin-guished faculty, supplemented with computer classes on mathematical typesetting (LaTeX) and computation (Sage). Eight additional guest lectures on special topics rounded out the curriculum. This was followed by two weeks of directed mathe-matical research. ASMI 2011 is the first to be entirely funded through the PIMS-AAET grant. Also directed at high school students was the AARMS *W. J. Blundon Seminar* held in May at Memorial U., co-sponsored by PIMS.

Also at UA, during 2011-2012, the Department of Mathematics and Statistics is observing significant anniversaries for its undergraduate, master and doctoral programs. A full year of celebrations began roughly with the Spring Convocation in May 2011 and will run through the convocation of May 2012. These have included receptions, activities around the Summer Meeting of the CMS (which took take place in Edmonton in June), a graduate alumni homecoming (and fundraiser), an honorary degree for Fields Medalist E. Zelmanov of the University of California, a series of Distinguished Colloquia, public lectures, and special outreach activities. These activities are partially supported by PIMS.

In addition, PIMS provides travel support for Canadian students to attend educational activities, for instance, the *Canadian Undergraduate Mathematics Conference 2011* at Laval University, and the joint *PIMS-IMA Mathematical Modeling in Industry Workshop*, held at the U. of Minnesota.

PIMS also uses its facilities for teaching; in 2011 PIMS-UBC hosted three mathematics courses, numerous seminar series, and streamed several video-conferenced courses from UC and UBC. PIMS also presented two *Hot Topics* courses, one on number theory at UBC and another on Mathematical Ecology at UA in the 2011 winter term.

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 wide-spread publicity in the mathematical community and beyond. See http://www. pims.math.ca/pims-glance/prizes-awards for details about past prizewinners.

III. Mechanisms of Access to PIMS

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 more 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 (http://www.pims.math.ca) offers easy global access to information on all PIMS activities, recent news and resources. A new feature is the Scientific Impacts section that shows results from PIMS researchers.
  ◊ **Mathtube.org** PIMS has just recently unveiled a dedicated http://www.mathtube.org site that will even tually archive all of PIMS written, video and audio media. mathtube 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 go back and review; or those who don't, a chance to see what they've missed. This new 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. We expect this will become an important resource for the scientific community.

◊ **PIMS Connection,** monthly enewsletter, was introduced in 2011. This brief email includes URL links to event updates and news items.

- **Hardcopy publications**

  ◊ **Year in Review** this booklet is designed to summarize the range of PIMS activities. The 2009 and 2010 Years in Review can be downloaded from http://www.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 http://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 materials 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: http://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 http://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, rep-resentatives from the business, industry and resource sectors as well as the major professional societies. Past annual reports (1997-2010) can be viewed at http://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 every six months for the first two years (2011-12) and then once annually.

2. AUDIO/VIDEO FACILITIES

PIMS-funded event coordinators are offered a wide range of audio-visual services to facilitate the global nature of col-laborative scientific work. PIMS current video-conferencing facilities underwent modernization recently as part of the WestGrid initiative that allows increased flexibility and offers full, high-definition video-conferencing service to users. 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, and a distance education course in Markov Decision Processes that was part of the NSERC CREATE program and included remote students in Vancouver, Edmonton and Montreal. Two statistics graduate courses at UBC and a number theory course at UC utilized these facilities this academic year, as did UL in 2010. PIMS Central's facility is one of 30-40 sites across Canada that participate in the Compute Canada seminar series. This series features a different mathematical or technical theme each term, which has helped raise awareness of PIMS among new groups and departments at UBC. PIMS also participates in the WestGrid seminar series training researchers in the use of the world-class computational and collaborative technologies offered by West Grid. Another increasingly popular use of the facility is to allow researchers to fulfill their academic responsibilities while at PIMS, such as sitting on graduate student examination committees at their home institutions. Starting this year, PIMS has instigated an online educational forum which uses video-conferencing to bring together all the PIMS education coordinators from BC, Alberta and Saskatchewan in biannual meetings to examine successful math educational programs and techniques and to plan new ones.

IV. Activities to keep abreast of Scientific Advances

The *Scientific Review Panel* (SRP) 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 caliber.

Aside from the role played by the SRP, the PIMS Directors regularly attend research conferences and meetings of professional societies (such as the American Mathematical Society, the Canadian Mathematical Society and CAIMS), and consult with leading experts to obtain/solicit information on recent advances in the mathematical sciences. This also involves establishing regular channels of communication with the PIMS community and encouraging researchers to use PIMS as a plat-form for the development of their ideas. In addition, through a systematic scanning of web based literature (such as pre-prints on the arXiv) and announcements of scientific breakthroughs in bulletin boards and journals, PIMS maintains a proactive involvement in learning about and enhancing the impact of new developments.

PIMS MRS NSERC Activity Report January 1 to December 31 2011

	Use of the resource (i.e. PIMS) Paid from all revenue sources January 1 to December 31 2011	Planned use of MRS funds January 1 to March 31 2012	Planned use of MRS funds April 1 2012 - March 31 2013
Resource Expenditures			
1) Salaries & Benefits			
a) IGTC students	197,279	32,500.00	95,903.00
b) Postdoctoral Fellows (includes CRG PDFs)	418,327	112,500.00	385,833.00
c) Technical/Professional Assistants (inc. Education)	55,089	0.00	0.00
d) Administrative Staff (includes Directors)	428,459	0.00	0.00
e) Scientific Support Personnel	122,182	30,150.00	124,110.00
2) Equipment or Facility			
a) Purchase or Rental	13,131	0.00	0.00
b) Operation and Maintenance Costs	53,943	0.00	0.00
3) Materials & Supplies			
a) Furniture	0	0.00	0.00
b) Meals/Refreshments	10,885	0.00	0.00
c) Office Supplies	11,758	0.00	0.00
4) Travel - by PIMS Staff			
a) PIMS Meetings (SRP, PDF, Board, Admin, Exec)	45,928	0.00	0.00
b) Grad Student and PDF Travel Support	1,833	0.00	0.00
c) Director Scientific Collaboration/Consultation	47,574	0.00	0.00
5) Dissemination Costs			
a) Publication Costs	8,320	0.00	0.00
b) Advertising & Networking	13,243	0.00	0.00
6) Other - Scientific Activities			
a) CRGs - events	123,943	0.00	97,500.00
b) IGTC - events	30,925	0.00	28,000.00
c) Conferences/Symposia	189,323	0.00	126,500.00
d) Summer Schools	96,189	0.00	100,500.00
e) Workshops/Seminars/Colloquia (inc. IPSW)	57,669	8,000.00	97,000.00
f) Distinguished Visitors/Chairs/Speakers	29,835	10,000.00	9,743.00
g) Education Initiatives	125,075	0.00	0.00
h) NICDS	0	0.00	4,911.00
i) Support for BIRS	799	0.00	0.00
j) CNRS/UNAM/PRIMA Visitors	25,632	6,500.00	0.00
k) Special Thematic Programs	134,394	0.00	0.00
l) Other Support	16,853	45,000.00	0.00
7) AARMS Activities		0.00	30,000.00
Theory Canada 6 & Atlantic General Relativity	2,599		
W.J. Blundon Seminar	2,000		
Cdn Math Education Study Group (CMESG) meeting	4,000		
SSC Annual Meeting	2,000		
Polynomial Identities in Algebra II	5,000		
AARMS Summer School	14,401		
TOTAL EXPENDITURES	**2,288,588**	**244,650**	**1,100,000**

Resource Revenues ***(collected during the period January 1 to December 31 2011)***

a)	User Fees (Registration Fees collected)	113,897
b)	Contributions from Partner Universities	
	UBC	255,250
	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	10,725
	University of Lethbridge	5,550
	Portland State University	3,892
	UNBC	5,000
c)	Contributions from MITACS	
	Applied Math Perspectives	45,000
	SMB09	1,400
	Gene Golub SIAM Summer School	24,279
	NAMIAM 2010	4,139
	Frontiers in Biophysics	2,950
d)	Private Donations	39,063
e)	Other Contributions	
	BC Govt re Year of Science/Legacy	117,700
	SIAM re Gene Golub SIAM Summer School	46,740
	Other Miscellaneous	19,452
	UVic various departments	19,376
	FNESC Math Workshops	17,700
	John MacDonald re Category Theory	7,780
	NSF re Gene Golub SIAM Summer School	7,731
	Universite de Montreal re NAMIAM 2010	5,852
	U of T re travel by Alejandro Adem to meetings	5,149
	UBC Math & Chemistry Dept	4,819
	FIELDS re NAMIAM 2010	4,492
	AMS re travel by Alejandro Adem for meetings	4,384
	Education Associates	3,500
	Hugh C. Morris Endowment Interest	1,650
f)	AAET Grant	219,857
g)	NSERC Grant	1,100,000
h)	Carried Forward from December 31 2010	791,488
TOTAL REVENUES (January 1 to December 31 2011)		**3,265,825**
	Revenue less Expenses	977,237

Appendix: 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
CIMAT	Center for Mathematical Research
CIMPA	Centre International de Mathématiques Pures et Appliquéez
CMS	Canadian Mathematical Society
CNRS	Centre National de la Recherche Scientifique
CRG	Collaborative Research Groups
CRM	Centre de Recherches Mathématiques
DIMACS	Centre for Discrete Mathematics and Theoretical Computer Science
GIMMC	Graduate Industrial Mathematics Modelling Camps
ICIAM	International Council for Industrial and Applied Mathematics
ICTP	International Centre for Theoretical Physics
IGTC	International Graduate Training Centre in Mathematical Biology
IHES	Institut des Hautes Études Scientifiques
IIMS	Institute of Industrial Mathematics
IMA	Institute for Mathematics and its Applications
IPAM	Institute for Pure and Applied Mathematics
IPSW	Industrial Problem Solving Workshop
IRMACS	Interdisciplinary Research in the Mathematical and Computational Sciences Centre
MITACS	Mathematics of Information Technology and Complex Systems
MSI	Mathematical Sciences Institute
MSRI	Mathematical Sciences Research Institute
NSERC	National Sciences and Engineering Research Council
PDF	Postdoctoral Fellows
PNRMS	Prairie Network for Research in the Mathematical Sciences
PRIMA	Pacific Rim Mathematical Association
PSU	Portland State University
SAMSI	Statistical and Applied Mathematical Sciences Institute
SFU	Simon Fraser University
SIAM	Society for Industrial and Applied Mathematics
SMB	Society for Mathematical Biology
SMM	Sociedad Matemática Mexicana
SSC	Statistical Society of Canada
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