Pacific Institute *for the* Mathematical Sciences

Annual Report *2015*

TABLE OF CONTENTS

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 Universities of Alberta, Calgary, British Columbia, Victoria and Simon Fraser University. Later the University of Washington in the United States and more recently the Universities of Regina, Saskatchewan, Lethbridge and Manitoba joined PIMS as full members, while Portland State University in Oregon joined as an affiliate. 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 – particularly those in Latin America and around the Pacific Rim.
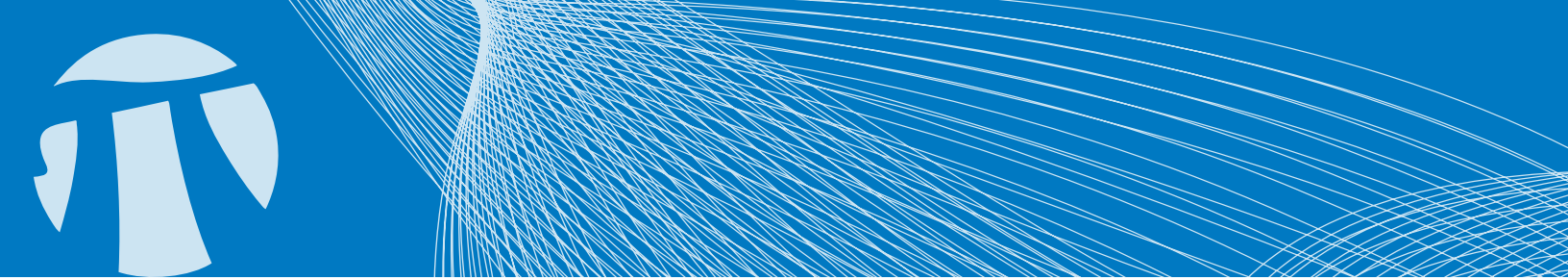
2. UNIQUE STRUCTURE OF PIMS

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

3. SCIENTIFIC HIGHLIGHTS IN 2015

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 Postdoctoral Training Centre in Stochastics as well as individual events and focus 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 30 CRGs to date. During April–August 2015 the established CRG on *Applied, Algebraic and Geometric Topology* organized a major focus period supported by the U.S. National Science Foundation (NSF) with workshops, summer schools, and public lectures at UV, UBC as well as UR. In addition to hosting seminar series at SFU and UBC, the CRG on *Applied Combinatorics* ran a summer school and the *CanaDAM* conference at US. Two new CRGs were launched in 2015: the first is based at SFU, UBC and the Maritimes and focuses on *Applied Partial Differential Equations*. It held a workshop and a summer school, both in July at Dalhousie U. The other, on *Explicit Methods for Abelian Varieties* involves activities at UC, SFU and UW. It kicked off with a workshop in May at UC and sponsored a Special Session at the winter CMS meeting. We have an

excellent pipeline of future CRGs, which exhibits the richness and diversity of our mathematical and scientific base. In particular, CRGs on *Cohomological Methods in Algebra* and *Geometric Analysis* are slated to start in 2016.It kicked off with a conference in algebraic topology in May 2014 followed by the *West Coast Algebraic Topology Summer School* on "Topological Field Theories" (also with significant NSF support). In 2015 two more CRGs will come online: *Applied Partial Differential Equations: Modeling, Analysis, and Computation* and *Explicit Methods for Abelian Varieties*. Finally CRGs on *Algebra* and *Geometric Analysis* are in development for 2016.

- Every year PIMS sponsors numerous *postdoctoral fellows* (PDFs)—50 in 2015—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. Over the past two years, one of PIMS' postdocs, S. Sarkar published 6 articles on triangulations and orbifolds in journals such as the *J. Ramanujan Math. Soc.* and *Topology and its Applications*. His work has led to progress on the famous problem of Hirzebruch as to which complex cobordism classes (of a certain type) contain connected nonsingular algebraic varieties. Another PIMS PDF, P. Youssef, and collaborators determined the extent to which the adjacency matrix of a random d-regular directed graph is invertible, a question that was asked twice in the International Congress of Mathematics in Seoul 2014. J. Hubicka generated 14 presentations along with 8 papers (in various stages of publication) over his 2014-2015 tenure as a PIMS PDF. He is currently at the Computer Science Institute of Charles University in Prague.

- This year PIMS inaugurated the *Postdoctoral Training Centre in Stochastics* (PTCS). PIMS has world-class groups in probability theory and its applications, and these groups have an excellent track record of postdoctoral supervision and placement. The program has attracted $550,000 in NSF funds for our UW site, and welcomed its first cadre of 5 PDFs at UA, UBC, UC, and UW. More information about this program is contained in §II.2B.

- PIMS organizes international summer schools to train the new generation of scientists in emerging areas of mathematics and its applications. The topics are as diverse as seismic imaging, the mathematics of sustainability, topological field theories, environmetrics, finance, atmospheric modelling and climate change, quantum information, mathematical biology, spatio-temporal modelling, optimization, link homology and cryptography. This year's offerings included geometric and computational spectral theory (CRM), applied combinatorics (US), probability (McGill U), rigorous computing (SFU) and differential equations and numerical analysis (Dalhousie U).

- PIMS has a lively program in industrial mathematics and runs *Mathematical Modeling in Industry Workshops* (MMIW) as well as *Industrial Problem Solving Workshops* (IPSW) for students, faculty and industry. The 2015 edition (the 18th) of the MMIW, held in Minneapolis, was the fifth dual effort of PIMS and the Institute for Mathematics and its Applications (IMA). In 2015 PIMS further cosponsored workshops on *Advances in Seismic Imaging and Inversion* at UA, *Hydraulic Fracturing* at IMA, and *Mathematical and Computational Issues in the Geosciences* at Stanford U.

- PIMS sponsors conferences and workshops throughout Canada and the world on a wide range of topics. This year's events took place in Switzerland, Australia, California, Minnesota, Ontario, Nova Scotia, Newfoundland and Quebec, as well as PIMS' 'home' provinces and states, and covered fields as diverse as biomathematics, computer science, genetics, physics, medicine and statistics.

- The 2015 *PIMS Marsden Memorial Lecturer* was Y. Brenier of the École Polytechnique (Paris). He spoke on "From Euler to Born-Infeld, Fluids and Electromagnetism" at the *Workshop on Classic and Stochastic Geometric Mechanics* hosted by the Bernoulli Centre at the École Polytechnique in Lausanne, Switzerland in June. 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.

- Our distinguished colloquia continue to bring first-rate speakers to all PIMS' sites. These included I. Daubechies (Duke U), R. Graham (Caltech), R. Murty (Queen's U), C. Frolich (U Texas), Y. Brenier (École Poly-technique, Paris), J. Pipher (Brown U), T. Hou (Caltech), B. Merriman, (Human Longevity, Inc.), F. Kamareddine (Heriot-Watt U) and D. Knuth (Stanford U).

- Each year PIMS awards four prestigious prizes. In 2015 the *CRM-Fields-PIMS Prize* went to K. Beh-rend of UBC while D. Hrimiuc of UA was the recipient of the *PIMS Education Prize*. The PIMS/Canadian Applied and Industrial Mathematics Society (CAIMS) *Early Career Award in Applied Mathematics* recognizes exceptional research in any branch of applied mathematics. The 2015 awardee was J. Heffernan of York U. The *UBC Mathematics and PIMS Faculty Award*, new in 2015, was awarded to Rachel Ollivier.

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 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.
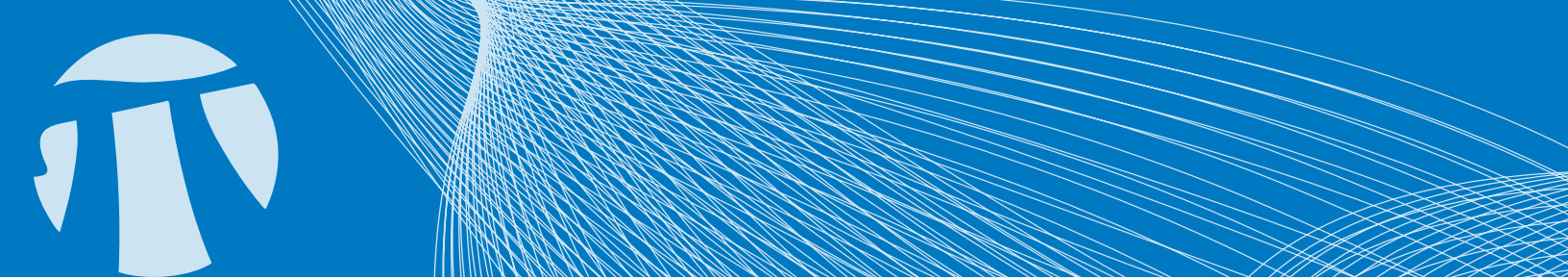
PIMS coordinates with AARMS, BIRS, CRM and Fields to support a number of Canadian activities, such as meetings of the societies (CAIMS, CMS and SSC), the Séminaire de Mathématiques Superieres in Montréal, and the regularly scheduled Canadian Discrete and Algorithmic Mathematics and CNTA meetings. Recently, we have agreed on a yearly national rotation for the IPSW, which were created by PIMS and then emulated by CRM and Fields. The next PIMS IPSW will be held in August 2016 at Fields. PIMS funding for activities in Atlantic Canada through AARMS is an important link to another region of the country. As part of the Long Range Plan for Mathematical and Statistical Sciences in Canada, PIMS and the other institutes commit significant resources to support the Canadian Statistical Sciences Institute (CANSSI). Joint activities have been underway for several years.

International: Part of the PIMS mandate is to establish international partnerships in order to provide mechanisms for Canadian researchers to participate in activities outside Canada and attract visitors from abroad, especially beyond the United States. The establishment of the Centre National de la Recherche Scientifique (CNRS) *Unité Mixte Internationale*, at PIMS (the first in mathematics in North America) has led to year-long visits by 35 researchers from France since 2007, fully funded by CNRS. 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; in the past 7 years there have been two PRIMA Congresses, in Sydney and Shanghai, with another planned for 2017 in Oaxaca (México). Our partnership with IMA (USA) allowed us to provide new opportunities in industrial mathematics for students via the annual MMIW. 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 ten universities has a site office and a site director (see *www.pims.math.ca/contact*). The role of the site directors is to look for local opportunities and synergies, while the site offices provide administrative assistance for organizing on-site PIMS activities. This distributed structure has allowed the Institute to support and energize the mathematical sciences across the whole of Western Canada.
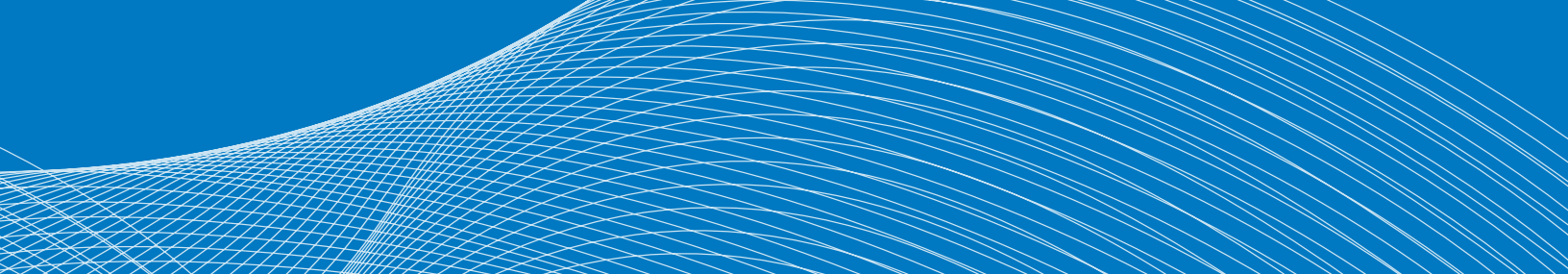
The strong presence of PIMS at the university level gives it access to a vast reservoir of scientists from all disciplines. Over the years, PIMS has been able to lower disciplinary barriers and create innovative research teams, making a sustained

effort to extend the PIMS community beyond mathematics and statistics departments so as to include scientists in areas such as computer science, physics, oceanography, genomics, biology, engineering, environmetrics, informatics, operations research, geology and economics.

In 2015 the day-to-day scientific administration of PIMS was carried out by **Martin Barlow** (Interim Director), **James Colliander** (Deputy Director) and **Mark J. Gotay** (Assistant Director), who are located at PIMS Central at UBC. PIMS operations are overseen by its *Board of Directors*, which includes a senior academic administrator from each of the universities, and senior scientists and representatives from industry. Scientific events are adjudicated by an independent *Scientific Review Panel* (SRP) composed of internationally renowned mathematical scientists. (For biographies of SRP members, see *pims. math.ca/pims-glance/scientific-review-panel*.) PIMS 2015 Site Directors were N. Bruin (SFU), C. Doran/V. Putkaradze (UA), M. Barlow/J. Colliander (UBC), C. Cunningham (UC), A. Akbary (UL), K. Kopotun (UM), D. Stanley (UR), R. Srinivasan/C. Soteros (US), A. Quas (UV) and C. Hoffman (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 NSF, the U.S. National Security Agency, the U.S. Army, the U.S. National Institute of Standards and Technology, Alberta Innovation and Advanced Education (AIAE), Alberta Innovates Technology Futures and other Canadian institutes such as AARMS, the Canadian Institute for Advanced Research (CIFAR), the Canadian Institute for Theoretical Astrophysics, CRM, the Fields Institute, Mitacs, the Pacific Institute for Theoretical Physics (PiTP), the Perimeter Institute and the Winnipeg Institute for Theoretical Physics. Events are also co-sponsored by professional societies such as the American Mathematical Society (AMS), the American Statistical Association (ASA), the Association for Logic Programming, Bernoulli Society, CAIMS, the Canadian Association of Physicists, the Canadian Institute for Health Research, CMS, the Canadian Number Theory Association, the Canadian Society for History and Philosophy of Mathematics, the International Association for Cryptologic Research (IACR), the International Linear Algebra Society, the International Mathematical Union (IMU), the Mathematical Association of America (MAA), the Society of Actuaries, the Society for Industrial and Applied Mathematics (SIAM), the Sociedad Matemática Mexicana, the Society for Mathematical Biology, and the Statistical Society of Canada (SSC), as well as by international partner institutions such as the CNRS, IMA, MSI, PRIMA, the (Kyoto) Research Institute for Mathematical Sciences (RIMS), and the Universidad Nacional Autónoma de México. Other partners include Accelerate Okanagan, the Actuarial Foundation of Canada, Akamai, the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems (Australia), the Australian Mathematical Sciences Institute (AMSI), the Australian Mathematical Society, the BC Centre for Disease Control, BC Oil and Gas, the Beijing International Center for Mathematical Research, BIRS, Boeing, the Canadian Institutes for Health Research, Capital One, the Center for Analysis and Modeling of Security, the Center for Discrete Mathematics and Theoretical Computer Science, the Centre for Experimental and Constructive Mathematics (CECM), the Centre Int. de Mathématiques Pures et Appliquées, the Centro de Investigación en Matemáticas (CIMAT), the Centro de Modeliamiento Matematico, CERTICOM, CGG, the Chern Institute of Mathematics, the Chinese Mathematical Society, CIBC, Clay Mathematics Institute, Conoco, CRC Press, CryptoWorks, D-Wave Systems, the École Fédérale Polytechnique de Lausanne, Elsevier, ENCORA, EPSRC, EQINOCS, Exxon-Mobil, the Federal Interlocutor for Métis and Non-status Indians, Fisheries and Oceans Canada, Formosa Tea Café, the Foundation Compositio Mathematica, FP Innovations, the French National Research Agency (ANR), the Global Risk Institute in Financial Services (GRI), Golden Key, Gouvernement de Benin, the H.R. MacMillan Space Centre, ICME, Imperial Oil, the Institute of Electrical and Electronic Engineers (IEEE), the Institut des Hautes Études Scientifiques, the Institute des Sciences Mathématiques, the Institute for Canadian Urban Research Studies, the Institute for Pure and Applied Mathematics, the Institute for Quantum Computing, the Institute of Industrial Mathematics, Intellimedia, the Interdisciplinary Research in the Mathematical and Computational Sci-ences Centre (IRMACS), the International Centre for Theoretical Physics, INTRIQ, Ion Torrent, the Isaac Newton Institute (Cambridge), JackTek System Ltd., JMP, J. Templeton Foundation (USA), K.C. Wong Education Foundation (Hong Kong), KLA-Temcor, the Korean Institute for Advanced Study, Laboratoire d'excellence Bézat, MSRI,

MapleSoft, the Max Planck-Gesellschaft, Microsoft Research, Miyo Wahkohtowin Educational, Modelling of Complex Social Systems, the National Institute for Mathematical and Biological Synthesis (NIMBioS), the National Natural Science Foundation of China, Nelson Education, the Number Theory Foundation, the (U.S.) Office for Naval Research, Pacific Bioscience, Pearson, the Prairie Network for Research in the Mathematical Sciences, Quantitative Sci. Course Union, Quantum Works, Quest 4D, RFEC Americas, the Research Network for Statistical Methods for Oceanic & Atmospheric Sciences, SAS, Schlumberger, Science World (Vancouver), SEAMOCS, Shanghai Center for Mathematical Science, Shell Canada, Siemens, the Simons Foundation, Springer-Verlag, StataCorp, Statistical and Applied Mathematics Institute, StatOil, the Swedish Foundation for Int. Cooperation in Research (STINT), SYREON Corp., TD Bank, Telus Spark, Tourism Edmonton, the Tutte Institute, and W.H. Freeman & Co.

The PIMS annual budget is approximately $4.3 million, with roughly 31% of this amount coming from NSERC.
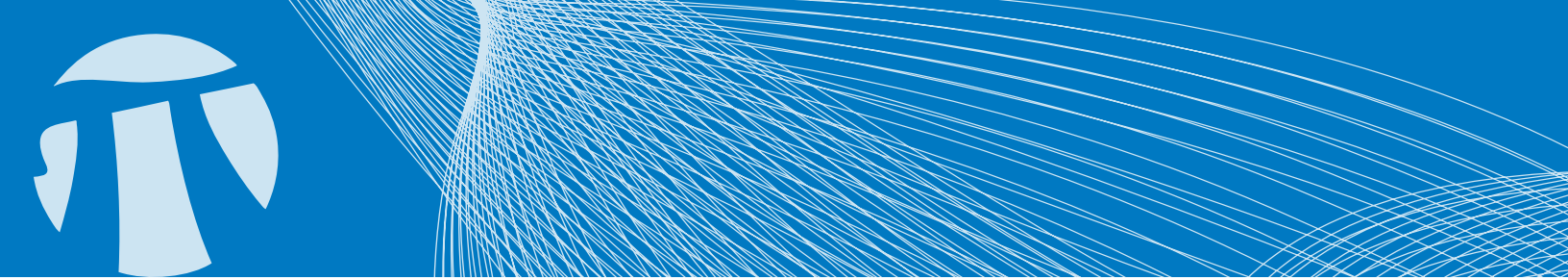
6. PIMS EDUCATIONAL AND OUTREACH ACTIVITIES

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 the participation of people of all backgrounds in mathematics, finding models and activities to facilitate this. PIMS is actively involved in promoting mathematical outreach events in schools throughout Western Canada, either directly or through mechanisms such as regional science fairs. These involve students, teachers and parents and seek to convey the excitement of discovery and learning that underlies mathematics and its applications.

PIMS has developed partnerships with Aboriginal schools in western Canada that have been supported by provincial 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, Alberta, Saskatchewan and Manitoba 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 14 educational associates in Alberta and British Columbia.

7. PIMS NEWS IN 2015

- A. Adem left his position as Director of PIMS on February 1 to become the CEO of Mitacs. M. Barlow (UBC) took the position of Interim Director.
- J. Colliander began his appointment as Deputy Director for a five-year period on July 1. He also as-sumed a faculty position in the Department of Mathematics at UBC.
- U Manitoba joined PIMS as a full member as of July 1. Dean of Science S. Baum represents UM on the PIMS Board of Directors and K. Kopotun has been appointed as the site director.
- V. Putkaradze was appointed site director at UA for the term July 1, 2015 - June 30, 2018.
- C. Soteros took over as site director at US on November 1, 2015.
- On December 30, PIMS founder N. Ghoussoub was appointed an Officer of the Order of Canada, one of this

country's highest civilian honours.

- D. Leeming, PIMS educational coordinator at UV, received the B.C. Council on Admissions and Transfers Franklin Gelin Lifetime Achievement Award on November 5, in recognition of the "tremendous impact of his work, tireless energy and determination."

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

II. PIMS CURRENT ACTIVITIES

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

1. SCIENTIFIC EVENTS

PIMS enables and funds Collaborative Research Groups (CRGs) and their thematic activities, training events in areas such as mathematical biology, stochastics and mathematical modeling, as well as occasional focus periods. It also sponsors and facilitates stand-alone conferences and workshops, runs summer schools for graduate students, finances lecture and seminar series, and cultivates interaction between academia and industry. 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 a desire to collaborate in developing aspects of their research programs. Groups organize focus periods—including workshops, summer schools, and seminars—make joint postdoctoral fellowship (PDF) appointments, and develop joint graduate training programs. CRGs are designed to promote and support long-term, multi-event, multi-site coordinated activities. During its period of operation, typically 3–4 years, a CRG can expect to receive priority access to all PIMS resources and benefit from collaborations with other institutes or funding agencies. Usually CRG activities are spread out over three years, often with a special focus period one summer. See *www.pims.math.ca/scientific/collaborative-research-groups* for more information.

Conferences and Workshops: PIMS organizes and funds a variety of meetings around North America and the Pacific Rim each year. These range from small one-day workshops to multi-week conferences involving hundreds of participants. The larger meetings are selected each year on a competitive basis by the SRP. Smaller events are often funded at the discretion of the Director and Deputy Director.
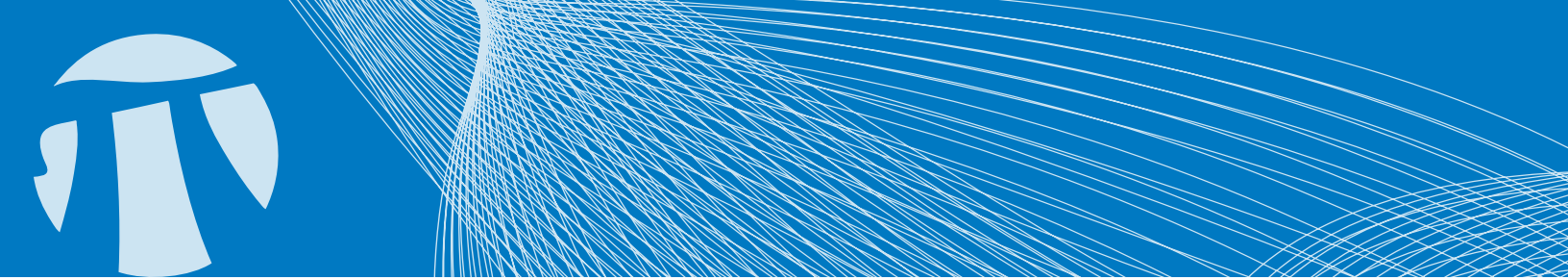
PIMS also hosts or cosponsors various meetings by professional societies such as the CMS, CAIMS, CNTA, IEEE and SSC.

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

Focus Periods: These intensive activities may occur as part of a CRG or on their own depending on current mathematical trends and collaborative prospects. Each covers a specific but substantial area of research of current importance to Canada, with participants ranging from students to world experts in the mathematical sciences. Focus Periods usually take place in the summer and vary in length depending on the discipline. Proposals are evaluated by the PIMS SRP to ensure the highest scientific quality and appropriateness of the subject.

Lecture and Seminar Series: PIMS supports various seminar series at member universities and industrial centres 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. IPSW are based on the Oxford Study Group Model, which poses problems of interest to participating industrial companies to the workshop attendees. Participating graduate

students and faculty spend five days working on the problems, and the results are often published. The advantages for participating students and academics are: (i) the challenge of applying one's skills to new and rele-vant 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 govern-ments the tangible benefits of supporting the mathematical sciences. The IPSW are held annually, rotating between PIMS, Fields and CRM. PIMS next plans to host an IPSW in 2018. MMIW enable graduate students from Canadian universities to learn various aspects of high-level techniques for solving industrial mathematics problems. From 2010-2015 these camps were co-organized by PIMS and the IMA and alternated between the two countries; in the future they will be run solely by PIMS and held in Canada. In addition, 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 that serve to disseminate newly developed mathematical tools that can be of use in industry. For instance, with the sponsorship of CGG, PIMS presents a series of lunch hour lectures at Calgary Place Tower 1. These talks, 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 – 4 in 2015 –are aimed at general audiences. PIMS has been holding this "lunchbox lecture series" in Calgary for seven years and is now expanding it to Vancouver. *www.pims.math.ca/industrial* has more information.

Activity	2014	2015	2016
Conferences/Workshops	34	41	36
Summer Schools	9	5	12
Collaborative Research Groups	5	6	6
Lecture / Seminar Series	28	24	30
Industrial Activities	3	7	4
Other	23	16	13

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

Note: The category "Conferences/Workshops" includes CRG events and Focus Period activities. Activities to be co-sponsored by AARMS in 2016 are not all known at this writing; we expect there will be 3-4 of these. PIMS also will be supporting CANSSI activities in 2016; details have not been specified yet. The numbers for 2016 are based on known events at this time.

All activities are listed individually below, along with *selected* highlights, so as to give a sense of what PIMS does. The sheer number of PIMS endeavors precludes us from doing much more than merely men-tioning them here; however, details about specific activities can be obtained at *www.pims.math.ca* or by request. Such details typically include lists of organizers and speakers, titles and abstracts of talks, scientific background and summaries, schedules, etc. Because of their importance, more detail is given on (i) CRGs in Section I.1D and (ii) PIMS support for AARMS and CANSSI resp., in Sections II.1 D & II.1E following

B. Listing of Activities: 2015

Conferences and Workshops

1. *Spring UBC/SFU Joint Statistical Seminar,* SFU-V, February 28
2. *Frontiers in Biophysics Conference,* UBC, March 14
3. *Bellingham Algebraic Geometry Seminar,* WWU, April 4
4. *Statistical Inference for Large Scale Data,* SFU, April 20-24 *
5. *The 3rd BC Combinatorics Day,* UV, April 25
   - ➢ A collection of ten talks on topics in discrete mathematics and theoretical computer science by speakers from eight different universities in BC and the surrounding regions.
6. *Cascade Topology Seminar,* UV, April 25-26
   - ➢ B. Strenner's result on the disproof of Penner's Conjecture is a novel breakthrough on a relatively old conjecture (from the 70's) in low-dimensional topology.
7. *2015 Canadian Human Statistical Genetics Meeting,* Victoria, May 3-6 *
8. *Alberta Mathematics Dialogue,* UL, May 8-9
9. *Big Data in Environmental Science,* UBC, May 11-15 *
   - ➢ Focused on building relevant tools in such areas as Laplace approximation techniques in high-dimensional Gaussian process modelling, stochastic PDE approaches to stochastic prediction and interpolation, state space models for big data, data compression, big data visualization tools, parallel processing and data management tools for statistical analysis, and sparsification techniques.
10. *Changing the Culture,* SFU, May 16
11. *Lie Theory Workshop: Geometry and Lie Theory,* UA, May 16-17
12. *Explicit Methods for Abelian Varieties: Kick-off Workshop,* UC, May 25-29
13. *Workshop on the Geometry of the Central Path in Linear Programming,* UC, May 26-29
    - ➢ Techniques of tropical geometry and model theory were applied to obtain several well-substantiated working hy-potheses concerning bounds on the curvature of the central path.
14. *PIMS Young Researchers Conference in Mathematics and Statistics,* UC, May 27-2
    - ➢ The conference included a skills workshop on The Art of Oral Presentations in Mathematics and a panel discussion on Job Search Tips for Mathematics and Statistics Students.
15. *Les mathématiques appliquées en sciences de l'environnement,* Rimouski, QC, May 29.°
16. *2015 Canadian Discrete and Algorithmic Mathematics Conference,* US, June 1-4
    - ➢ M. van de Panne of UBC gave a public lecture entitled, "Imagination Amplification: Empowering Creativity with Optimization Algorithms in Computer Graphics."
17. *Western International Workshop on Harmonic Analysis and PDE,* UBC, June 10-12
    - ➢ Some people came up with solutions to questions posed during the open problem session (e.g., problems on joint compactness).
18. *Theory Canada 10,* UC, June 11-14
    - ➢ The conference opened with a public talk, "Seeing the Invisible: Journey into the Quantum World" by S. Ghose (Laurier U).

19. *Alberta Number Theory Days 7,* Banff, June 12-14

20. *Connections in Discrete Mathematics Conference,* SFU, June 15-19
    - ➢ The conference attracted some of the most prominent discrete mathematicians of our time (Graham, Spencer, Nesetril, but also Fox, Demaine, and Conlon) and more than 50 Ph.D. candidates and post-doctoral fellows.
    - ➢ There will be a special volume featuring many of the plenary and invited speakers to be published by Cambridge U. Press in 2016. There will also be a special invited volume of J. Combinatorics dedicated to Ron Graham.

21. *2015 Canadian Undergraduate Mathematics Conference,* UA, June 17-21
    - ➢ Keynote talks ranged from "Why physics is better than math :-)" to "Statistics is Beautiful" and "Moonshine for Beginners."

22. *PIMS Symposium on the Geometry and Topology of Manifolds,* UBC, June 29-July 9
    - ➢ C. Manolescu's talks on the non-triangulability of topological manifolds were highly regarded.

23. *International Symposium on Statistics,* MUN, July 6-8 °

24. *Canadian Undergraduate Computer Science Conference 2015,* UBC-O, July 8-11
    - ➢ This was the first conference in N. America dedicated to showcasing undergraduate research in the computing sciences.

25. *Joint MSI-PIMS Workshop on Conformal Field Theory and Related Topics,* ANU, July 13-17

26. *Workshop on Pattern Formation,* Dalhousie U, July 18-19
    - ➢ A key objective was to focus on the analysis of the collective dynamics that arise from reductions of complicated PDE models.
    - ➢ The workshop was followed by a 'research week' where many of the participants collaborated on problems of common interest.

27. *WADS: Algorithms & Data Structures Symposium,* UV, August 5-7

28. *Symposium on Mathematics and Computation,* SFU, August 6

29. *Prairie Discrete Math Workshop,* BIRS, August 7-9

30. *Combinatorial Constructions in Topology,* UR, August 17-21

31. *Applied Topology and High-Dimensional Data Analysis,* August 17-28
    - ➢ This workshop brought together statisticians with applied topologists to allow the latter to get acquainted with persistent homology, which is a tool which many hope will eventually be useful for verifying or denying sparsity of data.
    - ➢ A highlight of the conference was the build-up of the theory of multi-persistence, culminating in Wright's world premiere of software for visualizing multi-variable persistence.

32. *Conference on the Mathematics of Sea Ice,* SFU-V, September 24-26
    - ➢ This conference explored how PDEs, numerical analysis, large scale models, dynamical systems, bifurcation theo-ry, fractal geometry, diffusion processes and statistical physics can – and are – being applied to help further our understanding of sea ice processes and structures and their roles in Earth's climate systems.

33. *West Coast Optimization Meeting,* UBC-O, October 10

34. *37th Annual Meeting of Alberta Statisticians,* UC, October 17 *

35. *Pacific Northwest Geometry Seminar,* UW, October 17-18
36. *Pacific Northwest Numerical Analysis Seminar,* WWU, October 17
37. *Pacific Northwest Probability Seminar,* UW, October 24
    ➢ The Birnbaum Lecturer was B. Virag (U Toronto).
38. *Fall 2015 UBC/SFU Joint Statistical Seminar, SFU-V October 24*
39. *Cascade Topology Seminar,* PSU, November 7-8
40. *Combinatorial Potlatch 2015,* UBC, November 21
41. *Special Session on Representation Theory, CMS Winter Meeting,* Montreal, December 5-6
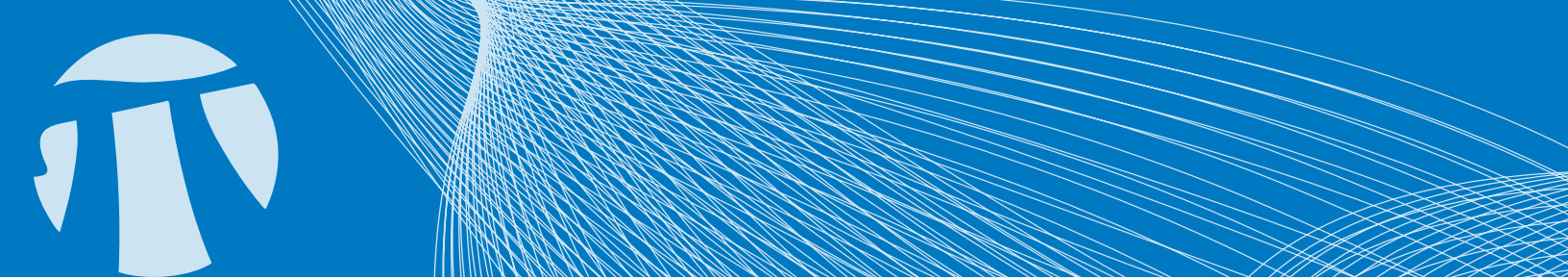
Summer Schools

1. *PIMS-US Graduate Summer School: Applied Combinatorics,* US, May 18-29
   ➢ C. Heitsch's lecture series about RNA folding and the intersection of discrete mathematics and molecular biology was a favourite.
2. *PIMS-SFU Undergraduate Summer School on Rigorous Computing,* SFU, June 7-27
3. *Séminaire de Mathématiques Supérieures: Geometric and Computational Spectral Theory,* CRM, June 15-26
   ➢ The school consisted of twelve minicourses focusing on four themes: geometry of eigenvalues, geometry of eigen-functions, spectral theory and spectral theory on singular spaces.
4. *CRM-PIMS Summer School in Probability,* McGill U & U Montreal, June 15-July 11
   ➢ R. van der Hofstad's lectures on percolation were highly praised.
5. *AARMS-PIMS Summer School in Differential Equations and Numerical Analysis,* Dalhousie U, July 6-31°*
   ➢ The school included 4 courses: nonlinear waves and patterns, reaction diffusion systems, structure-preserving dis-cretization of differential equations and numerical analysis of singularly perturbed differential equations.

Collaborative Research Groups†

1. *CRG 24 – Optimization: Theory, Algorithms and Applications,* 2012-2015
2. *CRG 26 – Geometry and Physics,* 2013-2016
3. *CRG 27 – Applied Combinatorics,* 2014-2017
4. *CRG 28 – Applied, Algebraic and Geometric Topology,* 2014-2018
5. *CRG 29 – Applied Partial Differential Equations: Modeling, Analysis, and Computation,* 2015-2018
6. *CRG 30 – Explicit Methods for Abelian Varieties,* 2015-2018

Focus Periods

1. *Applied, Algebraic and Geometric Topology*, late June-August 2015
2. *Mathematical Models and Algorithms for the Evolution of Genome Structure*, June 28-July 23
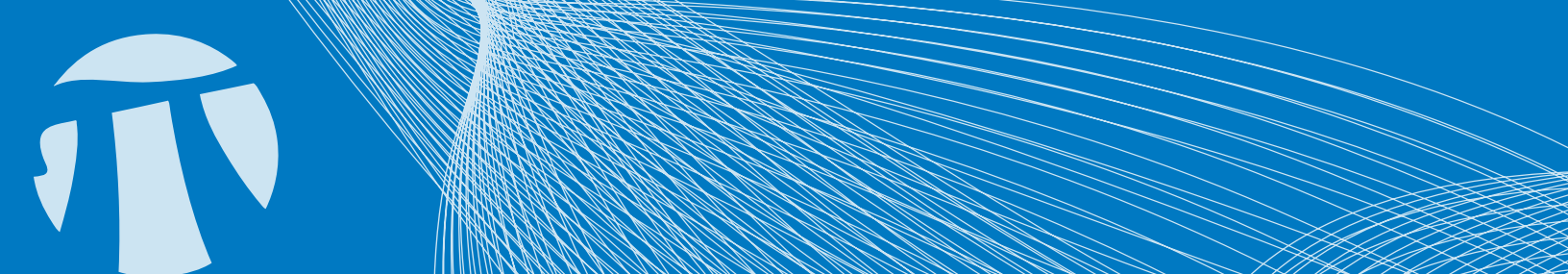
Lecture and Seminar Series

1. *UW-PIMS Colloquium,* UW
2. *PIMS/UBC Distinguished Colloquium Series,* UBC
3. *PIMS Distinguished Lecture Series,* UR
4. *The PIMS-AMI Seminar Series,* UA
5. *Niven Lecture,* UBC, May 25
   - ➢ I. Daubechies (Duke) explained how to "surf with wavelets."
6. *PIMS-UAlberta Distinguished Lecture Series,* UA
7. *The PIMS Marsden Memorial Lecture,* EPFL, Lausanne, Switzerland, June 10
   - ➢ Y. Brenier's (École Polytechnique) lecture covered "From Euler to Born-Infeld, Fluids and Electromagnetism."
8. *PIMS Applied Mathematics Seminar, US*
9. *PIMS-UV Distinguished Lecture Series*
10. *CS Distinguished Colloquium Series,* UBC
    - ➢ Turing Award winner D. Knuth (Stanford) invited his audience to an "All questions answered" event, where questions regarding any kind of topic were be posed by attendees.
11. *PIMS/CSC Distinguished Speaker Series,* SFU
12. *COCANA Seminars* (UBC-O
13. *Lethbridge Number Theory and Combinatorics Seminar,* UL
    - ➢ There were 25 seminars, including 11 talks by speakers from institutions such as Google, KTH (Sweden), Monash U (Australia), U Copenhagen, U Ottawa, and Queen's U. This was highest number of visitors since the inception of the seminar in 2004.
14. *The CORE Seminar Series,* UW
15. *Discrete Math Seminar,* SFU
16. *PIMS-UBC Statistics Constance van Eeden Lecture,* UBC, March 24, 2015
    - ➢ P. van Guttorp (UW) discussed how to project the uncertainty of sea level rise using climate models and statis-tical downscaling.
17. *SCAIM Seminar Series,* UBC
18. *UV Topology Seminar*
19. *PIMS-UW Distinguished Colloquia in Statistics,* UW
20. *IAM-PIMS Distinguished Colloquium Series,* UBC
21. *CRM-Fields-PIMS Prize Lecture, K. Behrend,* UBC, September 9, 2015
22. *PIMS Mathematical Biology Seminars,* UBC
23. *Richard and Louise Guy Public Lecture Series,* UC, September 17
    - ➢ R. Graham (UCSD), accomplished mathematician, juggler and trampolinist, spoke on "Juggling Mathematics and Magic."
24. *Geometry and Physics Seminar Series,* UA

Industrial Activities:

1. *PIMS/Shell Lunchbox Lecture Series, Calgary*
2. *IMA/PIMS Hot Topics Workshop on Hydraulic Fracturing, U Minnesota, May 11-14*
3. *PIMS Workshop on Advances in Seismic Imaging and Inversion, UA, May 20-22*
   - ➢ The short courses on wave propagation, full waveform inversion and related mathematical methods were very well received.
   - ➢ G. Margrave's talk on merging migration with inversion was brilliant and highlighted an effective research path to leverage the successes of seismic migration as practiced in industry with recent mathematical developments in solving inverse problems. It provided an excellent illustration of coupling current technology with past intuitions, expressed in a way that made a solid impression with the participants.
4. *The Fields AMMCS-CAIMS Discussion Panel, Laurier U, June 9*
   - ➢ A panel of 8 experts on industry/academic relations answered questions from an audience of (mainly) mathema-ticians at the CAIMS-AMMCS meeting. The panel included researchers who had left academia to start up their own companies, researchers who had joint appointments in academia and in industry, and representatives from funding agencies that fund such collaborations.
5. *PIMS Industrial Problem Solving Workshop, US, June 15-19*
   - ➢ Industrial problems studied included: designing quantum gates, optimal scheduling for potash production, and measuring advertising performance.
   - ➢ An invitation from the journal Mathematics-in-Industry Case Studies was received to publish the Workshop's results.
6. *Conference on Mathematical and Computational Issues in the Geosciences, Stanford U, June 29-July 2*
7. *IMA-PIMS Mathematical Modelling in Industry Workshop XIX, U Minnesota, August 5-14*
   - ➢ Real progress was made in applying new time-frequency methods to seismic data. In fact, a surprise was that the Basis Pursuit Method came out on top, ahead of the Wavelet Transform and Empirical Mode Decomposition.
   - ➢ Other student projects included: "Sparse Recovery Using Quantum Annealing," "Deep Learning for Image Anomaly Detection," and "Fast and Somewhat Accurate Algorithms."

Distinguished Visitors

1. M. Singer, SFU, January 25-February 7
   - ➢ His visit spurred a collaboration between himself and 3 SFU faculty on understanding the relationship between elliptic curves and lattice path enumeration.
2. C. J. Budd, SFU and UBC, February 1- June 30
   - ➢ Gave 10 scientific and educational lectures and prepared three articles for publication.
3. M. Henning, UV, March 8-21
   - ➢ Studied total domination in games and graphs. Several papers with UV researchers are in progress.
4. E. Knobloch, UA, March 25-29
5. E. Tannier, SFU, June 28-July 23
   - ➢ The featured lecturer at the focus period on Mathematical Models and Algorithms for the Evolution of Genome Structure.

6. C. Mathieu, UV, July 20-August 20

7. S. Komarova, SFU and UBC, September
    ➢ Applied mathematical modeling and mechanics to puzzling questions in bone physiology.

8. S. Siksek, SFU and UBC, September 5-18
    ➢ Completed the proof of Jacobi's observations on `sums of seven cubes.'
    ➢ Showed that all elliptic curves over real quadratic fields are modular.

9. C. Frohlich, UA, September 10

10. P. Schneider, UBC, August 29-October 3

Other

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

1. *CMS Regional Math Camp,* UC, June 28-July 6

2. *Miyo Wahkohtowin Education Presents: Math Mania!,* Ermineskin AB, July 6-17
    ➢ Ø Enrolment has increased 80% since the fist MWE math camp in 2013.

3. *Graduate Prizes in Algebra,* St. John's, January º

4. *Marine Mammal Roundtable,* UBC, May 4-8 *

5. *Statistical Society of Canada Annual Meeting,* Dalhousie U, June 14-17 *

6. *Special Sessions at the CMS Summer Meeting,* Charlottetown, June 5-8 º
    ➢ PIMS/AARMS supported 4 special sessions on: "Singularities and Phase Transitions," "Graph Designs and Hy-pergraphs," "Ergodic Theory," and "Games on Graphs."

7. *CAIMS Annual Meeting,* W. Laurier U., June 7-12

8. *Reception, Int. Chinese Statistical Association Canada Chapter Symposium,* UC, August 4

9. *CMS Winter Meeting,* Montreal, December 4-7

10. *PIMS Biology Seminar,* UBC

11. *PIMS Probability Seminar,* UBC

12. *PIMS Diff. Geom./Math. Phys./PDE Seminars,* UBC

13. *PIMS Topology Seminar,* UBC

14. *PIMS Discrete Mathematics Seminar,* UBC

15. *Alberta High School Mathematics Competition,* UA

16. *American Women in Mathematics Mentor Network*

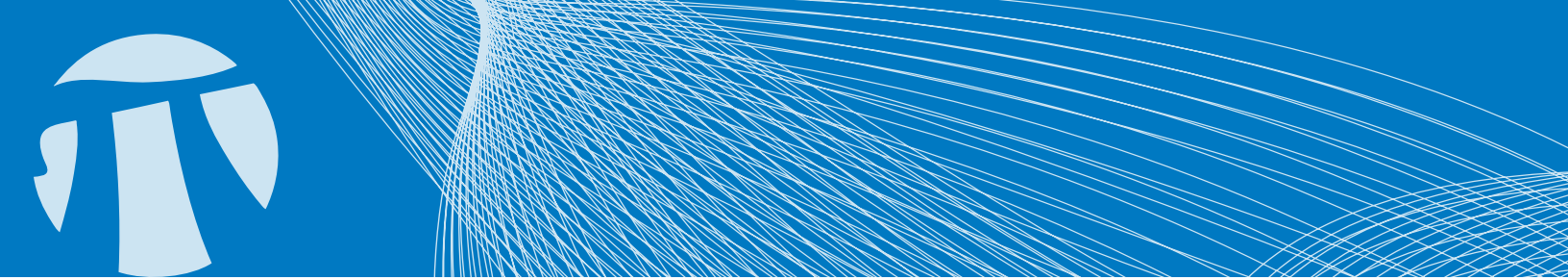º Circled events are co-sponsored with and organized by AARMS.

* Starred events are co-sponsored with and organized by CANSSI.

C. Listing of Planned Activities: 2016

Conferences and Workshops

1. *The 19th Conference on Quantum Information Processing,* Banff, Alberta, January 10-16
2. *2016 (Winter) Joint SFU-UBC Student Statistics Seminar,* SFU-V, March 19
3. *Combinatorial Structures in Perturbative Quantum Field Theory,* SFU, March 21-25
4. *Statistical Analysis of Large Administrative Health Databases Workshop,* SFU, April 4-6
5. *Alberta Number Theory Days VIII, BIRS,* April 15-17
6. *PIMS One-day Dynamics Meeting,* UV, April 23
7. *Alberta Mathematics Dialogue 2016,* Mt. Royal U., April 28-29
8. *Women in Topology,* Banff, April 25-29
9. *Cascade Topology Seminar,* Banff, April 30-May 1
10. *MMMM Graduate Student Combinatorics Workshop,* UM, April 30-May 1
11. *Changing the Culture,* SFU, May 13
12. *2016 Pacific Northwest Number Theory Conference,* Oregon State U, May 14-15
13. *Western Canada Linear Algebra Meeting (WCLAM) 2016,* UM, May 14-15
14. *Prairie Discrete Math Workshop 2016,* UM, May 16-17
15. *International Conference in Harmonic Analysis,* U Wisconsin, May 16-20
16. *The Emerging Mathematics Instructors Workshop,* UM, May 16-20
17. *Homotopy Type Theory and Univalent Foundations of Mathematics,* Fields Institute, Toronto, May 16-20
18. *Conference on Functional Analysis in Honour of Nicole Tomczak-Jaegermann,* UA, May 16-20
19. *North-American Workshop in Holomorphic Dynamics, Cancun,* May 27-June 4
20. *Special Session on Mathematical Biology, Biophysics Society of Canada Annual Meeting,* UM, June 1-3
21. *Foundational Methods in Computer Science,* UBC, June 2-5
22. *PIMS Young Researchers Conference in Mathematics and Statistics,* UA, June 13-16
23. *Conference on Geometry, Algebra, Number Theory, and Their Information Technology Applications, Fields In-stitute, Toronto,* June 13-16
24. *PIMS Workshop on Nonlocal Variational Problems and PDEs,* UBC, June 13-17
25. *Canadian Number Theory Association XIV,* UC, June 20-24
26. *Workshop on Perspectives in Geometric Analysis, Beijing International Centre for Mathematical Research,* Beijing & Xi'an, China, July 1-7
27. *Formal Power Series and Algebraic Combinatorics 6,* SFU-V, July 4-8
28. *Canadian Conference on General Relativity and Relativistic Astrophysics 16,* SFU, July 6-8
29. *Canadian Abstract Harmonic Analysis Symposium,* UBC, July 7-8
30. *International Symposium on Rarefied Gas Dynamics,* UV, July 10-14
31. *International Biometrics Conference 2016,* UV, July 10-15
32. *Journées Combinatoires Franco-Vancouvéroises,* SFU, July 11-12

33. *Statistical Causal Inference and its Applications to Genetics,* CRM, July 25-August 19
34. *24th International Congress of Theoretical and Applied Mechanics (ICTAM),* Montreal, August 21-26
35. *Workshop on Causal Inference,* UC, TBA
36. *ABC Workshop,* BIRS, Fall

Summer Schools

1. *Séminaire de Mathématiques Supérieures: Dynamics of Biological Systems,* UA, May 30-June 11
2. *Summer School in Explicit Methods for Abelian Varieties,* UC, June 16-18
3. *Summer School in Mathematical Finance,* UA, June 25-July 6
4. *Perspectives in Geometric Analysis,* Beijing International Centre for Mathematical Research, June 26-30
5. *Summer School for In-service Teachers,* SFU, mid June - mid July
6. *Superschool on Derived Categories and D-Branes,* UA, July 17-23
7. *Summer School on Surgery and Classification of Manifolds,* UC, July 18-22
8. *PIMS Summer School and Workshop on Geometric and Topological Aspects of the Representation Theory of Fi-nite Groups,* UBC, July 27-August 5
9. *2016 West Coast Algebraic Topology Summer School,* U Oregon, August 8-13
10. *PIMS-NSF Undergraduate Workshop in Supersymmetry,* UBC, August 14-20
11. *Two Weeks in Vancouver: a Summer School for Women in Math,* UBC, August 15-26
12. *Sirince Summer School in Mathematical Physics,* Sirince, Turkey, August 22-September 4

Collaborative Research Groups

1. CRG 27 - *Applied Combinatorics,* US, 2014-2017
2. CRG 28 - *Applied, Algebraic and Geometric Topology*, UBC, UV, UR, 2015-2018
3. CRG 29 - *Applied Partial Differential Equations: Modeling, Analysis, and Computation*, UBC, 2015-2018
4. CRG 30 - *Explicit Methods for Abelian Varieties, various locations*, 2015-2018
5. CRG 31 - *Geometric and Cohomological Methods in Algebra*, UA, UBC, UW, 2016-2019
6. CRG 32 - *Geometric Analysis, UBC, UW, ANU, Beijing*, 2016-2019

Focus Periods

1. *Perspectives in Geometric Analysis,* Beijing & Xi'an (China), June 25-July 7

Lecture and Seminar Series

1. *Hugh C. Morris Distinguished Lecture,* UBC, March 4
2. *Lethbridge PIMS Distinguished Speakers Series,* UL
3. *Math Across Campus,* UW
4. *PIMS Applied Mathematics Seminar Series,* US
5. *Lethbridge Number Theory and Combinatorics Seminar,* UL
6. *Lethbridge Analysis Seminar,* UL

7. *Discrete Math Seminar Series,* SFU
8. *Computer Science Distinguished Lecture Series,* UBC
9. *Fluid Mechanics Seminar,* UBC, 2016
10. *UW-PIMS Mathematics Colloquium,* UW
11. *Abelian Varieties Multi-site Seminar*
12. *PIMS/UBC Distinguished Colloquium Series,* UBC
13. *PIMS Distinguished Lecture Series,* UR
14. *The PIMS Marsden Memorial Lecture,* Banff, July 17
15. *PIMS-UM Distinguished Lecture Series,* UM
16. *CS Distinguished Lecture Series,* UBC
17. *PIMS-CSC Distinguished Speaker Series,* SFU
18. *Calgary Mathematics & Philosophy Lectures,* UC
19. *Abelian Varieties Multi-site Seminars,* U Colorado, SFU, UC, UW
20. *The PIMS-AMI Seminar Series,* UA
21. *UV Topology Seminar*
22. *The Niven Lecture,* UBC
23. *SCAIM Seminar Series,* UBC
24. *UW Statistics Seminar,* UW
25. *IAM-PIMS Distinguished Colloquium Series,* UBC
26. *CRM-Fields-PIMS Prize Lecture,* UBC
27. *Geometry and Physics Seminar Series,* UA
28. *The CORE Seminar Series,* UW
29. *PIMS-UBC Statistics Constance van Eeden Lecture,* January 19
30. *PIMS/UV Colloquium Series,* UV

Industrial Activities

1. *Mathematical Modeling in Industry Workshop (MMIW),* UBC, August 8-13
2. *Industrial Problem Solving Workshop (IPSW),* Fields Institute, August 14-21
3. PIMS Lunchbox Lectures, UBC
4. PIMS Lunchbox Lectures, UC

Distinguished Visitors

1. P. Thieullen, UV, January 1-March 2
2. F. Pappalardi, UL, January 18-28
3. R. Korikorian, UA, February
4. F. Buscemi, UC, February 14-21
5. H. Dette, UA, April

6. M. Florence, April 24-May 18
7. D. Benson, UL, June 24-August 6
8. M. Muzychuk, UL, October 1-21
9. H. Li, UA, Fall

Other

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

1. *Information Session on Actuarial Science,* UC, February 5
2. *ELMACON,* UBC, April 30
3. *Annual Meeting of the Canadian Society for the History and Philosophy of Mathematics,* UC, May 29-31
4. *SSC Annual Meeting,* Brock U, May 29-June 1
5. *CMS Summer Meeting,* UA, June 24-27
6. *14th RECOMB Comparative Genomics Workshop,* Montreal, October 11-14
7. *PIMS Biology Seminar,* UBC
8. *PIMS Probability Seminar,* UBC
9. *PIMS Diff. Geom./Math. Phys./PDE Seminars,* UBC
10. *PIMS Topology Seminar,* UBC
11. *PIMS Discrete Mathematics Seminar,* UBC
12. *Alberta High School Mathematics Competition,* UA
13. *American Women in Mathematics Mentor Network*

D. CRG Status Reports

PIMS had 6 active CRGs in 2015; below we briefly summarize current and upcoming activities and list their PDFs. New CRGs on *Applied Combinatorics* and *Applied, Algebraic and Geometric Topology* got underway in 2015. PIMS is currently developing new CRGs for following years.

CRG 24: Optimization: Theory, Algorithms and Applications (2012-2015)
Leaders: *Heinz H. Bauschke (UBC-O), Michael Friedlander (UBC), Y. Zinchenko (UC).*
2015 Activities:
- *Workshop on the Geometry of the Central Path,* UC, May 26-29
- *West Coast Optimization Meeting Fall 2015,* UBC-O, October 9-10
- *COCANA Seminars* (UBC-O: 17, UW: 6, SFU: 7, UC: 8)
- This CRG ended in 2015.

Visitors: C. Audet, Montreal, October; J. Burke, UW, October; J. Eaton, UW-Tacoma, October; J. Ye, UV, October; N. Nam, Portland U, October; A. Lau, UA, March, X. Li, SFU, October; S. Ramati, Thompson Rivers U, October, T. Rockafellar, UW, October; M. Schmidt, UBC, March; M. Tawhid, Thompson Rivers U, October; Y. Zinchenko, UC, June & October; X.-J. Long, Chongqing Technology and Business U (China), February-January 2016; V. Asimit (City

U, London); Z. Peng, Chongqing Jiao Tong U (China), February-January 2016.

Students & PDFs: S. Bartz (PIMS PDF, UBC-O, 2014-2015); I. Rahmanian (UBC-O, 2014-2015); M. Dao (NSERC Accelerator PDF, UBC-O, 2014-2015); A. Steele (PIMS PDF, UC, 2015), and 14 PhD and MSc students at UBC-O, UC and UBC.

Highlights:

- In a 40-page paper, just accepted for publication in the SIAM J. on Optimization, a comprehensive study of the so-called resolvent averages allowing for new ways for averaging monotone operators was given.
- New and surprising finite convergence results were derived for the Douglas-Rachford algorithm.
- The first-of-its-kind comprehensive numerical comparison of several competing methods to include generally perceived as intractable constraints within the radiotherapy optimization framework was carried out.
- The group around Hare and Lucet analyzed the construction of optimal road designs in collaboration with industry.
- CRG publications in 2015: 18 in print, 21 accepted and in press and 16 submitted.
- A noteworthy mention goes to the COCANA web-cast optimization seminars, which are hosted by the UBC-O optimization group and run roughly bi-weekly.

CRG 26: Geometry and Physics (2013-2016)

Leaders: Chuck Doran (UA), Jim Bryan (UBC) and Kai Behrend (UBC)

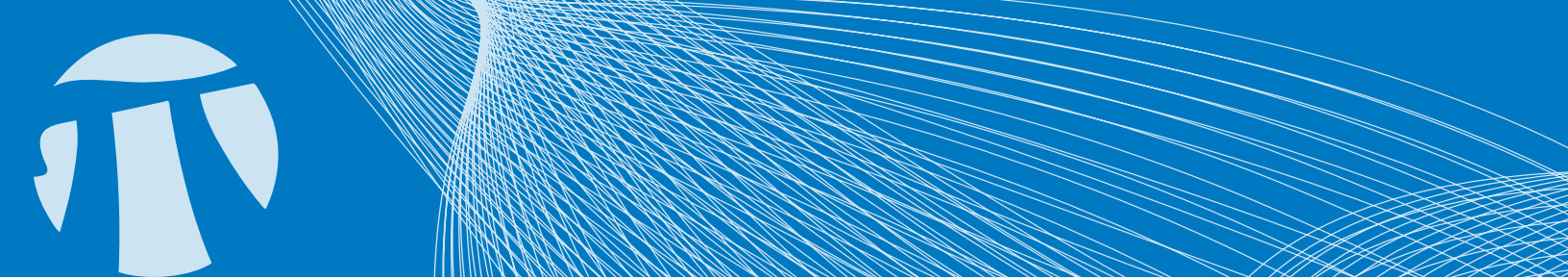**PIMS Faculty:** Vincent Bouchard, Thomas Creutzig, David Favero, Terry Gannon (UA)

2015 Activities:

- *The Geometry and Physics Seminar Series,* UA & UBC
- *The Mathematics of Conformal Field Theory,* Canberra, July 13-17

PDFs: C. Quigley (UA), M. Kool (UBC), N. Sabilla (UBC)

Highlights:

- UBC CRG M. Kool and CRG co-PI J. Bryan developed a new technique for studying the Donaldson-Thomas theory of elliptically fibered threefold which combines topic and motivic methods. This innovation has led to several new exact computations of DT partition functions and has revealed a surprising connection between the topological vertex and Jacobi forms.
- UA CRG postdoc C. Quigley completed a project with CRG co-PI's V. Bouchard, E. Diaconescu, and C. Doran deriving an explicit formula for the generating function of vertical D4-D2-D0 bound states on smooth K3 surface fibered Calabi-Yau threefolds, generalizing previous results of Gholampour and Sheshmani. They also showed that, as predicted by string theory, this formula satisfies strong modularity properties, leading in particular to a new construction of vector-valued modular forms exhibiting some of the features of a generalized Hecke transform.

CRG 27: Applied Combinatorics (2014-2017)

    Leaders: M. Mishna (SFU), A. Rechnitzer (UBC), C. Soteros (US) and K. Yeats (SFU)

    PIMS Faculty: SFU: C. Chauve, L. Yen; US: M. Atapour, M. Szafron, R. Bowles; UBC: O. Angel, S. van Willigenberg

    2015 Activities:

- *SFU Discrete Math Seminar*
- *UBC Discrete Math Seminar*
- *Summer School on Applied Combinatorics,* US, May 18-29.
- *Canadian Discrete and Algorithmic Mathematics Conference,* US, June 1-4

    2016 Activities (Planned):

- *SFU Discrete Math Seminar*
- *UBC Discrete Math Seminar*
- *Mini-conference on Combinatorial Structures in Perturbative Quantum Field Theory,* SFU, March 21.
- *Formal Power Series and Algebraic Combinatorics,* SFU-V, July 4-8. There will be a satellite graduate student event following this conference.

    Visitors: Y. Ponty (Polytechnique), SFU, fall 2014-onwards; E. Fusy (Polytechnique), SFU & UBC, fall 2014-summer 2016; K. Raschel (CNRS/Tours); A. Guttman (Melbourne), UBC, March; Distinguished PIMS Visitor M. Nebel, SFU, April; Erik Panzer (Oxford), May, US; G. Chapuy (CNRS/Paris 7), SFU, June; Distinguished PIMS Visitor S. Whittington, US, November 10-13.

    Students & PDFs: J. Courtiel (UBC, PIMS Postdoc), 2014-2015; N. Beaton (US, PIMS Postdoc), 2015; 3 Ph.D. and 11 other students.

    Highlights:

- Yeats has been looking at asymptotics for the parameters of chord diagrams which are relevant to the chord diagram expansion of Dyson-Schwinger equations in quantum field theory. She has also found a new apparent graph theoretic invariant for Feynman integrals.
- Mishna and her PDFs have been analyzing the average case complexity of alignment algorithms. This is an important question in bioinformatics, one for which they are developing analytic and combinatorial strategies.
- Rechnitzer and collaborators are studying random Hopf links by considering random embeddings of such into cubic lattices. This will enable them to examine statistical-topological questions about knot diagrams.
- Soteros' recent research has been focused on models of polymer entanglements and knotting and linking in closed DNA (DNA topology). She has proven the first results on the exponential growth rate of unknots in small tubes.
- 23 publications submitted, in press or published in 2015.
- The CRG has been a great draw for PIMS-CNRS researchers to date, with four such overlapping the CRG this year.

CRG 28: Applied, Algebraic and Geometric Topology (2014-2018)

    Leaders: K. Bauer (UC), R. Budney (UV), J. Palmieri (UW), A. Pettet (UBC), D. Rolfsen (UBC), D. Sinha (U Oregon), D. Stanley (UR).

    PIMS Faculty: A. Adem (UBC), R. Cockett (UC, computer science), R. Zach (UC, philosophy), P. Zvengrowski (UC), B. Botvinnik (U Oregon).

2015 Activities:

- *The 2015 Spring Cascade Topology Seminar,* UV, April 25-26
- *The PIMS Symposium on the Geometry and Topology of Manifolds,* UBC, June 29-July 9
- *Combinatorial Constructions in Topology,* UR, August 17-21
- *Applied Topology and High-Dimensional Data Analysis,* UV August 17-28
- *UV Topology Seminar*
- *UBC Topology Seminar*

2016 Activities (Planned):

- *Cascade Topology Seminar,* BIRS, April 30–May 1
- *Summer school on Surgery Theory and Classification of Manifolds,* UC, July 18-22
- *UV Topology Seminar*
- *PIMS-UBC Topology Seminar*

Visitors: B. Johnson (Union College), UC, 2015; C. Osborne (UC Riverside), UC, 2015; E. Riehl (Johns Hopkins U), UC, 2015, Amelia Tebbe (U Illinois, Urbana), UC, 2015; J. Lurie (Harvard U), UBC, 2015-16; K. Hess (EPFL), UC, 2016; M. Freedman (Microsoft), UV, 2016.

Students & PDFs: M. Cheng (UBC), B. Williams (UBC), H. Ruping (UBC), T. Pinsky (UBC), R. Wade (UBC), R. Koytcheff (UV), S. Sarkar (UR), O. Antolin (UBC), Diego Vela (UV); 8 Ph.D. students.

Highlights:

- R. Budney outlined some new developments, algorithmic challenges and some simple attacks on long-standing open problems concerning triangulations of 4-manifolds.
- 20 papers were generated in 2015.

CRG 29: Applied Partial Differential Equations: Modeling, Analysis, and Computation (2015-2018)

Leaders: T. Hillen (UA), T. Kolonikov (Dalhousie U), S. Ruuth (SFU), M. Ward & J. Wei (UBC)

2015 Activities:

- *Workshop on Pattern Formation,* Dalhousie U, July 18-19
- *AARMS-PIMS Summer School in Differential Equations and Numerical Analysis,* Dalhousie U, July 6-31

2016 Activities (Planned):

- *Workshop on Nonlocal Variational Problems and PDEs,* UBC, June 13–16

Visitors: H. Berestycki (U Paris 6), UA & UBC, Spring 2016

Students and PDFs: J. Tzou (UBC), September 15–; A. Bianchi (UA), starts February 1, 2016

Highlights:

- The workshop above brought together researchers who construct finite-dimensional reductions to analyze problems in a wide range of areas of application including: the study of vortex dynamics in Bose-Einstein condensates, models of swarming behavior and the study of first passage time problems in the presence of localized traps.
- Carried out a weakly nonlinear analysis of vortex formation in a dissipative variant of the Gross-Pitaevskii equation.

CRG 30: Explicit Methods for Abelian Varieties (2015-2018)

Leaders: J. Achter (Colorado State U), A. Akbary (UL), D. Jao (U Waterloo), K. Murty (U Toronto), M. Jacobson (UC), A. Stein (U Oldenburg), B. Viray (UW), N. Bruin (SFU), Laurent Imbert (CNRS & LIRMM) and C. Costello (Microsoft)

2015 Activities:
- *Kick-off Workshop,* UC, May 25-29
- *CMS Winter Meeting 2015, Special Session on Representation Theory*, Montreal, December 5-6
- *Multi-site Seminar Series, Various*, October onwards

2016 Activities (Planned):
- Summer School in Explicit Methods for Abelian Varieties, UC, June 16-18
- Multi-site Seminar Series, Various

Students and PDFs: A. Fiori, UC, September 2015–, J.-D. Bauch, SFU, October 2015–

Visitors: In early 2016: A. Sutherland (MIT) and L. Imbert (LIRMM). The remainder of 2016: 5 more visitors.

Highlights:
- 14 publications were generated during 2015.
- The CMS Special Session focussed on conjectures, such as the Langlands Correspondence, the Tate Conjecture and the Inverse Galois Problem, concerning the structure of Galois representations attached to abelian varieties.

E. Focus Periods

Mathematical Models and Algorithms for the Evolution of Genome Structure, SFU, June 28-July 23:

This "mini-focus period" centered around the visit of E. Tannier, from INRIA (the French institute for computer science research) and LBBE (an evolutionary biology lab at U Lyon).

The main component of this visit was a series of four lectures:

1. June 29: "How we learned that chromosomes are linear arrangements on genes (introductory/non-technical lecture about mathematical models of gene order evolution)";
2. July 2: "How we learned to forget it (survey of the state-of-the-art about mathematical models and computational algorithms to analyze genome rearrangements)";
3. July 8: "Multiscale Integrated Paleogenomics (models and algorithms for ancestral genomes recon-struction)"; and,
4. July 15: "Lateral Gene Transfers, from a phylogenetic nightmare to a phylogenetic marker (modelling, inferring, analyzing lateral gene transfers)."

They were each attended by around 20 people, composed mostly of graduate students and post-doctoral fellows from the Biological Sciences Dept. of SFU, the SFU Dept. of Mathematics and the SFU Graduate Program MADD-Gen (*https://www.sfu.ca/madd-gen.html*). Five visiting German graduate students were in attendance, including 4 from the Bielefeld sister program MADD-Gen (*http://wiki.techfak.uni-bielefeld.de/didy*) and PIMS-CNRS fellow Y. Ponty.

The focus period offered a unique opportunity for graduate students to be exposed to current research in a field (computational evolutionary genomics and genome rearrangements) that is not taught at either SFU or UBC. The active discussions following the lectures led to three ongoing research projects: (a) Bayesian sampling of ancestral gene order configurations, (b) integrated scaffolding of ancestral and extant genomes, and (c) dating species trees with lateral transfers. The three projects involve the development of efficient combinatorial and probabilistic algorithms (mostly based on dynamic programming) for combining large sequencing datasets and parsimonious analysis of genome evolution.

Algebraic, Applied and Geometric Topology, UBC, UR & UV, 2015:

Activities included a major international symposium at UBC, two other conferences at UV and UR, and a workshop at UV. Topology seminars were also hosted by the CRG at UV and UBC.

The main event was the *Symposium on the Geometry and Topology of Manifolds*, held from June 29 to July 9 at UBC. One hundred and twenty-seven mathematicians (including 64 graduate students and postdocs) from around the world came together to exchange ideas related to manifold theory. The attendees included diverse groups who have overlapping interests, but do not usually meet together, including specialists in high- and low-dimensional manifolds, geometric group theory and differential geometry.

Highlights included the recent spectacular results on the applications of curvature flows that were explained by G. Tian, and M. Gualtieri's presentation of a new approach to generalized complex structures on manifolds. The interplay with symplectic geometry was featured in the lecture of G. Cavalcanti, D. Ruberman reported on joint work with T. Mrowka, and N. Saveliev extended the Atiyah-Patodi-Singer eta-invariant to manifolds with periodic ends. The latest developments in geometric group theory were identified, with R. Charney presenting a new boundary theory for $CAT(0)$ spaces and M. Davis describing striking estimates for the action dimension of a right-angled Artin group. M. Bridson gave a broad overview of decision problems and the connections between curvature, topology and algorithms. In high-dimensional manifolds, O. Randal-Williams reported on joint work with B. Botvinnik and J. Ebert on the topology of moduli spaces of positive scalar curvature metrics, followed by joint work with S. Galatius on the cohomology of the spaces of manifolds in a fixed even dimension. Galatius also gave lectures on several homological stability results and their applications to describing the topology of classifying spaces Bdiff(M) for even-dimensional manifolds M.

Several lectures linked latest developments in topology, number theory and geometry. B. Farb explained a remarkable bridge – built by Weil, Grothendieck, Deligne and others – between topology and number theory, and T. Farrell gave two beautiful lectures: one on spaces of constrained Riemannian metrics and their associated Teichmueller spaces and the other on bundles of negatively curved manifolds. W. Lück highlighted new developments in studying L_2-acyclic manifolds with torsion-free fundamental group and the latest results on the Farrell-Jones Conjecture.

The symposium was generously supported by PIMS, UBC, the NSERC and the NSF.

Details about the other focus period activities can be found in the CRG 28 Status Report, in Section II.1.D above, and on the PIMS website.

Perspectives in Geometric Analysis, Beijing & Xi'an (China), June 26-July 7, 2016:

This is an upcoming activity of the international CRG in Geometric Analysis, which includes the Beijing International Centre for Mathematical Research, the Australian National U, PIMS, UBC and UW. The focus period consists of: a summer school (June 26-30), part A of a workshop (July 1-3 in Beijing) and part B of the workshop (July 5-7 in Xi'an). It aims to enhance collaboration among Pacific Rim researchers and provide training for junior people the field of geometric analysis.

The scientific committee consists of: B. Andrews (Australian National U), J. Chen (UBC), A. Fraser UBC), X. Liu (Peking U), G. Tian (Peking U), X. Wang (Australian National U) and Y. Yu (Jiaotong U).

F. AARMS & CANSSI Reports

As part of a national mandate, PIMS supports 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 2015 (PIMS' financial contribution to each activity is listed in parentheses):

1. *Graduate Prizes in Algebra*: St. John's, NL, January: There are two annual prizes for graduate students working in the universities of the Maritime provinces. To qualify, a student must be enrolled in a full-time graduate program, be supervised by a member of the Atlantic Algebra Centre and be actively involved in a productive research in algebra and it applications. The 2015 prizes went to S. Huntemann and N. Erey. ($1000)

2. *Les mathématiques appliquées en sciences de l'environnement,* Rimouski, QC, May 29: The symposium was attended by over 60 people, and twelve lectures were scheduled during the day of the symposium. The funding allowed the participation of 6 graduate students from U Moncton and two guest speakers ($2000).

3. *Special Sessions at the CMS Summer Meeting*, Charlottetown, PEI, June 5-8: Sessions supported were:
   - ➢ "Singularities and Phase Transitions": These well-attended presentations not only generated discussions on the state-of-the-art mathematical techniques used in understanding models coming from diverse areas of physics, materials science, and biology.
   - ➢ "Graph Designs and Hypergraphs": This session had generally 25-30 attendees at each talk.
   - ➢ "Optimization and Nonlinear Analysis": There were more than 16 speakers from all over the world sharing new results and developments.
   - ➢ "Ergodic Theory": Speakers convinced the general audience that dynamical systems theory has significant applications in many different areas such as population dynamics, fractals, fluid dynamics, finance, chaos theory, and oceanography.
   - ➢ "Games on Graphs": R. Nowakowski gave the Friday Night Public Lecture, entitled "Games: Playing Positions Purposefully" and also organized the special session "Games and Pursuit Games on Graphs." The quality of the talks and of the participants was high. ($12,648)

4. *International Symposium on Statistics*, St Johns, July 6-8 ($6300)

5. *AARMS Summer School*, Dalhousie U, July 21-August 15: Every summer highly regarded faculty from around the world deliver graduate courses in the mathematical sciences. In 2015 the the theme of the summer school was "Differential Equations and Numerical Analysis." An international collection of students took up to two graduate-level courses each from the following list: "Waves and patterns in nonlinear systems Instructors," "Topics in Reaction-Diffusion Systems: Theory and Applications Instructors," "Structure-preserving discretization of differential equations" and "Numerical analysis of singularly perturbed ODEs and PDES." There were also several associated events: the Bluenose Workshop, July 11-12; the Workshop on Pattern Formation, July 18-19 and the Workshop on Domain Decomposition Methods for PDE's, August 4-8. ($20,000)

6. AARMS administrator salary. ($8052)

PIMS also supports statistical activities throughout Canada through CANSSI. In 2015 these included:

7. *Statistical Inference for Large Scale Data*, SFU, April 20-24 ($2,000)
8. *Canadian Human and Statistical Genetics Meeting*, Victoria, May 3-6 ($9,681)
9. *Big Data in Environmental Science*, UBC, May 11-15 ($2,000)
10. *Statistical Society of Canada Annual Meeting*, Dalhousie U, June 14-17 ($2,542)

11. *Reception, Int. Chinese Statistical Association Canada Chapter Symposium*, UC, August 4 ($10,724)
12. *Alberta Statisticians Meeting*, UC, October 17 ($271)
13. Scientific Coordinator ($49,997), Postdoc ($23,751) & Research Assistant ($30,189) salaries

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 449 responded in 2015. The results were passed on to event organizers and scrutinized at PIMS Central. Below are charts summarizing responses to questions of particular interest to PIMS; here "1" represents the worst score (very dissatisfied/low/poor) and "5" the best score (very satisfied/high/excellent):

Scientific Value of Event

Overall Satisfaction With the Event
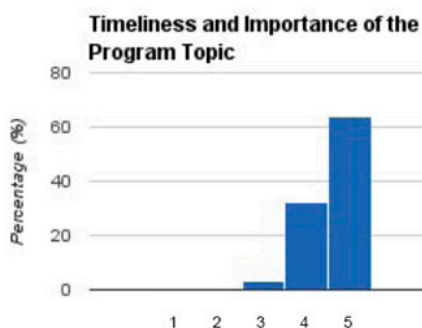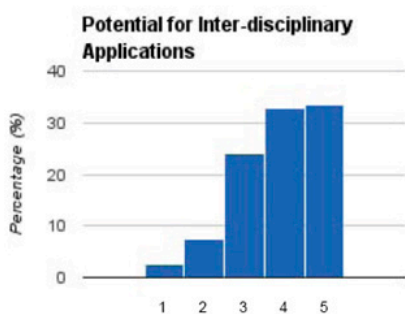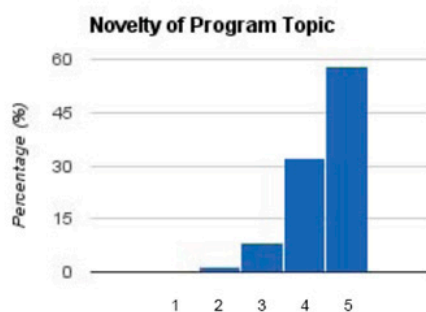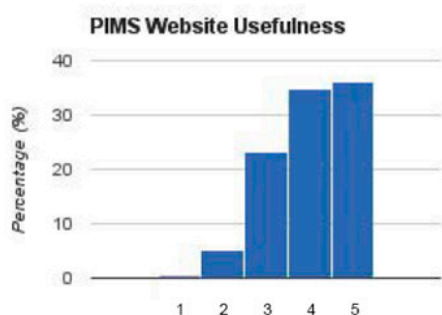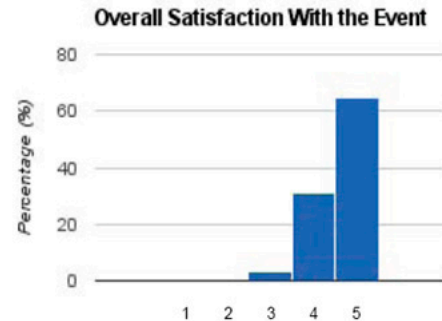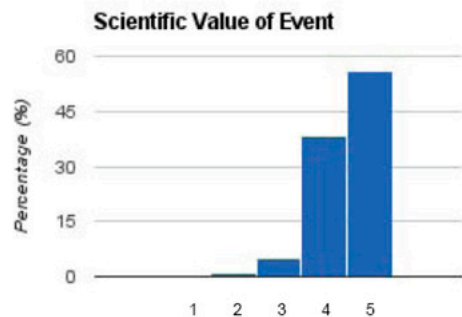
The results were broadly similar to those in previous years.

Individual comments regarding PIMS' events included:

- "It has been a long time since I have been at such a pleasant, well-organized and scientifically significant event. The scheduling, social events, chances for interactions were spectacular. Speakers were exceptional."
- "There were many excellent talks, but as a highlight I would mention the useful scientific discussions with some colleagues, which helped me to make progress in some mathematical problems I was stuck with for some time, and also the potential for future collaborations."
- "As a whole the workshop helped me realize that I indeed want to be an industrial mathematician."
- "Too many highlights to select! Almost all the plenary talks were excellent, well-prepared and delivered, and brought the latest scientific results to the meeting. A great mixture of topics, much more diverse than most other conferences."
- "All the organization by the PIMS staff was perfect and it was wonderful to be in the new building."
- "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."
- "This is one of my favorite scientific events because of the quality and originality of the works presented, and the very productive interactions with other participants.
- "This is one of the best organized conferences in which I participated and I am looking forward for the next edition. Ran smoothly and excellently despite a major natural disaster!"
- "This is the best academic workshop I have attended in the past 5 years, both in the technical and social settings. Thank you."
- "It was an honor to be asked to speak, and a real pleasure to hear such good mathematicians talk about their work. There were really exceptional talks by many people, broad overviews that could only come from the top people of the field. These mathematicians are really good."
- "Many of the talks were fantastic and I attended every single one which is a first in 30 years of conference attendance."
- "… a terrific conference. It is a rare event when I'm sad to leave a conference, but I wasn't ready to go home."
- "… engaging and well-organized. The courses were intensive and useful. … Overall the school was fantastic, and it was quite apparent that the organizers put a lot of effort into making the event a huge success."
- "This summer program has been a terrific experience mathematically. Both of the main courses were very well taught and had very interesting subject matter. I had many interesting conversations with students, post docs, and professors, some of which led directly to progress in my research. I started working on a new project with one of the students I met here, and we plan to continue collaborating in the future. I learned about several areas that are very appealing to work on in the future."
- "Great opportunity for young researchers: practice presentation, learn from others and socialize with others."
- "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."
- "[A highlight was] being able to meet so many other young mathematicians. I saw so many opportunities for future collaborations."

- "… the experience of learning … totally amazed me and fed a sense of beauty and wonder. … This course has been amazing."
- "I had several important conversations with important researchers in my field … who expanded my thinking… I could not ask for more!"
- "Seeing the breadth of undergraduate student research in the varying topics in Mathematics [was a highlight]. This conference is inspiring and eye-opening to the different fields and possibilities in Mathematics."
- "I appreciate from the bottom of my heart the opportunity… to attend… As a graduate student my goal was to learn the concepts… But [the] instructors have taken us to another level… having received hands-on experience on applying them to real data sets…"
- "Great event, with multiple opportunities to learn interesting material. Opened the way for possible future collaborations."
- "The organizers put together a truly brilliant program that gave the participants a broad and varied look at many topics in the field. A truly wonderful week."
- "I'm writing to thank you so much for making the amazing NLO workshop possible. I was blown away by everything."
- "Spectacular survey … outlining a number of interesting research directions that will help my PhD student."
- "(1) Met some professors from some prestigious universities. (2) Will have some potential collaboration with these professors in the future. (3) Had some insightful conversations with professors."
- "Unexpected interactions between several distinct areas of mathematics."
- "Diversity was the gold card there. So much [sic] different fields explored. It was interesting on every level."
- "The set-up of the workshop was excellent. 4 days was the perfect length of time… Also, all of the speakers were great and the organizers were approachable and friendly. Overall, an excellent workshop."
- "A great experience as the first experience for an undergraduate student can be."
- "…it helped expand my horizons and understand the mathematical community. I was intimidated but thoroughly enjoyed the experience! It was great…"
- "The meeting was terrific. I found the scientific content to be top-notch with an appropriate range of related topics. The time available to discuss the science as a group … was unique among the meetings I normally attend ... an important initiative for the advancement of science. ... It would be very exciting to build on this."
- "This is the most amazing conference I have ever ben to."
- "The workshop has exceeded my expectations. The program was carefully thought out, balanced current results with some background material and was of exceptionally high level altogether. A mixture of current results and recent work were reported which informed me and broadened my understanding of the current state of the field. I returned home inspired by the great mathematics I have learned."
- "… the diversity of the problems was a real bonus for me. High resolution photon measurement, to airplane design, to iron furnaces, to seismic imaging. All very diverse, yet making important use of mathematics."
- "The workshop was really excellent, with a focus that was narrow enough to provide real opportunities for research synergy but broad enough that one was not seeing 'the same people, one always sees.'"
- "The talks were wonderful and thought provoking. I am still working on some problems I learned at the meeting."
- "This workshop gave a clear view of state-of-the-art of the modeling and the numerical point[s] of view. … I was looking for something like that for years and now I feel confident about [what I] should do in terms of research. … It was one of the workshop[s] that I liked most in all my 25 years of scientific career, I learned a lot."
- "Great to have both academics and industry researchers attending, and presenting talks."
- "An unforgettable experience."
- "The most valuable aspect was getting to do group collaboration and to see what working for a company is like. It helped give me clearer direction for the future."
- "It is so hard for mathematicians and physicists to communicate. This effort is to be commended."
- "…the quality of the talks was, in general, very high. What's more, [this conference] is attracting many international participants while still highlighting Canadian involvement in the community."
- "Perhaps it's cliché, but this will be one of the defining moments in my life, probably. It was an amazing conference, in a wonderful locale, with stellar organization, and featuring amazing talks by both students and professors."

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, industrial and selected educational and '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. We also break down the Canadian participants by province.

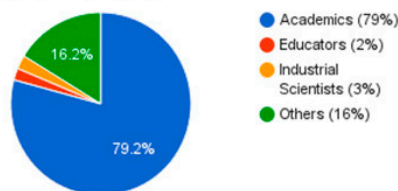In what follows, data from the two previous years are in brackets.

During the 2015 [2014/2013] reporting period, PIMS helped to support 94 [89/96] scientific activities of the types listed above. We have data on 80 activities—a substantial 85% return rate (Compare the 62% response rate for the Math and Physical Sciences Directorate of NSF in 2011). Of these,

- The total number of attendees: 5,914 [6,733/8,125]
- Attendee-days spent at PIMS activities: 27,188 [23,380/25,113]
- Average attendees/activity: 63 [76/92]
- Average attendee-days/activity: 289 [263/285]
- Average activity duration (days): 5 [3.2/3.3]

Of all identifiable attendees,

- 79% [66/60]% were academics, of which:
  - ➢ 38% [38/37]% were professors,
  - ➢ 8% [14/9]% were PDFs,
  - ➢ 37% [36/48]% were graduate students,
  - ➢ 11% [7/4]% were undergraduate students and
  - ➢ 6% [4/1]% were other academics.
- 2% [16/1]% were educators,
- 3% [9/4]% were industrial and
- 16% [8/34]% were others (this includes programs aimed at secondary and elementary school students)

Attendee Demographics — Academics (79%), Educators (2%), Industrial Scientists (3%), Others (16%); 16.2%, 79.2%

Academic Attendee Demographics — Undergraduate Students (11%), Graduate Students (37%), Post Doctoral Fellows (8%), Professors (38%), Others (6%); 37.7%, 36.9%
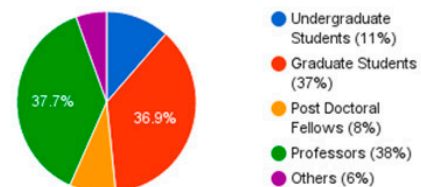
Many respondents also supplied their fields of expertise. They consisted of:

- 36% pure mathematicians
- 20% applied mathematicians
- 3% biological scientists

- 7% computer scientists
- 16% physical sciences and engineering
- 14% statisticians
- 4% others.

Subject Area

- Math (Pure) (36%)
- Math (Applied) (20%)
- Biological Science (3%)
- Computer Science (7%)
- Physical Sciences and Engineering (16%)
- Statistics (14%)
- Other (4%)

Attendee Gender Demographics

- Female (28%)
- Male (72%)

Of those attendees who stated their gender,
- 72% [77/76]% were male, and
- 28% [23/24]% were female.
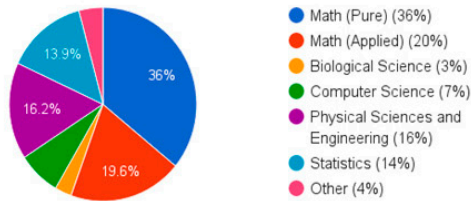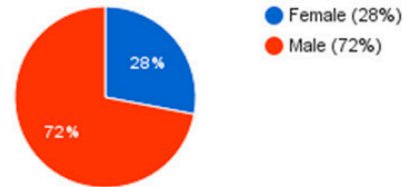
Also,
- 79% [70/72]% were from **Canadian** institutions, of which:
  - 55% [63/50]% were from British Columbia,
  - 31% [23/16]% were from Alberta,
  - 3% [2/1]% were from Saskatchewan,
  - 1% [0.5/1]% were from Manitoba,
  - 8% [11/17]% were from Ontario and Quebec, and
  - 2% [0.5/3]% were from the Atlantic Provinces.
- 12% [21/13]% were from other **North American** institutions, and
- 9% [9/15]% were from **elsewhere**.

We also computed the geographical distribution of PIMS events and programs, including Lecture & Seminar Series. Of the activities with well-defined geographic locations,
- 88% [92 /85]/88] were held in **Canada**, of which:
  - 49% [56/60]% were held in British Columbia,
  - 32% [20/23]% were held in Alberta,
  - 10% [10/4]% were held in Saskatchewan,
  - 3% [1/4]% were held in the Atlantic Provinces,
  - 6% [8/9]% were held in Quebec, Ontario and Manitoba,
- 10% [10/10]% were held in the **United States** (5 events in Washington, 1 in Oregon, 1 in California),
- 2% [3/5]% were held **elsewhere**.

Note that some programs such as CRGs are spread over several provinces and states.

I. Publications

PIMS CRG activities, PDFs and CNRS researchers produced almost 205 publications in 2015. Over the years, many of these appeared in top journals, such as the *Ann. Math., SIAM J. Math. Anal., Math. Proc. Cambridge Phil. Soc., J. Algebra, Commun. Pure Appl. Anal., Phys. Rev., Quart. J. Math., Acta Arith., Adv. Appl. Math., Int. J. Math., J. Amer. Chem. Soc., Compositio Math., J. Comp. Anal., Commun. Math. Sci., SIAM J. Num. Anal., Trans. A.M.S., Int. Math. Res. Not., Comm. Math. Phys., J. Funct. Anal., Nature, Math. Annalen, J. Math. Bio., J. Geom. Anal., Amer. Naturalist, Indiana U. Math. J., Arch. Rational Mechanics Anal., Inventiones Mathematicae, Ramanujan J., Commun. PDE, Biophys. Adv. Math., J. Proc. Nat. Acad. Sci. (USA)*, and the *Duke Math. J.*. A list is at: *www.pims.math.ca/resources/publications/pims-scientific-publication-lists*.

2. TRAINING OF HIGHLY QUALIFIED PERSONNEL (HQP)

A. Postdoctoral Fellows & CNRS/PIMS Scientists

PIMS has created a large number of postdoctoral opportunities for young researchers in the mathematical sciences. The regular PIMS Postdoctoral Fellow 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 CRGs, the PTCS, and/or Focus Periods; these go through the same rigorous review process. Candidates must be nominated by a scientist or group of scientists affiliated with PIMS. The two-year fellowships are tenable at any one of the member or affiliated universities. In 2015 (2014) PIMS supported 50 (40) PDFs, distributed as follows: SFU – 6, UA – 11, UBC – 8, UBC-O – 1, UC – 6, UL – 3, UR – 3, US – 4, UV – 4, and UW – 4. For a list of all PDF appointments, see: *www.pims.math.ca/scientific/postdoctoral/postdoctoral-fellowships*.

PIMS PDFs are closely mentored by sponsoring faculty at PIMS host institutions. In the case of CRG, PTCS 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 2015 (2014) PDFs gave to selected questions are listed in the following table (1 = worst score, 5 = best score).

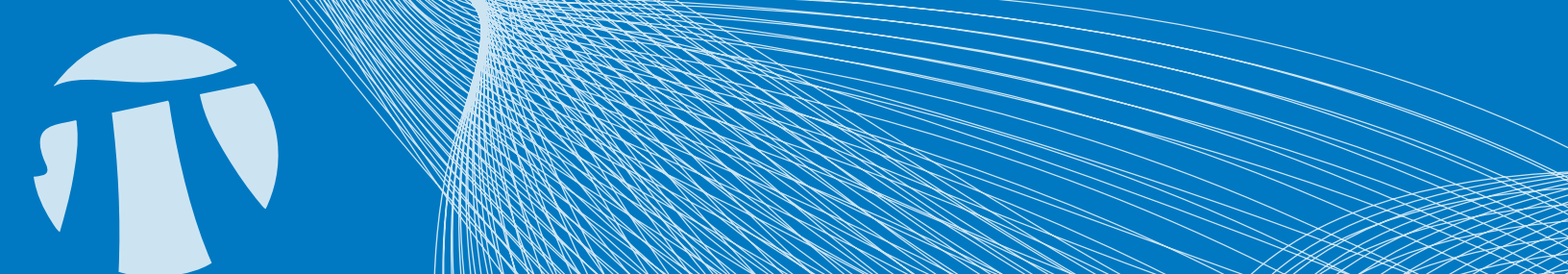| PDF Survey	Score
How well were you mentored in your department?	4.2 (4.4)
How suited to your academic interests was your department?	3.9 (4.0)
How suited to your academic interests was your mentor?	4.6 (4.2)
How was the intellectual life in your department?	3.9 (3.8)
How well were you looked after (in a practical sense) in your department?	4.4 (4.4)
Were there opportunities for collaborative interactions?	3.6 (3.8)
Amount of travel support:	2.7 (3.0)
Do you feel that your PIMS PDF has prepared you for your professional career?	4.1 (4.4)
Overall satisfaction with your postdoctoral experience:	4.4 (4.5)

PDFs move on professionally to a range of positions and activities at top places, including: Johns Hopkins U, City U Hong Kong, McGill U, Haverford College, Lancaster U (England), U Paul Cézanne (Aix-Marseille, Germany), UW, Charles U (Prague), Hong Kong U of Science and Technology, US, U Algarve (Faro, Portugal), U Waterloo, U Chile (Santiago), U Pittsburgh, Champlain College (QC), UCLA, Max Planck Institute for Informatics (Saarbrücken), U Massachusetts (Amherst & Boston), UC, Brno U of Technology (Czech Republic), U B. Pascal de Clermont-Ferrand (France), Oakland U, U Ottawa, Harvard U, Indian Institute of Science Education and Research (Kolkata), McMaster U, U Frankfurt, Nova Southeastern U, U Utrecht (Netherlands), Rice U, Atomic Energy Canada, Ltd., Western Washington U, U Newcastle (Australia), Columbia U, U Paris Diderot, INRIA Bordeaux Sud Ouest & Rennes (France), Princeton U, Nat. Acad. Sci. (Ukraine), U Toronto, École normale supérieure (Paris), U California (Berkeley), U Karlova v Praze (Prague, Czech Republic), U Kentucky, Laboratoire Écologie et Sciences Phytosanitaires (Rennes, France), Purdue U, SAP AG (Walldorf, Germany), Zhejiang Sci-Tech U (China), Victoria U (Wellington, NZ), U Gottingen (Germany), UA, Royal Institute of Technology, (Stockholm), MSRI, U Warsaw, École Polytechnique (Palaiseau, France), U London (UK), University of Zurich, U N. Carolina (Chapel Hill), Institut Joseph Fourier (Grenoble, France), Carnegie-Mellon U, Austrian Acad. Sci., Munich American Reassurance Company (WA), Institute for Advanced Study, CNRS (Montpellier, France), UBC, Max Planck Institute for Mathematics (Bonn), U Oregon, Ben-Gurion U, UR, École Polytechnique Federal Lausanne (Switzerland), U Mississippi, Moscow State U (Russia), Southern Illinois U, Hausdorff Ctr. (Bonn), D-Wave Systems (Calgary), Hong Kong Polytechnic U and Cambridge U.

At UBC, the PIMS PDFS are looked after intellectually, professionally, and socially. As well, PIMS Central holds yearly one-day workshops on professional development topics such as *Information Session on Grant Opportunities* and *Postdoc/Grad Student Job Forum*, and the PIMS workshops include discussions on "Postdoctoral life in different kinds of institutions—research, teaching and industrial." PIMS also hosts various social activities so as to reduce postdoc isolation and promote formation of long-term friendships and contacts.

Some verbatim comments from PDF exit interviews:

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

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

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

➢ "Working with members of the university was a joyful experience. I learned a lot and had a wonderful time both at work and social life. I consider this opportunity as a great help to advance my career."

➢ "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 very well with my mentor, 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."

➢ "I would like to thank PIMS for giving me this opportunity. I had an enjoyable and productive time … I sincerely hope that the PIMS PDF program continues for years and keeps giving opportunities to young researchers."

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

➢ "I learned new mathematics and became a more mature and independent mathematician. I am grateful to PIMS for this wonderful opportunity."

➢ "…my postdoc experience was an essential factor in obtaining this job. I am very grateful to PIMS for its program and the possibilities I was given in terms of collaborations, working conditions and excellent network. I would also like to emphasize the role of my supervisors who were extremely supporting and helped me a lot during those two years."

➢ "I have to say that overall I had a very good opportunity to collaborate with the people here at PIMS."

> ➤ "I was definitely very happy about my PIMs postdoc and managed to find several long term projects to work on."
> ➤ "… the staff at PIMS made the experience a most enjoyable one."

PIMS also hosts more senior researchers from France as part of its cooperative agreement with the CNRS. In 2015 N. Billerey (UBC, U B. Pascal - Clermont-Ferrand II), S. Le Coz (UBC, U Toulouse), G. Charlier (UV, Ceremade-Dauphine), E. Fusy (UBC, LIX - École Polytechnique - Palaiseau) and K. Raschel (SFU, U Tours) took part in this program.

In addition to PDFs and PIMS/CNRS scientists, PIMS sites host many long- and short-term visitors: over 199 in 2015 alone. They came from around the world, including Japan, India, Russia, China, Israel, Korea, New Zealand, Chile, Brazil, Hong Kong, Europe and of course North America.

B. PIMS Postdoctoral Training Centre in Stochastics

In 2015 PIMS launched the *Postdoctoral Training Centre in Stochastics* (PTCS), headed by E. Perkins (UBC). PIMS has world-class groups in probability theory and its applications, and these groups have an excellent track record of postdoctoral supervision and placement. These groups have joined forces through the new PTCS to train an outstanding cadre of postdoctoral fellows in probability theory. The program has attracted $550,000 in NSF funds for our UW site, in addition to the support from the Province of Alberta, and has already hired 5 PDFs. As part of the PTCS networking activities across Canada, PIMS supported a probability summer school at the CRM in Montreal. A summer school in Mathematical Finance at UA will take place in 2016. Further networking between PIMS sites and the Theory Group at Microsoft Research, as well as stochastic groups in Eastern Canada, will continue in 2016.

The First Annual PTCS Retreat was held September 18-20 at BIRS. It was attended by ten young researchers and seven supervising faculty. The purpose of the meeting was to enable the PDFs in the program, supervising faculty and other senior graduate students to get acquainted with each other, as well as to give the young researchers an opportunity to present their recent work to the Western Canadian probability community. Four of the five PDFs in the PTCS inaugural class attended, as did six senior PhD students from UA, UC, UBC and UW. There was a healthy mix between the latest developments in probability theory in such areas as the Brownian map, heavy tailed random walks on graphs and stochastic partial differential equations on one hand, and a number of applied modelling results in energy pricing, filtering equations and big data parameter estimation on the other. The tone of the meeting was informal with an open problems session generating discussion that extended into the evening. For example, a problem posed by UBC student B. Kolesnik, on coexistence for a pair of annihilating branching random walks, led to continued discussion with many participants and an ongoing project with Kolesnik, O. Angel and N. Berestycki.

3. EDUCATIONAL

A. K-12 Educational Activities:

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

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

1. General

Math Mania: This is a popular alternative math education event that has been presented in elementary and (more recently) middle schools in Western Canada for many years. All age levels are welcome, although it is particularly suited to students in grades 4-7. Math Mania presents a variety of interactive demonstrations, puzzles, games and art. These activities are designed to demonstrate to students – and their parents – fun ways of learning both math and computer science concepts. On average over two hundred students, parents and teachers participate in Math Mania events. In 2015 Math Manias were held in the community of Sooke on Vancouver Island, as well as around the greater Victoria area, Kamloops and Lytton in the interior of B.C, the Lower Mainland and Saskatoon. Further details are available at *www.pims.math.ca/educational/math-mania*.

One BC school principal wrote: "… a great evening! You don't know how much this means to our students and parents. I heard so many positive comments from parents and it was amazing how thrilled they were that we were doing this for the kids. Many of them had never looked at math as being very fun or exciting... Hopefully this will inspire them to take a real interest in math and develop a greater appreciation for its application to everyday life."
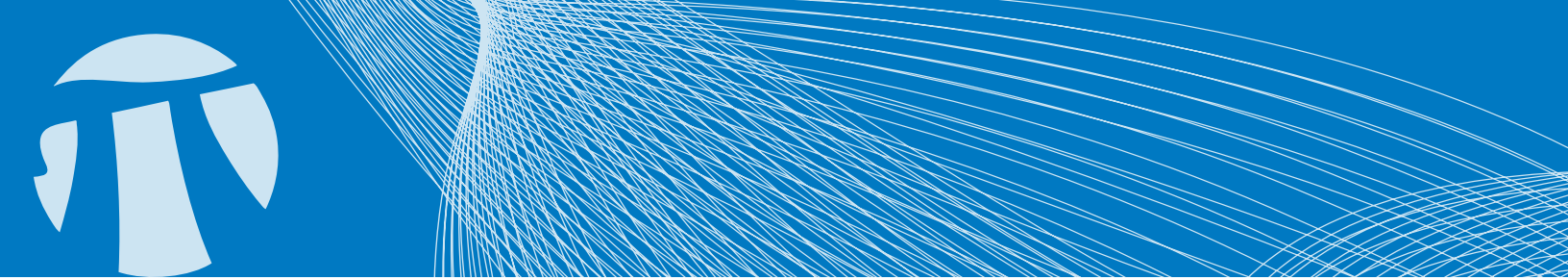
SNAP Math Fairs: PIMS sponsors these non-traditional **S**tudent-centered, **N**on-competitive, **A**ll-inclusive, and **P**roblem-based math fairs based in Alberta. The purpose of a SNAP math fair is to provide a meaningful problem-solving experience for all students. Several SNAP fairs were held in Okanagan and the Lower Mainland this past year. Visit *www.mathfair.com* for more information.

ELMACON: The **El**ementary **Ma**thematics **Con**test is a yearly event held at either UBC or 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 attracted about 343 participants in 2015, the largest turnout in ten years!

UBC/PIMS Math Workshops: These workshops in Lower Mainland schools aim to excite Grade 6-12 students about mathematics by exposing them to interesting and challenging problems and interesting mathematics personalities. In the case of Grade 12 students, careers and university programs in the mathematical sciences are also discussed. The workshops are conducted by faculty and student volunteers from the UBC Mathematics Department, and are coordinated by the PIMS-BC Education Coordinator. Over 90 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. Fourteen workshops to teach problem solving were held all around the province. Twelve additional workshops to support the teaching of JUMP math were held at PIMS-UBC and around the province. A new program, run in Vancouver this year, was a summer school for in-service teachers (see below). This was attended by 20 teachers and received very positive feedback.

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.

At UL, weekly problem-solving sessions for high school students called **Fun with Math** were instituted the 2012-2013 academic year.

Pi in the Sky: The widely distributed (estimated circulation is 1,700) high school level periodical produced by PIMS for students in Canada and the United States, aims to establish direct contact with teachers and students, to involve high school students in mathematical activities, as well as to promote careers in mathematical sciences. Go to *www.pims.math.ca/resources/ publications/pi-sky* for current and back issues.

Math Central: Beginning its 20th year, Math Central (*www.mathcentral.uregina.ca*) continues to be a successful tool for teachers. The site currently gets in excess of eight million hits per month from approximately 30,000 visitors per day. Math Central attracts answer submissions from keen mathematicians from all over the world including Italy, Romania, Turkey and Indonesia. It contains a number of services including the Resource Room, a facility where mathematics educators can store and retrieve resources on mathematics and the teaching thereof; Quandaries and Queries, a mathematics question and answer service; Math Beyond School which is a response to the question often asked by students, "When will I ever use this?"; Mathematics with a Human Face which profiles mathematicians and their careers and more. The site is maintained by PIMS Education Coordinator Harley Weston and faculty and students in the Mathematics and Statistics and Mathematics Education Departments of UR.

In addition, PIMS supports the **Alberta High School Mathematics Competition**, **Math Circles Coaching Program**, the **Vancouver Free Math Mentorship Program**, the **BC Math Challengers**, the **Mt. Doug Challenger Program**, the **Forever Annual Math Exhibition**, **Jump for Math**, the **Math Kangaroo Contest**, **Science Fairs** in Vancouver and Calgary and the **No Homework Club**, along with other local initiatives.

2. Aboriginal/First Nations

PIMS has shown its leadership in bringing together various people, resources and institutions in working towards the improvement of aboriginal mathematics education. In particular, under the auspices of the First Nations Education Steering Committee (FNESC), PIMS has developed a partnership with First Nations schools in British Columbia, which has received funding from private donors, Vancouver City, the Vancouver Foundation, the Kinder Foundation as well as provincial and federal agencies. In 2014 special funding for these programs was received from the Governments of British Columbia, Alberta and Saskatchewan. All these monies fund the activities listed below.

The Aboriginal Mathematics K-12 Symposium brings teachers, students, parents, administrators and academics together at UBC to explore and imagine ways of improving mathematics education for Aboriginal learners. This event is sponsored by PIMS, the Actuarial Society of Canada, NITEP, and Indigenous Education at UBC. PIMS has sponsored the Symposium since the first one in 2010. In 2015, 137 people attended.

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

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

Math summer camps, which PIMS has organized in Kamloops, Lytton, Merritt, Sooke, Duncan and Mount Currie for the past seven years. More than 200 children have attended these camps. This summer, 27 First Nations students in grades 10-12 attended the 5 week long SFU *Academic Summer Camp for Aboriginal Students* run jointly by PIMS, the SFU Faculty of Science, the SFU Office for Aboriginal Peoples, the IRMACS Centre, and the SFU Department of Mathematics. The

NSERC PromoScience Program provides partial financial support for the camp. As part of these camps, students took math and English classes each morning and in the afternoons they attended a variety of scientific, mathematical and cultural activities.

Academic Highlights: Ten of the students who attended Emerging Aboriginal Scholars camps, the SFU Academic Summer Camp for Aboriginal Students and the Mentorship Program in 2015 graduated from high school and were accepted to UBC or SFU.

Since 2007 scholarships have been provided to more than 70 students attending Britannia, Templeton, and Win-dermere high schools. Money for the scholarships was provided by private donors, the government of British Columbia and the Federal Government. Our programs have helped students move from the lower level math courses according to their grade.

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.

School partnerships: During the last six years, PIMS has developed a partnership with the Britannia, Templeton, Windermere and Point Grey secondary schools and the MacDonald elementary school in Vancouver, which have large numbers of aboriginal students. In recent summers PIMS organized a math summer camp for a group of these students. Together with the math department at UBC, PIMS has been coordinating mentorship programs at several elementary schools in Vancouver. PIMS is also coordinating a scholarship program to support the more needy of their aboriginal students. This program has been funded both by the federal government and private donors.
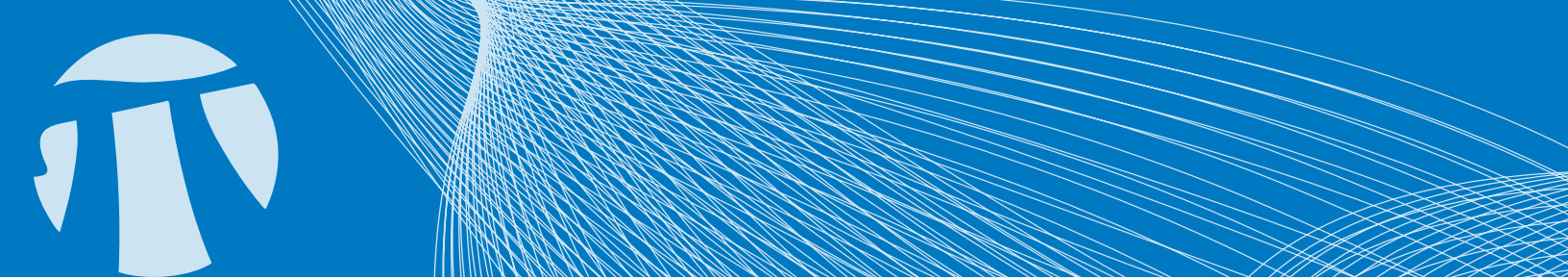
Aboriginal Perspectives: In Saskatchewan, PIMS supports the web site *AboriginalPerspectives.uregina.ca*, which serves as a means for delivering lesson ideas with an Aboriginal focus to K-12 teachers. Support from PIMS has been used to help hire the students who write the lessons and facilitate the workshops. PIMS also partially funds the ongoing *Aboriginal Perspectives Workshop*. S. Stavrou, PIMS' outreach coordinator at US, is working in several schools in Saskatoon, engaging students in hands-on math activities that includes content from the curriculum and First Nations perspectives.

B. Teacher Workshops

Summer School for In-service Teachers: The reality is that many teachers, especially in elementary schools, do not have the necessary knowledge or experience to feel comfortable teaching mathematics. It is thus important to provide further mathematical support training to in-service teachers. To this end in 2015 we developed a 4-week summer school. We paid each participant a \$1,600 stipend and provided \$200 of resources upon completion of the program. The funding to support this school was provided by a private donor and the Actuarial Foundation of Canada.

Twenty teachers attended the program; they were selected by math faculty from SFU, the president of the British Columbia Association of Math Teachers (BCMAT), and the Education Coordinator for PIMS. Our goal was to create a team of teachers at each school that could foster a cultural and academic shift with respect to the learning and enjoyment of mathematics by:

- increasing teachers' capability, confidence and attitude with regard to math,
- educating teachers to strive for and expect success for all their students,
- incorporating meta-cognition strategies so that teachers will understand their own learning processes for math, as well as that of their students,
- making teachers the harbingers for institutional change by changing their attitude toward the teaching and learning of

math at their schools, where they could develop with our support a variety of mathematical activities.

The program focused on three main themes (geometry, number, pattern), and a broad range of topics were covered related to different grades. With regard to numeracy, for example, the focus was on the following: numeracy for practical purposes, for interpreting society, for personal organization and for knowledge.

According to evaluations, participants were generally quite enthusiastic about the summer school and expected it to be very useful in their teaching. We plan to make this a yearly event.

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 94 participants, and discussed "Building Thinking Class-rooms."
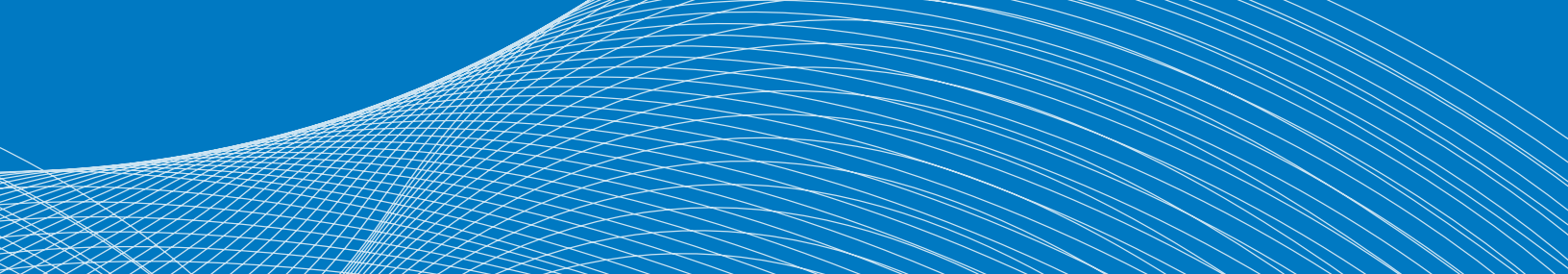
Teacher training/math development sessions: During this and past summers, mathematicians and educators provide lessons for teachers to help them assimilate teaching material for their mathematics courses. Sessions have been held in Kamloops, Lytton, Barriere, Port Alberni, Vernon and Merritt. Partner schools in the interior of British Columbia include: Stein Valley Nlakapamux School in Lytton, Neqweyqwelsten School in Barriere, First Nations elementary and secondary schools in Bella Bella, First Nations elementary school in Port Alberni, 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.

C. Post-Secondary Educational Activities

Colleges and universities wishing to enjoy an affiliation with PIMS (but not otherwise eligible for regular PIMS membership) may engage as *PIMS Education Associates*. Members are entitled to apply for PIMS funding to engage in appropriate education, outreach, and professional development activities in their region. Examples of approved activities are the support of a guest speaker, support for a regional math competition and for the purchase of mathematical models and demonstration materials for use in the classroom. Currently 10 colleges in BC and 4 in Alberta are PIMS Education Associates: Okanagan College (BC), U of the Fraser Valley (BC), Langara College (BC), Red Deer College (AB), Thompson Rivers U (BC), Concordia College (AB), Douglas College (BC), Grant McEwan U (AB), Mount Royal U (AB), Capilano U (BC), Selkirk College (BC), College of the Rockies (BC), Vancouver Island U (BC) and Camosun College (BC). PIMS hopes to enroll still more Education Associates in 2016.

PIMS directly sponsors high-level undergraduate activities such as the *Canadian Undergraduate Mathematics Conference* and the *Canadian Undergraduate Computer Science Conference*, the *PIMS-NSF Undergraduate Workshop in Supersymmetry* and the *PIMS-SFU Undergraduate Summer School in Scientific Computing on Curved Surfaces*, and sponsors series of public lectures such as the *PIMS Public Lecture Series* at UBC and the *R&L Guy Public Lecture* at UC. In addition, PIMS provides travel support for Canadian students to attend various educational activities, e.g., the *MMIW* and the *Pacific Northwest Probability Seminar*. PIMS also uses its facilities for teaching: in 2015 PIMS-UBC hosted a topology course, numerous seminar series in mathematics, earth sciences and statistics, as well as candidacy and thesis exams.

PIMS sponsors the annual *Alberta Mathematics Dialogue*, which provides a forum for a discussion of issues relating to mathematical education at all levels throughout the conference. This year it was held at UL. Another worthwhile educational event PIMS is supporting is *The Emerging Mathematics Instructors Workshop*. This new activity aims to gather graduate students from Manitoba and Saskatchewan who are interested in issues of teaching and learning, and who plan to take post-secondary teaching positions. Speakers from the Universities of Manitoba, Regina and Winnipeg will share ideas on everything from technology in the classroom to issues of academic integrity. There will also be guest speakers from UM's Centre for the Advancement of Teaching and Learning.

Every year the *PIMS Education Prize* is awarded to an outstanding mathematical educator in Alberta, British Columbia, Manitoba, Saskatchewan or Washington State. A cash award is attached to the prize, which has considerable prestige, and receives widespread publicity in the mathematical community and beyond. See *www.pims.math.ca/pims-glance/prizes-awards* for details about past prizewinners.

Seven of our ten BC PIMS Associates participated in the BC Secondary School Mathematics Contest (BCSSMC). There are two rounds held at each of two levels, grades 8-10 and grades 11-12. The Preliminary Round is held within the students' own schools. About 1300 juniors and 750 seniors participated. The Final Round is held with the top performers (and a teacher) spending a day at a regional college or university and involves several activities and lunch. On May 1, 2015 the Final Round of the BCSSMC was written at 10 provincial colleges and universities throughout the province. Similarly PIMS supports the Alberta High School Mathematics Competition.

Two institutions, Camosun and Okanagan, hosted the BC Math Challengers event in February. This is a half-day competition with both written and face-off elements to it. Math Challengers is sponsored by the provincial engineers' association, APEGBC. Three of our Associates, Douglas College, U of the Fraser Valley and Thompson Rivers U, presented *Math Mania* events at local elementary schools. Other outreach events included celebration of Pi Day (3/14), Math Fair style events (Capilano U and Langara College) as well as many classroom visits by most of our PIMS Associate partners.

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, as well as the global scientific community that PIMS has given thought and priority to communicating with them.
- Place education as a top priority in terms of gathering funding, program organization and awareness-raising.
- Build the PIMS community through regular, consistent and targeted formal and informal communications.

Key messages:
- PIMS is a leading mathematical institute in North America, with worldwide influence on research and industry. It has established innovative programs that 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 Aboriginal backgrounds. PIMS promotes numeracy as an integral part of development and learning.

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

Tools:
- Websites and electronic
  - **PIMS website** The PIMS website (*www.pims.math.ca*) offers easy global access to information on all PIMS activities, recent news and resources. One feature is the PIMS News/Press section that is highlighted on the home page; stakeholders can easily access the most current and noteworthy happenings at PIMS via this section, be they award notices, media coverage, funding announcements or site appointment updates.
  - **Mathtube.org** A dedicated site that will eventually archive all of PIMS written, video and audio media. *mathtube.org* was created to meet the increasing demand to see footage of past PIMS lectures. It provides global exposure to PIMS events and gives those who attend our events the chance to review and those who don't, a chance to see what they've missed. This resource also gives added value to conference organizers and participants, as well as a forum to see world-class speakers from all areas

of the mathematical sciences. These materials are an important resource and include contributions from some of the world's most distinguished contemporary mathematicians. mathtube.org is for those interested and engaged in the mathematical sciences; whether one is a student, a researcher, an industry professional or a mathematics teacher, *mathtube.org* includes useful content that will help advance one in their field.

➢ **PIMS Connection, monthly e-newsletter,** was introduced in 2011. This brief email includes links to upcoming events, updates and news items. Its circulation is over 3,500. In 2014, PIMS switched from a purely text-based format, to one that used an online resource (Mailchimp), which allows us to utilize a more brand-savvy digital template, and track the number of opens and link clicks.

➢ **Social Media** in 2012, PIMS began using Twitter and Facebook allowing us to connect with and provide all of our updates and news to the PIMS community. These posts are far more frequent than to any other of our communications vehicles and cover a range of content from event photo highlights, notices of publication availability, weekly event updates and more. (The same content is provided on both Twitter and Facebook.)

▪ **Hardcopy publications**

➢ **Year in Review** is a booklet designed to summarize the range of PIMS activities. The 2009–2014 Years in Review can be downloaded from *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 *www.pims.math.ca/resources/publications/pims-newsletter*. It has a circulation of 800 hardcopy issues. The latest issue (October 2014) was also sent out via Mailchimp in electronic format to a list of over 1,000 recipients.

➢ **Pi in the Sky** is primarily aimed at high-school students and teachers, with the main goal of providing a cultural landscape for mathematics. It has a natural extension to junior high school students and undergraduates, with articles that put curriculum topics in a different context. *Pi in the Sky* accepts material on any subject related to mathematics and its applications, including: articles, problems, cartoons, statements, jokes, etc. Pi in the Sky is produced once a year and mailed to various institutes and private subscriptions throughout Canada and the world (estimated circulation is 1,700) and can be downloaded from the PIMS website: *www.pims.math.ca/resources/publications/pi-sky*.

▪ **Other**

➢ **Advertising** PIMS-funded events and opportunities are advertised both electronically and in print. We advertise through websites and publications at institutions such as AMS, CMS, IMS and SIAM and by offering custom-designed event posters that are distributed to the major mathematical departments and institutes in Canada and the US, as well as an annual poster highlighting all of PIMS main events for the year, which is 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 format. (See *www.pims.math.ca*). Conference materials are attached to the corresponding event, which are listed chronologically and are searchable by keyword for ease of access. PIMS also produces an annual report that is sent to sponsors, administrators at PIMS-affiliated universities, representatives from the business, industry and resource sectors as well as the major professional societies. Past annual reports (1997-2014) can be viewed at *www.pims.math.ca/resources/publications/annual-reports*.

2. AUDIO/VIDEO FACILITIES

PIMS makes extensive use of technology to allow our event coordinators to work efficiently with remote collaborators and event participants. In 2015 we continued expanding in this regard, augmenting internal PIMS projects such as mathtube.org with new software. In the coming year, we expect to expand our technological offerings further after entering into an agreement with UBC to provide automated lecture capture and broadcasting facilities at PIMS-UBC.

Seminars and Lectures:

Seminar organizers at PIMS are offered the ability to include remote participants by picking from a wide variety of technologies. In addition to operating traditional h.323-based videocon-ferencing systems we integrate software solutions such as Skype and BlueJeans and Vidyo, to provide as low a barrier to participation as possible.

> ➤ As the UBC-Vancouver WestGrid/Compute-Canada collaboration node, PIMS-UBC participates in the WestGrid and Coast-to-Coast seminar series. The latter includes participants from through-out Canada and 2015 saw two series being run. The first was on "The Power of Linked Administrative Health Data for Population Health Research" and the second was on "Foundations and Applications of Big Data." PIMS-UBC hosted many of the speakers for these events. Historically, these seminars have been valuable to PIMS by bringing PIMS researchers into contact with a wide variety of external groups and offering an opportunity to showcase PIMS at the same time.

> ➤ In the winter term of 2015, PIMS sites are participating in a shared seminar series as part of the PIMS CRG in Explicit Methods for Abelian Varieties. This seminar series is conducted over Blue-jeans with participants and speakers coming from PIMS sites such as SFU and UW. These seminars are recorded and posted to our mathtube.org site. Earlier in 2015, we also concluded a successful video seminar series between UBC and UA in Geometry and Physics.

Academic Courses:

> ➤ R. Jardine of U Western Ontario is conducting a course during the winter term. It includes students from Western and UBC.

> ➤ D. Rolfsen of UBC provided a course in Topology to students at UBC in the fall of 2015. The for-mat of the course was a mix of in-person and electronic sessions. This flexible structure was essen-tial to accommodate the schedules of the participants, and the course would not have been possible otherwise.

Other Uses:

> ➤ The PIMS education coordinators held a virtual meeting to give program updates and to share techniques and best practices. This meeting was deemed so successful that it is expected to become a regularly scheduled event within PIMS.

> ➤ As in previous years our facilities were used to allow researchers to take care of academic duties such as participating in thesis defenses or academic job interviews.

IV. ACTIVITIES TO KEEP ABREAST OF SCIENTIFIC ADVANCES

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

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

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

PIMS CTRMS NSERC Activity Report January 1 to December 31 2015

Resource Expenditures	Use of the resource (i.e. PIMS) Paid from ALL revenue sources January 1 to December 31 2015	Planned use of CTRMS funds Jan 1 to March 31 2016	Planned use of CTRMS funds April 1 2016 - March 31 2017
1) Salaries & Benefits			
a) Administrative Staff	284,305	0	0
b) Directors & Site Directors Teaching Releases/Stipends	123,749	0	0
c) Scientific Support Personnel	303,734	46,500	75,000
d) Postdoctoral Fellows (inc. CRG PDFs)	448,372	103,000	525,000
e) Technical/Professional Assistants (inc. Education)	13,461	0	0
f) Graduate Students	115,000	0	0
2) Equipment or Facility			
a) Purchase or Rental	22,566	0	0
b) Operation and Maintenance Costs	27,617	0	0
3) Materials & Supplies			
a) Refreshments	6,181	0	0
b) Office Supplies	16,248	0	0
4) Meetings/Collaborations/Staff Travel			
a) PIMS Meetings (SRP, PDF, Board, Admin, Exec)	38,893	0	0
b) Staff/PDF Travel	17,862	0	0
c) Director Research Support and Scientific Consultation	36,034	0	0
5) Dissemination Costs			
a) Publication Costs	13,826	0	0
b) Advertising & Networking	3,007	0	0
6) Scientific Activities (inc. CRGs and IGTC)			
a) Conferences/Symposia	203,609	5,000	100,000
b) Summer Schools	88,626	0	60,000
c) Workshops/Seminars/Colloquia (inc. MMIW)	279,379	30,000	120,500
d) Distinguished Visitors/Chairs/Speakers	37,125	8,000	20,000
7) Education Initatives	199,777	0	0
8) AARMS Activities			
a) AARMS Summer School	20,000	0	40,000
b) International Symposium on Statistics	6,300	0	0
c) Special Sessions at CMS Summer Meeting	12,648	0	0
d) Administrative Staff	8,052	0	0
e) Environmental Symposium & Graduate Prizes in Algebra	3,000	0	0
9) CANSSI			
a) Scientific Meetings	27,537	0	220,000
b) Scientific Coordinator	49,977	12,494.00	
c) Postdoctoral Fellow	23,751	5,938.00	
d) Research Assistant	30,189	4,500.00	
TOTAL EXPENDITURES	2,460,825	215,432	1,160,500

Resource Revenues *(collected during the period January 1 to December 31 2015)*

a)	User Fees (Registration Fees collected)		38,213
b)	Contributions from Partner Universities		
		UBC	329,945
		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	13,639
		University of Lethbridge	35,000
		University of Manitoba	50,000
		Portland State University	5,153
c)	Contributions from MITACS/NSF		
		NSF for Topology Events	69,537
		Mitacs Industrial Innovation	50,000
d)	AIAE (Alberta Government)		575,000
e)	Private Donations		27,800
f)	Other Contributions		
		Light Integra for Frontiers in Biophysics	500
		Bruker BioSpin Corp for Frontiers in Biophysics	601
		UVic Math/Stats for Algebraic Topology & HDDA	800
		SFU Stats Dept for Statistical Inference	5,000
		SFU VP Research for Statistical Inference	3,500
		UBC Various Depts	11,844
		UBC various departments	3,611
		Other Miscellaneous	44,779
g)	NSERC Industrial Innovation Grant		182,000
h)	NSERC CTRMS Grant		1,171,000
i)	Carried Forward from December 31 2014		1,337,804

TOTAL REVENUES (January 1 to December 31 2015)   **4,332,736**

Revenue less Expenses   1,871,911

GLOSSARY OF ACRONYMS

PIMS	Pacific Institute for the Mathematical Sciences
AARMS	Atlantic Association of Research in the Mathematical Sciences
AMS	American Mathematical Society
BIRS	Banff International Research Station
CAIMS	Canadian Applied and Industrial Mathematics Society
CANSII	Canadian Statistical Sciences Institute
CMS	Canadian Mathematical Society
CNRS	Centre National de la Recherche Scientifique
CNTA	Canadian Number Theory Association
CRG	Collaborative Research Group
CRM	Centre de Recherches Mathématiques
IMA	Institute for Mathematics and its Applications
IPSW	Industrial Problem Solving Workshop
Mitacs	Mathematics of Information Technology and Complex Systems
MMIW	Mathematical Modeling in Industry Workshops
MSI	Mathematical Sciences Institute
MSRI	Mathematical Sciences Research Institute
NSERC	National Sciences and Engineering Research Council
PDF	Postdoctoral Fellow
PNRMS	Prairie Network for Research in the Mathematical Sciences
PRIMA	Pacific Rim Mathematical Association
PSU	Portland State University
PTCS	PIMS Postdoctoral Training Centre in Stochastics
SFU	Simon Fraser University
SFU-V	Simon Fraser University-Vancouver
SIAM	Society for Industrial and Applied Mathematics
SRP	Scientific Review Panel
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
WWU	Western Washington University