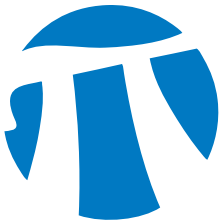

Pacific Institute *for the* Mathematical Sciences

Annual Report 2024

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ANNUAL PROGRESS REPORT

DIS-2022-568577

Pacific Institute for the Mathematical Sciences

January 1–December 31, 2024

HIGHLIGHTS

The France-Western Canada Workshop on Ocean and Polar Sciences

The Farnce-Western Canada Workshop on Ocean and Polar Sciences was a satellite event held over two days at the University of British Columbia. Organized by the Centre National de la Recherche Scientifique (CNRS), PIMS and the Consulate General of France in Vancouver, this workshop focused on quantitative approaches and analysis in this field. The main goal of the workshop was to identify shared research themes, to explore possibilities for new interactions, and to foster further cooperation between researchers in Canada and in France.

CRM-Fields-PIMS Prize

In 2024, Ram Murty from Queen's University was awarded the CRM-Fields-PIMS Prize, Canada's premiere award for mathematical research in Canada. The winner is invited to present a lecture at each institute or may choose to deliver a lecture in hybrid format at one of the institutes.

Joint Mathematics Meeting (JMM) Partnership

In late 2023, PIMS, along with the Centre de recherches mathématiques (CRM) and the Atlantic Association for research in Mathematical (AARMS) singed a joint long-term partnership agreement with the American Mathematical Society. The First CRM-PIMS- AARMS Invited address, given by Henri Darmon (McGill University) took place from January 3 to 6, 2024.

PIMS Partners with Distriq, the Quantum Innovation Zone of Quebec

In 2024, PIMS and Distriq, Quebec's Quantum Innovation Zone, signed an MOU to strengthen quantum science and mathematical research. This partnership links PIMS' Math to Power Industry (M2PI) program with Distriq's innovation ecosystem, fostering collaboration and excellence in quantum technologies and mathematics. Together, they aim to push the boundaries of both fields.

PIMS Education Prize

Assistant Teaching Professor Trefor Bazett from the Univer- sity of Victoria's Mathematics and Statistics department was awarded the 2024 PIMS Education Prize at the annual Changing the Culture con- ference on May 17, 2024. This prestigious prize hon- ors individuals who have significantly contributed to education in the mathematical sciences.

PIMS-Europe Fellowship Awards

University of Lethbridge Assistant Professor of Mathematics and Computer Science, Corina Birghila, was the recipient of the 2024 PIMS-Europe Fellowship Award.

WHAT'S NEW

PIMS Announces New Interim Co-Director International

In 2024, PIMS appointed Gabriel Paternain as Interim Co-Director International, effective July 1. A faculty member in the University of Washington's Department of Mathematics, Paternain holds a Licenciatura from Universidad de la República in Uruguay (1987) and a PhD from SUNY Stony Brook (1991). He became a Lecturer at the University of Cambridge in 2001 and a Professor in 2008, serving as Head of the Department of Pure Mathematics and Mathematical Statistics from 2014 to 2018. His research spans geometry, analysis, and dynamical systems.

PIMS Announces the Departure of Dr. Jayadev Athreya, Co-Director International

With mixed emotions, 2024 saw Dr. Jayadev Athreya step down as PIMS Co-Director, International. After serving as Interim Director from July 2021 to June 2022, he led a successful proposal to the Simons Foundation, securing funding for programs like PRIMA, the Institute Exchange Program, PIMS-BIRS Team Up, and the PIMS-Simons Postdoc program. Though we greatly miss his leadership, Dr. Athreya remains at PIMS as the University of Washington Site Director.

Collaborative Research Groups (CRG)

In 2024, PIMS started a new Collaborative Research Group: Structure-Preserving Discretizations and their Applications. Organized by professors at the University of Washington, Simon Fraser University, University of Saskatchewan, and University of California (Merced), this CRG brings together research specialists in structure-preserving discretizations to share their knowledge, expertise, and current challenges in their respective fields.

PIMS Resewarch Network (PRN)

The Maud Menten Insitute, which aims to provide a collaborative research platform for mathematical biologiest at PIMS sites was formed in 2024.

New Affiliate Member

In Spring 2024, First Nations University (FNUniv) became an Affiliate Member of PIMS. This partnership recognizes the valuable contributions Indigenous ways of knowing can bring to the mathematical sciences. It will enable PIMS to support Indigenous-led initiatives while providing FNUniv with access to enhanced funding opportunities and a wide array of education and outreach programs for K-12 students.

IMPACT OF RESEARCH ACTIVITIES

Creation, curation, sharing or reuse of data sets

- PIMS has been collecting demographic data for our postdoctoral competition since 2018.These data are specific to academic employment in the mathematical sciences, and broad enough to include more than one academic employer. Thus, we believe that the data can be used to give a snapshot of the population of early career researchers in the mathematical sciences.

Development of tools, including software, for use by researchers or by others in the public or private domain

- PIMS has developed expertise in cloud computing and, in partnership with Digital Research Alliance and Cybera, launched Jupyter Hub services for researchers and students in Canada and at the University of Washington. Specifically, the Syzygy project enables staff, students and faculty members at Canadian higher education institutions to access Jupyter using their existing institutional credentials. Jupyter is a powerful open-source web application that facilitates collaboration on live code, equations, visualizations and narrative text. Syzygy is deployed at 35 Canadian universities and University of Washington. Syzygy has been used by over 83,000 people and continues to be used by thousands every day. Individual users are given a curated computational environment customizable to research (as well as teaching and training) needs. By developing and making these computational resources accessible, PIMS has positively impacted the infrastructure for the mathematical sciences. While primarily intended for research, Syzygy has also been used by instructors of undergraduate and graduate courses nationwide.
- The Callysto project, created by PIMS in partnership with Cybera and funded by Cancode, uses the same architecture as Syzygy augmented with a rich set of interactive learning resources focused on training teachers and K-12 students in data science and computational thinking. Callysto has been used by over 160,000 students and 6,000 teachers and the resources created are used and updated via an open-source model. 2024 activities included entering a girls robotics team in Alberta First Tech Challenge and a program called “Empowering Young Mathematics Learners”. This program supports high school mathematics teachers to leverage new digital and technological resources to provide rich real-life contexts for deeper mathematics learning and engagement among high school students.
- In 2024, PIMS launched a new website. In addition to offering a more modern feel and streamlined navigation to key content, the website has also incorporated an efficient system for collecting applications for PIMS programs. This has lead to an improved experience for applicants to PIMS as well as reviewers.

Communication of research results and knowledge translation to specialist or non-specialist audiences, including the public

During 2024, PIMS supported 42 research conferences and workshops, 10 summer schools for graduate students and postdoctoral fellows (PDFs), 3 online seminar series, 24 department seminars and colloquia across its 10 member universities, dozens of education and outreach activities, and more. Below are some notable examples:

- The France-Western Canada Workshop on Ocean and Polar Sciences was a satellite event held over two days at the University of British Columbia. Organized by the Centre National de la Recherche Scientifique (CNRS), PIMS and the Consulate General of France in Vancouver, this workshop focused on quantitative approaches and analysis in this field. The main goal of the workshop was to identify shared research themes, to explore possibilities for new interactions, and to foster further cooperation between researchers in Canada and in France. There were several notable presentations. William Cheung spoke on "Solving the ocean sustainability challenges at the food-climate-biodiversity nexus", Christian Schoof presented "Glacier and Ice Sheet Dynamics", and Paul Vigneaux gave a talk on "Earth and Energies".
- The first CRM-PIMS-AARMS Invited Address was given by Henri Darmon at the 2024 Joint Mathematics Meeting. The title of his talk was "Fourier Coefficients of Modular Forms".
- PIMS continues to showcase the diversity of the mathematical sciences community via the online Network-Wide Colloquium. Terence Tao gave a talk on "Machine Assisted Proofs" in which he surveyed some historical and recent developments and speculated on the future roles of machine assistance in mathematics. Sheehan Olver also spoke on "Computing Equilibrium Distributions of Interacting Particles". Most of the talks in this series are recorded and available online. In 2024, PIMS ran seven other Distinguished Lecture Series at PIMS sites.
- The PIMS Emergent Research seminar series showcases the research of PIMS Postdoctoral Fellows. The seminar is a network-wide event offered virtually using Zoom. During the reporting period, 11 PIMS PDFs presented research in this seminar series.
- PIMS sponsors a large number of seminar series across our sites which play a key role in ensuring a regular flow of high-level visitors to member universities. In 2024, PIMS sponsored 24 seminar series at ten different universities.
- The CRM-Fields-PIMS Prize is the premier award for mathematical research in Canada, with the recipient chosen jointly by the three Canadian mathematical sciences institutes. The winner is invited to present a lecture at each institute or may choose to deliver a lecture in hybrid format at one of the institutes. In 2024, the winner was Ram Murty from Queen's University.
- MathTube (a PIMS creation) (mathtube.org) is a resource for sharing videos and other content. People can browse or search MathTube directly or they can find links to individual recordings on the event pages of the PIMS website. MathTube makes posting, finding and viewing mathematical content as simple and easy as possible. PIMS posts all applicable new media to MathTube.
- Social media is used to publicize the excellent research being done across our network. PIMS uses Bluesky, Instagram and LinkedIn to share its activities and programs, and to celebrate the accomplishments of its researchers.
- PIMS was highlighted in a dedicated article titled "The CNRS-PIMS (Pacific Institute for the Mathematical Sciences) international laboratory: an ever-expanding Canadian IRL" published by CNRS Mathematics (INSMI).

Advances to equity, diversity, inclusion and accessibility in the research ecosystem

- The Pacific Institute for the Mathematical Sciences (PIMS) believes that equity, diversity and inclusion (EDI) strengthen the mathematical community by increasing the impact and relevance of research; widening the pool of qualified potential participants; and enhancing the integrity of the programs. Our programs support inclusivity at all stages from early education to retirement.
- The PIMS EDI Committee (EDIC) includes faculty, students and postdoctoral fellows (PDFs) from across the PIMS network. They develop implementable, explicit strategies to monitor and improve equity, diversity and

inclusivity of the Institute and its activities. Within the mandate we consider inequities faced by women, Indigenous Peoples, persons with disabilities, members of visible minorities and diverse sexual orientation and gender identities.

- Increasing Diversity in Mathematical and Related Sciences is an annual summer school. The goals are to introduce students to research level mathematics and to encourage more female and female-identifying students to pursue graduate school in the mathematical sciences. The research theme of the 2024 summer school was Combinatorial Commutative Algebra.
- PIMS created a recruitment fund to provide supplemental salary to help make competitive offers to PDF applicants from diverse backgrounds. We recognize that many candidates face additional barriers in academia and seek to address those inequities.
- PIMS has established an Indigenous Engagement Committee (IEC) designed to identify and support Indigenous-led initiatives in the mathematical sciences. This committee consists of distinguished Indigenous mathematical scientists in academia and industry from across North America and the Pacific Rim. With guidance from this committee, we strive to ensure that PIMS fulfills its commitment to listening to Indigenous voices and ensuring the PIMS community is welcoming, respectful and supportive to Indigenous, First Nations, Inuit and Metis students and researchers.
- PIMS has established a program specifically targeting EDI goals. The PIMS/BIRS Team Up! Pathways to Inclusive Research is a joint program with the Banff International Research Station (BIRS). It provides opportunities for in-person collaboration to teams of mathematical scientists, targeting researchers whose research may have been disproportionately affected by various obstacles like family obligations, professional isolation, access to funding and the COVID-19 pandemic. This includes women, gender expansive and minority groups, Indigenous scholars, individuals with visible/invisible challenges and early-career researchers with limited resources. A key goal of this program is for researchers with caregiving responsibilities to fully participate. Support may be offered for lodging and travel expenses for children and a caregiver accompanying the member. In 2024 PIMS funded 4 teams.
- The Scientific Review Panel (SRP) and Postdoctoral Fellow Panel guidelines now have a strong emphasis on EDI. The PDF application now includes an EDI statement from applicants and a statement of supervisory philosophy from their sponsors.
- The 2024 Women in Math Day Celebration included a book signing and talk by Shohini Ghose author of “Her Space, Her Time: How Trailblazing Women Scientists Decoded the Hidden Universe”. Her book tells the inspiring stories of women physicists and astronomers who discovered fundamental rules of the universe and whose critical roles and contributions have not always been well-acknowledged.
- Math to Power Industry (M2PI), our industry training program, had its first all-female team in 2024. They worked with industry partner Nautical Crime Investigation Services (NCIS) on search engine improvements.
- The in-person Women in AI Career Fair, held in Calgary in partnership with PIMS and M2PI brought together a diverse group of professionals and emerging talent in AI. The event featured nine industry panelists, including Heather Vooys, who shared insights from her role as Machine Learning Lead at AERIUM Analytics, and Sogol Ghattan, Director at NCIS, who spoke on the ethical use of AI. Notably, both were M2PI mentors, underscoring M2PI’s ongoing influence in shaping future leaders in the field. The career fair offered an inspiring environment for fostering a strong community focus on learning, networking, and mentorship - demonstrating PIMS and M2PI’s commitment to enhancing diversity and growth in mathematics and AI. After participating in the career fair, M2PI participant Hiva Gheisari received an invitation from Women in AI (with free admission) to the Women in AI X Devfest YYC coding challenge.
- In 2024, PIMS supported the Women in Optimal Transport conference run by the Kantorovich Initiative as there is a lack of women in Optimal Transport in North America. This workshop served as a catalyst to create a large

community of women working in interdisciplinary optimal transport-based research.

Co-creation or transfer of products, technology, processes, services or advice useful to specific organizations (in the private, public or non-profit sectors), communities or society

- Developed by PIMS, Math to Power Industry (M2PI) is an annual professional development program positioned to benefit the Canadian economy and industry by linking highly trained personnel to career opportunities outside academia. Following an intensive training workshop, teams of graduate students work with mentors from industry and academia to solve a challenge from government or industry. This year, 32 students formed 7 teams who provided mathematical solutions to industrial problems supplied by non-academic partners. For example, the IOTO International team engineered new features for a data dashboard which will enhance engagement and/or predictive and decision-making analytics of legislative bodies. The Awesense team provided an integer programming model designed to optimally distribute loads across an energy grid to avoid phase imbalances. The Finite Carbon team engineered an automated system to detect emerging deforestation in Canada using satellite images and machine learning techniques. Nautical Crime Investigation Services and CompliLogic hired one M2PI participant as a Mitacs intern. They are now working with the industry partners to develop natural language processing products stemming from their M2PI work.
- Syzygy.ca is a project of PIMS, Digital Research Alliance and Cybera to bring Jupyter notebooks to researchers, educators and innovators across Canada. Jupyter is an interactive computing environment built for collaboration, where research tools such as Julia, Python and R are accessed via browser. It is integrated with single sign-on systems at postsecondary institutions.
- PIMS and Cybera created Callysto which is a free, online learning tool that helps Grades 5-12 students and teachers learn and apply in-demand data science skills including data analysis and visualization, coding and computational thinking. Interactive learning modules and lesson plans are available in a variety of subjects-from math to history-and are aligned with existing curriculum. An example of one of the 2024 lesson plans is “Health Data Privacy: A Locked Room Challenge” where students are introduced to real-world examples of common uses of personal data, from the good to the bad. Students engage in an activity similar to a virtual “locked room” where they will discover the clues to the next stages by utilizing basic data science skills.

Community service that leverages expertise, such as membership on scientific or advisory committees, or journal editorships

- PIMS Director Ozgur Yilmaz is on the Board of Directors of BIRS. He is also an Institute Appointed Member of the Board of Directors of the Canadian Mathematical Society. He serves in the Executive Committee of UBC Data Science Institute. He is on the Editorial Boards of “Applied and Computational Harmonic Analysis”, “Sampling Theory, Signal Processing, and Data Analysis”, and “Mathematics, Computation and Geometry of Data”.
- PIMS Co-Director, Industry, Kristine Bauer is on the Board of Brain CREATE. Engin Ozberk (PIMS Board Chair) is also on this Board. The Brain CREATE training program focuses on the development of neurotechnologies. The trainees will play critical roles in revamping and modernizing traditional industries with brain-centric innovations. Kristine Bauer is a founder of the Women in Topology network and serves on its Steering Committee.
- PIMS Co-Director, International, Gabriel Paternain is an Editor of “Inverse Problems and Imaging” and “Journal of Topology and Analysis”. He is a member of the Scientific Advisor Board of the Max-Plank-Institut fur Mathematik, Bonn.

- PIMS Education Coordinator, Melania Alvarez is a key organizer for Science Rendezvous at UBC. This is a national festival that takes science out of the lab and onto the street. Festival-goers get a chance to meet world-class researchers and innovators, participate in hands-on experiments, and see amazing scientific demonstrations.

Creation, direction, facilitation and/or strengthening of partnerships or collaborations in the Canadian or international research community, or with other communities, including through research networks, large collaborative projects or community-engaged research/citizen science

- PIMS Collaborative Research Groups (CRGs) develop research and training networks establishing lasting interdisciplinary links between researchers at member universities. CRGs are organized by researchers, typically faculty at PIMS universities, with common interests and a desire to collaboratively develop aspects of their research programs. CRGs are thematic programs including seminars, workshops, PDF appointments and graduate training programs. The fruits of these activities persist for many years, increasing visibility and communication with colleagues around the world. CRGs create a critical mass that enhances training programs, leveraging PIMS to support a large number of PDFs and creating new research opportunities for young scientists. PIMS started a new CRG in 2024 - Structure-Preserving Discretizations and their Applications. The organizers are from the University of Washington, Simon Fraser University, University of Saskatchewan and University of California, Merced. Structure-preserving discretizations are numerical methods that attempt to mimic mathematical structures or properties of the continuous system on the discrete (numerical) level. Such discretizations are often essential in order to maintain the accuracy and stability of simulations. Important applications whose predictions hinge on structure preservation include climate modelling, fusion, and turbulence. These applications are linked to some of the most pressing current societal issues. Moreover, emergent applications that utilize machine learning techniques can also benefit from incorporating structure-preserving ideas to improve their prediction and generalizability. In their opening year they ran a BIRS 5-day Workshop on structured machine learning and time-stepping for dynamical systems, a SIAM meeting minisymposium, a CMS meeting minisymposium and the PIMS Marsden Memorial Lecture presented by Anil Harani - A Friendly Introduction to Calculus and Geometry on Meshes and Graphs. Other active PIMS CRGs in 2024 were Novel Techniques in Low Dimension; Movement and Symmetry in Graphs; L-Functions in Analytic Number Theory; and Forecasting and Mathematical Modeling for Renewable Energy. The PIMS SRP also recommended funding of a new CRG on Diagram Categories in Homotopy Theory which will start in 2025.
- Building on the success of the CRG program, PIMS has developed large-scale initiatives called PIMS Research Networks (PRNs). These networks are designed to build bridges between research groups in academia, industry and the public sector. They are designed to go above and beyond the CRG mission by combining research, training, and crucially, strong external partnerships, leading to sustainable long-term collaborations. A new PRN began in 2024 - Maud Menten Institute. The leaders are from the University of Victoria and the University of Manitoba. The primary purpose of the Maud Menten Institute is to provide a collaborative research platform for mathematical biologists at PIMS sites to promote interactions with life science experts and decision makers in government, industry and NGOs. The secondary purpose is to develop the required training program for the non-academic pipeline in mathematical biology. This program will allow new generations of mathematical biologists to impact biological fields inside and outside of academia and will explicitly establish mathematical biology as a powerful tool of investigation in biology. The training focus is on broad-based career development for HQPs in conjunction with partners. In their first year, the Maud Menten Institute ran an HQP summit and working group meetings as well as a seminar series. The other active PRN in 2024 was the Kantorovich Initiative.

- The University of Alberta hosted the Alberta Mathematics Dialogue with well over one hundred people in attendance from across the Province of Alberta and beyond. The Alberta Mathematics Dialogue enables connections not only between the PIMS universities in the province but also between the universities and the province's other post-secondary colleges and institutions, strengthening bonds between researchers and educators across Alberta.
- PIMS partners with similar institutions around the world, for details on these partnerships, see the "Partnerships" section.

Publications:

- Selected key publications (from PIMS PDFs, Globalink exchange students and CRGs):
- C. Soubrier, E. Foxall, L. Ciandrini and K. Dao Duc, "Optimal control of ribosome population for gene expression under periodic nutrient intake", Journal of the Royal Society Interface, Volume 21, Issue 12, 6 March 2024.
- D. Artenstein et al, "The Hochschild cohomology ring of monomial algebras", Journal of Algebra 654 (2024) pp. 108-131.
- P. Ocal and A. Oswald, "A dichotomy between twisted tensor products of bialgebras and Frobenius algebras", Journal of Algebra 644 (2024) pp. 351-380.
- S. Cao, Z.-Q. Chen and T. Kumagai "Kigami's conjecture of the embedding Wp(K) ? C(K)", to appear in Proceedings of the American Mathematical Society.
- S. Cao and H. Qiu, "Dirichlet forms on unconstrained Sierpinski carpets", to appear in Probability Theory Related Fields.
- J. Hu, A. Wan and S. Van Fleet, "Fully discrete energy-dissipative and conservative discrete gradient particle methods for a class of continuity equations", accepted in SIAM Journal of Scientific Computing.
- Y. Fan, M. Henry, B. Pass and J.A. Rivero, "Multidimensional Inequality Measurement via Optimal Transport" to appear in Review of Economics and Statistics.
- B. Hosseini, A.W. Hsu and A. Taghvaei, "Conditional optimal transport on function spaces", SIAM/ASA Journal on Uncertainty Quantification, 2024.
- M. Al-Jarrah, N. Jin, B. Hosseini and A. Taghvaei, "Nonlinear Filtering with Brenier Optimal Transport Maps", International Conference of Machine Learning (ICML), 2024.
- J. Samaran, G. Peyre and L. Cantini, "scConfluence: single-cell diagonal integration with regularized Inverse Optimal Transport on weakly connected features", Nature Communications, 2024.
- F. Andrade, G. Peyre and C. Poon, "Sparsistency for Inverse Optimal Transport", Proc. ICLR'24, 2024.
- P. Emani and B. Pass, "Optimal transport with optimal transport cost: the Monge-Kantorovich problem on Wasserstein space," to appear in Calc. Var. Partial Differential Equations.
- X. Zhu and A. Drouot, "Topological edge spectrum along curved interfaces", accepted in Int. Math. Res. Not. (IMRN)
- The proceedings of our Math to Power Industry (M2PI) program will be published in an upcoming Springer volume "PIMS Activities in Mathematical Mentorships 2020-2024".

Non-technical publications:

- PIMS Annual Reports are available on our website.
- PIMS Connection and Year in Review are also available on our website.

- PIMS has signed an agreement with Springer-Verlag to produce the PIMS Activities in Mathematical Mentorship book series, featuring the research reports of Virtual Experimental Mathematics Labs (VXML) and M2PI student teams. The first volume is in preparation. The PIMS-Springer contract also includes an agreement to publish lecture notes stemming from PIMS summer schools; the first such volume (on Optimal Transport) is in preparation.

Support for traditional knowledge or Indigenous ways of knowing, including cultural practices

- First Nations University (FNUniv) is an active PIMS Affiliated Member. They are dedicated to enhancing the quality of life and preserving, protecting, and interpreting the history, culture and artistic heritage of First Nations.
- The PIMS Indigenous Engagement Committee (IEC), consisting of distinguished mathematical scientists and industrialists from Indigenous backgrounds, has done exemplary work in identifying Indigenous-led efforts in the mathematical sciences that PIMS can collaborate with and support including the Indigenous Mathematicians Network.
- Guided by the PIMS Indigenous Engagement Committee, organizational work has been done for the "CRM-PIMS-AARMS Special Session on Indigenous Voices in Mathematics" to be held at the Joint Mathematics Meetings (JMM) in January 2025.

PARTNERSHIPS AND COLLABORATIONS

Atlantic Association for Research in the Mathematical Sciences (AARMS)

- PIMS, AARMS and CANSSI together supported the Canadian Statistics Students Conference.
- PIMS and AARMS co-sponsor national meetings of the Canadian Mathematical Society (CMS) and the Canadian Applied and Industrial Mathematics Society (CAIMS) together with CRM and Fields.
- PIMS and AARMS together with CRM and Fields supported Combinatorial Algebra Meets Algebraic Combinatorics.
- PIMS, AARMS and CRM have joined with the American Mathematical Society (AMS) and become new partners at the Joint Mathematics Meeting (JMM).
- Increasing Diversity in Mathematical and Related Sciences, an annual summer school has been established in collaboration with BIRS, AARMS, CRM and Fields.

Banff International Research Station (BIRS)

- Together PIMS and BIRS have established the PIMS/BIRS Team Up! program. We also collaborated on the Summer School on the Mathematics of Renewable Energy held at UBCO.
- Increasing Diversity in Mathematical and Related Sciences, an annual summer school, has been established in collaboration with BIRS, AARMS, CRM and Fields.

Canadian Statistical Sciences Institute (CANSSI)

- PIMS and CANSSI collaborated on Biostatistics Research Day at the University of Calgary.
- PIMS, CANSSI and AARMS together supported the Canadian Statistics Students Conference.

Fields institute for Research in Mathematical Sciences (FIELDS)

- PIMS together with CRM and Fields award the CRM-Fields-PIMS Prize and collaborated on Seminaire de Mathematiques Superieures (SMS).
- We co-sponsored the national meetings of CMS and CAIMS.
- PIMS, Fields, CRM and AARMS all supported Combinatorial Algebra Meets Algebraic Combinatorics.
- Increasing Diversity in Mathematical and Related Sciences, an annual summer school, has been established in collaboration with BIRS, AARMS, CRM and Fields.

Centre de recherches mathématiques (CRM)

- PIMS and CRM, together with Fields, collaborated on Seminaire de Mathematiques Superieures (SMS). The topic for 2024 was Flows and Variational Methods in Reinmannian and Complex Geometry.
- PIMS and CRM collaborate together with Fields to award the CRM-Fields-PIMS Prize.
- We co-sponsor the national meetings of CAIMS and CMS.
- PIMS and CRM co-sponsor the PIMS-CRM Summer School in Probability.
- PIMS, Fields, CRM and AARMS all collaborated on Combinatorial Algebra Meets Algebraic Combinatorics.
- PIMS, AARMS and CRM have joined with the American Mathematical Society (AMS) and become new partners at the Joint Mathematics Meeting (JMM).
- Increasing Diversity in Mathematical and Related Sciences, an annual summer school, has been established in collaboration with BIRS, AARMS, CRM and Fields.

New Canadian Industry Partners

- In 2024, PIMS and Distriq, Quebec's Quantum Innovation Zone, signed an MOU to strengthen quantum science and mathematical research. This partnership links PIMS' Math to Power Industry (M2PI) program with Distriq's innovation ecosystems, fostering collaboration and excellence in quantum technologies and mathematics. Together, we aim to push the boundaries of both fields. This partnership will focus on promoting internship opportunities, facilitating industry partnerships, creating platforms for scientists to engage in conferences and networking events, and broadening the visibility and impact of industry programs.

New International Academia Partners

- PIMS and the Centre for Machine Learning and its Applications (CM2LA) of Pohang University of Science and Technology, Republic of Korea signed an MOU in the fall of 2024. This MOU will pave the way for joint research initiatives, researcher exchange programs, and collaborative projects that will benefit both academic communities.
- In late 2024, PIMS signed an MOU with the Instituto de Matematica y Estadistica Rafael Laguardia (IMERL)

in Uruguay. This partnership, which aims to foster international collaboration, will focus on facilitating the exchange of researchers, and exploring opportunities to collaborate on common research initiatives.

Highlights of a unique partnership that has taken place over the past year and the impact

- 2024 saw the third renewal of PIMS as an International Research Laboratory of the French Centre National de la Recherche Scientifique (CNRS). This collaboration champions the mutual exchange of knowledge between western Canada and France. Flagship programs include the CNRS Visitors program, where distinguished French researchers (funded by CNRS) spend the academic year at a PIMS member university and participate in research activities. PIMS had one CNRS visitor in 2024. PIMS-CNRS Fellowships enable faculty at PIMS sites to visit France for long term collaborations. There were two of these in 2024. Via the PIMS CNRS Student Mobility Program, senior undergraduate and graduate students conduct 3-6 month research programs at a PIMS member university or at an eligible French institution. We had two students participate in this program in 2024. The PIMS-CNRS Postdoctoral Fellowships bring French-educated researchers to a PIMS site for a postdoctoral fellowship and are a key part of the PIMS PDF program. We had one PIMS-CNRS Postdoctoral Fellowship begin in 2024. CNRS also supported the France-Western Canada Workshop on Ocean and Polar Sciences held at UBC.

INTERACTIONS AND OUTREACH

New initiatives that support equitable and inclusive participation in outreach activities

- IMAGINING UVIC 2024 is a 4-day summer camp held on UVic campus intended to encourage young women to pursue STEM fields. Interactive sessions lead by cutting edge researchers introduced participants to math concepts which went beyond the regular curriculum. Sessions included: Untangling the Mathematics of Knots; Constructive Constructions and Historical Triangles; and A Mathematicians Guide to World Domination. Collaborative problem-solving was emphasized through activities such as escape rooms. The camp concluded with a fun team math challenge designed to allow participants to apply the knowledge and skills they have learned throughout the week.
- At the UBC Girls in Data Science Summer Camp, students explored the world of data science and statistics and applied their knowledge on real data sets with the support of experienced mentors in the field. Topics included: introduction to data science; statistical inference and sampling; and machine learning fundamentals.

Highlights of a unique outreach activity that has taken place over the past year

- The Diversity in Research Experiences Across Mathematics (DREAMs) Institute is a three-week online summer enrichment program designed to provide high school students in their last year or two of studies an opportunity to explore the pursuit of mathematics at the University level. Participants are introduced to foundational areas of mathematics by guest lecturers during the first portion of the program and then work on inquiry-based projects with the support of lecturers and graduate student teaching assistants. One of the DREAMs Institute's primary goals is to help students envision a career in mathematics or STEM more broadly. Another goal is to support students with minoritized identities. The 2024 program included the following courses: Mathematics of Puzzles; Introduction to Abstract Algebra; Special Relativity; and Scientific Computing.

CONTRIBUTION TO THE TRAINING AND DEVELOPMENT OF HQP

Establishment of safe, equitable and inclusive research environments, practices and norms

- We have an established PIMS Code of Conduct, which provides rules that we expect all organizers and participants of PIMS events to follow. These guidelines are designed to ensure that our events are as safe, welcoming and inclusive as possible. Further, the Scientific Review Panel and Postdoctoral Fellow Panel guidelines have been updated with a strong emphasis on EDI. In particular, the PDF application now includes an EDI statement, and guidelines for evaluating candidates were made with EDI in mind to ensure that equity-deserving candidates receive fair consideration. The Math to Power Industry program includes an EDI training course to promote inclusive teams. This training is delivered immediately before participants engage in team-based projects.

Formal or informal mentoring of HQP, colleagues, collaborators, relevant partners, other professionals or community members

- PIMS has transitioned from virtual to local Experimental Mathematics Labs (XML). In 2024 PIMS supported the Washington XML, Manitoba XML and QuanTA at the University of Saskatchewan.
- PIMS First Year Interest Groups (FYIG) bring together early career researchers to study active research topics in the mathematical sciences. Each FYIG is led by a PIMS PDF and centers on an accessible subject for beginning graduate students. 2024 subjects included lattice-based cryptography and polynomial methods in combinatorics.
- PIMS hosts a virtual orientation, introducing the postdocs to their cohort, providing resources for professional development and EDI training and creating channels for interaction within the cohort.
- Changing the Culture brings together mathematicians and mathematics educators to work towards narrowing the gap between mathematicians and teachers of mathematics.

Outreach to and engagement with students, youth or members of the general public

- Math Mania presents a variety of interactive demonstrations, puzzles, games and art. These activities are designed to demonstrate to children, parents and teachers a fun way of learning both math and computer science concepts.
- Math Circle Workshops are conducted for students in grades 4-7. The goal is to convey to students the importance of mathematics in the real world. c254 PIMS conducts Elmacon, a mathematics competition for students in grades 5-7.
- PIMS participates in Science Rendezvous, a national program bringing exciting STEM experiences and programming to the public.
- In 2024, PIMS ran a series of weeklong Mathematics Summer Camps for children. They studied mathematics in the mornings and had a variety of adventures in the afternoons.
- See above for Girls in Data Science Summer Camp and IMAGINING UVIC.

Supervision of HQP in the research process

- PIMS currently has 41 PDFs across its network. These fellowships are highly competitive and are awarded by our PDF Panel. The expected quality of supervision is one of the main evaluation criteria in awarding these fellowships, with the goal of assuring that the HQP receives appropriate supervision.
- In 2024, PIMS hosted the first annual Postdoc Summit in-person meeting to foster networking amongst the 2024 postdoctoral cohort, and to deliver workshops in career development specifically aimed at postdoctoral fellows.
- During the M2PI workshop, teams of 4-6 graduate students work with industry and academic mentors on a challenge provided by the mentor. The program requires industry partners to provide at least 2 hours per day of mentorship to students while they are working on the team project.
- PIMS CRGs and PRNs create long term (3 year) thematic programs that give HQP a dynamic research environment where they get supervision through interaction with various CRG researchers.

Training in traditional knowledge or Indigenous ways of knowing including cultural practices

- PIMS supported the Play and Learn Summer Camp which incorporated Indigenous culture, language and ways of knowing throughout the camp. An Elder of the T'Sou-ke Nation attended and lead several workshops on topics including storytelling, language work, traditional drumming and shared traditional ecological knowledge.
- PIMS Education Coordinator, Melania Alvarez, made a presentation to UBC Statistics Department on Indigenous Realities in Canada as part of a student orientation. She and an outreach partner also travelled to several First Nations schools to run workshops for teachers, host math activities for students and participate in First Nations conferences.
- One of the lesson plans in the Callysto program is "Indigenous Populations in Canada". This notebook employs data science to investigate the current distribution of Indigenous lands in the Americas, as well as the geographic locations of First Nations people at the time of contact with Europeans.

Development and delivery of training workshops outside of research or course requirements

- Developed by PIMS, Math to Power Industry (M2PI) is an annual professional development program positioned to benefit the Canadian economy and industry by linking highly trained personnel to career opportunities outside academia. Following an intensive training workshop, teams of graduate students work with mentors from industry and academia to solve a challenge from government or industry.
- PIMS also created Math2PowerQuantum, a summer school aimed at helping students in the mathematical sciences learn about quantum computing and quantum information and associated career paths.
- PIMS supported 10 summer schools for graduate students in 2024 on research topics including quantum computing, probability and Koszul duality in representation theory.
- PIMS supports networking and career development for graduate students and PDFs. The online PIMS Emergent Research Seminar features the research of PIMS PDFs to help them build their network. PIMS organizes career development sessions.

Initiatives or changes to policy that support equitable and inclusive training and development of HQP

- PIMS has programs aimed at underrepresented groups including, but not limited to, women, Indigenous Peoples (First Nations, Inuit and Metis), persons with disabilities, members of visible minorities/ racialized groups and members of LGBTQ+ communities.
- PIMS created an EDI recruitment fund to provide salary supplements to help make attractive and competitive offers to PDF applicants from diverse backgrounds. This program acknowledges that many of these candidates face additional barriers in academia and seeks to address those inequities to ensure that their excellence can be recognized.
- PIMS has an Indigenous Engagement Committee to ensure that PIMS listens to Indigenous voices in identifying ways of supporting Indigenous led activities in the mathematical sciences.
- PIMS/BIRS Team Up Pathways to Inclusive Research targets researchers whose program may have been disproportionately affected by various obstacles like family obligations, professional isolation, access to funding and the Covid pandemic. It provides opportunities for in-person collaboration to teams of mathematical scientists.
- PIMS offers Network-wide courses and a Network-wide Colloquium Series to enhance accessibility for individuals from smaller universities with limited resources.
- The First Year Interest Groups (FYIG) aim to bring together early career researchers to study an accessible subject for beginning graduate students. Each group is led by a PIMS PDF.

Highlight one or two unique mentorship or training opportunities that have taken place over the past year

- Math2PowerQuantum is an industrial quantum computing summer school held over two days. It is aimed at helping students in the mathematical sciences learn - through a combination of lectures and hands-on demonstrations - about the emerging fields of quantum computing and quantum information. At the same time, the school creates opportunities for students to learn about industry opportunities in quantum computing. Over the two days, students received a broad introduction to quantum computing and quantum information as well as specific, hands-on instruction in programming languages typically used in quantum computing (such as IBM Qiskit). They also learned about the emerging field of quantum security, including quantum-safe cryptographic schemes. This event was held at the University of Saskatchewan.
- The PRN Maud Menten Institute held its first HQP Summit and Working Group Meeting. There were 83 participants. 62 of them were Institute trainees. The first part of the meeting involved research communications activities. Participants were divided into 4 groups. One group focused on giving a 3-point summary using the key message template of a previously circulated article. The second group worked on writing an abstract in 6 sentences. The third group went through a mock publication process including selecting the journal, writing a cover letter, peer review and editor's decision. The fourth group worked on an elevator pitch - a one-minute advertisement for their research. The second part of the meeting involved working groups which involved targeted talks and discussions. There were three working groups: Environmental and Ecological Forecasting; Quantitative Medicine and Physiology; and Heterogeneous Disease Modelling. Post-event surveys indicated participants felt this event was very successful.

HQP participation in institute organized activities by career stage

ACTIVITY	TOTAL NUMBER OF PARTICIPANTS	UNDERGRADUATE		GRADUATE**		DOCTORAL		POSTDOCTORAL	
		NUMBER	%OF TOTAL	NUMBER	% OF TOTAL	NUMBER	% OF TOTAL	NUMBER	% OF TOTAL
Conferences/Workshops	3359	561	16.7	1196	35.6	N/A	N/A	457	13.6
Summer Schools (outside CRGs)	589	0	0.0	497	84.4	N/A	N/A	52	8.9
CRG/PRN Events	332	3	1.0	159	48.0	N/A	N/A	27	8.0
Lecture-Seminar Series	3200	90	2.8	1299	40.6	N/A	N/A	397	12.4
Industrial Activities - M2PI	202	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Other	780	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

MANAGEMENT & BUDGET

Costs paid from all revenue sources

BUDGET ITEM	2023 ACTUAL	2024 BUDGETED	2024 ACTUAL	2025 BUDGETED
SALARIES & BENEFITS				
Technical/professional	808138.00	832382.00	847679.00	959982.00
HQP stipends/awards	922438.00	1160000.00	913681.00	794689.00
Director/Co-Directors/Site Directors	162815.00	180500.00	148765.00	160650.00
INSTITUTE				
Operating costs	48127.00	50000.00	52027.00	55000.00
Maintenance	19927.00	22000.00	25722.00	25000.00
Minor Equipmetn Upgrades	23070.00	13000.00	11411.00	13000.00
TRAVEL (INCLUDING ACCOMMODATION, MEALS, ETC)				
Conference	306009.00	300000.00	240522.00	259000.00
Engagement	527515.00	550000.00	501363.00	512000.00
Board/Exec. Mtgs	57300.00	600000.00	56795.00	47000.00
DISSEMINATION COSTS				
Outreach to user communities	1978.00	2500.00	5455.00	1500.00
Scientific Publications	1967.00	2000.00	3481.00	2000.00
OTHER COSTS				
Education initiatives	121497.00	100000.00	74976.00	64500.00

Costs paid from NSERC Discovery Institute Support Grant funding

BUDGET ITEM	2022 ACTUAL	2023 BUDGETED	2023 ACTUAL	2024 BUDGETED
SALARIES & BENEFITS				
Technical/professional	247032.00	255000.00	212431.00	154349.00
HQP stipends/awards	905438.00	910000.00	854124.00	794689.00
TRAVEL (INCLUDING ACCOMMODATION, MEALS, ETC)				
Conferences	210000.00	100000.00	130000.00	120000.00
Engagement	207000.00	80000.00	70400.00	80000.00

Institute revenues

REVENUE SOURCE	2023 ACTUAL	2024 BUDGETED	2024 ACTUAL
User fees	113318.00	75000.00	49047.00
Partner Universities	832266.00	811310.00	839671.00
Donations/contributions	142355.00	120654.00	61051.00
Callysto	273788.00	47500.00	95000.00
NSERC DIS	962226.00	1153748.00	1153748.00
Prairies Can	6947.00	51500.00	52526.00
Simons Foundation	130205.00	245830.00	260111.00

Overall financial statement of account

Previous balance at 31/12/2023	1304967.00
Actual institute revenues for 2024	2511154.00
Total actual institute costs for 2024	2881877.00
Total carry forward at 31/12/2024	934244.00

The carry forward resulted from a reduction in in-person events following Covid but has been steadily decreasing over the past few years as activities have resumed. Carry forward at the end of 2023 was $1,304,967 and now it is $934,244. The shift to hybrid formats has reduced travel needs, but we have also expanded support for postdoctoral researchers and extended visit durations, encouraging visits to multiple sites per trip. Additionally, we are increasing the number of in-person events and launching new programs with longer collaboration periods, such as PIMS/BIRS Team Up! and the PIMS-BIRS-Simons Travel Awards. However, we aim to maintain a carry forward balance rather than eliminating it entirely. A reserve of $200,000-$500,000 is necessary to ensure continuity of programs and appointments through the fiscal year end period.

RESEARCH AREA	PROPORTION OF INSTITUTE FUNDS
Pure math	43
Applied math	21
Statistics	3
Computer science	3
Math biology	19
General math (mixed)	11

Initiatives or changes to policy that support an equitable and inclusive research, management or work environment

- PIMS has been working on updating its Code of Conduct. PIMS strives to provide a supportive and safe environment that is dedicated to excellence, equity and mutual respect. PIMS envisions a climate in which all participants are provided with the best possible conditions for learning and research. We expect all members of the PIMS community to conduct themselves in a manner so as not to cause, condone or participate in the discrimination, harassment or prejudice of another person or group of persons.
- All PIMS Central staff are required to complete courses on Preventing and Addressing Workplace Bullying and Harassment as well as Workplace Violence Prevention.
- PIMS has an EDI recruitment fund to provide a salary supplement to recruit candidates from diverse backgrounds. We consider inequalities faced by women, Indigenous Peoples, persons with disabilities, members of visible minorities and diverse sexual orientation and gender identities in all of our EDI initiatives.
- We have updated our terms of reference for the Postdoctoral Fellow Panel and the Scientific Review Panel incorporating EDI best practices.

Problems Encountered

Barriers or challenges for different groups to fully access or participate in the activities

- Some potential conference participants/speakers have had to cancel their trips due to very long waits for visitor visas.
- Some PDFs have had to start their appointments late due to immigration delays such as obtaining a visa/work permit.

External factors related to the COVID-19 pandemic

- Some speakers/participants have been unable to travel to a specific event as they were ill with Covid-19 at the time. Whenever possible, we arranged hybrid events.

Equipment and facilities

- At times it has been difficult to secure suitable lecture room space for hybrid seminars and events. We have attempted to equip more lecture rooms with the necessary equipment for hybrid events. There is a problem with soundproofing in our designated lecture room. We are working toward improving this situation by securing additional funding.

Staffing issues, inlcuding students

- PIMS Central office once had a significant number of staff turnovers in key positions. The Finance Manager, Communications Manager and Program and Events Manager positions were all unstaffed for at least a month in 2024. We now have new permanent staff members in place. The University of Calgary was also without a Site Administrator for a couple of months while a replacement was hired.

GENERAL INFORMATION

- The institute's website is maintained weekly
- The institute's website is maintained weekly.
- NSERC acknowledgement can be found at https://www.pims.math.ca
- NSERC funding is almost always acknowledged in written materials developed by the institute.
- The content of the institute's website is only available in English

LOOKING FORWARD

- A key theme for PIMS in 2025 will be Mathematics for the Future. As part of that program, PIMS will support the Mathematical Foundations of Quantum Advantage Workshop at SFU. This week-long workshop will bring together mathematicians with physicists and computer scientists who share a common interest in achieving a deeper mathematical understanding of precisely how quantum computers achieve advantages over classical machines.
- As part of the Increasing Diversity in Mathematical Sciences program, PIMS will host the 3MC-PIMS-ICMS Summer School on Quantitative Molecular and Cellular Biology. Participants will be graduate students and postdoctoral fellows from Canada and Africa. The summer school aims to equip students with essential tools and methodologies for investigating complex molecular and cellular questions. Courses will cover techniques relevant to structural, molecular, and cellular biology, all driven by specific biological questions. Cancer will be used as an integrative example throughout the program. The school structure includes lectures and project work. Students will work in small diverse groups on assigned research problems, applying lecture content. Instructors provide guidance, and students present their findings at the end of the school in oral presentations and written reports. Students will be grouped based on their academic and geographic backgrounds, promoting collaborative learning and research.
- PIMS will host the long-running Summer School in Probability at UBC.
- PIMS will launch a new CRG on Diagram Categories in Homotopy Theory in 2025. They will focus on functor calculus, equivariant homotopy theory, and polyhedral products. Planned activities include a summer school, several workshops, mini schools and an international research conference.

Participation by region in institute organized actvities

ACTIVITY	TOTAL NUMBER OF PARTICIPANTS	WESTERN CANADA (AB, BC)		CENTRAL CANADA (SK, MB)		ONTARIO		QUEBEC		EASTERN CANADA (NB, NL, NS, PEI)		NORTHERN CANADA (NWT, NvT, YT)		INTERNATIONAL	
Conferences/Workshops	3359	1868	55.6	376	11.2	339	10.1	47	1.4	67	2.0	0	0.0	662	19.7
Summer Schools (outside CRGs)	589	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CRG/PRN Events	332	201	60.7	70	21.0	7	2.0	4	1.3	0	0.0	0	0.0	50	15.0
Lecture-Seminar Series	3200	1917	59.9	425	13.3	29	0.9	10	0.3	10	0.3	26	0.8	783	24.5
Industrial Activities (M2PI)	202	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Others	780	645	82.7	32	4.1	15	1.9	7	0.9	8	1.0	0	0.00	73	9.4

Participation by sector in institute organized actvities

ACTIVITY	TOTAL NUMBER OF PARTICIPANTS	INDUSTRY		GOVT.		NGO		ACADEMIA		EDUCATOR (K-12)		OTHER	
Conferences/Workshops	3359	47	1.4	N/A	N/A	N/A	N/A	3151	93.8	67	2.0	94	2.8
Summer Schools (outside CRGs)	589	0	0.0	N/A	N/A	N/A	N/A	589	100.0	0	0.0	0	0.0
CRG/PRN Events	332	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lecture-Seminar Series	3200	42	1.3	N/A	N/A	N/A	N/A	2720	85.0	35	1.1	403	12.6
Industrial Activities (M2PI)	202	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Others	780	0	0.0	N/A	N/A	N/A	N/A	145	18.6	13	1.7	622	79.7