Pacific Institute *for the* Mathematical Sciences

Annual Report 2022

TABLE OF CONTENTS

ANNUAL PROGRESS REPORT

CTRMS-342044-2014

Pacific Institute for the Mathematical Sciences

January 1–December 31, 2022

I. OVERVIEW OF 2022

2022 has been a year of new beginnings for PIMS. We resumed a full slate of in-person activities, while diligently following safety protocols.

1. HIGHLIGHTS

We diversified our funding portfolio with support from the Natural Sciences and Engineering Research Council (NSERC), the Simons Foundation, Prairies Economic Development Canada (PrairiesCan), and the US National Science Foundation, and used this support to leverage funding from our member institutions, positioning us to build on our strengths in facilitating excellent and inclusive collaborative research and educational programs in the mathematical sciences.

- New Leadership Structure

Starting July 1, 2022, Ozgur Yilmaz became the Director of PIMS, while Jayadev Athreya transitioned from his role as Interim Director to the role of Co-Director International, and Kristine Bauer joined the PIMS Directorate as Co-Director Industry. The portfolios of the newly created co-Directorate positions were designed in consultation with the PIMS Board and stakeholders to align with the strategic priorities of PIMS and to provide PIMS with a strong collaborative leadership team.

- Return to in-person events

With the relaxation of pandemic-related precautions, PIMS cautiously resumed in-person activities in 2022. After a two-year delay, the PIMS-Centre de Recherches Mathématiques (CRM) Summer School in Probability was held at UBC in June with in-person participation by almost 100 graduate students from across the world. The 2022 Séminaire de Mathématiques Supérieures on Floer Homotopy Theory was also held at UBC with 62 participants and a total of 30 lectures.

- Network-wide colloquium

In 2021, we celebrated our 25th Anniversary with a new Network-Wide Colloquium, held online, with a fantastic collection of lecturers from all across the world. This series continued in 2022, with colloquia by Benoît Perthame (Sorbonne), Ingrid Daubechies (Duke), Holly Krieger (Cambridge), Bryna Kra (Northwestern), and Weinan E (Peking). These lectures are posted on the PIMS website www. mathrube.org, where consent is given. A huge thanks to PIMS University of Victoria Site Director Anthony Quas for his leadership and organization of this series.

- Network-wide graduate courses

Led by Nathan Ng, our PIMS ULethbridge site director, PIMS developed a suite of Network-Wide Courses, which are advanced graduate courses accessible to students across the PIMS network, helping to build strong research communities within PIMS.

- PDF orientation and seminar

Pioneered by our former Deputy Director, Marni Mishna of SFU, and now led by our Co-Director Industry, Kristine Bauer, the Emergent Research Postdoctoral Fellow Seminar highlighted the fantastic research done by PIMS postdoctoral fellows across the network. To help build community amongst our PDFs, and to introduce them to the PIMS network and its resources, we conduct an online orientation for our PDF community, emphasizing the great opportunities for research, education, and equity, diversity, and inclusion in the PIMS network.

2. WHAT'S NEW

- VXML

PIMS launched the Virtual Experimental Math Labs (VXML), modeled on successful labs at UWashington, UManitoba, and USaskatchewan. The VXML brings together vertically integrated teams from across the PIMS network (faculty, postdocs, graduate and undergraduate students) to work on exciting research problems in the mathematical sciences through experimental, computational and visual mathematics, showcasing the mathematical sciences as a creative discipline. To facilitate the transition to research for graduate students in the PIMS network via near-peer mentoring, we launched in 2022 the PIMS First Year Interest Groups (FYIG) program, which brings together early-year graduate students with a PIMS Postdoc to study active research topics in the mathematical sciences. We currently have three FYIGs distributed across the PIMS network.

- PRNs and CRGs

Collaborative Research Groups (CRGs) and the newly developed PIMS Research Networks (PRNs) are at the heart of PIMS collaborative research activities. This year saw the start of a new CRG - L-Functions in Analytic Number Theory ,with organizers from UBC, University of Northern British Columbia and University of Lethbridge. This CRG started with a flurry of activities, including a launch event at the Banff International Research Station (BIRS). Other PIMS CRGs are in the fields of Optimal Transport, Quantum Topology, and Movement and Symmetry in Graphs. We are excited that the CRG on optimal transport, also known as the Kantorovich Initiative, will transition to our first PIMS Research Network starting April 2023. Our new CRG on Renewable Energy will also launch in April 2023.

- Postdoctoral Program

PIMS continued to host a strong PDF cohort of 18 new postdocs across its network of 10 universities. Supported by funding from the Simons Foundation and from our member institutions, PIMS launched the PIMS-Simons postdoctoral program, a way to recognize and recruit top postdoctoral researchers. The flexibility of this funding has also allowed us to sponsor postdocs in Math, Applied Math, and Statistics at the University of Washington.

- PRIMA

PIMS hosted its largest-ever scientific meeting, the Pacific Rim Mathematical Association (PRIMA) 2022 Congress in Downtown Vancouver in December. Originally scheduled for 2021 and rescheduled to 2022 in light of the pandemic, PRIMA brought together over 250 distinguished mathematical scientists from around the Pacific Rim for a vibrant and exciting meeting, including engaging plenary and public lectures, and high-quality scientific special sessions. A highlight was the first in-person meeting of the Indigenous Mathematicians Network. Starting with an opening reception at the Museum of Anthropology, the PRIMA Congress helped PIMS strengthen its connections with mathematics institutes across the Pacific Rim.

- Equity, Diversity, and Inclusion

Equity, Diversity, and Inclusion are part of our core values. We are are working on several fronts to address these issues in the mathematical sciences community, through incredible work done by our EDI committee, co-chaired by Susan Cooper (UManitoba) and Chris Soteros (PIMS USaskatchewan Site Director). The PIMS Indigenous

Engagement Committee (IEC) was established in 2021 and consists of distinguished mathematical scientists and industrialists from Indigenous backgrounds. Since its inception, it has done exemplary work in identifying Indigenous-led efforts in the mathematical sciences that PIMS can collaborate with. The IEC had its first in-person meeting at the PIMS Central Offices in conjunction with the 2022 PRIMA Congress. For example, PIMS is helping to support the Canadian meeting of the American Indian Science and Engineering Society (AISES), both by supporting the UBC AISES chapter which is hosting the meeting, and supporting travel from AISES members from other PIMS sites. With our terrific education team, led by Dr. Melania Alvarez, we continue to sponsor summer camps for high school students and teacher workshops for teachers serving Indigenous students. These workshops help create pathways to careers in the mathematical sciences. To support PIMS community members who want to learn more about EDI issues, we have sponsored, in collaboration with the Canadian Statistical Sciences Institute (CANSSI), targeted training activities for our members.

- Math To Power Industry

Together with our partners in industry and government, PIMS offered a 3-week virtual Math to Power Industry (M2PI) workshop for graduate students and postdoctoral fellows in the mathematical and statistical sciences to gain the industry skills needed for success in their careers. This year four new industry partners joined M2PI: Awesense, Cedar Academy Society, Novion and Perfit. Thirty-five M2PI fellows gained hands-on experience as part of a team working on a real-world problem posed by an industry partner, and industrial partners gained valuable access to the cutting-edge problem solving capabilities of M2PI fellows. Teams presented an overview of the solutions they developed during the M2PI graduation ceremony, and during the ceremony M2PI announced its new partnership with Prairies Canada. Video of the graduation is available on MathTube.

- Partnerships

In 2022, the PIMS Centre National de la Recherche Scientifique (CNRS) International Research Lab resumed in-person programs that support research collaborations between France and PIMS, including four PIMS-Europe Fellowships, two CNRS Postes Rouge Awards, and four CNRS Visitors in 2022. We continue to work closely with our mathematical sciences institutes in Canada and across the world. We've developed exciting new exchange programs with premier research institutes in France, the US, and India, and collaborations on mathematics for public health and mathematics for climate change with our fellow Canadian Mathematical Sciences institutes. A special new partnership with the Quantum Algorithms Institute (QAI) is establishing PIMS as a key partner in the North American ecosystem in quantum computing research. QAI was also a title sponsor of the 2022 PRIMA Congress.

- Looking forward

In 2023, PIMS will focus on challenges facing humanity that require imminent solutions with contributions from the mathematical sciences. With this in mind, we are delighted to announce the summer of 2023 will be PIMS Action on Climate Thematic Summer (PIMS ACTS) Special activities include a summer school and a workshop on clean energy, both organized by our newly founded CRG on Forecasting and Mathematical Modeling for Renewable Energy; a French Ameri-Can Talks (FACTS) conference (in collaboration with the French Consulate in Vancouver) on "Tackling Climate Change and the Just Transition to Renewable Energy", and focusing our M2PI projects on climate and clean energy. Building on discussions at PRIMA, with PRIMA public lecturer and International Centre for Mathematical Sciences (ICMS)-Edinburgh Director Minghyong Kim, PIMS recently joined a collaboration with ICMS on their Mathematics for Humanity program. Stay tuned for several jointly organized, hybrid events between the two institutes in 2023 and beyond.

- Team-Up

Closer to home, PIMS is delighted to announce our new partnership with our sister institute, BIRS: the PIMS/BIRS Team Up! program. This program, inspired by the Simons Laufer Mathematical Sciences Institute's Summer Research in Mathematics program, provides opportunities for in-person collaboration to teams of mathematical scientists, targeting researchers whose research program may have been disproportionately affected by various obstacles like family obligations, professional isolation, access to funding, and the COVID-19 pandemic. This includes, but is not limited to, women, gender-expansive, and minoritized 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 in its scientific activities.

II. IMPACT OF RESEARCH ACTIVITIES

1. HOW WE ADVANCE EQUITY, DIVERSITY, INCLUSION AND ACCESSIBILITY IN THE RESEARCH ECOSYSTEM

The Pacific Institute for the Mathematical Sciences (PIMS) believes that equity, diversity and inclusion (EDI) practices 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 graduate study, to research activity.

- The PIMS EDI Committee (EDIC) includes faculty, students and Postdoctoral Fellows (PDFs) from across the PIMS network. The purpose of the PIMS EDI Committee (EDIC) is to develop implementable, explicit strategies to monitor and improve equity, diversity and inclusivity of the Institute and its activities, and potentially impact the wider mathematical sciences community. 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. The EDI Committee is instrumental in the development of PIMS programs that celebrate diverse communities and their contributions to the mathematical sciences.
- In 2022, Canadian Statistical Sciences Institute (CANSSI) and PIMS hosted two EDI workshops: "Engaging in Dialogue about Race and Bias" in April and "Addressing Conflicts Related to Bias, Privilege, and Identity in the STEM Fields" in November. These workshops provided a supportive space to PIMS/CANSSI communities to learn about the types of conflict that can arise and how to facilitate interventions to confront bias and move towards more equitable learning, teaching, and research environments.
- PIMS is studying the demographics of its PDF applicant pool to work to diversify this pool moving forward. PIMS created a recruitment fund to provide supplemental salary to help make attractive and competitive offers to PDF applicants from diverse backgrounds. This program recognizes that many candidates face additional barriers in academia and seeks to address those inequities to ensure that their mathematical excellence can be recognized and developed.

- 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. An important special session at the recent Pacific Rim Mathematical Association (PRIMA) Congress, hosted by PIMS, celebrated the work of Indigenous mathematicians. Talks included "Teaching Mathematics in Connection to Culture" and "A Pangrammatic Autogram in Plains Cree." PIMS also supported the Indigenizing University Mathematics conference held at First Nations University.
- PIMS is currently starting two new programs 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 but need not be limited to, women, gender-expansive, and minority groups, Indigenous scholars, individuals with visible/invisible challenges and early-career researchers with limited resources. Successful applicants receive lodging and meals at either the Banff or Kelowna BIRS site, as well as reasonable reimbursement of travel expenses. A key goal of this program is for researchers with caregiving responsibilities to fully participate in its scientific activities. To this end, support may also be offered for lodging and travel expenses for children accompanying the member, as well as lodging and travel expenses for a caregiver. The second new program, First Year Interest Groups, aims to build community and networks for graduate students, especially benefiting early career researchers from underrepresented groups. Each group is led by a PIMS PDF and centers on an accessible subject for beginning graduate students.
- 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 2022 Celebration of Women in Mathematics was held in hybrid format and included a Network-Wide Colloquium by Matilde Lalin, a panel discussion and a video montage.

2. HOW WE COMMUNICATE RESEARCH RESULTS AND KNOWLEDGE TRANSLATION TO SPECIALISTS OR NON-SPECIALIST AUDIENCES

- PIMS hosted the 2022 Pacific Rim Mathematical Association (PRIMA) Congress in Vancouver, Canada, from December 4-9, 2022, bringing together a distinguished array of speakers and participants from the Pacific Rim. The PRIMA Congress is held every four years to bring together mathematical scientists from around the Pacific Rim. The PRIMA 2022 Congress event featured two high-profile public lectures. Professor Katherine Stange from the University of Colorado presented "The illustrated field diary of a mathematical naturalist" and Professor Minhyong Kim from the International Centre for Mathematical Sciences, Edinburgh, presented "Measurement, Calculation, and History". PRIMA 2022 also featured a job fair with employers from across North America, and showcased research from early career researchers.

- PIMS continues to showcase the diversity of the mathematical sciences community via the online Network-Wide Colloquium. 2022 talks included "Monge-Kantorovich distance and PDEs" by Benoit Perthame from Laboratoire Jacques-Louis Lions, Sorbonne and "Transcendental values of power series and dynamical degrees" by Holly Krieger from the University of Cambridge. Most of the talks in this series are recorded and available online. In 2022, PIMS ran six other Distinguished Lecture Series at PIMS sites. We expect this number to increase as we continue to emerge from the pandemic.
- 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 2022 PIMS sponsored 19 seminar series at nine different universities.
- During the reporting period, PIMS sponsored 25 research conferences and workshops, including three which were primarily graduate student-oriented.
- The CRM-Fields-PIMS Prize is intended to be 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 2022 the winner was Bálint Virág from the University of Toronto. He presented a lecture titled "Random plane geometry - a gentle introduction". The 2021 winner, Andrew Granville also gave an address in 2022 called "Primes, postdocs and pretentiousness".
- PIMS created MathTube (mathtube.org) as a resource for sharing video 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 is intended to make posting, finding and viewing mathematical content as simple and easy as possible. Currently we are posting all new PIMS media to Mathtube and, in the future we intend to migrate our existing media archives there as well. Recordings of all of the above, if available online, can be found on MathTube.
- Social media is used to spread the word about the excellent research being done across our network. PIMS uses X (formerly known as Twitter), Instagram and LinkedIn to publicize its activities and programs, and to celebrate the accomplishments of its researchers.

3. HOW WE LEVERAGE OUR EXPERTISE IN THE SCIENTIFIC COMMUNITY

- PIMS Director Ozgur Yilmaz is on the Board of Directors of BIRS, the Executive Committee of the UBC Data Science Institute, and the Steering Committee of the UBC-AIM-SI (AI Methods for Scientific Impact) Cluster. He is also 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 has also been nominated for the American Mathematical Society (AMS) Council.
- PIMS Co-Director, International, Jayadev Athreya is a member of the AMS Nominating Committee and will chair it in 2024. He serves on the Park City Mathematics Institute Steering Committee, and is an

associate editor at the Illinois Journal of Mathematics. He will be Chair Jean-Morlet at CIRM Luminy in Autumn 2023.

- BC 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 of all ages get a chance to meet world-class researchers and innovators, participate in hands-on experiments, and see amazing scientific demonstrations.

4. HOW WE CREATE, CURATE, SHARE OR REUSE DATASETS

- 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.

5. HOW WE CREATE, DIRECT, FACILITE AND/OR STRENGTHEN PARTNERSHIPS OR COLLABORATIONS IN THE CANADIAN OR INTERNATIONAL RESEARCH COMMUNITY

- 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 graduate students and creating new research opportunities for young scientists. PIMS started a new CRG in 2022 - L-Functions in Analytic Number Theory. The organizers are from UBC, University of Northern British Columbia and University of Lethbridge. Analytic number theory focuses on arithmetic questions through the lens of L-functions. The main focuses of this CRG include moments of L-functions and automorphic forms, explicit results in analytic number theory, and comparative prime number theory. Other active PIMS CRGs during 2022 were: Movement and Symmetry in Graphs; Pacific Interdisciplinary hub on Optimal Transport; Novel Techniques in Low Dimension; and Quantum Topology and its Applications. The PIMS SRP also recommended funding of a new CRG on "Forecasting and Mathematical Modeling for Renewable Energy" which will launch on April 1, 2023. This new CRG is already planning a flurry of activities in the coming months.
- PIMS SRP recommended funding of our first PIMS Research Network (PRN), "The Kantorovich Initiative" in November 2022. 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. Our first PRN, the Kantorovich Initiative, was created to address challenges in optimization and optimal transport. It is named after the mathematician and Nobel Laureate in Economics, Leonid Kantorovitch. Optimal transport is a unifying theme which brings together diverse areas of mathematics with transformational applications in artificial intelligence, economics, genomics, and logistics problems common to many industry sectors.

- PIMS hosted its largest-ever scientific meeting, the Pacific Rim Mathematical Association (PRIMA) 2022 Congress in Downtown Vancouver in December. Originally scheduled for 2021 and rescheduled to 2022 in response to the pandemic, PRIMA brought together over 250 distinguished mathematical scientists from around the Pacific Rim for a vibrant and exciting meeting, including engaging plenary and public lectures, and high-quality scientific special sessions. A highlight was the first in-person meeting of the Indigenous Mathematicians Network. Starting with an opening reception at the Museum of Anthropology, the PRIMA Congress helped PIMS strengthen its connections with mathematics institutes across the Pacific Rim.
- PIMS Partners with similar institutions around the world, for details on these partnerships, see the "Partnerships" section.

6. HOW WE CO-CREATE OR TRANSFER SERVICE RELATED TO PRODUCTS, TECHNOLOGY, PROCESSES, OR ADVICE USEFUL TO SPECIFIC ORGANIZATIONS, COMMUNITIES OR SOCIETY

- Developed by PIMS, the 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 coming from government or industry. As a result of the 2022 program, 6 products, processes, services or technologies were developed or improved. For example, the team mentored by Heather Hardeman-Vooys of Aerium Analytics used image processing and machine learning algorithms to detect human-made objects in vegetation with images taken by drones. This technology could be used in agriculture to locate equipment or in search-and-rescue operations. The team mentored by Kai Kaletsch of Environmental Instruments Canada (EIC) presented a modification of the usual radon detection protocol which detects the presence of radon-220, rather than only detecting the more commonly observed radon-222. This built on the work done by the 2020 workshop team and further improved EIC's radon detection product. As a result of the continued success of M2PI teams, EIC hired a Mitacs intern. Novion, a green technology company, provides city-workers with a product which allows them to remotely monitor rainfall activity in bioswales. The Novion team, mentored by Devpreet Bhullar, analyzed time-series data collected from bioswales, making it possible to predict from this data when a bioswale will require attention or repair. During the M2PI graduation, Mr. Bhullar reported that the results of this project were expected to save hundreds of worker-hours.
- Syzygy.ca is a project of PIMS, Digital Research Alliance (formerly Compute Canada) 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. Digital Research Alliance has extended their support for another year.
- 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. Our 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 these modules is "Drawing Angles with Turtles" where students visualize and name angles using a Python turtle. Another example is "Visualizing Exponential Growth" in which students explore the

logarithmic scale and exponential growth with COVID-19 case data. Callysto renewed its funding from CanCode in 2022.

7. HOW WE DEVELOP TOOLS 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. 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, visualization and narrative text. Syzygy is deployed at 26 Canadian universities and University of Washington. Syzygy has been used by over 46,000 people and is regularly used by thousands every day. Individual users are given a curated computational environment customizable to research, 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. For example, SFU Statistics uses Jupyter notebooks via Syzygy for roughly 500 students per term.
- 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 80,000 students and 3,000 teachers and the resources created are used and updated via an open source model. The CanCode program was recently renewed and PIMs and Cybera have received funding to extend Callysto to 2024. The theme of the activities in 2022 was "Developing Responsible Digital Citizens"
- As part of the CRG on Optimal Transport (also funded by Genome BC Pilot Innovation fund), a U.S. Provisional Patent was filed in 2022. Title: A DNA-based global positioning system. Inventors: G. Schiebinger, A. Afanassiev, Y. Kijima, L. Greenstreet, N. Yachie and M. Heitz.

8. PUBLICATIONS

Selected key publications (from PIMS PDFs and CRGs):

- C. Cipriani, H. Huang, J. Qui, Zero-inertia limit: from particle swarm optimization to consensus based optimization, SIAM Journal on Mathematical Analysis, 54(2022) 3091-3121.
- I. Boettcher, A. Gorshkov, A. Kollar, J. Maciejko, S. Rayan, R. Thomale, Crystallography of hyperbolic lattices, Phys. Rev. B 105 (2022), no. 12, 125118 - Editor's Pick.
- J. Maciejko, S. Rayan, Automorphic Block Theorems for hyperbolic lattices, PNAS 119 (2022), no. 9, e2116869119. This paper was recently awarded 'Finalist' designation in the Physical and Mathematical Sciences category of the 2022 Cozzarelli Prize, for the best papers published in PNAS this past year.
- J. Males, Higher Siegel theta lifts on Lorentzian lattices, harmonic Maass forms, and Eichler-Selberg type relations - Mathematische Zeitschrift, to appear.
- K. Meagher, M.N. Shirazi, B. Stevens, An extension of the Erdos-Ko-Rado theorem to uniform set partitions, to appear in Ars Mathematica Contemporanea, accepted 25 December 2,22.

- K. Pillutla, S. Swayamdipra, R. Zellers, J. Thickstun, S. Welleck, Y. Choi, Z. Harchaoui. Mauve: Measuring the Gap Between Neural Text and Human Text using Divergence Frontiers. In Advances in Neural Information Processing Systems 34 (NeurIPS), 2021 Outstanding Paper Award.
- N. Irons, M. Scetbon, S. Pal, Z. Harchaoui. Triangular Flows for Generative Modeling: Statistical Consistency, Smoothness Classes, and Fast Rates. In International Conference on Artificial Intelligence and Statistics (AISTATS), 2022.
- S. Pal. On the difference between entropic cost and the optimal transport cost. To appear in The Annals of Applied Probability, 2022.
- Xin Fu, Tseleung So, The homotopy classification of four dimensional toric orbifolds, Proceedings of the Royal Society of Edinburgh Section A: Mathematics, 152, (2022) 626-648.

Non-technical publications:

- PIMS Annual Reports are available on our website.
- PIMS Connection and Year in Review are also available on our website.
- Math to Power Industry final reports-publication is imminent and will appear on the m2pi.ca website.
- In March 2022, quanTA CRG member Steven Rayan and PIMS PDF Kazuki Ikeda were featured in Scientific American in an article about the geometric Langlands program that advertises emerging connections between pure mathematics and condensed matter theory.
- The unique interdisciplinary approach undertaken by the QuanTa CRG at the University of Saskatchewan's Centre for Quantum Topology and Its Applications was featured in a documentary produced by the American Physics Society, available here: https://www.youtube.com/watch?v=02jrbqIWjG4. The importance of this work was stated in the film by Dr. Joseph Maciejko, "We are witnessing a very, very sharp transition which is leading into a revolution which is possibly only comparable to the industrial revolution."

9. HOW WE SUPPORT TRADITIONAL KNOWLEDGE OR INDIGENOUS WAYS OF KNOWING, INCLUDING CULTURAL PRACTICES

- The PIMS Indigenous Engagement Committee (IEC), established in 2021, 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. After a year of online meetings, the IEC had its first in-person meeting at the PIMS Central Offices in conjunction with the 2022 Pacific Rim Mathematical Association Congress.
- An Indigenous Mathematical Scientist session was held at the 2022 PRIMA Congress. One of the lectures was "Navigating Concepts of Ethnomathematics, Decolonizing, and Indigenizing as an Indigenous Mathematics Educator" by Florence Glanfield. Another talk was "Creating an Inclusive Classroom through Traditional Navigation and Wayfinding" by Kamuela Yong.
- The IEC has helped identify several activities that PIMS can help support. Some examples follow.
- PIMS is helping to support the Canadian meeting of the American Indian Science and Engineering Society (AISES), both by supporting the UBC AISES chapter which is hosting the meeting, and supporting travel from AISES members from other PIMS sites.
- PIMS is also supporting the Indigenous Mathematicians Network, and hosted the first in-person meeting of this network at the 2022 PRIMA congress.

III. PARTNERSHIPS AND COLLABORATIONS

1. COLLABORATIONS WITH DIS-FUNDED INSTITUTES

- Atlantic Association for Research in the Mathematical Sciences (AARMS)
  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. They also collaborated in the EIDM Network Mathematics for Public Health, and in an initiative toward a national Mathematics for Climate Change program. PIMS and AARMS supported the Canadian Undergraduate Mathematics Conference.
- Banff International Research Station (BIRS)

  Together PIMS and BIRS launched the PIMS/BIRS Team Up! Program. We also collaborated on several events: Western Canada Math Biology Spring Workshop, Alberta Montana Combinatorics and Algorithms Days, and L-Functions in Analytic Number Theory Launch Event.
- Canadian Statistical Sciences Institute (CANSSI)

  PIMS collaborated with CANSSI on two EDI training workshops "Addressing Conflicts Related to Bias, Privilege, and Identity in the STEM Fields" and "Engaging in Dialogue about Race and Bias". PIMS and CANSSI also collaborated on the Alberta Graduate Mathematics and Statistics Conference as well as the Canadian Statistics Student Conference.
- Centre de recherches mathématiques (CRM)

  PIMS and CRM collaborated on the PIMS-CRM Summer School in Probability and Séminaire de Mathématiques Supérieures (SMS). The topic for the 2022 SMS was Floer Homotopy Theory. PIMS and CRM also collaborated on the Canadian Undergraduate Mathematics Conference, Canadian Statistics Student Conference, and Geometry and Topology Seminar. We co-sponsor the national meetings of CAIMS and CMS. PIMS and CRM collaborate, together with Fields, to award the CRM-Fields-PIMS-Prize. They also collaborated in the EIDM Network Mathematics for Public Health, and in an initiative toward a national Mathematics for Climate Change program.
- Fields Institute for Research in Mathematical Sciences (FIELDS)

  PIMS and Fields collaborated in the EIDM Network Mathematics for Public Health, and in an initiative toward a national Mathematics for Climate Change program. We co-sponsored the national meetings of CMS and CAIMS and supported the Geometry and Topology Seminar and Seminaire de Mathematiques Superieures, and together with CRM, PIMS and Fields award the CRM-Fields-PIMS Prize.

2. NEW CANADIAN PARTNERSHIPS

- Industry
  - > QAI is a not-for-profit corporation aiming to secure BC's position as a global leader in the application of quantum computing technology to real world problems. The goal of the partnership is to leverage the existing quantum computing cluster while building a talent pipeline capable of developing quantum computing software and algorithms.
  - > Awesense Inc. is a company in the green energy sector. Their M2PI team created an app which determines EV charging station capacity on an energy grid.

> Big River Analytics is an interdisciplinary consulting firm. Their M2PI team produced predictive models of labour market information.

> Novion Inc. specializes in green infrastructure management. Their M2PI team used data to monitor changes in water levels in bioswales, saving city worker-hours.

> Perfit is a start-up company developing a virtual fitting room app. Their M2PI team modeled cloth-on-cloth collisions, implementing the result using Fortran.

- Government (federal, provincial, municipal)

  Prairies Economic Development Canada (PrairiesCan) is the department that diversifies the economy across the Canadian Prairies. PrairiesCan leads in building a strong, competitive Canadian economy by supporting business, innovation and community economic development unique to Alberta, Saskatchewan and Manitoba. They have partnered with PIMS to deliver M2PI. This is a 3-year contract.

- Non-government organization

  Cedar Academy Society is a non-profit data analytics organization dedicated to democratizing access to technological developments through data analytics. Their M2PI team integrated real-time traffic data into a digital twin.

- Academia (university or college)

> The Mathematics for Public Health (MfPH) program is a program to develop a national network of infectious disease modelers and public health policy makers that can rapidly respond to public health emergencies. This initiative is a pan-Canadian, Emerging Infectious Disease Modelling (EIDM) multi-disciplinary network that applies advanced mathematical techniques to help achieve public health objectives. This initiative is a partnership between the Fields Institute, the Atlantic Association for Research in Mathematical Sciences (AARMS), the Centre de recherches Mathématiques (CRM), and PIMS.

> Mathematics for Climate Change is a program involving PIMS, Fields, CRM and AARMS and is linked to the upcoming PIMS Action on Climate Thematic Summer. It began with a Climate Change Brainstorming Discussion at Fields in February and continued with a 2-Day Mathematics for Climate Change workshop at Fields in October.

3. NEW INTERNATIONAL PARTNERSHIPS

- Non-government organization

  The PIMS Institutional Exchange Program aims to reduce the carbon footprint of travel. Inspired by the Simons Oberwolfach Visiting Professor Program, it allows scholars to extend visits to include nearby institutions, facilitating additional scientific collaboration. Researchers traveling between PIMS and one of the partner institutes may be funded to extend their visit. Partners include ICERM, IMSI, IPAM, and SLMath (USA), ICTS (India), CIRM and IHP (France).

- Academia (university or college)

  > PIMS has formed a partnership with the Istanbul Center for Mathematical Sciences (IMBM) in Turkey to promote the exchange of researchers in mathematical sciences and collaboration on activities and

research programs of common interest.

> Simons Laufer Mathematical Sciences Institute (SLMath) formerly MSRI in the USA collaborated with PIMS on PRIMA Congress 2022.

4. UNIQUE PARTNERSHIPS AND THEIR IMPACT

- PIMS is an International Research Laboratory of the French Centre National de la Recherche Scientifique (CNRS). This partnership builds collaborations between mathematical scientists at PIMS Member universities and researchers in France. In 2022, the CNRS International Research Lab resumed in-person programs that support research collaborations between France and PIMS. 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 four CNRS Visitors in 2022. PIMS-CNRS Fellowships enable faculty at PIMS sites to visit France for long-term collaborations. There were four of these in the past year. 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. 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. All of these programs were active in 2022. The collaboration between PIMS and CNRS was strengthened in the past year by the reactivation of the Postes Rouges program. These are research positions with 3 months of salary support available to non-French academics at any PIMS member university. Two PIMS researchers will be heading to France in 2023 as part of this program. CNRS is also partnering with PIMS by supporting our Action on Climate Thematic Summer in 2023.
- PIMS partnered with Quantum Algorithms Institute (QAI) to improve Canada's research and development capacity through activities intertwining non-academic partners with network universities. QAI was a major sponsor of the 2022 PRIMA Congress. Together our partnership will include collaboration with respect to a PIMS Research Network and the development of the Math to Power Quantum (M2PQ) program. This will be an industry-academic training and collaboration program focused on Quantum Science.

IV. INTERACTIONS AND OUTREACH

1. NEW INITIATIVES

- PIMS, the University of Victoria and the Association for Women in Mathematics developed an exciting new program for high school students. IMAGINING UVic (Inspiring Mathematical Growth and Intuition in Girls) is a summer camp and seminar series aimed at encouraging young women (grade 11 and 12) to pursue STEM fields. At the summer camp, interactive sessions were led by cutting-edge researchers and introduced participants to new and exciting math concepts which went beyond the BC curriculum. Participants had opportunities to interact and form connections with professors and graduate students in mathematics. Collaborative problem solving was emphasized throughout the week. The program continued during the school year in the form of monthly seminars which built on the concepts introduced during the summer while providing further opportunities for collaboration.
- In 2022, PIMS supported the Girls Excel in Math Summer Camp for grades 7-10 students who identify as girls. The camp aimed to encourage girls to pursue their passion for mathematics and exposed students to female role models in STEM. Students engaged in mathematical sessions and built connections with peers who share similar interests. There was also a "Women in Math" panel that focused on "What can you do with a math degree?"

2. UNIQUE OUTREACH ACTIVITIES

- Summer School for Elementary School Teachers-Many teachers, especially in elementary school, do not have the necessary math knowledge or experience to feel comfortable teaching mathematics. This is a lack that is of essential importance to address to support our students' mathematical learning. For this reason PIMS developed a 4-week summer school for in-service teachers. The aim of this camp is to create teams of 3 teachers at each participating 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; and making teachers the harbingers for institutional change by changing their attitude toward the teaching and learning of math at their schools.
- Bows and Arrows, Stories and Math was an event to allow Indigenous students to see and experience the depth of mathematics, science and engineering within bow making, and their Stoney culture and knowledge. Indigenous High School students were taught orally, from Knowledge Keepers, the stories and processes on how to make a bow and arrow. They created bows and arrows from materials from the Land, while learning about their spirit and stories. This event was co-supported by the Telus Spark Science Centre (https://www.sparkscience.ca/bows-project).

3. SIGNIFICANT CONTRIBUTIONS TO TRAINING AND MENTORSHIP

- Development and delivery of training workshops outside of research or course requirements
  - > Developed by PIMS, the 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 coming from government or industry. PIMS supported 4 summer schools for graduate students in 2022 on emerging research topics.

  - PIMS supports networking and career development for graduate students and PDFs. For example, the PIMS Emergent Research Seminar is an online seminar featuring the research of PIMS PDFs in a venue where potential employers learn about them and their work. We also provide travel funds for PDFs to help them build their network. PIMS organizes career development sessions for both graduate students and PDFs.
  - PIMS and CANSSI have collaborated to provide EDI training events as mentioned above.

- Establishment of safe, equitable and inclusive research environments, practices and norms
  - We established the PIMS Code of Conduct , which provides rules that we expect all organizers and participantof 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 launched the Virtual Experimental Mathematics Lab (VXML) which brings together teams (faculty, postdocs, graduate and undergraduate students) to work on research problems through experimental, computational and visual mathematics, showcasing the mathematical sciences as a creative discipline, and exposing students to research via near-peer mentoring.
  - To facilitate the transition to research for graduate students, PIMS launched the First Year Interest Group (FYIG) program, which brings together small groups of early-year graduate students with a PIMS Postdoc to study active research topics in the mathematical sciences.
  - 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, including through in-person or online targeted activities or capacity building
  - 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.

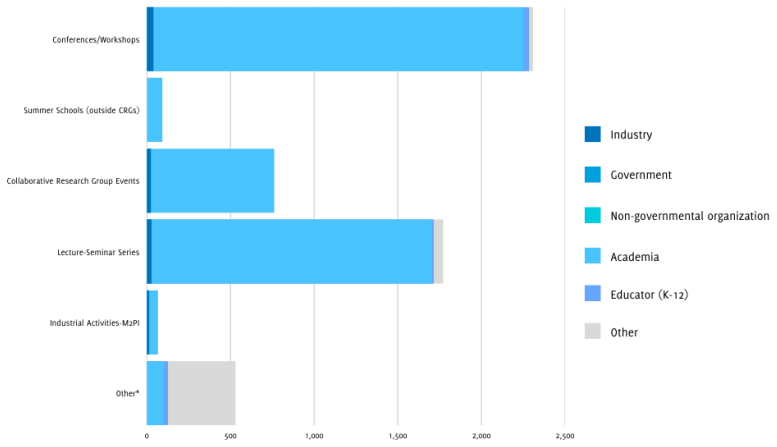
- > PIMS conducts Elmacon, a mathematics competition for students in grades 5-7.
- > PIMS participates in Science Rendezvous, a national program bringing exciting STEM experiences and programming to the public.
- > IMAGINING UVic (Inspiring Mathematical Growth and Intuition in Girls) is a summer camp and seminar series aimed at encouraging young women to pursue STEM.
- > Through the Callysto program, PIMS funds proposals targeting Grades 5-12 students to improve their computational literacy.
- > See above for Girls Excel in Math.

- Supervision of HQP in the research process
  - > PIMS runs a large PDF program (currently 42 PDFs) across its network of 9 Canadian universities. These fellowships are highly competitive and are awarded by our PDF Panel. The expected quality of supervison is one of the main evaluation criteria in awarding these fellowships, with the goal of assuring that the HQP receive appropriate supervision.
  - > During the M2PI workshop, teams of 4-6 graduate students work with industry 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 during the time they are working on the team project; many partners provide more. In addition, many teams consult with an academic mentor during their project as well.
  - > PIMS CRGs and PRNs create long term (3 years) thematic programs that give HQP a dynamic research environment, where they get supervision through interaction with various CRG leaders as well as other students and PDFs in these groups.
- Training in traditional knowledge or Indigenous ways of knowing including cultural practices in the NSE context
  - > The PIMS Indigenous Engagement Committee (IEC) is designed to ensure that PIMS fulfills its commitment to listening to Indigenous voices and ensuring the PIMS community is respectful of and welcoming to Indigenous, First Nations, Inuit and Metis students and researchers. Traditional blessing by Indigenous Elder to open PRIMA.
  - > Indigenizing University Mathematics 2 was a four-day symposium of talks, panels, yarning and sharing. The theme in 2022 was Indigenous perspectives on math and applications. PIMS is proud to be a sponsor for this symposium, which is part of an ongoing project called the Indigenising University Mathematics Project. This conference was held, in part, at the First Nations University of Canada, an affiliate college of PIMS Member the University of Regina. There was strong PIMS involvement in this conference including talks by PIMS IEC members Kamuela Yong and Edward Doolittle as well as several faculty members from PIMS institutions.
- Other
  - > One of the learning modules in the Callysto program is "Coast Salish Basket Motifs" where students can explore geometric motifs and patterns while learning about traditional basket weaving of the Tla'amin Nation. In this notebook, students are able to create their own motif.
  - > PIMS regularly produces Medium articles on a variety of topics. In 2022 we focused on the work of our Postdoctoral Fellows.
  - > Pi in the Sky Magazine is primarily aimed at high-school students and teachers with the main

goal of providing a cultural context/landscape for mathematics. This magazine is available on our website. It includes items on any subject related to mathematics and its applications. In 2022, articles were procured for our upcoming 2023 edition.

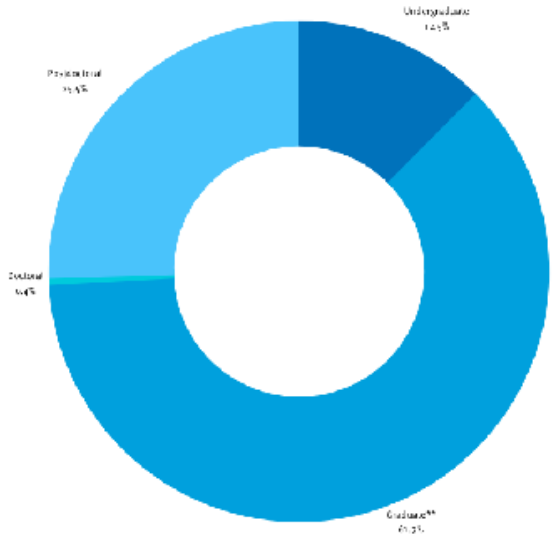
4. DEMOGRAPHIC PARTICIPATION IN INSTITUTE SUPPORTED ACTVITIES

Participation by Activity



*These participant numbers do not include Syzygy or Callysto programs.

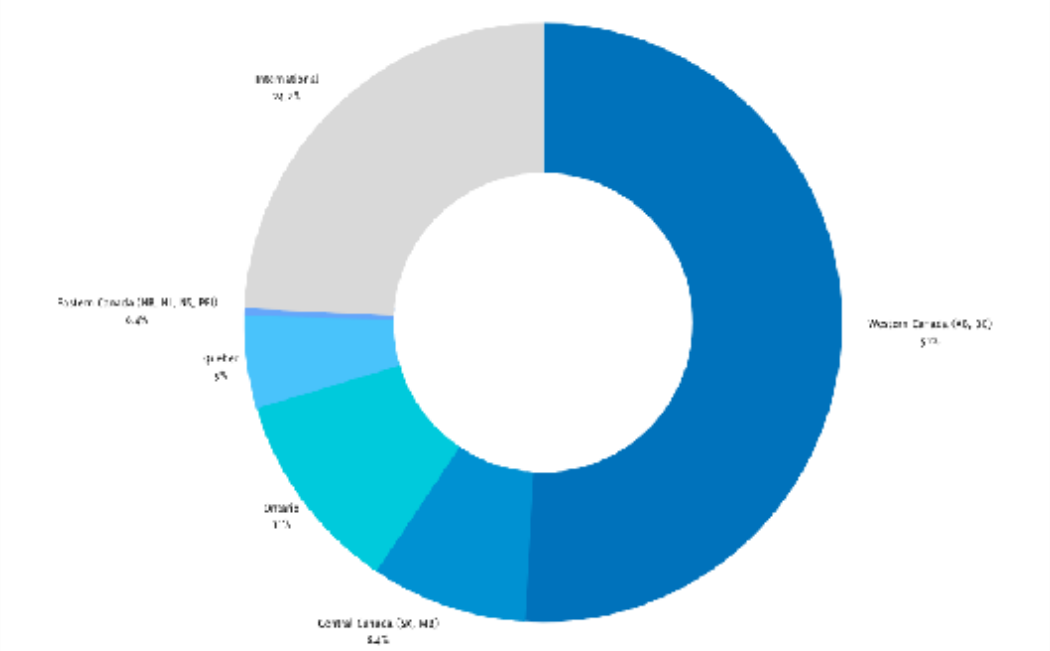
HQP Participation by Career Stage



Numbers in the pie chart are a total sum of the number of participants in institute organized activities, unless specified otherwise. Conferences/Workshops, Summer Schools (outside CRGs), Collaborative Research Group Events, Lecture-Seminar Series, Industrial Activities-M2PI, and Other.

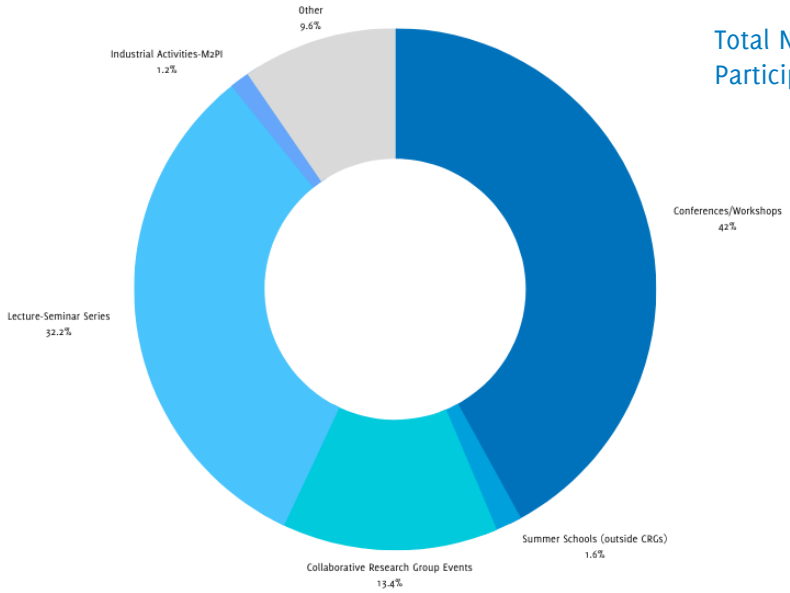
**Except for M2PI, Graduate includes both Master and Doctoral students.

Participation by Region



*Sections in the pie chart are a total sum of the number of participants in institute organized activities, unless specified otherwise: Conferences/Workshops, Summer Schools (outside CRGs), Collaborative Research Group Events, Lecture Seminar Series, Industrial Activities M2PI, and Other.

Total Number of Participants



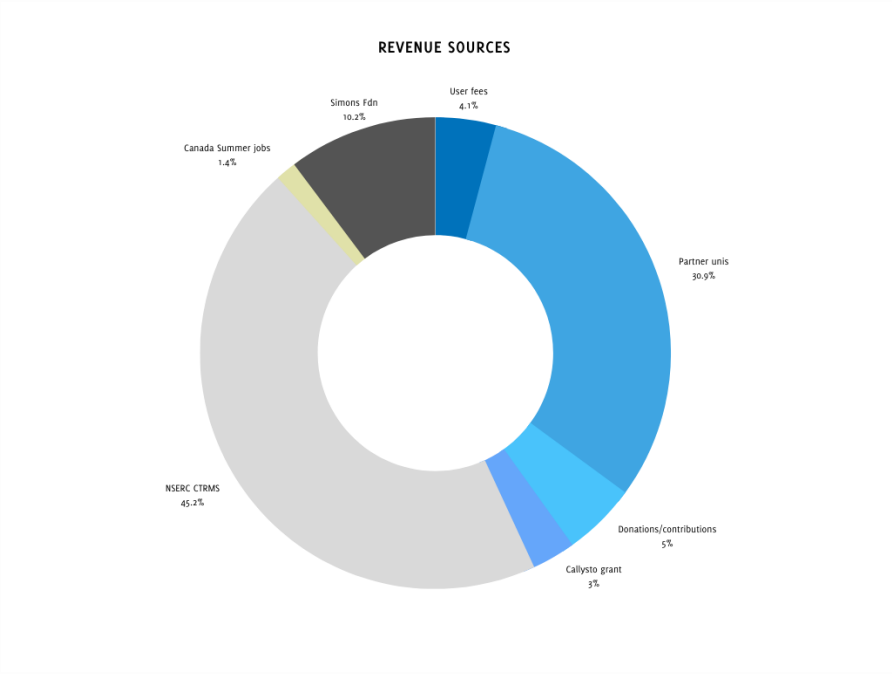
5. CHANGES TO POLICY THAT SUPPORT EQUITABLE AND INCLUSIVE TRAINING AND DEVELOPMENT OF HQP

- PIMS has programs aimed at underrepresented groups including, but not limited to, women, Indigenous Peoples (First Nations, Inuit and Métis), persons with disabilities, members of visible minorities/racialized groups and members of LGBTQ2+ communities.
- For Math to Power Industry recruitment, we advertised at a CMS event for women. This resulted in a high number of female applicants in 2022 and hopefully will serve as a model going forward.
- PIMS and CANSSI collaborated to provide EDI training available to the PIMS community.
- 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 recognizes 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 formed a new Indigenous Engagement Committee to ensure that PIMS listens to Indigenous voices and is respectful and welcoming to Indigenous peoples.
- PIMS/BIRS TeamUp! 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.

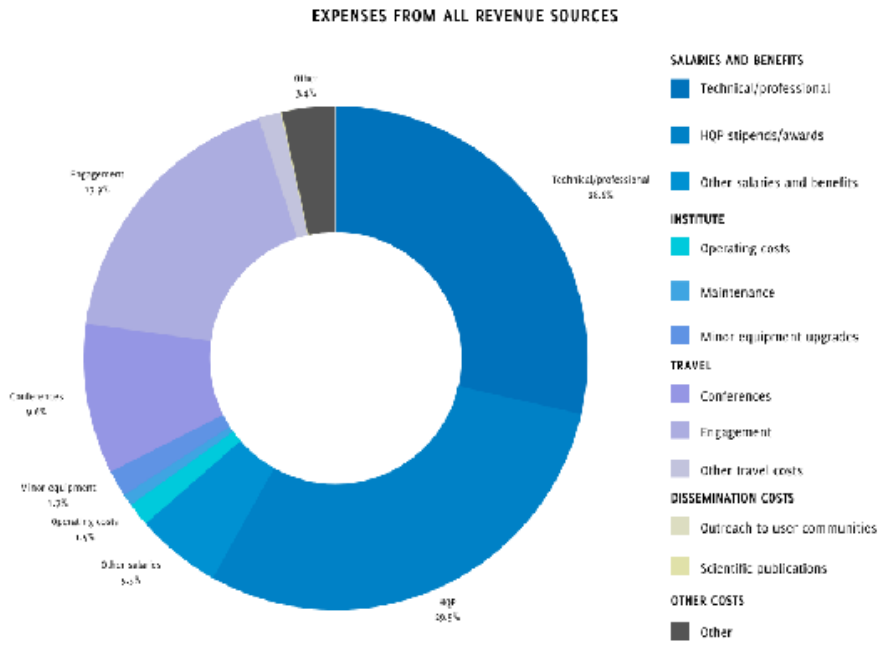
6. UNIQUE MENTORSHIP OR TRAINING OPPORTUNITIES

- The Math to Power Industry (M2PI) program continues to be a unique mentorship and training opportunity for graduate students and postdoctoral fellows. Organizations are invited to submit math challenges for teams of graduate students and postdoctoral fellows to tackle during the workshop. PIMS offers a full week of training in professional skills development, including technical skills (e.g. using collaborative software such as Github), communication skills and teamwork skills. PIMS matches non-academic organizations to teams of 4-6 students to tackle a mathematical challenge provided by the partner organization. Students have access to industry mentors, and industry mentors have access to academic mentors to provide the ideal ecosystem for producing rapid solutions to these challenges. Last year, 6 of 9 partners reported that the solution produced by their M2PI team improved a marketable product or process. Efforts are made to link organizations to talent during and beyond the workshop for the purpose of filling internship or permanent positions.
- To facilitate the transition to research for graduate students in the PIMS network via near-peer mentoring, PIMS launched the First Year Interest Group (FYIG) program, which brings together small groups of early-year graduate students in groups led by a PIMS Postdoc to study active research topics in the mathematical sciences, focusing on a paper or book that inspired the postdoc at a similar stage of their career. We currently have three FYIGs distributed across the PIMS network: Tropical Meteorology and Cloud Modeling; Variational Methods and Partial Differential Equations; Modular Forms in Number Theory.

7. MANAGEMENT AND BUDGET (INSTITUTE REVENUES)



8. MANAGEMENT AND BUDGET (INSTITUTE EXPENSES)



9. NEW INITIATIVES OR CHANGES TO POLICY THAT SUPPORT AN EQUITABLE AND INCLUSIVE RESEARCH, MANAGEMENT OR WORK ENVIRONMENT

- PIMS implemented a 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.
- PIMS established an EDI recruitment fund to provide a salary supplement to recruit candidates from diverse backgrounds. We consider inequities 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.
- In 2022 PIMS supported the Canadian chapters of the American Indian Science and Engineering Society (C-AISES) , the Pacific Northwest Indigidata Conference and the Indigenous Mathematicians Network (https://indigenous mathematicians.org) all related to increasing the representation of Indigenous peoples in STEM studies and careers.

10. CHALLENGES

- Equipment and facilities
  - > At times it has been difficult to secure suitable classroom space for hybrid seminars and events during this year of transition from pandemic social gathering restrictions to the new normal. We have attempted to equip more classrooms with the necessary equipment for hybrid events.
- Staffing issues, inlcuding students
  - > PIMS experienced a leadership transition in July 2022 which presented organizational challenges but also rewards. We previously had a Director and Deputy Director. Now we have a Director, Co-Director Industrial and Co-Director International. The portfolios of the newly created positions were designed to align with the strategic priorities of PIMS and to provide PIMS a strong collaborative leadership team.
  - > The PIMS Communication Assistant position was vacant for a couple of months but has now been filled.
- Barriers or challenges for different groups to fully access or participate in the activities
  - > Once we went back to in-person events, some people with particular health problems had challenges participating while COVID was still a concern. In one instance, an invited speaker contracted COVID while mid-travel. He was able to give his lecture virtually from his local hotel room, and the audience quickly pivoted and invented a virtual social activity for the visitor.
  - > Some potential participants 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
  - > In some cases, Covid restrictions were still in place and some participants had difficulty arranging travel. Whenever possible, we arranged hybrid events.

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
CRG	Collaborative Research Group
CRM	Centre de Recherches Mathématiques
CWiMAC	Connecting Women in Mathematics Across Canada
EDI	Equity, Diversity and Inclusivity
FI	Fields Institute
K-12	Kindergarten to Grade 12
M2PI	Math to Power Industry
M2PQ	Math to Power Quantum
MSRI	Mathematical Sciences Research Institute
NSERC	Natural Sciences and Engineering Research Council
PDF	Postdoctoral Fellow
PIHOT	Pacific Interdisciplinary Hub on Optimal Transport
PRIMA	Pacific Rim Mathematical Association
PTCS	PIMS Postdoctoral Training Centre in Stochastics
QAI	Quantum Algorithms Institute
SRP	Scientific Review Panel
SSC	Statistical Society of Canada
STEM	Science, Technology, Engineering and Mathematics