Pacific Institute *for the* Mathematical Sciences

Year in Review 2021

Simon Fraser University • University of Alberta • University of British Columbia • University of Calgary
University of Lethbridge • University of Manitoba • University of Regina • University of Saskatchewan
University of Victoria • University of Washington

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Dr. Lisa Kalynchuk, Vice-President Research, University of Victoria
Dugan O'Neil, Vice-President Research and Professor of Physics, Simon Fraser University

About PIMS

The Pacific Institute for the Mathematical Sciences was founded in 1996; it is a consortium of universities in the Pacific Northwest and Western Canada.

Member universities: Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Lethbridge, University of Manitoba, University of Regina, University of Saskatchewan, University of Victoria and University of Washington.

Affiliates: Portland State University, the University of Northern British Columbia, and Athabasca University.

The Pacific Institute for the Mathematical Sciences (PIMS) is a collaborative network dedicated to the promotion of discovery, understanding and awareness in the mathematical sciences. PIMS brings together leading researchers from major universities across western Canada, as well as the University of Washington, and is an International Research Lab of the National Center for Scientific Research (Le Centre national de la recherche scientifique, CNRS).

PIMS sponsors and organizes educational and community outreach, aboriginal math camps, and summer schools for both teachers and students, as well as initiatives to promote diversity in mathematics, partnerships that bring mathematical research to industry, cutting edge mathematical and scientific research, and events across the PIMS network that promote advancement in computer science, pure and applied mathematics, and statistics.

The central office is at the University of British Columbia, with a PIMS site office and a Site Director local to each of the ten member universities. The Site Director facilitates local opportunities and synergies, while the PIMS site offices provide administrative assistance for organizing local events. This distributed structure renders it quite unique, involving strong local site offices and activities, and allowing a broad impact across Western Canada and beyond.

The Board of Directors oversees the administration of PIMS, with membership consisting of the VP of Research from each of the member universities, as well as distinguished scientists and representatives from industry. An independent Scientific Review Panel composed of internationally renowned mathematical scientists assesses proposals for scientific events and programs.

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From the Directorate

2021 *has been a year of transition and adjustment for all of us, and PIMS is no exception. With the dedicated efforts of our community and our remarkable staff, we have maintained a high level of scientific activity, often in new and innovative formats, as we adjust to the challenges of the COVID-19 pandemic.*

Network Wide Events

We celebrated our 25th Anniversary with a new Network-Wide Colloquium, held online, with a fantastic collection of lecturers from all across the world (kicked off by former PIMS postdoc Ben Green in February). Our speakers in 2021 included L. Williams (Harvard), J. Baez (UC Riverside), A. Naor (Princeton), M. Malliaris (Chicago), and R. Mazzeo (Stanford), distinguished mathematical scientists representing the diversity of individuals and intellectual approaches in the mathematical sciences community. A huge thanks to PIMS Site Director Anthony Quas of UVic for his leadership and organization of this series.

Pioneered by our former Deputy Director, Marni Mishna of SFU, the Emergent Research Postdoctoral Fellow Seminar highlighted the fantastic research done by PIMS postdoctoral fellows across the network. In 2021, we also held an online orientation for our PDF community, introducing them to the PIMS network and all our resources. To increase awareness of the funding, education, and outreach we participate in, we created a PIMS-at-a-Glance info sheet and held a virtual "open house" session where we invited the PIMS community to drop to say hi, ask questions, and share their ideas about PIMS.

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

Math To Power Industry

Together with our partners in industry and government, and led by Program Director and URegina Site Director Allen Herman, PIMS offered a 4-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. Attendees 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 top-of-the line thinkers and problem solvers. Through the vision of the PIMS Jobs committee, led by UCalgary Site Director Kristine Bauer, the M2PI Workshop is growing to a program of activities offered periodically through the year. This year also marked the first collaboration between M2PI and the BIRS Career & Innovation Hub: the Math to Power Careers and Innovation workshop was held in November.

Public Health

Of course, the role of the mathematical sciences in public health has been at the forefront of our minds during the pandemic. PIMS has been proud to help support the BC COVID-19 Modeling group, which has provided some of the sharpest analyses of the pandemic; to work closely with the Canadian Network for Modeling Infectious Disease (CANMOD); as well as to work with our fellow Discovery Institutes in the Math for Public Health (MfPH) program.

Equity, Diversity, and Inclusion

Equity, Diversity, and Inclusion are part of our core values. We 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 USask Site Director).

A crucial new PIMS initiative in 2021 was constituting an Indigenous Engagement Committee, chaired by

Melania Alvarez (our BC Education coordinator) and made up of distinguished scientists and industrialists from Indigenous backgrounds, to help us identify and support Indigenous-led efforts in the mathematical sciences.

With our terrific education team, also led by Dr. Alvarez, we continue to sponsor summer camps for high school students, and teacher workshops for teachers serving Indigenous students, in the recognition that these issues start very early on the pathways to careers the mathematical sciences.

To support PIMS community members who want to learn more about EDI issues, we are sponsoring, in collaboration with CANSSI, training activities for our members.

PRIMA 2022

PIMS is proud to be hosting the Pacific Rim Mathematical Association (PRIMA) 2022 congress in Vancouver. Originally scheduled for 2021, we have moved it to 2022 in recognition of the pandemic. PRIMA will bring together distinguished Mathematical Scientists from around the Pacific Rim for a vibrant and exciting meeting.

Partnerships

PIMS is unique in its stature as an international institute, with members in the US and Canada, and our status as a CNRS International Research Lab. We are continuing to work closely with our fellow mathematical sciences institutes in Canada and across the world, including exciting new exchange

programs with institutes in France, the US, and India. 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.

CRGs and PRNs

We continue to develop and support our key collaborative research programs, with exciting new programs emerging in the fields of Optimal Transport, Quantum Topology, Movement and Symmetry in Graphs, and L-functions in Number Theory, covering a wide range of the mathematical sciences and their applications. Basic research in the mathematical sciences is, and always will be, the heart of what PIMS does.

Leadership

In July 2021, a new leadership team took over at PIMS. We (Jayadev and Özgür) are very lucky to follow in the footsteps of Jim Colliander and Marni Mishna, who have taken PIMS from strength to strength. With the advice and help of many members of the PIMS community (especially our Board, our Site Directors, and our incredible staff), the transition has been smooth, and PIMS is in a strong position moving forward. In 2022, we will have a new leadership structure, with Özgür stepping into the role of Director, Jayadev becoming the Co-Director, International, and Kristine Bauer becoming Co-Director, Industry. We look forward to serving PIMS well in the years to come. Thank you for all your support!

Dr. Jayadev Athreya
Interim Director

Dr. Özgür Yilmaz
Incoming Director

PIMS 25th Anniversary

Since its inception in 1996, the Pacific Institute for the Mathematical Sciences has been and continues to be a leading player in the Mathematical Sciences both nationally and internationally. At the time of its inception, PIMS was the third of Canada's Mathematical Sciences Institutes. PIMS founders, Nassif Ghoussoub (UBC), Ivar Ekeland (UBC), Ed Perkins (UBC), Arvind Gupta (UBC, now UT), George Bluman (UBC), Uri Ascher (UBC) and other scientists, worked tirelessly to build a unique institute within Canadian mathematics and to secure funding to ensure its continued existence. After 25 years, the benefits of PIMS' impact can be seen across the globe. A short summary of our efforts are briefly described below:

Annually, PIMS hosts or co-hosts more than 60 scientific workshops, conferences, summer schools and seminar series across our 10 member and 3 affiliate universities.

Our Educational Coordinators have been particularly active in organizing events targeted to students from K–12 and high school teachers. The famous event, Changing the Culture, is a one day conference drawing teachers from across the Vancouver mainland. Since the first meeting in 1998, the conference has grown tremendously and is popular amongst Mathematics educators. It has now moved online with an even greater participation rate across Western Canada.

Industrial programs have been at the heart of PIMS events. PIMS has hosted industrial problem solving workshops, the Shell Lunchbox Lectures in Calgary,

and many other collaborations in the private and public sectors. In 2020 and 2021, PIMS hosted the Math to Power Industry workshops online. Students have managed to secure internships and appointments as a result of these programs.

The PIMS PDF program is a highly competitive program and selected PDFs are recognized and respected the world over. Most continue in academia, but many move to industrial positions.

We continue to collaborate with our partner institutes across Canada. We work with Canadian Mathematical Society (CMS), Atlantic Association for Research in the Mathematical Sciences (AARMS), and jointly collaborate with the Canadian Statistical Sciences Institute (CANSSI), the Fields Institute for Research in Mathematical Sciences (FIELDS) and Le Centre de recherches mathématiques (CRM) on prizes, summer schools and other research opportunities.

Last but not least, while PIMS leaders were growing the institute, they were also planning the establishment of Mathematics of Information Technology and Complex Systems (MITACS)!!

"Much more recently mathematicians at UBC, SFU and UVic joined forces to create PIMS, the Pacific Institute for the Mathematical Sciences. They were joined by the two major universities in Alberta. I think that PIMS will become a very important institution, with an influence that extends far beyond the first-class mathematical research done by its members. Mathematics has been called the language of high technology. It is part of the mission of PIMS to extend literacy in that language to business and industry in all sectors of the economy, and in that way to help them use the most modern tools in solving their problems. The organizers of PIMS have received NSERC support to try doing this, and based on their success to date I think that PIMS has the potential to raise by a couple of notches the level of technical competence in all sectors of business and industry in western Canada..." Tom Brzustowski, NSERC President in a 1998 speech at the Vancouver Board of Trade.

2021 Around the Sites

UNIVERSITY OF LETHBRIDGE
Habiba Kadiri (ULethbridge), Keira Gunn (UCalgary) and Dang Khoa Nguyen (UCalgary) hosted the online event, Summer School on Inclusive Paths Toward Number Theory, that brought together undergraduates in the mathematical sciences. The summer school had 9 lecture sessions and 1 EDI session, all delivered through Zoom, and had active participation in all the sessions.

UNIVERSITY OF REGINA
The PIMS URegina Distinguished lecture was given by University of Regina hosted Adrian Ioana from UC San Diego, Classification and rigidity for group von Neumann algebras .

UNIVERSITY OF CALGARY
The PIMS UCalgary Math and Philosophy Lectures aim to introduce topics at the intersection of mathematics and philosophy to a general academic audience. The 2021 Lecture was given by Patricia Blanchette, University of Notre Dame. her topic, Geometry, Logic, and Philosophy: The Case of the Parallels Postulate, investigated the development of tmodels and modelling as it transitioned from a geometric tool to an all-purpose tool of logic.

UNIVERSITY OF MANITOBA
UManitoba once again hosted the Path2Math Academy for Indigenous undergraduate students. The program is designed to improve the outcomes of Indigenous students in mathematics and science, and increase representation of First Nations, Metis and Inuit students in science courses and programs at the University of Manitoba. The program expanded from one week to two, and was coordinated by the PIMS-UManitoba Education Coordinator, Darja Barr, and Emily McKinnon from Access.

UNIVERSITY OF BRITISH COLUMBIA
In the spring of 2021 UBC-Okanagan and the Thompson Rivers University brought together optimizers and mathematicians at Thompson Rivers University (TRU) and the University of British Columbia (UBC), Okanagan campus for the inaugural TR(U)BC Seminar. This half day event featured Yana Nec (TRU) and Heiinze Bauschke(UBCO) giving talks on spike patterns and projection Mappings. UBC Vancouver hosted Cheryl Praeger for the annual Niven Lecture, and in the fall continues the PIMS-UBC Math Job Forum-an annual Forum to help graduate students and postdoctoral fellows in Mathematics and related areas with their job searches.

SIMON FRASER UNIVERSITY
Activities at SFU continued despite covid. SFU held the Discrete Math seminar series almost every other week during the year. The computational and applied math series continued to actively meet via Zoom.

UNIVERSITY OF VICTORIA
The Math Department Colloquia continued online and speaker talks were hosted on Mathtube.org. The PIMS Distinguished Colloquium, by Louigi Addario-Berry was given in the Fall. The UVic Probability and Dynamics Seminar began its series in the Fall semester as well. One highlight from the Mathematical Sciences was the event"Women Leading Change in STEM". This was hosted online by the University, to mark International Women's Day.

UNIVERSITY OF SASKATCHEWAN
The PIMS Collaborative Research Group (CRG) in Quantum Topology and its Applications (quanTA) hosted the second PIMS Summer School on Algebraic Geometry in High-Energy Physics. The four-day virtual summer school provided early-career researchers with new perspectives on algebraic geometry in high-energy physics. The CRGS hosted a regular quanTA seminar throughout the semesters.

UNIVERSITY OF ALBERTA
Though delivered online, UAlberta hosted the fourth PIMS Diversity in Math Summer School in July 2021. The Summer Schools aim to promote diversity and inclusivity in STEM. The 2021 had two streams One for high school students in grade 11 and 12; and the second for Indigenous students in grade 9 and 10 transitioning into the precalculus stream of math courses in high school. More than 30 students from Alberta and BC participated in the online event.

UNIVERSITY OF WASHINGTON
UWashington welcomed its very own Arunima Bhattacharya to give the PIMS Distinguished lecture in the Fall of 2021. The PIMS CRG on Optimal Transport began the PIHOT Seminar Series held online, speakers included Nathael Gozlan (University of Paris), Jan-Christian Hutter (Genentech), Lang Liu (University of Washington) amongst others.

2021 Announcements

Indigenous Engagement Committee

The PIMS IEC is designed to ensure that PIMS fulfills its commitments to listening to Indigenous voices and ensuring the PIMS community is one respectful of and welcoming to Indigenous First Nations, Inuit and Metis students and researchers. The committee, chaired by Melania Alvarez (UBC/PIMS) includes the PIMS directorate, distinguished Indigenous scientists and educators from across North America and the Pacific Rim

Committee Members

Dr. Jayadev Athreya, UWashington, PIMS
Dr. Melania Alvarez, UBC, PIMS
Shawn Desaulniers, UAlberta
Hannes Edinger, Big River Analytics, PIMS BoD
Ian Foulds, UBCO, Indigenous Reconciliation in Engineering

Dr. Florence Glanfield, UAlberta, Vice Provost for Indigenous Programming and Research
Marissa Loving, Georgia Tech
Robert Megginson, UMichigan
Kamuela Yong, UHawaii

Leadership Transitions

The PIMS Board approved the appointment of Prof. Jayadev Athreya as the Interim Director of PIMS, and Prof. Özgür Yilmaz as the Interim Deputy. Both positions will be active until the end of June 2022, when new transitions begin. On July 1, 2022 Prof. Yilmaz will begin his term as the PIMS Director. He will be joined by Prof. Kristine Bauer (UCalgary) who will join the team as Co-Director Industry. Prof. Athreya will continue to be a part of the directorate, joining the team as the Co-Director International.

Collaborations with the Quantum Algorithms Institute (QAI)

This partnership is designed to leverage BC's existing quantum computing cluster within academia and industry while building a talent pipeline with capabilities in developing quantum computing software and algorithms and the application of quantum technology to real world problems. A defined goal is to develop the Math to Power Quantum (M2PQ) program, an industry-academic training and collaboration program focused on quantum science. QAI will participate in the PRIMA 2022 Congress.

2021 New Collaborative Research Groups

Movement and Symmetry in Graphs: 2021–2024

The Movement and Symmetry in Graphs Collaborative Research Group will look at Graph Theory. Graph theory is a thriving discipline that lies at the interface of computer science and pure mathematics; the goal of this CRG is to make the prairie region into a thriving centre for graph theory, and an international destination for researchers interested in this field. The strengths of the CRG lie in the overlapping and complementary areas of algebraic graph theory, combinatorial matrix theory, graph and hypergraph infection and percolation, and extremal combinatorics. These are all very active fields, and the best modern results are found using an inter-disciplinary approach.

CRG Organizers: Karen Meagher (University of Regina), Joy Morris (University of Lethbridge), Karen Gunderson (University of Manitoba)

Pacific Interdisciplinary Hub on Optimal Transport: 2021-2024

The Pacific Interdisciplinary hub on Optimal Transport (PIHOT) is a Collaborative Research Group examining the research and applications of Optimal Transportation across a wide audience of researchers, students, industry, policy makers and the general public.

CRG Organizers: Young-Heon Kim (University of British Columbia), Soumik Pal (University of Washington), Brendan Pass (University of Alberta)

2021 Prizes & Awards

CRM-Fields-PIMS Prize
Andrew Granville, University of Montréal

Professor Granville's broad range of accomplishments include tackling questions in arithmetic geometry, Diophantine approximation, algorithmic and cryptographic aspects, and his deep contributions to analytic number theory. Professor Granville has more than 160 published papers to his credit, many of which appear in the field's top journals.

Professor Granville has played a significant leadership role in Canadian mathematics since obtaining his PhD from Queens University in 1987. In 2002, he joined the Department of Mathematics and Statistics at the Université de Montréal as a senior Canada Research Chair. His presence has had a galvanizing effect on the Montreal mathematics community, in particular. The list of graduate students and postdocs he has trained reads like a who's who amongst the younger generation of stellar analytic number theorists.

CAIMS PIMS Early Career Winner
Brendan Pass, University of Alberta

Prof. Brendan Pass of the University of Alberta is awarded the 2021 CAIMS/PIMS Early Career Award in recognition of his contributions to the study of optimal transport problems. In particular, Dr. Pass has worked on multi-marginal optimal transport problems, Wasserstein barycenters, and optimal transportation between unequal dimensions. These problems have many applications including in economics, physics, and quantum chemistry. Prof. Pass is one of the organizers of the PIMS Collaborative Research Group Pacific Interdisciplinary Hub on Optimal Transport.

PIMS Education Prize
Dr. Bruce Dunham, University of British Columbia

Dr. Dunham has served on the British Columbia Committee on the Undergraduate Program in Mathematics (BCCUPMS) since 2006 and has been the chair of the BCCUPMS Statistics sub-committee since that time. At the national level, Dr. Dunham has served in various roles in the Statistical Society of Canada. He has served on the executive committee of the Society's Education Section, having previously been secretary and president and currently president-elect. He has served on the Society's Education Committee.

The evaluation committee was particularly impressed by the direct public impact of his curriculum work in the BC school system, and the development of free software for the community. Dr. Dunham is a tremendous advocate for mathematics and statistics, his leadership contributes to public awareness, fostering communication among various groups concerned with mathematical training.

Digital Collaboration and Learning During the Pandemic

The PIMS Digital Collaboration Committee has been responsible for advising on all aspects of PIMS digital operations. This includes evaluating and recommending technologies for collaboration and events, as well as organizing larger programs such as the PIMS Network Wide Digital Courses initiative, which makes graduate level courses in the mathematical sciences available throughout the PIMS network and beyond.

Production Studios: Investment in Remote Learning Technology

PIMS offices in both UBC and UManitoba have invested in the technology necessary to participate in remote and hybrid learning across the sites. Production studios will allow for more engagement using popular applications such as zoom, Microsoft Teams, Bluejeans and a host of other platforms.

PIMS Network-wide Graduate Courses

The PIMS Network-wide graduate courses utilize the PIMS network to deliver a rich variety of graduate level courses in the mathematical sciences at PIMS member universities. This program benefits instructors by reaching a larger potential audience and students by offering a broader variety of courses. Students at PIMS sites can typically receive credit for the courses in this program through the Western Deans Agreement (some conditions and fees may apply). Instructors offering courses apply in the spring and fall, and if selected meet with members of the PIMS Digital Collaboration Committee to discuss logistics and support. Selected courses are advertised throughout the PIMS network and may be eligible for course related expenses.
PIMS Courses offered:

Courses were offered between Jan 1, 2021 and Dec 31, 2021 and included the following:

- Algebraic Topology: Martin Frankland (University of Regina)
- Algebraic Topology with Applications in Combinatorics: Bojan Mohar (Simon Fraser University)
- Cantor Minimal Dynamics: Ian F. Putnam (University of Victoria)
- Comparative Prime Number Theory: Greg Martin (University of British Columbia)
- Stochastic Differential Equations: Yaozhong Hu (University of Alberta)
- Ergodic Theory: Christopher Hoffman (University of Washington) , Anthony Quas (University of Victoria)
- Design and Analysis of Experiments Adam Kashlak (University of Alberta)
- Introduction to Vertex Algebras and Their Representation Theory: Fei Qi (University of Manitoba)
- Mathematical Data Science: Lele Wang (University of British Columbia)
- Parallel Programming for Scientific Computing: Raymond Spiteri (University of Saskatchewan)
- Optimal Transport + Machine Learning (OT + ML): Zaid Harchaoui and Soumik Pal (University of Washington)
- Differential Equations in Algebraic Geometry: Charles Doran (University of Alberta)

Network-wide Colloquium Series

Starting in 2021, PIMS inaugurated a high-level network-wide colloquium series. Distinguished speakers gave talks across the full PIMS network with one talk per month during the academic term. The 2021-2022 speaker series is part of the PIMS 25th Anniversary showcase.

- February 2, 2021 - New Lower Bounds for Van der Waerden Numbers: Ben Green, University of Oxford
- March 11, 2021 - From Hopping Particles to Macdonald and Schubert Polynomials: Lauren Williams, Harvard University
- April 7, 2021 - The Answer to the Ultimate Question of Life, the Universe and Everything: John Baez, University of California (Riverside)
- September 23, 2021 - Isomorphic Reverse Isoperimetry and Lipschitz Extension: Assaf Naor, Princeton University
- October 28, 2021 - Model theory and complexity: Maryanthe Malliaris, University of Chicago
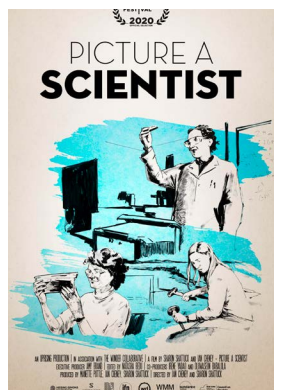- November 18, 2021 - Z_2 harmonic spinors in gauge theory: Rafe Mazzeo, Stanford University

Equity, Diversity, and Inclusion

Since 2020, the PIMS EDI Committee (EDIC) had met regularly 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. The Committee strives to support inclusivity at all stages from K to retirement, recognizing that gains made through support of one level can often be impacted by a weakness at another. They recognize that clear, successful policies are required by funding agencies. Within the mandate of the committee is the consideration of inequities faced by women, Indigenous Peoples, persons with disabilities, members of visible minorities and diverse sexual orientation and gender identities. In 2021 the EDI Committee hosted two noteworthy events with the PIMS community. It also oversaw the development of the first PIMS EDI snapshot.

Picture a Scientist - Women in Mathematics Day, Movie & Panel Discussion: May 12–15

As part of Women in Mathematics Day, PIMS hosted a free, online film screening followed by a panel discussion with the PIMS Network. The panel discussed notable issues affecting women and marginalized groups in the mathematical sciences and invited questions and contributions from participants.

The panelists included Dr. Shawn Desaulniers (University of Alberta), Hon. Dr. Lilian Eva (Quan) Dyck (University of Saskatchewan), Dr. Piper H (University of Toronto), and Dr. Mary Catherine Kropinski (Simon Fraser University).

PIMS EDI Panel - Effective Allyship in STEM: June 16

Following the successful Panel on Women in STEM held in May, this event looked at ways in which effective allyship can build a better and stronger community in the Mathematical Sciences. The panelists looked at actionable steps we can take to be better champions in academia. Participants were invited to engage in the conversation.

THE PANELISTS INCLUDED SOPHIE MACDONALD (UNIVERSITY OF BRITISH COLUMBIA), BOBBY WILSON (UNIVERSITY OF WASHINGTON), SHIROU WANG (UNIVERSITY OF ALBERTA), DOUGLAS FARENICK (UNIVERSITY OF REGINA), GREG MARTIN (UNIVERSITY OF BRITISH COLUMBIA).
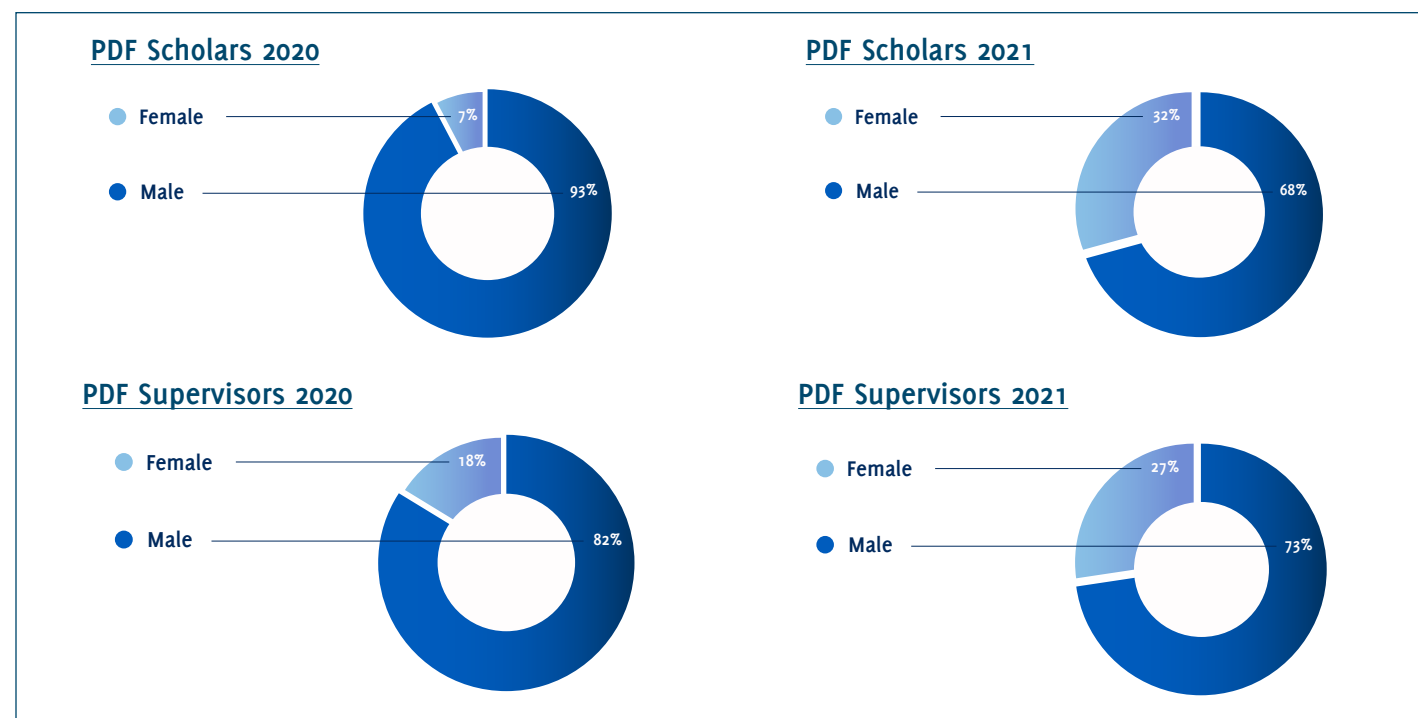
2020–2021 Equity, Diversity, and Inclusion Snapshot

The programs that PIMS supports should promote and develop a rich research community, and be accessible to every member of the community. PIMS makes an effort to track and quantify ratios in the level-of-study and gender representation in our leadership and meetings. The data we collect from our meetings and events is anonymous and voluntarily submitted. Data on participant level of study is broken down to Faculty, Postdoctorate, PhD, MSc and Undergraduate levels; gender is tracked in binary form: male or female.

PIMS EDI Report 2021

Each year, PIMS invites nominations for postdoctoral fellowships in nine of the Member Institutions. Candidates must be nominated by one or more scientists/supervisors. Gender inclusivity was highest in 2021 for accepted scholars and supervisors.

See the full report online for more demographics on executive leadership, meetings and events, and PIMS Prize Winners. https://www.pims.math.ca/files/PIMS_EDI_Report_2021.pdf

PDF Scholars 2020
- Female
- Male

7%
93%

PDF Scholars 2021
- Female
- Male

32%
68%

PDF Supervisors 2020
- Female
- Male

18%
82%

PDF Supervisors 2021
- Female
- Male

27%
73%

Postdoctoral Fellows

Every year PIMS sponsors numerous postdoctoral fellows (PDFs), attracting outstanding young scientists who contribute to PIMS research programs, many of whom later become faculty members at Canadian universities. PDFs are distributed throughout PIMS sites on a competitive basis. In addition, each one of PIMS' Collaborative Research Groups is allocated a number of PDFs, the selection of which is determined by an assessment panel. PIMS PDFS are required to present their work at the Emergent Research Seminars.

2021 Postdocs:

Natalie Clare Behague (UVic)
Raphaël Belliard (UAlberta)
Kubra Benli (ULethbridge)
Jordan Culp (UCalgary)
Elizabeth A Carlson (UVic)
Wenzhao Chen (UBC)
Jesse Jianting Huang (UAlberta)

Reinier Kramer (UAlberta)
Joshua Benjamin Males (UManitoba)
Evan Miller (UBC)
Anirudh Asuri Mukundan (UBC)
Venkata Raghu Tej Pantangi (ULethbridge)
Hansol Park (SFU)

Youngmin Park (UManitoba)
Puttipong Pongtanapaisan (USaskatchewan)
Meredith R Sargent (UManitoba)
Thomas Alexander Theurer (UCalgary)
Prateek Kumar Vishwakarma (URegina)
Amy Wiebe (SFU)

Featured Postdoctoral Fellow: Elizabeth Carlson

Postdoctoral Researcher at the University of Victoria
Our PIMS PDF Elizabeth Carlson, started her PDF tenure at the University of Victoria, BC in July 2021. She grew up in Helena, Montana, was homeschooled, attended Carroll College in her hometown (in her words the "best undergraduate institution I have ever encountered"), and graduated with a major in mathematics and a minor in physics in 2016. She got her Masters in 2018 and Ph.D. in 2021 at the University of Nebraska — Lincoln, where for the last three of those years she was a National Science Foundation (NSF) Graduate Research Fellow. She spent the last two years of her Ph.D. at Los Alamos National Laboratory applying her theoretical research in the real-world setting of climate science, in particular oceanography.

Her research is in fluid dynamics, focusing on the well-posedness of systems of partial differential equations (PDEs) and numerical computations and analysis in fluid dynamics. "My work has been directly tied to the core of what drives my passion for research: the rigor of theoretical mathematics provides deeper insights into observations of the physical world, and observations provide intuition for directions to explore in

theoretical mathematics", she notes.

Elizabeth's interest in this research area was first sparked in her first internship. She had taken a class on multivariable calculus and had studied wind vector fields and high altitude balloons. The study qualified for an application for the Montana Space Grant Consortium's BOREALIS Internship program. It is at BOREALIS (in full the Balloon Outreach, Research, Exploration And Landscape Imaging System) where Elizabeth's interest in fluid dynamics spawned. The internship and its overall exposure to multidisciplinary skills and learning directly impacted both her undergraduate senior thesis and doctoral dissertation.

For her doctoral work, she had been

studying data assimilation, a collection of methods that uses observed data to inform a mathematical model when the initial condition is not known. Specifically, she investigated analytical bounds on error in the context of incorrect parameters, sensitivity of systems of equations to the choice of parameters, well-posedness and convergence of a nonlinear version of the algorithm, and has implemented the algorithm in the context of real-world models. She has 5 papers on this topic and is involved in an ongoing research group in this area.

At the University of Victoria, Elizabeth works with her Sponsor, Prof. David Goluskin. They are currently studying energy stability using sum of squares techniques and semi-definite programming, and exploring many related research topics. Of her current research, Elizabeth notes that "It will require a lot of the same techniques I have studied and adapted over the years, but there are many new techniques and ideas I am learning. In fact, one of the main reasons I chose to accept this postdoc was because of the opportunity it provided to sharpen and expand my existing skill set, in addition to the fact that the project uses both theoretical and applied mathematics to gain insight into the problems".

Education Overview

PIMS is dedicated to increasing public awareness of the importance of mathematics and encouraging students to see mathematics as a subject that opens doors to careers in many exciting fields. An integral part of the PIMS mandate is to enrich public awareness of mathematics through outreach and to enhance mathematical training for teachers and students in K-12. PIMS is also a strong advocate for First Nations students.

Math education and outreach are fundamentally important components of PIMS' activities. We engage and connect with the different groups within the PIMS community, and deliver relevant content that promotes K-12 education in math through high quality education programs.

Changing the Culture: May 20

The annual Changing the Culture Conference, organized and sponsored by the Pacific Institute for the Mathematical Sciences, brings together mathematicians, mathematics educators and school teachers from all levels to work together towards narrowing the gap between mathematicians and teachers of mathematics, and between those who do and enjoy mathematics and those who think they don't. Changing the Culture has been held every year, in person, at SFU Harbour Centre in Vancouver. Due to pandemic restrictions, the 2020 and 2021 conferences were held online—more than 100 educators joined via Zoom.

Diversity in Math High School Math Camp: July 26–30

The 2021 Diversity in Math High School Summer Camps were run as entirely online experiences from July 26-30, starting with a joint welcome ceremony featuring an inspirational drum performance and presentation by Steve Wood. This year the summer school was run in two different streams: a camp of Indigenous students in grades 9-10, and an enrichment camp for students in grades 11-12. Facilitating the programs were Professors Shawn Desaulnier and Charles Doran from the University of Alberta.

The Indigenous Students' camp was an amazing experience for the students who participated. Students from Alberta including some from remote communities registered for the program. The Lead instructor was Gordon Naylor, a Math teacher and an Assistant Principal at Maskwacîs Education Schools in Alberta. Gordon is from the Muskoday First Nation in Saskatchewan and grew up mostly in Wabasca, Alberta. There was an opportunity for the students to experience multiple facets of mathematics, diving into conceptual and application-based aspects of junior high to university level math. Students spent time with Gordon each morning and had guest speakers in the afternoons. The morning math sessions helped the students prepare for the STEM version of grade 10 math. The afternoon sessions focused on important applications of advanced mathematics for Indigenous communities such as digital literacy, data science, and population modeling, as well as ethnomathematics.

This camp will continue to be a success in years to come as we prepare more indigenous students to pursue higher-level mathematics in high school and post-secondary. Prof. Desaulnier noted that " Showing these young people what math can do for them and with them creates brighter futures for all the reserves, settlements, and municipalities they live in".

Gordon Naylor

The second stream, the Enrichment Camp facilitated by Prof. Charles Doran, consisted of three lecture series by Delilah Gates (Harvard), Kevin Iga (Pepperdine); Prof. Doran did double duty by substituting for Elana Kalashnikov's lectures). The students were introduced to sophisticated undergraduate-level mathematics involving relativity, topology, and combinatorics.

Halfway through the week, the students began working on small group projects, guided by the lecturers and TAs, building on what they had learned in the lectures. This "learning by doing" provided a taste of research in mathematics. The students gave their own presentations on what they discovered in a ceremony on Friday morning. One highlight of the event was the "Zoom-bombing" by Prof. Jim Gates, President of the American Physical Society.

The success of the DIM program is a result of careful planning and we hope to host it again in 2022.

> " The course was interesting, engaging and fun. I really enjoyed exploring new concepts in a new and exciting way. Melania and Cameron helped me to think outside the box, discuss math concepts with friends and family and genuinely renewed my love for math. Thank you to everyone who made this course possible; it should be a staple for all elementary teachers! —Participant

Math Summer School for Elementary School Teachers: July 5–30

Throughout July, elementary school math teachers from districts all over BC met with PIMS Education Coordinator, Melania Alvarez, and UWaterloo Lecturer, Cameron Morland. Together they practiced various exercises, shared ideas, watched inspiring videos—all for the purpose of getting their students hyped on math.

The material was diverse and touched multiplication, algebra, and fractions. Concepts were explored in geometry, barter systems with beans, triangles with compass, origami, and fractions. Hands-on activities, along with small group interactions, allowed participants to share and learn with each other.

Key takeaways from the course include:

- Slowing down and taking the time to really explore numbers and ensure the students are understanding
- Using puzzles and games that were open-ended, allowed for multiple solutions and approaches
- Process vs. product — the process in which students learn is more important than the product

Bows and Arrows, Stories, and Math: August 3, 4 and 10

In July and August, TELUS Spark Science Centre and PIMS, supported Îyârhe Nakoda Youth to create bows and arrows using Indigenous and Western knowledge, science, engineering, and math. Knowledge was passed on through stories by local Îyârhe Nakoda Elders and Knowledge Keepers. From this knowledge, participants learned experientially to locate adequate trees, how to carve, and the importance of testing and breaking different arrows and bows. Experiential methodologies are central to learning through Indigenous perspectives, as they allow the body and spirit to learn relationally.

Scientific highlights of this workshop included:

- Trajectory (how to fire a bow, angles, movement)
- Force of bows (differences between wood, size, balance, purpose)
- Arrow Aerodynamics (feather positing, wood)
- Relationally between trees, water, and ideal wood for bows
- Biology of different trees (chokecherry, diamond willow) used for different of bows
- Science of traditional materials (rocks, hide, granite, sap, sinew)
- Leverage in making and shaping the bows and arrows

This workshop took place in Îyârhe Stoney Nakoda Land and Calgary, Alberta—which is situated on the traditional territories of the people of the Treaty 7 region in Southern Alberta, which includes the Blackfoot Confederacy (comprising the Siksika, Piikani, and Kainai First Nations), the Tsuutina First Nation, and the Îyârhe Stoney Nakoda (including the Chiniki, Bearspaw, and Wesley First Nations). Calgary is also home to Métis Nation of Alberta, Region 3.

> "I enjoyed the stories and the lessons of the bow and arrow. I learned how to make a whistle [from a piece of willow]."—Participant

> "I learned that it is ok to break your bow!"—Participant

> "It was fun and creative."—Participant

> "I enjoyed making friends and learned a lot about curves and math."—Participant

Path2Math Summer Academy: Aug 9-20

The Path2Math Academy for Indigenous undergraduate students is designed to improve the outcomes of Indigenous students in mathematics and science courses and increase representation of First Nations, Metis and Inuit students in science courses and programs at the University of Manitoba. Science programs also feed directly into many professional health programs (e.g. Medicine, Nursing). Currently, Indigenous students are underrepresented in the sciences relative to non-Indigenous students, reducing their success not only in these programs but also for future applications to professional health programs.

The program expanded from one week to two weeks, and the PIMS Education Coordinator, Darja Barr together with Emily McKinnon, a science education specialist at UManitoba, held it fully online. During the session, students participated in four math workshops (probability, interpreting graphs, personal finance, geometry) and four critical thinking cafes balanced by a mentor Indigenous student panel, a virtual math in Indigenous art session, and a discussion group on the Navajo Math Circles movie featuring Dr. Henry Fowler. Throughout the program students experience one-on-one interactions with math and science instructors, upper-year Indigenous undergraduate peer-mentors, and Indigenous supports on campus.

13 participants completed the program this year. The score on their pre-assessment was a 47% average (highest score of 65%), whereas their post-assessment had a 64% average (highest score of 90%).
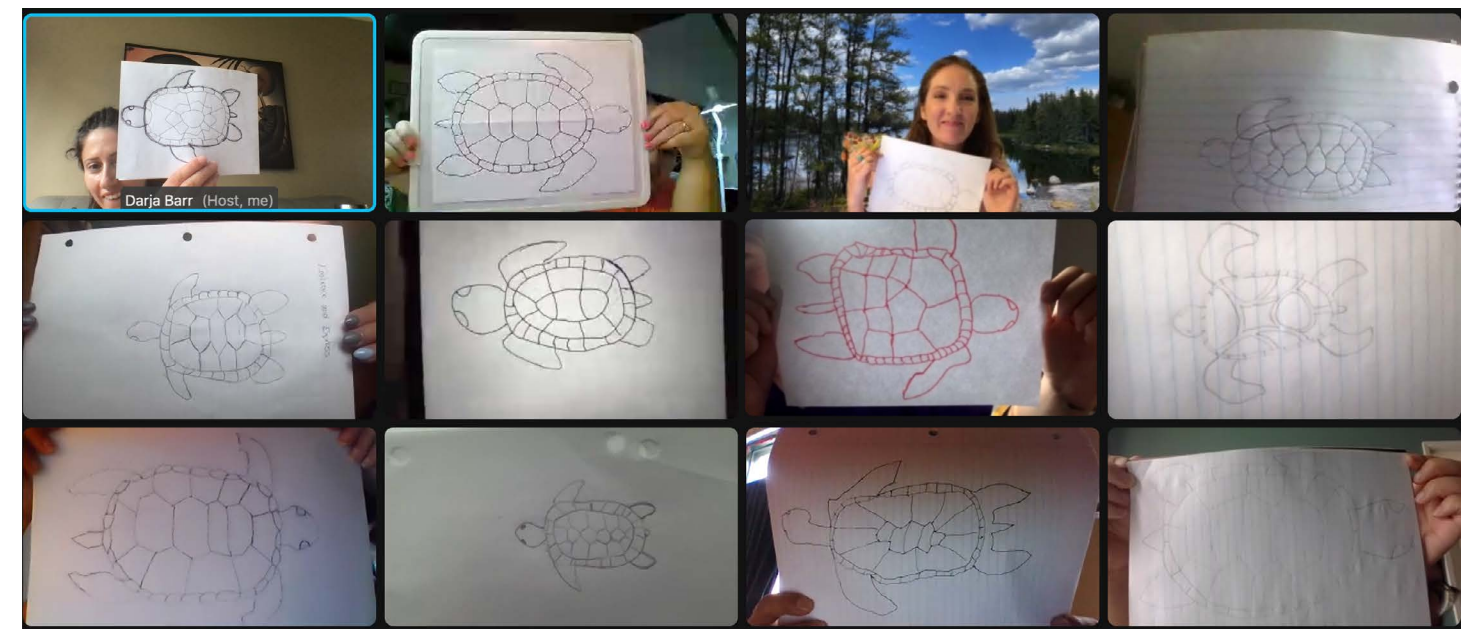
Mahkwa omushki kiim: Pathway to Indigenous Nursing Education (PINE) Math Academy: Aug 23-27

The PINE Math Academy focuses on supporting students in the PINE cohort each year in successfully completing their Mathematics course requirement in order to be able to apply for and graduate from the Nursing program at the University of Manitoba. The program combines three full afternoon math sessions (math in art, nursing math, solving linear equations) with information about preparing for nursing, the university, supports on campus, and tips for studying and wellness. Students are able to meet their instructors and build relationships that can encourage and motivate them throughout the term.

This year, 28 students participated in the week-long orientation. For the first time, the students in the cohort were planning on taking Mathematics in Art as their math course rather than Applied Finite Mathematics,

so the math content of the sessions focused on preparing them for that course, as well as for the general mathematics that nursing students must be comfortable with. Currently there are 11 PINE students completing the Math in Art class, which this year included a session on mathematics in beading (led by beading artist Shawna Bowler), as well as a math in Indigenous symbols sharing circle. The program was coordinated by the PIMS Education Coordinator at UManitoba, Darja Barr.

University of Alberta Mathematics Outreach Activities, November 24-26

In the fall of 2021, November 24 and 26, the University of Alberta's PIMS education Coordinator hosted in-person Math Fairs. Although there were much smaller groups than usual, it was wonderful having children on campus again after a long time. We hosted several mathematics contests so far this school year. The CMGC, COMC, and AMC 10/12 were held in-person, however due to the current wave of the Covid-19 virus, the Tournament of the Town (partnered with University of Calgary) and AMC 8 were held online.
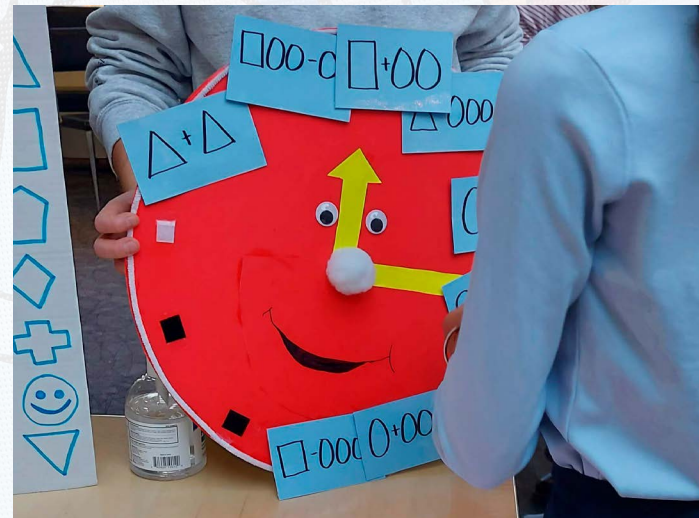
The second annual Math^Industry (Math to Power Industry) virtual workshop took place during August 2021, offered by the Pacific Institute for the Mathematical Sciences (PIMS), with the help of its training and industrial partners. The workshop was launched in 2020 by PIMS in response to the economic impacts of the COVID-19 pandemic on mathematical sciences graduates. With the pandemic impacts continuing in 2021, and an ever increasing need for mathematics and data sciences-skilled talent in North American industry sectors, online workshops like this one have become a vital bridge for connecting mathematics graduates and postdoctoral fellows to job opportunities in industry.

As in the first year, the workshop program began with a 10-day training bootcamp followed by a 2-week experience working as part of a team on a real problem provided by an industry or government agency partner. Workshop training courses included training on the latest programming and data workflow environments, effective teamwork, EDI (equity, diversity, and inclusion), communication, ethics in data science, startups and entrepreneurship. Seven of the real-world problems were contributed by industry partners, with four companies returning from the previous year, and three were contributed by municipal and federal government agencies.

Motivation for these problems ranged from companies trying to make use of artificial intelligence in their decision-making, improve the safety and operation of their products, minimize environmental impacts of food production and transport, manage and control insect infestations, and improve the health of our communities. Our teams approached these problems through advanced mathematical modelling, statistics, optimization, and computational techniques. In some cases the results had immediate positive impacts for these organizations, saving them both time and money, and in other cases the industry partner or government agency was able to use the workshop to recruit the highly skilled talent they need to be successful.

The M2PI program is chaired by Prof. Kristine Bauer at the University of Calgary.

> Students that worked on the projects were already familiar with the problems. In addition, our goal is to take the project end reports and to extend them so that they form the basis for peer-reviewed manuscripts. Students that worked on the problems demonstrated their ability to push these problems into the realm of peer-reviewed research and so they were ideal candidates to hire on a contract basis to do so.— **Devin Goodsman, Natural Resources Canada (Industry Mentor)**

> Using many of the skills developed earlier in the workshop, alongside an exciting new software, my team and I were able to tackle a very interesting project and produce interesting and exciting results. Once the workshop had ended, I was offered a contract with Natural Resources Canada to pursue my team's work to completion.
> — **Noah Bolohan, UOttawa (Participant)**

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December 4–9, 2022 | Vancouver, BC | #PRIMA2022

Pacific Rim Mathematical Association
Congress 2022

PRIMA

The 2022 Pacific Rim Mathematical Association Congress will take place in Vancouver, Canada, between December 4–9, 2022. The fourth meeting will be hosted by the Pacific Institute for the Mathematical Sciences (PIMS).

Every four years, mathematical scientists from around the Pacific Rim converge to discuss the latest developments in Mathematics. The Pacific Rim Mathematical Association (PRIMA) was established to bring a well coordinated and concerted effort among our institutions and countries to stimulate a vibrant and interconnected mathematical community whose activities have an unprecedented impact on our economic, social, and cultural development.

Scientific Sessions

Algebraic Number Theory and Arithmetic Geometry

Arithmetic Geometry: Theory and Computation

Enumerative Algebraic Geometry

Geometric Analysis

Geometric Group Theory

Graph Theory and Combinatorics

Harmonic Functions and Laplace Eigenfunctions

Hyperbolic and Parabolic Dynamics

Indigenous Mathematicians

Mathematics of Infectious Disease Modelling

Mathematics of Information

Moduli Spaces in Algebraic Geometry

New Trends in Geometry and Mathematical Physics

Optimal Transport and Applications

Representation Theory and Applications

Invited Plenary and Public Speakers

Caroline Colijn SIMON FRASER UNIVERSITY

Isabel Hubard UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

Kathryn Mann CORNELL UNIVERSITY

Ciprian Manolescu STANFORD UNIVERSITY

Andres Navas UNIVERSIDAD DE SANTIAGO DE CHILE

Narutaka Ozawa KYOTO UNIVERSITY

Sylvia Serfaty NEW YORK UNIVERSITY

Tatiana Toro UNIVERSITY OF WASHINGTON

Yang Wang THE HONG-KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Katherine Stange UNIVERSITY OF COLORADO

Minhyong Kim UNIVERSITY OF WARWICK

2022 Event Highlights

SEMINARS, CONFERENCES & WORKSHOPS

1 January – Ongoing	Geometry, Algebra & Physics (GAP) Seminars — University of Saskatchewan
1 January – Ongoing	Geometric Analysis Seminar — University of Calgary
1 January – Ongoing	SFU Computational Math Seminar — Simon Fraser University
1 May – Ongoing	The Mathematics of Ethical Decision-making Systems — University of Victoria
1 July – Ongoing	PIMS-UBC Distinguished Colloquia — University of British Columbia - Vancouver
4 March	Kickoff Event for FAIR COVID-19 Data for Canada — University of British Columbia - Vancouver
22 – 24 April	Second Canadian Geometry & Topology Symposium — Université du Québec à Montréal
13 – 15 May	Western Canada Math Biology Spring Workshop — University of British Columbia - Okanagan
16 – 20 May	GAP XVII — Deformations & Higher Structures — University of British Columbia - Vancouver
28 May	Canadian Statistics Student Conference 2022 — Simon Fraser University
1 – 2 June	Mathematical & Computational Challenges in Cryo-Electron Microscopy — University of British Columbia - Vancouver
2 – 4 June	Statistics in Genomics & Pharmaceutical Science Conference — University of Victoria
20 – 25 June	Foundational Methods in Computer Science — Barrier Lake Field Station
27 June – 1 July	Conference on Combinatorial, Computational, & Applied Algebraic Geometry — University of Washington
4 – 8 July	Alberta Graduate Mathematics & Statistics Conference — University of Calgary

SUMMER SCHOOLS

30 May – 24 June	PIMS-CRM Summer School in Probabilit — University of British Columbia - Vancouver y
19 June – 1 July	PIMS-IFDS-NSF Summer School on Optimal Transport — University of Washington
11 – 22 July	Séminaire de Mathématiques Supérieures 2022: Floer Homotopy Theory — University of British Columbia - Vancouver

COLLABORATIVE RESEARCH GROUPS

2020 – 2024	Novel Techniques in Low Dimension: Floer Homology, Representation Theory & Algebraic Topology
2020 – 2024	Quantum Topology and its Applications
2021 – 2024	Movement & Symmetry in Graph
2021 – 2024	Pacific Indterdisciplinary Hub on Optimal Transport
2022 – 2025	L-Functions in Analytic Number Theory

INDUSTRY EVENTS

11 – 29 July	Math^Industry Workshop — Online

K-12 EDUCATION EVENTS

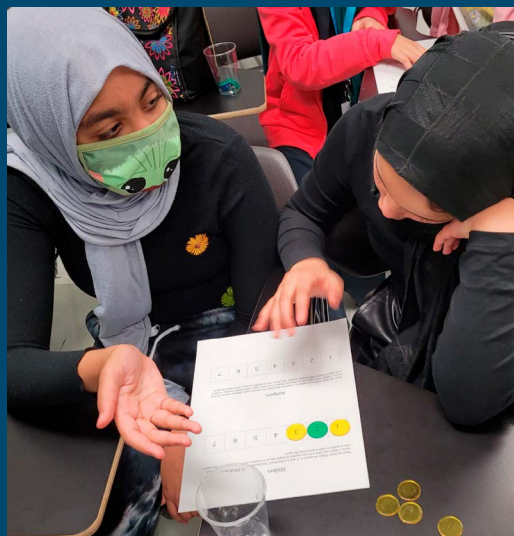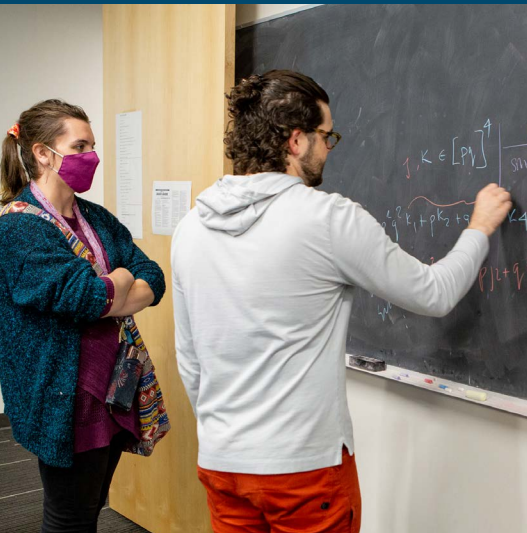|	
30 April	Elementary Math Contest (ELMACON)
7 May	ScienceRendezvous.ca — PIMS Sites Canada-wide
20 May	Changing the Culture — Online
July – August	Math Summer School for Elementary School Teachers — Online

The Pacific Rim Mathematical Association Congress 2022
December 4–9, Vancouver

Mathematicians from around the Pacific Rim will converge to discuss the latest developments in Mathematics.

For more information and updates, visit www.pims.math.ca

Pacific Institute *for the* Mathematical Sciences