



STEP INSIDE THE PERIMETER

a year in review: 2017/18



STRONG
GRAVITY

COSMOLOGY

MATHEMATICAL
PHYSICS

QUANTUM
INFORMATION

A BRIGHT FUTURE STARTS HERE

Perimeter Institute for Theoretical Physics (PI) is a made-in-Canada success story. Founded in 1999, it has become a world-leading centre of research in the lowest-cost, highest-return area of science: fundamental physics.

At Perimeter, scientists pursue the kinds of breakthroughs that will reshape our world. From the smallest subatomic particles to the entire cosmos, explorations in theory pave the way for transformative technologies.

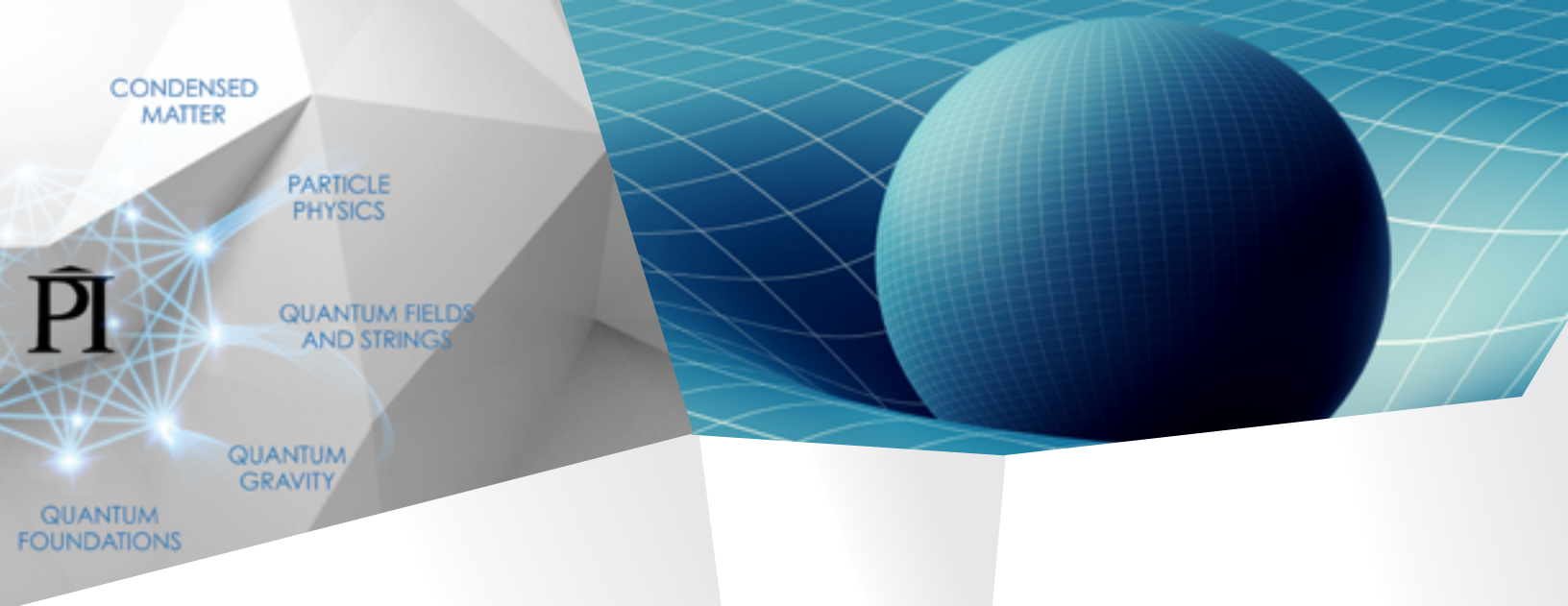
Now the largest independent theoretical physics institute in the world, Perimeter is the destination of choice for many of the field's leaders and for rising young talent. We attract the brilliant and the

curious, and we equip them with the skills to be pathbreakers in many fields – from scientific research to innovation, tech, and beyond.

The fundamental research done at Perimeter helps drive an entire emerging innovation ecosystem. The Quantum Valley in Waterloo Region spans theoretical research, experimental labs, technological development, venture capital, and early-stage entrepreneurship. Grounded in discovery, Perimeter aims to ensure that Ontario and Canada will be at the forefront of the next innovation revolution.

“We realized that theoretical physics was an area where – if we were strategic – we could actually move the needle. We could bend the curve of history.”

– Mike Lazaridis, Perimeter Institute Founder and Board Chair



BIG QUESTIONS

How did the universe begin? What is it made of? How can we understand and harness the quantum world? Where do our best theories break – and what will replace them? What new technologies could this lead to?

Perimeter researchers tackle big questions, from space and time to matter and information. This year, Perimeter researchers published 495 research papers in high-impact journals. Many past PI papers have gone on to become landmarks in the field.

Since its founding, Perimeter researchers have produced over 5,200 papers, which have appeared in more than 170 journals, attracting well over 240,000 citations.

In 2017/18, Perimeter researchers:

- Won 13 major honours and prizes, including the 2018 Breakthrough Prize in Fundamental Physics
- Were awarded more than \$3.2 million in research grants

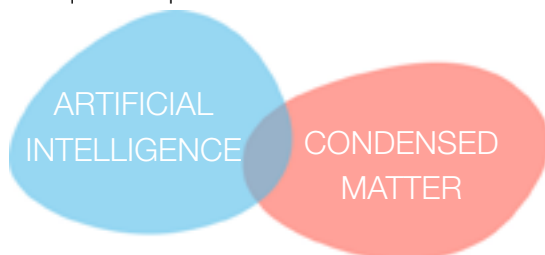
The 2018 Breakthrough Prize in Fundamental Physics was co-awarded to Kendrick Smith, the Daniel Family P. James E. Peebles Chair in Theoretical Physics, for his work on the pioneering WMAP experiment to map the universe's oldest light.

POWERFUL NEW INTERSECTIONS

String theory meets general relativity. Particle physics meets astrophysics. Quantum information meets quantum field theory. History shows that the fertile areas between specialties are

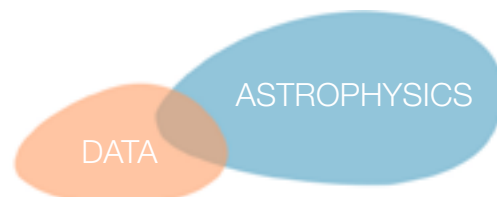
most ripe for discovery. This year, Perimeter researchers broke significant ground in two strategic interfaces:

Applying AI algorithms to complex quantum questions




Using nature's building blocks to create novel "quantum matter"

Using many kinds of telescopes and detectors in concert to study major astronomical events



Turning torrents of data into our richest-ever picture of the universe – and predicting what to look for next



“Perimeter reminds me of a cool start-up, but for physicists. The design of the building, all these spaces for collaboration, the restaurant where everyone eats together – it’s different than other places for doing physics.”

– Perimeter Faculty member William East

BRINGING TOGETHER THE BEST

Perimeter Institute’s emphasis on collaboration and creativity has created an unparalleled research environment. The Institute is home to more than 180 resident researchers ranging from master’s students to eminent senior scientists, and hosts more than 1,000 visiting researchers each year.

Our emphasis is on brilliance, creativity, and potential. We recruit the best and provide them with the optimal environment in which to tackle the most challenging questions in science. We encourage collaborative approaches and unusual collisions between fields and ideas.

Perimeter’s community goes well beyond our resident researchers. Eminent scientists from around the world view Perimeter as their second research home through our Distinguished Visiting

Research Chairs program, and physicists from across Canada can visit the Institute any time for research and collaboration through our Affiliate researcher program.

In 2017/18, Perimeter’s research community grew to include:

- 25 faculty (4 new)
- 19 associate faculty jointly appointed with partner universities (3 new)
- 10 Perimeter Research Chairs (1 new)
- 51 Distinguished Visiting Research Chairs (1 new)
- 46 Visiting Fellows (17 new)
- 61 postdoctoral researchers (23 new)
- 116 Affiliate researchers (10 new)

QUANTUM MATTER INITIATIVE

A revolution in condensed matter physics is providing new insights into exotic quantum phenomena. Called “quantum matter,” it is rooted in the Nobel Prize-winning discoveries of high-temperature superconductivity and topological states of matter, and unifies concepts from condensed matter and quantum information.

Quantum matter is laying the foundation for a new era of materials science and technology. The Quantum Matter Initiative at Perimeter Institute is bringing together leading scientists to seize this opportunity and pursue breakthroughs through interdisciplinary collaboration.

“We’ve taken what I thought the frontier was, and we’ve pushed it to another level that we don’t fully understand yet.”

– Roger Melko, Associate Faculty at Perimeter Institute, Professor at the University of Waterloo, and member of Quantum Matter Initiative



WORKSHOPS AND CONFERENCES THAT PUSH SCIENCE FORWARD

Advances in physics are happening fast as massive collaborations spanning theory and experiment push science forward. Collaboration and communication are essential to this effort – and Perimeter plays a key role. The Institute holds can't-miss workshops and conferences attended by hundreds of scientists, catalyzing rapid research progress.

In 2017/18, Perimeter hosted:

- 424 visiting scientists
- 290 scientific talks
- 20 conferences and workshops, attended by 713 scientists from around the world
- 11,000+ seminars, conference talks, and courses on Perimeter's video archive (PIRSA.org), which was accessed by 115,402 unique visitors from 190 countries

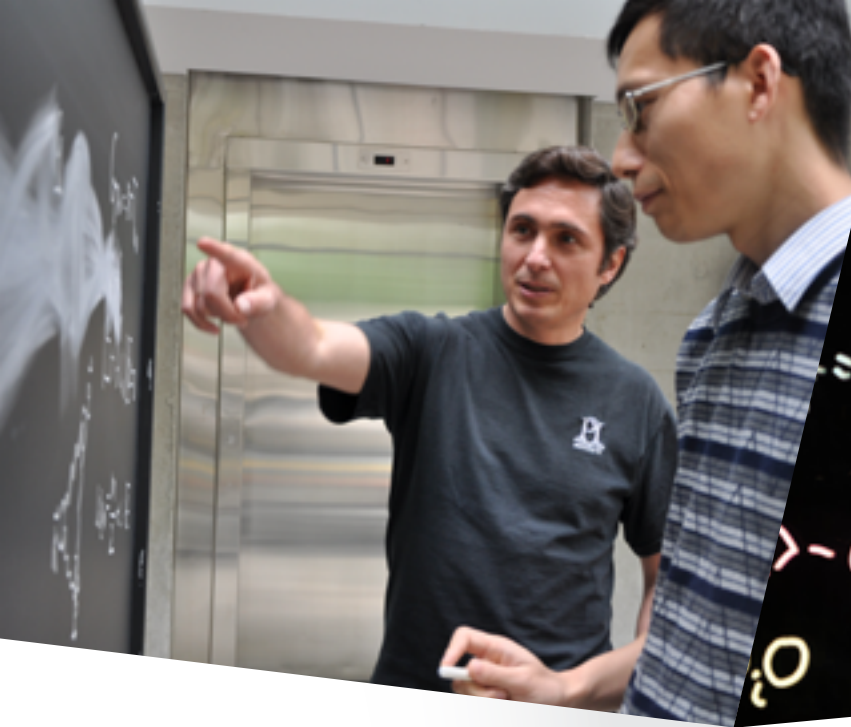
“The best way to expand your ideas is to reach across the edges of them.”

– Phiala Shanahan, Assistant Professor at the Massachusetts Institute of Technology (MIT) Center for Extreme Quantum Information Theory (xQIT) and 2018 Simons Emmy Noether Fellow at Perimeter Institute

REACHING OUT FOR GREATER IMPACT

The world comes to Perimeter and we reach out to the world. A growing partnership with the South American Institute for Fundamental Research (SAIFR) in Brazil is building research collaborations and recruiting new talent. Pedro Vieira, the Clay Riddell Paul Dirac Chair at Perimeter, spends several months at SAIFR each year building these efforts, conducting research, and organizing scientific events, while Perimeter and SAIFR

postdocs make frequent research visits between the institutes. This year, Perimeter's Outreach team began translating four of its educational resources into Portuguese and began collaborating on a series of Teacher Network workshops at SAIFR. Meanwhile, four graduate students from South America came to Canada to attend the Perimeter Scholars International master's program.



TRAINING FOR A WORLD OF OPPORTUNITY

Perimeter's training programs are unique – and powerful. We emphasize collaboration over competition, and problem-solving over rote learning. Students emerge with skills that prove valuable in academia and beyond, from advanced analytical thinking and problem solving to computer-based modelling and more.

Perimeter Scholars International (PSI), jointly administered with the University of Waterloo, is one of the world's most sought-after master's programs.

Our PhD program attracts outstanding students – and retains brilliant PSI students – thanks to unparalleled opportunities to interact with scientific leaders.

In 2017/18, Perimeter had 128 scientists in training:

- 53 PhD students
- 31 master's students (including 13 women)
- 44 Visiting Graduate Fellows



"I think one of the most important things that I got from PSI was confidence in my problem-solving abilities at quite a high level. I now think everything is solvable, which is a good mindset to have."

– Imogen Wright

When Imogen Wright graduated from the first class of Perimeter Scholars International in 2010, she wanted to change the world. Today, she is the co-founder of Hyrax Biosciences, a precision medicine start-up in South Africa that uses genomics and AI to predict HIV drug resistance, helping to save thousands of lives in the process.



FROM ACADEMIA INTO INDUSTRY

The greatest impact of physics is often felt outside academia. Alumni of Perimeter's scientific training programs are pursuing careers in technology, finance, government, healthcare, and beyond. In May 2018, Perimeter hosted its first "Career Trajectories Day" to ignite the imaginations – and highlight the career potential – of

more than 150 graduate students and postgraduate researchers from Perimeter and eight Ontario universities. From data science to jet propulsion, from genetic diagnostics to entrepreneurialism, physics is just the start.

"Flight 21 was my most memorable launch. It was the first flight with a densified propellant, which was a project that I worked on. It was my baby ... the first practical launch of this completely new design. It was so cool to be a part of that."

– Brigette Riley, SpaceX Propulsion Development Engineer and PSI alum

IMPACT BEYOND PHYSICS

Perimeter's scientific training programs bring promising young physicists from around the world to study in Canada. Many stay in the country to pursue careers in industry and academia. This wide-ranging impact was recognized in 2018 when Perimeter won the Labour award from the Creative Destruction Lab at

the University of Toronto's Rotman School of Management. The award recognized the positive impact of Perimeter's training programs on the high-skills labour market that is critical to national economic growth.

"I am pleased with the Institute's efforts in helping advance Canada's prominence in theoretical physics, an area with broad transformative potential to benefit our economy and improve the quality of life of Canadians."

*– The Hon. Kirsty Duncan,
Minister of Science and Sport*





“More women in science today means more women in science tomorrow. That’s not only good for women – it’s good for society.”

– Dr. Mona Nemer, Chief Science Advisor, Government of Canada, speaker at “Inspiring Future Women in Science” 2018



CHARTING A COURSE TO GREATER DIVERSITY

To solve the toughest problems in physics, we need all of the brightest minds. Perimeter Institute’s efforts to increase gender diversity in physics coalesce around the Emmy Noether Initiatives, a suite of programs that support women from high school through to faculty.

Our flagship program received a considerable boost in 2017/18 thanks to a major grant from the Simons Foundation. The Simons Emmy Noether Fellowships allow early- and mid-career researchers to spend up to a year in Perimeter’s vibrant research environment and to deepen that involvement with return visits, a researcher network, and more.

In 2017/18, Perimeter:

- Welcomed nine Simons Emmy Noether Fellows
- Hosted nearly 200 high school students at the annual “Inspiring Future Women in Science” conference
- Sponsored the “Canadian Conference for Undergraduate Women in Physics 2018” at Queen’s University
- Sponsored the “Women in Physics Canada” conference at the University of Sherbrooke



FORCES OF NATURE

There have long been amazing women in physics. The problem is, we often don’t know about them, let alone acknowledge their work. In 2017/18, Perimeter Institute released a series of free posters to highlight great scientists who also happen to be women.

“Forces of Nature: Great women who changed science” shines a spotlight on some of women’s historical contributions to the field. The posters took off immediately, and were downloaded over 3,500 times in the first few months — and there are more to come.

▶ Stacie Moltner, doctoral student at the University of Texas at Austin



BRINGING GREAT SCIENCE TO THE WORLD

Sharing the joy and wonder of science is a core element of Perimeter's mission, and we are recognized as an international leader in science outreach. From summer schools for teachers and for students, to comprehensive online offerings, through to the popular Public Lecture Series, Perimeter is the place to turn to for engaging, fun, and fascinating physics.

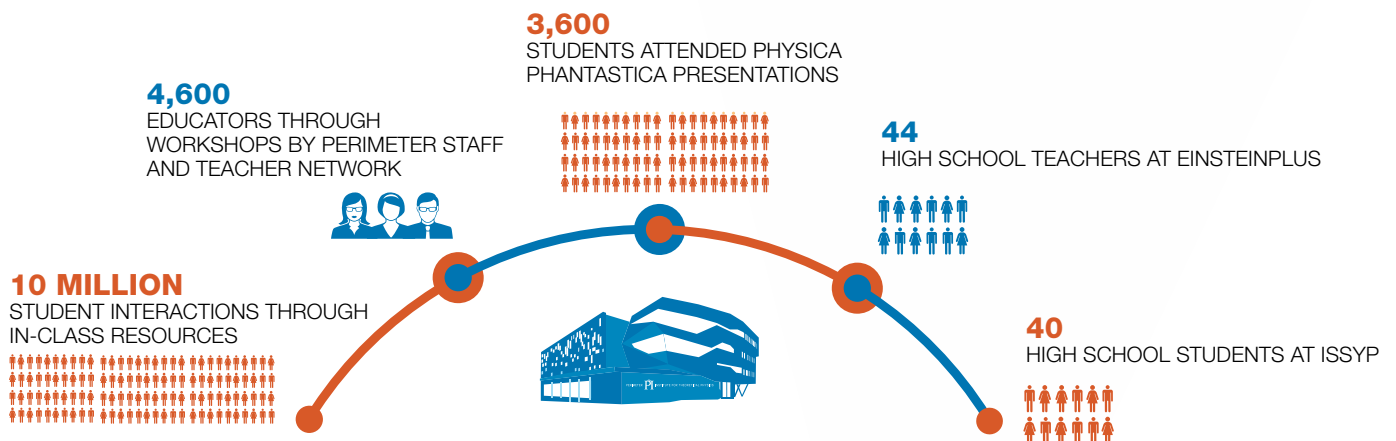
Nowhere is this more important than classrooms, where our in-class resources bring cutting-edge science to tomorrow's researchers, entrepreneurs, and innovators. This year, Perimeter released three new educational resources – in English and French – exploring different aspects of the universe: “Evidence for climate change” (Grade 10), “A deeper understanding of energy” (Grade 11), and “Wave model applications” (Grade 11).

“Your work is remarkable. You have found a way to break down complex subject matter into an engaging, hands-on format for teachers and students ... Your program helps to level the playing field for those students who have few educational opportunities in this arena.

We are proud to be associated with your work.”

– Denise Avchen, Executive Director and Co-Founder, Environmental Research Advocates

In 2017/18, Perimeter's Educational Outreach efforts reached:





COMMUNICATING THE POWER OF SCIENCE

Science is a beacon. Bringing together people from around the world, united in the effort to understand nature at its most fundamental level, physics connects us to everything, from the smallest particles to the cosmos itself.

That's why Perimeter Institute is committed to bringing the latest research to public audiences. The Institute's award-winning website insidetheperimeter.ca features stories of great science, profiles of scientists, easy explainers, and fun science shareables for all ages.

PAGE VIEWS



411,000

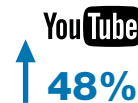
TWITTER FOLLOWERS



FACEBOOK FANS



YOUTUBE SUBSCRIBERS



THOUSANDS ARE TUNING IN

Perimeter's flagship Public Lecture Series invites top researchers to explain their own work to a live audience at Perimeter Institute. The seven lectures in 2017/18 explored the universe's strangest stars, artificial intelligence, a new theory of gravity, and more.

Broadcast live online, these diverse and fascinating talks reach a worldwide audience of science enthusiasts. This year's series had amassed more than 1 million views by the end of 2018, through Perimeter's YouTube channel and media partners who stream the talks on their websites, including:

SCIENTIFIC AMERICAN™

MACLEAN'S

COSMOS

theguardian

APS physics

livescience

physicsworld



WE ARE ALL PART OF THE EQUATION

Perimeter is building a world-leading scientific institute in Canada. This bold effort is made possible through the Institute's successful public-private funding model.

Our partners recognize that supporting fundamental science is a powerful strategy. Seventy years after Silicon Valley was founded on fundamental science discoveries, it continues to drive massive wealth creation. The coming quantum revolution may well hold just as much potential.

Thanks to government partners, Perimeter will continue to be a strategic talent magnet and a catalyst for an innovation ecosystem. Major investments of \$50 million over five years from

both the Government of Canada and the Province of Ontario provide essential funding for this effort.

They are joined by individuals, corporations, and foundations who understand that scientific discovery is one of humanity's greatest assets. This year, the Institute passed the \$30 million mark in its \$100 million campaign, raising \$6.42 million in 2017/18 and securing \$3.71 million in new fundraising commitments.

Perimeter has a growing group of private partners from around the world. Friends of Perimeter, the Institute's US public charitable foundation, welcomes donors to join our global mission.

This year, Mike Serbinis and Laura Adams pledged a major gift to create a new summer school program for outstanding undergraduates entering their final year. Students will take a deep dive into theoretical physics, learning research and collaboration skills, all while immersed in Perimeter's buzzing, multi-disciplinary environment.

LIGHTING THE WAY

Perimeter recognizes and thanks the following donors, who have made cumulative gifts totalling \$100,000 or more since 2014, following the lead of Perimeter's Founding Donor, Mike Lazaridis.

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BMO Financial Group
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The Cowan Foundation
Joanne Cuthbertson and Charlie Fischer
The Daniel Family Foundation
The Delaney Family
The Ira Gluskin and Maxine Granovsky Gluskin Charitable Foundation
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Shaw Communications
Jim and Marilyn Simons Foundation
Stavros Niarchos Foundation
Sun Life Financial
John Templeton Foundation
Mac Van Wielingen, Viewpoint Foundation
Dr. Scott A. and Sherry Vanstone and family



IT'S A BIG UNIVERSE.
 FORTUNATELY, WE HAVE BIG IDEAS.

$$\int B_e \text{ Part of } \overset{\text{(the)}}{\Sigma} \text{quAktion}^2$$



PERIMETER **PI** INSTITUTE FOR THEORETICAL PHYSICS

