

CAREERS

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PERIMETER INST.



The Stephen Hawking Centre at the Perimeter Institute in Waterloo hosts leading theoretical physicists from around the world.

QUANTUM MECHANICS

Waterloo gets physical

After a decade of investment, physics research is thriving in Southern Ontario, Canada.

BY HANNAH HOAG

“Go home.” That’s what Robert Myers was told when he turned up for his first day at the Perimeter Institute for Theoretical Physics in Waterloo, Canada. A mix-up meant that the newly founded research institute had no office space for its recruits.

By the end of that day in 2001, Myers and the eight other Perimeter Institute physicists had relocated to the city’s old post-office building, which had just been vacated by a failed restaurant. They installed desks on the top floor and blackboards in the former bar. The old billiards room became a seminar space, and Canada’s first independent theoretical-physics institute was in business. “It was a simple start, but

already it was a huge leap,” says Myers.

Myers, who studies quantum gravity and string theory, had been recruited from a faculty position at McGill University in Montreal, Canada. Many of his colleagues worried that he was throwing away his career by joining an almost unknown institute with no university affiliation. But he had been won over by Perimeter’s vision of independence that would give scientists the space and time to think about time and space.

The man behind the Perimeter Institute was Mike Lazaridis, co-founder of Research in Motion — the Waterloo-based company that developed the BlackBerry phone. Lazaridis had often spoken of his passion for physics, and in 2000 he put his money where his mouth was, launching Perimeter with a Can\$100-million

(US\$97-million) endowment. He wanted to transform Waterloo, in the province of Ontario, into Canada’s ‘quantum valley’.

The region already had academic and entrepreneurial strengths, and with Lazaridis’s money, it had the potential to become a physics hub. Connections to nearby cities — most notably Toronto, 90 kilometres to the east — have helped it to pull in talent from around the world. Southern Ontario has become a physics destination.

FORCE OF GRAVITY

In 2004, the Perimeter Institute’s research staff moved into a sleek 6,000-square-metre structure wrapped in black metal and glass. Seven years later, the institute almost doubled in ►

► size with the Can\$29-million Stephen Hawking Centre, which provides research space and hosts the Perimeter Scholars International programme, a 10-month master's course.

Today, about 150 resident researchers work at the institute, including 20 faculty members and around 40 postdocs in nine research areas: condensed-matter physics, mathematical physics, particle physics, cosmology, quantum fields and strings, quantum foundations, quantum gravity, quantum information and strong gravity. By 2018, there will be 50 faculty members at a range of career levels, and 50 postdocs.

The institute offers tenure and tenure-track positions, and some faculty members are hired immediately after completing a postdoc. There are also 12 associate faculty members, who have joint appointments at nearby universities, with reduced teaching loads. Matthew Johnson is a cosmologist with a joint appointment at York University in Toronto. He enjoys teaching, but likes having more time for his research. "I get the best of both worlds," he says.

Perimeter struggled to bring in senior researchers at first. But in 2010, it announced the creation of research chairs funded through public-private partnerships. The first, the BMO Financial Group Isaac Newton Chair in Theoretical Physics, came with Can\$4 million from BMO Financial Group, a bank based in Toronto, and Can\$4 million from the Perimeter Institute, to cover lab-group salaries, travel and equipment for 10 years. In 2011, the post was filled by Xiao-Gang Wen, a condensed-matter theorist from the Massachusetts Institute of Technology in Cambridge. The institute aims to fill eight such chairs by 2018.

Perimeter also offers a visiting-scholar programme for people interested in more temporary engagements. Postdocs and faculty members can invite collaborators to work at the institute for up to a year. "We can do a lot of work over e-mail and Skype, but there's no substitute for being in front of a blackboard with someone," says Kendrick Smith, a cosmologist who joined the institute in 2012 after a postdoc at Princeton University in New Jersey.

QUANTUM GROWTH

In 2002, Lazaridis got generous again. He donated Can\$100 million to the University of Waterloo to launch the Institute for Quantum Computing (IQC), headed by quantum-information scientist Raymond Laflamme. In 2012, the institute moved into the 26,000-square-metre Quantum-Nano Centre, which it shares with the Waterloo Institute for Nanotechnology. The complex includes underground labs that minimize electromagnetic interference and vibration, and a fabrication facility for designing nanometre-scale structures.

The IQC bridges theory and experimental physics, and researchers focus on computing, communication and sensing technologies, says Laflamme. The centre has 20 faculty members, 30 postdocs and more than 100 graduate

students, and aims to increase the number of its faculty members and postdocs by about one-third in the next five years. Most early recruits were mathematicians or quantum information scientists, but the hiring emphasis is now shifting towards engineering, including nanotechnology and materials science, says Laflamme.

The potential for close collaboration was what brought Matteo Mariantoni, who studies superconducting quantum circuits, to the IQC after a postdoc at the University of California, Santa Barbara. His start-up funding is comparable to what he might have received at a US university, he says, but he was won over by the number of IQC groups working on topics similar to his own.

DENSE MATRIX

The Perimeter Institute's funding and expertise has also boosted other academic institutions. In 2005, McMaster University in nearby Hamilton paired with the institute to start a particle-



"When we understand a piece of the world, we can learn how to control it and build technologies that have an impact."

Raymond Laflamme

physics theory group. The broader physics department plans to expand in the next five years, and to hire researchers studying condensed-matter physics, biophysics and astronomy and astrophysics to replace retiring scientists, says department chair David Venus. In the past year, the Perimeter Institute has also advertised associate positions with the nearby Western University in London, Ontario, and the University of Guelph.

The area's largest university has made its own contribution. The University of Toronto launched the Centre for Quantum Information and Quantum Control in 2004, bringing together chemists, physicists, mathematicians, computer scientists, material scientists and electrical engineers to collaborate on theoretical and experimental quantum research.

Ten faculty posts have been filled in the past four years, mostly in electrical engineering, says Amr Helmy, a photonics researcher and director of the centre. Stephen Julian, chair of the university's physics department, says that hiring has slowed in the department at large since the 2008 economic downturn, but in the next few years he hopes to recruit two faculty members specializing in quantum optics and condensed-matter physics.

The region's job opportunities extend

beyond academia. Technology firms including Google and the software company OpenText have operations in Waterloo. Furthermore, Toronto is Canada's business and financial centre, and banks including Scotiabank and BMO Financial Group are on the lookout for physicists and mathematicians willing and able to apply their expertise to the financial sector as quantitative analysts, or quants (see *Nature* **471**, 255–256; 2011). "Physics offers a combination of building simple mathematical models and applying them to the real world. There's quite a big stream of people who go to work in the financial sectors after doing their PhD in physics," says Julian. According to the American Institute of Physics in College Park, Maryland, 6% of physics PhD holders in the United States find their first permanent jobs in finance or business. (The Canadian Association of Physicists, based in Ottawa, does not have a recent survey of physics graduates, but says that the US numbers are representative.)

START-UP CULTURE

Waterloo welcomes start-ups, particularly in information and communication technology, says Iain Klugman. He is chief executive of Communitech, a technology hub in nearby Kitchener, which supports the commercialization of innovative technologies through coaching and mentoring programmes. Two local university incubators, VeloCity at the University of Waterloo and the Laurier Launchpad at Wilfrid Laurier University, also offer support to people wishing to spin off companies from their research. In the 2012–13 fiscal year, the region saw the launch of 474 digital-media, software and information-technology start-ups employing 711 people, and added 1,620 technology jobs to existing companies, says Klugman. He says that some 83% of start-ups that open in the Waterloo area are still operating after five years.

In 2010, Laflamme co-founded Universal Quantum Devices in Waterloo to develop devices for quantum cryptography. There are few quantum start-ups in the region, but that is not down to a lack of entrepreneurial spirit among researchers, says Martin Laforest, senior manager of scientific outreach for the IQC. "What was missing was the capital," he says. There is some help on the way, however. In March, Lazaridis and Research In Motion co-founder Doug Fregin launched Quantum Valley Investments, a Can\$100-million venture-capital fund to support the commercialization of advances springing from the quest for a quantum computer.

"When we understand a piece of the world, we can learn how to control it and build technologies that have an impact on society," says Laflamme. "Quantum information science is on that frontier." ■

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