Physics
UNIVERSITY OF TORONTO

Fall 2023

INTERACTIONS

The Department of Physics Newsletter

McLennan Physical Labs
(credit: University of Toronto)

MESSAGE FROM THE CHAIR

Welcome to the Fall 2023 issue of Interactions, the Department of Physics newsletter!

Dear Physics community,

I'm pleased to introduce our Fall 2023 Newsletter, another full issue showcasing the latest happenings in the Department of Physics. As usual, we introduce our newest members, profile several others, and say good-bye to a few faculty and staff. We have so much exciting news to share with you — from research highlights to congratulations to our June 2023 PhD graduates and other awards and recognitions.

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We have a busy recruitment season ahead, with four faculty searches getting underway, and in January, we will welcome Morgan O'Neill as Assistant Professor Tenure Stream in Theory, Modelling, and Dynamics of the Atmosphere. Meanwhile, in this issue's Faculty Profile, we interview our newest faculty member, Boris Braverman, who joined us in August as Assistant Professor Tenure Stream in Quantum Information Science. Three new staff members recently joined the Department: Pam Mann as part-time Library Technician, Jonathan Hucker as Learning Technology Specialist, and Helen Pham as ATLAS Project Coordinator. In addition, Darlene Gorzo is currently working part-time as Graduate Assistant, replacing Beata Kuszewska who is on secondment from her position in the Graduate Office. We say good-bye to three departing faculty and staff: Carolyn Sealfon, Daisy Yuan, and Pius Santiago.

The Newsletter includes profiles of quantum optics Post-Doctoral Fellow Coraline Fujiwara, atmospheric physics PhD Student Sabrina Madsen, and Physics Specialist Angela Xiang. Our Emeriti Profile features nuclear physicist Tom Drake, who was a professor in the Department from 1971 to 2005. For our Alumni Profile, we interview Jaclyn Sikka, whose double Major in Math and Physics provided her with skills needed for her job as a specialty tax analyst helping businesses involved in research and development.

The Research Spotlight in this issue is on Prof. Anton Zilman and graduate student Tiantian Zheng and their recent PNAS paper in which they developed a physical model of the nuclear pore complex in cells to investigate how it maintains rapid and efficient transport between the nucleus and the rest of the cell. As always, you can read about other departmental news and research at Physics News.

Congratulations to our fifteen June 2023 PhD graduates and to all the Physics students, staff, and faculty who have received numerous awards and recognitions since our Spring Newsletter. I'm especially pleased to announce that we have awarded the Momentum Builders Scholarship to the two inaugural recipients: Taha Aboshanab and Ezra Msolla. Thanks to the generous response of many of you to our appeal for donations, we now have an endowment of more than $100,000 that will enable scholarships to be awarded annually to Indigenous and Black undergraduate students in Physics.

At our June end-of-year party, Nicholas Sullivan was awarded the 2022-23 Loudon-Hines Gold Medal, and the four recipients of this year's Van Kranendonk TA Awards were announced: Nathan Carlson, Alistair Duff, Dylan Jow, and Emily Zhang. The Centre for Quantum Information and Quantum Control (CQIQC) Scholarship was awarded to four Physics undergraduate students: Amirali Atrli, Tanmay Grover, Nicholas Taylor, and Qinyuan Yang.

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The 2023 Department of Physics Staff Awards were also announced in June, with Michael Manley receiving the Award for Administrative Excellence and Lilian Leung receiving the Award for Technical Excellence. Steven Butterworth was honoured by the Faculty of Arts & Science with the Dean's Outstanding Technical Service Award for his exemplary work as Manager of Physics Computing Services.

On the faculty side, the Physics Student Union announced the third cohort of recipients of their Teaching Awards to recognize exceptional pedagogy in undergraduate courses: Ania Harlick for PHY224, PHY293, and PHY424, and Bob Orr for PHY250. In July, Nikolina Ilic was promoted to the position of Institute of Particle Physics Continuing Research Scientist and to the rank of Associate Professor. New awards for our faculty include the 2023 IEEE Photonics Society Quantum Electronics Award for Hoi-Kwong Lo, the 2023 CAP/DCMMP Brockhouse Medal for Hae-Young Kee, the 2023 CAP Medal for Excellence in Teaching Undergraduate Physics for Jason Harlow, Fellowship in the UK's Royal Society and the 2023 ACS's Helen M. Free Award for Public Outreach for Dwayne Miller, and appointment to the Royal Society of Canada's College of New Scholars, Artists and Scientists for Debra Wunch, and a CAP Fellowship and the APS Hans A. Bethe Prize for Dick Bond.

Our physCAP Physics Mentorship Program launched with an event in early October and it was a busy spring and summer for Outreach in Action, including in-person school visits, Science Rendezvous, Girls SySTEM, Doors Open, and the Science Unlimited Summer Camp. A very big thank-you to 2022-23 Outreach Committee Chair Jason Harlow, Special Projects Coordinator Supreet Randhawa, and all our physCAP and outreach volunteers!

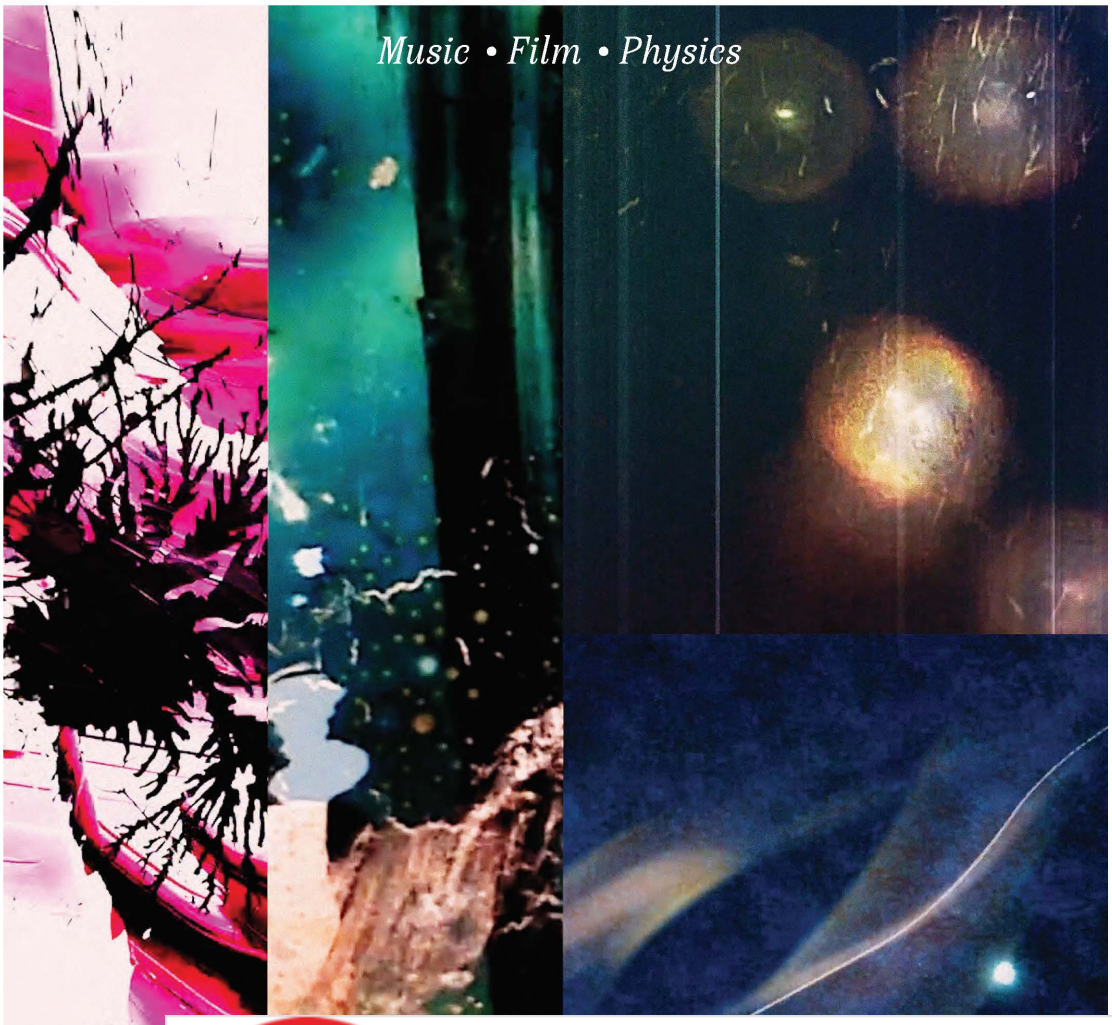
As always, we welcome your feedback on Interactions – please contact our new Editor, Supreet Randhawa, at newsletter@physics.utoronto.ca with your comments and news.

With very best wishes,

Kimberly Strong

Professor and Chair

McLennan Physical Labs Walkway
(credit: Daisy Yuan)



Patterns From Nature

An ambitious new project is set to captivate audiences with a mesmerizing fusion of physics, film, and music.

Quinsin Nachoff

ArtSci Salon presents

PATTERNS FROM NATURE

SATURDAY November 4 · 2023 · 8:00PM *free admission*

ISABEL BADER THEATRE

93 CHARLES ST. WEST · TORONTO, ON · CANADA

A collaboration between **Quinsin Nachoff** (composition/saxophone), **Stephen Morris** (University of Toronto Physics), and filmmakers **Gita Blak**, **Tina de Groot**, **Lee Hutzulak** and **Udo Prinsen**. The centerpiece is a four movement, forty minute work where the filmmakers and composer delve into **Patterns from Nature**, exploring **Branches**, **Flow**, **Cracks** and **Ripples**. The films premiere with new music from a fifteen piece chamber orchestra featuring **François Houle** (clarinet) • **The Molinari String Quartet** • **Santiago Leibson** (piano) • **Carlo De Rosa** (bass) • **Satoshi Takeishi** (drums) • **Ryan Keberle** (trombone), and Quinsin, in an immersive blend of jazz, classical, and film.

Conseil des arts du Canada Canada Council for the Arts FIELDS CALQ Conseil des arts et des lettres du Québec

DESIGN: *Leisure Thief*

Faculty Profile

Boris Braverman

Assistant Professor, Quantum Information Science

Dr. Boris Braverman joined the Department on August 15, 2023.

Welcome to U of T Physics Dr. Braverman!

Why did you decide to pursue physics? What was your inspiration?

There are many engineers, mathematicians, and physicists in my family and I had a lot of early exposure to these fields. My older brother participated in math contests, so I started doing them too. But, what really got me excited was a physics textbook that my father gave me one summer n high school. I was immediately drawn in by the elegance of describing nature using the language of mathematics, and being able to use these abstract tools to predict the very real behaviour of systems in the physical world.

Can you tell us a little bit about your educational background?

I did my undergraduate degree in physics at the University of Toronto. I then did my PhD at MIT, followed by a postdoctoral fellowship at the University of Ottawa.

What was the topic of your PhD thesis and why?

For my PhD, I worked on implementing an optical lattice clock whose precision is enhanced by quantum entanglement. Atomic clocks are among the most precise measurement tools ever constructed by humanity, but there is always room to make them even better. Precise clocks lead to not only practical applications such as GPS navigation, but also they help advance and precipitate other scientific discoveries. For atomic clocks that use inherently quantum objects to measure time, quantum noise is one of the limiting factors in their precision. Entanglement is a uniquely quantum-mechanical behaviour that induces atom-atom correlations and suppresses the quantum noise during their observation. Part of the excitement and challenge in my PhD project was to design and build a new physics experiment from conception to implementation, which taught me many scientific and engineering skills.

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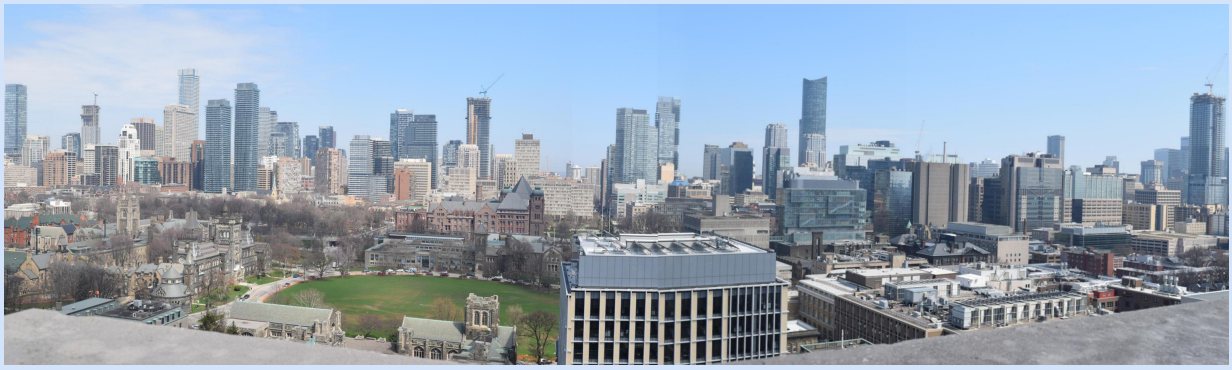
Please share your research background and why did you choose this field specifically.

One of my first research projects during my undergraduate studies was the experimental observations of Bohm trajectories for photons. Trajectories of quantum particles are technically impossible to measure, and yet here we had an experiment where we could operationalize and observe these trajectories. This project got me very interested in quantum measurement, and trying to understand what these measurements mean. I continued this journey of exploring quantum measurement during my PhD at MIT, where I built an experiment where we showed that quantum effects can be used to make an optical atomic clock more precise. During my postdoc, I learned to use the spatial structure of light for quantum communication and quantum imaging, all of which tie back to questions of measurement in the context of quantum theory.

I chose to work in AMO (Atomic, Molecular, and Optical physics) because it lies at the intersection of theory and experiment, pure science and applied technology, and classical and quantum physics. It's a real privilege to work in a field where the same tools can be used not only as precision clocks, magnetometers, and gyroscopes, but also for answering basic physics questions like searching for new fundamental forces and particles, or looking for fluctuations in the universe's constants. But the real reason is that AMO physics is an incredibly fun field to work in, and I think that it is one of the few fields of physics where one can be good at both theoretical and experimental work. As well, atomic physics experiments are lab-scale and are often accomplished by relatively small teams, where each person can both have a significant role and a sense of teamwork and camaraderie with their colleagues.

What are you looking forward to about being in Toronto?

Toronto is where I did my undergraduate studies, so in many ways it is a homecoming for me. I look forward to rediscovering all of my old favorite restaurants, and trying all the new places that have opened in the decade I've been away. I also look forward to finding all the delightful and surprising nooks in the UofT campus where one can spend a couple of hours reading or discussing ideas with colleagues.



MP View (Credit: Raul Cunha)

Post Doctoral Fellow Profile

Coraline Fujiwara

Quantum Optics

Dr. Coraline Fujiwara is a postdoctoral fellow working with Professor Joseph Thywissen studying trapped gases of ultracold potassium. From 2020 to 2022, she was a recipient of a Centre for Quantum Information and Quantum Control postdoctoral fellowship. Before joining the University of Toronto community in January of 2020, Coraline received her PhD in Physics at the University of California, Santa Barbara under the tutelage of Professor David Weld.

Dr. Fujiwara loves spending her time in the laboratory as it allows her to work with her hands and apply her physics education every day. She particularly enjoys the exquisite control and freedom afforded by the table-top experiments featured in AMO (Atomic, Molecular, and Optical) physics, where the entirety of an experiment is localized to single space. She feels grateful to have worked with and mentored fantastic undergraduate and graduate students over the years in the tight-knit teams formed in these relatively small-scale experiments.

Dr. Fujiwara's current research focuses on using ultracold fermionic potassium in optical lattices to study problems in condensed matter physics in a field known as quantum simulation. In these systems, the hopping of atoms in the optical lattice potential is analogous to the motion of electrons moving in a conventional solid-state material. Working with a theory team at the University of Colorado, Boulder they recently demonstrated control over so-called unitary p-wave interactions between potassium atoms in a three-dimensional optical lattice [1, 2, 3]. Control over these kinds of interactions could enable the realization of exotic phases of matter in atomic systems which have been previously challenging to generate.

An additional exciting feature of the experiment here at the University of Toronto, is the ability to spatially image individual atoms in an optical lattice in a technique known as Quantum Gas Microscopy [4]. This enables read-out of spatial correlators, which directly probe the various phases of matter realized in the optical lattice.

For her PhD, Dr. Fujiwara helped construct an experiment studying Bose Einstein Condensates of lithium and studied its dynamical properties in one-dimensional optical lattices. Here, she investigated the thermalization and transport behavior of these systems when subjected to extreme forces in a technique known as Floquet engineering [5].

Outside of the laboratory, Dr. Fujiwara enjoys skiing and backpacking when the season allows. She also enjoys puzzle video games and chess. More information about her may be found at her group website [6] or her personal page [7].

Graduate Student Profile

Sabrina Madsen

PhD Candidate

Atmospheric Physics

Sabrina has loved physical sciences since grade school and was always fascinated by physics and space documentaries. In addition to her love for physics, Sabrina is very passionate about the environment and found it difficult to decide between the two disciplines. Despite being the first in her family to study sciences in higher education, she was strongly encouraged by her family, friends, and high school teachers to follow her passion. In the end she decided to pursue a physics major at the University of British Columbia's Okanagan campus, just south of her hometown. Despite the small size of the physics department there, she learned a lot and found a great sense of community and support from peers and professors which pushed her to continue following her goals.

When moving towards the end of her undergraduate degree, she was again conflicted between continuing her passion for physics and pursuing her interests in environmental issues. At many schools, graduate studies in environmental sciences fell into a separate category from physics. However, she was ecstatic after discovering that the University of Toronto's Physics Department has the Earth, Atmospheric, and Planetary Physics (EAPP) group as this would allow her to combine her two passions. After talking to her now supervisor, Debra Wunch, about studying the carbon cycle from a physics perspective, she was hooked. Sabrina has really enjoyed working with this group due to its wide variety of approaches to studying the carbon cycle, enabling group members to follow their own ideas while still receiving guidance and chances for collaboration. She also really appreciates this group's interests in educating one another about topics in equity diversity and inclusivity, and the encouragement to have a healthy work-life balance.

Sabrina now studies fluxes of carbon dioxide to and from vegetation using satellite measurements of solar-induced fluorescence, a light signal emitted by plants during photosynthesis, as well as observation-driven vegetation models. In particular, she is studying biogenic CO2 fluxes in and around the Greater Toronto Area with a special focus on vegetation in the city of Toronto and the Greenbelt of Ontario which surrounds the Greater Toronto Area. After graduation, Sabrina hopes to work somewhere like Environment and Climate Change Canada where she can continue researching the carbon cycle.

Outside of her studies, Sabrina loves spending time in nature, including gardening in her local community garden and hiking. She also enjoys cooking with her partner, drawing, and playing board games with friends.

Undergraduate Student Profile

Angela Xiang

Program: Specialist in Physics and Minor in Computer Science
Year of Study: 4

Why did you decide to major in physics? What was your inspiration?
Pinpointing a specific inspiration is rather difficult but I can probably attribute fifty percent of my interest in physics to the various science YouTubers I watched growing up and forty percent to my father. While he did not officially study physics, choosing instead to pursue computer science, he did try to keep up to date with new scientific discoveries and was always eager to learn more about the topic. Once I was old enough, he encouraged me to do the same and we would often discuss what we had learned. The last ten percent, I'll chalk up to other media influences and genetic predisposition.

I believe (or at least sincerely hope) that everyone who chooses to study physics does so because they have a need to understand how the world works, a curiosity that leads them to ask questions that don't yet have answers, a drive to go answer (a subset of) those questions themselves and the delusion that they will be able to answer questions that some of the greatest minds in the past couldn't even begin to consider. And if it isn't already abundantly obvious, I am studying physics. So it would be rather hypocritical of me not to "live by my own doctrine".

Making that first decision was easy though, it amounted to no more than clicking a few buttons on an online form; it is the follow through that is rather more difficult. The day-to-day of being a student studying physics is unfortunately often rather removed from the passions that initially lead me to the subject. Fortunately, my curiosity has been powerful enough (or my delusions grand enough) to have kept me coming back time and time again despite the (at times) grueling problem sets and punishing exams.

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On a slightly more practical and less aspirational note, I decided to study physics not only because I was interested but also because I knew it would be difficult for me to gain the same depth of knowledge on the topic elsewhere. Meanwhile I knew I could gain business and sales or computer science skills on my own.

What do you enjoy most about the physics program?
The best thing about UofT's physics program is the sheer number of choices that are available to students due to the size of the department. This applies for both courses and research opportunities.

I never once felt limited by what was available to me and that's something that can't be said for most physics' programs in the world.

What other extra-curricular activities are you involved in during your degree?
As I'm sure most students at UofT can relate to, between the demanding courses and the demands of basic human necessities, there isn't much time for extra-curricular activities. However, I still try to make time to get involved with the community, mostly in the summer. I'm a volunteer at Not Far From The Tree (NFFTT). We work with homeowners in Toronto so we can pick fruits from their yards! It's so much fun to be able to climb trees, pick fruit and then importantly eat that fruit or make something delicious with it. At the risk of this sounding like an advertisement, I'll keep it at that.

I also participate in Dig In!, UofT's student-led urban agriculture group. We have many garden plots around campus where we grow fresh produce. Another agriculture related group I'm a part of is Trinity Food Systems Lab. There's something so special about growing your own produce in the middle of a city.

What are your research interests?
Honestly, even now that I'm going into my final year of undergraduate studies, I still haven't committed myself to a specific field of physics research. An argument could be made for the idea that many fields of physics simply use different "tools" to answer the same fundamental questions.

With that in mind I've tried to follow the problems that interest me most and put less emphasis on what exact technique I will use to solve them. That is not to say, some techniques aren't better suited for certain problems than others.

At the moment, I really enjoy questions that are "simple" in some way. It could be that the problem has very clear physical intuition or perhaps it involves a phenomenon that we see

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in day-to-day life. For example, one of the questions that captured my interest was, "How fast does a chain of dominoes fall?" This seemingly innocuous question still remains unanswered to this day.

There are many other questions like this out there waiting to be answered and it would be the greatest pleasure to find them and follow them wherever they might lead.

What is your favorite course and why?
So far, my favourite physics course has been the research course. It gave me a lot of freedom to explore a topic I was really passionate about and provided me with much needed guidance to succeed. I love that UofT offers students the opportunity to gain research experience for credit.

Some other honourable mentions are advanced classical mechanics (PHY354), Analysis II (MAT257) and introduction to computer science (CSC148).

What are your future plans?
Currently, I'm planning on attending graduate school for physics. I do not yet know where, but hopefully I will soon. After that, we'll see where things go!

Where do you see yourself in 10 years?
Frankly, I don't have a clue. I've always tried to leave as many doors open for myself so if I ever change my mind in the future, I'm able to pivot easily. I don't want to be too set on a specific path and miss out on possibilities that present themselves that could lead somewhere spectacular. So, I'm just taking it one step at a time and making sure to take time to reflect on if I'm on a journey that I'm genuinely enjoying.

Tell me something interesting about yourself!
I have two adorable cats: Misty and Paws. Misty is Paws' mother and I adopted them together when Paws was only six weeks old. I also love knitting, crocheting, sewing, baking, gardening and foraging. Essentially, I'm the embodiment of the archetypal grandma. One might think all my joints creak and I can barely get out of bed without pulling a muscle and they would be correct. But I also enjoy doing various aerial sports (a great activity for all grandmas out there). For those who are interested, my favourite is probably lyra (aka aerial hoop) but I've tried aerial silks, hammock and pole as well!

Emeriti Profile

Welcome to the Emeriti Profile where we ask one of our emeritus faculty questions about their careers and what they have being doing since retirement. Is there a faculty member that you recall from being a student and are you wondering what they are up to? Do you have fond memories of a certain instructor? Tell us who they are and we will try and connect with them for an update.

Tom Drake

Can you tell us about your educational background starting from your undergraduate degree?

My early pedigree includes:

1961: BSc. (Eng-Sci) & MSc. (nuclear physics) at Queen's University.
1962 - 1963: Electrical engineer at Algoma Steel Corporation.
1964 - 1967: PhD (nuclear physics) University of Saskatchewan.
1967 - 1969: NSERC Post-Doctoral Fellow at Kelvin Lab, Glasgow University.
1969 - 1971: Lecturer in Department of Natural Philosophy, Glasgow University.
1971 - 2005: University of Toronto teaching undergraduate and graduate courses in the Physics Department.

What are your fondest memories of being a faculty member in the U of T Physics Department?

In my years at U of T, where a large physics department supports a variety of choices for careers in physics, our department provides a friendly and cordial atmosphere with dedicated faculty and staff. From my perspective, I joined to work with Dr. Carl Westcott

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and Dr. Warwick Knowles then at Chalk River (AECL), on a proposal for a storage ring addition to the 60 MeV electron linear accelerator located in the McLennan Laboratory basement. However, NSERC funded a competitive proposal from the University of Saskatchewan, and the efforts of my students, postdoc and the Chalk River collaborators in building a Photon Monochromator with fission chambers and detectors, which needed an electron beam of high duty cycle, were moved to a new superconducting electron microtron at the University of Illinois. Here, our students designed a system to transport the beam to our monochromator, which resulted in photo-fission measurements of Thorium. Meanwhile at UofT, Professors David Rowe and Sam Wong authored the "Open-Shell Random Phase Approximation" to describe excitation and decay of atomic nuclei. My students, with Prof. Sam Wong and myself, set about experiments to excite nuclei with beams of photons at Illinois, electrons at MIT Bates, protons at the Indiana University Cyclotron facility (IUCF), and protons and pions at TRIUMF on the UBC campus. We were later joined at TRIUMF by our UofT colleagues Profs. Dick Azuma and Jim King.

These efforts culminated with published papers led by our students and post-doctoral fellows. Later experiments were performed in collaboration with the "8pi spectrometer and superconducting cyclotron group" at Chalk River, using heavy ion beams. This extended period of activity from 1971 to 2005 is illustrated on my website in the Physics Department.

Here some specific papers with our Ph.D. students and postdocs as principal authors are displayed, giving a flavour to research in physics. From 2005 to the present, my group activity has been with an inter-varsity team using the ISACII and ARIEL accelerators at TRIUMF to produce radioactive beams with an emphasis on astrophysics. This endeavour is led by our former students and research associates, who are now leading scientists at Canadian universities and laboratories.

So, from the shadows of this current generation of science seekers, I would like to say that my tenure at UofT has been extremely enjoyable and challenged by interaction as teacher and as collaborator with our students: their enthusiasm, motivation and perseverance is truly remarkable.

How have things changed since you were a faculty member?

Going forward, I do have some concerns. The gap between high school and a university entrance syllabus has been made even wider by COVID, which presents a serious problem to entrance level courses and career paths. It used to be addressed with province-wide entrance exams but now?

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What have you been doing during more recently?

I have recently read two new books (easy reads): One entitled "Hero of Two Worlds" by Mike Duncan, which covers the French and the American revolutions 1750-1850 and portrays existing factions in the European and the American cultures, which seem to me to resemble those in our society today. A second book on psychology, "Think Again" by Adam Grant, presents many examples from various parts of our current culture which may foster an essential skill for communication between these factions, and I think should make an excellent course in our high schools.

Tom Drake with wife Elaine, 2023

Alumni Profile

Jaclyn Sikka

HBSc 2016 - Double Major in Math and Physics

Why did you choose to study physics at university?
I chose to study physics because I have always been fascinated by the natural world and deeply impressed by people's ability to witness phenomena, investigate it, and develop an explanation for it. Everything we know today; we know because someone one day wanted an explanation to a phenomenon.

What are you doing now?
I currently work as a specialty tax analyst. I help businesses apply for tax credits and refunds based on the research and development work that they do. My client base is very diverse, ranging from small start-ups with 1 or 2 employees to multimillion dollar corporations. What they all have in common though, is that they are working to overcome scientific or technological uncertainties.

How has physics helped you in this career?
Working on my physics degree allowed me to cultivate valuable skills such as critical thinking and analysis. It also helped me gain the confidence required to learn about new technologies that my clients are developing; you can understand anything if you just spend enough time studying it.

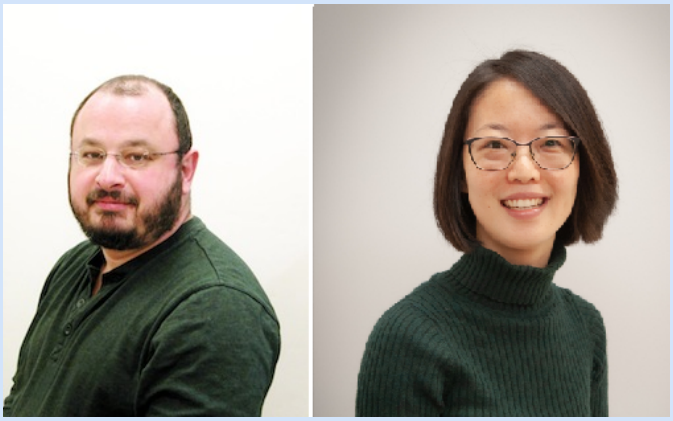
What are your fondest memories of being a U of T student?
I liked to explore campus at any available opportunity. Where does this door lead, is it locked? Can I access every floor of this building? Exploring this way made me feel connected to the campus and deepened my sense of belonging. I also made some neat discoveries along the way, such as the quickest way to get from one lecture to another, and how to minimize outdoor exposure in the grueling winter months.

Any final thoughts?
Your time at U of T is very short, so try to make the best of it. Apply yourself, ask questions, and give your courses the time and attention they deserve so that you can look back on your time as a student proudly. However, it is also very important to give yourself grace; accept your failures (there will be many!) and try to learn from them. Also, don't be afraid to approach your classmates. The mere fact that you are in the same course at the same time suggests you have way more in common than you might think.

Research Spotlight

Prof. Anton Zilman and Tiantian Zheng – Biological Physics

"Self-regulation of the nuclear pore complex enables clogging-free crowded transport" published in February 2023 in *Proceedings of the National Academy of Sciences (PNAS)*



Authors: Anton Zilman and Tiantian Zheng (left to right)

In all eukaryotic (that is non-bacterial) living cells -- from yeast to humans -- the carrier of genetic information, the DNA, is sequestered in a separate compartment -- the cell nucleus. This ancient arrangement endows our cells with many benefits such as more complex regulation, resistance to mutations, and evolvability. However, it also poses a difficult transport logistics problem as the separation of the nucleus and the rest of the cells necessitates large-volume -- millions of molecules per second -- molecular transport between the two compartments.

All this enormous transport is facilitated by biological "nanomachines" known as the nuclear pore complexes (NPCs). NPCs are one of the most complex and largest molecular assemblies in the cell, comprising dozens of different molecule types in large copy numbers. Yet, surprisingly, our previous work has shown that despite this complexity, the molecular architecture and the transport mechanism of the NPC can be understood based on relatively simple physical principles. Partially due to this, NPC has served as an inspiration for creation of artificial nanopores for molecular sorting for bio-nano-technology applications.

In this particular work, we have a developed a physical model of the NPC to investigate one of the puzzles of its function -- how can it maintain rapid, efficient, and selective high throughput transport despite the fact that its transport channel is highly crowded with many simultaneously translocating cargo-carrying transport proteins? Past experimental results suggest that the NPC is surprisingly resistant to clogging and that transport may even become faster and more efficient as the crowding in the channel increases. Our model explains these puzzling observations and shows how the unique internal architecture of the NPC engenders clogging-relieving mechanisms that—counterintuitively

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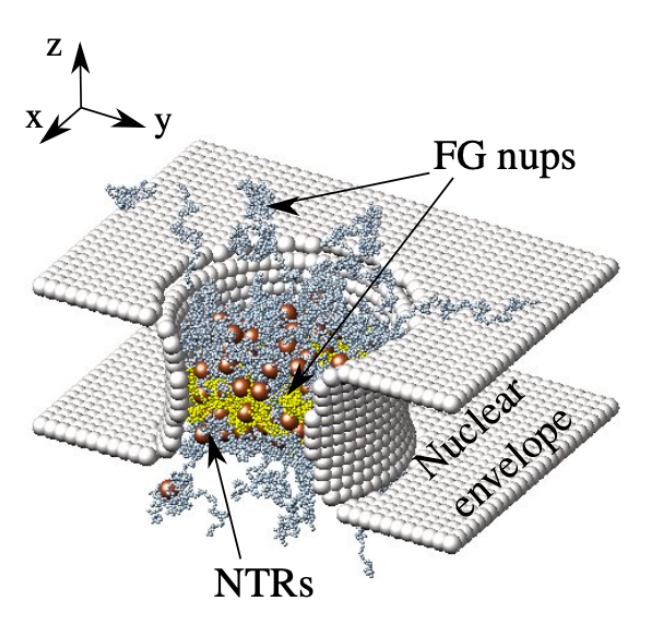
—harness crowding toward faster and more efficient transport. These results explain long-standing puzzles and suggest design principles for the optimization of artificial selective nanochannels inspired by the NPC.



This figure provides a snapshot of a minimal complexity simulation of the Nuclear Pore Complex (NPC).

Interview with the authors of this research:

What is the relevance of looking at transport systems in cells as a physicist?
As physicists, we are interested in understanding the world we live in using the tools of mathematics. While biological systems present many challenges through their sheer complexity, non-linearity, non-equilibrium nature, and stochasticity they are governed by the laws of Physics as much as any other system in the universe. Understanding how cellular structures function and are regulated is a key aspect of identifying how physics produces the myriad of diverse phenomena that characterize life. Specifically, we are using the tools of non-equilibrium statistical physics to understand transport phenomena on the nanoscale by various biological "nanomachines".

Is this research used to diagnose or treat medical conditions or contribute to medical techniques?
The particular "transport machine" of interest for us -- the nuclear pore complex (NPC) -- is implicated in diseases such as cancers and neurodegenerative diseases, and one mechanism for disease is the clogging of the NPC by amyloids. However, during healthy cell function, the interior of the NPC is also extremely crowded with a multitude of different cargoes being transported, which apparently doesn't lead to clogging. Our research set out

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to understand how crowding is managed by the healthy cell, and how it prevents normal levels of crowding from escalating into clogging. So yes, our research builds the foundation for a better understanding of the dysfunction of the cellular transport in pathological conditions, and development of better treatments.

What is the long-term impact of this research?

By understanding how the NPC operates normally, we hope that in the long term this will allow us to identify abnormal conditions, and how to correct them therapeutically. The operation of the NPC also has served as an inspiration for creation of artificial nanochannels for various bio-nano-technological devices such as protein sorting and detection with applications ranging from disease detection to water purification. On the mode basic side, our work has provided new theoretical and computational tools to deal with complex biomolecules in confined spaces on the nanoscale.

What challenges do you face in this field of research and how do you overcome some of these challenges?

One of the main challenges in this field of research is the difficulty of experimentally probing the NPC directly in live cells. Our methods of physical modelling strongly depend on having high-quality experimental data with which to compare to or fine tune our models on. However, the small size of the NPC (~10 nm), and fast time-scales of the dynamics of NPC components make direct experimental characterization of the NPC difficult. Studies measuring transport properties are typically conducted in cells, and such experiments are extremely resource and time intensive. In our work, we have relied on synthesis of multiple streams of data -- from in vitro experiments on the biophysics of the NPC components to single molecule tracking in live cells -- to identifying the "consensus" features between different results from different labs to inform our modelling approaches. Another big challenge in an inter-disciplinary field is to bridge the gaps in scientific cultures and ways of thinking about the problem between very disparate fields, including theoretical physics, cell biology and biochemistry, and the success of our research really derives in a large part from long-standing collaborations with experimentalists in different fields.

What is your area of research and why did you choose to specialize in this field?

TZ: I have been working on research in biophysics since my third year of undergraduate studies. I was drawn to the field because of the variety of interesting problems that touched on some of my favourite areas of physics (in particular stochastic processes and nonlinear dynamics).

AZ: I was always attracted to inter-disciplinary problems (one discipline is too boring!). My PhD is in statistical physics/physical chemistry, and I was drawn by the challenge of understanding principles of function of very complex non-equilibrium systems that are present in living organisms using relatively simple physical and mathematical models.

Continued on next page.

What else are you working on?

TZ: We have just recently finished a follow-up paper which addresses how the NPC avoids clogging when cargoes are transported through the pore in both directions at the same time (whereas the highlighted paper focusses on transport in one direction). We again found several novel regulation mechanisms which arise through the collective dynamics of the system, some of which could potentially be applied to increase the performance of artificial nanoscale filters which are inspired by the NPC.

AZ: Beyond cellular transport, my group is generally interested in how various biological processes can be so precise and specific despite ubiquitous noise on molecular and cellular scales, including molecular signaling and spatial organization of multi-cellular collectives. One area in which we are very active now is signaling in the immune system, trying to understand the molecular signaling "code" using tools of statistical inference theory and machine learning.

Read the full paper here: https://www.pnas.org/doi/abs/10.1073/pnas.2212874120

More on Professor Anton Zilman's Group here:
https://www.physics.utoronto.ca/~zilmana/

McLennan Physical Laboratories and Lash Miller Chemical Laboratories from Ursula Franklin Street (credit: Matthew Gerry)

June 2023 PhD Graduates

Congratulations to our June 2023 graduates!

Bedroya, Olinka - Resource-Efficient Real-Time Polarization Compensation for MDI-QKD (Supervisors H.K. Lo & L. Qian)

Feng, John Kit Fai - Next Generation Ultrafast Electron Diffractometer. (Supervisor R. J. D. Miller)

Ketabchi Haghighat, Sana - Measurement of the cross section of the Higgs boson production in association with a Z boson and decaying into W W∗. (Supervisor P. Krieger)

Ladan, John - Experiments on the formation of rippled icicles. (Supervisor S. W. Morris)

Lin, Fang Xi - Dispersion Measure Variations Predict Lensing in Pulsars (Supervisor U.- L. Pen)

Massarelli, Geremia - The properties of Dirac materials: Strain, magnetoelectrics and Krein-Hermiticity (Supervisor A. Paramekanti)

Rothschild, Jeremy - The role of stochastic competitive processes on population diversity and dynamics in ecological communities (Supervisor A. Zilman)

Uribe Castano, Leonardo Jose - Wide-field Polarimetric Second Harmonic Generation Microscopy for Histology Imaging. (Supervisor V. Barzda)

Basso, Matthew Joseph - Measurement of Associated Production of Higgs Bosons Decaying to Pairs of W Bosons with the ATLAS Detector at the Large Hadron Collider. (Supervisor R. S. Orr)

Gordon, Jacob Aaron Simmons - Exploring Symmetry and Field-Induced Phenomena in Kitaev Materials. (Supervisor H.-Y. Kee)

Han, Yi Fei - Measurement of Electroweak V V jj Production in Semileptonic Final States in pp Collisions at √12 s = 13 TeV with the ATLAS Detector (Supervisor P. Savard)

Jackson, Shira Golda - Toward a compact two-photon optical clock based on calcium (Supervisor A. Vutha)

Kirby, Duncan - Mesoscopic models of cellular signaling reveal strategies for specificity in crosstalk signal pathways. (Supervisor A. Zilman)

Oghbaey, Saeed - Fixed Target Sample Delivery for Serial Crystallography and Ultrafast Study of Bismuth by Electron Diffraction. (Supervisor R. J. D. Miller)

Xu, Peihang - Probing atom on-site interactions in an optical lattice. (Supervisor J. H. Thywissen)

Student Awards

Momentum Builders Scholarship

The Department of Physics is delighted to announce that Taha Aboshanab and Ezra Msolla are the inaugural recipients of the Momentum Builders Scholarship.

Our appeal for donations to establish the Momentum Builders Scholarship to support Indigenous and Black undergraduate students in Physics has been very successful, resulting in an endowment of more than $100,000. In spring 2023, once sufficient expendable funds were available, a call for applications was sent to students, with the first two recipients announced at the Physics Start-of-Year Party in September.

Taha Aboshanab

Taha Aboshanab is starting his third year in the Physics Specialist program. Taha is an Egyptian student who is pursuing a physics degree at U of T in hope of finding a nurturing environment through which he can achieve his main two goals: to solve the energy problem worldwide, and to improve on the existing theoretical physics knowledge. As a young amateur enthusiast, Taha reports that he enjoyed reading articles in physics about black holes and quantum mechanics. He also watched all the Feynman lectures he could get his hands on. Not understanding 99% of what was written or discussedmade him love this subject called physics. He says that he doesn't think the pleasure in pursuing physics lies in knowing there's an answer to every question. Instead, the pleasure lies in the pursuit of an answer. And he hopes that will be his career: an enthusiastic, lifelong-learner of physics!

Ezra Msolla

Ezra Msolla is starting his third year in the Astronomy and Physics Specialist program. Ezra is originally from Tanzania but grew up in Italy, where he first developed a curiosity for the sciences. Studying physics more deeply in high school, Ezra grew to love astronomy and cosmology which led him to U of T, where he believed his expertise and talent would be nurtured. He says that he took an interest in learning about the use of fast radio bursts in cosmological research during his involvement in the Directed Reading Program. He is now looking forward to continuing this journey in physics, exploring the areas of cosmological research at a higher level.

Continued on next page.

The Department of Physics congratulates Taha and Ezra on their accomplishments to date and wishes them every success in their studies and future endeavours.

The Momentum Builders Scholarship is awarded annually to one or more full-time Indigenous and/or Black undergraduate student(s) enrolled in a Major, Specialist, or Joint Specialist program in the Department of Physics, on the basis of academic merit and financial need. This scholarship has been established through the generosity of donors who wish to support the next generation of physicists and build momentum for greater diversity in physics. The Department aims to create opportunities for Indigenous and Black physics students to achieve their educational goals and contribute their ideas, insights and knowledge, thereby enriching our collective understanding of physics and the universe.

The Department sincerely thanks everyone who has supported this initiative. Donations to the Momentum Builders Scholarship are still being accepted at this link.

The Loudon-Hines Gold Medal in Physics

The recipient for 2022-23 is Nicholas Sullivan, Physics Specialist Program.

The Loudon-Hines Gold Medal and Scholarship is presented annually to an outstanding graduating student in the Specialist or Major program in Physics who also demonstrates creativity and a clear promise in the discipline of physics.

Originally awarded as the Loudon Gold Medal, named for James Loudon, the first Canadian-born Professor of Physics at U of T, it was renamed the Loudon-Hines Gold Medal in 2018, in honor of distinguished atmospheric physicist and mathematician Colin O. Hines (who himself received the Loudon Medal in 1949).

This year's recipient is Nicholas Sullivan, a graduating student in the Physics Specialist Program. Nicolas excelled in his physics courses, including his lab courses and two graduate courses, and is now pursuing graduate studies in the Department.

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Van Kranendonk Awards

The Van Kranendonk Award is given every year to four graduate students who have done the best job as Teaching Assistants during the current year, based on nominations from undergraduate students.

Named in honour of U of T Physics Professor Jan Van Kranendonk, who was the recipient of many awards (including the 1976 Gold Medal for achievement in physics awarded by the Canadian Association of Physicists) but who was also renowned as an excellent teacher.

Nathan Carlson PHY151, PHY152

"He is the best TA that students wish to have! He was supportive and kind. He cares about students even after the practical hours. For example, he stayed after our lab to explain the concept we were struggling. He was organized, and he sent the slides shortly after each lab. He always, provided us with solutions after each session. He always explained about our mistakes from previous lab session. He was informative and useful during the practical class".

Alistair Duff PHY100, PHY450

"Alistair has been an incredible TA throughout this semester. He is helpful, knowledgeable, and cares a lot about the classes he teaches. He is clearly passionate about physics and helping people understand it. My first semester has been a great experience because of his classes".

Dylan Jow PHY483

"Dylan Jow has provided some of the best teaching I've received throughout my four years at UofT and is very supportive and understanding of the class and its needs."
"Dylan Jow is an exceptional example of going to great lengths to ensure you learn the material, and then going a step beyond to do a little more."

Continued on next page.

Emily Zhang PHY250, PHY256

"She is the only reason I survived the courses. Best TA. Caring and teaches extremely well."

"The concepts taught and the derivations done during the tutorial sessions are crystal clear, and they never get intermingled and rushed over."

This picture was taken during the departmental "End of Year" party on June 8, 2023.

CQIQC Scholarship awarded to four Physics students

Four undergraduate Physics students at the University of Toronto spent their summer conducting cutting-edge research in quantum science and engineering — a unique opportunity for undergraduate students.

Their research projects were funded through the Centre for Quantum Information and Quantum Control (CQIQC) Undergraduate Summer Research Scholarship Program. CQIQC is a research centre in the University of Toronto's Faculty of Arts and Science, whose mission is to advance quantum science and technology research at U of T. CQIQC's faculty members are professors in different departments at the University, including Electrical and Computer Engineering (ECE), Physics, Chemistry, Math, and

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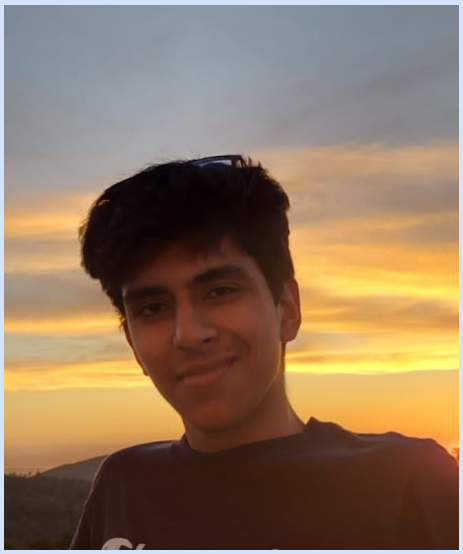
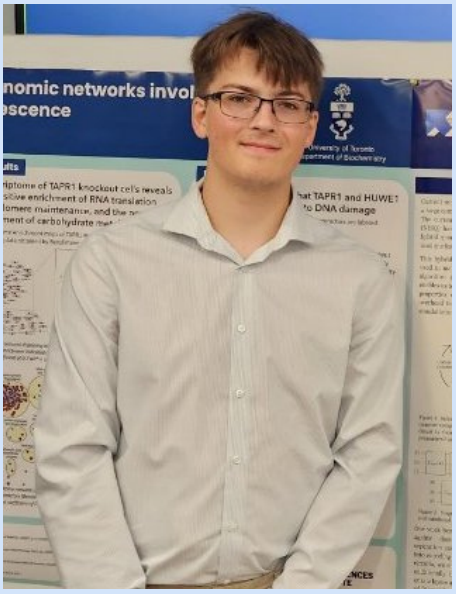
Computer Science. The summer scholarships allow recipients to undertake summer research projects in the research groups of CQIQC members.

This year, CQIQC received 65 outstanding applications. Four students were selected through a process based on academic performance and a supplementary application.

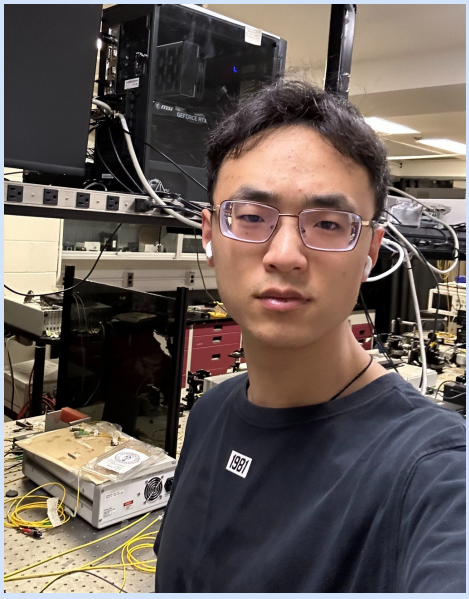
Amirali Atrli *(2nd year, Physics Specialist with a Math Minor). CQIQC supervisor: Professor John Sipe (Physics)*



Tanmay Grover *(2nd Year, Physics and Math Specialist). CQIQC supervisor: Professor Arun Paramekanti (Physics)*



Nicholas Taylor *(3rd year, Physics Specialist with a Math Major). CQIQC supervisor: Professor Arno Jacobsen (ECE)*



Qinyuan Yang *(3rd year, Physics and Math Specialist). CQIQC supervisor: Professor Li Qian (ECE)*

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The number of applicantions CQIQC received is a testament to the stellar talent and brilliance in U of T's undergraduate community. "We were delighted to have received so many outstanding applications from top students. It was difficult to disappoint so many of them," says Dvira Segal, CQIQC's Director and a professor in the Departments of Physics and Chemistry. "To all students – those who have joined CQIQC this summer and those we could not extend an offer – I hope that each of you maintains your passion for research wherever your journey continues".

More information here: https://cqiqc.physics.utoronto.ca/news/recent-news/nicholas-taylor-earns-top-prize-at-dsis-suds-showcase/

Faculty Awards & Recognitions

Recognitions

Nikolina Ilic

Assistant Professor Nikolina Ilic has been promoted to the position of Institute of Particle Physics Continuing Research Scientist and to the rank of Associate Professor, effective July 1, 2023.

Physics Student Union (PhySU) Teaching Awards

The PhySU Teaching Award is an annual award started in 2021 to recognize exceptional pedagogy in undergraduate Physics courses. The award is given to two individuals (one per semester) at the end of each academic year. The winners are selected by the PhySU Executive based on student nominations.

Continued on next page.

Fall 2022 - Ania Harlick - for exceptional pedagogy in PHY224, PHY293, and PHY424

"Professor Harlick is a very good lecturer and always made sure we understood the lecture content and had really interesting demo's to demonstrate concepts. They also went above and beyond to help me during labs when it comes to understanding theory, they reinforced my passion for physics and gave me career advice that helped me make decisions about 3rd year and onwards."

"Prof. Harlick actively caters to different learning styles by embracing different teaching methods. Their accessibility for students outside of regular lecture hours was exceptional."

"Professor Harlick deserves to be recognized for their commitment to teaching excellence and their ability to inspire and motivate students. The passion and dedication demonstrated in their classroom, combined with their extensive knowledge in physics, makes them an exceptional candidate for the PhySU Teaching Award."

This picture was taken during the departmental "End of Year" party on June 8, 2023.

Winter 2023 - Robert Orr - for exceptional pedagogy in PHY250

"Prof. Orr's enthusiasm for physics provided a refreshing respite from the dreary winter atmosphere; I would always look forward to their lectures. Their dedication to the course and undergraduate population is evident, most clearly exemplified in this quote from the second week of lectures: "There's no such thing as paranoia, since your worst fears can come true. I was writing my lecture notes last night when my laptop died. Did I give up and not deliver the lecture? No! Because I'm like a boy scout, I'm always well prepared."

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"The way Professor Orr engages and teaches the class by incorporating their funny stories and experiences, along with their traditional lecture style of going slow and in depth, has allowed me to fully grasp concepts in a way that I never understood before. It is also amazing how perfectly they pace the lectures whilst also being able to incorporate short pauses. Their funny, inspirational, and in-depth style of teaching is exceptional."

This picture was taken during the departmental "End of Year" party on June 8, 2023.

Professor Hoi-Kwong Lo has been awarded the 2023 IEEE Photonics Society Quantum Electronics Award

Prof. Lo has been honoured with this achievement for establishing the theoretical and experimental foundation for practical quantum cryptography and quantum network.
More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-hoi-kwong-lo-has-been-awarded-the-2023-ieee-photonics-society-quantum-electronics-award/

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Professor Hae-Young Kee has been awarded the 2023 CAP/DCMMP Brockhouse Medal for Outstanding work in Theoretical Quantum Research

This medal recognizes significant experimental or theoretical contributions to condensed matter and materials physics. Dr. Hae-Young Kee is recognized as one of the world's foremost theoreticians in identifying new quantum materials with desirable functionalities. Her work has emphasized identifying appropriate model Hamiltonians that have led to new insights and predictions.

More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-hae-young-kee-has-been-awarded-the-2023-capdcmmp-brockhouse-medal-for-outstanding-work-in-theoretical-quantum-research/

Professor Jason Harlow has been awarded the 2023 CAP Medal for Excellence in Teaching Undergraduate Physics

This medal is in recognition of Jason Harlow's comprehensive knowledge and deep understanding of the subject and the ability to communicate their knowledge and understanding in such a way as to lead their students to high academic achievement in physics. Prof. Harlow is known as an inspiring instructor who encourages students to think independently, critically, and analytically.

More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-jason-harlow-has-been-awarded-the-2023-cap-medal-for-excellence-in-teaching-undergraduate-physics/

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Professor R.J. Dwayne Miller named Fellow of U.K.'s Royal Society and recipient of the 2023 ACS's Helen M. Free Award for Public Outreach

In May 2023, Prof. Miller was named a Fellow of the Royal Society for his substantial contribution to the advancement of science and, having "pushed forward the boundaries of their respective fields and had a beneficial influence on the world beyond."
More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-rj-dwayne-miller-named-fellow-of-uks-royal-society/

Prof. Miller received ACS's Helen M. Free Award for Public Outreach in August 2023 for his passion and achievements in science advocacy, education, and outreach. His commitment to science promotion extends beyond urban centers as he actively works with remote and Indigenous communities in Canada.
More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-rj-dwayne-miller-receives-the-2023-acss-helen-m-free-award-for-public-outreach/

Professor Debra Wunch appointed to the Royal Society of Canada's 2023 College of New Scholars, Artists and Scientists

Professor Debra Wunch has been honored by the Royal Society of Canada for her pathbreaking leadership in atmospheric physics. Members of the RSC's College of New Scholars, Artists and Scientists are selected for demonstrating exceptional accomplishment.
More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-debra-wunch-appointed-to-the-royal-society-of-canadas-college-of-new-scholars-artists-and-scientists/

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Professor Dick Bond honoured by Canadian and American physics communities

The Canadian Association of Physicists has named Prof. Dick Bond a CAP Fellow, a distinction that recognizes service to the Canadian physics community and noteworthy contributions to physics research. In addition, the American Physical Society has awarded Bond the Hans A. Bethe Prize for developing conceptual and quantitative tools that have enabled cosmologists to measure the geometry, content and age of the universe.

More: https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-dick-bond-honoured-by-canadian-and-american-physics-communities/

Staff Awards

Department of Physics Staff Awards

Michael Manley - 2023 Award for Administrative Excellence

Manager, Finance and HR Administration

"2022-23 saw the departure of 66% of our core administrative team, with the retirements of two staff members who together had more than 60 years of administrative experience at UofT. Michael was responsible for recruiting new staff, and for planning and implementing what turned out to be a very smooth and successful transition. He is also leading the adoption of an online time management process for casual employees and was instrumental in moving staff absence recording to the University's ESS online system. All of these remarkable achievements, on top of his exemplary management of the department's payroll, including faculty PTR, and his outstanding contributions to the Department's financial management, deserve special recognition."

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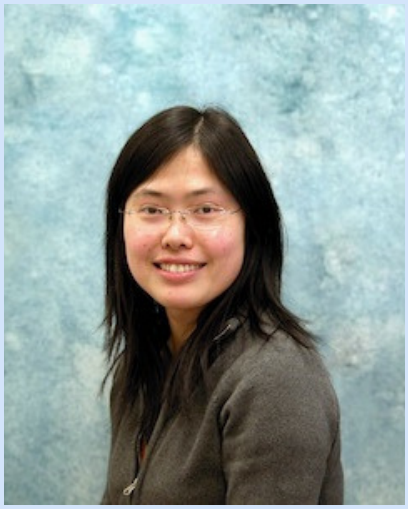
Lilian Leung - 2023 Award for Technical Excellence

Senior Learning Services Specialist



"Lilian is a mainstay of our first-year learning program, and especially the teaching labs and practicals. Her extensive experience and deep care for students and instructors gives her an amazing ability to predict what will be required regardless of what is requested, and her hard work and technical wizardry insures the delivery of everything that is required. Besides her work in the labs, her efforts to maintain the A/V equipment in our meetings, seminars and colloquia is indispensable. Most important of all, she carries out all of these fantastic support activities with irrepressible good humour and enthusiasm."

This picture was taken during the departmental "End of Year" party on June 8, 2023.

Continued on next page.

Dean's Outstanding Staff Awards

Steven Butterworth - Dean's Outstanding Technical Service Award
Manager, Physics Computing Services

The Dean's Outstanding Technical Service Award in the Faculty of Arts and Science is presented to a technical staff member who has made an outstanding contribution to technical services and, as a result, has had a direct impact on improving teaching and/or research. This award recognizes, for example, innovative solutions to problems, improvements in efficiency, and cost-savings in labs, computer areas and shops.

Steven was selected for his outstanding contributions as the Manager of Physics Computing Services and anchor for IT services in the Physics Department over the past 20 years.

The award recognizes his professionalism and teamwork, his demonstrated commitment to the Physics and A&S, his contributions to morale, and the strong positive impact he has made within the Department and beyond.

His contributions this year have been above and beyond, including additional work to improve the security of our systems and to move our entire computing infrastructure from the Data Centre in McLennan Physics to a temporary location.

Congratulations to Steve on this well-deserved award!

More: https://www.artsci.utoronto.ca/news/2023-outstanding-achievement-awards

Steven Butterworth (third from right) receiving the award from Dean Melanie Woodin (fourth from right) in June 2023.

Arrivals & Departures

We welcome three new staff and say good-bye to three faculty and staff.

Arrivals

Permjit (Pam) Buadhwal Mann

Library Technician

Pam joined the Physics Library on July 3, 2023. She previously worked at the Engineering & Computer Science Library (2001-2003), the UTSC Library (2004-2014), and the UTM Library (2015-2023). Pam has experience providing the following library services: circulation, resource sharing, curation, media, digitization, image editing, metadata, student supervision, reference assistance and reading list materials. Pam graduated from the University of Toronto with a BSc 1998 (Biology & Physical Anthropology), a Master of Museum Studies 2003, and a Master of Information 2019 (Library Science and Information Systems & Design). Pam looks forward to employing her diverse educational and work experience to assist faculty, students and other Physics Library users.

Jonathan Hucker

Learning Services Specialist

Jon joined the Department on September 5, 2023, in the role of Learning Services Specialist. He previously attended Queen's University as a physics graduate student and is currently finalizing his master's dissertation. Enthusiastic about physics, Jon is excited to join the U of T physics community and is motivated to provide students with innovative and creative physics demonstrations.

Helen Pham

ATLAS Project Coordinator

Helen joined the Department on September 27, 2023. Helen's professional background includes working in various academic hospitals, where she gained extensive experience in project management, change management, budget planning, and research grant contracts and administrations. She firmly believes in the phrase "Bloom where you are planted" and is excited to bring her expertise to the ATLAS project.

Continued on next page.

Departures

Daisy Yuan

Daisy joined the Department of Physics in 2018 as a part-time Library Technician.

Her presence at the Physics Library desk became a staple face for those who frequented the library, and a welcoming and helpful person to any newcomers.

During the pandemic closure of the library, Daisy became a pivotal player in services when access to the building was limited. Daisy coordinated chapter scans and access to materials during the tumultuous time when instructors were scrambling to adapt their courses to an online environment.

In October of 2022, Daisy accepted a full-time position as a library technician at the Kelly Library of St. Michael's College. Daisy happily drops by the Physics Library on occasion for a quick chat during her lunch break. Although we were sad to see her go, we're also happy that she's quite close by and thriving in her new environment.

By Nuree Lee

Nuree Lee, Daisy Yuan, and Prof. Kim Strong at the Farewell Luncheon 2023

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Pius Santiago

IIn May 2023, Pius Santiago left his position as Learning Services Specialist to take up another position at U of T. Pius was hired for this role in April 2018 and if you carefully read Pius' job description, it sounds like an impossible task that cannot be completed without magic. From supporting outreach activities, making sure colloquium talks are accessible to a broad audience, making sure everyone can attend departmental meetings and gatherings from anywhere, to ensuring large service courses are as good as can be - he does it all. I can say with full confidence [and Jason Harlow nodded when I said it!] that large service courses were taught at the level they were because of Pius's support. While not only being extremely knowledgeable about the resources available in the department, he is also a talented developer, who designed and built demonstrations we needed but didn't have!

And while this is not often recognized - Pius did every aspect of his job with unbelievable kindness and generosity of his time. No request for demonstrations (not matter how last minute) was too late and no need for assistance was too cumbersome for him to address.

By Professor Ania Harlick

Prof. Kim Strong, Pius Santiago, and Prof. Ania Harlick at the End of Year Party, June 8, 2023

Continued on next page.

Carolyn Sealfon

Carolyn's part-time term appointment as Assistant Professor Teaching Stream finished at the end of June 2023. She held this position for three years, after several years as a sessional instructor. Carolyn is a dedicated instructor who cares deeply about the students she teaches. They in turn appreciate her passion, enthusiasm, and care. She was primarily involved in teaching lectures and practicals for PHY131 and PHY132, our two large first-year physics courses for students in the life sciences. Of particular note, as the pandemic moved all our teaching online, she was at the forefront of adapting our PHY131 practicals so that students could do them at home with a small kit of supplies. Carolyn also taught two of our fourth-year courses and provided valuable training and advice to our new graduate students with the Microteaching Course for Teaching Assistants offered at the beginning of each fall term. She implemented a variety of active learning methods in her teaching, as well as supervising undergraduate students in Physics Education Research projects. She was also actively engaged in the life of the Department, especially in the IDEA Committee. We thank Carolyn for her many contributions to the Department over the last several years and wish her future success and happiness.

By Kim Strong

Prof. Kim Strong and Prof. Carolyn Seaflon at the End of Year Party, June 8, 2023

In Memoriam

Vatche Berj Deyirmenjian

September 27, 1967 - May 15, 2023

We are deeply saddened to report that Vatche Berj Deyirmenjian, Associate Professor Teaching Stream in the Department of Physics, passed away in Toronto on May 15, 2023, having succumbed to an illness.

Vatche's connection to the Department of Physics at U of T goes back to 1986 when he began his BSc in Physics and Mathematics here. After graduating in 1990, he went to the University of Cambridge, where he completed his PhD in 1995, with a thesis on "Quantum Mechanical Simulation of the Mechanical Behaviour and Metallic Bonding of Defective Aluminium". This was followed by a postdoctoral fellowship in the Department of Physics at the Massachusetts Institute of Technology (1995-1996). He then returned to U of T, where he worked with Professor Stephen Morris from 1996 to 2000, initially supported by an NSERC Postdoctoral Fellowship. Vatche was appointed as a Lecturer in the Department of Physics in 2000, promoted to Senior Lecturer in 2010, and then to Associate Professor, Teaching Stream in 2016.

As a PhD student, Vatche's research interests were focussed on modelling atomic scale defects using electronic structure computations, comparing quantum mechanical calculations with classical schemes, describing the dependence of mechanical behaviour on interatomic bonding, and comparing continuum theories of solids with atomistic simulations. At MIT, he implemented electronic structure calculations based on wavelets and studied the statistical mechanics of dislocations in solids. Back at U of T, he calculated the coherence properties of electrons originating from metals, demonstrated the coherent control of electron emission from metal surfaces, and analyzed nonlinear electroconvection in liquid crystal fluid films.

After his appointment as Lecturer, Vatche turned his attention to teaching physics. Over more than 20 years, thousands of students learned about physics from Vatche, who always taught with his own special style. At the undergraduate level, he taught PHY131 and PHY132 (Introduction to Physics I and II) as well as PHY256 (Introduction to Quantum Mechanics), PHY480/PHY452 (Statistical Mechanics), PHY454 (Continuum Mechanics),

Continued on next page.

PHY[1]491 (Current Interpretations of Quantum Mechanics), and several of our first-year laboratories. He also enjoyed teaching breadth courses to non-science students, including PHY100 (The Magic of Physics) for almost 20 years, PHY196 (Emergence in Nature), PHY202 (The Physics of Science Fiction and Gaming), and PHY205 (The Physics of Everyday Life). At the graduate level, he taught PHY1860 (Foundations of Quantum Optics) and PHY2205 (Special Topics in Quantum Optics: Photons and Atoms). In addition to teaching, Vatche was involved in the Physics Olympiad Preparation Program at U of T (2002-2003) and helped operate the Canadian Chemistry and Physics Olympiad National Camp in 2009.

After learning of Vatche's sudden and unexpected passing, his colleagues remembered him with affection and respect. His kindness, willingness to help, and dry sense of humour were greatly appreciated. He is also remembered as a brilliant physicist who had a passion for science, a gift for explaining complex topics, and a deep dedication to teaching his students. Vatche is greatly missed and fondly remembered by his friends, colleagues, and students.

By Kimberly Strong

MP Balcony (Credit: Orfeo Colebatch)

PhysCAP Recap

Updates from the Physics Career Accelerator Program.

Physics Mentorship Program

The 2023-2024 Physics Mentorship Program was launched on October 5, 2023 with an in-person launch event. The program has almost 50 mentor-mentee matches. Mentors consist of alumni, faculty and graduate students and student mentees who are 3rd and 4th year undergraduate students.

The event was well attended by undergraduate students who sought the opportunity to connect with other mentors and their peers. Raia Ottenheimer and Angela Xiang spoke passionately about their experiences in the program from last year and how it significantly contributed to their personal and professional growth. Their perspectives shed light on the attributes and approaches that proved instrumental in deriving maximum benefit from the mentorship program.

Our seasoned Mentors, Randall McArthur and Julius Lindsay, who have been with the program for at least four years also took to the stage and spoke on their experience as Mentors, and how to best support the journey of mentees.

Selected mentee comments:

"I learnt so much about both academia and life outside in the industry. I feel like I have a much stronger holistic foundation going into graduate school."

"The most important thing I gained is the insight on what the life in a career related to physics feels like. For example, what is the difference between private and governmental hiring, or what kind of job are you expecting on the daily basis. I was also able to learn what kind of mindset you are suppose to have going into the field."

Selected mentor comments when asked what they liked best about the program:

"Meeting and getting to know a bright young student who is in a similar position as I was years ago, and being able to offer my insights and experiences!"

More information on the Physics Mentorship Program can be found here:

https://www.physics.utoronto.ca/undergraduate/physics-career/mentorship/

Outreach in Action

U of T Physics School Visit Program

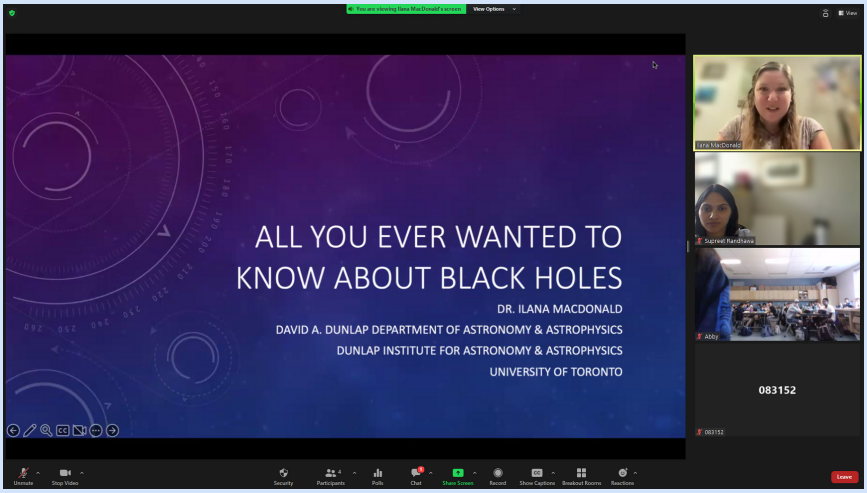
On May 18, 2023, students in grade 11 and 12 from Ontario Science Centre School visited the Department of Physics for a Laser Diffraction workshop by Professor Brian Wilson.

On June 6, 2023, students in grade 7 and 8 from Avalon Montessori School visited the Department for a Light-Matter Interactions workshop by graduate students Joscelyn van der Veen and Kiera Augusto. The workshops were followed by Telescope tours run Dr. Ilana MacDonald in Astronomy and a Physics facility tour by Arman Malik.

Continued on next page.

Outreach in Action

On June 6, 2023, students in grade 7 and 8 from Avondale Alternative Elementary School visited the Department for a virtual workshop on black holes by Dr. Ilana MacDonald.



Are you a high school teacher who wants to bring your class to the Department of Physics for a visit or participate in a virtual visit?
For more information visit:
https://www.physics.utoronto.ca/physics-at-uoft/outreach/school-visits-students/

Rainbow over MP (credit: Andy Jiao)

Outreach in Action

Science Rendezvous

On Saturday, May 13, the Department of Physics participated in Science Rendezvous. Science Rendezvous is Canada's largest Science Festival and is free for everyone. There were over 300 events across 30 cities and 1000s of mind-blowing exhibits. At Physics, 30 student and faculty volunteers made the event a huge success, 100s of people came through the throughout the day for the variety of demonstrations, talks and tours. Demonstrations included: Spandex table – time and space model, Sound Waves & Pendulum Waves, Angry Birds, Singing Wine Glasses, 1m tall dominos, Optical illusions using Ghost Light Bulb, Real image of Frog, Miracle Mirror, Classic Van de Graaff generator, the Superconducting Train, Chladni Plates, Levitating Magnets, Eddy Current Tubes, Homopolar Motors and more. Prof. John Wei also gave a public talk on High Temperature Superconductors.

More information here: https://www.physics.utoronto.ca/physics-at-uoft/outreach/science-rendezvous/

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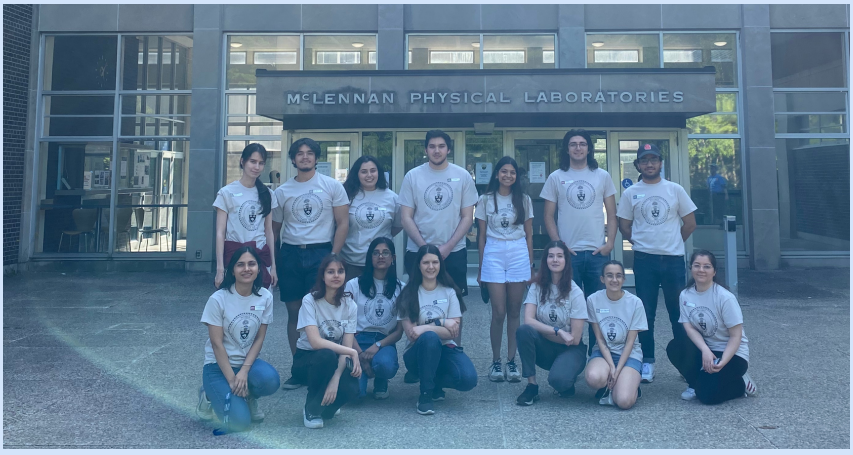
Girls sySTEM

The Department of Physics participated in workshops for Girls sySTEM again this year. This program is for girls in grade 7-12 interested who are in STEM. This year, the following workshops were provided:

- John Wei ran a workshop on “Superconductivity”
- Andrew Cox ran a workshop on “Theoretical Physics”
- Kaley Walker, Cassandra Chanen, and Alexandra Corapi ran a workshop on “Atmospheric Physics: Up, Up and Away!”
- Joscelyn van der Veen ran two workshops on "The magic of microwaves" and "Hello darkness my old friend"
- Mohamed Shabaan ran a workshop on "Experimentally probing the Dark Universe"
- Daniel Gregory ran a workshop on "Starburst Rock Cycle"
- Earth Sciences graduate students ran two workshops on "Virtual Museum Tour: History of Life on Earth" and "Virtual Earth Sciences Field Trips"

Doors Open

TThe Physics Department participated in Doors Open Toronto on May 26 and 27, 2023. Over 1700 visitors saw the lecture hall where Good Will Hunting was filmed, as well as receiving other historical information about the McLennan Physics building. There were a variety of physics demonstrations for children, parents, and curious people of all ages. The event was organized by Professor David Bailey with the help of our technicians, and a number of volunteers from the Department.



A group photo of the volunteers from Doors Open Toronto, 2023

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The building is home to the Department of Physics, professors, researchers and students who work together on theory and experiments involving high energy particles, the atmosphere of Earth and other planets, quantum computers and more. Visitors had the opportunity to visit the 15th floor roof of the McLennan tower and look over the University campus and downtown Toronto, overlooking buildings historic, modern, and under construction. Visitors also saw the first-year undergraduate laboratories, where they can explore our teaching and learning spaces, tried some of the apparatus, and met our scientists and students.

More information on Doors Open can be found here.

Photos from Doors Open, 2023

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Science Unlimited Summer Camp

Science Unlimited Summer Camp took place from August 14-18, 2023. 50 high school students to participated in a week of workshops hosted by Departments of Astronomy and Astrophysics, Chemistry, Computer Science, Earth Sciences, Math, Physics and the School of the Environment. At Physics, students learned about scientific computing, various physics demos, and atmospheric science.

Students commented that they enjoyed the hands-on activities, seeing the U of T campus, and working on the design challenge with their groups. They also enjoyed meeting new people:
"I enjoyed all of the activities over the week and it was an unforgettable experience to learn new topics in every course we took!" – 2023 Science Unlimited Summer Camp participant.

"I liked presenting the design challenge on Friday. After a whole week of preparation and work, being able to present to our peers was really exciting. The prospect of a prize upped the stakes as well, which made me quite invested. I learned a lot from other groups' ideas that I didn't know before." – 2023 Science Unlimited Summer Camp participant.

We look forward to camp next year and are grateful to the departments who made this week possible.

More information on Science Unlimited can be found here:
https://summercamp.physics.utoronto.ca/

Physics News

U of T researcher joins effort to establish transatlantic quantum communications link

Prof. John Sipe, one of the co-leads on the project, is a professor in the Department of Physics whose research focuses on quantum optics and condensed matter physics. The project aims to demonstrate the feasibility of the technology, which could ultimately make quantum applications more attractive and realistic in the near future.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/u-of-t-researcher-joins-effort-to-establish-transatlantic-quantum-communications-link/

Shifting gears: How data science led Madeleine Bonsma-Fisher from studying germ models to bike lanes

Madeleine Bonsma-Fisher, a cycling activist and postdoctoral researcher at the University of Toronto's Data Sciences Institute, is using data analysis to study traffic patterns in Toronto. Her current research focuses on whether essential destinations such as grocery stores, healthcare, and schools can be reached by bike within 30 minutes using only bike lanes and traffic-calmed roads.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/shifting-gears-how-data-science-led-madeleine-bonsma-fisher-from-studying-germ-models-to-bike-lanes/

Professor Barth Netterfield shares his work on measuring dark matter using SuperBIT, a balloon telescope

A research team from the University of Toronto's Departments of Astronomy and Astrophysics, and Physics built a high-tech balloon-borne telescope, SuperBIT, to study the distribution of dark matter in galaxy clusters and large-scale clusters of the Universe.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-barth-netterfield-shares-his-work-on-measuring-dark-matter-using-superbit-a-balloon-telescope/

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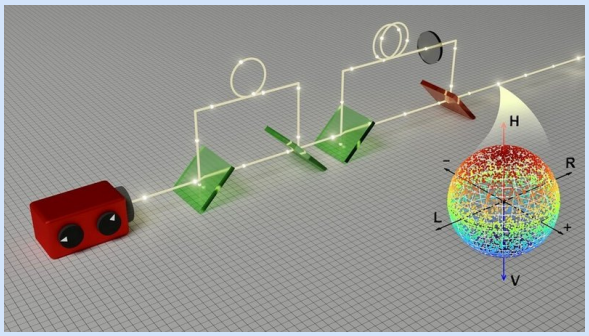
Quantum Key Distribution Breakthrough Improves Communication security



A research team led by Professor Hoi -Kwong Lo and Dr. Wenyuan Wang (HKU Department of Physics) has proposed a QKD scheme without any modulators, which removes a major source of side channels on QKD sources. The proposal suggests a new type of passive linear optical QKD source.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/quantum-key-distribution-breakthrough-improves-communication-security/

Professor Kent Moore provides insights into wildfires & climate change

Prof. Kent Moore, a climate scientist and a Professor in the Department of Chemical and Physical Sciences at UTM and in the Department of Physics, commented on the recent wildfires in Nova Scotia, surpassing the total land burnt in June surpassing the numbers for an entire summer.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-kent-moore-provides-insights-into-wildfires-climate-change/

Prof. Pekka Sinervo sheds light on radioactive water pollution from the Fukushima nuclear plant

Prof. Pekka Sinervo has been closely following the story and shared his concerns on this action in an interview with CTV.
It has been 12 years since the Fukushima nuclear plant was damaged in an earthquake and tsunami in March 2011. The authorities in Japan are planning to clear the water remaining in the plant, in case there is another earthquake, and to decommission the plant.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-pekka-sinervo-sheds-light-on-radioactive-water-pollution-from-the-fukushima-nuclear-plant/

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'Why the day is 24 hours long': Astrophysicists reveal why Earth's day was a constant 19.5 hours for over a billion years

A team of astrophysicists including Norman Murray, Hanbo Wu, Kristen Menou, Jeremy Laconte and Christopher Lee, has revealed how the slow and steady lengthening of Earth's Day caused by the tidal pull of the moon was halted for over a billion years.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/why-the-day-is-24-hours-long-astrophysicists-reveal-why-earths-day-was-a-constant-195-hours-for-over-a-billion-years/

Matt Russo transforms data from space into a musical album, in collaboration with NASA

Matt Russo, an astrophysicist and a musician at the University of Toronto, has collaborated with Kimberly Arcand, a visualization scientist at NASA's Chandra X-ray Observatory in Cambridge, Massachusetts, to transform visual data into almost musical sequences of sounds. This is part of Matt's outreach project called SYSTEM Sounds.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/matt-russo-transforms-data-from-space-into-a-musical-album-in-collaboration-with-nasa/

Physics researchers investigate Dark Matter at SNOLAB

Professors Miriam Diamond, Ziqing Hong, and Pekka Sinervo are working on the SuperCDMS experiment at SNOLAB to detect dark matter. Scientists estimate that dark matter makes up 85 percent of all mass in the Universe. Despite its presence, its nature remains elusive. Dark matter has mostly revealed itself through its gravitational influence on distant galaxies.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/physics-researchers-investigate-dark-matter-at-the-snolab/

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Physicists sleuth hidden order

Unlike fridge magnets, many crystals exhibit complex magnetism involving more than just north+south poles. Recent work by graduate student Sreekar Voleti, working with Professor Paramekanti and collaborators, shows how one can probe such "multipolar" magnets using impurities, which like the Roman God Janus, have a dual effect - they detect the order but ultimately destroy it.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/physicists-sleuth-hidden-order/

Physics undergraduate student takes climate change science to the streets

For physics undergraduate student Sebastian Ibarra Mendez, monitoring levels of methane in the GTA is a natural extension of a project he began in high school in Colombia.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/physics-undergrad-student-takes-climate-change-science-to-the-streets/

Professor Nicolas Grisouard on climate change and impact on global water circulation

Professor Nicolas Grisouard, a professor at the University of Toronto, Department of Physics, explains how the Atlantic Meridional Overturning Circulation (AMOC) works and its impact in an interview with CBC.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/summer-abroad-students-probe-the-subatomic-universe-at-cern-the-worlds-largest-particle-physics-lab/

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Documentary on Balloon-borne Telescope Developed at U of T Streaming Now

Earlier this year, astronomers successfully launched a balloon-borne telescope that captured extraordinary images of the universe on its first flight above the Earth's atmosphere. The SuperBIT was flown to the edge of space by a helium-filled NASA scientific balloon the size of a football stadium, where it also helped researchers investigate the mystery of dark matter.

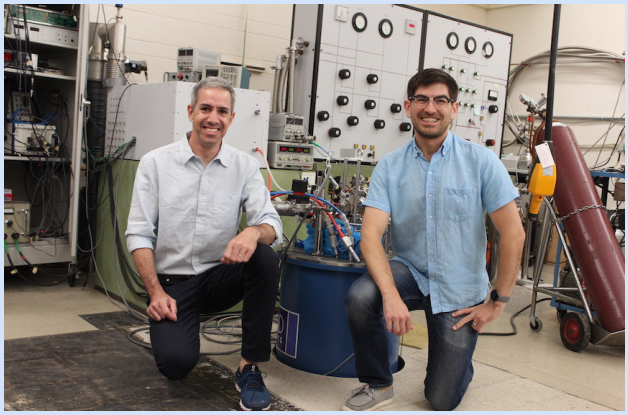
More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/documentary-on-balloon-borne-telescope-developed-at-u-of-t-streaming-now/

How one U of T PhD student's dream of exploring space took flight on a balloon

Physics graduate student Emaad Paracha was a key member of the team that launched the Super-pressure Balloon-borne Imaging Telescope, known as SuperBIT, earlier this year.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/how-one-u-of-t-phd-students-dream-of-exploring-space-took-flight-on-a-balloon/

Physicists coax superconductivity and more from quasicrystals



Professor Sergio de la Barrera and researchers at the MIT introduce a new approach to realizing two-dimensional quasicrystals using layered materials like graphene. These findings in a quasicrystalline system may have important implications for the possible symmetries of superconducting and correlated electronic states.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/physicists-coax-superconductivity-and-more-from-quasicrystals/

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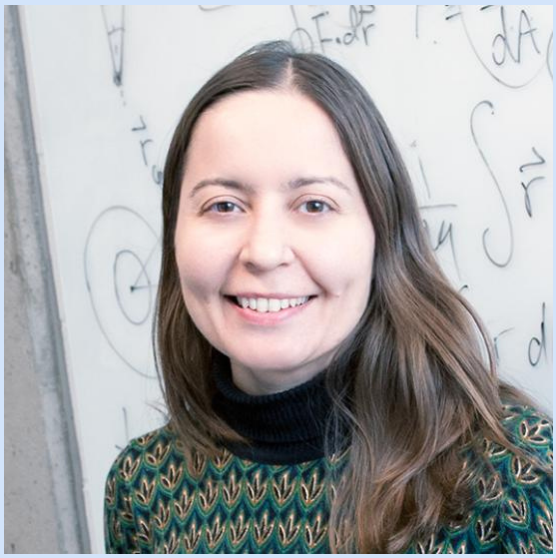
Professor Sarah Rauscher and Liam Haas-Neill make new findings about stem cells



Prof. Sarah Rauscher and PhD student Liam Haas-Neill extend the use of fluorescent proteins in stem cells to report on local density in crowded environments. This broadens the use of fluorescent proteins beyond just tracking — they can also report on heterogeneities in density.

More:

https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-sarah-rauscher-and-liam-haas-neill-make-new-findings-about-stem-cells/

MP City View (Credit: Raul Cunha)

University of Toronto Campus in the Winter
(credit: Aephraim Steinberg)

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