Physics
UNIVERSITY OF TORONTO

Spring 2025

INTERACTIONS

The Department of Physics Newsletter

McLennan Physical Labs
(credit: University of Toronto)

MESSAGE FROM THE CHAIR

Welcome to the Spring 2025 issue of Interactions, the Department of Physics newsletter!

Dear Physics Community,

The signs of spring are slowly but surely arriving and, with them, the chance to reflect on the past six months in my leadership role in this fine department and community. There have been many highlights for me, but three stand out. First, at our November celebration of the great work of outgoing Chair, Prof. Kimberly Strong and her leadership team, we welcomed many well-wishers from the Department and the Faculty of Arts and Science. See the write-up of this event in this

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issue of Interactions. (link) I especially enjoyed the thoughtful expressions about how Kim and team helped the Department thrive in challenging times – lessons that will certainly apply to future challenges.

Second, at our 2025 Faculty Retreat, which took place January 10 and 11 in the beautiful Music Room of Hart House, I was gratified by my colleagues' creative engagement as we considered the future of the McLennan Physical Laboratories facility. This was part of our contribution to the MP Renewal Masterplan Project (see the article in this issue (link). We are fortunate to be able to draw on the rich experience of our great faculty and community as we consider the future of the facility.

Finally, the third highlight was the continued celebration of University Professor Emeritus Geoffrey Hinton's Nobel Prize in Physics, at the Nobel Week in December, in Stockholm, Sweden and at the Martin Family Lecture in Physics in February. (See the article about the Martin Lecture in this issue. (link)

About Nobel Week in December: I was privileged to represent our Department as part of the University of Toronto's delegation. The University hosted several events in Stockholm's beautiful hotel and museum spaces and at the Canadian Embassy to Sweden. The week featured Prof. Hinton and others leading fascinating discussions about the state and future of artificial intelligence, about Canada's work in this area, and about cooperation and investment activity between Sweden and Canada. I got to take part in great conversations about the Physics perspective on this prize. I was also offered many opportunities to highlight our Department's initiatives, particularly in experimental physics and quantum information science, with alumni attending the event, representatives of Swedish industry, and our own university leadership. I'm hopeful that these connections will help advance some of our most pressing needs.

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I also want to mention a few other milestones, including that:

- Prof. Ziqing Hong has passed his interim review with the wholehearted support of the Department;
- Our Librarian, NuRee Lee, has been awarded permanent status and promotion to Librarian III;
- Prof. Yoni Kahn, covered in a separate profile (link) and mentioned in the Martin Lecture article (link), has joined our Department in December;
- Ms Harim Ulfig has joined the department as Executive Assistant and Projects Coordinator for the Chair's Office; and
- Ms Jennifer Pinker has been seconded as Outreach, Facilities and Special Projects Coordinator at Department of Physics. Thank you, Jennifer, for your work on this issue of Interactions!

I'm sure you'll enjoy reading the many features of Interactions in the coming pages. You can rewatch the presentations by this year's Welsh Lecturers (link), get a chance to learn about Prof. Dylan Jones's appointment to the Wilson Professorship (link), get an update on our many Outreach (link) and Physics Student Union (PhysU) (link) activities, and become better acquainted with our community through faculty, student, and alumni profiles. Our work continues to show how U of T Physics can thrive and lead, even in challenging times, as we pursue our Physics teaching and research mission with energy, passion and integrity. The support of our community in this mission is deeply appreciated.

Wishing you all the best for the summer.

Sincerely,

Paul Kushner
Professor and Chair, Department of Physics, University of Toronto

Cherry blossoms outside Robarts library. Credit: Jennifer Pinker

Celebration of Kimberly Strong and the Outgoing Physics Leadership Team

Outgoing Chair Prof. Kimberly Strong (who was Department Chair 2019-2024) and her leadership team were recognized on November 4, at a reception held in the Faculty Club to celebrate her and her leadership team's tenure. This was a great occasion to acknowledge Kim and the team's valuable contributions while working through many challenges, including the COVID pandemic. Her service featured numerous faculty hires, a major external review (UTQAP), many awards and recognitions for the Department, and initiatives such as the formation of the IDEA Committee, the Momentum Builders Scholarship and Pursue STEM. Throughout, Kim approached her work with diligence, dedication, and a warm sense of good will, which was deeply appreciated by all of us.
Thank you to Kim and her great team!

Left to right: Prof. Kim, Peter Hurley, Prof. Strong, Prof. Krieger, Prof Thywissen

Credit: Eva Cheung

Prof. Strong's research team

Martin Family Lecture by Prof. Geoffrey Hinton

We continue to celebrate Prof Geoffrey Hinton's being awarded the 2024 Nobel Prize in Physics for his revolutionary work enabling machine learning with artificial neural networks. To mark this tremendous achievement, the Department of Physics invited Prof. Hinton to deliver the 2025 Martin Family Lecture in Physics. (link) (As a reminder, through the generosity of the Martin Family's endowment, the Martin Family Lectures are offered every four years in the Department of Physics, and rotate through three other Departments in other years.)

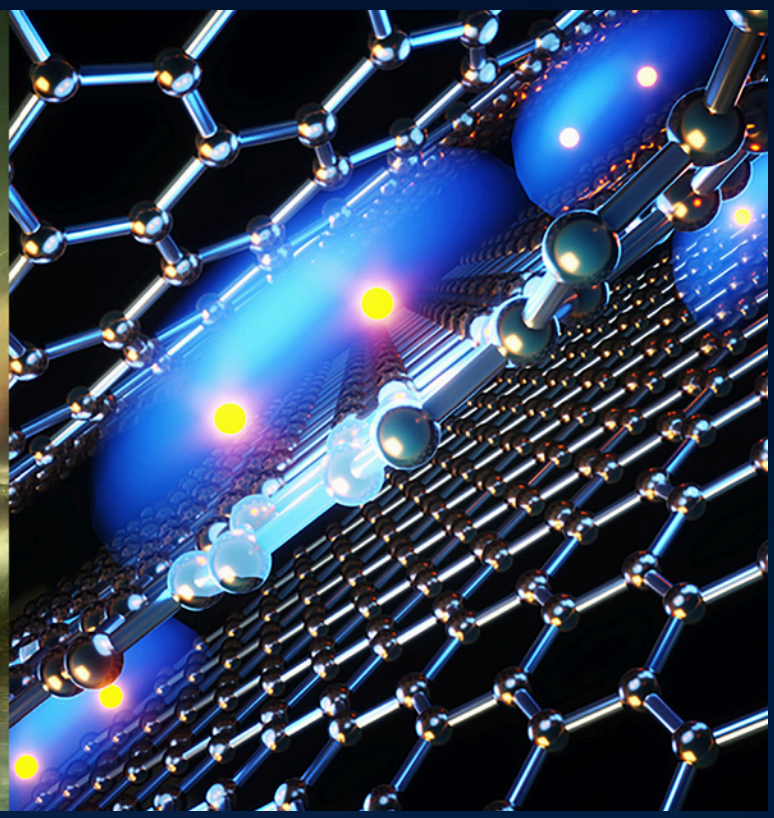
On February 25, Prof. Hinton delivered a compelling lecture on the role of his thought and discoveries in the early stages of the development of modern AI. The lecture and subsequent reception took place at the Schwartz-Reisman Innovation Campus. In the talk, *Boltzmann Machines: Statistical Physics meets Neural Networks*, Hinton discussed his invention of the Boltzmann machine, an early example of an unsupervised deep learning model, one which arose from ideas in statistical physics. His work has helped lead to advancements in a wide range of areas, such as speech recognition and object classification, that greatly impact our lives today. The lecture was followed by an exciting fireside chat with Prof. Hinton and Prof. Yonatan Kahn, who is newly appointed to the Department of Physics (see later in this issue), on what the future will bring in exploring the connections between Physics, machine learning and AI.

As a token of the warm recognition and esteem in which Prof. Hinton is held in the Department of Physics, we appointed Prof. Hinton honorary Graduate Faculty Membership (Emeritus) in Physics; we made sure this this appointment conferred zero administrative duties!
More on this annual lecture: 2025 Martin Lecture in Physics | Faculty of Arts & Science

Credit:
Diana Tyszko

Prof. Hinton delivering his talk with Prof. Kahn

THE WELSH LECTURES
IN PHYSICS 2025



PROF. CUMRUN VAFA
Harvard University, USA

PUBLIC TALK

THURSDAY, MAY 1, 1:30 PM

Fundamental Lessons from String Theory

EARTH SCIENCES CENTRE
Auditorium ES1050, 5 Bancroft Ave.

COLLOQUIUM

FRIDAY, MAY 2, 2:00 PM

String Theory and Our Universe

KOFFLER HOUSE
Auditorium KP 108, 569 Spadina Cres.

PROF. PABLO JARILLO-HERRERO
MIT, USA

PUBLIC TALK

THURSDAY, MAY 1, 3:30 PM

Magic Angle Graphene: the Twist and Shout of Quantum Materials

EARTH SCIENCES CENTRE
Auditorium ES1050, 5 Bancroft Ave.

COLLOQUIUM

FRIDAY, MAY 2, 11:00 AM

The Magic of Moiré Quantum Matter

KOFFLER HOUSE
Auditorium KP 108, 569 Spadina Cres.

Sponsored by the Department of Physics. For further information, call (416) 978-7135, visit https://welsh.physics.utoronto.ca/ or email: iyer@physics.utoronto.ca

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Faculty Profile

Yonatan Kahn

Assistant Professor, Tenure-Stream

Welcome to Professor Yonatan Kahn, our newest faculty member in the Theoretical High Energy Physics group, who began in December, 2024.

Can you provide a brief introduction to yourself, including your academic background and area of research?

I'm coming to U of T from a previous faculty position at University of Illinois. I'm originally from California; I did my undergraduate work at Northwestern University, went to MIT for a Ph.D., and then did postdoctoral fellowships at Princeton and University of Chicago. I'm a theoretical particle physicist, and my main area of research is looking for dark matter (it's 80% of the mass of the universe and we have no idea what it is!). Recently I've gotten interested in studying neural networks and artificial intelligence more broadly from the perspective of physics.

Could you share some details about your current interests and any specific projects you are working on?

I'll give two examples to illustrate the different kinds of work that I do.

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1. I'm working with condensed matter physicists at University of Illinois, chemists at MIT, and dark matter experimentalists at Fermilab to develop a new dark matter detector made out of an organic compound called trans-stilbene. This is basically a fancy kind of plastic where if you shine light on it or bombard it with electrons (or dark matter), it glows. We can capture the light in a device similar to the one in your phone camera, one photon at a time, and look for variations in the rate over the course of the day as the Earth rotates with respect to the "wind" of galactic dark matter coming at us from the direction of the Cygnus constellation. We're hoping that once we develop a prototype, we can work with EHEP [experimental high energy physics] professors Ziqing Hong and Miriam Diamond here to deploy it and take first data in the next few years.

2. The most precise measurement of a fundamental particle humanity has ever made is the magnetic moment of the electron, which we know to 13 decimal places. The wizards who measure this quantity by trapping a single electron in a box (Gerald Gabrielse and his team at Northwestern University, and Xing Fan at Harvard) want to push to even more precision, but the leading source of uncertainty will be a quantity that can't be directly measured, only calculated: the effect of the walls of the box on the quantum energy levels of the electron. This calculation is a beautiful bit of early 20th-century physics with some subtle twists, and has actually informed the way I plan to teach quantum mechanics and quantum field theory.

What is your approach to teaching, and are there specific teaching methods or philosophies you are particularly passionate about?

I think teaching works best when the students are actively engaged: I love getting interrupted by questions during a lecture, and I am a big fan of hands-on assignments such as coding projects or open-ended research in addition to the standard problem sets. I find that writing my own notes on the course material from scratch helps me solidify my understanding and presentation of the material. Quantum field theory in particular is a tricky subject to teach: one of my favorite textbooks makes the point that, unlike every other core physics subject, field theory has been around for almost 100 years but every book takes a completely different approach, which means we still don't know how to teach it! I've been toying with the idea of writing a book on the subject myself, but I think this will be a post-tenure project.

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Are there any interdisciplinary or collaborative initiatives you are interested in pursuing within the department?

I'm really interested in forging collaborations with the Vector Institute, where I'm a faculty affiliate in addition to my appointment in the Physics Department. U of T has been at the forefront of artificial intelligence research for decades -- many of the cutting-edge advances which power ChatGPT were developed by U of T students or postdocs -- and it's a wonderful ecosystem to join. Many developments in modern AI (for example, diffusion models for image generation, or symmetry-equivariant networks) were loosely inspired by physics, and physics – which has a long history of extracting useful predictions from complex systems with enormous numbers of degrees of freedom – can be used to understand pieces of what is happening inside large AI models. I think many in the AI field would agree that safe and responsible AI is a crucial goal, and to the extent that better understanding and interpretability lead to better safety, I think physics can play a very useful role.

In what ways do you hope to make an impact within the department and the broader academic community?

This is a very interesting time for physics and society. On the one hand, we have a spectacularly successful theory of particle physics which can predict the result of basically any experiment ever performed on Earth to fantastic accuracy. On the other hand, we know that dark matter exists, but we've never seen it on Earth, and the key to its identity may be found in astrophysical data. On a parallel track, artificial intelligence is poised to completely change how we live and work over the next decade, but we still don't understand fundamental things about how neural networks make their predictions. I am excited to try to unify all of these perspectives: using physics to understand AI better (and to teach AI from a physics perspective), and then to exploit that improved understanding in order to harness AI to do better physics. This has the potential to strengthen connections within the Physics Department, as well as establish collaborative relationships with statistics, computer science, and the Vector Institute.

What advice would you offer to students who are interested in pursuing a career in teaching?

It's a bit cliché, but true: the best way to find out if you know something is to teach it. A career in teaching really lets you improve your own understanding of the subjects you teach every time you teach them! In addition, the "aha" moment when a mathematical manipulation or a physical insight suddenly "clicks" for a student is incredibly rewarding to witness. My most generally applicable piece of advice is to think back to the things that confused you the very first time you saw a particular subject (I still remember the visceral feeling of bafflement when I first saw the equation $\hat{x}\ |x\rangle = x\ |x\rangle$ in quantum mechanics), recognize that your students will likely be confused by a similar thing, and try to use your accumulated knowledge to ease them through those conceptual roadblocks.

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Are there any lessons from your own academic journey that you would like to share?
Getting an academic job in physics is part research, but part performance: the way you give a job talk, the way you interact with prospective graduate students, the 1-on-1 conversations with other faculty members, all of these are what actually make the difference at the end of the day. Your research will get you an interview, but your interpersonal skills will actually land you the job. Give lots of practice talks!

What drew you to join our department, and what aspects do you find most appealing or unique?
One of the best things about the Physics Department at U of T is the incredible strength in experimental particle physics, especially dark matter. The best underground lab in the world is SNOLAB in Sudbury, and several U of T professors are directly involved in experiments there. A main part of my research program is proposing new experiments to search for dark matter, and I am very excited for the collaborative possibilities there.

I am a classically-trained French horn player with a particular interest in historical instruments from the 18th and 19th centuries. Toronto happens to be one of the few cities in the world with a large community of people passionate in this kind of music (including several at the Faculty of Music), so I'm really looking forward to making some musical connections!

Post Doctoral Fellow Profile

Yuxuan Zhang, Quantum AI

Where did you complete your Ph.D.? What was the topic of your Ph.D. thesis, and what motivated you to do research in it?

I completed my Ph.D. at the University of Texas at Austin (another UT!). I was fortunate to be advised by physicist Andrew C. Potter and computer scientist Scott Aaronson. My dissertation, titled "Exploring Quantum Matter in the Era of Quantum Computers," focused on leveraging quantum computing to study complex quantum systems.

The motivation behind developing quantum computers is twofold: theoretically, quantum computers have the potential to tackle problems that are intractable for classical computers; practically, modern chip manufacturing is approaching the quantum regime, making the development of quantum technologies an urgent and inevitable task.

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Could you describe the focus of your current research as a postdoc? What inspired or motivated you to pursue this specific research area?

As a child, I was fascinated by the universe and wondered: What fundamental principles govern both the stars and the Earth? This curiosity led me to a physics major at the University of California, Santa Barbara, where I was introduced to mind-blowing concepts like quantum entanglement. Soon, I began asking deeper questions: How does our understanding of quantum physics advance quantum computation? And how can quantum computers help us better understand physics? These questions led to the first major direction of my current research.

In recent years, the rapid advancements in artificial intelligence—exemplified by large language models—have demonstrated the transformative power of AI in computation. This naturally leads to another question: How can AI be leveraged to tackle the theoretical and engineering challenges in quantum physics and quantum computing? My second research direction focuses on harnessing AI to push the boundaries of quantum science.

By bridging these two fields—quantum computation and artificial intelligence—I aim to contribute to the future of computing and deepen our understanding of the quantum world.

Have you collaborated with other researchers or departments during your postdoc? How have these collaborations enhanced your research?

Yes! During my postdoc at U of T, I have engaged in interdisciplinary collaborations that have significantly enriched my research. I attend group meetings led by Dvira Segal (U of T Chemistry) and Nathan Wiebe (U of T Computer Science), where I benefit greatly from both formal discussions and informal exchanges with their group members.

Beyond U of T, I have had the opportunity to collaborate with researchers from institutions worldwide, including Perimeter Institute, Princeton, ETH Zurich, and U Tokyo. These collaborations not only keep me informed about the latest advancements across different fields but also help me stay open-minded about innovative approaches and emerging research directions.

How do you believe your research contributes to the broader field or addresses current challenges?

Since my appointment in September 2023, my research has contributed to multiple key areas at the intersection of quantum computing and artificial intelligence. These include:

1. Quantum Complexity – Advancing our understanding of the computational power and limitations of quantum systems;
2. Physical Applications of Quantum Computers – Exploring how quantum devices can be leveraged for simulating quantum;
3. Quantum Error Correction – Developing strategies to enhance the improve the quantum processors' robustness to noise;
4. Machine Learning for Quantum Science – Utilizing AI to optimize quantum simulations and improve quantum hardware control; and

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- I'm excited that some of our papers have been published in top-tier journals like Nature Communications and PRX Quantum. One of our works was even featured in PRX's special collection celebrating the International Year of Quantum Science and Technology, highlighting its relevance to the broader physics community.

What challenges have you encountered in your research, and how have you worked to overcome them?

When I first started working in quantum computing during graduate school, I had little background in computer science and computational complexity. This initially felt like a big challenge, but I quickly learned an important lesson: Don't hesitate to step out of your comfort zone.

To bridge the gap, I first exposed myself in the field—attending lectures and engaging in discussions with experts (I recall that I asked many naïve questions!). After a few months, I took on an open problem that Scott Aaronson suggested. Having a concrete problem to work on significantly boosted my motivation and accelerated my learning.

What ways has your postdoctoral experience contributed to your professional development?

My postdoctoral experience has significantly contributed to my professional development in several key ways:

- Teamwork – I've learned that no one can be the best in all aspects, so it's crucial to collaborate with experts across different disciplines. Engaging with colleagues from physics, computer science, and chemistry has sharpened my ability to communicate and coordinate effectively with people from different backgrounds.
- Adaptability – As a postdoc, I often encounter new methods, tools, and ideas, especially when working at the intersection of different fields. The ability to quickly learn and adapt to novel techniques has been essential.
- Time Management – While academic research doesn't always have strict deadlines like in industry, I've learned to be self-motivated. I set weekly agendas and milestones to track progress efficiently, ensuring that projects move forward and that I meet submission deadlines.

Beyond these, my postdoc experience has strengthened my ability to mentor students and think about the long-term impact of my work. It has been an invaluable period of growth, both as a researcher and as an individual.

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Are you actively involved in departmental activities or events? How do you engage with the department's academic and social community?

Yes, I am actively involved in the Physics Department's activities and social events. The department organizes a variety of gatherings (seminars, coffee hours, parties, etc.), and I attend whenever possible. After work, we often hang out at local bars, and occasionally, we even plan road trips together.

Outside the quantum world, Yuxuan enjoys traveling and photography.

This photo was captured by Claire at the Bruce Peninsula National Park.

What are your future career aspirations after completing your postdoc?

In the fall, I will be moving to UCLA as a Quantum Postdoctoral Fellow to further pursue my passion for AI and quantum computing. Returning to Southern California feels fulfilling, as this is where my journey as a physicist began. My long-term career goal is to become a faculty member or a research scientist.

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What advice would you give to graduate students or early-career researchers considering a postdoc? Are there lessons learned during your postdoc that you believe would be valuable for others in the field?

I encourage graduate students to plan their careers ahead of time. When applying for positions, it's important to recognize that postdoc roles often require different skills than industry positions. Rather than hedging your bets on both, I recommend focusing on what you truly want.

Based on my personal experience, being a postdoc offers more freedom to choose your projects compared to working in a company. If that's something you value, then a postdoc position might be a great choice for you!

Courtyard at Sir Daniel Wison Residence. Credit: Jo-Anne Wurster (2024)

Graduate Student Profile

Andrija Rasovic

Ph.D. Candidate, Theoretical Physics

What sparked your interest in physics?

I've been fascinated by physics for as long as I can remember. Growing up in Montenegro, I was always drawn to big questions about the universe—why things work the way they do, what the fundamental laws governing reality are. Over time, that curiosity evolved into a more structured interest in theoretical physics.

Can you tell us more about your academic journey?

At 16, I moved to the Netherlands after receiving a scholarship to attend UWC Maastricht, an international school that emphasized academic excellence and cross-cultural understanding. It was a significant transition that exposed me to new perspectives and challenges. After graduating in 2017, I pursued my undergraduate degree at Cornell University, where I developed a deeper understanding of physics and gained valuable research experience. In 2021, I began my Ph.D. at the University of Toronto, focusing on fundamental questions in theoretical physics.

Can you give us a brief summary of your research?

My research explores unresolved questions within the Standard Model, such as the origin of dark matter, the matter-antimatter asymmetry, and the nature of neutrino masses. One of the frameworks I study is the Mirror Twin Higgs model, which proposes a hidden twin sector of particles that could explain the Higgs boson's unexpectedly low mass while also providing a potential dark matter candidates. We studied how existence of such sectors can help us answer the question of why there is more matter than anti-matter in our universe. If such a model is realized in nature, it could have observable consequences in future experiments, including specific astrophysical and collider signatures. Understanding the interplay between this hidden sector and the Standard Model could provide key insights into why our universe looks the way it does.

Additionally, I work on improving Quantum Field Theory (QFT) techniques to better describe the high-temperature conditions of the early universe. Standard QFT approaches fail when dealing with the extreme conditions that existed just after the Big Bang. By developing new theoretical tools, we can make more precise predictions about cosmological phase transitions, especially focusing on ones that might occur in models with complex dark sectors. This has profound implications for the study of gravitational waves, which could serve as a direct probe of new physics beyond the Standard Model. My research aims to bridge the gap between fundamental theory and observational data, helping us better understand the forces that shaped the early universe.

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What extracurricular activities are you involved in?

Outside of research, I'm a competitive wrestler and a member of the University of Toronto Varsity Blues wrestling team. I have placed twice in 5th position at the Ontario University Athletics (OUA) conference. Wrestling provides a physical and strategic challenge that complements my research—it requires discipline, problem-solving, and perseverance, much like theoretical physics. It also offers a valuable balance to the abstract nature of my academic work, reinforcing the importance of persistence and adaptability.

Wrestling for U of T

What advice would you give to aspiring physicists?

First and foremost, curiosity is key. The most exciting discoveries in physics come from asking deep, fundamental questions and not being afraid to challenge existing ideas. Learning physics can be difficult, and there will be moments of frustration, but persistence and resilience are essential. Don't hesitate to seek out mentors, collaborate with peers, and engage in research as early as possible—it's one of the best ways to develop an intuition for physics. Finally, keep an open mind. Some of the most fascinating developments in physics come from unexpected places.

Teaching at U of T

Undergraduate Student Profile

Stephanie Sui

Physics and Philosophy Specialist Program

Year of Study: 4th

Why did you decide to major in Physics? What was your inspiration?

My interest in science began at an earlier age from reading science fiction novels and watching "The X Files". I was later drawn to Physics specifically because of its combination of rigorous theory and real-life considerations. I enjoy being challenged and having to think creatively to solve complex problems, and I never stopped being curious about the universe we live in.

What do you enjoy most about the physics program?

I appreciate the many opportunities we have to learn computational and mathematical techniques that can be applied when solving any problem. I love that physics problems range from highly abstract to deeply grounded in reality, allowing me to explore the philosophical implications of quantum mechanics one moment and debug circuits the next. Another highlight has been the like-minded peers I've met - physics attracts students who are genuinely passionate about the subject, and collaborating with them has been an incredibly rewarding experience.

Image of the front entrance to the McLennan Physics building in the different seasons, taken by Stephanie.

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What other extra-curricular activities are you involved in during your degree?
I am currently the President of the History and Philosophy of Science Undergraduate Society (HPSUS). We hosted academic and graduate panels last semester, and in March, we had our annual International Undergraduate Research Conference that occurs virtually, where student researchers from across the world come together to share their work in Science, Technology, Medicine, and Society (STMS).

In my first two years, I was involved in the Victoria University Students' Administrative Council (VUSAC), first as the communications coordinator and then as the co-chair of the Academic Commission where we organized study nights, career workshops, and networking events with Vic alumni. I also copyedited and wrote articles for the Victoria College student journal, *The Strand*.

What are your research interests?
I'm conducting research in the Super Cryogenic Dark Matter Search (SuperCDMS) group under the supervision of Prof. Pekka Sinervo, where I run simulations to gauge the viability of applying machine learning techniques to improve energy and position reconstruction of SuperCDMS detectors. I deeply enjoy investigating patterns within the data and trying to understand the physical phenomena behind them. Being part of a large collaboration also gives me the chance to improve my presentation skills I'm also hoping to expand my horizon and engage in research in other fields.

What are your future plans?
I wish to continue strengthening my skills by immersing myself in research and pursue graduate studies.

Where do you see yourself in 10 years?
In ten years, I see myself living in a different country but still staying in contact with my closest friends.

Tell me something interesting about yourself.
I was involved in many theatre productions in my high school through acting, script writing, and editing.

Alumni Profile

Yara Mohajerani

B.Sc. Physics

How did your time at the university shape your career aspirations?

My time in the physics undergraduate program at U of T was pivotal in shaping my career trajectory. It provided me with the intellectual confidence and flexibility to tackle any challenge that piqued my interest. More than just technical skills, my physics education taught me how to think critically and learn effectively, giving me a distinct edge in graduate school and beyond. This foundation not only enhanced my ability to adapt to new fields but also equipped me with the tools to succeed across diverse disciplines.

What career path did you pursue after graduating from U of T?

After my undergraduate degree in physics at U of T, I obtained my Ph.D. in Earth System Science from the University of California, Irvine. After completing two postdocs at the UC Irvine and the University of Washington, I returned to Canada to establish a climate-tech startup together with another U of T physics classmate from undergrad. We operated the business for two years, providing data and services to the financial sector. I then took a role as a consulting manager in climate risk at Ernst and Young. In 2025, I returned to the entrepreneurial world to launch a new company that provides speciality products and services to professionals.

What are some of your fondest memories from your time at the university?

To this day, I socialize very regularly with my friends from undergrad. We routinely talk about all the late nights doing assignments together in the physics building. The PASU (Physics and Astronomy Student Union) office was a second home to us, where we spent the majority of every day for 4 years. The bonds and memories formed in those years will forever be a core part of my life.

What challenges did you face as you transitioned from university to the professional world? How did you overcome those challenges, and what did you learn from them?

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The largest challenge has been to broaden my perspective from a purely technical one into a more multifaceted approach that also values soft skills that go a long way in the business world. Earlier in my career, I put all my effort into the technical aspect of projects and products, without sufficient focus on relationship building and personal and professional "brand" building. These terms may seem icky to a physics-graduate, but I learned to embrace the way the world works and strengthen my non-technical abilities. I overcame these challenges by jumping head-first into the business world where I was forced to learn the required skills.

What advice would you give to current students who are studying in your field? Are there specific skills or experiences you recommend they focus on to enhance their future prospects?

The world is now changing faster than ever. The best thing you can learn is HOW to learn, and there is no place better for that than a physics program. At the same time, don't fall into the trap of looking down on everything that's not technical or "physics-y" enough. Be open to learn and evolve.

Have you been involved with the university since graduation, such as through alumni associations or mentorship programs?

I participated as a mentor in the mentorship program once, which was a very fulfilling experience. However, unfortunately the time pressure from my own career has prevented me from being more active. I hope to increase my involvement in the future.

Looking back, what do you consider to be the most valuable aspect of your university experience?

The most valuable part of my university experience was going through an immense intellectual challenge with a group of peers that provided me with lifelong friendships and the intellectual backbone to push forward in an ever-changing and exciting world.

Cherry blossoms, Robarts Library, Credit: Jennifer Pinker

Research Spotlight

Experimental Quantum Condensed Matter Physics (Prof. Young-June Kim's Research Group)

Prof. Kim's graduate student in the lab

Interview with Prof. Young- June Kim:

Could you describe the primary focus of your research project? What specific objectives or questions are you aiming to address through your research?

One of the goals of quantum condensed matter physics is to find a new state of matter and describe its physical properties. We learned in school that phases of matter can change by temperature change. For example, raising the temperature, which is equivalent to increasing the thermal agitation of atoms, will turn ice into water. In the same manner, even at zero temperature, we can crank up quantum "agitation" and "melt" a solid via purely quantum mechanical effects. One example is called quantum spin liquid, which is expected when the quantum effect becomes too strong to sustain magnetic order in a magnet. Although quantum spin liquids are predicted by theory, whether this phase can be found in real materials is a contentious issue. The goal of our research group, along with many other groups in the world, is to discover a new material that exhibits a quantum spin liquid phase. To do so, we also have to study various types of quantum materials and gain a deep understanding of the magnetic properties of these materials.

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What methodologies or approaches are you employing in your research? Are there any innovative or unique aspects to your research methods?

Our group's research has two distinct aspects. In one, we spend a lot of time in our lab trying to synthesize new quantum materials. This requires painstaking trial and error working with lots of chemicals, so, yes, we had to learn lots of chemistry as well. Once we have good single-crystal samples, we use neutron and X-ray scattering to investigate their properties. Because neutrons and X-ray photons have wavelengths similar to atomic length scales, they are excellent "agents" to go deep into the materials and extract information about the material. A particularly innovative tool we helped develop in recent years is called resonant inelastic X-ray scattering, or RIXS, which allows us to study elementary excitations in extremely tiny samples. This type of experimental tool is particularly important for studying quantum spin liquids. Because a hallmark of quantum spin liquid is the presence of fractional (quasi)particles, measuring the quasiparticle's properties like mass, charge, and spin using scattering techniques is crucial. To do these types of experiments, graduate students in our group usually travel to large international experimental facilities, such as synchrotron light sources. This can be quite a stressful experience because you have to work around the clock during the beam time given to you. But at the same time traveling around the world is also a lot of fun.

How do you envision your research impacting the broader field or society? Are there potential real-world applications for your findings?

Quantum spin liquids, and particularly the fractional particles found in such phases, are considered an essential ingredient of the next generation of quantum computing technology, called topological quantum computing. In addition, there are many technologically important materials that we study to gain a deeper understanding of the underlying physics. Many of these materials could be important for clean energy, such as superconductors for energy transmission and thermoelectric materials for energy harvesting.

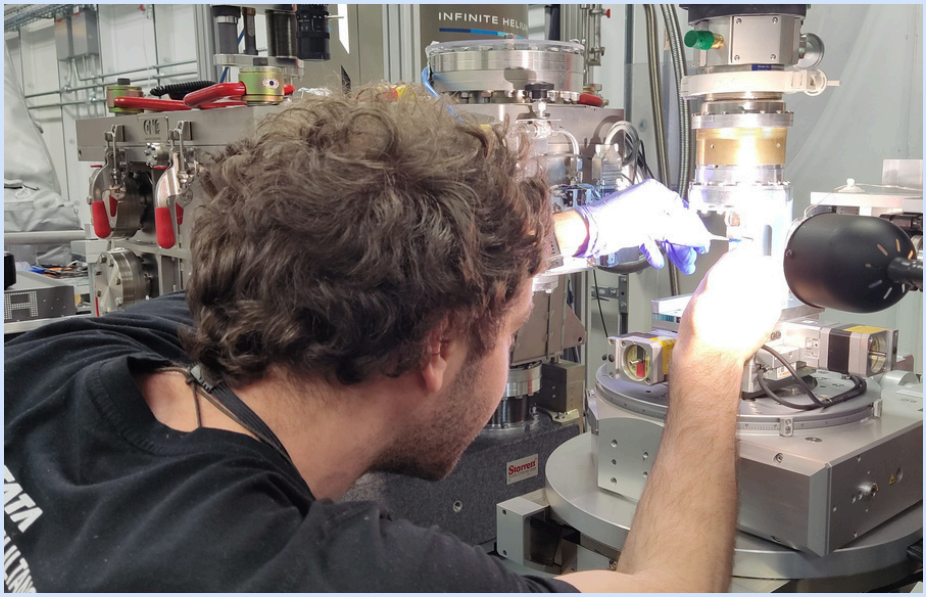
What challenges have you encountered during your research, and how have you worked to overcome them? Are there specific strategies or solutions you've found particularly effective?

Because quantum materials tend to be extremely sensitive to even a small amount of impurities, you can be misled if your sample has many defects. A good example is our work on alpha-RuCl3, which many believe is the best candidate for quantum spin liquid. Many papers published in the early days, including our own work, reported confusing results due to variations in sample quality. To overcome this, we decided to improve sample quality. It took a lot of effort. My graduate student, Subin, spent almost two years perfecting the synthesis condition through much trial and error. In experimental research, persistence often prevails. These new improved samples gave us a clearer picture of what is happening in this material. We, along with our collaborators, are still working hard to understand the basic physics underlying this material.

Continued on next page.

What are your plans for the future of your research? Are there specific goals you hope to achieve in the next few years?

In addition to our investigation of alpha-RuCl3, we are also working on synthesizing other materials showing similar structural and magnetic properties as this material. This is one way to find another candidate for quantum spin liquid, although we are continuously on the lookout for new types of materials. What is interesting about materials like alpha-RuCl3 is that they can be easily cleaved using scotch tape, just like graphene, and it is easy to make this material into a paper-thin two-dimensional material. We are interested in creating two-dimensional quantum materials and studying their magnetic and electronic properties.



Prof. Kim's graduate student in the lab.

What advice would you give to other researchers in the department, especially those in related fields? Are there lessons learned from your research journey that you'd like to share?

What I found frustrating as a condensed matter physicist is that it is very difficult to predict the impact of your research. Some of my most influential work was done very hastily without too much effort, while there were many projects in which the opposite was true. We spent an enormous amount of time and energy on this project, but it resulted in a paper that attracted very little attention. The lesson I learned is not to put all eggs in one basket when running your research program. A balanced research program with some "easy" projects, along with a few ambitious projects, has been my approach, and it has worked well.

Continued on next page.

How do you engage with the departmental community, such as through seminars, workshops, or collaborative initiatives? Are there specific ways you encourage student involvement or mentorship in your research?

My group members are strongly encouraged to attend colloquia and seminars, which are important opportunities to meet other members of the department as well as learn about giving good presentations. My group members also participate in lab tours, as a part of local workshops or outreach events. In addition, involvement in hiring and supervision of undergraduate students is an important part of graduate students training in our group.

Prof. Kim's research group: https://youngjunekim.physics.utoronto.ca/

A view of campus from the McLennan building. Credit: Aephraim Steinberg

November Ph.D. Graduates

Congratulations to our November 2024 graduates!

Credit: Jennifer Pinker

ANTO-SZTRIKACS, N.- Open quantum system techniques beyond the Lindblad equation (Supervisor: D. Segal)

CHOU, C.-C. Using ESA's Aeolus Mission to Study the Impact of Wind Observations on Numerical Weather Prediction (P. J. Kushner)

CLEPKENS, J. Unconventional Multiband Superconductivity in Correlated Metals (H.-Y. Kee)

JOW, D. L. Theory and applications of wave optics in the gravitational and plasma lensing of coherent sources (U.L. Pen)

KLYSHKO, Y. "Not Just Proteins: Unraveling the Role of Water in Protein Dynamics and Allostery" (S. Rauscher)

LAU, B. Anomalous electronic transport in the hexagonal ternary arsenides FeCrAs, CrNiAs, and CrPdAs (S. R. Julian)

LUPU-GLADSTEIN, N. Quantum Measurements are Disturbing: Experiments studying the role of disturbance in postselected metrology, quantum pigeonholes, and entangled sheep. (A.M. Steinberg)

Continued on next page.

November Ph.D. Graduates

Congratulations to our November 2024 graduates!

Credit: Jennifer Pinker

MA, T. An (Ultimate) Guide to Surviving on the Bacterial Battleground: The Role of Mechanics on Microbial Ecology within Confined Spaces (J. Milstein)

MORRIS, M. O. Dynamics of Extreme Wind Speeds in Canada and Their Response to Climate Change (P. J. Kushner)

SCHEE, M. Thermohaline staircases in the Arctic Ocean: Detection, evolution, and interaction (N. Grisouard)

SCHULTZ, D. J. Quantum Phase Transitions in the Multipolar Kondo Lattice (Y. B. Kim)

SMYTH, S. Characterization of Disordered Protein States and Complexes using Single-molecule Fluorescence Spectroscopy (C. Gradinaru)

UNCU, J. The Scattering of Internal Tides by Balanced Flows (N. Grisouard)

WANDLER, F. D. Nonperturbative physics of center-stabilized compactifications of Yang-Mills theory & A new perturbative method for extracting effective spin models out of condensed matter systems (E. Poppitz)

ZHANG, E. Z. "Dynamical Signatures of Exotic Phases in Frustrated Honeycomb Magnets"(Y. B. Kim)

Awards & Recognitions

Student Award

Stephanie Cui Awarded TRIUMF Azuma fellowship for 2025 Fellowship

Stephanie Cui, a 4th year student in the Philosophy and Physics Specialist has been awarded a TRIUMF Azuma fellowship for 2025. She has elected to join the Radioactive Molecules group of Stephan Ettenaur-Malbrunot for the summer.

As part of the Fellowship, Stephanie is eligible for a $5000 entrance scholarship for her first year of graduate school should she elect to join one of the member universities doing research related to TRIUMF program.

Faculty Award

Joseph Thywissen elected a Fellow Member of Optica by the Society's Board of Directors

Congratulations to Professor Joseph Thywissen who has been elected a Fellow Member of Optica by the Society's Board of Directors.

Joseph is being honored specifically "For pioneering experimental work on dynamical phenomena in interacting ultra cold atoms, from orbital interactions to transport measurements."

More information is also available online at www.optica.org/Fellows.

Continued on next page.

Faculty Award

Congratulations Prof. Dylan Jones on being appointed as J. Tuzo Wilson Professor!

Congratulations to Prof. Dylan Jones of Earth, Atmospheric and Planetary Physics (EAPP) on his appointment as the J. Tuzo Wilson Professor for 2024-2029. The J. Tuzo Wilson Professor is a tenured Professor in the Faculty of Arts & Science who is a specialist in Earth, Atmospheric, or Planetary Physics and who is broadly recognized for their excellence in research and scholarship, technical expertise, support of the geoscientific enterprise, and connections to industry.

According to Physics Chair, Prof. Paul Kushner, "Prof. Jones's use of satellite instruments and global three dimensional modelling of tracer transport to study atmospheric trace gases and pollution, and the connection of his research to fundamental problems of inference of trace gas and pollutant sources, fits very nicely within the scope of the Wilson Professorship".

Prof. Jones's main responsibility as J. Tuzo Wilson Professor will be to organize the annual J Tuzo Wilson Lecture, and, following tradition, he will be the first Lecturer of the new cycle.

More information on this prize:
https://tuzowilson.physics.utoronto.ca/j-tuzo-wilson-professorship/

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Faculty Award

Congratulations to ATLAS team for prestigious 2025 Breakthrough Prize in Fundamental Physics

Congratulations to the University of Toronto's ATLAS team including Miriam Diamond, Nikolina Ilic, Peter Krieger, Bob Orr, Pierre Savard, Pekka Sinervo, Richard Teuscher, William Trischuk, and many other group members for their contributions to the ATLAS experiment at CERN's LHC. (Congratulations also to Andrew Kubik, Adjunct Professor in our Department, and a member of the CERN CMS experiment!)

They are among the thousands of researchers honoured with the Breakthrough Prize awarded to the ATLAS Collaboration at CERN's Large Hadron Collider (LHC) alongside its sister experiments ALICE, CMS and LHCb.

The Breakthrough Prize specifically highlights the ATLAS Collaboration's significant contributions to particle physics, including detailed measurements of Higgs boson properties, studies of rare processes and matter-antimatter asymmetry, and the exploration of nature under the most extreme conditions.

The University of Toronto has been at the forefront of ATLAS research since the creation of the collaboration in the early 90s, contributing to:

- Construction and operation of the forward calorimeter, which has played a central role in the Higgs boson discovery and subsequent measurements.
- Development of software and calibration algorithms for the calorimeter and the muon spectrometer systems.
- Leadership roles in detector operations and upgrade efforts, as well as in physics analysis. These leadership roles have included convener positions in the Higgs and Exotics physics groups, the Jets/Etmiss performance group, and service as Physics Coordinator, helping to shape the experiment's scientific direction.

The Atlas team
Credit: Atlas Member

According to ATLAS team member Prof. Pekka Sinervo:

"*This prize recognizes a 20-year effort to construct the Large Hadron Collider and the ATLAS and CMS experiments, as well as ten years of data collection and analysis. The U of T team has had a key role in the ATLAS work. They have taken lead roles in uncovering the properties of the still mysterious Higgs boson.*"

U of T's team is deeply involved in preparing ATLAS for its next chapter. They are leading the development of a new all-silicon inner tracker (ITK) for the High-Luminosity LHC, which will increase collision rates tenfold when it begins operation in 2030.

- ATLAS Official Website

Arrivals & Departures

We welcome two new staff

Arrivals

Harim Ulfig
Executive Assistant to the Chair and Project Coordinator

Harim joined in December as the Chair's Office as Executive Assistant and Special Projects Coordinator. Harim brings extensive experience in academic administration, including stints at the Centre for Entrepreneurship and at Victoria College's Principal's Office. Chair, Prof. Kushner says "I'm very much looking forward to working with her as she gets set up for us for next year. One of the key projects we will be working on is the McLennan Physics Masterplan Renewal project and our associated internal consultation. You'll be hearing from her in connection with that in the coming weeks and months."

Jennifer Pinker
Outreach, Facilities and Special Project Coordinator

Jennifer joined in January as the Outreach, Facilities and Special Projects Coordinator, on secondment to cover Supreet Randhawa's parental leave. Jennifer comes from the Division of Central Student Life where her main focus was supporting graduate students on the STG campus, around everything from the transition into grad school, finding community, through until they transition out as well as overseeing outreach and Communications. Chair, Prof. Kushner says "It's great to have Jennifer on board with us to fill the important roles in Outreach and in editing and producing the Newsletter."

PhysCAP Recap

Updates from the Physics Career Accelerator Program

Physics Mentorship Program

This year's mid-year Mentorship Program was held on January 30, where mentors and students chatted in breakout rooms, forming new connections while discussing their futures.

One 2nd Year Physics-Astrophysics Specialist participant said:

"I wish it was longer, I had so much fun, and it was so eye opening! The career and personal development paths of the mentors are really like what I am planning for my future."

The farewell Mentorship Program Event for this year's cohort happened on April 3 in the Grad Lounge to thank everyone involved and to celebrate the value of mentorship.

More information on the Physics Mentorship Program: https://www.physics.utoronto.ca/undergraduate/physics-career/mentorship/

Credit: Jennifer Pinker

Mentor Event to Mandarin and AtkinsRéalis Candu Energy control room

A special Mentoring event was organized by Physics Alumni Dr. Randall McArthur on February 18 at the Mandarin restaurant, followed by visiting the AtkinsRéalis Candu Energy control room simulator. A large group of University of Toronto Physics students were fortunate to be able to engage in this exciting event.

Continued on next page.

PhysCAP Recap

physCAP Careers Outside Academia

The 2024-2025 PhysCAP Careers Outside Academia panel event was held on February 26, focused on careers outside academia. Students learned about career opportunities that could be pursued starting with their degrees in Physics. The event featured a diverse group of speakers who shared their personal stories and described the paths they had taken over the years and how their trajectories had shifted from their original plans. The 2025 alumni panelists are featured below:

David Gourlay
Lawyer, City of Toronto

Ronny Thomas
2nd Year U of T
Medical Student

Rebecca Ceppas de Castro
Data Analyst, Forecast
Research Institute

More information about the Careers Events can be found here:
https://www.physics.utoronto.ca/undergraduate/physics-career/physics-career-fair/

Credit: Jennifer Pinker

Prof. Sinervo facilitating the Career Panel

High School Visits

Credit: Jo-Anne Wurster

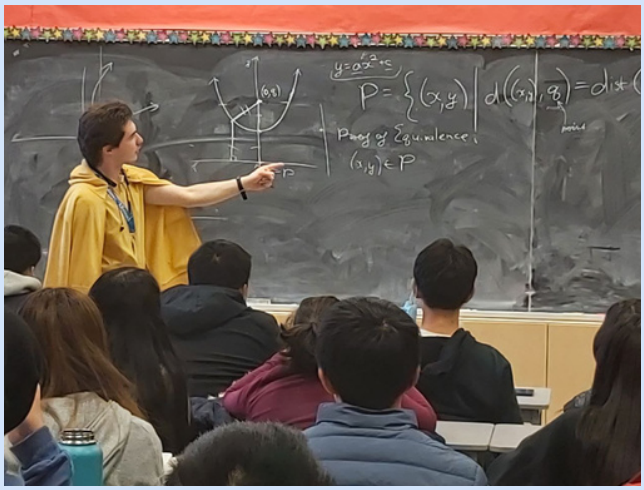
The department looks forward to welcoming a grade 12 group from Albert Campbell CI on May 5, to learn about Wave Nature of Light with Prof. Brian Wilson. Ivan Ovchinnikov, PhySU President, will also be leading a tour of the lab facilities.

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/

Outreach in Action

Not Quite a Lecture Series - Undergraduate Outreach



Credit: Eva Cheung

Not Quite a Lecture is an outreach program run by undergraduate students at the University of Toronto, aiming to foster interest in the sciences by delivering talks to high schools in the GTA. The program has had major growth since its outset in Fall 2023. This year, we launched our Demo team, a group of undergraduates constructing physics demonstrations to be used in classes and public events. We are currently working to set up a Media team, which will be providing coverage on the academic life of the whole department.

We also hosted Professor Thywissen with a workshop on "*Effective Science Communication*", which is now available on our youtube channel. Of course, we didn't forget our original mission: preparing undergraduates to give accessible talks for high school students. This year, we made over 50 visits to more than 20 schools in the GTA, with topics ranging from chemistry, physics and astronomy. As we prepare for a new set of visits in May, we hope that our work will help inspire the next generation of explorers and inventors.

Continued on next page.

Outreach in Action
PhySU, the Physics Student Union

By Shivangi Aneja (PhySU Communications)

This year, the Physics Student Union focused on launching new initiatives to expand outreach. We hosted our first *Meet the Profs* event, where over 60 students and faculty from across the Department of Physics at the University of Toronto connected in an informal setting. Students explored a wide range of research areas and learned about upcoming opportunities like the *Summer Undergraduate Research Fellowship* (link) and the *Summer Undergraduate Research Program* . (link) Feedback from both students and professors confirmed it was a successful networking event. We also introduced the *Reading Group* program (link), pairing first-year students with upper-years to dive into advanced physics topics beyond the usual curriculum. Over 30 students participated in the Winter term. Learn more at physu.org.

This semester also stood out for its collaborative efforts. We partnered with the Environmental Students' Union to host *Prof Talks*, featuring Professors Kaley Walker and Kim Strong, and worked with the Undergraduate Research Students' Association for *Biophysics Day*, which included talks by Professors Siddhartha Goyal, William Ryu, and Fernandez-Gonzalez. We also launched our largest collaboration yet—the *Quercus Quiz Cup*, a cross-disciplinary trivia event co-hosted with five student societies and open to students, faculty, and graduate students across campus.

Another major highlight was *Physics Pathways*, an event supporting gender minorities in physics. Students engaged in small group discussions with professors and graduate students who shared their experiences and career journeys. Faculty attendees included Professors Miriam Diamond, A.W. Peet, Ting Li, Ania Harlick, and Yaquin Woo.

We wrapped up the term with a playful April Fool's Day celebration. That morning, a group of first-year students "accidentally" (wink, wink) spilled a box of yellow rubber ducks—part of their PHY151 lab—throughout MP, compromising the safety of our beloved MP. Luckily, students and faculty teamed up to retrieve the rogue ducks and restore order!

There's still more we couldn't include for example Pi Day, Game Night, PhySU LovesU and so on—Follow us on Instagram @physu to stay updated!

Credit: PhySU

Outreach in Action

Pursue Stem

The Pursue Stem Program launched for another year on February 5 with lots of keen and bright high school students. The launch day included a parent presentation put on by the Office of Student Recruitment.

Pursue Stem is an outreach program that encourages and supports Black students interested in science, technology, engineering and math (STEM) launched in March 2021. Pursue STEM is delivered in a partnership between Leadership by Design (LBD), U of T's Office of Student Recruitment, and the Department of Physics.

Credit: Darby Bates and Jennifer Pinker

Outreach in Action

High School Canadian Association of Physicists (CAP) Exam Preparation Workshops

The annual preparatory workshops were presented for GTA high school students on February 15 and March 22 for those high school students interested in writing the upcoming Canadian Association of Physicists (CAP) exam. There was lots of engagement and questions from keen participants. Thank you to Prof. Harlick for leading the sessions, Prof. Hong for leading a lab demonstration with his graduate student and to Prof. Braverman for providing strategies for success based on his own time as a student.

Good luck to all of this year's participants!

Credit: Jennifer Pinker

Lab Demo. Credit: Prof. Hong

Other Physics News

McLennan Physics Renewal Update

Did you know that McLennan Physical Laboratories will soon be turning 60 years old?

Consultations have been happening with department members on the renewal plan of the McLennan Physics, with a view to setting McLennan Physics up for many more decades of research and teaching. The University has initiated a “Masterplan Renewal Project” and is soliciting input from Physics and the other Departments that share space in McLennan Physics.

Credit: Eva Cheung

Town hall meetings were held in the fall for faculty, students, and staff and a Faculty Retreat was held at Hart House in January, encouraging our physics community to share input on ways to improve the facility and identify major priorities for the renovation. Ideas from this information gathering will provide input into the renewal masterplan’s report on the status and options for McLennan Physics. This report will include an assessment of the size and adequacy of the current space, and will make recommendations on different options for renewing the facility, such as renewal of the basement laboratories and dealing with McLennan’s aging infrastructure.

Areas of discussion at the retreat included research spaces, teaching and learning spaces, welcoming and inclusive environment, accessibility, and research and teaching infrastructure. In future editions of this newsletter, we will highlight some of the report’s recommendations with a view to planning for future renewal efforts and getting our physics community further engaged with the future of McLennan Physics. Stay tuned!

Continued on next page.

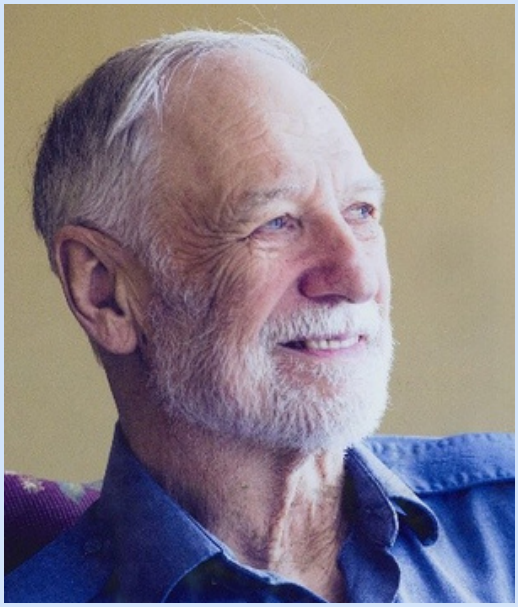
Upcoming Events

Science Unlimited Summer Camp: August 18-22, 2025

Robarts library, Credit: Jennifer Pinker

In Memoriam

Prof. Emeritus Albert David May, 1933-2024



A. David May, passed away in December, 2024, at the age of 91.

He is remembered fondly by several colleagues. His former Ph.D. student, Prof. Emeritus Stephen Morris, said:

"he very graciously allowed me to 'do my own thing' for my unorthodox PhD project. ... He was always an enthusiastic researcher with a can do attitude."

David was an atomic spectroscopist and laser physicist who joined the faculty in the 1960's and remained scientifically active after his retirement in the mid-1990's.

David attended the University of Toronto, completing the honours physics program and continued his graduate studies under Profs. Welsh and Stryland, receiving his Ph.D. degree in 1957. His Ph.D. thesis entitled "The Raman Spectra of Gases at High Pressure," looked at the spectrographic 'fingerprints' of light scattering from vibrational modes of simple molecular gases under higher pressures than had been previously studied.

David taught courses for both physics and engineering students. His teaching style was open and laid-back. He was happy to take questions at any time in order to make sure students were keeping up with the lecture. His courses included quantum mechanics and he was quite effective at explaining what can be an obscure subject.

He enjoyed a lifelong career at the University of Toronto and continued with research after retiring from teaching. His final paper, "The impact theory of spectral line shapes: a paradigm shift" by A.D. May, W.-K. Liu, et al., was published in the 2013 issue of the Canadian Journal of Physics (Vol 91[11]

Thank you to the May family for contributing some of the background information.

Burton Tower from King's College Circle, Jo-Anne Wurster

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