Shayan Majidy, Ph.D.

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Research & Teaching Interests

Using tools from mathematics, physics, and AI to develop the foundations for scalable quantum computing.

Research Positions

2024– **Banting Postdoctoral Fellow**, Department of Physics, Harvard University
Faculty Advisors: Misha Lukin, Joshua and Beth Friedman University Professor
Michael Gullans, NIST Physicist

Education

2019–2024 **Ph.D. in Physics**, University of Waterloo
Faculty Advisors: Raymond Laflamme, late Professor of Physics
Nicole Yunger Halpern, NIST Physicist
Thesis: Effects of Noncommuting Charges in Quantum Information and Thermodynamics
Funding: Vanier Scholarship, 2021-2024

2018–2019 **M.Sc. in Physics**, University of Waterloo
Faculty Advisors: Raymond Laflamme, late Professor of Physics

2011–2015 **B.Sc. in Theoretical Physics**, University of Guelph

Publications

Textbooks

1. **S. Majidy**, C. Wilson, and R. Laflamme, "Building quantum computers: A practical introduction," Cambridge University Press, (2024).

Journal Articles (10)

2. D. Bluvstein, A. Geim, ..., **S. Majidy**, ..., M.D. Lukin, "A fault-tolerant neutral-atom architecture for universal quantum computation," *Nature* (2025).
3. **S. Majidy**, D. Hangleiter, M. Gullans, "Scalable and fault-tolerant preparation of encoded k-uniform states," *Phys. Rev. A* 112, 042409 (2025).
4. **S. Majidy** "Noncommuting charges can remove non-stationary quantum many-body dynamics," *Nat. Comm.* 15, 8246 (2024).
5. **S. Majidy**, W. F. Braasch, Jr., A. Lasek, T. Upadhyaya, A. Kalev, and N. Yunger Halpern, "Noncommuting conserved charges in quantum thermodynamics and beyond," *Nat. Rev. Phys.* 5, 689–698 (2023).
6. **S. Majidy**, U. Agrawal, S. Gopalakrishnan, A. Potter, R. Vasseur, and N. Yunger Halpern "Critical phase and spin sharpening in SU(2)-symmetric monitored quantum circuits," *Phys. Rev. B* 108, 054307 (2023).
7. **S. Majidy** "A unification of the coding theory and OAQEC perspective on hybrid codes," *Int. J. Theor. Phys.* 62.8: 177 (2023).
8. **S. Majidy**, A. Lasek, D. A. Huse, and N. Yunger Halpern, "Non-abelian symmetry can increase entanglement entropy," *Phys. Rev. B*, 107, 045102 (2023).
9. N. Yunger Halpern and **S. Majidy**, "How to build hamiltonians that transport noncommuting charges in quantum thermodynamics," *npj Quantum Information* 8, 10 (2022)
10. **S. Majidy**, J. J. Halliwell, and R. Laflamme, "Detecting violations of macrorealism when the original Leggett-Garg inequalities are satisfied," *Phys. Rev. A* 103, 062212 (2021)
11. **S. Majidy**, H. Katiyar, G. Anikeeva, J. Halliwell, and R. Laflamme, "Exploration of an augmented set of Leggett-Garg inequalities using a noninvasive continuous-in-time velocity measurement," *Phys. Rev. A*, 100, 042325 (2019).

Preprints (2)

12. M. Bilokur, S. Goplakishanan **S. Majidy** "Thermodynamic limitations on fault-tolerant quantum computing," arXiv:2411.12805 (2024).
13. **S. Majidy** "Addressing misconceptions in university physics: A review and experiences from quantum physics educators," arXiv:2405.20923 (2025).

Presentations

Conference & Workshop Talks (10)

Architectural mechanisms of a universal fault-tolerant quantum computer
- Year of Quantum Across Canada, Waterloo, Ontario (Oct 7, 2025) [Recording]

Non-Abelian symmetry can increase entanglement entropy
- CQIQC-X, University of Toronto, Ontario (Aug 26, 2024). [Recording]
- Raymond Laflamme's 60th Birthday Conference, University of Waterloo, Ontario (Jul 19, 2023).
- RQS annual workshop, University of Maryland, Maryland (June 22, 2023).
- IQC Graduate Student Conference, University of Waterloo, Ontario (May 18, 2023).
- Canadian Graduate Quantum Conference 2023, University of Waterloo, Ontario (Jan 25, 2023).
- Quantum Non-Markovianity 2022, Online, (Dec 8, 2022)

Noncommuting charges: Bridging theory to experiment
- Perimeter Institute Graduate Students' Conference 2022, Perimeter Institute, Ontario (Sep 1, 2022).
- Information Engines at the Frontiers of Nanoscale Thermodynamics 2022, Telluride Science Research Center, Colorado (July 22, 2022).

Exploration of an augmented set of Leggett-Garg inequalities using a noninvasive continuous-in-time velocity measurement
- CAM Graduate Student Physics Conference 2019, Laurentian University, Ontario (Jul 25th, 2019).

Invited Seminars (26)

Architectural mechanisms of a universal fault-tolerant quantum computer
- CQIQC Seminar, University of Toronto, Toronto, Ontario (Oct 3, 2025) [Recording]

A noncommuting charge puzzle
- PI QI Seminar Series, Perimeter Institute, Waterloo, Ontario (Jan 8, 2025) [Recording]
- Harvard Quantum Initiative Seminar, Cambridge, Massachusetts (Jun 28, 2024)

Noncommuting charges can increase entanglement and induce critical dynamics
- Yale Quantum Institute Seminar, Yale, Connecticut (Jan 16, 2024)
- Quantum Information Seminar, Perimeter Institute, Ontario (Nov 29, 2023) [Recording]
- Princeton Centre for Theoretical Physics seminar organized by Biao Lian, Princeton, New Jersey (Sept 22, 2023).

Monitored Quantum Circuits with Noncommuting Conserved Quantities
- Qiskit Seminar, IBM, Online (Sept 15, 2023). [Recording]
- Eduardo Martin-Martinez's Group, Waterloo, Ontario (Aug 30, 2023).

Non-Abelian symmetry can increase entanglement entropy
- NSF site visit, University of Maryland, Maryland (July 14, 2023).
- PIQuIL Seminar, Perimeter Institute, Ontario (Apr, 21 2023).
- InfoQ Seminar, Institut Quantique, Quebec (Mar 28, 2023).
- Special INTRIQ/CPM Seminar, McGill University, Quebec (Mar 24, 2023).
- Irfan Siddiqi's group, Berkeley, California (Feb 25, 2023).
- Ehud Altman's group, Berkeley, California (Feb 25, 2023).
- Eduardo Martin-Martinez's Group, Waterloo, Ontario (Feb 16, 2023).
- Stanford Institute for Theoretical Physics seminar organized by Xiaoliang Qi, Stanford, California (Feb 24, 2023).
- Pitzer Center Theoretical Chemistry Seminar, Berkeley, California (Feb 22, 2023).
- Redwood seminar, Berkeley, California (Feb 22, 2023).
- Würzburg Seminar on Quantum Field Theory and Gravity, Universitat Wurzburg, Online (Feb 7, 2023).
- Fields Institute seminar, University of Toronto, Ontario (Feb 3, 2023). [Recording]

Noncommuting charges: Bridging theory to experiment
- Theoretical Physics Seminar Series, Australian Institute for Physics, Online (Aug 18, 2022). [Recording]

- RQS Seminar, University of Maryland, Maryland (Aug 2, 2022).
- Bristol QIT Online Seminar Series, University of Bristol, Online (Jun 9th, 2021).
- David Jenning's group, University of Leeds, Online (Jun 3rd, 2021).

An introduction to quantum thermodynamics
- Mila, Online (Dec 1st, 2021).

Exploration of an augmented set of Leggett-Garg inequalities using a noninvasive continuous-in-time velocity measurement.
- Eduardo Martin-Martinez's Group, Waterloo, Ontario (Mar 3rd, 2021).

Interviews & Media Relations

News

Shayan Majidy awarded W.B. Pearson Medal. Link.
Institute for Quantum Computing grad receives prestigious Faculty of Science medal. Link.
Invited Panelist: Quantum + The Near Future. Link.
Shayan Majidy wins prestigious Vanier Scholarship. Link.
IQC student awarded Vanier Graduate Scholarship. Link.
Graduate students recognized for excellence in research and scientific outreach. Link.

Interviews

National Radio Interview: CBC's Quirks and Quarks. Link.
Quantum + The Near Future Panel at Quantum Connections 2024.

Media Interventions

IQC Achievement Award recipient Shayan Majidy shares research insights. Link.
Quantum Q&A with Shayan Majidy. Link.
Quantum Frontiers: Identical twins and quantum entanglement. Link.
Quantum Frontiers: Mo' heights mo' challenges – Climbing mount grad school. Link.
Quantum Frontiers: Building a Koi pond with Lie algebras. Link.
Quantum Today: Bridging Quantum Thermodynamics Theory to Experiment. Link.
Brief documentary on Unentangled by Ward1 Studios. Link.
IQC Fireside Chat with Shayan Majidy - Sharing quantum science with a young audience. Link.

Teaching & Mentoring Experience

Sessional Lecturer, University of Waterloo

Responsibilities included developing course content and syllabus, delivering lectures, developing and grading all assignments, managing teaching assistants, and holding office hours.
- *Introduction to Implementation of Quantum Information Processing* (Fall 2022)

Teaching Assistant, University of Waterloo

Responsibilities included leading discussion sessions, grading all assignments, and holding office hours
- *Quantum Information Processing Devices* (Winter 2020-22)
- *Electricity and Magnetism 1* (Winter 2021)
- *Introduction to Implementation of Quantum Information Processing* (Fall 2021)

Graduate Educational Developer, Centre for Teaching Excellence (Jan 2022—May 2022)

Responsibilities included teaching observations, facilitation of advanced workshops and microteaching sessions, and development of new workshops (10 hrs/week).

TA Workshop Facilitator, Centre for Teaching Excellence (Jan 2021—Dec 2021)

Responsibilities included facilitating graduate-student teaching workshops, preparing five to six workshops each term, and participating in monthly meetings to refine workshop offerings (30 hrs/term).

Teaching Accreditations

Certificate in University Teaching
Fundamentals of University Teaching

Mentoring

2 graduate students at Harvard, one at ETH, and one at the University of Waterloo.
One undergraduate student at Princeton, and 3 at the University of Waterloo

Selected Fellowships & Awards

Fellowships

Banting Fellowship (**$140,000**), 2024–2026. Canada's highest-valued Postdoctoral Fellowship. I was ranked 3rd out of 185 applicants in my field.

Prizes & Award

W.B. Pearson Medal, 2025. Awarded to one PhD graduate annually in physics for a creative research in their doctoral thesis.

Vanier Scholarship (**$150,000**), 2021—2024. Canada's highest-valued PhD scholarship.

John Brodie Memorial Award (**$1,000**), 2024. The Perimeter Institute's highest valued PhD award, evaluated on research impact and independence.

Institute for Quantum Computing's Achievement Award (**$5,000**), 2022. IQC's highest valued PhD award, evaluated on "exceptional achievement in research."

IQC David Johnston Award for Scientific Outreach (**$2,500**), 2018. Award for outstanding commitment to scientific outreach and community engagement through volunteerism

Professional Service

Reviewer

Nature Journals (3): *Nature Communications* (1); *npj Quantum Information* (2).

Physical Review Journals (35): *Physical Review Letters* (3); *PRX Quantum* (6); *Physical Review Research* (2); *Physical Review A* (23); *Physical Review E* (1).

Conference review subreviewer: QIP 26 (2); QEC 25 (3); QCTIP 2025 (1); TQC 2024 (1).

Leadership

Founder, Unentangled, Brief documentary

Organizer, Raymond Laflamme's 60th Birthday Conference, 2023

Seminar organizer, Quantum Steampunk Seminars, University of Maryland, 2021

Organizing committee, Canadian Graduate Quantum Conference 2020, University of Waterloo, 2020

Outreach

Panelist, From TA to Course Instructor Workshop, 2023

Panel Facilitator, Developing Your Teaching Skills in Grad School, 2021

Session Chair, University of Waterloo Teaching and Learning Conference, 2021

Facilitator, USEQIP, 2019–2021

Facilitator, Quantum Cryptography School for Young Students, 2018–2021

Facilitator, IQC Science Outreach, 2017–2021

Panelist, Tech Under Twenty Expo, 2020

Facilitator, EinsteinPlus, 2019

Committee Memberships

Member Physics GSA, 2019–2024

Member, Institute for Quantum Computing GSA, 2019–2024

Graduate student member, Faculty Committee on Student Appeals, 2020–2021

Co-President, Physics GSA,, 2019–2020

Executive member, Institute for Quantum Computing GSA, 2019–2020