

# MATTHEW DUSCHENES

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## SUMMARY

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A PhD candidate (graduating ~ May, 2026) who loves spreading a joy for learning and empathy at the University of Waterloo with the late Dr. Raymond Laflamme, Dr. Juan Carrasquilla, and Dr. Roger Melko. An NSERC PGS-D scholarship recipient, a graduate of the University of Michigan Applied Physics and Scientific Computing Master's programs, a graduate of the Perimeter Scholars International Master's program, and an Engineering Physics graduate of Queen's University. Research interests in theoretical and computational approaches to assess the abilities of quantum technologies. Experienced in developing and delivering materials in physics, machine-learning, and statistics disciplines. An ambitious and passionate learner and teacher who collaborates to develop new techniques efficiently within a challenging environment.

## SKILLS

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### Communication and Outreach

- Effective project leader (international 3 year project with 4+ senior and junior members).
- Emphatic mentor (mentor of 5+ undergraduate and master's students and projects).
- Experienced course content developer and guest lecturer (6+ courses, 10+ guest lectures).
- Outreach contributor (5+ years of public and academic outreach within the scientific community).

### Software and Numerical Methods

- Tensor network methods; open quantum system simulation; constrained optimization; graph-theoretic approaches; Bayesian and Monte Carlo methods; generative modelling.
- Python (JAX, Sympy), C++ (Eigen), Latex, Linux/Bash scripting languages.

## EXPERIENCE

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### Graduate Research Assistant

Fall, 2021 - Present

*Department of Physics, University of Waterloo*

- Developed theoretical and numerical approaches to investigate dynamics of quantum systems.
- Resolved open questions regarding the impact of noise on the current abilities of quantum computing technologies, with respect to their optimization, statistics, and simulation.

### Research Intern

Summer, 2023 - Present

*Los Alamos National Laboratory*

- Selected as one of 20 from 600 graduate students for the Quantum Computing Summer School.
- Developed analytical tools to resolve open questions regarding statistics in quantum systems.
- Multi-year project lead of team with 4 faculty members from Los Alamos, EPFL (Lausanne), and Institute for Quantum Computing (Waterloo) with various deliverables and conference presentations.

### Guest Lecturer - Dimensional Reduction and Generative Modelling

Fall, 2025

*University of Waterloo*

- PHYS 449 - Machine Learning: Lecture on dimensional reduction techniques (PCA and t-SNE), derivations of their physically motivated equations, and demonstrations with code examples.
- PSI 602 - Statistical Physics: Lecture on generative modelling and its connections to statistical physics, and derivations of intuitive equations used in Restricted Boltzmann Machines.

**Teaching Assistant - Perimeter Scholar's International Start Program** Summer, 2024  
*Perimeter Institute*

- Taught lectures and mentored students on analytical and numerical approaches in physics.

**Teaching Assistant - Quantum Computing Implementations - PHYS 468** Fall, 2024  
*University of Waterloo*

- Assisted with lectures, office hours, and grading for 30 students, with Dr. Raymond Laflamme.
- Developed course lecture notes; edited course textbook (Building Quantum Computers, 2024).

**Teaching Assistant - Electricity and Magnetism - PHYS 242** Winter, 2023-2024  
*University of Waterloo*

- Assisted with lectures, office hours, and grading for 50 students, with Dr. Raymond Laflamme.
- Developed exam and assignment questions; delivered guest lectures.

**Lecturer - International Summer School for Young Physicists** Summer, 2022-2023  
*Perimeter Institute*

- Developed and delivered 2-week course on undergraduate statistical and computational physics.

## EDUCATION

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**Physics PhD Program** Fall, 2021 - Summer, 2026  
*University of Waterloo, Institute for Quantum Computing, Vector Institute, Perimeter Institute*

- Research in theoretical and computational quantum information and many-body systems, with the late Dr. Raymond Laflamme, Dr. Juan Carrasquilla, and Dr. Roger Melko.
- *Publications, Conferences, and Symposia:*
  - Duschenes, M., Martin, D., Larocca, M., Holmes, Z. & Cerezo, M. "Connecting channel expressiveness to gradient magnitudes and noise induced barren plateaus" (2024). APS March Meeting, Session T51: Quantum Machine Learning Training and Beyond
  - Duschenes, M., Carrasquilla, J. & Laflamme, R. Characterization of overparametrization in the simulation of realistic quantum systems. *Physical Review A* **109**, 062607 (2024)

**Applied Physics and Scientific Computing Master's Degree** Fall, 2018 - Summer, 2021  
*University of Michigan, Michigan Institute for Computational Discovery & Engineering*

- Research on graph-theoretic approaches for high dimensional systems, with Dr. Krishna Garikipati.
- *Publications:*
  - Duschenes, M., Srivastava, S. & Garikipati, K. Numerical analysis of non-local calculus on finite weighted graphs. *Comput. Methods Appl. Mech. Eng.* **402**, 115513 (2022)
  - Zhang, X., Teichert, G. H., Wang, Z., Duschenes, M., Srivastava, S., Sunderarajan, A., Livingston, E. & Garikipati, K. mechanoChemML: A software library for machine learning in computational materials physics. *Computational Materials Science* **8**, 111493 (2022)

**Perimeter Scholars International Master's Degree** Summer, 2017 - Spring, 2018  
*Perimeter Institute*

- Fully funded 2-year Masters of Science in a 1-year program.
- *Master's thesis:* With Dr. Roger Melko, on the use of Monte Carlo and dimensional reduction machine learning to distinguish phases of matter.

**Engineering Physics and Electrical Engineering Bachelor's Degree** Fall, 2013 - Spring, 2017  
*Queen's University*

## ACTIVITIES AND INTERESTS

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### Fundamentals of University Teaching Certificate Program 2025

*University of Waterloo*

- Completion of 6 workshops on teaching in university settings (Effective Lesson Plans, Classroom Delivery Skills, Teaching STEM Tutorials, Giving and Receiving Feedback, Effective Question Strategies, Reflecting on Diversity in the Classroom).
- Completion of 3 teaching sessions, where lesson plans are developed and delivered as interactive lessons using the BOPPS and SMART models, in front of a panel.
- Completion of 30 hour course on preparation of teaching dossiers within academia.

### Perimeter Academic Programs 2021 - Present

*Perimeter Institute*

- Contributor to scientific outreach PSI-START and Einstein+ programs; tour guide for public open houses, delivered guest lectures to public and academic Quetzal and Girls-In-Quantum programs; developed and presented 4 talks on quantum computing for high school students.
- Chair of graduate student seminar series; invited speakers and organized workshops.
- Member of the gender equity in physics working group; mentor of 4 Perimeter master's students; mentor of undergraduate researcher; student representative on scientific communication committees.

### Journal and Conference Reviewer 2023 - Present

*Various Organizations*

- Reviewer for npj, Phys. Rev, IOP journals, and QCTIP, TQC conferences.

### Varsity Cross Country and Track and Field Teams 2013 - 2017

*Queen's University*

- Competed across North America in long distance running events, and coordinated workouts.

## AWARDS

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### NSERC PGS-D Graduate Scholarship 2023 - 2026

*Natural Sciences and Engineering Research Council of Canada (\$100,000)*

### President's Award, Marie Curie Award, Physics Department Fellowship 2023 - 2026

*University of Waterloo (\$24,000)*

### Vector Research Grant 2022 - 2025

*Vector Institute (\$24,000)*

### Applied Physics Graduate Fellowship 2018 - 2020

*Applied Physics Program, University of Michigan (\$50,000)*

### Perimeter Scholar's International Scholarship 2017 - 2018

*Perimeter Institute and University of Waterloo (\$45,000)*

### Principal's Scholarship, W.W. King Scholarship 2013 - 2014

*Faculty of Applied Science, Queen's University (\$24,000)*

## REFERENCES

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References available upon request.

## Publications

- [1] Duschenes, M. *Distinguishing phases and detecting local and non-local order using t-SNE and Monte Carlo methods*. Master's thesis, Perimeter Scholar's International Essays, Perimeter Institute, Waterloo, Ontario (2018).
- [2] Kochunas, B., Garikipati, K., Duschenes, M. & Folk, T. The graph theoretic approach for nodal cross section parameterization (2020). arXiv:2010.09683 [physics.comp-ph].
- [3] Duschenes, M. & Garikipati, K. Reduced order models from computed states of physical systems using non-local calculus on finite weighted graphs (2021). arXiv:2105.01740 [math.NA].
- [4] Price, D., Folk, T., Duschenes, M., Garikipati, K. & Kochunas, B. Methodology for Sensitivity Analysis of Homogenized Cross-Sections to Instantaneous and Historical Lattice Conditions with Application to AP1000® PWR Lattice. *Energies* **14**, 3378 (2021).
- [5] Zhang, X., Teichert, G. H., Wang, Z., Duschenes, M., Srivastava, S., Sunderarajan, A., Livingston, E. & Garikipati, K. mechanoChemML: A software library for machine learning in computational materials physics. *Computational Materials Science* **8**, 111493 (2022).
- [6] Duschenes, M., Srivastava, S. & Garikipati, K. Numerical analysis of non-local calculus on finite weighted graphs. *Comput. Methods Appl. Mech. Eng.* **402**, 115513 (2022).
- [7] Duschenes, M., Carrasquilla, J. & Laflamme, R. Characterization of overparametrization in the simulation of realistic quantum systems. *Physical Review A* **109**, 062607 (2024).
- [8] Duschenes, M. simulation: Jax based simulator for quantum systems (2022). <https://github.com/mduschenes/simulation>.

## Seminars

- [1] Duschenes, M. “Graph theoretic approaches for physical systems”. In *UM Phys. Grad. Student Symp.* (2020).
- [2] Duschenes, M. “Reduced order modelling on finite weighted graphs”. In *MICDE Student Semin.* (2021).
- [3] Duschenes, M. “Reduced order models using non-local calculus on unstructured weighted graphs”. In *US Natl. Congr. Comput. Mech.* (2021).
- [4] Duschenes, M. “Learning and Overparameterization of Constrained Variational Quantum Circuits”. In *IAIFI Summer School and Workshop* (2022).
- [5] Duschenes, M. “Overparameterization of Realistic Quantum Circuits”. In *Perimeter Institute Quantum Matter Workshop* (2022).
- [6] Duschenes, M. “Overparameterization of Realistic Quantum Systems”. In *Perimeter Graduate Student Seminar Series* (2022). PIRSA:22110060 see, <https://pirsa.org>.
- [7] Duschenes, M. “Overparameterization of Realistic Quantum Systems”. In *Quantum Days Conference* (2023).
- [8] Duschenes, M. “Overparameterization of Realistic Quantum Systems”. In *Canadian Quantum Graduate Conference* (2023).
- [9] Duschenes, M., J., C. & R., L. “Overparameterization of Realistic Quantum Systems” (2023). APS March Meeting, Session Y70: Quantum System Learning.
- [10] Duschenes, M. “Overparameterization of Realistic Quantum Systems”. In *IQC Graduate Quantum Conference* (2023).
- [11] Duschenes, M. “Noisy Overparameterization of Quantum Systems”. In *Vector Institute Quantum + Machine Learning Workshop* (2023).
- [12] Duschenes, M. “Overparameterization of Realistic Quantum Systems”. In *PI/MILA Quantum/AI Workshop* (2023).
- [13] Duschenes, M., Martin, D., Larocca, M., Holmes, Z. & Cerezo, M. “Connecting channel expressiveness to gradient magnitudes and noise induced barren plateaus” (2024). APS March Meeting, Session T51: Quantum Machine Learning Training and Beyond.
- [14] Duschenes, M. “Expressivity measures of quantum channels and their operational meaning”. In *Perimeter Graduate Student Seminar Series* (2024). PIRSA:24040122 see, <https://pirsa.org>.
- [15] Duschenes, M. Overparameterization and expressivity of realistic quantum systems (2024). Invited Talks - IBM Zurich (Christa Zoufal), Freie Universität Berlin (Jens Eisert Group), EPFL (Zoe Holmes Group).
- [16] Duschenes, M. “Channel Expressivity Measures”. In *IQC Graduate Student Conference* (2024).
- [17] Duschenes, M. “Channel Expressivity Measures”. In *Perimeter Graduate Student Conference* (2024). PIRSA:24090201 see, <https://pirsa.org>.
- [18] Duschenes, M. “Expressivity measures of quantum channels and their operational meaning”. In *CQIQC Conference X* (2024).
- [19] Duschenes, M. “Moments of Quantum Channels”. In *Benasque Quantum Information* (2025).
- [20] Duschenes, M. Moments of quantum channels (2025). Invited Talk - IFCO Barcelona (Antonio Acin Group).

- [21] Duschenes, M. “Simulation of Noisy Quantum Systems with POVM-MPS”. In *IQC Grad Student Conference* (2025).
- [22] Duschenes, M. “Moments of Quantum Channels”. In *Quantum Across Canada Conference* (2025).