MATTHEW DUSCHENES

Waterloo, Ontario, Canada • mduschen@uwaterloo.ca

SUMMARY

A PhD student at the University of Waterloo with the late Dr. Raymond Laflamme, Dr. Juan Carrasquilla, and Dr. Roger Melko. 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 studying quantum information and the current abilities of quantum computing technologies. Experienced in developing course content, guest lecturing, and academic outreach, in physics, machine-learning, and statistics disciplines. Highly proficient in Python (JAX), C++, and Bash languages. A driven, ambitious, and passionate learner and teacher who develops new techniques efficiently, and enjoys both team and independent work in a challenging environment.

EDUCATION

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 with Dr. Krishna Garikipati on development of numerical and graph-theoretic approaches for modelling high dimensional physical systems.
- *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, Electrical Specialization Bachelor's Degree **Fall, 2013 - Spring, 2017**
Queen's University

- Graduated with Honours within the double-major program.
- *Relevant Courses:* Statistical Mechanics, Mathematical Methods, Advanced Laboratories.

EXPERIENCE

Graduate Research Assistant **Fall, 2021 - Present**
Department of Physics, University of Waterloo

- Developed theoretical and numerical approaches to investigate correlations and noise-induced phenomena in quantum systems and to understand simulation and optimization methods.

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.
- Project lead of team with 4 senior and junior faculty members across North America and Europe.

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.

Graduate Research Assistant **Winter, 2019 - Summer, 2021**
Department of Mechanical Engineering, University of Michigan

- Developed novel graph theoretic methods and formalisms for efficient representations of dynamics.

ACTIVITIES AND INTERESTS

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 programs; delivered guest lectures to public and academic 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 women in physics working group; mentor of 4 Perimeter master's students and mentor of undergraduate programs; student representative on the scientific communication committee.

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

NSERC PGS-D Graduate Scholarship **2023 - 2026**
Natural Sciences and Engineering Research Council of Canada

President's Award, Marie Curie Award, Physics Department Fellowship **2023 - 2026**
University of Waterloo

Vector Research Grant **2022 - 2025**
Vector Institute

Perimeter PhD Student Residency **2021 - 2025**
Perimeter Institute

Applied Physics Graduate Fellowship **2018 - 2020**
Applied Physics Program, University of Michigan

Perimeter Scholar's International Scholarship **2017 - 2018**
Perimeter Institute and University of Waterloo

Principal's Scholarship, W.W. King Scholarship **2013 - 2014**
Faculty of Applied Science, Queen's University

REFERENCES

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).

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).