Michael Zurel

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EDUCATION

- **PhD** — University of British Columbia
  Physics (Quantum information and computation) — Sep., 2020 – Aug., 2024
  - Supervisors: Dr. Robert Raussendorf and Dr. William G. Unruh
  - Thesis: Classical descriptions of quantum computations: foundations of quantum computation via hidden variable models, quasiprobability representations, and classical simulation algorithms

- **MSc** — University of British Columbia
  Physics (Quantum information and computation) — Sep., 2019 – Oct., 2020
  - Supervisor: Dr. Robert Raussendorf
  - Thesis: Hidden variable models and classical simulation algorithms for quantum computation with magic states on qubits

- **BSc** — University of British Columbia
  Combined honours in Physics and Mathematics — Sep., 2014 – May, 2019
  - Honours thesis: Contextuality and Simulating Quantum Computation with Magic States

EXPERIENCE

- **NSERC Postdoctoral Fellow** — Vancouver, Canada
  Department of Mathematics, Simon Fraser University — Sep., 2024 –

- **Research Assistant** — Vancouver, Canada
  Department of Physics & Astronomy, University of British Columbia — Sep., 2018 – Aug., 2024

- **Teaching Assistant** — Vancouver, Canada
  Department of Physics & Astronomy, University of British Columbia — Sep., 2019 – Dec., 2023

- **Research Assistant** — St. John's, Canada
  Department of Geography, Memorial University — May, 2017 – Aug., 2018

AWARDS

- NSERC Postdoctoral Fellowship (NSERC PDF), $140,000 — 2024 – 2026
- CGS - Michael Smith Foreign Study Supplement (NSERC CGS-MSFSS), $6,000 — 2023
- Alexander Graham Bell Canada Graduate Scholarship (NSERC CGS-D), $105,000 — 2021 – 2024
- UBC Four Year Doctoral Fellowship (UBC 4YF) — 2021 – 2024
- President's Academic Excellence Initiative PhD Award — 2020 – 2024
- UBC Faculty of Science PhD Tuition Award — 2020 – 2024

SUCCESSFUL FUNDING

- PIMS Workshop grant: Mathematical Foundations of Quantum Advantage, $20,000 — Awarded Nov., 2024
  Joint with Nadish de Silva (SFU) and Carmen Constantin (UCL/Oxford) — Unlisted co-author

- NSERC Alliance Catalyst Grant, $25,000 — Awarded Jul., 2024
  Joint with Nadish de Silva (SFU) and Mark Howard (Galway) — Unlisted co-author

PATENTS

- Patent Application US20230206102A1; EP4128083A1; WO2021195783A1 — Status: Pending
  Method of simulating a quantum computation, system for simulating a quantum computation, method for issuing a computational key, system for issuing a computational key

Publications & preprints

[1] **MZ**, L. Z. Cohen, and R. Raussendorf, "Simulation of quantum computation with magic states via Jordan-Wigner transformations," *Physical Review A*, vol. 112, p. 042 602, 2025. DOI: 10.1103/ng4l-96kd. eprint: arXiv:2307.16034.

[2] **MZ**, C. Okay, and R. Raussendorf, "Simulating Quantum Computation: How Many 'Bits' for 'It'?" *PRX Quantum*, vol. 5, p. 030 343, 2024. DOI: 10.1103/PRXQuantum.5.030343. eprint: arXiv:2305.17287.

[3] **MZ** and A. Heimendahl, "Efficient classical simulation of quantum computation beyond Wigner positivity," 2024. eprint: arXiv:2407.10349.

[4] **MZ**, C. Okay, R. Raussendorf, and A. Heimendahl, "Hidden variable model for quantum computation with magic states on qudits of any dimension," *Quantum*, vol. 8, p. 1323, 2024. DOI: 10.22331/q-2024-04-30-1323. eprint: arXiv:2110.12318.

[5] R. Raussendorf, C. Okay, **MZ**, and P. Feldmann, "The role of cohomology in quantum computation with magic states," *Quantum*, vol. 9, p. 979, 2023. DOI: 10.22331/q-2023-04-13-979. eprint: arXiv:2110.11631.

[6] C. Okay, **MZ**, and R. Raussendorf, "On the extremal points of the Λ-polytopes and classical simulation of quantum computation with magic states," *Quantum Information & Computation*, vol. 21, no. 13&14, pp. 1091–1110, 2021. DOI: 10.26421/QIC21.13-14-2. eprint: arXiv:2104.05822.

[7] **MZ**, C. Okay, and R. Raussendorf, "Hidden Variable Model for Universal Quantum Computation with Magic States on Qubits," *Physical Review Letters*, vol. 125, p. 260 404, 2020. DOI: 10.1103/PhysRevLett.125.260404. eprint: arXiv:2004.01992.

[8] R. Raussendorf, J. Bermejo-Vega, E. Tyhurst, C. Okay, and **MZ**, "Phase-space-simulation method for quantum computation with magic states on qubits," *Physical Review A*, vol. 101, p. 012 350, 2020. DOI: 10.1103/PhysRevA.101.012350. eprint: arXiv:1905.05374.

For PDFs see mzurel.github.io; for citation statistics see Google Scholar.

Software

- BinarySymplectic.jl — Tools for working with symplectic vector spaces and symplectic groups over $\mathbb{Z}_2$.

- QuditStabilizers.jl — Tools for working with the stabilizer formalism on odd-prime-dimensional qudits.

- RandomQM.jl — Julia functions for generating random quantum states and random quantum channels

- LasserreIS.jl — Julia code for computing Lasserre bounds for the independence number of graphs.

- RandomStabilizers.jl — Julia code for generating random stabilizer states and random symplectic group elements based on the "SYMPLECTICImproved" algorithm of J. Math. Phys. **55** 122202 (2014).

- NetworkViz — Data visualization web app for input-output data, census data, and other socio-economic data in Newfoundland and Labrador. Written in R.

Code available on GitHub: github.com/mzurel

Conference talks

Quasiprobability distributions in quantum information (QuiDiQua3) [Invited]	35 minute talk	
Efficient classical simulation of quantum computation beyond Wigner nonnegativity	Nov., 2025	
Foundations of Quantum Computation	5 minute lightning talk	
The Λ polytopes and their applications	Jun., 2025	
Foundations of Quantum Computational Advantage (FoQaCiA) Workshop [Invited]	45 minute talk	
Introduction to the Λ polytopes and their applications	Jun., 2025	
Algebraic Structures in Quantum Computation VI (ASQC6) [Invited]	45 minute talk	
Introduction to the Λ polytopes and their applications	Feb., 2025	

- Quantum Physics and Logic (QPL)
  Efficient classical simulation of quantum computation beyond Wigner positivity
  30 minute talk
  Jul., 2024

- Southwest Quantum Information and Technology (SQuInT) Workshop
  Simulating quantum computation: how many "bits" for "it"?
  30 minute talk
  Oct., 2023

- Quantum Physics and Logic (QPL) [presented by a co-author]
  Simulation of quantum computation with magic states via Jordan-Wigner transformations
  30 minute talk
  Jul., 2023

- Coogee Workshop 2023 [Invited]
  No-go theorems for discrete Wigner functions and alternative quasiprobability representations for quantum computation with magic states
  60 minute talk
  Feb., 2023

- Foundations of Quantum Computational Advantage (FoQaCiA) Workshop [Invited]
  Λ polytopes and classical simulation of quantum computation with magic states
  45 minute talk
  Nov., 2022

- Theory of Quantum Computation, Communication, and Cryptography (TQC)
  Hidden variable model for quantum computation with magic states on qudits of any dimension
  25 minute talk
  Jul., 2022

- Quantum Physics and Logic (QPL)
  Hidden variable model for quantum computation with magic states on qudits of any dimension
  10 minute talk
  Jun., 2022

- Algebraic Structures in Quantum Computation V (ASQC5)
  Hidden variable models for quantum computation with magic states
  45 minute talk
  Jun., 2022

- Theory of Quantum Computation, Communication, and Cryptography (TQC)
  Hidden variable model for universal quantum computation with magic states on qubits
  30 minute talk
  Jul., 2021

- Quantum Physics and Logic (QPL)
  Hidden variable model for universal quantum computation with magic states on qubits
  30 minute talk
  Jun., 2021

- Algebraic Structures in Quantum Computation IV (ASQC4)
  Hidden variable model for universal quantum computation with magic states on qubits
  60 minute talk
  Jun., 2020

- Quantum Physics and Logic (QPL)
  Phase-space-simulation method for quantum computation with magic states on qubits
  25 minute talk
  Jun., 2019

For slides, videos, etc., see mzurel.github.io/talks

INVITED SEMINARS

- School of Mathematical & Statistical Sciences seminar @ University of Galway
  Efficient classical simulation of quantum computation beyond Wigner nonnegativity
  60 minute talk
  Nov., 2025

- David Gross group seminar @ University of Cologne
  Efficient classical simulation of quantum computation beyond Wigner positivity
  60 minute talk
  Apr., 2024

- Quantum information group seminar @ Leibniz University Hannover
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity
  60 minute talk
  Apr., 2024

- Quantum information group seminar @ DAMTP, University of Cambridge
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity
  60 minute talk
  Apr., 2024

- Dan Browne group seminar @ University College London
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity
  60 minute talk
  Apr., 2024

- QLOC Group Seminar @ Iberian Nanotechnology Laboratory
  A hierarchy of classical simulation algorithms for quantum computation
  60 minute talk
  Sep., 2023

- Shealf talks (Samson Abramsky group seminar @ University of Oxford)
  The role of cohomology in quantum computation with magic states
  60 minute talk
  Dec., 2022

- David Gross group seminar @ University of Cologne
  Quasiprobability representations for quantum computation with magic states
  60 minute talk
  Jul., 2022

- Math Grad Seminar @ Bilkent University
  Polytopes in quantum computation and quantum information
  60 minute talk
  Jun., 2022

- Institute of Applied Mathematics Seminar @ University of British Columbia
  Polytopes in quantum computation and quantum information
  60 minute talk
  Jun., 2022

- Internal talk for QuEra Computing Inc. software/algorithms team
  Classical simulation of quantum computation with magic states
  45 minute talk
  Apr., 2022

POSTER PRESENTATIONS

- Year of Quantum Across Canada @ Perimeter Institute
  The role of cohomology in quantum computation with magic states
  Sep., 2025

- Helgoland 2025: 100 Years of Quantum Mechanics
  Hidden variable model for universal quantum computation and Wheeler's "It from Bit"
  Jun., 2025

- Southwest Quantum Information and Technology (SQuInT) Workshop
  Efficient classical simulation of quantum computation beyond Wigner negativity
  Oct., 2024

- Theory of Quantum Computation, Communication, and Cryptography (TQC)
  Efficient classical simulation of quantum computation beyond Wigner positivity
  Sep., 2024

- Quantum Information Processing (QIP)
  Simulation of quantum computation with magic states via Jordan-Wigner transformations
  Jan., 2024

- Quantum Information Processing (QIP)
  Simulating quantum computation: how many "bits" for "it"?
  Jan., 2024

- Southwest Quantum Information and Technology (SQuInT) Workshop
  Simulation of quantum computation with magic states via Jordan-Wigner transformations
  Oct., 2023

- Quantum Physics and Logic (QPL)
  Simulating quantum computation with magic states: how many "bits" for "it"?
  Jul., 2023

- Max Planck - UBC - UTokyo Centre for Quantum Materials Annual Meeting,
  Hidden variable model for quantum computation with magic states on qudits of any dimension
  Sep., 2022

- Max Planck - UBC - UTokyo Centre for Quantum Materials Annual Meeting
  The role of cohomology in quantum computation with magic states
  Sep., 2022

- Theory of Quantum Computation, Communication, and Cryptography (TQC)
  The role of cohomology in quantum computation with magic states
  Jul., 2022

- Quantum Information Processing (QIP)
  Hidden variable model for quantum computation with magic states on qudits of any dimension
  Mar., 2022

- Quantum Information Processing (QIP)
  Hidden variable model for universal quantum computation with magic states on qubits
  Mar., 2021

- Southwest Quantum Information and Technology (SQuInT)
  Phase-space-simulation method for quantum computation with magic states on qubits
  Feb., 2020

For poster PDFs see mzurel.github.io/talks

WORKSHOP & SUMMER SCHOOL ORGANIZATION

- Mathematical Foundations of Quantum Advantage Workshop, 2nd edition
  Simon Fraser University
  May, 2026
  Co-organizer

- Mathematical Foundations of Quantum Advantage Workshop
  Simon Fraser University, Vancouver, Canada
  May, 2025
  Co-organizer

- Algebraic Structures in Quantum Computation V (ASQC5) June, 2022
  University of British Columbia, Vancouver, Canada Co-organizer
- Cornerstone Models of Quantum Computing Summer School August, 2021
  TRIUMF, Vancouver, Canada Teaching assistant for MBQC module
- Cornerstone Models of Quantum Computing Summer School August, 2020
  TRIUMF, Vancouver, Canada Teaching assistant for MBQC module

Peer review

Referee for the following journals:
- Physical Review Letters
- PRX Quantum
- Physical Review A
- Physical Review Applied
- npj Quantum Information
- Quantum Journal
- Journal of Mathematical Physics
- Journal of Physics A: Mathematical and Theoretical
- Journal of Applied and Computational Topology

Subreviewer for the following conferences:
- Quantum Information Processing (QIP)
- Theory of Quantum Computation, Communication and Cryptography (TQC)

I also serve on NSERC Review Committee 178 (Physics and Astronomy), a review committee for postdoctoral fellowships and postgraduate scholarships offered by the Natural Sciences and Engineering Research Council of Canada (NSERC).

Teaching experience

• Teaching assistant: Computational Physics	Sep., 2023 – Dec., 2023
• Teaching assistant: Frontiers in Physics	Sep., 2023 – Dec., 2023
• Teaching assistant: Introduction to Quantum Mechanics	Jan., 2022 – Apr., 2022
• Teaching assistant: Electricity and Magnetism	Sep., 2021 – Dec., 2021
• Teaching assistant: Electricity and Magnetism	Sep., 2020 – Dec., 2020
• Teaching assistant: Enriched Physics I	Sep., 2020 – Dec., 2020
• Teaching assistant: Introductory Physics for Engineers II	Jan., 2020 – Apr., 2020
• Teaching assistant: Introductory Physics	Sep., 2019 – Dec., 2019