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**, 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. arXiv: 2305.17287.

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

[3] **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. arXiv: 2110.12318.

[4] **MZ**, L. Z. Cohen, and R. Raussendorf, "Simulation of quantum computation with magic states via Jordan-Wigner transformations," [Accepted in Physical Review A], 2023. arXiv: 2307.16034.

[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. 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. 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. 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. 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

- 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	Nov., 2025
Foundations of Quantum Computation *The Λ polytopes and their applications*	5 minute lightning talk	Jun., 2025
Foundations of Quantum Computational Advantage (FoQaCiA) Workshop [Invited] *Introduction to the Λ polytopes and their applications*	45 minute talk	Jun., 2025
Algebraic Structures in Quantum Computation VI (ASQC6) [Invited] *Introduction to the Λ polytopes and their applications*	45 minute talk	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 — 30 minute talk
  Simulating quantum computation: how many "bits" for "it"? — Oct., 2023
- Quantum Physics and Logic (QPL) [presented by a co-author] — 30 minute talk
  Simulation of quantum computation with magic states via Jordan-Wigner transformations — Jul., 2023
- Coogee Workshop 2023 [Invited] — 60 minute talk
  No-go theorems for discrete Wigner functions and alternative quasiprobability representations for quantum computation with magic states — Feb., 2023
- Foundations of Quantum Computational Advantage (FoQaCiA) Workshop [Invited] — 45 minute talk
  Λ polytopes and classical simulation of quantum computation with magic states — Nov., 2022
- Theory of Quantum Computation, Communication, and Cryptography (TQC) — 25 minute talk
  Hidden variable model for quantum computation with magic states on qudits of any dimension — Jul., 2022
- Quantum Physics and Logic (QPL) — 10 minute talk
  Hidden variable model for quantum computation with magic states on qudits of any dimension — Jun., 2022
- Algebraic Structures in Quantum Computation V (ASQC5) — 45 minute talk
  Hidden variable models for quantum computation with magic states — Jun., 2022
- Theory of Quantum Computation, Communication, and Cryptography (TQC) — 30 minute talk
  Hidden variable model for universal quantum computation with magic states on qubits — Jul., 2021
- Quantum Physics and Logic (QPL) — 30 minute talk
  Hidden variable model for universal quantum computation with magic states on qubits — Jun., 2021
- Algebraic Structures in Quantum Computation IV (ASQC4) — 60 minute talk
  Hidden variable model for universal quantum computation with magic states on qubits — Jun., 2020
- Quantum Physics and Logic (QPL) — 25 minute talk
  Phase-space-simulation method for quantum computation with magic states on qubits — Jun., 2019

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

INVITED SEMINARS

- David Gross group seminar @ University of Cologne — 60 minute talk
  Efficient classical simulation of quantum computation beyond Wigner positivity — Apr., 2024
- Quantum information group seminar @ Leibniz University Hannover — 60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity — Apr., 2024
- Quantum information group seminar @ DAMTP, University of Cambridge — 60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity — Apr., 2024
- Dan Browne group seminar @ University College London — 60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity — Apr., 2024
- QLOC Group Seminar @ Iberian Nanotechnology Laboratory — 60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation — Sep., 2023
- Shealf talks (Samson Abramsky group seminar @ University of Oxford) — 60 minute talk
  The role of cohomology in quantum computation with magic states — Dec., 2022
- David Gross group seminar @ University of Cologne — 60 minute talk
  Quasiprobability representations for quantum computation with magic states — Jul., 2022
- Math Grad Seminar @ Bilkent University — 60 minute talk
  Polytopes in quantum computation and quantum information — Jun., 2022
- Institute of Applied Mathematics Seminar @ University of British Columbia — 60 minute talk
  Polytopes in quantum computation and quantum information — Jun., 2022
- Internal talk for QuEra Computing Inc. software/algorithms team — 45 minute talk
  Classical simulation of quantum computation with magic states — Apr., 2022

Poster presentations

- 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 May, 2025
  Simon Fraser University, Vancouver, Canada 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
- 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

Last updated: June, 2025