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

- **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) — 2024 – 2026
- CGS - Michael Smith Foreign Study Supplement (NSERC CGS-MSFSS) — 2023
- Alexander Graham Bell Canada Graduate Scholarship (NSERC CGS-D) — 2021 – 2024
- UBC Four Year Doctoral Fellowship (4YF) — 2021 – 2025
- President's Academic Excellence Initiative PhD Award — 2020 – 2024
- UBC Faculty of Science PhD Tuition Award — 2020 – 2024

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," 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 data see Google Scholar.

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*

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

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

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

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

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

Theory of Quantum Computation, Communication, and Cryptography (TQC), Jul., 2022	25 minute talk
Hidden Variable Model for Quantum Computation with Magic States on Qudits of Any Dimension	

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

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

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

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

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

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

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

Poster presentations

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

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

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

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

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

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

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

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

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

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

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

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

For poster PDFs see mzurel.github.io/talks

Invited seminars

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

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

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

- Dan Browne group seminar @ University College London, Apr., 2024   60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation of increasing complexity
- QLOC Group Seminar @ Iberian Nanotechnology Laboratory, Sep., 2023   60 minute talk
  A hierarchy of classical simulation algorithms for quantum computation
- Shealf talks (Samson Abramsky group seminar @ University of Oxford), Dec., 2022   60 minute talk
  The role of cohomology in quantum computation with magic states
- "FoQaCiA" collaboration kick-off meeting @ INL, Portugal, Nov., 2022   60 minute talk
  Λ polytopes and classical simulation of quantum computation with magic states
- David Gross group seminar @ University of Cologne, Jul., 2022   60 minute talk
  Quasiprobability representations for quantum computation with magic states
- Math Grad Seminar @ Bilkent University, Jun., 2022   60 minute talk
  Polytopes in quantum computation and quantum information
- Institute of Applied Mathematics Seminar @ University of British Columbia, Jun., 2022   60 minute talk
  Polytopes in quantum computation and quantum information
- Internal talk for QuEra Computing Inc. software/algorithms team, Apr., 2022   45 minute talk
  Classical simulation of quantum computation with magic states

Workshop & summer school organization

- Mathematical Foundations of Quantum Advantage Workshop   TBD
  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

Referee for the following conferences:
- Quantum Information Processing (QIP)

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: December, 2024