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
  - Affiliations: University of British Columbia (Physics) & Stewart Blusson Quantum Matter Institute
  - 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

- 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

- 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 Physics A: Mathematical and Theoretical

Referee for the following conferences:

- Quantum Information Processing (QIP)

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