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
- **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**, Cihan Okay, and Robert Raussendorf. "Simulating quantum computation: how many 'bits' for 'it'?" Accepted in PRX Quantum on July 25, 2024. arXiv: 2305.17287.

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

[3] **MZ**, Cihan Okay, Robert Raussendorf, and Arne Heimendahl. "Hidden variable model for quantum computation with magic states on qudits of any dimension". In: *Quantum* 8 (2024), p. 1323. DOI: 10.22331/q-2024-04-30-1323. arXiv: 2110.12318.

[4] **MZ**, Lawrence Z. Cohen, and Robert Raussendorf. "Simulation of quantum computation with magic states via Jordan-Wigner transformations". 2023. arXiv: 2307.16034.

[5] Robert Raussendorf, Cihan Okay, **MZ**, and Polina Feldmann. "The role of cohomology in quantum computation with magic states". In: *Quantum* 9 (2023), p. 979. DOI: 10.22331/q-2023-04-13-979. arXiv: 2110.11631.

[6] Cihan Okay, **MZ**, and Robert Raussendorf. "On the extremal points of the Λ-polytopes and classical simulation of quantum computation with magic states". In: *Quantum Information & Computation* 21.13&14 (2021), pp. 1091–1110. DOI: 10.26421/QIC21.13-14-2. arXiv: 2104.05822.

[7] **MZ**, Cihan Okay, and Robert Raussendorf. "Hidden Variable Model for Universal Quantum Computation with Magic States on Qubits". In: *Physical Review Letters* 125.26 (2020), p. 260404. DOI: 10.1103/PhysRevLett.125.260404. arXiv: 2004.01992.

[8] Robert Raussendorf, Juani Bermejo-Vega, Emily Tyhurst, Cihan Okay, and **MZ**. "Phase-space-simulation method for quantum computation with magic states on qubits". In: *Physical Review A* 101.1 (2020), p. 012350. 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 $\mathbb{Z}_2$.
- 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

Last updated: August, 2024