

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**, 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](https://doi.org/10.26421/QIC21.13-14-2). arXiv: [2104.05822](https://arxiv.org/abs/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](https://doi.org/10.1103/PhysRevLett.125.260404). arXiv: [2004.01992](https://arxiv.org/abs/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](https://doi.org/10.1103/PhysRevA.101.012350). arXiv: [1905.05374](https://arxiv.org/abs/1905.05374).

For PDFs see mzurel.github.io; for citation data see [Google Scholar](https://scholar.google.com/).

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
A 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