

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, \$20,000 Awarded Nov., 2024
- Workshop proposal: Mathematical Foundations of Quantum Advantage* Unlisted co-author
- NSERC Alliance Catalyst Grant, \$25,000 Awarded Jul., 2024
- 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. 030343, 2024. DOI: [10.1103/PRXQuantum.5.030343](https://doi.org/10.1103/PRXQuantum.5.030343). arXiv: [2305.17287](https://arxiv.org/abs/2305.17287).
- [2] **MZ** and A. Heimendahl, “Efficient classical simulation of quantum computation beyond wigner positivity,” 2024. arXiv: [2407.10349](https://arxiv.org/abs/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](https://doi.org/10.22331/q-2024-04-30-1323). arXiv: [2110.12318](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://doi.org/10.22331/q-2023-04-13-979). arXiv: [2110.11631](https://arxiv.org/abs/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](https://doi.org/10.26421/QIC21.13-14-2). arXiv: [2104.05822](https://arxiv.org/abs/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. 260404, 2020. DOI: [10.1103/PhysRevLett.125.260404](https://doi.org/10.1103/PhysRevLett.125.260404). arXiv: [2004.01992](https://arxiv.org/abs/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. 012350, 2020. 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/).

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

- Algebraic Structures in Quantum Computation VI (ASQC6) [Invited], Feb. 2025 45 minute talk
TBD
- 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

INVITED SEMINARS

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- 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

POSTER PRESENTATIONS

- Helgoland 2025: 100 Years of Quantum Mechanics, Jun., 2025
Hidden variable model for universal quantum computation and Wheeler's "it from bit"
- 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

WORKSHOP & SUMMER SCHOOL ORGANIZATION

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|---|--|
| • Mathematical Foundations of Quantum Advantage Workshop
<i>Simon Fraser University, Vancouver, Canada</i> | TBD
Co-organizer |
| • Algebraic Structures in Quantum Computation V (ASQC5)
<i>University of British Columbia, Vancouver, Canada</i> | June, 2022
Co-organizer |
| • Cornerstone Models of Quantum Computing Summer School
<i>TRIUMF, Vancouver, Canada</i> | August, 2021
Teaching assistant for MBQC module |
| • Cornerstone Models of Quantum Computing Summer School
<i>TRIUMF, Vancouver, Canada</i> | August, 2020
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

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| • 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