

# Michael Zurel

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## EDUCATION

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- **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

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- **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

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- 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

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- [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  $\Lambda$ -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. 260 404, 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. 012 350, 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](https://mzurel.github.io); for citation data see [Google Scholar](https://scholar.google.com/).

## PATENTS

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- 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

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- [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](https://github.com/mzurel)

## CONFERENCE TALKS

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- 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](https://mzurel.github.io/talks)

## POSTER PRESENTATIONS

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- 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](https://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  
*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

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- 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

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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)

## 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