# Michael Vasmer

*Curriculum vitae*

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I am a researcher working in the exciting field of quantum information. In my work I focus on quantum error correction: making sure that quantum computers function correctly even when some of their components go wrong. This research is crucial in the quest to build large-scale quantum computers capable of solving important problems for science and society.

## Experience

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| 2023–present | **Senior Quantum Architecture Scientist**, *Xanadu Quantum Technologies* |
| 2022–present | **Research Scientist**, *Perimeter Institute* |
| 2022–2023 | **Quantum Error Correction Researcher**, *Xanadu Quantum Technologies* |
| 2021–2022 | **Independent Contractor**, *Xanadu Quantum Technologies* |
| 2019–2022 | **Postdoctoral Fellow**, *Perimeter Institute & Institute for Quantum Computing* |
| | Mentors: Raymond Laflamme and Daniel Gottesman |

## Education

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| 2016–2019 | **Ph.D. Quantum Computing**, *University College London* |
| | Thesis: *Fault-tolerant quantum computing with three-dimensional surface codes*. |
| | Supervisor: Dan Browne. |
| 2015–2016 | **M.Res. Quantum Technologies**, *University College London*, Distinction |
| | Dissertation: *Swapping between color codes and surface codes*. |
| | Supervisor: Dan Browne. |
| 2011–2015 | **M.Sci. Natural Sciences**, *Durham University*, First Class Honours |
| | Specialized in Physics and Computer Science. |

## Funding

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| 2021 | **Making noisy quantum processors practical: From theory to applications**, *Natural Sciences and Engineering Research Council of Canada & Innovate UK*, $330k + £300k |
| | Co-principal investigator. I co-authored the grant proposal and I lead the research program on the Canadian side of the grant. |
| 2021–2022 | **IonQ Academic Research Credits Program**, $20k |
| | I secured funding for running experiments on IonQ's trapped-ion quantum computers. |

## Publications

[1] A. O. Quintavalle, P. Webster, and M. Vasmer, "Partitioning qubits in hypergraph product codes to implement logical gates," *Quantum* **7** (Oct., 2023) 1153, `arXiv:2204.10812`.

[2] E. Huang, A. Pesah, C. T. Chubb, M. Vasmer, and A. Dua, "Tailoring three-dimensional topological codes for biased noise," *PRX Quantum* **4** (Sep, 2023) 030338, `arXiv:2211.02116`.

[3] J. Huang, S. M. Li, L. Yeh, A. Kissinger, M. Mosca, and M. Vasmer, "Graphical CSS code transformation using ZX calculus," in *Proceedings of the Twentieth International Conference on Quantum Physics and Logic (QPL 2023)*, vol. 384 of *Electronic Proceedings in Theoretical Computer Science*, pp. 1–19. August, 2023. `arxiv:2307.02437`.

[4] A. Kubica and M. Vasmer, "Single-shot quantum error correction with the three-dimensional subsystem toric code," *Nat. Commun.* **13** no. 1, (Oct., 2022) 6272, `arXiv:2106.02621`.

[5] T. R. Scruby, M. Vasmer, and D. E. Browne, "Non-Pauli errors in the three-dimensional surface code," *Phys. Rev. Research* **4** no. 4, (Oct., 2022) 043052, `arXiv:2202.05746`.

[6] H. Chen, M. Vasmer, N. P. Breuckmann, and E. Grant, "Automated discovery of logical gates for quantum error correction," *Quantum Inf. Comput.* no. 11&12, (Sept., 2022) 0947–0964, `arXiv:1912.10063`.

[7] M. Vasmer and A. Kubica, "Morphing quantum codes," *PRX Quantum* **3** no. 3, (Aug., 2022) 030319, `arXiv:2112.01446`.

[8] T. R. Scruby, D. E. Browne, P. Webster, and M. Vasmer, "Numerical implementation of just-in-time decoding in novel lattice slices through the three-dimensional surface code," *Quantum* **6** (May, 2022) 721, `arXiv:2012.08536`.

[9] P. Webster, M. Vasmer, T. R. Scruby, and S. D. Bartlett, "Universal fault-tolerant quantum computing with stabilizer codes," *Phys. Rev. Research* **4** no. 1, (Feb., 2022) 013092, `arXiv:2012.05260`.

[10] A. O. Quintavalle, M. Vasmer, J. Roffe, and E. T. Campbell, "Single-shot error correction of three-dimensional homological product codes," *PRX Quantum* **2** no. 2, (June, 2021) 020340, `arXiv:2009.11790`. Editors' suggestion.

[11] J. E. Bourassa, R. N. Alexander, M. Vasmer, A. Patil, I. Tzitrin, T. Matsuura, D. Su, B. Q. Baragiola, S. Guha, G. Dauphinais, K. K. Sabapathy, N. C. Menicucci, and I. Dhand, "Blueprint for a scalable photonic fault-tolerant quantum computer," *Quantum* **5** (Feb., 2021) 392, `arXiv:2010.02905`.

[12] M. Vasmer, D. E. Browne, and A. Kubica, "Cellular automaton decoders for topological quantum codes with noisy measurements and beyond," *Sci. Rep.* **11** no. 1, (Jan., 2021) 2027, `arXiv:2004.07247`.

[13] M. Vasmer, *Fault-tolerant quantum computing with three-dimensional surface codes*. PhD thesis, University College London, Dec., 2019.

[14] M. Vasmer and D. E. Browne, "Three-dimensional surface codes: Transversal gates and fault-tolerant architectures," *Phys. Rev. A* **100** no. 1, (July, 2019) 012312, `arXiv:1801.04255`.

## Preprints

[1] D. H. Menendez, A. Ray, and M. Vasmer, "Implementing fault-tolerant non-Clifford gates using the [[8,3,2]] color code," *arXiv preprint* (Sept., 2023) , `arxiv:2309.08663`.

[2] J. C. Bridgeman, A. Kubica, and M. Vasmer, "Lifting topological codes: Three-dimensional subsystem codes from two-dimensional anyon models," *arXiv preprint* (May, 2023) , `arxiv:2305.06365`.

[3] G. Dauphinais, D. W. Kribs, and M. Vasmer, "Stabilizer Formalism for Operator Algebra Quantum Error Correction," *arXiv preprint* (Apr., 2023) , `arxiv:2304.11442`.

## Invited talks

Feb 2024 **Implementing fault-tolerant non-Clifford gates using the [[8,3,2]] color code**
IBM Quantum Information Technical Exchange colloquium (online)

Nov 2023 **Fault-tolerant quantum computation beyond the surface code**
Quantum Innovators Workshop, Waterloo ON, Canada

Jun 2023 **Fault-tolerant quantum computation with topological subsystem codes**
International Workshop on General-Purpose Quantum Computing and Information Theory, Institute of Theoretical Physics, Chinese Academy of Sciences (online)

Mar 2023 **3D subsystem codes from 2D topological codes**
APS March Meeting, Las Vegas NV, USA

Oct 2022 **Fault-tolerant quantum computing in the age of "good codes"**
Q-SITE Conference, Toronto ON, Canada

Jul 2022 **Single-shot quantum error correction: Part II**
IBM Quantum Error Correction Summer School, Tarrytown NY, USA

## Contributed talks & seminars

Dec 2023 **Decoding the 3D subsystem toric code**
Inria Paris, France

Dec 2023 **Photonic quantum computation beyond the surface code**
Télécom Paris, France

May 2022 **Fault-tolerant quantum computation beyond the surface code**
QuEra Computing (online)

2022 **Morphing quantum codes**
Riverlane, Cambridge, UK
APS March Meeting, Chigaco IL, USA

2021 **Single-shot quantum error correction with the 3D subsystem toric code**
Cambridge Quantum Computing, UK
University College London, UK
Freie Universität Berlin (online), Recording: `https://youtu.be/idmrNQy09Aw`

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| 2021 | **Locally unencoding the color code** |
| | TQC 2021 (online), Recording: `https://youtu.be/jUYOjC9Z68g` |
| | 1QB Information Technologies (online) |
| 2020 | **Cellular automaton decoders for toplogical codes with noisy measurements and beyond** |
| | Quantum code design and architecture seminar (online) |
| | Université de Sherbrooke, Sherbrooke QC, Canada |
| Mar 2019 | **Cellular automaton decoder for topological codes with boundaries** |
| | APS March Meeting, Boston MA, USA |
| | Quantum code design and architecture kick-off meeting, Paris, France |
| 2018 | **Quantum computing with 3D surface codes** |
| | Perimeter Institute, Waterloo ON, Recording: `https://doi.org/10.48660/18110080` |
| | Quantum Roundabout 2018, Nottingham, UK |
| | Northern Quantum meeting, Durham, UK |

## Awards

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| Aug 2019 | **Poster Prize**, *5th International Conference on Quantum Error Correction, London UK* |
| Sep 2017 | **Prize for outstanding performance in the MRes in Quantum Technologies**, *University College London* |
| Jun 2012 | **Outstanding achievement prize**, *Durham University Physics Department* |

## Supervision

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| 2021–present | Supervising one Master's and one PhD student at the University of Waterloo working on error mitigation projects. |
| Summer 2022 | Supervised two undergraduate students for projects on error correction and mitigation (resulted in preprint [1] and another manuscript in preparation). |
| Summer 2021 | Supervised a Perimeter Scholars International master's student for his thesis (resulted in publication [2]). |

## Teaching

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| Winter 2022 | Delivered six (one-hour) lectures as part of a quantum error correction and fault-tolerance graduate course at the University of Waterloo. |
| 2017–2019 | Delivered tutorials on quantum technologies to master's students at University College London. Total: 12 hours. |

## Equity, diversity and inclusion (EDI)

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| 2022–2023 | Member: Institute for Quantum Computing EDI committee. |
| 2017–2019 | PhD tutor, The Brilliant Club (`https://thebrilliantclub.org`). |
| | Delivered university-style tutorials about quantum computing to students at low-participation schools. Designed my own course over multiple placements. |

## Community contributions

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| 2024 | Organizer: Fault-tolerant quantum technologies workshop (Benasque, Spain). |
| 2022, 2024 | Program committee member: Quantum Computing Theory in Practice workshop. |
| 2022 | Organizer: Workshop on industrial quantum error mitigation (London, UK). |
| 2020–2022 | Organizer: Perimeter Institute quantum information seminar. |
| 2017 | Organizer: QCumber 2017 student conference (Windsor, UK). |
| 2020–present | Reviewer for scientific journals (number of reviewed articles in brackets): |

- Nature (1)
- Nature Physics (1)
- Physical Review A (2)
- Physical Review Applied (1)
- Physical Review Letters (4)
- Physical Review X (1)
- PRX Quantum (4)
- Quantum (7)

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| 2021–present | Reviewer for academic conferences: |

- Conference on Quantum Information Processing (QIP)
- Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC)
- IEEE International Symposium on Information Theory (ISIT)
- IEEE Information Theory Workshop (ITW)

## Computer skills

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| Software development | Programming languages: Python, C++, Julia, GAP, Mathematica.<br>Source control: Git, GitHub. |
| Quantum computers | Experience running quantum circuits on superconducting and trapped-ion quantum comptuers over the cloud, see preprint [1]. |
| High-performance computing | Experience with multiple supercomputing clusters, including the Digital Research Alliance of Canada systems, see publications [4, 5, 8, 10, 11, 12] and preprint [2]. |

## Personal details

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| Date of birth | January 19th 1993 |
| Citizenship | United Kingdom |
| Languages | English (native), Welsh (native), French (B1), German (A2). |

## References

Available on request.