Matthew B. Weiss

PhD Candidate, Computational Physics, University of Massachusetts Boston

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Research Interests

Quantum information theory and quantum foundations, with emphasis on symmetric informationally complete measurements, mutually unbiased bases, t-designs, and operational reconstructions of quantum theory. Measures of magic and nonclassicality. Generalized probabilistic theories and postclassical modeling beyond physics.

Education

University of Massachusetts Boston — Boston, MA
Computational Physics PhD. Advisor: Christopher Fuchs — 2021–2026
Dissertation: "Redesigning quantum theory"
Committee: Olga Goulko, Akira Sone, Kourosh Zarringhalam, Christopher Fuchs, Marcus Appleby

University of Pennsylvania — Philadelphia, PA
Post-baccalaureate courses in mathematics and physics — 2019–2020

Iowa Writers' Workshop — Iowa City, IA
MFA in Fiction — 2013–2015

Brown University — Providence, RI
BA in Literary Arts, Magna Cum Laude — 2008–2012

Academic Appointments

Graduate Researcher, QBism Group — 2021–Present
Department of Physics, University of Massachusetts Boston

Publications

[3] S. Cepollaro, G. Cuffaro, M. B. Weiss, S. Cusumano, A. Hamma, and S. Lloyd. *Stabilizer Entropy of Subspaces*. 2025. arXiv: 2512.23013 [quant-ph]. URL: https://arxiv.org/abs/2512.23013.

[4] G. Cuffaro and M. B. Weiss. *Clifford entropy*. 2025. arXiv: 2512.23050 [quant-ph]. URL: https://arxiv.org/abs/2512.23050.

[5] S. Gupta and M. B. Weiss. *A simple realization of Weyl-Heisenberg covariant measurements*. 2025. arXiv: 2512.22111 [quant-ph]. URL: https://arxiv.org/abs/2512.22111.

[6] R. S. Piera, J. B. DeBrota, M. B. Weiss, G. B. Lemos, J. S. Araújo, G. H. Aguilar, and J. L. Pienaar. "Synthesizing the Born rule with reinforcement learning". *Physical Review Research* 7.3 (July 2025). DOI: 10.1103/physrevresearch.7.033042. URL: http://dx.doi.org/10.1103/PhysRevResearch.7.033042.

[9] M. B. Weiss. "Characterizing quantum state-space with a single quantum measurement". *Phys. Rev. A* 111 (5 May 2025), p. 052205. DOI: 10.1103/PhysRevA.111.052205. URL: https://link.aps.org/doi/10.1103/PhysRevA.111.052205.

[13] C. Kyeremah, M. Weiss, D. Kandel, D. Haehn, and C. Yelleswarapu. "Single-beam digital holographic reconstruction: a phase-support enhanced complex wavefront on phase-only function for twin-image elimination". *Journal of Biomedical Optics* 29.07 (July 2024). DOI: 10.1117/1.jbo.29.7.076502. URL: http://dx.doi.org/10.1117/1.JBO.29.7.076502.

[14] M. B. Weiss. *Depolarizing Reference Devices in Generalized Probabilistic Theories*. 2024. arXiv: 2312.12790 [quant-ph]. URL: https://arxiv.org/abs/2312.12790.

[20] C. A. Fuchs, M. B. Weiss, and M. Olshanii. "Quantum mechanics? It's all fun and games until someone loses an i". *Asian Journal of Physics* 30.12 (2021), pp. 1707–1726. DOI: 10.48550/arXiv.2206.15343. URL: https://arxiv.org/abs/2206.15343.

Invited and Contributed Talks

[7] M. B. Weiss. "A 3-design is (still) all you need". *Tufts Quantum Computing Seminar*. Invited talk. Apr. 2025.

[8] M. B. Weiss. "A 3-design is all you need". *APS March Meeting*. Session MAR-G35: Applied Quantum Foundations. Mar. 2025.

[10] M. B. Weiss. "Characterizing quantum state-space with a single quantum measurement". *6th Workshop On Algebraic Structures in Quantum Computation*. Leibniz University. Invited talk. Feb. 2025. URL: https://youtu.be/His7JXArWtk.

[12] M. B. Weiss. "Post-classical modeling beyond physics". *Quantum Social Science Bootcamp*. Ohio State University. May 2025.

[15] M. B. Weiss. "QBism for the human sciences: elegant tools for post-classical modeling". *Quantum Information and Probability: from Foundations to Engineering (QIP24)*. Linnaeus University. Invited talk. June 2024. URL: https://lnu.se/en/meet-linnaeus-university/current/events/2024/conferences/qip24/.

[16] M. B. Weiss. "How Quantum is QBism?" *The Quantum Reconstruction Program and Beyond*. University of Graz. Invited talk. Aug. 2023. URL: https://youtu.be/3mFLca038G8?si=IfICAk2z64HmPbPn.

[18] M. B. Weiss. "The Group Inverse for Quantum Information Theory". *APS March Meeting*. Session F65: Quantum Field Theories and Foundations. Mar. 2023.

[19] M. B. Weiss. "Two Measures of Non-classicality". *Seventh Annual CSM Showcase (Poster session)*. UMass Boston. May 2023.

Grants

Professional Development Grant, University of Massachusetts Boston Spring 2025

Supported as Graduate Researcher by:

- NSF Grant OSI-2328774. *ExpandQISE (Track 2: EQUIP-UMB)*. PI: Robin Cote. 2023–2028.
- NSF Grant PHY-2210495. *Symmetric informationally complete measurements and quantum computation*. PI: Christopher Fuchs, Blake Stacey. 2022–2026.
- Templeton Foundation Grant 62424. *What is Metrology if Quantum Measurements Participate in Making Reality?* . PI: Christopher Fuchs, Jacques Pienaar. 2022–2025.

Software

[1] M. B. Weiss. *cirq_sic*. GitHub repository: Python, Cirq. Circuits for implementing multiqubit SIC measurements. 2025-6. URL: https://github.com/heyredhat/cirq_sic.

[2] M. B. Weiss. *qbism and qbuki: python tools for the budding quantum bettabilitarian*. GitHub repositories. `https://github.com/heyredhat/qbism` and `https://github.com/heyredhat/qbuki`. Helpful functions for working with the probability-first representation of quantum mechanics. 2021-present.

[11] M. B. Weiss. *magicgap*. GitHub repository: Python, Scipy, Jax. Calculates the average stabilizer entropy of subspaces both exactly and in Monte Carlo approximation. 2025. URL: `https://github.com/heyredhat/magicgap`.

[17] M. B. Weiss. *pySimplexEmbedding*. GitHub repository: Python. Port of Mathematica program to witness the non(classicality) of states and effects. 2023. URL: `https://github.com/heyredhat/pySimplexEmbedding`.

[21] M. B. Weiss. *spheres: toolbox for higher spin and symmetrization*. GitHub repository: Python, Qutip, StrawberryFields, Qiskit. Developed as part of the Quantum Open Source Foundation's mentorship program. Exploits the Majorana representation of higher spin states to prepare them as symmetric multiqubit states on qubit-based quantum computers and as oscillator states on photonic systems. 2021. URL: `https://github.com/heyredhat/spheres`.

Technical Skills

Programming: Python (NumPy, SciPy, JAX, TensorFlow), Cirq, Qiskit, Strawberry Fields; Mathematica; LaTeX; basic C/C++/Java.
Mathematics: Frame theory, multilinear algebra, convex geometry, Euclidean Jordan algebras, generalized probabilistic theories.
Quantum: Resource theories; SIC-POVMs, MUBs, t-designs; coherent-state and probability-first representations; numerical optimization over measurements. Continuous quantum measurement.

Teaching

PHYSIC 114: Fundamentals of Physics II Summer 2025
- Thermodynamics and E & M at an accelerated pace to undergraduates at UMass Boston.

Quantum Mechanical Puzzles Spring and Fall 2024
- Designed an introductory course on quantum foundations for the Osher Lifelong Learning Institute.

Brooklyn Quantum Meetup 2017–2018, 2020–2021
- Organized biweekly gatherings for laypeople interested in quantum physics, developing freely available education material: *Essays on Quantum Physics*.

Instructor, Creative Writing Studio; The Interpretation of Literature 2013–2015
The University of Iowa

Service

- Treasurer of the *Physics Graduate Club* (2022–2026), twice awarded best graduate club at UMass Boston. Organized seminars for graduate students and professors in the Boston area and beyond.
- Refereeing: *Entropy*, *Quantum Journal*.

Professional Memberships

- American Physical Society.