Robert I. Booth

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British and French nationality

10/5 Brougham Place
EH3 9HW Edinburgh
United Kingdom

Profile

I am a researcher with a particular interest in the mathematical foundations of quantum computing. In no particular order, I am interested in: categorical methods and diagrammatic calculi, programming languages and semantics, measures of non-classicality in quantum theory, and infinite-dimensional models of quantum computing. Beyond continuing to develop these techniques, I am interested in applying them to the compilation of quantum computations and to quantum error correction.

Research experience

06/2024–05/2028 *ongoing*
Research Associate in Quantum Software
Department of Computer Science, University of Oxford
Working with Aleks Kissinger
• *Diagrammatic reasoning and applied category theory* • *Compilation of quantum programs* • *Fault-tolerance of quantum computations* • *Quantum programming languages and semantics*

04/2022–05/2025
Research Associate
School of Informatics, University of Edinburgh
School of Mathematics, University of Bristol
Working with Chris Heunen and Noah Linden
• *Optimisation and distribution of quantum circuits* • *Resources for distributed quantum computation.* • *Diagrammatic reasoning and applied category theory*

11/2018–02/2022
Doctoral Student in Quantum Computation
Laboratoire d'Informatique de Paris 6, Sorbonne Université, Paris
Laboratoire Lorrain de Recherche en Informatique et ses Applications, Nancy
Title: *Measurement-based quantum computation beyond qubits*
Supervised by Damian Markham and Simon Perdrix
• *Measurement-based quantum computation with qudits and continuous variables* • *Quantum circuit extraction algorithms and the qudit ZX-calculus* • *Contextuality in continuous-variable systems and its connection with other notions of non-classicality*

Mar.–Jul. 2018
Research Intern in Quantum Information Theory
Laboratoire d'Informatique de Paris 6, Université Pierre et Marie Curie, Paris
Supervised by Damian Markham

Apr.–Jul. 2017
Research Intern in Experimental Quantum Optics
Università degli Studi Roma Tre, Rome
Supervised by Marco Barbieri

Feb.–May 2016
Research Intern in Experimental Physical Chemistry
Laser Chemistry, Spectroscopy and Dynamics Laboratory
University of Bristol, United Kingdom
Supervised by Prof. Michael N. R. Ashfold FRS

Teaching experience

Spring 2024
Introduction to Quantum Programming and Semantics
Guest Lectures and Tutorials
University of Edinburgh

Spring 2023 | **Categories and Quantum Informatics**
Lectures, Computer Labs, and preparation of course material
University of Edinburgh
My work on this course earned a University of Edinburgh Staff Award

Education

2016–2018 | **Master's Degree in Fundamental Physics**
Université Pierre et Marie Curie, Paris

2016 | **Double Honours Bachelor's Degree in Physics and Chemistry**
Université Paris-Sud, Orsay, France

2012 | **Scientific Baccalaureate**, France

Publications

Journal articles

- Francesco Arzani, Robert I. Booth, and Ulysse Chabaud (Nov. 6, 2025). "Effective descriptions of bosonic systems can be considered complete". In: *Nature Communications* 16.1. Publisher: Nature Publishing Group, p. 9744. DOI: 10.1038/s41467-025-64872-3
- Robert I. Booth and Damian Markham (Oct. 19, 2023). "Flow conditions for continuous variable measurement-based quantum computing". In: *Quantum* 7. Publisher: Verein zur Förderung des Open Access Publizierens in den Quantenwissenschaften, p. 1146. DOI: 10.22331/q-2023-10-19-1146
- Robert I. Booth, Aleks Kissinger, Damian Markham, Clément Meignant, and Simon Perdrix (Feb. 2023). "Outcome determinism in measurement-based quantum computation with qudits". In: *Journal of Physics A: Mathematical and Theoretical* 56.11. Publisher: IOP Publishing, p. 115303. DOI: 10.1088/1751-8121/acbace
- Robert I. Booth, Ulysse Chabaud, and Pierre-Emmanuel Emeriau (Nov. 29, 2022). "Contextuality and Wigner negativity are equivalent for continuous-variable quantum measurements". In: *Physical Review Letters* 129.23, p. 230401. DOI: 10.1103/PhysRevLett.129.230401. arXiv: 2111.13218[math-ph,physics:quant-ph]
- Vasco Cavina, Luca Mancino, Antonella De Pasquale, Ilaria Gianani, Marco Sbroscia, Robert I. Booth, Emanuele Roccia, Roberto Raimondi, Vittorio Giovannetti, and Marco Barbieri (Nov. 9, 2018). "Bridging thermodynamics and metrology in nonequilibrium quantum thermometry". In: *Physical Review A* 98.5. DOI: 10.1103/PhysRevA.98.050101
- Luca Mancino, Vasco Cavina, Antonella De Pasquale, Marco Sbroscia, Robert I. Booth, Emanuele Roccia, Ilaria Gianani, Vittorio Giovannetti, and Marco Barbieri (Oct. 17, 2018). "Geometrical Bounds on Irreversibility in Open Quantum Systems". In: *Physical Review Letters* 121.16. DOI: 10.1103/PhysRevLett.121.160602

Conference proceedings

- Boldizsár Poór, Robert I. Booth, Titouan Carette, John Van De Wetering, and Lia Yeh (Aug. 29, 2023). "The Qupit Stabiliser ZX-travaganza: Simplified Axioms, Normal Forms and Graph-Theoretic Simplification". In: *Electronic Proceedings in Theoretical Computer Science*. Twentieth International Conference on Quantum Physics and Logic. Vol. 384. Paris, France, pp. 220–264. DOI: 10.4204/EPTCS.384.13
- Robert I. Booth and Titouan Carette (2022). "Complete ZX-Calculi for the Stabiliser Fragment in Odd Prime Dimensions". In: *47th International Symposium on Mathematical Foundations of Computer Science (MFCS 2022)*. Ed. by Stefan Szeider, Robert Ganian, and Alexandra Silva. Vol. 241. Leibniz International Proceedings in Informatics (LIPIcs). ISSN: 1868-8969. Dagstuhl, Germany: Schloss Dagstuhl – Leibniz-Zentrum für Informatik, 24:1–24:15. DOI: 10.4230/LIPIcs.MFCS.2022.24

Preprints

- Robert I. Booth and Cole Comfort (Nov. 27, 2025). *Denotational semantics for stabiliser quantum programs.* DOI: 10.48550/arXiv.2511.22734. arXiv: 2511.22734[cs]
- Clément Poirson, Joschka Roffe, and Robert I. Booth (May 5, 2025). *Engineering CSS surgery: compiling any CNOT in any code.* DOI: 10.48550/arXiv.2505.01370. arXiv: 2505.01370[quant-ph]
- Robert I. Booth, Titouan Carette, and Cole Comfort (Mar. 15, 2024a). *Complete equational theories for classical and quantum Gaussian relations.* arXiv: 2403.10479[quant-ph]
- Robert I. Booth, Titouan Carette, and Cole Comfort (Jan. 30, 2024b). *Graphical Symplectic Algebra.* DOI: 10.48550/arXiv.2401.07914. arXiv: 2401.07914[quant-ph]

Dissemination

Conferences

- "Denotational semantics for stabiliser quantum programs', 6th International Workshop on Programming Languages for Quantum Computing, Rennes, France, 2026 (Cole Comfort)
- "Can effective descpritions of bosonic systems be considered complete?", 29th Annual Quantum Information Processing Conference, Riga, Latvia, 2026 (Francesco Arzani)
- "CSS surgery: compiling any CNOT in any code", 22nd International Conference on Quantum Physics and Logic, Varna, Bulgaria, 2025
- "A graphical language for Gaussian quantum processes", 21st International Conference on Quantum Physics and Logic, Buenos Aires, Argentina, 2024
- "Contextuality and Wigner negativity are equivalent for continuous-variable measurements", 19th International Conference on Quantum Physics and Logic, Oxford, 2022 (Pierre-Emmanuel Emeriau)
- "CSS surgery: compiling any CNOT in any code", 22nd International Conference on Quantum Physics and Logic, Varna, Bulgaria, 2025
- "A graphical language for Gaussian quantum processes", 21st International Conference on Quantum Physics and Logic, Buenos Aires, Argentina, 2024
- "Complete equational theories for classical and quantum Gaussian relations", 7th International Conference on Applied Category Theory, Oxford, 2024 (Cole Comfort)
- "Graphical Symplectic Algebra", 7th International Conference on Applied Category Theory, Oxford, 2024 (Cole Comfort)
- "The Qupit Stabiliser ZX-travaganza: Simplified Axioms, Normal Forms, and Graph-theoretic Simplification", 20th International Conference on Quantum Physics and Logic, Paris, 2023 (Boldizsár Poór)
- "Complete ZX-calculi for the stabiliser fragment in odd prime dimensions", 47th International Symposium on Mathematical Foundations of Computer Science, Vienna, 2022
- "Complete ZX-calculi for the stabiliser fragment in odd prime dimensions", 19th International Conference on Quantum Physics and Logic, Oxford, 2022 Video: YouTube
- "Contextuality and Wigner negativity are equivalent for continuous-variable measurements", 19th International Conference on Quantum Physics and Logic, Oxford, 2022 (Pierre-Emmanuel Emeriau) Video: YouTube
- "Extracting reversible quantum circuits from measurement-based quantum computations with qudits", 19th International Conference on Quantum Physics and Logic, Oxford, 2022 Video: YouTube
- "Contextuality and Wigner negativity are equivalent for continuous-variable measurements", 20th European Conference on Foundations of Physics, Ecole Normale Supérieure Paris, October 30th, 2021
- "F-flow: determinism in measurement-based quantum computing with qudits", 19th International Conference on Quantum Physics and Logic, University of Gdánsk, June 9th, 2021, Video: YouTube

- "F-flow: determinism in measurement-based quantum computing with qudits", Sixth International Conference for Young Quantum Information Scientists, Michigan State University, April 15th, 2021
- "Flow conditions for continuous variable measurement-based quantum computation", 18th International Conference on Quantum Physics and Logic, Paris, June 15th, 2020, Video: YouTube

Workshops

- "Denotational semantics for stabiliser quantum programs', 6th Scottish Programming Language Seminar, Glasgow, United Kingdom, 3 December 2025
- "A symplectic vision for the ZX-calculus", CATNIP workshop, University of Aberdeen, May 3rd, 2024
- "Distributing quantum circuits with the ZX-calculus", National Center for Quantum Computing Launch Event, University of Edinburgh, December 13th, 2022
- "Outcome determinism in measurement-based quantum computing with qudits", Workshop on recent advances on quantum computing, Collège de France, June 17th, 2021
- "Flow conditions for continuous-variable measurement-based quantum computation", Workshop on Quantum Networks and Information 2020, National Institue of Informatics, Tokyo
- "Convergence of continuous-variable measurement-based quantum computations", Edinburgh-Paris Joint Quantum Workshop, Edinburgh, July, 2019

Seminars

- "A convenient setting for fault-tolerant compilation", Quantum Lunch seminar, University of Oxford, 30 April 2025
- "Finding a convenient setting for fault-tolerant quantum compilation", University College London, 29 April 2025
- "CSS surgery: compiling any CNOT in any CSS code", PhiQus team seminar, École Polytechnique, Saclay, France, 28 November 2024
- "The nullifier theory of Gaussian quantum states", Qatalyze seminar, Paris, France, 27 November 2024
- "Complete Equational Theories for Classical and Quantum Gaussian Relations", ZX seminar, 2024, online, Video: YouTube
- "Graphical reasoning for Gaussian quantum mechanics", Loria, Nancy, 9 April 2024
- "Graphical Symplectic Algebra", ZX seminar, 2024, online, Video: YouTube
- "ZX-calculus: (my) past, present... future?", LIP6 QI team seminar, Paris, 2023
- "Complete ZX-calculi for the stabiliser fragment in odd prime dimensions", ZX seminar, 2022, online, Video: YouTube
- "Contextuality and Wigner negativity are equivalent for continuous-variable measurements", Online Quantum and Linear Optical Computation seminar, 2022
- "Outcome determinism in measurement-based quantum computing with qudits", ZX seminar, 2021, online
- "F-flow: determinism in measurement-based quantum computing with qudits", ZX seminar, 2020, online

Academic Service

- Organiser of the University of Edinburgh's Quantum Software Lab Seminar, 2023-2025
- Member of the Program Committe for *QPL 2026*, *QPL 2025*, *ACT 2025*, *PLanQC 2022*
- Reviewer for the US Department of Energy grant call "Express: 2023 Exploratory Research for Extreme-Scale Science"
- Reviewer for the journals *Quantum*, *Compositionality*, *Logical Methods in Computer Science*
- Reviewer for the conferences *LICS 2025*, *ACT 2024*, *QPL 2023*, *QPL 2022*, *QPL 2021*
- Held the "Quantum Spies" stand at Edinburgh Science Festival 2022, and alongside the Doctor Who Worlds of Wonder exhibition, both at the National Museum of Scotland

Other

Languages	**English and French, bilingual**
Computing	Python, Mathematica, UNIX, LaTeX