

Joshua B. Ruebeck

Curriculum Vitae

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Education

- 2017–2019 **MSc in Physics: Quantum Information**, *University of Waterloo*, ON.
- 2013–2017 **B.A. in Physics and Music**, *Carleton College*, MN.
Summa Cum Laude

Research Experience

- 2017–present **Ontological models**, *University of Waterloo*, Prof. Joseph Emerson.
During my Master's degree, I am exploring topics in interpretations of quantum mechanics, generally working within the ontological models formalism. I have studied state-update under measurement in this context as it relates to other ideas in quantum foundations, like the ψ -epistemic/ontic distinction and contextuality.
- 2016 **Computational mechanics**, *UC Davis*, Prof. James Crutchfield.
For my REU project, I studied classical and quantum information theory and how they apply to physical (stochastic) processes through hidden Markov models. In the classical realm, I found (analytically) the first provably minimal generative HMMs for a general binary Markov chain and worked on computational efforts to find minimal generators for more complex processes. As part of the group's efforts in quantum information, I built Python programs to calculate the entanglement of formation and accessible information for arbitrary bipartite systems, which are both nontrivial constrained global minimizations.
- 2014–2017 **Entanglement and chaos**, *Carleton College*, Prof. Arjendu Pattanayak.
In this research experience, I investigated quantum entanglement and its relation to classical chaos in a system called the 'kicked top.' The project included analytical and computational work, as well as communication with the Martinis Group at UCSB which was conducting related experiments. We found that connections previously observed between semiclassical and classical versions of the same system held in the quantum limit, and consequently that the existing interpretation of the result needs re-evaluation. While previous studies claimed that chaos in the classical system and entanglement in the quantum system are strongly correlated, we found evidence to the contrary and accordingly provide a new interpretation of the weaker correlation that does exist. This includes work done for academic credit during the term and a paid position during the summer of 2015.

Teaching Experience

- 2018–present *Teaching assistantships*: Course TA for Quantum Mechanics I and a modern physics survey course. Responsibilities involved creating and leading tutorials, including short lectures and guided problem-solving. Also delivered lectures in the absence of the professor.

- 2018–present *Fundamentals of University Teaching certificate*: Completed the Center for Teaching Excellence’s basic teaching certificate, which included six workshops and three ‘microteaching’ sessions.
- 2017–2018 *Tutoring*: Provided private tutoring services to undergraduate students; primarily calculus, linear algebra, and introductory physics courses.
- 2017–2018 *Outreach*: Participated in Let’s Talk Science K–12 classroom visits, and in Faculty of Science outreach events at the University of Waterloo.

Honors and Awards

- 2018–2019 **Ontario Graduate Scholarship.**
- 2017 **Laurence McKinley Gould Prize.**
Awarded annually to a member of the senior class who has demonstrated excellence in scientific research and who has studied one of the other humanities at a level well beyond the minimum College requirement
- 2017 **Graduated *Summa Cum Laude*.**
- 2017 **Inducted into *Phi Beta Kappa* honor society.**
- 2016 **NSF Research Experience for Undergraduates (REU).**
- 2017 **Honors in music performance.**
- 2014–2017 **Carleton College Dean’s list.**

Publications

Articles published in peer-reviewed journals

- J.B. Ruebeck, R.G. James, J.R. Mahoney, and J.P. Crutchfield. *Prediction and generation of binary Markov processes: can a finite-state fox catch a Markov mouse?* *Chaos: An Interdisciplinary Journal of Nonlinear Science* (2018). arXiv:1708.00113 doi:10.1063/1.5003041
- J.B. Ruebeck, J. Lin, and A.K. Pattanayak. *Entanglement and its relationship to classical dynamics.* *Physical Review E* (2017). arXiv:1708.00545 doi:10.1103/PhysRevE.95.062222

Available preprints

- J.B. Ruebeck, P. Lillystone, and J. Emerson. *Epistemic interpretations of quantum theory have a measurement problem.* Submitted to *Physical Review X* (2019). arXiv:1812.08218

Presentations

Posters at conferences and workshops

- “Entanglement in a 2-qubit system is related to the classical nonlinear dynamics.” Southwest Quantum Information Technology (SQulnT) workshop (2016).

Undergraduate Theses

- Title *Quantum Communication, Shannon Theory, and Error Correction*
Supervisor Professor Andres Aragonese

Description This thesis took the form of a very broad review of topics relevant to quantum communication (QC), including: basic classical Shannon theory and its analogues in QC (i.e. Schumacher compression); some general quantum error correcting codes; classical linear codes and their extensions in QC (CSS codes); and photonic implementations (polarization vs spacial mode representations and single-photon detectors)

Title *True Story: a Concept EP*

Supervisors Professor Andrea Mazzariello and Professor J. Andrew Flory

Description In this thesis for the music major, I investigated the history of concept albums through listening and secondary academic work, producing a number of essays based on this research. I also composed, performed, recorded & produced an original concept EP, *True Story*. Awarded distinction.

Computer skills

Proficient Mathematica, Python (SciPy), \LaTeX , Microsoft Office, iWork
Familiar Java, C, Unix (bash)