Alexander R. H. Smith

Department of Physics, Saint Anselm College
100 Saint Anselm Drive, Goulet Science Center, Room 3201B
Manchester, New Hampshire 03102, USA

arhsmith@anselm.edu • (917) 688-4282 • www.anselm.edu/faculty-directory/alexander-smith

Academic Appointments

- Assistant Professor of Physics — 2020 - present
  Department of Physics, Saint Anselm College
- Adjunct Assistant Professor — 2020 - present
  Department of Physics and Astronomy, Dartmouth College
- Junior Fellow, Society of Fellows — 2017 - 2020
  Department of Physics and Astronomy, Dartmouth College
- NSERC Postdoctoral Fellow — 2017 - 2019
  National Science and Engineering Research Council of Canada (NSERC)

Education

- University of Waterloo, Waterloo, Canada — 2017
  Doctorate of Philosophy in Theoretical Physics
- Macquarie University, Sydney, Australia — 2017
  Doctorate of Philosophy in Theoretical Physics

  Thesis title: Detectors, Reference Frames, and Time
  Published as a book by Springer International (2019)
- University of Toronto, Toronto, Canada — 2012
  Master of Science in Theoretical Physics

  Thesis title: Black Holes and the Kodama Vector Field
- University of Waterloo, Waterloo, Canada — 2011
  Honours Bachelor of Science (Co-op) in Physics, Deans Honour List

  Thesis title: Persistence of Tripartite Nonlocality for Non-inertial Observers
  Specialization: Astrophysics and Applied Physics

Summary of Qualifications

- Research interests: quantum information science, relativistic quantum information, quantum field theory on curved spacetime, quantum foundations, quantum reference frames, relational quantum mechanics, space-based tests of general relativity.
- $391,875 in received funding from competitive scholarships, awards, and grants.
- Designed freshmen physics laboratory curriculum at Saint Anselm College, implementing a guided discovery pedagogy backed by physics education research. Designed and taught a new course at Dartmouth College titled 'Introductory Mathematical Methods for Physicists'.
- Experience supervising undergraduate research students resulting in 3 undergraduate theses, 3 publication with student authors, and 3 student presentations at national conferences.
- Industry research experience at a large private lab (Xerox Research Centre of Canada) and a small solar start-up company (Morgan Solar Inc.), along with field experience in geophysics (WorlyParsons).

Publications and Preprints

Peer-reviewed articles

1. The trinity of relational quantum dynamics
   Philipp A. Höhn, **Alexander R. H. Smith**, Maximilian P. E. Lock
   Physical Review D 204, 066001(2021)

   *Note alphabetical order of the first two authors, who share first authorship.

2. Generalized probability rules from a timeless formulation of Wigner's friend scenarios
   Veronika Baumann, Flavio Del Santo, **Alexander R. H. Smith**, Flaminia Giacomini, Esteban Castro-Ruiz, Časlav Brukner
   Quantum 5, 524 (2021)

   *Note alphabetical order the first three authors, who all contributed equally.

3. Equivalence of approaches to relational quantum dynamics in relativistic settings
   Philipp A. Höhn, **Alexander R. H. Smith**, Maximilian P. E. Lock
   Invited contribution, Frontiers of Physics 9, 587083 (2021)

4. Quantum time dilation in atomic spectra
   Piotr T. Grochowski, **Alexander R. H. Smith**, Andrzej Dragan, Kacper Dębski
   Physical Review Research 3, 023053 (2021)

5. Quantum clocks observe classical and quantum time dilation
   Alexander R. H. Smith and Mehdi Ahmadi
   Nature Communications 11, 5360 (2020)

   – Nature Communications 2020 Top 50 Physics articles, fourth most downloaded physics article.

   – Scientific American interview 'Quantum Time Twist Offers a Way to Create Schrödinger's Clock'.

   – Reported on by United Press International (UPI), 'Atomic clocks experience the quantum phenomenon called superposition', Phys.org, 'Timekeeping theory combines quantum clocks and Einstein's relativity', and 20 other news outlets.

6. Gravitational waves affect vacuum entanglement
   Qidong Xu, Shadi Ali Ahmad, **Alexander R. H. Smith**
   Physical Review D 102, 065019 (2020)

7. Anti-Hawking phenomena
   Laura J. Henderson, Robie A. Hennigar, Robert B. Mann, **Alexander R. H. Smith**, and Jialin Zhang
   Physics Letters B 135732 (2020)

8. Quantizing time: Interacting clocks and systems
   Alexander R. H. Smith and Mehdi Ahmadi
   Quantum 3, 160 (2019)

   – Perspective written on this article appeared in Quantum Views 3, 16 (2019)

9. Quantum satellites and tests of relativity
   Piergiovanni Magnani, Matteo Schiavon, **Alexander R. H. Smith**, Daniel R. Terno, Giuseppe Vallone, Francesco Vedovato, Paolo Villoresi, and Sai Vinjanampathy
   15th Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics, and Relativistic Field Theories, arXiv:1906.04415 [quant-ph] (2019)

10. Entangling detectors in anti-de Sitter space
    Laura J. Henderson, Robie A. Hennigar, Robert B. Mann, **Alexander R. H. Smith**, and Jialin Zhang
    Journal of High Energy Physics 178 (2019)

11. Communicating without shared reference frames
Alexander R. H. Smith
Physical Review A 99, 052315 (2019)

12. Detectors, Reference Frames, and Time
Alexander R. H. Smith
Springer Theses (Springer International Publishing, 2019)

13. Harvesting entanglement from the black hole vacuum
Laura J. Henderson, Robie A. Hennigar, Robert B. Mann, **Alexander R. H. Smith**, and Jialin Zhang
Classical and Quantum Gravity Letters 35, 21LT02 (2018)

14. Massive Unruh particles cannot be directly observed
Filip Kiałka, **Alexander R. H. Smith**, Mehdi Ahmadi, and Andrzej Dragan
Physical Review D 97, 065010 (2018)

    – Featured in $N+1$ internet publication (2018)

15. Quantum reference frames associated with noncompact groups: The case of translations and boosts, and the role of mass
Alexander R. H. Smith, Marco Piani, and Robert B. Mann
Physical Review A 94, 012333 (2016)

16. Effect of gravity on localized two-mode Gaussian quantum states
Mehdi Ahmadi, Krzysztof Lorek, Agata Chęcińska, **Alexander R. H. Smith**, Robert B. Mann, and Andrzej Dragan
Physical Review D 92, 124031 (2016)

17. Spacetime structure and vacuum entanglement
Eduardo Martín-Martínez, **Alexander R. H. Smith**, and Daniel R. Terno
Physical Review D 93, 044001 (2016)

    *Note alphabetical order of authors; Smith was the lead investigator.

18. Communication between inertial observers with partially correlated reference frames
Mehdi Ahmadi, **Alexander R. H. Smith**, and Andrzej Dragan
Physical Review A 92, 062319 (2015)

19. Post-Newtonian gravitational effects in optical interferometry
Aharon Brodutch, Alexei Gilchrist, Thomas Guff, **Alexander R. H. Smith**, and Daniel R. Terno
Physical Review D 91, 064041 (2015)

    *Note alphabetical order of authors; Smith and Terno were the lead investigators.

20. Looking inside a black hole
Alexander R. H. Smith and Robert B. Mann
Classical and Quantum Gravity 31, 082001 (2014)

    – International media coverage in Spektrum, *Hinterm Horizont geht's weiter?* (2016)

    – Featured in Classical and Quantum Gravity Plus, *Black hole voyeurism* (2014)

21. Persistence of Tripartite Nonlocality for Non-inertial Observers
Alexander R. H. Smith and Robert B. Mann
Physical Review A 86, 012306 (2012)

Preprints

Quantum Relativity of Subsystems
Philipp A. Höhn, Maximilian P. E. Lock, Shadi Ali Ahmad, **Alexander R. H. Smith**, Thomas D. Galley
arXiv:2103.01232 [quant-ph] (2021)

Other articles and publications

Quantum time dilation: A new test of relativistic quantum theory
Alexander R. H. Smith
arXiv:2004.10810 [quant-ph] (2020)

Proposal for an Optical Test of the Einstein Equivalence Principle
Daniel R. Terno, Francesco Vedovato, Matteo Schiavon, **Alexander R. H. Smith**, Piergiovanni Magnani, Giuseppe Vallone, Paolo Villoresi
arXiv:1811.04835 [gr-qc] (2018)

Decoherence resulting from the gravitational interaction between two quantum objects
Jack Davis, Robert B. Mann, and **Alexander R. H. Smith**
Physics in Canada Magazine 73, 4 (2017)

Presentations

Invited talks

1. *Relational quantum dynamics and quantum time dilation*
   Workshop on "Time in Quantum Theory"
   ETH Zürich, Switzerland (2021)

2. *Relational quantum dynamics and quantum time dilation*
   Workshop on "Quantum Foundations, Gravity, and Causal Order"
   Banff International Research Station, Canada (2021)

3. *Relational quantum dynamics and quantum time dilation*
   Seminar at the Collaborative Research Center 1227 - Designed Quantum States of Matter
   Leibniz Universität, Hannover, Germany (2021)

4. *Quantum time dilation*
   International Relativistic Quantum Information - North
   University of Waterloo, Canada (2021)

5. *Relational dynamics and quantum time dilation*
   The Polish Academy of Science, Warsaw, Poland (2020)

6. *The trinity of relational quantum dynamics*
   Frontiers of quantum physics seminar, Department of Physics,
   University of Oxford, Oxford, U.K. (2020)

7. *Quantum time dilation*
   Quantum science seminar, Quantum Science & Technology Institute
   University College London, London, U.K. (2020)

8. *Relativistic quantum time dilation: A new test of quantum theory*
   Colloquium, Department of Physics and Astronomy
   Saint Anselm College, Manchester, USA (2020)

9. *What happens when we quantize time?*
   Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical Physics (ITAMP)
   Harvard University, Cambridge, USA (2020)

10. *What happens when we quantize time?*
    Indefinite Causal Structure Workshop
    Perimeter Institute for Theoretical Physics, Waterloo, Canada (2019)

11. *Quantum clocks, conditional probabilities, and probabilistic time dilation*
    Institute for Quantum Optics and Quantum Information - Vienna
    Austrian Academy of Sciences, Vienna, Austria (2019)

12. *Quantizing time*
    Physics and Astronomy Colloquium
    Dartmouth College, Hanover USA (2018)

13. *Quantizing time: General total Hamiltonians in the conditional probability interpretation of time*
    University of Warsaw, Warsaw, Poland (2017)

14. *Quantizing time: General total Hamiltonians in the conditional probability interpretation of time*
    University of Strathclyde, Glasgow, Scotland (2017)

15. *Tools for relativistic quantum reference frames*
    University of Calgary, Calgary, Canada (2016)

16. *Relativistic quantum reference frames*
    University of Vienna, Vienna, Austria (2016)

17. *Relativistic quantum reference frames*
    University of Strathclyde, Glasgow, Scotland (2016)

18. *Spacetime topology and quantum field theory*
    University of Warsaw, Warsaw, Poland (2015)

19. *Inside a black hole*
    Faculty winner and University finalist in the 3 Minute Thesis (3MT) competition
    University of Waterloo, Waterloo, Canada (2014)

Conference presentations

1. *Quantum time dilation and temporal nonlocality*
   American Physical Society April Meeting
   Held Virtually, (2020)

2. *Relativistic quantum clocks*
   The Time Machine Factory
   University of Turin, Turin, Italy (2019)

3. *Quantum clocks in Minkowski space*
   Second Hermann Minkowski Meeting on the Foundations of Spacetime Physics
   Albena, Bulgaria (2019)

4. *Quantum Clocks: Gravitation and Relativity*
   American Physical Society March Meeting
   Boston, USA (2019)

5. *Quantizing Time: Interacting Clocks and Systems*
   International Relativistic Quantum Information - North
   University of Vienna, Vienna, Austria (2018)

6. *How spacetime structure affects field entanglement*
   International YQIS
   University of Vienna, Vienna, Austria (2018)

7. *Quantizing Time: Interacting Clocks and Systems*
   Foundations 2018
   Utrecht University, Utrecht, Netherlands (2018)

8. *Time from Quantum Correlations*
   Gravity in the Quantum Regime
   Dartmouth College, Hanover, USA (2018)

9. *Interacting Clocks within the Conditional Probability Interpretation of Time*
   27th Midwest General Relativity Meeting
   University of Michigan, Ann Arbor, United States (2017)

10. *Spacetime Structure and Vacuum Entanglement*
    26th Midwest General Relativity Meeting
    Perimeter Institute for Theoretical Physics, Waterloo, Canada (2016)

11. *Time in Quantum Mechanics*
    "Gong Show" at the It from Qubit Workshop
    Perimeter Institute for Theoretical Physics, Waterloo, Canada (2016)

12. *Tools for relativistic quantum reference frames*
    Relativistic Quantum Information - North
    Institute of Quantum Computing, Waterloo, Canada (2016)

13. *Tools for relativistic quantum reference frames*
    Canadian Association of Physicists Congress
    University of Ottawa, Ottawa, Canada (2016)

14. *Quantum frames of reference and relativity*
    Rethinking Foundations of Physics Workshop
    Dorfgastein, Austria (2016)

15. *Quantum reference frames*
    9th Relativistic Quantum Information Workshop
    Customs House, Brisbane, Australia (2015)

16. *Spacetime structure and vacuum entanglement*
    International Relativistic Quantum Information - North
    Dartmouth College, Hanover, USA (2015)

17. *Inside a black hole: detectors as topological probes*
    International Relativistic Quantum Information - North
    University of Seoul, Seoul, Korea (2014)

18. *Detectors as topological probes*
    Canadian Association of Physicists Congress
    Laurentian University, Sudbury, Canada (2014)

19. *Modelling 2D illumination patterns on a triple junction solar cell*
    Canadian Undergraduate Physics Conference
    University of Dalhousie, Halifax, Canada (2010)

Other presentations

1. *Panel discussion on the future of indefinite causal structure*
   Perimeter Institute for Theoretical Physics, Waterloo, Canada (2019)

2. *The structure of reality: information, relativity, and the quantum*
   Dartmouth College, Hanover, USA (2018)

3. *Panel discussion on graduate studies in physics*
   with Carolyn Earnest, Ali Ramadha, Jennifer Reid, Allison Sachs, and Paulina Ugalde
   University of Waterloo, Waterloo, Canada (2016)

4. *Relativistic quantum information*
   Macquarie Physics Department Jam Session
   Macquarie University, Sydney, Australia (2015)

5. *Vacuum entanglement and spacetime structure*
   Poster presentation
   Macquarie University, Sydney, Australia (2015)

6. *Entanglement in non-inertial reference frames*
   Poster presentation
   University of Waterloo, Waterloo, Canada (2012)

Teaching Experience

Instructor of record

Quantum Mechanics, Saint Anselm College 2021

– A junior level course that introduces students to an axiomatic formulation of quantum mechanics and examines photons, spin-1/2 particles, the harmonic oscillator and hydrogen atom. Students perform five quantum optic experiments, which include observing single photon interference and violating a Bell inequality by preparing and measuring entangled photons.

Classical Mechanics, Saint Anselm College 2020, 2021

– A junior level course that introduces students to the study of Newton's laws in different coordinate systems, drag forces, damped-driven harmonic motion, and the phenomena of resonance. The principle of least action and Lagrangian mechanics are studied in detail.

Calculus-Based Physics I and II, Saint Anselm College 2020, 2021

– A two semester freshman course that surveys Newtonian mechanics in three dimensions, momentum and impulse, energy and power, gravity, fluid mechanics, harmonic motion, waves, sound, and electrostatics. A guided discovery laboratory curriculum was implemented using iOLab data acquisition devices.

Introductory Mathematical Methods for Physicists, Dartmouth College 2019, 2020

– Designed and taught a new course in the Department of Physics and Astronomy that introduced undergraduate students to linear algebra and the study of differential equations from the perspective of a physicist with a focus on applications.

Researcher supervision

Undergraduate research supervision, Dartmouth College 2019 - present

– Currently supervising an undergraduate researcher in the completion of a project in the area of quantum thermodynamics, which involves the student applying a mix of analytic and computational techniques. The same student has already published two papers on related topics under my supervision.

Graduate research supervision, Dartmouth College 2019 - present

– Supervised a graduate researcher in the completion of a project examining how gravitational waves affect quantum field correlations, which results in a peer reviewed publication.

Co-supervisor of undergraduate researcher, University of Waterloo 2016 - 2017

– Co-supervised an undergraduate researcher in completion of their undergraduate thesis titled: *Quantum Reference Frames and the Three Body Problem.* The student went on to win best student poster at the Canadian Association of Physicists Congress in 2017 and we published an article in Physics Canada Magazine based on their work.

Co-supervisor of undergraduate researcher, University of Waterloo 2013 - 2014

– Co-supervised an undergraduate researcher in completion of their undergraduate thesis titled: *An Unruh-Dewitt detector orbiting around a stationary BTZ black hole.*

Other teaching activities

Guest Lecturer, Dartmouth College 2019

– Invited talk about the emergence of time in quantum gravity for students enrolled in *Philosophy of Time & Time Travel*, offered by the Dartmouth Philosophy Department.

Teaching Assistant, University of Waterloo 2013 - 2014, 2016 - 2017

– Assisted teaching Physics for Engineers, Quantum Mechanics I, and Quantum Mechanics II. Responsibilities including leading tutorials, marking assignments, and proctoring and marking exams.

Lab Instructor, University of Waterloo 2012 - 2013

– Ran first year physics labs for physics students, which included giving a 30 minute weekly lecture, supervising student experiments, and marking lab reports.

Lab Instructor, University of Toronto 2011 - 2012

– Led a two hour laboratory twice a week for first year physics and engineering students. My weekly responsibilities included: two 40 minute lectures, supervising student experiments, and marking lab reports.

Awards, Scholarships, and Grants

Major awards

$10,000	Society of Fellows Venture Funding Awarded by Dartmouth College based on research performance	2019 - 2020
$167,000	Junior Fellowship in the Society of Fellows, Dartmouth College Awarded by Dartmouth College	2017 - 2021
$90,000	NSERC Postdoctoral Fellowship Awarded by the Canadian Government based on research performance and leadership	2017 - 2019
$15,000	Ontario Graduate Scholarship Awarded by the Ontario provincial government based on research performance	2016 - 2017
$25,400	International Macquarie University Research Excellence Scholarship Awarded internationally by Macquarie University based on research and academic performance	2014 - 2015

$15,000	Ontario Graduate Scholarship Awarded by the Ontario provincial government based on research performance	2012 - 2013
$10,000	President's Graduate Scholarship Awarded by the University of Waterloo based on research performance	2012 - 2013
$20,000	University of Toronto Research Grant Awarded by the University of Toronto based on research performance	2011 - 2012

Minor awards

$500	Springer Theses, Recognizing Outstanding Ph.D. Research Awarded by Springer Publishing upon publication of PhD thesis	2019
$5,000	President's Graduate Scholarship Awarded by the University of Waterloo based on research performance	2016 - 2017
$2,500	International Experience Award Awarded by the University of Waterloo to students who are traveling internationally based on academic and research performance	2017
$2,600	Marie Curie Graduate Student Award Awarded by the University of Waterloo Department of Physics & Astronomy based on research performance	2016
$3,750	UW Graduate Scholarship Awarded by the University of Waterloo based on academic and research performance	2016
$3,750	Post Graduate Research Award Awarded by Macquarie University based on research performance	2015
$2,500	Governor General David Johnson International Experience Award Awarded by the University of Waterloo to students who are studying internationally based on academic and research performance	2014
$5,600	Marie Curie Graduate Student Award Awarded by the University of Waterloo Department of Physics & Astronomy based on research performance	2013 - 2014
$6,275	Science Graduate Experience Award Awarded by the University of Waterloo Faculty of Science based on teaching responsibility	2012 - 2013
$3,000	University of Waterloo Graduate Entrance Scholarship Awarded by the University of Waterloo based on academic performance	2012 - 2013

$3,000	University of Toronto Admission Award Awarded by the University of Toronto based on academic performance	2011 - 2012
$1,000	University of Waterloo Merit Scholarship Awarded by the University of Waterloo based on academic performance	2006 - 2007

Other awards

Awarded trusted reviewer status by the Institute of Physics (IOP) 2020

Runner-up in the Canadian Association of Physicists, Division of Theoretical Physics, Thesis Competition 2018

Nominated for the Governor General's Gold Medal, University of Waterloo, on behalf of the Government of Canada 2017

Nominated for the W.B. Pearson Medal for best PhD Thesis, University of Waterloo 2017

2nd place in the theory division of the Canadian Association of Physicists student oral presentation competition, Canadian Association of Physics Congress, Ottawa, Canada 2016

3 Minute Thesis (3MT) Science Faculty winner and University of Waterloo finalist 2014

Service and Leadership

Conference organization

Quantizing Time, Perimeter Institute, Canada 2021

– Co-organizer of Quantizing Time Conference, the aim which is to discuss the full consequences of treating time as a quantum phenomena in light of the recent progress on information-theoretic and operational descriptions of time as quantum observable.

Gravity in the Quantum Regime, Dartmouth College, USA 2018

– Organizer of the Gravity in the Quantum Regime workshop, which focused on conceptual technical issues at the intersection of quantum theory and gravitational physics.

Quantum Frontiers, Dartmouth College, USA 2018

– Organizer of the Quantum Frontiers workshop, which brought together a group of researchers working on wide range of topics in quantum information science.

Spacetime and Information Workshop, Manitoulin Island, Canada 2017

– Co-organizer of the international Spacetime and Information Workshop, which brought together young researchers from around the world (Canada, USA, Australia, Austria, United Kingdom, and China) working on relativistic quantum information, and related areas, to discuss recent developments in the field and work on open problems.

International Relativistic Quantum Information - North Conference, University of Waterloo 2016

– Member of the organizing committee for 2016 International Relativistic Quantum Information - North Conference, held at the Institute for Quantum Computing, Waterloo, Canada.

Referee duties

Referee 4-5 articles per year for the following journals: Physical Review Letters (American Physical Society), Nature Communications (Springer Nature), Communication Physics (Springer Nature), Quantum, njp Quantum Information (Springer Nature), Science Advances (AAAS), Journal of High Energy Physics (Springer) Physical Review A (American Physical Society), Quantum Information Processing (Springer), Foundations of Physics (Springer Nature), Classical and Quantum Gravity (IOP Publishing), and the Canadian Journal of Physics (Canadian Science Publishing).

Group organization

Reading group, University of Waterloo, Canada 2016 - 2017

– Founded a pedagogical reading group for senior graduate students and professors focused on topics in canonical quantum gravity.

Journal club, University of Toronto, Canada 2011 - 2012

– Founded a journal club focusing on articles addressing quantum foundations and the philosophy of science.

Other service

Advisory committee for the Center for Teaching Excellence, Saint Anselm College, USA 2020 - 2021

Served as member of an undergraduate thesis committee, Dartmouth College, USA 2019

Scientific Outreach

Physics Colloquium Series, Saint Anselm College, USA 2021 - present

– Founded the Physics Colloquium, which highlights the discoveries and novel technologies being pursued by physicists today to the entire Saint Anselm community by inviting leading scientists to speak with students, faculty, and staff three times a semester.

Watch party and discussion session, Saint Anselm College, USA 2020

– Organized a watch party for students, faculty, and staff to view live a lecture by Dr. Sean Carroll titled 'The Many Worlds of Quantum Mechanics', which was followed by a discussion session.

Public lecture host, Dartmouth College, Hanover, USA 2018

– Organized and hosted a public lecture given by Professor Andrzej Dragan from the University of Warsaw titled: Quantum Theory versus Common Sense.

Participant in panel discussion, University of Waterloo, Waterloo, Canada 2016

– Discussed the realities of pursuing graduate studies in physics with several other graduate students for an audience of undergraduate students.

Science fair judge, Waterloo-Wellington Science and Engineering Fair, Waterloo, Canada 2014, 2016

– Judged and provided constructive feedback for both elementary and high school student science fair projects.

Presenter, Macquarie University Physics Jam, Sydney, Australia 2015

– Presented my current research with the aim of showcasing the research interests of the Macquarie University Physics and Astronomy Department to prospective graduate students.

Volunteer scientist, BrainSTEM exhibition, Perimeter Institute, Waterloo, Canada 2013

- Explained the science behind new and novel technologies to the public at the BrainSTEM exhibition held at the Perimeter Institute for Theoretical Physics.

Mentor, International Summer School for Young Physicists, Perimeter Institute, Waterloo, Canada 2013

- Mentored high school students from around the world who came to the Perimeter Institute for Theoretical Physics for an intensive two week summer camp focused on physics.

Professional Development

Workshop on Gaps in Postsecondary Quantum Education and Training, Laboratory for Physical Sciences and the Qubit Collaboratory. 2021

Broadening Participation: Mathematical and Physical Sciences Workshop for Young Investigators, University of Florida and the National Science Foundation 2021

Institutional Review Board Member training, CITI Program 2021

Social and Behavioral Responsible Conduct of Research, CITI Program 2021

Faculty LGBTQ+ Workshop 100: Foundations for Awareness, Saint Anselm College, USA 2021

Bard Summer School on Quantum Gravity, Bard College, Annandale-on-Hudson, USA 2019

Kresge's Writer's Retreat, Dartmouth College, Hanover, USA 2018

DCAL Future Faculty Program, Dartmouth College, Hanover, USA 2018

Fundamentals of University Teaching Program, University of Waterloo, Waterloo, Canada 2017

It from Qubit Summer School, Perimeter Institute, Waterloo, Canada 2016

Writing Research Proposals Workshop, Macquarie University, Sydney, Australia 2015

Physics Teaching Assistant Workshop, University of Waterloo, Waterloo, Canada 2012

Academic Integrity Workshop, University of Waterloo, Waterloo, Canada 2012

Physics Undergraduate Teaching Workshop, University of Toronto, Toronto, Canada 2011