Shelby Kimmel

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Education

2009-2014   **Massachusetts Institute of Technology (MIT),** Cambridge, MA
Ph.D. in Physics. Advised by Edward Farhi. GPA 5.0/5.0
Thesis Title: Cumulative Effects in Quantum Algorithms and Quantum Process Tomography

2004-2008   **Williams College**, Williamstown, MA
B.A. in Astrophysics. Advised by William Wootters. GPA 3.96/4.0
Thesis Title: Quantifying the Entanglement Cost of Nonlocal Measurements.

Research Experience

2014-present   **Hartree Postdoctoral Fellow at the Joint Center for Quantum Information and Computer Science (QuICS), University of Maryland.** *College Park, MD.*

- With QuICS postdoc Bill Fefferman, proved an oracle separation between QMA and QCMA (two quantum versions of NP).

- With QuICS fellow Yi-Kai Liu, combined compressed sensing with robust process tomography to create a new efficient and accurate process characterization procedure.

- With Caltech postdoc Stacey Jeffery, explored the connection between quantum algorithms for formula evaluation problems and graph connectivity

- With Sandia National Labs researcher Kenneth Rudinger, analyzed new techniques for architecture-independent process tomography

- With QuICS postdoc Cedric Lin and others, created procedures for simulating quantum Hamiltonians given a quantum description of the Hamiltonian.

- With Berkeley postdoc Henry Yuen and others, investigated a triply quantum version of the complexity class NP (with a quantum problem, quantum verifier, and a quantum proof).

- With U. Sydney postdoc Chris Granade, created a procedure to accurately characterize quantum states without well-characterized measurements.

2009-2014   **Center for Theoretical Physics, MIT**. *Cambridge, MA.*
Advised by Edward Farhi

- Created quantum algorithms for classes of Boolean formula evaluation problems and quantum satisfiability problems.

- Created a technique for non-constructively proving the existence of a quantum algorithm; using it, you can determine an algorithm with certain properties must exist, but might not know what the algorithm is.

Summers, 2012, 2013	**Raytheon BBN Technologies.** *Cambridge, MA.* Advised by Marcus P. da Silva

- Designed and analyzed new procedures for robust quantum process characterization.
- Implemented procedures on a superconducting qubit system and analyzed the results of experiments using MATLAB.

Summer, 2011	**Institute for Quantum Computing at the University of Waterloo.** *Waterloo, ON.* Advised by Andrew Childs

- Developed quantum algorithms for Boolean formulas using quantum search subroutines.
- Studied semi-definite programs that characterize query complexity.

2007-2008	**Williams College.** *Williamstown, MA.* Advised by William Wootters

- Studied the entanglement resources needed to perform measurements on a quantum state shared by two separated parties.

Teaching

Fall 2016	**Co-Teacher, Introduction to Quantum Information Processing,** *University of Maryland, College Park, MD*

- Taught 12 hours of lecture to 40 first-year graduate physics and computer science students.
- Incorporated active learning exercises.
- Organized peer editing system for project paper to encourage students to refine their writing.

Fall 2016	**Discussion Section Teacher, Object Oriented Programming,** *University of Maryland, College Park, MD*

- Taught Java to 40 undergraduate students for 2 hours a week
- Classes included a mix of short lectures, small group discussions, and coding activities

Springs 2012, 2014	**Writing Assistant, Undergraduate Quantum Mechanics,** *MIT, Cambridge, MA*

- Guided ~15 students through the process of writing an academic style research report on a topic of the student's choosing within quantum mechanics.
- Led peer-review meetings where students critiqued each other's work in a supportive environment

Spring 2011	**Teaching Assistant, Undergraduate First Year Electricity and Magnetism,** *MIT, Cambridge, MA*

- Taught weekly problem solving sessions to 45 students.
- Participated in active learning lessons three times a week, leading students through concept questions and experiments.

2010-2011   **Graduate Teaching Certificate Program,** *MIT, Cambridge, MA*
- Attended 8 workshops on pedagogy, curriculum planning, and classroom best practices, and gave a lecture that was critiqued by the class and instructor.

2010-2013   **Middle School Tutor for Tutoring Plus**, *Cambridge MA*
- Worked with one student for an hour a week over the course of the school year to help him with essays, math homework, and the development of critical reading skills.

2008-2009   **Fulbright Korea: English Teaching Assistant.** *Gochangbuk High School, Gochang, S. Korea*
- Planned and taught lessons in conversational English at a rural Korean high school and middle school to ~500 students a week

2005-2008   **Writing Tutor.** *Williams College, Williamstown, MA.*
- Worked one-on-one with ~4 different undergrads a week to help them brainstorm, organize and edit papers.

Advising

Summer 2016   **Undergraduate Research Advising,** *University of Maryland, College Park, MD*
- Advised Andrew Zhao on a project researching whether compressed sensing techniques can be used to achieve Heisenberg scaling in phase estimation of quantum unitaries.

Spring 2016   **Undergraduate Research Advising,** *University of Maryland, College Park, MD*
- Advised two students, Andrew Zhao and Mark Hubbert, on a project studying optimal cost strategies for quantum tomography schemes. The students studied the problem analytically and numerically, and won 3rd prize in a physics department undergraduate poster contest.

Summer 2015   **Undergraduate Research Advising,** *University of Maryland, College Park, MD*
- Advised (with Prof. Andrew Childs) Hardik Bansal, on a project to find optimal ways of measuring a quantum state shared between two physically separated parties.

2014-present   **Women in Physics Mentoring Program,** *University of Maryland, College Park, MD.*
- Participated in a mentoring group that included an undergraduate woman and a graduate woman in physics.

2009-2014   **Women in Physics Mentoring Program,** *MIT, Cambridge MA*
- Coordinated graduate/undergraduate women in physics mentoring program with undergraduate co-leader.
- Mentored 2 undergraduate women each year. Discussed finding research advisors, time management, and applying to graduate school.
- Organized a networking seminar

Leadership

Summer 2016   **Co-organizer, Workshop on QMA(2) and the Complexity of Entanglement,** *University of Maryland, College Park, MD.*

- Planned a small, highly specialized workshop in the field of quantum complexity theory. Responsibilities included deciding on scope, format, and attendees; maintaining the website; chairing sessions; and communicating logistics to attendees.

2010-2012   **Graduate Women at MIT (GWAMIT).** *MIT, Cambridge, MA*

- Co-organized mentoring program for graduate women. Helped to recruit 200 alumni, professors, and graduate students to the program, matched participants through surveys, managed a committee of 8 people, and planned bi-yearly dinners.
- Arranged speakers, advertised, and hosted the Online Personal Branding Event at the GWAMIT Empowerment Conference (2010)
- Informed the MIT Women in Physics group of various GWAMIT events as the GWAMIT physics liaison.

Awards

2014   Hartree Postdoctoral Fellow, QuICS

2013   Graduate Women of Excellence Award (1 of 50), MIT.

2012   Best Student Paper Track A (1 of 2), ICALP. (For "Quantum Adversary (Upper) Bound.")

2012   Best Scientific Poster (1 of 2), QIP. (For "The Quantum Query Complexity of Read-Many Formulas.")

2011   Best Talk (1 of 3) Women in Physics Canada.

2009   American Physical Society Apker Award Finalist (national award for undergraduate research; 1 of 3)

Selected Talks

2016   Schrodinger Sessions (a workshop to introduce quantum mechanics to science fiction writers). College Park, MD. "Quantum Algorithms."

2016   Last Frontiers in Quantum Information Workshop. Juneau, AK. "Turning States Into Unitaries: Optimal Sample-Based Hamiltonian Simulation."

2015   Sandia National Labs. Robust Phase Estimation with Applications to Single-Qubit Process Characterization.

2014   Williams College. Williamstown, MA. "Problems with Multiple Oracles."

2014   APS March Meeting, Invited Talk. Denver, CO. "Randomized Benchmarking Tomography."

2013   Coogee Quantum Information Conference. Sydney, AU. "Problems with Multiple Oracles."

2013   Isaac Newton Institute, Cambridge, UK. "Robust Characterization of Quantum Processes."

2013   Perimeter Institute. Waterloo, Canada "The Quantum Adversary (Upper) Bound."

2012   UC Berkeley. "The Quantum Query Complexity of Read Many Formulas."

2011   Women in Physics Canada. Waterloo, Canada. "Super-polynomial Quantum Speed-ups in Boolean Formulas."

Skills

- Matlab, Mathematica: very experienced
- Java, Julia, Python, html, CSS: proficient

Professional Service

- Referee for Nature Communications

- Program Committee for Asian Quantum Information Science conference

- Referee for Theory of Computing

- Referee for Theory of Quantum Computing conference

- Referee for Quantum Information and Computation

- Sorter for the American Physical Society March Meeting

- Referee for Symposium on Theoretical Aspects of Computer Science

- Referee for European Symposium on Algorithms

- Referee for International Journal of Quantum Information

- Referee for Symposium on Discrete Algorithms

Publications

- **S. Kimmel**, C. Y. Y. Lin, G. H. Low, M. Ozols, T. J. Yoder. Hamiltonian Simulation with Optimal Sample Complexity. Arxiv:1608.00281. (Accepted for talk at TQC 2016)

- E. Farhi, **S. Kimmel,** K. Temme. A Quantum Version of Schöning's Algorithm Applied to Quantum 2-SAT. Arxiv:1603.06985. (Accepted to Quantum Information and Computing.)

- S. Jeffery. **S. Kimmel.** NAND-trees, Average Choice Complexity, and Effective Resistance. Arxiv:1511.02235

- B. Fefferman, **S. Kimmel.** Quantum vs Classical Proofs and Subset Verification. Arxiv:1510.06750.

- **S. Kimmel,** Y.-K. Liu. Quantum Compressed Sensing Using 2-Designs.

Arxiv:1510.08887.

- **S. Kimmel,** C. Y. Y. Lin, H. H. Lin. Oracles with Costs. *Proceedings of Theory of Quantum Computing 2015*. pp 1-26. Arxiv:1502.02174

- B. R. Johnson, M. P. da Silva, C. A. Ryan, **S. Kimmel**, J. M. Chow, T. A. Ohki. Demonstration of Robust Quantum Gate Tomography via Randomized Benchmarking. New Journal of Physics 17 (11), 113019. 2015.

- **S. Kimmel,** G. H. Low, T. J. Yoder. Robust calibration of a universal single-qubit gate set via robust phase estimation. *Phys. Rev. A* 92 (6), 062315.

- **S. Kimmel,** M. P. da Silva, C. Ryan, B. Johnson, T, Ohki. Robust Extraction of Tomographic Information via Randomized Benchmarking. In *Physical Review X*, 2014, vol 4, n 1, pp 011050.

- A. M. Childs, **S. Kimmel**, R. Kothari. The Quantum Query Complexity of Read-Many Formulas. *Proceedings of ESA 2013*, pp 337-348.

- **S. Kimmel.** Quantum Adversary (Upper) Bound. *Chicago Journal of Theoretical Computer Science*, vol 2013 n 4. And *Proceedings of ICALP*. 2012 pp 557-568.

- B. Zhan, **S. Kimmel**, A. Hassidim. Super-polynomial Quantum Speed-ups for Boolean Evaluation Trees with Hidden Structure. *Proceedings of ITCS*, pp 249-265. 2012

- S. Bandyopadhyay, G. Brassard, **S. Kimmel**, W. Wootters. Entanglement Cost of Nonlocal Measurements. *Phys. Rev. A*. vol 80, n 1, pp 012313, 2009.

- J. Pasachoff, **S. Kimmel**, M. Druckmuller, V. Rusin, M. Saniga. The April 8, 2005 Eclipse White-light Corona. *Solar Physics*. vol 238, n 2, pp 261-270, 2006.