

# Shelby Kimmel

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University of Maryland - QuICS

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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.*
- Started new collaborations: with QuICS postdoctoral fellow Bill Fefferman, I proved an oracle separation between QMA and QCMA; with QuICS fellow Yi-Kai Liu, I looked at combining compressed sensing with robust process tomography; with QuICS fellow Stephen Jordan, I analyzed a Rabi-flopping inspired algorithm for triangle finding; with Caltech postdoc Stacey Jeffery, I studied the connection between quantum algorithms for formula evaluation problems and graph connectivity; with Sandia researchers Robin Blume-Kohout and Kenneth Rudinger, I investigated new techniques for architecture independent process tomography.
- 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, **Raytheon BBN Technologies.** *Cambridge, MA.*
- 2012, 2013 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.

2008 **Williams College.** *Williamstown, MA.*

Advised by William Wootters

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

## Teaching and Research Mentorship

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 both analytically and numerically, and won 3<sup>rd</sup> prize in an physics department-wide undergraduate poster contest.

2015 **Undergraduate Research Advising,** *University of Maryland, College Park, MD*

- Advised (with Prof. Andrew Childs) Hardik Bansal, an undergraduate student on a research project I designed on measuring a quantum state shared between two physically separated parties. I met frequently with the student to discuss his progress and suggest next steps.

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

- 2014
- 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.

## Leadership and Service

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

- 2015 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 APS March Meeting. Baltimore, MD. Robust, Universal-Single-Qubit-Gate-Set Calibration via Robust Phase Estimation.
- 2015 Caltech. Robust Phase Estimation with Applications to Single-Qubit Process Characterization.
- 2015 Sandia National Labs. Robust Phase Estimation with Applications to Single-Qubit Process Characterization.
- 2014 Williams College. Problems with Multiple Oracles.
- 2014 APS March Meeting. 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. The Quantum Adversary (Upper) Bound.
- 2012 UC Berkeley. The Quantum Query Complexity of Read Many Formulas.
- 2011 University of Waterloo. Super-polynomial Quantum Speed-ups in Boolean Formulas.
- 2011 Women in Physics Canada. Super-polynomial Quantum Speed-ups in Boolean Formulas.

## Posters

- 2015 QuICS Frontiers of Quantum Information and Computer Science Workshop. “Quantum vs. Classical Proofs and Subset State Verification” (with Bill Fefferman).
- 2015 QIP (Quantum Information Processing Workshop). “Oracles with Costs” (with Cedric Lin and Han-Hsuan Lin).
- 2014 Fields Institute Quantum Optimization Workshop. “Oracles with Costs” (with Cedric Lin and Han-Hsuan Lin).
- 2013 Fields Institute Workshop on Mathematical Methods of Quantum Tomography. “Beyond Randomized Clifford Benchmarking” (with Marcus da Silva).
- 2013 QIP. “Beyond Randomized Clifford Benchmarking” (with Marcus da Silva).
- 2012 QIP. “The Quantum Query Complexity of Read-Many Formulas” (with Robin Kothari and Andrew Childs).

## Skills

### Computing Languages:

- Matlab and Mathematica, very experienced
- Java, Julia and Python, 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

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