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, 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.

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

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 both 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, an undergraduate student on a research project I designed on measuring a quantum state shared between two physically separated parties.

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.

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

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, 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.