

# ADAM BOULAND

## POSTDOCTORAL RESEARCHER, COMPUTER SCIENCE

University of California at Berkeley  
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### INTERESTS

Quantum computation, computational complexity theory, and connections with physics.

### EDUCATION

**Massachusetts Institute of Technology**, Cambridge, MA

Ph.D. in Computer Science, September 2017

Thesis title: The Space Around BQP

Advisor: Scott Aaronson, GPA: 5.0/5.0

**University of Cambridge**, Cambridge, UK

M.Phil. in Advanced Computer Science, 2011 (Advisor: Anuj Dawar)

M.A.St. in Mathematics, 2010

**Yale University**, New Haven, CT

B.S. Computer Science & Mathematics, Physics, 2009

*Summa Cum Laude*, Distinction in Both Majors, GPA: 4.0/4.0

### AWARDS

**NSF Graduate Research Fellowship**, 2011-2016

**Marshall Scholar**, UK Government, 2009-2011

**George J. Schulz Prize**, Yale Physics Department, 2009

**Deforest Prize**, Yale Mathematics Department, 2009

**Howard L. Schulz Prize**, Silliman College, Yale, 2009

**Senior High Scholarship Award**, Yale Science and Engineering Association, 2009

**Junior High Scholarship Award**, Yale Science and Engineering Association, 2008

**Barry M. Goldwater Scholar**, US Government, 2008

**Junior Inductee into Phi Beta Kappa**, Yale Chapter, 2007

**Member**, Johns Hopkins Study of Exceptional Talent

### POSITIONS

**Postdoctoral Researcher**, Theory Group, Dept. of EECS, UC Berkeley, Sept. 2017-Present  
Research in quantum computational complexity theory. Advised by Umesh Vazirani.

**Research Visitor:** U. Bristol, Aug. 2016 (Host: Ashley Montanaro), Tokyo Institute of Technology, Dec. 2016 (Host: Tomoyuki Morimae), Joint Center for Quantum Information and Computer Science (QuICS), University of Maryland, Aug. 2016 (Host: Stephen Jordan), Centre for Quantum Technologies (CQT), Singapore, Jan.-Apr. 2014, Jun.-Aug. 2015 (Host: Miklos Santha).

**Undergraduate Research in Algorithms**, Yale University, 2009

Designed algorithms to improve multi-way sparse cuts in graphs. Advised by Daniel Spielman.

**Undergraduate Cosmology Research**, Yale, Stanford, 2008-2009

Created software to analyze cosmic microwave background anisotropies and galaxy cluster surveys. Advised by Richard Easther (Yale) and Risa Wechsler (Stanford).

## TEACHING

**Mentor**, MIT SPUR and UROP programs for undergraduate research, Summers 2012, 2013, 2014 and subsequent semesters. Mentored undergraduate students on research projects in theoretical computer science and theoretical physics. Projects resulted in three publications. Students and projects included:

- Xue Zhang: Quantum Computing with Commuting Gate Sets (Summer 2014-Spring 2015)
- Mitchell Lee: Quantum Computing with Hidden Variables (Summer-Fall 2013)
- Hyun Sub Hwang: Quantum vs. Classical Oracles (Summer 2013)
- Lynn Chua: Psi-Epistemic Theories (Summer-Fall 2012)
- Mark Velednitsky: Graph Isomorphism and Crossing Number (Summer 2012)

**Teaching Assistant**, Quantum Complexity Theory, MIT Subject 6.845, Fall 2014

**Grader**, Quantum Complexity Theory, MIT Subject 6.845, Fall 2012

## PUBLICATIONS

S. Ben-David, A. Bouland, A. Garg and R. Kothari . “Classical Lower Bounds from Quantum Upper Bounds.” In preparation, to be submitted to *Conference on Computational Complexity (CCC’18)*.

A. Bouland and M. Ozols. “Trading Inverses for an Irrep in the Solovay-Kitaev Theorem.” In preparation.

A. Bouland, D. Koh and J. Fitzsimons. “Quantum Advantage from Conjugated Clifford Circuits.” To be submitted to *Conference on Computational Complexity (CCC’18)*. arXiv:1709.01805 (2017).

S. Aaronson, A. Bouland, G. Kuperberg and S. Mehraban. “The Computational Complexity of Ball Permutations.” In *Proc. 49<sup>th</sup> ACM Symposium on the Theory of Computation (STOC’17)*. arXiv:1610.06646 (2017).

A. Bouland, L. Chen, D. Holden, J. Thaler, and P. N. Vasudevan. “On the Power of Statistical Zero Knowledge.” In *Proc. 58<sup>th</sup> Annual IEEE Symposium on Foundations of Computer Science (FOCS’17)*. arXiv:1609.02888 (2017).

N. Bao, A. Bouland, A. Chatwin-Davies, J. Pollack and H. Yuen. “Rescuing Complementarity with Little Drama.” *Journal of High Energy Physics (JHEP)* 2016:26. arXiv: 1607.05141 (2016).

I. Arad, A. Bouland, D. Grier, M. Santha, A. Sundaram, and S. Zhang. “On the Complexity of Probabilistic Trials for Hidden Satisfiability Problems.” In *Proc. 41<sup>st</sup> International Symposium on Mathematical Foundations of Computer Science (MFCS’16)*. arXiv:1606.03585 (2016).

A. Bouland, L. Mančinska and X. Zhang. “Complexity Classification of Two-Qubit Commuting Hamiltonians.” In *Proc. 31<sup>st</sup> Conference on Computational Complexity (CCC’16)*. arXiv:1602.04145 (2016).

N. Bao, A. Bouland and S. Jordan. “Grover Search and the No-Signaling Principle.” *Physical Review Letters* 117, 120501. arXiv: 1511.00657 (2016).

S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. “The Space ‘Just Above’ BQP.” In *Proc. 2016 ACM Conference on Innovations in Theoretical Computer Science (ITCS’16)*. arXiv: 1412.6507 (2016).

A. Bouland and S. Aaronson. “Generation of Universal Linear Optics by Any Beamsplitter.” *Physical Review A* 89, 062316. Editor’s Suggestion. arXiv:1310.6718 (2014).

S. Aaronson, A. Bouland, L. Chua and G. Lowther. “Psi-Epistemic Theories: The Role of Symmetry.” *Physical Review A* 88, 032111. Editor’s Suggestion. arXiv:1303.2834 (2013).

A. Bouland, A. Dawar and E. Kopczyński. “On Tractable Parameterizations of Graph Isomorphism.” In *Proc. 7th International Symposium on Parameterized and Exact Computation (IPEC)* (2012).

A. Bouland, R. Easther and K. Rosenfeld. “Caching and Interpolated Likelihoods: Accelerating Cosmological Monte Carlo Markov Chains”. *Journal of Cosmology and Astroparticle Physics (JCAP)* 2011(05). arXiv: 1012.5299 (2011).

## **EXPOSITORY WRITINGS**

“Establishing Quantum Advantage.” XRDS: Crossroads, The ACM Magazine for Students. Volume 23 Issue 1, Fall 2016, Pages 40-44 (2016).

## **ORAL PRESENTATIONS**

“Classical Lower Bounds from Quantum Upper Bounds.” S. Ben-David, A. Bouland, A. Garg and R. Kothari. To appear as a contributed talk at *Quantum Information Processing (QIP)* 2018, Delft, Netherlands, January 2018.

“Quantum Advantage from Sampling Problems.” Stanford/Google X workshop on Quantum Information, Mountain View, CA, November 2017.

“The Space Below BQP.” Quantum Innovators in Math and Computer Science Workshop, Institute for Quantum Computing, Waterloo, Canada, September 2017.

“The Space Around BQP.” Thesis Defense. MIT, Cambridge, MA, June 30 2017.

“On the Power of Statistical Zero Knowledge.” A. Bouland, L. Chen, D. Holden, J. Thaler and P. Vasudevan. UT Austin Theory Colloquium, May 2017.

“Grover Search and the No-Signaling Principle.” N. Bao, A. Bouland and S. Jordan. Stanford Institute for Theoretical Physics Seminar, Stanford, CA, February 2017.

“Grover Search and the No-Signaling Principle.” N. Bao, A. Bouland and S. Jordan. U. Bristol Quantum Information seminar, Bristol. UK, August 2016.

“Equivalence of Adiabatic and Circuit Based Quantum Computing” and “Why physicists should care about the complexity zoo.” It from Qubit Summer School Focus Lectures. Waterloo, Canada, July 2016.

“Complexity Classification of Two-Qubit Commuting Hamiltonians.” A. Bouland, L. Mančinska and X. Zhang. Presented as a contributed talk at Quantum Information Processing (QIP) 2016, Banff, Canada, January 2016.

“The Space ‘Just Above’ BQP.” S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. Invited talk, The space around BQP [workshop], Tokyo, Japan, December 2015.

“On the Complexity of Commuting Quantum Circuits.” A. Bouland, L. Mančinska and X. Zhang. QuICS Seminar, University of Maryland, September 2015.

“On the Complexity of Commuting Quantum Circuits.” A. Bouland, L. Mančinska and X. Zhang. Centre for Quantum Technologies - Computer Science Seminar, Singapore, August 2015.

“Generation of Universal Linear Optics by Any Beamsplitter.” A. Bouland and S. Aaronson. Presented as a contributed talk at Quantum Information Processing (QIP) 2015, Sydney, Australia, January 2015.

“Any Beamsplitter Generates Universal Quantum Linear Optics.” A. Bouland and S. Aaronson. Centre for Quantum Technologies - Computer Science Seminar, Singapore, February 2014.

## POSTER PRESENTATIONS

“Trading Inverses for an Irrep in the Solovay-Kitaev Theorem.” A. Bouland, M. Ozols. QIP 2018, Delft, Netherlands, January 2018.

“Quantum Advantage from Conjugated Clifford Circuits.” A. Bouland, J. Fitzsimons and D. Koh. QIP 2018, Delft, Netherlands, January 2018.

“On SZK and PP.” A. Bouland, L. Chen, D. Holden, J. Thaler, and P. N. Vasudevan. QIP 2017, Seattle, Washington, January 2017.

“The Computational Complexity of Ball Permutations.” S. Aaronson, A. Bouland, G. Kuperberg, and S. Mehraban. QIP 2017, Seattle, Washington, January 2017.

“Grover Search and the No-Signaling Principle.” N. Bao, A. Bouland and S. Jordan. QIP 2016, Banff, Canada, January 2016.

“The Space ‘Just Above’ BQP.” S. Aaronson, A. Bouland, J. Fitzsimons and M. Lee. Gordon Research Conference on Quantum Science, Easton, MA, USA, August 2014.

“Any Beamsplitter and Any Phase Generate Universal Quantum Linear Optics.” A. Bouland and S. Aaronson. QIP 2013, Beijing, China, January 2013.

## SERVICE & OUTREACH

**Reviewer or Subreviewer for:** Symposium on the Theory of Computing (STOC), Quantum Information Processing (QIP), Symposium on Discrete Algorithms (SODA), International Colloquium on Automata, Languages and Programming (ICALP), Innovations in Theoretical Computer Science (ITCS), Theory of Computing (ToC), Symposium on Theoretical Aspects of Computer Science (STACS), Theory of Cryptography Conference (TCC), Information Processing Letters (IPL), IEEE Transactions on Neural Networks and Learning Systems (TNNLS), Computing and Combinatorics Conference (COCOON), Physical Review Letters (PRL), Physical Review A (PRA), Proceedings of the Royal Society A (P. R. Soc. A), Quantum Information & Computation (QIC), Quantum Information Processing (QINP), Nature Partner Journal Quantum Information (NPJQI), Mathematical Reviews (MathSciNet).

**Co-organizer,** Quantum CS (QuaCS) group meeting, 2015-2017 (joint with Robin Kothari)

**Theory representative,** CSAIL Student Committee, 2013