

# ADAM BOULAND

## POSTDOCTORAL RESEARCHER, COMPUTER SCIENCE

University of California at Berkeley  
617 Soda Hall, UC Berkeley, Berkeley, CA 94709  
aboutland@berkeley.edu, www.adambouland.com

**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

**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

## AWARDS

**Invited paper**, SICOMP special issue for FOCS, 2017

**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**: F. U. Berlin, June 2018 (Host: Jens Eisert), 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. 2015 (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 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

A. Bouland, B. Fefferman, C. Nirkhe, and U. Vazirani. “On the Complexity and Verification of Quantum Random Circuit Sampling.” *Nature Physics* 2018. Abstract to appear in *Proc. 2019 ACM Conference on Innovations in Theoretical Computer Science (ITCS’19)*. arXiv:1803.04402 (2018).

S. Ben-David, A. Bouland, A. Garg and R. Kothari . “Classical Lower Bounds from Quantum Upper Bounds.” In *Proc. 59<sup>th</sup> Annual IEEE Symposium on Foundations of Computer Science (FOCS’18)*. arXiv:1807.06256 (2018).

A. Bouland and M. Ozols. “Trading Inverses for an Irrep in the Solovay-Kitaev Theorem.” In *Proc. Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC’18)*. arXiv:1712.09798 (2018).

A. Bouland, D. Koh and J. Fitzsimons. “Complexity Classification of Conjugated Clifford Circuits.” In *Proc. 33rd Conference on Computational Complexity (CCC’18)*. arXiv:1709.01805 (2018).

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)*. To appear in *SIAM Journal on Computing (SICOMP)* special issue for 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* 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. 31st 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* 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**

“Introduction to Quantum Complexity”, Invited talk at Quantum Information for Developers Summer School, ETH Zurich, Switzerland, September 2018.

“Quantum Supremacy and the Complexity of Random Circuit Sampling.” A. Bouland, B. Fefferman, C. Nirkhe, and U. Vazirani. To be presented as a contributed talk at *Quantum Information Processing (QIP) 2019*, Boulder, Colorado, January 2019. Also presented at: Google quantum information seminar, Los Angeles, CA, April 2018. Stanford Institute for Theoretical Physics (SITP) seminar, Stanford, CA, May 2018. MIT Quantum Information seminar, Cambridge, MA, May 2018. FU Berlin Quantum Information seminar, Berlin, Germany, June 2018. Simons Institute lightning talk, July 2018.

“Classical Lower Bounds from Quantum Upper Bounds.” S. Ben-David, A. Bouland, A. Garg and R. Kothari. Presented as a contributed talk at *Quantum Information Processing (QIP) 2018*, Delft, Netherlands, January 2018. Presented as an invited talk at *Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC) 2018*, Sydney, Australia, July 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.” MIT Thesis Defense, 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. 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. Also presented at QuICS Seminar, University of Maryland, September 2015. Centre for Quantum Technologies - Computer Science Seminar, Singapore, August 2015.

“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.

“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. Also presented at Centre for Quantum Technologies - Computer Science Seminar, Singapore, February 2014.

## SERVICE & OUTREACH

**Program Committee Member:** Foundations of Computer Science (FOCS) 2019.

**Reviewer or Subreviewer for: Computer Science & Math Venues:** Symposium on the Theory of Computing (STOC), Foundations of Computer Science (FOCS), Computational Complexity Conference (CCC), 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), International Conference on Randomization and Computation (RANDOM), Theory of Cryptography Conference (TCC), International Conference on the Theory and Applications of Cryptographic Technique (EUROCRYPT), International Symposium on Mathematical Foundations of Computer Science (MFCS), Information Processing Letters (IPL), IEEE Transactions on Neural Networks and Learning Systems (TNNLS), IEEE Transactions on Knowledge and Data Engineering (TKDE), Computing and Combinatorics Conference (COCOON), Mathematical Reviews (MathSciNet), SIAM Review (SIREV).

**Physics & Quantum Computing Venues:** Quantum Information Processing (QIP), Physical Review Letters (PRL), Physical Review A (PRA), Nature Partner Journal Quantum Information (NPJQI), Quantum, Proceedings of the Royal Society A (P. R. Soc. A), Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC), Quantum Information & Computation (QIC), Quantum Information Processing (QINP).

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