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Physicist, Applied and Computational Mathematics Division
National Institute of Standards and Technology (NIST)
100 Bureau Drive, Gaithersburg, MD 20899-8913.

Fellow, Joint Center for Quantum Information and Computer Science (QuICS)
University of Maryland
3100 Atlantic Building, College Park, MD 20742.

Education

- PhD in physics, Massachusetts Institute of Technology, 2008. Advisor: Edward Farhi. Thesis: *Quantum Computation Beyond the Circuit Model*.
- BS in physics, Pennsylvania State University, 2003. Honors thesis: *Simulating the Inversion of Graphene Nanocones*.

Research Experience

- April 2011-Present: Physicist at National Institute of Standards and Technology (NIST).
- 2014-Present: Fellow of the NIST/U. Maryland Joint Center for Quantum Information and Computer Science (QuICS) and adjunct associate professor in University of Maryland Institute for Advanced Computer Studies (UMIACS).
- September 2008-April 2011: Sherman Fairchild Prize Postdoctoral Fellow, Caltech. Advisor: John Preskill.
- June/July 2008: Visiting researcher, RIKEN Institute for Chemistry and Physics, Wakoshi, Japan. Host: Franco Nori.
- 2005-2008: QuaCGR Fellowship for Quantum Computing. Advisor: Edward Farhi.
- 2003-2004: MIT Presidential Fellow.
- Summers, 2000-2003: REU (Research Experiences for Undergraduates) program at Penn State. Advisors: Vincent Crespi, Moses Chan, and Rafael Garcia.

Awards

Sigma-Xi Katharine Gebbie Young Investigator Award, 2016
NIST Information Technology Laboratory Outstanding Journal Paper Award, 2013
Sherman Fairchild Prize Fellowship, Caltech Physics, 2008
QuaCGR Fellowship, 2005
MIT Presidential Fellowship, 2003
Braddock Scholarship, Penn State, 1999-2003
Robert C. Byrd Scholarship, 1999-2003
Schreyer Honors College, Penn State, 1999-2003
Phi Beta Kappa
Jean Bennett Award, Penn State Physics, 2003

Teaching Experience

- Summer 2016: Lecturer at Perimeter Institute "It From Qubit" Summer School.
- Summer 2014: Instructor, Quantum Algorithms Short Course, NIST.
- Winter 2013/2014: Lecturer at Israel Institute for Advanced Studies Winter School in Theoretical Physics.
- Spring 2005,2006,2007: Writing Assistant, MIT 8.06: Quantum Mechanics III, Prof. Krishna Rajagopal and Prof. Hong Liu
- Fall 2004/Spring 2005: Teaching Assistant, MIT 8.14/8.15: Experimental Physics I & II, Prof. Ulrich Becker and Prof. Isaac Chuang

PhD Students

- Michael Jarret. PhD in Physics, University of Maryland, March 2016. Thesis title: *Spectral graph theory with applications to adiabatic optimization.*

Talks

- "High complexity at low energy." Simons center workshop on entanglement in field theory and gravity. Stony Brook, NY. Dec 5, 2016.
- "Topological Quantum Field Theory and Quantum Computing."
  - Caltech high energy theory seminar. Pasadena, CA. Oct 28, 2016.
  - Workshop on quantum stochastic differential equations for the quantum simulation of physical systems. Army Research Laboratory, Adelphi, MD. August 22, 2016.
- "Simulating Physics on Quantum Computers." It from Qubit Summer School. Perimeter Institute, Waterloo, Canada. July 23 and July 25, 2016.
- "Adiabatic Optimization vs. Monte Carlo"
  - CQCS Conference, Center for Quantum Coherent Science. Berkeley, CA. January 11, 2017.
  - Institute for Quantum Information (IQI) Seminar, Caltech, Pasadena, CA. Oct 25, 2016.
  - Workshop on Quantum Algorithms and Devices, Microsoft Faculty Summit, Redmond, WA. July 15, 2016.
  - AQC2016, Google, Venice Beach, CA. June 27, 2016.
  - University of New Mexico Center for Quantum Information and Control (CQuIC) seminar. Albuquerque, NM. March 24, 2016.
  - Canadian Institute for Advanced Research (CIFAR) program meeting. College Park, MD. April 3, 2016.
- "Black Holes, Causality, and Grover Search" University of California San Diego quantum information seminar. June 24, 2015.
- "Quantum Computation: From Philosophy to Technology in One Generation" Keynote, Qualcomm QTech forum, San Diego, CA. June 23, 2015.

- "Device-independently Secure Randomness Expansion Using Photonic Bell Tests" Randomness in Quantum Physics and Beyond, Barcelona, Spain. May 7, 2015.
- "Quantum Adiabatic Optimization and Spectral Graph Theory" Hebrew University quantum information seminar, Jerusalem, Israel. February 26, 2015.
- "What is the Computational Power of the Universe?" Israeli-American Kavli Frontiers of Science Symposium, Jerusalem. February 25, 2015.
- "Quantum Algorithms for Applied Mathematics" Department of Energy ASCR Workshop on Quantum Computing, Plenary session, February 17, 2015.
- "Quantum Algorithms" (series of three lectures). Israel Institute for Advanced Studies Theoretial Physics Winter School. December 30 & 31, 2013 and January 5, 2014.
- "Partial-indistinguishability Obfuscation Using Braids"
  - U. Maryland Crypto Reading Group, College Park, MD. March 7, 2014.
  - PIQUDOS Seminar, Perimeter Institute, Waterloo, ON. April 8, 2013.
  - Hughes Research Laboratory, Malibu, CA. January 17, 2013.
  - IQIM Seminar, Caltech, Pasadena, CA. January 8, 2013.
- "Super-polynomial Quantum Speedups Tutorial," Lorentz Center, Leiden, Netherlands. Nov 5, 2012.
- "Computational Complexity of Quantum Field Theory"
  - RIKEN Quantum Materials seminar, Tokyo, Japan. December 8, 2015.
  - Joint Quantum Institute seminar, College Park, MD. Oct 5, 2015.
  - Stanford Institute for Theoretical Physics seminar, Palo Alto, CA. May 22, 2015.
  - Los Alamos National Laboratory quantum information seminar, Los Alamos, NM. April 23, 2015.
  - APS March Meeting, Invited Session, San Antonio, TX. March 2, 2015.
- "Quantum Algorithms for Simulating Quantum Field Theories"
  - Advances in Quantum Algorithms and Computation, Aspen, CO. March 14, 2014.
  - Ben-Gurion University Physics Colloquium, Be'er Sheva, Israel. January 8, 2014.
  - Quantum Information Processing (QIP '13), Tsinghua University, Beijing. January 24, 2013. [Plenary Lecture]
  - University of Pennsylvania Physics Colloquium, Philadelphia, PA. December 5, 2012.
  - Capital Area Theory Seminar, U. Maryland, College Park, MD. April 6, 2012.
  - C. N. Yang Institute Seminar, SUNY Stony Brook, NY. March 8, 2012.
  - NIST Applied and Computational Mathematics Seminar, Gaithersburg, MD. February 21, 2012.
  - MIT Center for Theoretical Physics Special Seminar, Cambridge, MA. February 15, 2012.

  - NASA Quantum Future Technologies Conference, Mountainview, CA. January 21, 2012.
  - Workshop on Quantum Cryptanalysis, Schloss Dagstuhl, Germany, September 23, 2011.
  - Institute for Quantum Computation Lunch Seminar, Waterloo, Canada. August 2, 2011.
  - NIST Quantum Information and Bose Einstein Condensate Seminar, Gaithersburg, MD. July 13, 2011.
  - Laboratory for Physical Science Special Seminar, University Park, MD. May 5, 2011.

- "Limitations of Quantum Fourier Sampling," NIST Post-Quantum Cryptography Seminar, Gaithersburg, MD. December 20, 2013.
- "Quantum Algorithms for the Subset-Sum Problem," NIST Post-Quantum Cryptography Seminar, Gaithersburg, MD. April 26, 2013.
- "Quantum Computation of Zeta Functions of Curves," NIST Post-Quantum Cryptography Seminar, Gaithersburg, MD. February 22, 2013.
- "Attacks on NTRUEncrypt," NIST Post-quantum Cryptography Seminar, Gaithersburg, MD. April 23, 2012.
- "Quantum Computation and Lattice Based Cryptography," NIST Cryptography Club Seminar, Gaithersburg, MD. May 25, 2011.
- "QMA-complete Problems and Universal Adiabatic Computation with Stoquastic Hamiltonians" Abdus Salam International Center for Theoretical Physics, Trieste, Italy. June 15, 2010.
- "Quantum Algorithms for Topological Invariants"
  - NIST Mathematical and Computational Sciences Division Seminar Series, Gaithersburg MD. February 3, 2010.
  - Sandia National Laboratories, Albuquerque NM. February 23, 2010.
- "Gadgets and Gizmos for Adiabatic Quantum Computation" Kavli Institute Program in Quantum Information Science, Santa Barbara. September 17, 2009.
- "QMA-complete Problems for Stoquastic Hamiltonians and Markov Matrices" Workshop on Quantum Computation and Quantum Spin Systems. Erwin Schrödinger Institute, Vienna. August 10, 2009.
- "Permutational Quantum Computation"
  - Workshop around BQP. Tokyo, Japan. December 7, 2015.
  - Twelfth Annual Southwest Quantum Information and Technology (SQuInT) Workshop. Santa Fe, NM. February 20, 2010.
  - Conference on Complexity Resources in Quantum Computation, Oxford, August 25, 2009.
  - Vladimir Buzek group meeting, Slovak Academy of Sciences, August 18, 2009.

- Todd Brun group meeting, USC, July 14, 2009.
- Alan Aspuru-Guzik group meeting, Harvard, May 12, 2009.
- Quantum Information Seminar, MIT, May 11, 2009.
- Quantum Lunch Seminar, UC Berkeley, April 17, 2009.
- PIQUDOS Seminar, Perimeter Institute, Waterloo, ON. April 3, 2009.

- "Quantum Computation and Jones Polynomials" RIKEN Quantum Seminar. Wako-shi, Japan. July 15, 2008.
- "Locality and Fault Tolerance of Adiabatic Quantum Computation" Workshop on quantum computation and solid state systems, RIKEN, Wako-shi, Japan. June 9, 2008.
- "Perturbative Gadgets at Arbitrary Orders" Workshop on Universal Adiabatic Quantum Computation. D-Wave Systems, Burnaby, British Columbia. March 18, 2008.
- "Improved Fault Tolerance for Adiabatic Quantum Computers" Quantum Error Correction (QEC) 2007. University of Southern California, December 19 2007.
- "Estimating Jones Polynomials is a Complete Problem for One Clean Qubit" PIQUDOS Seminar, Perimeter Institute, October 31, 2007.
- "Quantum Computing Beyond the Circuit Model" ARO Program Review. Minneapolis, MN. August 17, 2007.
- "Error Correcting Codes for Adiabatic Quantum Computation" PIQUDOS Seminar, Perimeter Institute, July 18, 2007.
- "Quantum Gradient Estimation and Classical Optics" Workshop on Quantum Computational Methods for Differential Equations and Physics Problems, Los Alamos National Laboratory, May 25, 2007.
- "Error Correcting Codes for Adiabatic Quantum Computation"
  - Institute for Quantum Information (IQI) Seminar, Caltech, January 9, 2007.
  - Quantum Information Processing (QIP) 2007. University of Queensland, Brisbane Australia. Feb 2, 2007.
- "Quantum Blackbox Algorithms" MIT Center for Theoretical Physics Graduate Seminar. Cambridge, MA. Sep 23, 2005.
- "Fast Quantum Algorithm for Numerical Gradient Estimation," International Seminar on Continuous Algorithms and Complexity, Schloss Dagstuhl, Germany, Sept 2004.
- "Simulating the Inversion of Carbon Nanocones" APS March Meeting. Austin, TX. March 7, 2003.

Service and Outreach

- Author and maintainer of the "Quantum Algorithm Zoo," an online repository of all known quantum algorithms. (`http://math.nist.gov/quantum/zoo/`)
- Member of Quantum Information Science Interagency Working Group, US Office of Science and Technology Policy, 2015-present.
  (Report at: `https://goo.gl/r3AzN2`)

- Member of NIST post-quantum cryptography working group 2011-present. (Report at: `http://goo.gl/z7dD0E`)
- Member of Department of Energy study group on quantum testbeds, 2016.
- Member of Department of Energy study group on grand challenges at the interface of quantum information science, particle physics, and computing, 2015. (Report at `http://goo.gl/rpCTDK`)
- Member of Department of Energy ASCR Quantum Computing Working Group, 2015. (Report at `http://goo.gl/0mbSh0`)
- Panelist at National Science Foundation Conference on Mathematical Challenges in Quantum Information, Feb 12-13, 2015.
- Program coordinator for Kavli Institute for Theoretical Physics (KITP) program on Quantum Physics of Information, to be held Fall 2017.
- Referee for Physical Review, Nature, STOC, FOCS, Quantum Information and Computation, Proceedings of the Royal Society, Quantum Information Processing, SIAM Journal on Computing, Theory of Computing, New Journal of Physics, Quantum Topology, and Communications in Mathematical Physics.
- Developer of software to run the NIST/U. Maryland Quantum Information Journal Club (a web application written in PHP).
- Member, scientific advisory board, MetaMed. 2012-2015.
- National Science Foundation reviewer.
- Co-organizer NIST-UMD Workshop on Quantum Information and Computer Science. (Held March 31 and April 1, 2014.)
- Organizer QuICS Workshop on Frontiers of Quantum Information and Computer Science. (To be held Sept 28-Oct 2, 2015).
- Member, QuICS executive committee, 2015-present.
- Program committee member, Quantum Information Processing (QIP) 2013 and 2015.
- Program committee member, Theory of Quantum Computing (TQC), 2017.
- Member, Cryptoworks21 (NSERC Training Program in Cryptographic Infrastructure)
- Author of "Black holes, quantum mechanics, and the limits of polynomial-time computability," for XRDS, the undergraduate magazine of the Association of Computing Machinery. (Vol. 22, No. 1, pg. 30–33)
- AAAS Science podcast, June 1, 2012. (`http://bit.ly/KI5NyX`) and YouTube video "Helping Quantum computers Study the Physics of the Universe" (`http://bit.ly/MD87Me`)
- MIT Alumni Association Faculty Forum Webcast: "The world's first quantum computer," August 18, 2016.
- Speaker at University of Maryland SPIRAL program for undergraduate math majors at minority serving institutions, 2011 and 2012.
- Organizer of MIT quantum computing journal club, Fall 2005-Spring 2008.

Papers and Preprints

[33] Stephen P. Jordan. Fast quantum computation at arbitrarily low energy. *arXiv:1701.01175*, 2017.

[32] Michael Jarret, Stephen P. Jordan, and Brad Lackey. Adiabatic optimization versus diffusion Monte Carlo. *Physical Review A*, 94:042318, 2016. arXiv:1607.03389.

[31] Ning Bao, Adam Bouland, and Stephen P. Jordan. Grover search and the no-signaling principle. *Physical Review Letters*, 117:120501, 2016. arXiv:1511.00657.

[30] Gorjan Alagic, Michael Jarret, and Stephen P. Jordan. Yang-Baxter operators need quantum entanglement to distinguish knots. *Journal of Physics A*, 49(7):075203, 2016. arXiv:1507.05979.

[29] Michael Jarret and Stephen P. Jordan. Modulus of continuity eigenvalue bounds for homogeneous graphs and convex subgraphs. *arXiv:1506.08475*, 2015.

[28] Michael Jarret and Stephen P. Jordan. Adiabatic optimization without local minima. *Quantum Information and Computation*, 14(3/4):0181–0199, 2015. arXiv:1405.7552.

[27] Stephen P. Jordan, Keith S. M. Lee, and John Preskill. Quantum algorithms for fermionic quantum field theories. *arXiv:1404.7115*, 2014.

[26] Stephen P. Jordan, Keith S. M. Lee, and John Preskill. Quantum computation of scattering in scalar quantum field theories. *Quantum Information and Computation*, 14(11/12):1014–1080, 2014. arXiv:1112.4833.

[25] Michael Jarret and Stephen P. Jordan. The fundamental gap for a class of schrödinger operators on path and hypercube graphs. *Journal of Mathematical Physics*, 55(5):052104, 2014. arXiv:1403.1473.

[24] Stephen P. Jordan. Strong equivalence of reversible circuits is coNP-complete. *Quantum Information and Computation*, 14(15/16):1302–1307, 2014. arXiv:1307.0836.

[23] Gorjan Alagic, Stacey Jeffery, and Stephen Jordan. Partial-indistinguishability obfuscation using braids. In *Proceedings of the Sixth Conference on Theory of Quantum Computation, Communication and Cryptography (TQC14)*, 2014. arXiv:1212.6358.

[22] Gorjan Alagic, Aniruddha Bapat, and Stephen Jordan. Classical simulation of Yang-Baxter gates. In *Proceedings of the Sixth Conference on Theory of Quantum Computation, Communication and Cryptography (TQC14)*, 2014. arXiv:1407.1361.

[21] Adam Bookatz, Stephen Jordan, Yi-Kai Liu, and Pawel Wocjan. Quantum nonexpander problem is quantum-Merlin-Arthur-complete. *Physical Review A*, 87:042317, 2013. arXiv:1210.0787.

[20] Stephen P. Jordan, Keith S. M. Lee, and John Preskill. Quantum algorithms for quantum field theories. *Science*, 336(6085):1130–1133, 2012. arXiv:1111.3633.

[19] Stephen P. Jordan, Hirotada Kobayashi, Daniel Nagaj, and Harumichi Nishimura. Perfect completeness in classical-witness quantum Merlin-Arthur proof systems. *Quantum Information and Computation*, 12(5/6):460–470, 2012. arXiv:1111.5306.

[18] Stephen P. Jordan, Toufik Mansour, and Simone Severini. On the degeneracy of $SU(2)_3$ topological phases. *Russian Journal of Mathematical Physics*, 19(1):21–26, 2012. arXiv:1009.0114.

[17] Stephen P. Jordan and Gorjan Alagic. Approximating the Turaev-Viro invariant of mapping tori is complete for one clean qubit. In *Proceedings of the Sixth Conference on Theory of Quantum Computation, Communication and Cryptography (TQC11)*, 2011. arXiv:1105.5100.

[16] G. Alagic, S. Jordan, R. Koenig, and B. Reichardt. Approximating Turaev-Viro 3-manifold invariants is universal for quantum computation. *Physical Review A*, 82:040302(R), 2010. arXiv:1003.0923.

[15] Stephen Jordan, David Gosset, and Peter Love. QMA-complete problems for stoquastic Hamiltonians and Markov matrices. *Physical Review A*, 81(3):032331, 2010. arXiv:0905.4755.

[14] P. Wocjan, S. Jordan, H. Ahmadi, and J. Brennan. Efficient quantum processing of ideals in finite rings. *arXiv:0908.0022*, 2009.

[13] Stephen P. Jordan. Permutational quantum computing. *Quantum Information and Computation*, 10(5/6):470–497, 2009. arXiv:0906.2506.

[12] Stephen P. Jordan and Pawel Wocjan. Efficient quantum circuits for arbitrary sparse unitaries. *Physical Review A*, 80(062301), 2009. arXiv:0904.2211.

[11] Stephen P. Jordan and Pawel Wocjan. Estimating Jones and HOMFLY polynomials with one clean qubit. *Quantum Information and Computation*, 9(3/4):264–289, 2009. arXiv:0807.4688.

[10] A. Childs, R. Cleve, S. Jordan, and D. Yonge-Mallo. Discrete query quantum algorithm for NAND trees. *Theory of Computing*, 5:119–122, 2009. arXiv:quant-ph/0702160.

[9] Stephen P. Jordan. Fast quantum algorithms for approximating some irreducible representations of groups. *arXiv:0811.0526*, 2008.

[8] Stephen P. Jordan. *Quantum computation beyond the circuit model*. PhD thesis, MIT, 2008. arXiv:0809.2307.

[7] Stephen P. Jordan and Edward Farhi. Perturbative gadgets at arbitrary orders. *Physical Review A*, 77:062329, 2008. arXiv:0802.1874.

[6] I. Kassal, S. Jordan, P. Love, M. Mohseni, and A. Aspuru-Guzik. Quantum algorithms for the simulation of chemical dynamics. *Proceedings of the National Academy of Sciences*, 105(48):18681–18686, 2008. arXiv:0801.2986.

[5] Peter W. Shor and Stephen P. Jordan. Estimating Jones polynomials is a complete problem for one clean qubit. *Quantum Information and Computation*, 8(8/9):681–714, 2008. arXiv:0707.2831.

[4] Stephen P. Jordan, Edward Farhi, and Peter W. Shor. Error correcting codes for adiabatic quantum computation. *Physical Review A*, 74:052322, 2006. arXiv:quant-ph/0512170.

[3] Stephen P. Jordan. Fast quantum algorithm for numerical gradient estimation. *Physical Review Letters*, 95:050501, 2005. arXiv:quant-ph/0405146.

[2] Stephen P. Jordan and Vincent H. Crespi. Mechanical manipulation of graphene nanocones: Chiral inversion of a micron-scale three-dimensional object. *Physical Review Letters*, 93:255504, 2004.

[1] R. Garcia, S. Jordan, J. Lazzaretti, and M. Chan. Quartz microbalance study of think He-4 film near the superfluid transition. *Joural of Low Temperature Physics*, 134(1–2):527–533, 2004.