

Sergio Boixo

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Experience in Research

USC – ISI

CS & Quantum Computing Engineer

Staff in the new USC Lockheed Martin Quantum Computing Center. Research in quantum computation, in emphasis in practical applications of current implementations of quantum annealing.

Marina del Rey, USA

September 2011 – present

Harvard University

Harvard associate

Research in quantum computation, quantum information, quantum simulators, and computational quantum chemistry, in collaboration with Alan Aspuru-Guzik's group.

Cambridge, USA

September 2011 – present

Harvard University

Postdoctoral Scholar

Research in quantum computation, quantum information, quantum simulators, and computational quantum chemistry, as part of Alan Aspuru-Guzik's group.

Cambridge, USA

August 2010 – September 2011

California Institute of Technology

Postdoctoral Scholar

Research in quantum computation and quantum information within the Institute of Quantum Information. The director of this research group is John Preskill.

Pasadena, USA

September 2008 – August 2010

Los Alamos National Laboratory

Graduate Research Assistant

Research in quantum metrology, nonlocality, quantum algorithms, advised by Howard Barnum.

Los Alamos, USA

September 2006 – September 2008

University of New Mexico

Research Assistant

Research in quantum estimation theory and decoherence. My PhD advisor was Carlton M. Caves.

Albuquerque, USA

September 2005 – September 2008

Los Alamos National Laboratory

Summer Research Assistantship

Research in the study of the decoherence of Generalized Coherent States under a Markovian environment, advised by Gerardo Ortiz and Lorenza Viola.

Los Alamos, USA

Summer 2005

Universidad Autonoma de Barcelona

Barcelona, Spain

Associate Professor

August 2003 – August 2004

Teaching assistant for several courses, like Quantum Mechanics and Classical Mechanics. Research advised by Emili Bagan. More recently, I have participated on the project “Informacion cuantica y temas afines II: estimacion, entrelazamiento y simuladores” (“Quantum information and related topics II: estimation, entanglement and simulators”) by the Spanish Ministerio de Ciencia y Tecnología.

Education

- Ph.D. in Physics, University of New Mexico, USA, 2008.
- M. Sc. in Physics, Universidad Autonoma de Barcelona, Spain, 2008.
- B.S. in Mathematics, UNED, Spain, 2003.
- B.A. in Philosophy, UNED, Spain, 2000.
- B.S. in Computer Science, Universidad Complutense, Spain, Madrid, 1996.

Published Papers

1. S. Boixo and C. Heunen, *Entangled and sequential quantum protocols with dephasing*, Phys. Rev. Lett. **108**, 120402 (2012).
2. M-H Yung, J. D. Whitfield, S. Boixo, D. G. Tempel and A. Aspuru-Guzik, *Introduction to Quantum Algorithms for Physics and Chemistry*, arXiv:1203.1331 (2012). To appear in Adv. Chem. Phys.
3. S. Boixo, M. Diaz-Vicente, A. Colmenar and M. Castro, *Potential energy savings from cool roofs in Spain and Andalusia*, Energy, **38**, 425 (2012).
4. S. Boixo, L. Aolita, D. Cavalcanti, K. Modi and A. Winter, *Quantum locking of classical correlations and quantum discord of classical-quantum states*, IJQI, **9**, 1643 (2011).
5. R. D. Somma and S. Boixo, *Spectral gap amplification*, arXiv:1110.2494. Accepted to QIP 2012 as a contributed talk.
6. D. Cavalcanti, L. Aolita, S. Boixo, K. Modi, M. Piani and A. Winter, *Operational Interpretations of Quantum Discord*, Phys. Rev. A **83**, 032324 (2011).
7. C. Heunen and S. Boixo, *Completely positive classical structures and sequentializable quantum protocols*, Accepted to QPL 2011 as a contributed talk. To be published in EPTCS (2012).
8. E. Bilgin and S. Boixo, *Preparing Thermal States of Quantum Systems by Dimension Reduction*, Phys. Rev. Lett **105**, 170405 (2010). Accepted to QIP 2011 as a contributed talk.
9. A. B. Tacla, S. Boixo, A. Datta, A. Shaji and C. M. Caves, *Nonlinear Interferometry with Bose-Einstein Condensates*, Phys. Rev. A **82**, 053636 (2010).
10. S. Boixo, E. Knill and R.D. Somma, *Fast Quantum Algorithms for Traversing Paths of Eigenstates*, arXiv:1005.3034.
11. H. Barnum, S. Beigi, S. Boixo, M.B. Elliott, and S. Wehner, *Local Quantum Measurement and No-Signaling Imply Quantum Correlations*, Phys. Rev. Lett. **104**, 140401 (2010). Accepted to QIP 2010 as a contributed talk.

12. S. Boixo and R.D. Somma, *Necessary Condition for the Quantum Adiabatic Approximation*, Phys. Rev. A **81**, 032308 (2010).
13. S. Boixo, A. Datta, M.J. Davis, A. Shaji, A.B. Tacla, C.M. Caves, *Quantum-limited Metrology and Bose-Einstein Condensates*, Phys. Rev. A **80**, 032103 (2009).
14. S. Boixo, E. Knill, and R. D. Somma, *Eigenpath Traversal by Phase Randomization*, QIC **9**, 0833 (2009).
15. S. Boixo, A. Datta, M.J. Davis, S.T. Flammia, A. Shaji, A.B. Tacla, C.M. Caves, *Quantum Metrology from an Information Theory Perspective*, Ninth International Conference on QCMC **1110**, 427 (2009).
16. S. Boixo, A. Datta, M.J. Davis, S.T. Flammia, A. Shaji, A.B. Tacla, C.M. Caves, *Quantum Metrology with Bose-Einstein Condensates*, Ninth International Conference on QCMC **1110**, 423 (2009).
17. S. Boixo, A. Datta, M.J. Davis, S.T. Flammia, A. Shaji, and C.M. Caves, *Quantum Metrology: Dynamics versus Entanglement*, Phys. Rev. Lett. **101**, 040403 (2008).
18. R. D. Somma, S. Boixo, H. Barnum and E. Knill, *Quantum Simulations of Classical Annealing Processes*, Phys. Rev. Lett. **101**, 130504 (2008).
19. S. Boixo, S. and R. D. Somma, *Parameter Estimation with Mixed-state Quantum Computation*, Phys. Rev. A **77**, 052320 (2008).
20. S. Boixo and A. Monras, *An Operational Interpretation for Multipartite Entanglement*, Phys. Rev. Lett. **100**, 100503 (2008).
21. S. Boixo, A. Datta, S. T. Flammia, A. Shaji, E. Bagan and C. M. Caves, *Quantum-limited Metrology with Product States*, Phys. Rev. A **77**, 012317 (2008).
22. R. D. Somma, S. Boixo and H. Barnum, *Quantum Simulated Annealing*, arXiv:0712.1008, (2008).
23. S. Boixo, S. T. Flammia, C. M. Caves and JM Geremia, *Generalized Limits for Single-Parameter Quantum Estimation*, Phys. Rev. Lett. **98**, 090401 (2007).
24. S. Boixo, L. Viola and G. Ortiz, *Generalized Coherent States as Preferred States of Open Quantum Systems*, Europhys. Lett. **79**, 40003 (2007). Highlighted article in Europhys. Lett. in 2007.
25. S. Boixo, C. M. Caves, A. Datta and A. Shaji, *Decoherence in Quantum Clock Synchronization*, Laser Physics **16**, 1 (2006).

Ph. D. Thesis

Nonlinear Quantum Metrology, University of New Mexico, August 2008. My advisor was professor Carlton. M. Caves (UNM) and my co-advisor was Howard Barnum (Los Alamos National Laboratory).

I show how to improve the fundamental scaling of the uncertainty of a physical measurement. I study possible implementations using Bose-Einstein condensates. Some of the theory developed has been recently implemented in an optical experiment (M. Napolitano et. al., Nature, 2011).

Teaching Experience

- Instructor, Applied Quantum Mechanics, Harvard, 2011.
- Young Engineering and Science Scholars (YESS) Instructor, Caltech, summer of 2010.
- TA, Electrodynamics (graduate course), UNM, 2006.
- Associate Professor, E&M Lab., UAB, 2005.
- Associate Professor, Theoretical Classical Mechanics, UAB, 2004.
- Associate Professor, Quantum Physics, UAB, 2004.

Talks

1. *Benchmarking D-Wave One (with quantumness)*, USC Physics Colloquium, Los Angeles, CA, Apr 2012.
2. *Benchmarking D-Wave One*, APS March Meeting, Boston, MA, Feb 2012.
3. *Benchmarking D-Wave One*, SQuInT, Albuquerque, NM, Feb 2012.
4. *Adiabatic Quantum Computation: Theory and Practice*, USC, Los Angeles, CA, Feb 2012.
5. *Adiabatic Quantum Machine Learning*, NASA Ames, Moffett Field, CA, January 2012.
6. *Optimization for Prediction of Solar Cell Materials*, NSF QIQC Winter School, Palm Springs, CA, January 2012.
7. *Quantum Annealing for Machine Learning*, ISI, Los Angeles, CA, June 2011.
8. *Quantum Machine Learning for Validation of Dynamical Control*, LM Fellows Conference, Orlando, FL, September 2011.
9. *Quantum Engineering*, USC, Los Angeles, CA, April 2011.
10. *Perturbation of Thermal States and Quantum Thermalization*, IQC seminar, Waterloo, ON, Canada, March 2011.
11. *The Adiabatic Theorem and Eigenpath Traversal*, PI seminar, Waterloo, ON, Canada, March 2011.
12. *Stochastic Matrices vs. Stoquastic Hamiltonians and Gap Amplification Quantum Speedups*, DWave, Burnaby, BC, Canada, January 2011.
13. *Quantum Adiabatic Speedups for V&V, General Theoretical Remarks*, Dalhousie University, Halifax, NS, Canada, September 2010.
14. *Fully Sequentializable Quantum Estimation Protocols*, UNM, Albuquerque, NM, July 2010.
15. *Preparing Thermal States of Quantum Systems on a Quantum Computer*, Los Alamos National Laboratory, NM, July 2010.
16. *Quantum State Preparation by Phase Randomization*, invited talk at the American Physical Society March Meeting, Portland, OR, March 2010.
17. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, USC, Los Angeles, CA, March 2010.
18. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, National University of Singapore, CQT, Singapore, March 2010.

19. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Harvard, Cambridge, MA, February 2010.
20. *Local Quantum Measurement and Relativity Imply Quantum Correlations*, Workshop on Quantum Information Processing, Zurich, Switzerland, January 2010.
21. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Perimeter Institute, Waterloo, Canada, August 2009.
22. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Universidad Complutense, Madrid. Spain, August 2009.
23. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, ICFO, Barcelona. Spain, August 2009.
24. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Universidad Autonoma de Barcelona, Barcelona. Spain, August 2009.
25. *Quantum Computing through Phase Randomization*, Universidad Autonoma de Barcelona, Barcelona, Spain, March 2009.
26. *Quantum Computing through Decoherence*, Southwest Quantum Information and Technology, Seattle, WA, February 2009.
27. *Generalized Quantum Metrology with BECs*, Interf08, Trento, Italy, April 2008.
28. *Quantum Simulated Annealing*. American Physical Society March Meeting, New Orleans, LA, 2008.
29. *Quantum-limited Metrology with Product States*. Southwest Quantum Information and Technology, Santa Fe, NM, February 2008.
30. *Quantum Simulated Annealing*. Institute Quantum Information seminar, Caltech, Pasadena, CA, January 2008.
31. *Quantum Simulated Annealing*. Universidad Autonoma de Barcelona, Barcelona, Spain, December 2007.
32. *Quantum Phase Estimation*. PIQuDos seminar, Perimeter Institute, Waterloo, Canada, November 2007.
33. *Simple Multi-parameter Unitary Estimation*. American Physical Society March Meeting, Denver, CO, 2007.
34. *Distinguished Quantum States*. Quantum Lunch, Los Alamos National Laboratory, January, 2007.
35. *Generalized Coherent States via Markovian Decoherence*. American Physical Society March Meeting, Baltimore, MD, 2006.
36. *Generalized Coherent States via Markovian Decoherence*. Universidad Autonoma de Barcelona, Barcelona, Spain, December 2005.
37. *Generalized Coherent States via Markovian Decoherence*. Dartmouth University, Hanover, NH, October 2005.

Experience in Industry

Semanticedge Berlin
System architect and senior developer. 4th quarter 2000 - 3rd quarter 2002
Design the architecture of the software modules and integration. Research on applicable technologies in natural dialog, natural language, speech and knowledge management. Key role in bringing a set of research ideas into an advanced commercial product. Team leader and developer. The systems designed were deployed in several businesses and banks.

Consultant, private company Europe
Software analyst and C++ developer 2nd quarter 1998 - 3rd quarter 2000
Consultant, under a private company, for software projects. Work included project design and analysis, software development, and database management. The list of companies is:

- ADIG Financial Bank (Commerzbank), Frankfurt, 3rd quarter 2000.
- Siemens, Zurich, 2nd quarter 2000.
- Deloitte Consulting, Madrid, 4th quarter 1999 - 1st quarter 2000.
- Dresdner Bank, Frankfurt, 2nd quarter 1998 - 4th quarter 1999.

European Central Bank Frankfurt
C++ developer - designer 2nd quarter 1997 - 2nd quarter 1998
C++ programming and methodology implementation. Main responsibilities in the context of data exchange between EU NCBS (National Central Banks), several EU statistical offices, and the ECB (European Central Bank). Responsibilities including coding and design at the European Central Bank, technical advise and co-ordination across EU organizations and providers. Participant in EU EDIFACT GESMES specialized subcommittee.

General Medical Association of Spain Madrid
Project Manager 4th quarter 1996 - 2nd quarter 1997
Patient database with intelligent plugins. Project management, analysis of legacy code and new user requirements. Redesigning the project based on the analysis effected, reverse engineering of existing code and database, followed by redevelopment and porting of the application to a different operating system environment.

Awards and Honors

- Mutua Madrilenia Fellowship, 2008.
- PhD with Honors, 2008.
- Phi Kappa Phi, 2005.
- La Caixa Fellowship, 2004.
- Chip de Oro (“Golden Chip”) price for outstanding academic achievements in computer science, 1996.
- Roll of Honor, Universidad Complutense, 1996.

Additional activities

- Journal referee for Nature, Phys. Rev. Lett., Phys. Rev. A, Quantum Information & Computation, New Journal of Physics, ACM Transactions on Computation Theory, ICML, Frontiers of Physics and Europhysics Letters.
- Session chair at the American Physical Society March Meeting, 2008.
- Science Fair Judge in NM, USA.