Sergio Boixo

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Experience in Research

USC – ISI Marina del Rey, USA
R. A. Professor, Computer Scientist September 2012 – present
Staff in the USC Lockheed Martin Quantum Computing Center. Research in quantum computation, with emphasis in theory and practical applications of current implementations of quantum annealing.

USC – ISI Marina del Rey, USA
CS & Quantum Computing Engineer September 2011 – September 2012
Staff in the USC Lockheed Martin Quantum Computing Center. Research in quantum computation, with emphasis in theory and practical applications of current implementations of quantum annealing.

Harvard University Cambridge, USA
Harvard Associate September 2011 – present
Research in quantum computation, quantum information, quantum simulators, and computational quantum chemistry, in collaboration with Alan Aspuru-Guzik's group.

Harvard University Cambridge, USA
Postdoctoral Scholar August 2010 – September 2011
Research in quantum computation, quantum information, quantum simulators, and computational quantum chemistry, as part of Alan Aspuru-Guzik's group.

California Institute of Technology Pasadena, USA
Postdoctoral Scholar September 2008 – August 2010
Research in quantum computation and quantum information within the Institute of Quantum Information. The director of this research group is John Preskill.

Los Alamos National Laboratory Los Alamos, USA
Graduate Research Assistant September 2006 – September 2008
Research in quantum metrology, nonlocality, quantum algorithms, advised by Howard Barnum.

University of New Mexico Albuquerque, USA
Research Assistant September 2005 – September 2008
Research in quantum estimation theory and decoherence. My PhD advisor was Carlton M. Caves.

Los Alamos National Laboratory   Los Alamos, USA
Summer Research Assistantship   Summer 2005
Research in the study of the decoherence of Generalized Coherent States under a Markovian environment, advised by Gerardo Ortiz and Lorenza Viola.

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, 2002.
- B.S. in Computer Science, Universidad Complutense, Spain, Madrid, 1996.

Papers

1. Boixo S., Rønnow T. F., Isakov S. V., Wang Z., Wecker D., Lidar D. A., Martinis J. M., Troyer M., *Quantum annealing with more than one hundred qubits', arXiv:1304.4595 (2013).*

2. *R. D. Somma and S. Boixo,* Spectral gap amplification, *SIAM Journal on Computing,* **42**, *593, (2013). Accepted to QIP 2012 as a contributed talk.*

3. *S. Boixo, T. Albash, F. M. Spedalieri, N. Chancellor, and D. A. Lidar,* Experimental signature of programmable quantum annealing, *arXiv:1212.1739 (2012).*

4. *J-S Xu, M-H Yung, X-Y Xu, S. Boixo, Z-W Zhou, C-F Li, A. Aspuru-Guzik and G-C Guo,* Demon-like Algorithmic Quantum Cooling and its Realization with Quantum Optics, *arXiv:1206.4197 (2012).*

5. *T. Albash, S. Boixo, D. A. Lidar, P. Zanardi,* Quantum Adiabatic Markovian Master Equations, *New J. Phys.* **14**, *123016 (2012).*

6. *S. Boixo and C. Heunen,* Entangled and sequential quantum protocols with dephasing, *Phys. Rev. Lett.* **108**, *120402 (2012).*

7. *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.*

8. *S. Boixo, M. Diaz-Vicente, A. Colmenar and M. Castro,* Potential energy savings from cool roofs in Spain and Andalusia, *Energy,* **38**, *425 (2012).*

9. *C. Heunen and S. Boixo,* Completely positive classical structures and sequentializable quantum protocols, *In Proceedings 8th International Workshop on Quantum Physics and Logic, Nijmegen, Netherlands, 2011. EPTCS* **95** *91 (2012).*

10. *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).*

11. *D. Cavalcanti, L. Aolita, S. Boixo, K. Modi, M. Piani and A. Winter,* Operational Interpretations of Quantum Discord, *Phys. Rev. A* **83**, *032324 (2011).*

12. *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.*

13. *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).*

14. *S. Boixo, E. Knill and R.D. Somma,* Fast Quantum Algorithms for Traversing Paths of Eigenstates, *arXiv:1005.3034.*

15. *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.*

16. *S. Boixo and R.D. Somma,* Necessary Condition for the Quantum Adiabatic Approximation, *Phys. Rev. A* **81**, *032308 (2010).*

17. *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).*

18. *S. Boixo, E. Knill, and R. D. Somma,* Eigenpath Traversal by Phase Randomization, *QIC* **9**, *0833 (2009).*

19. *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).*

20. *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).*

21. *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).*

22. *R. D. Somma, S. Boixo, H. Barnum and E. Knill,* Quantum Simulations of Classical Annealing Processes, *Phys. Rev. Lett.* **101**, *130504 (2008).*

23. *S. Boixo, S. and R. D. Somma,* Parameter Estimation with Mixed-state Quantum Computation, *Phys. Rev. A* **77**, *052320 (2008).*

24. *S. Boixo and A. Monras,* An Operational Interpretation for Multipartite Entanglement, *Phys. Rev. Lett.* **100**, *100503 (2008).*

25. *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).*

26. *R. D. Somma, S. Boixo and H. Barnum,* Quantum Simulated Annealing, *arXiv:0712.1008, (2008).*

27. *S. Boixo, S. T. Flammia, C. M. Caves and JM Geremia,* Generalized Limits for Single-Parameter Quantum Estimation, *Phys. Rev. Lett.* **98**, *090401 (2007).*

28. *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.*

29. *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. *Experimental signatures of quantum annealing,* invited talk at the American Physical Society March Meeting, Baltimoore, MD, March 2013.

2. *Experimental signature of programmable quantum annealing,* The Second International Workshop on Adiabatic Quantum Computing (AQC 2013), Invited Speaker, London, England, March 2013.

3. *Experimental signatures of quantum annealing,* Southwest Quantum Information and Technology, Santa Barbara, CA, February 2013.

4. *Quantum Annealing,* NASA Ames Colloquium, Moffett Field, CA, February 2013.

5. *Benchmarks with D-Wave 108-Qubits Chip,* ITAMP workshop, Harvard, June 2012.

6. *Benchmarking D-Wave One (with quantumness),* USC Physics Colloquium, Los Angeles, CA, Apr 2012.

7. *Benchmarking D-Wave One,* American Physical Society March Meeting, Boston, MA, Feb 2012.

8. *Benchmarking D-Wave One,* Southwest Quantum Information and Tech- nology, Albuquerque, NM, Feb 2012.

9. *Adiabatic Quantum Computation: Theory and Practice,* USC, Los Angeles, CA, Feb 2012.

10. *Adiabatic Quantum Machine Learning*, First NASA Quantum Future Technologies Conference , Moffett Field, CA, January 2012.

11. *Optimization for Prediction of Solar Cell Materials*, NSF QIQC Winter School, Palm Springs, CA, January 2012.

12. *D-Wave One quantum processor: technology and applications*, Masterworks talk in the International Conference for High Performance Computing, Networking, Storage and Analysis (SC11), November 2011.

13. *Quantum Annealing for Machine Learning*, ISI, Los Angeles, CA, June 2011.

14. *Quantum Machine Learning for Validation of Dynamical Control*, Lockheed Martin Fellows Conference, Orlando, FL, September 2011.

15. *Quantum Engineering*, USC, Los Angeles, CA, April 2011.

16. *Perturbation of Thermal States and Quantum Thermalization*, IQC seminar, Waterloo, ON, Canada, March 2011.

17. *The Adiabatic Theorem and Eigenpath Traversal*, PI seminar, Waterloo, ON, Canada, March 2011.

18. *Stochastic Matrices vs. Stoquastic Hamiltonians and Gap Amplification Quantum Speedups*, DWave, Burnaby, BC, Canada, January 2011.

19. *Quantum Adiabatic Speedups for V&V, General Theoretical Remarks*, Dalhousie University, Halifax, NS, Canada, September 2010.

20. *Fully Sequentializable Quantum Estimation Protocols*, UNM, Albuquerque, NM, July 2010.

21. *Preparing Thermal States of Quantum Systems on a Quantum Computer*, Los Alamos National Laboratory, NM, July 2010.

22. *Quantum State Preparation by Phase Randomization*, invited talk at the American Physical Society March Meeting, Portland, OR, March 2010.

23. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, USC, Los Angeles, CA, March 2010.

24. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, National University of Singapore, CQT, Singapore, March 2010.

25. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Harvard, Cambridge, MA, February 2010.

26. *Local Quantum Measurement and Relativity Imply Quantum Correlations*, Workshop on Quantum Information Processing, Zurich, Switzerland, January 2010.

27. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Perimeter Institute, Waterloo, Canada, August 2009.

28. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Universidad Complutense, Madrid. Spain, August 2009.

29. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, ICFO, Barcelona. Spain, August 2009.

30. *The Quantum Adiabatic Theorem and Eigenpath Traversal*, Universidad Autonoma de Barcelona, Barcelona. Spain, August 2009.

31. *Quantum Computing trough Phase Randomization*, Universidad Autonoma de Barcelona, Barcelona, Spain, March 2009.

32. *Quantum Computing through Decoherence*, Southwest Quantum Information and Technology, Seattle, WA, February 2009.

33. *Generalized Quantum Metrology with BECs*, Interf08, Trento, Italy, April 2008.

34. *Quantum Simulated Annealing.* American Physical Society March Meeting, New Orleans, LA, 2008.

35. *Quantum-limited Metrology with Product States.* Southwest Quantum Information and Technology, Santa Fe, NM, February 2008.

36. *Quantum Simulated Annealing.* Institute Quantum Information seminar, Caltech, Pasadena, CA, January 2008.

37. *Quantum Simulated Annealing.* Universidad Autonoma de Barcelona, Barcelona, Spain, December 2007.

38. *Quantum Phase Estimation.* PIQuDos seminar, Perimeter Institute, Waterloo, Canada, November 2007.

39. *Simple Multi-parameter Unitary Estimation.* American Physical Society March Meeting, Denver, CO, 2007.

40. *Distinguished Quantum States.* Quantum Lunch, Los Alamos National Laboratory, January, 2007.

41. *Generalized Coherent States via Markovian Decoherence.* American Physical Society March Meeting, Baltimore, MD, 2006.

42. *Generalized Coherent States via Markovian Decoherence.* Universidad Autonoma de Barcelona, Barcelona, Spain, December 2005.

43. *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 Madrilena Fellowship, 2008.
- PhD with Distinction, 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

- Editorial Board Member, Scientific Reports, Nature Publishing Group.
- 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.
- Organized Focus Session at the American Physical Society March Meeting, 2013.
- Science Fair Judge in NM, USA.