Dave Bacon

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Research Interests

Quantum computing, quantum error correction, quantum algorithms, quantum entanglement, decoherence, natural computing, fault-tolerant computing

Education

University of California, Berkeley, Berkeley, CA

Ph.D. from the Department of Physics, 2001

- Dissertation: "Decoherence, Control, and Symmetry in Quantum Computers"
- Advisor: K. Birgitta Whaley (Chemistry)

California Institute of Technology, Pasadena, CA

B.S. with honors, Physics, 1997
B.S. with honors, Literature, 1997

Current Position

University of Washington, Seattle, WA

Research Assistant Professor, Department of Computer Science & Engineering **2006 - present**
Adjunct Research Assistant Professor, Department of Physics **2007 - present**

Past Positions

University of Washington, Seattle, WA **2005-2006**
Principal Research Scientist, Department of Computer Science & Engineering

Santa Fe Institute, Santa Fe, NM **2004-2005**
Postdoctoral Fellow

California Institute of Technology, Pasadena, CA **2001-2004**
Postdoctoral Scholar, Department of Physics and Institute for Quantum Information

Honors and Awards

Commencement Speaker, Yreka High School, Yreka, CA	2007
Outstanding Graduate Student Instructor Award, U.C. Berkeley	1998
Department of Physics Fellowship, U.C. Berkeley	1997-1998
Carnation Merit Scholarship (full tuition scholarship), Caltech	1995-1997
Frederic W. Hinrichs, Jr. Memorial Award for student leadership, Caltech	1997
Green Memorial Scholarship for creative research in science, Caltech	1997

Grants

NSF CCF division, Award 0829937 2008-2011
"Robust Quantum Simulation Techniques for Fault-Tolerant Quantum Computation"
Three years, $300,000. PI: Dave Bacon

NSF PHY division, Award 803478 2008-2011
"Quantum Concatenated Code Hamiltonians"
Three years, $300,000. PI: Dave Bacon

GRANTS CONTINUED

DARPA QuEST Grant 2008-2011
Budget TBD, PI:Dave Bacon

NSF CCF division, Award 06221621 2006-2009
"Microarchitectures for Quantum Computers"
Three years, $275,000. PIs: Mark Oskin and Dave Bacon

US Army Research Office/National Security Agency, Award W911NSF-06-1-037 2006-2009
"The Hidden Subgroup Conjugacy Problem and Beyond"
Three years, $300,000. PI: Dave Bacon

NSF CCF division, Award 0523359 2005-2008
"Self-Correcting Fault-Tolerant Quantum Computers"
Three years, $400,000 plus $6000 REU. PIs: Dave Bacon and Mark Oskin

SERVICE

Member of the American Physical Society, active in the APS topical group on quantum information:

Elected vice-chair of topical group (appointment terminating in chair position) 2008-2011
Member of the award committee of topical group 2007
Advisory board member and acting Secretary/Treasurer of topical group 2006-2007

Referee and Publications

Associate editor: ACM Transactions on Computation Theory, 2008-present
Journal referee: Science, Nature Physics, Physical Review A, Physical Review B, Physical Review Letters, Reviews of Modern Physics, Proceeding of the Royal Society A, Europhysics Letters, Journal of Physics A, Journal of Optics B, Physica A, Foundations of Physics Letters, Quantum Information Processing, Quantum Information and Computation, and New Journal of Physics, Information and Computation.
Conference referee: FOCS, STOC, CCC, QIP, and ISIT.

Conferences

Program Committee: QIP 2008, TQC 2009
Local Coorganizer: SQuInT 2009
Co-organizer: student participation NSF ITR PI meeting (Ft. Lauderdale, FL), 2003
Student Co-organizer: SQuInT summer school (Santa Fe, NM), 2001.
Member: SQuInT executive committee 2006-present

Committees

Member: Advisory committee for Sandia Grand Challenge in quantum computing, 2007-present
Member: Provost appointed committee for establishment of a Molecular Engineering Program at the University of Washington. Education subcommittee lead. 2006-2007

Outreach

Blog: Member of Scienceblogs, Seed magazine's select blogging site, and maintainer of "The Quantum Pontiff" blog which covers quantum computing and quantum theory news. Web site: http://www.scienceblogs.com/pontiff
Science 2.0: Creator and proprietor of SciRate, a digg like front end for the preprint arXiv. Web site: http://scirate.com

Member APS, IEEE, ACM, SIGACT

Supervision

Postdoctoral Scholars

Thomas Decker, UW Department of Computer Science & Engineering, currently postdoc at McGill University, Montreal, Canada 2006-2007

Ph.D. Graduate Students

Gregory Crosswhite, UW Department of Physics, DOE CSGF Fellowship winner 2006-present
Alice Neels, UW Department of Computer Science & Engineering, 2008-present
Paul Pham, UW Department of Computer Science & Engineering, on leave 2006

Masters Graduate Students

Yoshiro Toda, UW Department of Physics, Evening Masters Program 2006-present
Roger Wolfson, UW Department of Physics, Evening Masters Program 2007-present

Visiting Graduate Students

Andrea Casaccino, Department of Computer Science, University of Siena, Italy 2006

Undergraduate Students

Elizabeth Muhm, UW Department of Computer Science & Engineering and Department of Math, Washington NASA Space Grant winner 2007-present
William Johnson, UW Department of Computer Science & Engineering 2008-present
Alper Sarikaya, UW Department of Computer Science & Engineering and Department of Chemistry 2008-present
Thomas Patecky, UW Department of Computer Science & Engineering 2005-2006

Teaching

University of Washington

CSE 322: Introduction to Formal Methods in Computer Science (undergrad)	Autumn 2008
CSE 322: Introduction to Formal Methods in Computer Science (undergrad)	Spring 2008
CSE 321: Discrete Mathematics (undergrad)	Autumn 2007
CSE 326: Data Structures (undergrad)	Winter 2007
CSE 370: Introduction to Digital Design (undergrad)	Spring 2006
CSE 599d: Quantum Computing (graduate)	Winter 2006
CSEP 590: Quantum Computing (professional masters course)	Summer 2005

Summer Schools, Tutorials, Outreach, Guest Lectures

Quantum Error Correction Conference (USC) 2008
Tutorial on topological quantum codes and subsystem codes

CSE 471 guest lecture (University of Washington) 2008
Introduction to quantum computing and quantum architectures

CSE professional masters program guest lecture (University of Washington) 2008
Introduction to quantum computing and quantum algorithms

CSE 471 guest lecture (University of Washington) 2007
Introduction to quantum computing and quantum architectures

Math Club talk, (Santa Monica, CA) 2005
Public lecture on quantum computing

Scuola di Dottorato in Ingegneria Informatica (Siena, Italy) 2005
Six summer school lectures introducing quantum computing

Santa Fe Institute Complex Systems Summer School (Santa Fe, NM) 2005
Introductory lecture on quantum computing

SQuInT Student Retreat (Tucson, AZ) 2005
Lectures on quantum algorithms

Teaching Continued

Computing Beyond Silicon Summer School (Caltech) Lecture on quantum information theory	2004
SAGE Class on Physics and Information (University of Arizona) Introductory public lecture on quantum computation	2004
SQuInT Student Retreat (Asilomar Conference Grounds, Monterey, CA) Two lectures on quantum error correction	2003
Sophomore Quantum Mechanics, Upper Level Classical Mechanics (Caltech) Two lectures on quantum theory, one on classical mechanics	2003
Quantum Information Science (MIT) Three guest lectures for graduate level quantum computation class	2003
MSRI Introductory Workshop in Quantum Computation (Berkeley) Lectures on quantum error correction and novel quantum computation	2002
Computing Beyond Silicon Summer School (Caltech) Lecture on quantum algorithms	2002
Quantum Information and Computation Summer School (Univ. of Queensland) Lectures on quantum error correction and fault-tolerance	2002
SQuInT Student Retreat (St. Johns College Santa Fe, NM) Lecture on universal quantum computation	2001
Graduate student instructor (Berkeley) Freshman honors mechanics (outstanding graduate instructor award) Quantum mechanics for physics major. Freshman mechanics for engineers	1997-2000

Journal Articles

28. D. Bacon, "Quantum Concatenated Code Hamiltonians," Physical Review A, 78, 042324 (2008)

27. G. Crosswhite and D. Bacon, "Finite automata for caching in matrix product algorithms", Physical Review A, 78, 012356 (2008)

26. D. Bacon and T. Decker, "The Optimal Single Copy Measurement for the Hidden Subgroup Problem," Physical Review A, 77, 032335 (2008)

25. D. Bacon, "How a Clebsch-Gordan Transform Helps to Solve the Heisenberg Hidden Subgroup Problem," Quantum Information and Computation, 8, 0438-0467 (2008)

24. D. Bacon, "Does Our Universe Allow for Robust Quantum Computation?" Science, 317, 1876-1877 (2007).

23. D. Bacon and D. Leung, "Toward a world with quantum computers," Communications of the ACM, 50, 55-59 (2007)

22. D. Bacon, I.L. Chuang, and A.W. Harrow, "Efficient Quantum Circuits for Schur and Clebsch-Gordan Transforms," Physical Review Letters, 97, 170502 (2006)

21. D. Bacon, A.M. Childs, and W. van Dam, "Optimal measurements for the dihedral hidden subgroup problem," Chicago Journal of Theoretical Computer Science, 2, (2006)

20. D. Bacon, "Operator Quantum Error-correcting Subsystems for Self-correcting Quantum Memories," Physical Review A, 73, 012340 (2006)

19. T. Tessier, C.M. Caves, I.H. Deutsch, D. Bacon and B. Eastin, "Optimal Classical-Communication-Assisted Local Model of n-qubit Greenberger- Horne-Zeilenger Correlations," , Physical Review A, 72, 032305 (2005)

JOURNAL ARTICLES CONTINUED

18. M.J. Bremner, D. Bacon, and M. A. Nielsen, "Simulating Hamiltonian Dynamics Using Many-qudit Hamiltonians and Local Unitary Control,". Physical Review A, 71, 052312 (2005)

17. D. Bacon, "Quantum Computational Complexity in the Presence of Closed Timelike Curves," Physical Review A, 70, 032309 (2004)

16. M.J. Bremner, J.L. Dodd, M.A. Nielsen, and D. Bacon, "Fungible Dynamics: There are Only Two Types of Entangling Multiple-qubit Interactions", Physical Review A, 69, 012313 (2004)

15. B.F. Toner and D. Bacon, "The Communication Cost of Quantum Correlations," Physical Review Letters, 91, 187904 (2003)

14. D. Bacon and B.F. Toner, "Bell Inequalities with Auxiliary Communication," Physical Review Letters, 90, 157904 (2003)

13. D. Bacon, K.R. Brown, and K.B. Whaley, "Coherence-Preserving Quantum Bits," Physical Review Letters, 87, 247902 (2001)

12. J. Kempe, D. Bacon, D.P. DiVincenzo, and K.B. Whaley,"Encoded Universality from a Single Physical Interaction Quantum Information and Computation," Quantum Information and Computation, 1, 33-55 (2001)

11. D. Bacon, A.M. Childs, I.L. Chuang, J. Kempe, D.W. Leung, and X. Zhou, "Universal Simulation of Markovian Quantum Dynamics," Physical Review A, 64, 062302 (2001)

10. S. Massar, D. Bacon, N. Cerf, and R. Cleve, "Classical Simulation of Quantum Entanglement without Local Hidden Variables," Physical Review A, 63, 052305 (2001)

9. D.P. DiVincenzo, D. Bacon, J. Kempe, G. Burkard, and K.B. Whaley,"Universal Quantum Computation with the Exchange Interaction," Nature, 408, 339-342 (2001)

8. J. Kempe, D. Bacon, D.A. Lidar, and K.B. Whaley,"Theory of Decoherence-Free Fault-Tolerant Quantum Computation," Physical Review A, 63, 042307 (2001)

7. D.A. Lidar, D. Bacon, J. Kempe, and K.B. Whaley, "Decoherence-Free Subspaces for Multiple-Qubit Errors. II. Universal, Fault-Tolerant Quantum Computation," Physical Review A, 63, 022307 (2001)

6. D.A. Lidar, D. Bacon, J. Kempe, and K.B. Whaley, "Decoherence-Free Subspaces for Multiple-Qubit Errors. I. Characterization," Physical Reveiw A, 63, 022306 (2001)

5. D. Bacon, J. Kempe, D.A. Lidar, and K.B. Whaley,"Universal Fault-Tolerant Quantum Computation on Decoherence-Free Subspaces," Physical Review Letters, 85, 1758-1761 (2000)

4. D.A. Lidar, D. Bacon, J. Kempe, and K.B. Whaley,"Protecting Quantum Information Encoded in Decoherence-Free Subspaces Against Exchange Errors," Physical Review A, 61, 052307 (2000)

3. D. Bacon, D.A. Lidar, and K.B. Whaley,"Robustness of Decoherence-Free Subspaces for Quantum Computation," Physical Review A, 60, 1944-1955 (1999)

2. D.A. Lidar, D. Bacon, and K.B. Whaley, "Concatenating Decoherence-Free Subspaces with Quantum Error Correcting Codes," Physical Review Letters, 82, 4556-4559 (1999)

Journal Articles Continued

1. D. Bacon, T. Cahill, and T.A. Tombrello, "Sailing Stones on Racetrack Playa," The Journal of Geology, 104, 121-125 (1996)

Journal Articles Submitted

1. D. Bacon, "Simon's Algorithm, Clebsch-Gordan Sieves, and Hidden Symmetries of Multiple Squares" (2008) Eprint arXiv:0808.0174

Papers in Refereed Proceedings

3. D. Bacon, I.L. Chuang, and A.W. Harrow, "The Quantum Schur Transform: I. Efficient Qudit Circuits," Proceedings of the 18th Annual ACM-SIAM Symposium on Discrete Algorithms, SIAM (Philadelphia, PA) 1235 1244 (2007)

2. D. Bacon, A.M. Childs, and W. van Dam,"From Optimal Measurement to Efficient Quantum Algorithms for the Hidden Subgroup Problem over Semidirect Product Groups," Proceedings of the 46th Annual Symposium on Foundations of Computer Science, IEEE (Los Alamitos, California) 469 (2005)

1. D. Bacon, J. Kempe, D.P. DiVincenzo, D.A. Lidar, and K.B. Whaley, "Encoded Universality in Physical Implementations of Quantum Computers," Proceedings of the International Conference on Experimental Implementation of Quantum Computation, Sydney, Australia (2001)

Book Reviews

2. D. Bacon "Populist Quantum Theory", Nature Physics, 4, 509 (2008)

1. D. Bacon "On 'Principles of Quantum Computation and Information. Volume 1: Basic Concepts."' Quantum Information and Computation, 5, 178 (2005)

Invited Contributions to Unrefereed Proceedings

1. D. Bacon, and A. Casaccino, "Quantum Error Correcting Subsystem Codes From Two Classical Linear Codes," Proceedings of the 44th Annual Allerton Conference on Communication, Control, and Computing, (2006)

Patents

1. K. B. Whaley, D. A. Lidar, J. Kempe, and D. Bacon,U.S. Patent #7,184,555 "Quantum Computation," Assignee: Magiq Technologies, Inc (2007)

Invited Talks

2008

University of Washington Physics Colloquium (Seattle, WA)
DoD HPCMP Users Group Conference (Seattle, WA)
IBM Quantum seminar (IBM TJ Watson, Yorktown Heights, NY)
APS 2008 March Meeting Invited Talk (New Orleans, LA)
Princeton PCTP Seminar (Princeton, NJ)

2007

Asian Conference on Quantum Information Science (Kyoto, Japan)
ARO Quantum Algorithms Program Review (Minneapolis, Minnesota)
University of Oregon, Department of Physics Colloquium (University of Oregon)
Perimeter Institute Quantum Discussions Seminar (Perimeter Institute)
MIT Quantum Information Processing Seminar (MIT)
8th Annual Meeting of the SQuInT Network (Caltech)
Condensed Matter / AMO Seminar (University of Washington)

2006

Georgia Tech Physics Colloquium (Georgia Tech)
Reed College Physics Seminar (Reed College)
Quantum Information seminar (University of Innsbruck, Austria)
Condensed Matter / AMO Seminar (University of Washington)

Invited Talks Continued

2006 continued

7th European QIPC Workshop (London, England)
Computer Science & Engineering Colloquium (University of Washington)
Quantum Information Meets Nanotechnology (Bell Labs, NJ)
7th Annual Meeting of the SQuInT Network (Albuquerque, NM)
Workshop on Ion Trap Quantum Computing (NIST Boulder)
44th Annual Alerton Conference (Alerton House, IL)
9th Annual Meeting of the APS Northwest Section (University of Puget Sound, WA)

2005

Institute for Quantum Information Seminar (Caltech)
Computer Science Department Colloquium (Portland State University)
Two Quantumlah Group Seminars (National University of Singapore
Computer Science & Engineering Colloquium (University of Washington)
6th Annual Meeting of the SQuInT Network (Tucson, AZ)
Possible Paths Seminar (Santa Fe Institute)
The Eighth Workshop on Quantum Information Processing (MIT)

2004

Center for Advanced Studies Seminar (University of New Mexico)
Quantum Information and Quantum Control Conference (University of Toronto)
DARPA Workshop on Quantum Error Correction (Chicago)
Perimeter Institute Seminar (Perimeter Institute)
Solid State Seminar (Oregon State)

2003

Los Alamos Quantum Lunch Series (Los Alamos, NM)
Quantum Information Processing Seminar (MIT)
5th Annual Meeting of the SQuInT Network (Santa Fe, NM)
US-Australia Workshop on Solid State and Optical Approaches to QIS (Sydney, Australia)

2002

MSRI Quantum Algorithms and Complexity Conference (Banff, Alberta)
Toronto Quantum Information Seminars (University of Toronto)
Quantum Information and Computation Summer School (University of Queensland)
The 6th International Conference on QCMC (MIT)
Quantum Technologies Seminar (JPL)

2001

Institute for Quantum Information seminar (Caltech)
31st Winter Colloquium on the Physics of Quantum Electronics (Snowbird, Utah)
Quantum Computing Program Review for DARPA/ARO/NSA (Baltimore, MD)

2001

2nd Annual Meeting of the SQuInT Network (University of New Mexico)