

## **ROBERT J. SCHOELKOPF**

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### **PERSONAL**

U.S. Citizen. Married, two children.

### **EDUCATION**

Princeton University, A.B. Physics, cum laude.	1986
California Institute of Technology, Ph.D., Physics.	1995

### **ACADEMIC APPOINTMENTS**

Director of Yale Quantum Institute	2014 – present
Sterling Professor of Applied Physics and Physics, Yale University	2013- present
William A. Norton Professor of Applied Physics and Physics, Yale University	2009-2013
Co-Director of Yale Center for Microelectronic Materials and Structures	2006-2012
Associate Director, Yale Institute for Nanoscience and Quantum Engineering	2009
Professor of Applied Physics and Physics, Yale University	2003-2008
Interim Department Chairman, Applied Physics, Yale University	July-December 2012
Visiting Professor, University of New South Wales, Australia	March-June 2008
Assistant Professor of Applied Physics and Physics, Yale University	July 1998-July 2003
Associate Research Scientist and Lecturer, Department of Applied Physics, Yale University	January 1995-July 1998
Graduate Research Assistant, Physics, California Institute of Technology	1988-1994
Electrical/Cryogenic Engineer, Laboratory for High-Energy Astrophysics, NASA/Goddard Space Flight Center	1986-1988

### **HONORS AND AWARDS**

Connecticut Medal of Science (The Connecticut Academy of Science and Engineering)	2017
Elected to American Academy of Arts and Sciences	2016
Elected to National Academy of Sciences	2015
Max Planck Forschungspreis	2014
Fritz London Memorial Prize	2014
John Stewart Bell Prize	2013
Yale Science and Engineering Association (YSEA) Award for Advancement of Basic and Applied Science	2010
Member of Connecticut Academy of Science and Engineering	2009
APS Joseph F. Keithley Award for Advances in Measurement Science	2009
Fellow of American Association for the Advancement of Science	2007
Fellow of American Physical Society	2005
Member of Defense Science Study Group	2004-2005
Yale University Junior Faculty Fellowship	2002-2003

**CURRENT DOCTORAL ADVISEES**

Christopher Axline	(2012 – present)
Luke Burkhart	(2014 – present)
Kevin Chou	(2011 – present)
Jacob Curtis	(2017 - present)
Sal Elder	(2017 - present)
Yvonne Gao	(2012 – present)
Suhas Ganjam	(2017 - present)
Parker Henry	(2016 – present)
Lev Krayzman	(2015 – present)
Kaicheng Li	(2016 – present)
Philip Reinhold	(2013 – present)
James Teoh	(2017 - present)
Christopher Wang	(2015 – present)
Taekwan Yoon	(2016 - present)

**GRADUATE STUDENTS SUPERVISED**

Jacob Blumoff	<i>(Ph.D. - 2017; Research Staff, HRL)</i>
Teresa Brecht	<i>(Ph.D. - 2017; Research Staff, HRL)</i>
Andrei Petrenko	<i>(Ph.D. - 2015; Quantum Measurement Scientist, Quantum Circuit, Inc.)</i>
Matthew Reagor	<i>(Ph.D. - 2015; Research Staff at Rigetti Computing)</i>
Eric Holland	<i>(Ph.D. – 2015; Research Staff at Lawrence Livermore National Lab)</i>
Brian Vlastakis	<i>(Ph.D. – 2015; Research Staff at IBM)</i>
Andreas Fragner	<i>(Ph.D. – 2013; Quantitative Analyst, Oxford Asset Management)</i>
Matthew Reed	<i>(Ph.D. – 2013; Research Staff at HRL)</i>
Adam Sears	<i>(Ph.D. – 2013; Research Staff at Lincoln Labs)</i>
Blake Johnson	<i>(Ph.D. – 2011; Research Staff at Raytheon BBN)</i>
Jerry M. Chow	<i>(Ph.D. – 2010; Research Staff at IBM Watson)</i>
John Teufel	<i>(Ph.D. – 2008), Research Staff at NIST/Boulder)</i>
David Schuster	<i>(Ph.D. – 2007; Faculty at University of Chicago)</i>
Julie Wyatt-Love	<i>(Ph.D. – 2007; Corporate Strategy at Adobe)</i>
Benjamin Turek	<i>(Ph.D. – 2007; Research Staff at John Hopkins APL)</i>
Minghao Shen	<i>(Ph.D. – 2005); Advanced Micro Devices, Inc.</i>
Lafe Spietz	<i>(Ph.D. – 2001)</i>

**UNDERGRADUATE STUDENTS SUPERVISED**

Katherine Aidala	Faculty at Mount Holyoke College, MA
Will Braff	
Spencer DeSanto	
Benjamin Jarvis	
Sameer Kumar	
Molly Silfen	

## Robert J. Schoelkopf

Jared Schwede  
Max Ventilla  
Shunjiang Xu

Co-founder of Spark Thermionics, CA

### CURRENT POSTDOC ADVISEES

Yiwen Chu  
Brian Lester  
Chan U Lei  
Wolfgang Pfaff  
Serge Rosenblum

### PAST POSTDOCTORAL ADVISEES

Leonardo DiCarlo	<i>Faculty at Delft University of Technology</i>
Luigi Frunzio	<i>Senior Research Scientist, Applied Physics, Yale University</i>
Reinier Heeres	<i>Physicist at CEA Saclay, France</i>
Andrew Houck	<i>Faculty at Princeton</i>
Gerhard Kirchmair	<i>Faculty at University of Innsbruck</i>
Konrad Lehnert	<i>JILA, Univ of Colorado</i>
Johannes Majer	<i>Staff at Atominstitut, TU Vienna</i>
Nissim Ofek	<i>Google, Inc. (Israel)</i>
Hanhee Paik	<i>Research Staff at IBM Watson</i>
Ken Segall	<i>Faculty at Colgate University</i>
David Schuster	<i>Faculty at University of Chicago</i>
Irfan Siddiqi	<i>Faculty at UC Berkeley</i>
Luyan Sun	<i>Faculty at Tsinghua University</i>
Andreas Wallraff	<i>Faculty at ETH Zurich</i>
Chen Wang	<i>Faculty at University of Massachusetts Amherst</i>

### ADVISORS

Thomas G. Phillips	<i>John D. MacArthur Professor of Physics, Emeritus, California Institute of Technology (CALTECH)</i>
Daniel E. Prober	<i>Professor of Applied Physics, of Electrical Engineering and of Physics</i>
Jonas Zmuidzinas	<i>Merle Kingsley Professor of Physics; Chief Technologist, Jet Propulsion Laboratory, Division of Physics, Mathematics and Astronomy</i>

### PEER REVIEWED PUBLICATIONS

- 146) S. Rosenblum, Y.Y. Gao, P. Reinhold, C. Wang, C.J. Axline, L. Frunzio, S.M. Girvin, L. Jiang, M. Mirrahimi, M.H. Devoret, R. Schoelkopf, *A CNOT gate between multiphoton qubits encoded in two cavities*, arXiv:1709.05425v1.
- 145) A. Hosseinkhani, R.-P. Riwar, R. J. Schoelkopf, L. I. Glazman, and G. Catelani, *Optimal configurations for normal-metal traps in transmon qubits*, arXiv:1706.09336v1.
- 144) S. Touzard, A. Grimm, Z. Leghtas, S.O. Mundhada, P. Reinhold, R. Heeres, C. Axline, M. Reagor, K. Chou, J. Blumoff, K.M. Sliwa, S. Shankar, L. Frunzio, R.J. Schoelkopf, M. Mirrahimi, M.H. Devoret, *Coherent oscillations in a quantum manifold stabilized by dissipation*, arXiv:1705.02401v2.

- 141) Y. Chu, P. Kharel, W. Renninger, L.D. Burkhardt, L. Frunzio, P. Rakich, R. Schoelkopf, *Quantum acoustics with superconducting qubits*, Science, **358**, Issue 6360, pp. 199-202, DOI: 10.1126/science.aao1511. (2017)
- 142) A.P. Reed, K.H. Mayer, J.D. Teufel, L.D. Burkhardt, W. Pfaff, M. Reagor, L. Sletten, X. Ma, R.J. Schoelkopf, E. Knill, K.W. Lehnert, *Faithful conversion of propagating quantum information to mechanical motion*, Nature Physics, DOI: 10.1038/NPHYS4251. (2017)
- 143) R.W. Heeres, P. Reinhold, N. Ofek, L. Frunzio, L. Jiang, M. H. Devoret, R. J. Schoelkopf, *Implementing a Universal Gate Set on a Logical Qubit Encoded in an Oscillator*, Nature Communications **8**, 94. DOI: 10.1038/s41467-017-00045-1. (2017)
- 140) W. Pfaff, C. J. Axline, L. D. Burkhardt, U. Vool, P. C. Reinhold, L. Frunzio, L. Jiang, M. H. Devoret, and R. J. Schoelkopf, *Controlled release of multiphoton quantum states from a microwave cavity memory*, Nature Physics. DOI:10.1038/nphys4143. (2017)
- 139) T. Brecht, Y. Chu, C. Axline, W. Pfaff, J. Z. Blumoff, K. Chou, L. Krayzman, L. Frunzio, and R.J. Schoelkopf, *Micromachined integrated quantum circuit containing a superconducting qubit*. Physical Review Applied, **7**, 044018. DOI: 10.1103/PhysRevApplied.7.044018. (2017)
- 138) C. Shen, K. Noh, V.V. Albert, S. Krastanov, M. H. Devoret, R. J. Schoelkopf, S. M. Girvin, L. Jiang, *Quantum Channel Construction with Circuit Quantum Electrodynamics*, Physical Review B, **95**, 134501. DOI: 10.1103/PhysRevB.95.134501. (2017)
- 137) C. Shen, R. W. Heeres, P. Reinhold, L. Jiang, Y-K. Liu, R. J. Schoelkopf, L. Jiang, *Optimized tomography of continuous variable systems using excitation counting*, Phys. Rev. A **94** (5), 052327. (2016).
- 136) Y. Chu, C. Axline, C. Wang, T. Brecht, Y. Y. Gao, L. Frunzio, R. J. Schoelkopf, *Suspending superconducting qubits by silicon micromachining*. Appl. Phys. Lett. **109**, 112601 (2016). DOI:10.1063/1.4962327.
- 135) R.-P. Riwar, A. Hosseinkhani, L.D. Burkhardt, Y.Y. Gao, R. J. Schoelkopf, L.I. Glazman, G. Catelani, *Normal-metal quasiparticle traps for superconducting qubits*. Phys. Rev. B **94**, 104516 (2016). DOI:10.1103/PhysRevB.94.104516.
- 134) J. Z. Blumoff, K. Chou, C. Shen, M. Reagor, C. Axline, R. T. Brierley, M. P. Silveri, C. Wang, B. Vlastakis, S. E. Nigg, L. Frunzio, M. H. Devoret, L. Jiang, S. M. Girvin, R. J. Schoelkopf, *Implementing and characterizing precise multi-qubit measurements*. Phys. Rev. X **6**, 031041. (2016) DOI: 10.1103/PhysRevX.6.031041.
- 133) W.C. Smith, A. Kou, U. +Vool, I.M. Pop, L. Frunzio, R.J. Schoelkopf, M.H. Devoret, *Quantization of inductively shunted superconducting circuits*, Phys. Rev. B **94**, 144507 (2016) DOI:10.1103/PhysRevB.94.144507.
- 132) U. Vool, S. Shankar, S.O. Mundhada, N. Ofek, A. Narla, K. Sliwa, E. Zalys-Geller, Y. Lui, L. Frunzio, R.J. Schoelkopf, S.M. Girvin, M.H. Devoret, *Continuous quantum non-demolition*

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- measurement of the transverse component of a superconducting qubit*, Phys. Rev. Lett **117**, 133601 (2016). DOI:10.1103/PhysRevLett.117.133601.
- 131) C. Axline, M. Reagor, R. Heeres, P. Reinhold, C. Wang, K. Shain, W. Pfaff, Y. Chu, L. Frunzio, R.J. Schoelkopf, *An architecture for integrating planar and scaling 3D cQED devices*, Appl. Phys. Letter. **109**, 042601 (2016). DOI:10.1063/1.4959241.
- 130) A. Narla, S. Shankar, M. Hatridge, Z. Leghtas, K. M. Sliwa, E. Zaly-Geller, S.O. Mundhada, W. Pfaff, L. Frunzio, R. J. Schoelkopf, M. H. Devoret, *Robust concurrent remote entanglement between two superconducting qubits*, Phys. Rev. X **6**, 031036. (2016) DOI: 10.1103/PhysRevX.6.031036.
- 129) N. Ofek, A. Petrenko, R. Heeres, P. Reinhold, Zaki Leghtas, B. Vlastakis, Y. Liu, L. Frunzio, S. M. Girvin, L. Jiang, M. Mirrahimi, M. H. Devoret, R. J. Schoelkopf, *Extending the Lifetime of a Quantum Bit with Error Correction in Superconducting Circuits*, Nature. (2016). DOI:10.1038/nature18949.
- 128) M. Reagor, W. Pfaff, C. Axline, R.W. Heeres, N. Ofek, K. Sliwa, E. Holland, C. Wang, J. Blumoff, K. Chou, M. Hatridge, L. Frunzio, M. H. Devoret, L. Jiang, R.J. Schoelkopf. *Quantum Memory with Millisecond Coherence in Circuit QED*, Phys. Rev. B **94**,014506 (2016). DOI:10.1103/PhysRevB.94.014506.
- 127) C. Wang, Y. Y. Gao, P. Reinhold, R. W. Heeres, N. Ofek, K. Chou, C. Axline, M. Reagor, J. Blumoff, K. M. Sliwa, L. Frunzio, S. M. Girvin, L. Jiang, M. Mirrahimi, M. H. Devoret, R. J. Schoelkopf, *A Schrödinger Cat Living in Two Boxes*, Science. Vol. **352**. Issue 6289. DOI: 10.1126/science.aaf.2941.
- 126) V. V. Albert, C. Shu, S. Krastanov, C. Shen, R-B. Liu, Z-B. Yang, R. J. Schoelkopf, M. Mirrahimi, M. H. Devoret, L. Jiang, *Holonomic Quantum Control with Continuous Variable Systems*, Phys. Rev. Lett. **116**, 140502 (2016), DOI:10.1103/PhysRevLett.116.140502.
- 125) Y. Liu, N. Ofek, M. Hatridge, A. Narla, K. M. Sliwa, L. Frunzio, R. J. Schoelkopf, M. H. Devoret, *Comparing and Combining Measurement-Based and Driven-Dissipative Entanglement Stabilization*. Phys. Rev., **6**, 01022 (2016), DOI: 10.1103/PhysRevX.6.011022.
- 124) T. Brecht, C. Wang, Y. Chu, L. Frunzio, M. H. Devoret, R. J. Schoelkopf, *Multilayer Microwave Integrated Quantum Circuits for Scalable Quantum Computing*. NPJ Quantum Information, **2** (2016), 16002. 10.1038/npjqi.2016.2.
- 123) G. Yang, A. Fragner, G. Koolstra, L. Ocola, D.A. Czaplewski, R.J. Schoelkopf, and D.I. Schuster, *Coupling an ensemble of electrons on superfluid helium to a superconducting circuit*. Phys. Rev. X, **6** (2016), DOI: 10.1103/PhysRevX.6.011031.
- 122) Z. K. Mineev, I. M. Pop, Z. Leghtas, K. Sliwa, M. J. Hatridge, L. Frunzio, R. J. Schoelkopf, M. H. Devoret, *Planar Multilayer Circuit Quantum Electrodynamics*, Phys. Rev. Applied, **5** (2016), DOI: 10.1103/PhysRevApplied.5.044021.
- 121) C. Wang, C. Axline, Y.Y. Gao, T. Brecht, Y. Chu, L. Frunzio, M.H. Devoret, R.J. Schoelkopf,

- Surface Participation and Dielectric Loss in Superconducting Qubits. Applied Physics Letters*, **107** (2015), 162601, DOI: 10.1063/1.4934486.
- 120) B. Vlastakis, A. Petrenko, N. Ofek, L. Sun, Z. Leghtas, K. Sliwa, Y. Liu, M. Hatridge, J. Blumoff, L. Frunzio, M. Mirrahimi, L. Jiang, M.H. Devoret, R.J. Schoelkopf, *Characterizing Entanglement of an Artificial Atom and a Cavity Cat State with Bell's Inequality. Nature Communications*, **6** (2015) 8970. DOI: 10.1038/ncomms9970.
- 119) K.M. Sliwa, M. Hatridge, A. Narla, S. Shankar, L. Frunzio, R.J. Schoelkopf, M.H. Devoret, *Reconfigurable Josephson Circulator/Directional Amplifier. Phys Rev X*, **5** (2015). 041020, DOI: 10.1103/PhysRevX.5.041020.
- 118) Z. Leghtas, S. Touzard, I.M. Pop, A. Kou, B. Vlastakis, A. Petrenko, K.M. Sliwa, A. Narla, S. Shankar, M.J. Hatridge, M. Reagor, L. Frunzio, R.J. Schoelkopf, M. Mirrahimi, M.H. Devoret, *Confining the State of Light to a Quantum Manifold by Engineered Two-Photon Loss. Science*, **347** (2015) 853-857. DOI: 10.1126/science.aaa2085.
- 117) S. Krastanov, V.V. Albert, C. Shen, C.L. Zou, R.W. Heeres, B. Vlastakis, R.J. Schoelkopf, L. Jiang, *Universal Control of an Oscillator with Dispersive Coupling to a Qubit. Phys Rev A*, **92** (2015). 040303, DOI: 10.1103/PhysRevA.92.040303.
- 116) E.T. Holland, B. Vlastakis, R.W. Heeres, M.J. Reagor, U. Vool, Z. Leghtas, L. Frunzio, G. Kirchmair, M.H. Devoret, M. Mirrahimi, R.J. Schoelkopf, *Single-Photon-Resolved Cross-Kerr Interaction for Autonomous Stabilization of Photon-Number States. Phys Rev Lett*, **115** (2015). 180501, DOI: 10.1103/PhysRevLett.115.180501.
- 115) R.W. Heeres, B. Vlastakis, E. Holland, S. Krastanov, V.V. Albert, L. Frunzio, L. Jiang, R.J. Schoelkopf, *Cavity State Manipulation Using Photon-Number Selective Phase Gates. Phys Rev Lett*, **115** (2015). 137002, DOI: 10.1103/PhysRevLett.115.137002.
- 114) T. Brecht, M. Reagor, Y. Chu, W. Pfaff, C. Wang, L. Frunzio, M.H. Devoret, R.J. Schoelkopf, *Demonstration of Superconducting Micromachined Cavities. Applied Physics Letters*, **107** (2015). 192603, DOI: 10.1063/1.4935541.
- 113) C. Wang, Y.Y. Gao, I.M. Pop, U. Vool, C. Axline, T. Brecht, R.W. Heeres, L. Frunzio, M.H. Devoret, G. Catelani, L.I. Glazman, R.J. Schoelkopf, *Measurement and Control of Quasiparticle Dynamics in a Superconducting Qubit. Nature Communications*, **5** (2014). 5836, DOI: 10.1038/ncomms6836.
- 112) U. Vool, I.M. Pop, K. Sliwa, B. Abdo, C. Wang, T. Brecht, Y.Y. Gao, S. Shankar, M. Hatridge, G. Catelani, M. Mirrahimi, L. Frunzio, R.J. Schoelkopf, L.I. Glazman, M.H. Devoret, *Non-Poissonian Quantum Jumps of a Fluxonium Qubit Due to Quasiparticle Excitations. Phys Rev Lett*, **113** (2014). 247001, DOI: 10.1103/PhysRevLett.113.247001.
- 111) L. Sun, A. Petrenko, Z. Leghtas, B. Vlastakis, G. Kirchmair, K.M. Sliwa, A. Narla, M. Hatridge, S. Shankar, J. Blumoff, L. Frunzio, M. Mirrahimi, M.H. Devoret, R.J. Schoelkopf, *Tracking Photon Jumps with Repeated Quantum Non-Demolition Parity Measurements. Nature*, **511** (2014) 444-+. DOI: 10.1038/nature13436.

- 110) I.M. Pop, K. Geerlings, G. Catelani, R.J. Schoelkopf, L.I. Glazman, M.H. Devoret, *Coherent Suppression of Electromagnetic Dissipation Due to Superconducting Quasiparticles*. *Nature*, **508** (2014) 369-+. DOI: 10.1038/nature13017.
- 109) A. Narla, K.M. Sliwa, M. Hatridge, S. Shankar, L. Frunzio, R.J. Schoelkopf, M.H. Devoret, *Wireless Josephson Amplifier*. *Applied Physics Letters*, **104** (2014). 232605, DOI: 10.1063/1.4883373.
- 108) M. Mirrahimi, Z. Leghtas, V.V. Albert, S. Touzard, R.J. Schoelkopf, L. Jiang, M.H. Devoret, *Dynamically Protected Cat-Qubits: A New Paradigm for Universal Quantum Computation*. *New Journal of Physics*, **16** (2014). 045014, DOI: 10.1088/1367-2630/16/4/045014.
- 107) B. Abdo, K. Sliwa, S. Shankar, M. Hatridge, L. Frunzio, R. Schoelkopf, M. Devoret, *Josephson Directional Amplifier for Quantum Measurement of Superconducting Circuits*. *Phys Rev Lett*, **112** (2014). 167701, DOI: 10.1103/PhysRevLett.112.167701.
- 106) B. Vlastakis, G. Kirchmair, Z. Leghtas, S.E. Nigg, L. Frunzio, S.M. Girvin, M. Mirrahimi, M.H. Devoret, R.J. Schoelkopf, *Deterministically Encoding Quantum Information Using 100-Photon Schrodinger Cat States*. *Science*, **342** (2013) 607-610. DOI: 10.1126/science.1243289.
- 105) M. Reagor, H. Paik, G. Catelani, L.Y. Sun, C. Axline, E. Holland, I.M. Pop, N.A. Masluk, T. Brecht, L. Frunzio, M.H. Devoret, L. Glazman, R.J. Schoelkopf, *Reaching 10 Ms Single Photon Lifetimes for Superconducting Aluminum Cavities*. *Applied Physics Letters*, **102** (2013). 192604, DOI: 10.1063/1.4807015.
- 104) Z. Leghtas, G. Kirchmair, B. Vlastakis, R.J. Schoelkopf, M.H. Devoret, M. Mirrahimi, *Hardware-Efficient Autonomous Quantum Memory Protection*. *Phys Rev Lett*, **111** (2013). 120501, DOI: 10.1103/PhysRevLett.111.120501.
- 103) Z. Leghtas, G. Kirchmair, B. Vlastakis, M.H. Devoret, R.J. Schoelkopf, M. Mirrahimi, *Deterministic Protocol for Mapping a Qubit to Coherent State Superpositions in a Cavity*. *Phys Rev A*, **87** (2013). 042315, DOI: 10.1103/PhysRevA.87.042315.
- 102) G. Kirchmair, B. Vlastakis, Z. Leghtas, S.E. Nigg, H. Paik, E. Ginossar, M. Mirrahimi, L. Frunzio, S.M. Girvin, R.J. Schoelkopf, *Observation of Quantum State Collapse and Revival Due to the Single-Photon Kerr Effect*. *Nature*, **495** (2013) 205-209. DOI: 10.1038/nature11902.
- 101) M. Hatridge, S. Shankar, M. Mirrahimi, F. Schackert, K. Geerlings, T. Brecht, K.M. Sliwa, B. Abdo, L. Frunzio, S.M. Girvin, R.J. Schoelkopf, M.H. Devoret, *Quantum Back-Action of an Individual Variable-Strength Measurement*. *Science*, **339** (2013) 178-181. DOI: 10.1126/science.1226897.
- 100) K. Geerlings, Z. Leghtas, I.M. Pop, S. Shankar, L. Frunzio, R.J. Schoelkopf, M. Mirrahimi, M.H. Devoret, *Demonstrating a Driven Reset Protocol for a Superconducting Qubit*. *Phys Rev Lett*, **110** (2013). 120501, DOI: 10.1103/PhysRevLett.110.120501.
- 99) M.H. Devoret, R.J. Schoelkopf, *Superconducting Circuits for Quantum Information: An Outlook*. *Science*, **339** (2013) 1169-1174. DOI: 10.1126/science.1231930.

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- 98) L. Sun, L. DiCarlo, M.D. Reed, G. Catelani, L.S. Bishop, D.I. Schuster, B.R. Johnson, G.A. Yang, L. Frunzio, L. Glazman, M.H. Devoret, R.J. Schoelkopf, *Measurements of Quasiparticle Tunneling Dynamics in a Band-Gap-Engineered Transmon Qubit*. *Phys Rev Lett*, **108** (2012). 230509, DOI: 10.1103/PhysRevLett.108.230509.
- 97) A.P. Sears, A. Petrenko, G. Catelani, L. Sun, H. Paik, G. Kirchmair, L. Frunzio, L.I. Glazman, S.M. Girvin, R.J. Schoelkopf, *Photon Shot Noise Dephasing in the Strong-Dispersive Limit of Circuit QED*. *Phys Rev B*, **86** (2012). 180504, DOI: 10.1103/PhysRevB.86.180504.
- 96) M.D. Reed, L. DiCarlo, S.E. Nigg, L. Sun, L. Frunzio, S.M. Girvin, R.J. Schoelkopf, *Realization of Three-Qubit Quantum Error Correction with Superconducting Circuits*. *Nature*, **482** (2012) 382-385. DOI: 10.1038/nature10786.
- 95) S.E. Nigg, H. Paik, B. Vlastakis, G. Kirchmair, S. Shankar, L. Frunzio, M.H. Devoret, R.J. Schoelkopf, S.M. Girvin, *Black-Box Superconducting Circuit Quantization*. *Phys Rev Lett*, **108** (2012). 240502, DOI: 10.1103/PhysRevLett.108.240502.
- 94) K. Geerlings, S. Shankar, E. Edwards, L. Frunzio, R.J. Schoelkopf, M.H. Devoret, *Improving the Quality Factor of Microwave Compact Resonators by Optimizing Their Geometrical Parameters*. *Applied Physics Letters*, **100** (2012). 192601, DOI: 10.1063/1.4710520.
- 93) G. Catelani, S.E. Nigg, S.M. Girvin, R.J. Schoelkopf, L.I. Glazman, *Decoherence of Superconducting Qubits Caused by Quasiparticle Tunneling*. *Phys Rev B*, **86** (2012). 184514, DOI: 10.1103/PhysRevB.86.184514.
- 92) D.I. Schuster, L.S. Bishop, I.L. Chuang, D. DeMille, R.J. Schoelkopf, *Cavity QED in a Molecular Ion Trap*. *Phys Rev A*, **83** (2011). 012311, DOI: 10.1103/PhysRevA.83.012311.
- 91) H. Paik, D.I. Schuster, L.S. Bishop, G. Kirchmair, G. Catelani, A.P. Sears, B.R. Johnson, M.J. Reagor, L. Frunzio, L.I. Glazman, S.M. Girvin, M.H. Devoret, R.J. Schoelkopf, *Observation of High Coherence in Josephson Junction Qubits Measured in a Three-Dimensional Circuit QED Architecture*. *Phys Rev Lett*, **107** (2011). 240501, DOI: 10.1103/PhysRevLett.107.240501.
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- 12) R.J. Schoelkopf, A.A. Kozhevnikov, D.E. Prober, M.J. Rooks, *Observation of "Photon-Assisted" Shot Noise in a Phase-Coherent Conductor. Phys Rev Lett*, **80** (1998) 2437-2440. DOI: 10.1103/PhysRevLett.80.2437.
- 11) P.J. Burke, R.J. Schoelkopf, D.E. Prober, A. Skalare, B.S. Karasik, M.C. Gaidis, W.R. McGrath, B. Bumble, H.G. LeDuc, *Spectrum of Thermal Fluctuation Noise in Diffusion and Phonon Cooled Hot-Electron Mixers. Applied Physics Letters*, **72** (1998) 1516-1518. DOI: 10.1063/1.121044.
- 10) R.J. Schoelkopf, P.J. Burke, D.E. Prober, B. Karasik, A. Skalare, W.R. McGrath, M.C. Gaidis, B. Bumble, H.G. LeDuc, *Noise Bandwidth of Diffusion-Cooled Hot-Electron Bolometers. IEEE Transactions on Applied Superconductivity*, **7** (1997) 3576-3579. DOI: 10.1109/77.622173.
- 9) R.J. Schoelkopf, P.J. Burke, A.A. Kozhevnikov, D.E. Prober, M.J. Rooks, *Frequency Dependence of Shot Noise in a Diffusive Mesoscopic Conductor. Phys Rev Lett*, **78** (1997) 3370-3373. DOI: 10.1103/PhysRevLett.78.3370.
- 8) R.D. Grober, R.J. Schoelkopf, D.E. Prober, *Optical Antenna: Towards a Unity Efficiency near-Field Optical Probe. Applied Physics Letters*, **70** (1997) 1354-1356. DOI: 10.1063/1.118577.
- 7) A. Skalare, W.R. McGrath, B. Bumble, H.G. LeDuc, P.J. Burke, A.A. Verheijen, R.J. Schoelkopf, D.E. Prober, *Large Bandwidth and Low Noise in a Diffusion-Cooled Hot-Electron Bolometer Mixer. Applied Physics Letters*, **68** (1996) 1558-1560. DOI: 10.1063/1.115698.
- 6) P.J. Burke, R.J. Schoelkopf, D.E. Prober, A. Skalare, W.R. McGrath, B. Bumble, H.G. LeDuc, *Length Scaling of Bandwidth and Noise in Hot-Electron Superconducting Mixers. Applied Physics Letters*, **68** (1996) 3344-3346. DOI: 10.1063/1.116052.
- 5) R.J. Schoelkopf, J. Zmuidzinas, T.G. Phillips, H.G. LeDuc, J.A. Stern, *Measurements of Noise in Josephson-Effect Mixers. IEEE Transactions on Microwave Theory Techniques*, **43** (1995) 977-983. DOI: 10.1109/22.375263.
- 4) R.J. Schoelkopf, T.G. Phillips, J. Zmuidzinas, *A 100 GHz Josephson Mixer Using Resistively-*

## Robert J. Schoelkopf

*Shunted NB Tunnel-Junctions. IEEE Transactions on Applied Superconductivity, Vol 3, No 1, March 1993 Pts 2-4, (1993) 2250-2253. DOI: 10.1109/77.233556.*

- 3) R.J. Schoelkopf, R.L. Kelley, *Detection of Coherent 7.6 Hz Oscillations during a Burst from Aquila x-1. Astrophysical Journal, 375 (1991) 696-700. DOI: 10.1086/170234.*
- 2) A. Szymkowiak, R. Kelley, G. Madejski, H. Moseley, R. Schoelkopf, B. Edwards, M. Juda, D. Mccammon, M. Skinner, J. Zhang, *High-Resolution Microcalorimeters as Detectors for Inelastic-Scattering. Review of Scientific Instrument, 60 (1989) 1557-1560. DOI: 10.1063/1.1141034.*
- 1) S.H. Moseley, R.L. Kelley, R.J. Schoelkopf, A.E. Szymkowiak, D. Mccammon, J. Zhang, *Advances toward High Spectral Resolution Quantum X-Ray Calorimetry. IEEE Transactions on Nuclear Science, 35 (1988) 59-64. DOI: 10.1109/ 23.12673.*

## CONFERENCE PROCEEDINGS AND OTHER PUBLICATIONS

- 5) C. R. Monroe, R. J. Schoelkopf and M. D. Lukin, *Quantum Connections. Scientific American, 314, 5. (2016) 50-57.*
- 4) A. Andre, D. DeMille, J.M. Doyle, M.D. Lukin, S.E. Maxwell, P. Rabl, R.J. Schoelkopf, P. Zoller, *Hybrid Quantum Information Processing with Polar Molecules. In C. Roos, H. Haffner, & R. Blatt, ed. Atomic Physics 20, vol. 869 of American Institute of Physics Conference Series, pp. 128–135: (2006). DOI:10.1063 /1.2400642.*
- 3) J.D. Teufel, T.R. Stevenson, W.T. Hsieh, M.J. Li, K.W. Rhee, C.M. Stahle, E.J. Wollack, A. Assime, P. Delsing, P. Wahlgren, D.E. Prober, R.J. Schoelkopf, *Recent Progress on Photon-Counting Superconducting Detectors for Submillimeter Astronomy. Proc. SPIE, 4855 (2003) 182-191. DOI: 10.1117/12.459712.*
- 2) W.R. McGrath, A. Skalare, B. Karasik, M. Gaidis, B. Bumble, H.G. LeDuc, P.J. Burke, R.J. Schoelkopf, D.E. Prober, *Superconductive Hot Electron Mixers for Thz Heterodyne Receiver Applications. Proc. SPIE, 3357 (1998) 14-21. DOI: 10.1117/12.317341.*
- 1) B.S. Karasik, A. Skalare, W.R. McGrath, B. Bumble, H.G. LeDuc, J.B. Barner, A.W. Kleinsasser, P.J. Burke, R.J. Schoelkopf, D.E. Prober, *Low-Noise and Wideband Hot-Electron Superconductive Mixer for Thz Frequencies. Proc. SPIE, 3465 (1998) 170-179. DOI: 10.1117/12.331162.*

## INVITED TALKS

- 77) *Oscillators for quantum information: the cat code, error correction, and two mode entanglement*  
Gordon Conference on Quantum Science, Massachusetts, August, 2016
- 76) *Oscillators for quantum information: the cat code, error correction, and two mode entanglement*  
International Conference on Atomic Physics (ICAP), Seoul, South Korea, July 2016
- 75) *Interconnects for Superconducting Quantum Computers*



**Robert J. Schoelkopf**

IEEE International Interconnect Technology Conference, San Jose, CA, May 2016

- 74) *Extending the lifetime of quantum information through error correction.*  
Southwest Quantum Information and Technology (SQUINT), Albuquerque, New Mexico, February, 2016.
- 73) *A Quantum Error Corrected Memory in Circuit QED*  
Workshop on the Physics of Quantum Electronics, Snowbird Utah, January 2016
- 72) *Extending the lifetime of a qubit through quantum error correction.*  
IBM ThinkQ workshop, T.J. Watson Research Center, December 2015.
- 71) *Putting the Bell on Schrodinger's Cat.*  
Invited talk at the workshop for 30<sup>th</sup> Anniversary of Quantronics Group, Paris, France, July 2015.
- 70) *Using Cat States in a Microwave Cavity for Quantum Information*  
CIFAR Quantum Cavities Workshop, Aachen, Germany, June 2015.
- 69) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Invited talk at CLEO Conference, San Jose, CA, May 2015.
- 68) *Tracking a Quantum Error Syndrome in Real Time: Quantum Jumps of Photon Parity.*  
Invited talk at the APS March Meeting, San Antonio, TX, March 2015.
- 67) *Circuit QED and Quantum Computing with Superconducting Devices.*  
Max Planck Prize Winner's Ceremony, Berlin, Germany, November 2014.
- 66) *Circuit QED: Quantum Optics and Quantum Information with Superconducting Circuits.*  
London Prize Winner's speech at International Low-Temperature Physics Conference LT-28, Buenos Aires, Argentina, August 2014.
- 65) *Quantum Optics with Real and Artificial Atoms.*  
Discussion leader at Gordon Research Conference on Atomic Physics, Stone Hill College, Easton, Massachusetts, July 2014.
- 64) *Using Cat States in a Microwave Cavity for Quantum Information.*  
Microsoft Workshop, Redmond WA, July 2014.
- 63) *Building a Quantum Computer*  
Invited talk at the Microsoft Faculty Research Summit, Redmond, WA, July 2014.
- 62) *Using Cat States in a Microwave Cavity for Quantum Information,* Aspen Winter Workshop on Advances in Quantum Algorithms and Computation, Aspen, CO March 2014.
- 61) *The Future of Superconducting Quantum Computation.*  
Army Research Office Workshop, Virginia, September 2013.
- 60) *Circuit QED, Schrodinger Cats, and Quantum Jumps of Parity.* Workshop on Cavity and Circuit

**Robert J. Schoelkopf**

Quantum Electrodynamics, Max Plank Institute, Munich, Germany, September 2013.

- 59) *Quantum Optics with Superconducting Circuits: From Single Photons to Schrodinger Cats.*  
Canadian Institute for Advanced Research (CIFAR) Workshop on Quantum Cavities, Montreal, Canada, May 2013.
- 58) *Qubits, Cavities, and Quantum Error Correction.*  
APS March Meeting, Baltimore MD, March 2013.
- 57) *Quantum Algorithms and Error Correction with Superconducting Circuits.*  
SFB meeting, Innsbruck, Austria, March 2013.
- 56) *Quantum Optics with Superconducting Circuits: From Single Photons to Schrodinger Cats.*  
New England Section of American Physical Society meeting Williams College, MA, November 2012
- 55) *Quantum Optics with Superconducting Circuits: From Single Photons to Schrodinger Cats.*  
Conference on Quantum Noise and Measurement in Engineered Electronic Systems at the MPIPKS, October 2012.
- 54) *Error Correction, Improving Coherence, and the Future of Superconducting Quantum Computing.*  
IARPA MQCO program review and conference, Minneapolis, MN, May 2012.
- 53) *Making Quantum Circuits More Coherent: Circuit QED Goes 3D!*  
Collège de France, Paris, France, May 2012.
- 52) *Entanglement and Quantum Algorithms with Superconducting Circuits.*  
Norman Hascoe Distinguished Lecture, Storrs, CT April 2012.
- 51) *Quantum Computing and Quantum Error Correction in Superconducting Circuits.*  
Southwest Quantum Information and Technology Workshop, Albuquerque, NM, March 2012.
- 50) *Towards Quantum Computation with Superconducting Circuits.*  
APS March Meeting invited talk, Dallas, TX, March 2011.
- 49) *Entanglement and Quantum Algorithms with Superconducting Circuits.*  
Frontiers in Optics & Laser Science (FIO-LS) Conference, Rochester, NY, October 2010.
- 48) *Making and Measuring Bell States with Superconducting Circuits.*  
Gordon Conference on Atomic, Molecular, and Optical Physics, Tilton, NH, July 2009.
- 47) *Demonstration of Quantum Algorithms with a Solid State Device.*  
Nobel Committee Symposium on Qubits for Quantum Information, Gothenburg, Sweden, May 2009.
- 46) *Quantum Computing with Superconducting Circuits: Current Status.*  
Office of Science and Technology Policy Workshop on Quantum Information Science, Vienna, VA, April 2009.
- 45) *Microwave Measurements of Mesoscopic Devices.*

**Robert J. Schoelkopf**

APS Joseph F. Keithley Award Lecture, APS March Meeting, Pittsburgh PA, March 2009.

- 44) *Better Qubits by Design.*  
Materials Research Society Fall Meeting, Boston, MA, December 2008.
- 43) *How Better Amplifiers Could Improve the Fidelity of Dispersive Qubit Readouts.*  
First Workshop on Analog Quantum Information Processing (AQIP), Boulder, CO, October 2008.
- 42) *Quantum Computing with Solid-State Systems (Discussion Group Leader).*  
Gordon Conference on Quantum Information Science, Big Sky, Montana, August 2008.
- 41) *Circuit QED: Quantum Optics and Quantum Computing on a Superconducting Chip.*  
Plenary lecture at 25th International Conference on Low Temperature Physics (LT-25), Amsterdam, the Netherlands, August 2008.
- 40) *Recent Results in Circuit Quantum Electrodynamics.*  
Invited “Hot Topics” presentation at the 2008 International Congress on Atomic Physics, Storrs, CT, July 2008.
- 39) *How I Learned to Stop Worrying About  $1/f$  Noise and Love the Charge Qubit.*  
Workshop on Decoherence in Superconducting Qubits, Berkeley CA, December 2007.
- 38) *Quantum Optics and Quantum Computing with Superconducting Circuits.*  
Workshop on Nanoelectronics, Canadian Institute for Advancement of Research, Vancouver, Canada, November 2007.
- 37) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Invited talk at Rochester Conference on Quantum Optics (CQO9), June 2007.
- 36) *Quantum Optics and Quantum Computing with Superconducting Circuits.*  
Symposium on 50th Anniversary of the BCS Theory of Superconductivity, Brown University, April 2007.
- 35) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Invited seminar at College de France Paris, December 2006.
- 34) *QND Measurements of Qubits and Photons.*  
WE-Heraeus-Seminar on “Strong Coupling of Light and Matter”, Bad Honnef, Germany, September 2006.
- 33) *Circuit QED and the Prospects for Quantum Circuits with Polar Molecules.*  
20th International Conference on Atomic Physics, Innsbruck, Austria, July 2006.
- 32) *QND Measurements of Qubits and Photons.*  
Macroscopic Quantum Coherence and Computing MQC2 2006, Naples, Italy, June 2006.
- 31) *Circuit QED and the Prospects for Quantum Circuits with Polar Molecules.*  
Gordon Conference on Quantum Information Processing, Il Ciocco, Italy, May 2006.

- 30) *Cavity QED with Polar Molecules?*  
DoD Workshop on Quantum Computing with Polar Molecules, Washington, DC, September 2005.
- 29) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Gordon Conference on Atomic, Molecular, and Optical Physics, Tilton, NH June 2005
- 28) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
APS Division of Atomic, Molecular, and Optical Physics Annual Meeting, Lincoln, NE, June 2005
- 27) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Gordon Conference on Quantum Information Science, Ventura, CA, March 2005
- 26) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Southwest Quantum Information Network Annual Meeting, Tucson, AZ, February 2005
- 25) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Frontiers in Nanoscale Science and Technology Workshop, Harvard University, October 2004.
- 24) *Experiments in Cavity QED with Superconducting Circuits.*  
International Workshop on Mesoscopic Physics, Quantum Optics, and Quantum Information, ITAMP/Harvard University, May 2004.
- 23) *Continuous Measurements of Superconducting Qubits.*  
International Conference on Solid-State Quantum Information Processing (plenary talk), Amsterdam, the Netherlands, December 2003.
- 22) *Superconducting Charge Qubits and the Prospects for Strong Cavity QED.*  
Summer School: Quantum Entanglement and Information, Les Houches, France, July 2003.
- 21) *Qubits as Spectrometers of Quantum Noise.*  
SPIE Conference on Fluctuations and Noise, Santa Fe, NM, June 2003.
- 20) *Superconducting Charge Qubits and the Prospects for Strong Cavity QED.*  
AFOSR Program Review on Superconducting Quantum Computing, NY, May 2003.
- 19) *Superconducting Charge Qubits and the Prospects for Strong Cavity QED.*  
Gordon Research Conference on Quantum Information, Ventura, CA, March 2003.
- 18) *Measuring Single Charges.*  
Workshop on Quantum Information in Group IV Semiconductors, Oxnard, CA, March 2003.
- 17) *Superconducting Single-Photon Detectors for Submillimeter Astronomy.*  
SPIE Conference on Astronomical Telescopes and Detectors, Kona, HI, August 2002.
- 16) *Quantum Coherence in Single-Charge Electronics: Engineering and Measuring a Single Spin.*  
Gordon Research Conference on Correlated Electron Systems, Waterville, ME, June - August, 2002.

**Robert J. Schoelkopf**

- 15) *The Cooper-pair Box as a Quantum Spectrum Analyzer.*  
NATO/ASI Workshop on Quantum Noise in Mesoscopic Systems, Delft, the Netherlands, June 2002.
- 14) *Presentation and discussion leader.*  
AFOSR Workshop on Superconducting Quantum Computing, Virginia Beach, VA, March 2002.
- 13) *Measuring Quantum Coherence in the Single Cooper-Pair Box.*  
International Symposium on Mesoscopic Superconductivity and Spintronics, NTT Laboratories, Hon-Atsugi, Japan, March 2002.
- 12) *Quantum Control and Measurement of Artificial Atoms or Engineering Quantum Circuits for Fun, Physics and Technology.*  
Meeting of 2001 Packard Fellows, Monterey, CA, September 2001.
- 11) *Fast Electrometry of Coherent Macroscopic States in the Cooper-pair Box.*  
ITP Workshop on Nanoscience, Santa Barbara, CA, August 2001.
- 10) *Single Electron Transistor Readouts for UV thru Sub-mm Single-Photon Counting Detectors.*  
9th International Workshop on Low Temperature Detectors, Madison, WI, July 2001.
- 9) *Probing the Dynamics of Single-Charge Circuits with Fast Electrometry.*  
XXXVIth Rencontres de Moriond, Savoie, France, January 2001
- 8) *Probing the Dynamics of Single-Charge Circuits with Fast Electrometry.*  
International Workshop on Mesoscopic Electronics, Ascona, Switzerland, October 2000.
- 7) *Probing the Dynamics of Single-Charge Circuits with Fast Electrometry.*  
Applied Superconductivity Conference 2000, Virginia Beach, September 2000.
- 6) *Far-Infrared Photon-Counting Detectors.*  
NASA Workshop on Space Astrophysics Detector Development, STScI, Baltimore, MD, June 2000.
- 5) *A Fast Coulomb-Blockade Electrometer: Toward Single-Charge Dynamics.*  
LT-22 Conference, Helsinki, Finland, August 1999
- 4) *A Fast Coulomb-Blockade Electrometer: Toward Single-Charge Dynamics.*  
NEDO Workshop on Andreev Physics and Single Charge Tunneling, Gothenburg, Sweden, April 1998.
- 3) *Frequency-Dependent Noise in Mesoscopic Conductors.*  
American Physical Society March Meeting, Los Angeles, March 1998.
- 2) *A Fast Coulomb-Blockade Electrometer: Toward Single-Charge Dynamics.*  
XXXIVth Recontres de Moriond, Quantum Physics at the Mesoscopic Scale, Les Arcs, France, January 1998.
- 1) *Diffusion-Cooled Hot-Electron Bolometers.*  
Proceedings of the International Superconducting Electronics Conference 97, Berlin, Germany, June

1997.

**SEMINARS**

- 61) *Extending the Lifetime of Information through Quantum Error Correction.*  
Distinguished EE Colloquium, Stanford University, Palo Alto, CA, May, 2016.
- 60) *Extending the Lifetime of a Qubit Through Error Correction.*  
Physics Colloquium, Northwestern University, Chicago, February, 2016.
- 59) *Extending the Lifetime of Quantum Information Through Error Correction.*  
The Laboratory for Physical Sciences (LPS), University of Maryland, February, 2016.
- 58) *Using Cat States in a Microwave Cavity for Quantum Information.*  
Colloquium at NASA Goddard Space Flight Center, Greenbelt, MD, June 2015.
- 57) *Tracking a Quantum Error Syndrome in Real Time: Quantum Jumps of Photon Parity.*  
Atomic Physics seminar at Stanford University, Palo Alto, CA, May 2015.
- 56) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Colloquium at RWTH Aachen University, Aachen, Germany, November 2014.
- 55) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Colloquium at JILA/Colorado University, Boulder, CO, September 2014.
- 54) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Yale Physics Colloquium for Graduate Student Open House, New Haven, CT, April 2014.
- 53) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Physics colloquium at Caltech, Pasadena, CA, January 2014.
- 52) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
Physics Colloquium, California Institute of Technology, January 2014.
- 51) *The Birth, Care, and Feeding of Cat States in Circuit QED: Quantum Jumps of Photon Parity.*  
MIT/Harvard Center for Ultracold Atoms Seminar, Massachusetts Institute of Technology, November 2013.
- 50) *Quantum Optics in Circuit QED: From Single Photons to Schrodinger Cats.*  
Seminar, TU Vienna and University of Vienna, Vienna Austria, March 2013.
- 49) *Quantum Optics in Circuit QED: From Single Photons to Schrodinger Cats.*  
Seminar, Max-Planck Institute for Quantum Optics, Munich Germany, March 2013.
- 48) *Quantum Quantum Optics in Circuit QED: From Single Photons to Schrodinger Cats.*  
Seminar, University of Innsbruck, Austria, February 2013.
- 47) *Optics in Circuit QED: From Single Photons to Schrodinger Cats.*

**Robert J. Schoelkopf**

Physics Colloquium, University of Chicago, Chicago IL, January 2013.

- 46) *Optics in Circuit QED: From Single Photons to Schrodinger Cats.*  
Colloquium, Fermilab National Laboratory, Batavia IL, January 2013.
- 45) *Optics in Circuit QED: From Single Photons to Schrodinger Cats.*  
Physics Colloquium, Northwestern University, Evanston IL, January 2013.
- 44) *Making Quantum Circuits More Coherent: Circuit QED Goes 3D!*  
Seminar at CEA Saclay, May 2012.
- 43) *Entanglement and Quantum Algorithms with Superconducting Circuits.*  
Physics Colloquium, Princeton University, New York, October 2011.
- 42) *Entanglement and Quantum Algorithms with Superconducting Circuits.*  
Physics Colloquium, Columbia University, New York, October 2009.
- 41) *Entanglement and Quantum Algorithms with Superconducting Circuits.*  
Physics Colloquium, Yale University, New Haven, September 2009.
- 40) *Demonstration of Quantum Algorithms with a Solid-State Device.*  
Physics Colloquium, University of California, San Diego, April 2009.
- 39) *The Transmon: Better Superconducting Qubits by Design.*  
Chez Pierre Condensed Matter Seminar, Massachusetts Institute of Technology, September 2008.
- 38) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Physics Colloquium, Massachusetts Institute of Technology, September 2008.
- 37) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Physics/Chancellors Colloquium, Macquarie University, Sydney, Australia, June 2008.
- 36) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Physics Colloquium, University of Melbourne, Melbourne, Australia, May 2008.
- 35) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Physics/EE Colloquium, University of New South Wales, Sydney, Australia, April 2008.
- 34) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Seminar, Physics Department, University of Queensland, Brisbane, Australia, April 2008.
- 33) *Quantum Noise and Measurement.*  
A four lecture mini-course, Centre for Quantum Computing Technology, University of New South Wales, Australia, April 2008.
- 32) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Seminar at Joint Quantum Institute, Univ. of Maryland, College Park, MD, January 2008.

**Robert J. Schoelkopf**

- 31) *Circuit QED Quantum Optics on a Superconducting Chip.*  
Colloquium, Waterloo University, Montreal, Canada, March 2007.
- 30) *QED with Superconducting Resonators.*  
Workshop on Physics and Applications of Superconducting Microresonators, California Institute of Technology, March 2007.
- 29) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Colloquium, McGill University, Montreal, Canada, January 2007.
- 28) *Circuit QED: Quantum Optics on a Superconducting Chip.*  
Colloquium, California Institute of Technology, November 2006.
- 27) *Circuit QED: QND Measurements of Superconducting Qubits and Single Photons.*  
Ecole Normale Superieure, Paris, France, May 2006.
- 26) *Circuit QED: QND Measurements of Superconducting Qubits and Single Photons.*  
CEA/Saclay Condensed Matter Seminar, May 2006.
- 25) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Colloquium, University of Minnesota, February 2006.
- 24) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Colloquium, SUNY Stony Brook, January 2006.
- 23) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Colloquium, Amherst College, November 2005.
- 22) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Colloquium, Harvard University, April 2005.
- 21) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Quantum Information Seminar, MIT, December 2004.
- 20) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Colloquium, New York University, November 2004.
- 19) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Yale University, November 2004.
- 18) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Seminar, Rutgers, September 2004.
- 17) *Circuit Quantum Electrodynamics: DOIng Quantum Optics on a Chip.*  
Michigan State, November 2004.
- 16) *Experiments in Cavity QED with Superconducting Circuits.*  
Laboratory for Physical Sciences/NSA, July 2004



## Robert J. Schoelkopf

- 15) *Experiments in Cavity QED with Superconducting Circuits.*  
CEA/Saclay, Paris, France, May 2004.
- 14) *Experiments in Cavity QED with Superconducting Circuits.*  
Ecole Normale Supérieure, Paris, France, May 2004.
- 13) *Experiments in Cavity QED with Superconducting Circuits.*  
Seminar, Cornell, April 2004.
- 12) *Experiments in Cavity QED with Superconducting Circuits.*  
Princeton, April 2004.
- 11) *Kondo Physics and the Lamb Shift in the Single-Electron Box.*  
Solid-State Seminar, University of Minnesota, February 2006
- 10) *Kondo Physics and the Lamb Shift in the Single-Electron Box.*  
Solid-State Seminar, Caltech, April 2004.
- 9) *Kondo Physics and the Lamb Shift in the Single-Electron Box.*  
Yale, May 2003.
- 8) *The Ideal Electron Gas Thermometer.*  
Seminar, NIST Temperature Metrology Group, Gaithersburg, MD, January 2003.
- 7) *Measuring Quantum Coherence in the Single Cooper-Pair Box.*  
Solid-State Seminar, UMass/Amherst, October 2002
- 6) *Measuring Quantum Coherence in the Single Cooper-Pair Box.*  
Solid-State Seminar, SUNY Stony Brook, December 2001.
- 5) *Measuring Quantum Coherence in the Single Cooper-Pair Box.*  
Physics Colloquium, Yale University, November 2001.
- 4) *Probing the Dynamics of Single-Charge Circuits with Fast Electrometry.*  
Seminar, Quatronics Group, Saclay/CEA, October 2000.
- 3) *Probing the Dynamics of Single-Charge Circuits with Fast Electrometry.*  
Physics Colloquium, Caltech, October 1999.
- 2) *Superconducting Single-Photon Detectors for Submillimeter Waves.*  
Cosmology/Gravity Group Seminar, Princeton University, October 1999.
- 1) *The RF-SET: a Fast and Ultrasensitive Quantum Electrometer.*  
Solid-State Seminars at: Caltech, MIT, Berkeley, Michigan, Oregon, Florida, Northeastern, Virginia, Dartmouth, NASA/Goddard Space Flight Center, Lab for Physical Sciences/NSA, 1998.

## PUBLIC OUTREACH

**Robert J. Schoelkopf**

- 15) Panelist for “*Beyond Moore’s Law*,” at the 2015 World Economic Forum in Davos, Switzerland.  
<http://www.weforum.org/sessions/summary/beyond-moore-s-law>
- 14) Presenter and panelist on quantum computing at Nature IdeaLabs session at World Economic Forum, 2015. <https://www.youtube.com/watch?v=GV7YmbheW6s>
- 13) *The Yale Quantum Institute: a Proposal*  
Presentation to the Yale Corporation, December 2013.
- 12) *Forecast: Extremely Cold!*  
Cryogenics presentation for 2nd graders at Kathleen Ryerson Elementary School, May 2012.
- 11) *Exploring the Quantum - a Conversation with Scientists.*  
City University of New York, November 2011.
- 10) *Entanglement and Algorithms with Superconducting Circuits.*  
Lecture for Perspectives on Science, Yale University, October 2009.
- 9) *Circuit QED: Atoms and Cavities in Superconducting Circuits.*  
Tutorial in session on solid-state cavity QED, APS March Meeting, Baltimore, March 2006.
- 8) *Quantum Noise and Measurement.*  
Four lecture series at Boulder Summer School on Mesoscopic Physics, Boulder, CO, July 2005.
- 7) *Quantum Optics and Quantum Computing with Superconducting Circuits.*  
Talk for Annual Spring Meeting of JASON, Washington, DC, April 2005.
- 6) *Quantum Computing with Superconducting Circuits.*  
Yale Society of Physics Students, April 2003.
- 5) *Single-Electronics: Circuits to Control and Measure Electrons One-by-One.*  
Yale Science Forum, New Haven, CT, April 2001.
- 4) *The Coldest Place in Connecticut.*  
Tours and demos for Yale’s Tercentennial Open House, October 2000.
- 3) *Single Electron Devices.*  
Yale Society of Physics Students, April 2000.
- 2) *The Small and the Cold: Nanoscale Electronics.*  
Lecture in Frontiers of Science and Engineering, a Saturday program for high-school juniors, March 2000.
- 1) *Single Electronics.*  
Perspectives on Science lecture for Yale freshman interested in majoring in science, October 1998.

## **STUDENT AND ALUMNI AWARDS**

- Matthew Reagor (Yale PhD 2015), now research staff at Rigetti Computing, was awarded the 2015 IEEE CSC Graduate Study Fellowship.
- Matthew Reed (Yale PhD 2013). His thesis was awarded the Richard L. Green Dissertation Award of the American Physical Society, and also the Northeast Council of Graduate Schools ProQuest Distinguished Dissertation Award in the Physical Sciences (2014).
- Jerry M. Chow (Yale PhD 2010, now research staff at IBM Watson) - 2011 Forbes Magazine 30 Under 30 Technology, December 2012
- David Schuster (Yale PhD 2007 and postdoctoral associate, now asst. professor at University of Chicago) - 2011 William L. McMillan Award, University of Illinois
- Leonardo DiCarlo (postdoctoral associate, now asst. professor at Delft University of Technology) – 2009 Young Researcher Award ISEC Conference, Fukuoka Japan, June 2009
- Andrew Houck (postdoctoral associate, now asst. professor at Princeton) - 2008 New York Academy of Sciences, Blavatnik Postdoctoral Award
- David Schuster (Yale PhD 2007): "Circuit Quantum Electrodynamics" - Northeastern Association of Graduate Schools (NAGS) Award for Best Doctoral Dissertation in Physical Sciences, Mathematics, or Engineering 2007.
- Lafe Spietz (Yale PhD 2006) - the Henry Prentiss Becton Prize for best engineering dissertation of the year at Yale, for "The Shot Noise Thermometer".
- Andreas Wallraff (postdoctoral associate, now asst. professor at ETH Zurich) - the 2006 Nicholas Kurti European Science Prize.

## **PATENTS**

U.S. Patent 5696372: "High Efficiency Near-Field Electromagnetic Probe Having a Bow-Tie Antenna Structure", R.D. Grober, R.J. Schoelkopf, and D.E. Prober.

WO2014/163728, patent pending (2014): "Superconducting Device with at least one Enclosure", R. J. Schoelkopf, T. Brecht, L. Frunzio, M. H. Devoret

WO2014/168665, patent pending (2014): "Method for making a Superconducting Device with at least one Enclosure", R. J. Schoelkopf, T. Brecht, L. Frunzio, M. H. Devoret.

U.S. 2015/0241481 A1, patent pending (2015): "Wireless Josephson Bifurcation Amplifier", A. Narla, K. Sliwa, M. Hatridge, S. Shankar, L. Frunzio, R. J. Schoelkopf, M. H. Devoret.

WO2015/057839, patent pending (2015): "Low-noise Josephson Junction-based Directional Amplifier", B. Abdo, K. Sliwa, L. Frunzio, R. J. Schoelkopf, M. H. Devoret.

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WO2016/138378, patent pending (2016): “*Techniques of an Oscillator Control for Quantum Information Processing and Related Systems and Methods*”, R. Heeres, B. Vlastakis, V. Albert, S. Krastanov, L. Jiang, R. J. Schoelkopf.

WO2016/138395, patent pending (2016): “*Techniques for Coupling Planar Qubits to Non-planar Resonators and Related Systems and Methods*”, Z. Mineev, K. Serniak, I. Pop, Y. Chu, T. Brecht, L. Frunzio, M. H. Devoret, R. J. Schoelkopf.

WO2016/138406, patent pending (2016): “*Josephson Junction-based Circulators and Related Systems and Methods*”, K. Sliwa, M. Hatridge, A. Narla, S. Shankar, L. Frunzio, R. J. Schoelkopf, M. H. Devoret.

WO2016/138399, patent pending (2016): “*Techniques for Universal Quantum Control of Quantum Coherent States and Related Systems and Methods*”. L. Jiang, R. J. Schoelkopf, M. H. Devoret, V.V. Albert, S. Krastanov, C. Shen.

WO2016/168642, patent pending (2016): “*Wireless Josephson Parametric Converter*”, K. Sliwa, M. Hatridge, A. Narla, S. Shankar, L. Frunzio, R. J. Schoelkopf, M. H. Devoret.

WO2017/065856, patent pending (2017): “*Techniques of Oscillator State Manipulation for Quantum Information Processing and Related Systems and Methods.*”, R. Heeres, P. Reinhold, V.V. Albert, L. Jiang, L. Frunzio, M. H. Devoret, R. J. Schoelkopf.

Provisional patent filed on 1/15/2016: “*Controlling and Entangling Two Cavities Through an Ancillary Josephson Junction*”, C. Wang, Y. Gao, L. Frunzio, M. H. Devoret, R. J. Schoelkopf.

Provisional patent filed on 1/15/2016: “*Quantum Computer State Controller*”, N. Ofek, L. Frunzio, M. H. Devoret, R. J. Schoelkopf.

## NEWS AND ARTICLES ABOUT SCHOELKOPF GROUP

“*Physicists create and measure quantized mechanical oscillations*”, by Tim Wogan, Physicsworld.com, September 2017.  
<http://physicsworld.com/cws/article/news/2017/sep/25/physicists-create-and-measure-quantized-mechanical-oscillations>

“*Quantum Computing Might Be Here Sooner Than You Think*”, by Jon Asmundsson, Bloomberg Markets, June 14, 2017. <https://www.bloomberg.com/news/features/2017-06-14/the-machine-of-tomorrow-today-quantum-computing-on-the-verge>

“*Dead or Alive, Schrödinger's Cat Can Be in 2 Boxes at Once*” by Tia Ghose, Livescience, May 26, 2016 - <http://www.livescience.com/54890-schrodinger-cat-can-be-in-two-places.html#sthash.E0y5kImX.dpuf>

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“*Schrödinger’s cat now has a playmate*” by Jason Thomson, The Christian Science Monitor, May 28, 2016. <http://www.csmonitor.com/Science/2016/0528/Schroedinger-s-cat-now-has-a-playmate>

“*Dream Machine, The mind-expanding world of quantum computing*”, by Rivka Galchen, The New Yorker, May 2, 2011 issue. <http://www.newyorker.com/magazine/2011/05/02/dream-machine>

“*Towards superconductor-spin ensemble hybrid quantum systems*”, by Tim Duty, Centre for Engineered Quantum Systems, School of Mathematics and Physics, The University of Queensland, St. Lucia, Queensland, Australia, Published September 27, 2010. <http://rsl.yale.edu/sites/default/files/files/Duty%20PRL%20Viewpoint%20on%20spins%20experiment.pdf>

“*Qubits ride the photon bus*”, by Antti O. Niskanen and Yasunobu Nakamura, Nature, Vol. 449, September 27, 2007. <http://rsl.yale.edu/sites/default/files/files/Nakamura%20circuit%20QED%20News%20and%20Views%20Sept%202007.pdf>

“*Photon lab in a circuit*”, by Frank K. Wilhelm and Enrique Solano, Nature, Vol 445, February 1, 2007. <http://rsl.yale.edu/sites/default/files/files/Number%20splitting%20news%20and%20views.pdf>

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“*The Spintronics gets a magnetic flute*”, by Jonathan Sun, Nature, Vol 425, September 25, 2003. <http://rsl.yale.edu/sites/default/files/files/nanomagnet%20news%20and%20views.pdf>

## PROFESSIONAL AFFILIATIONS

Member of National Academy of Sciences

Member of American Academy of Arts and Sciences

Member of Connecticut Academy of Science and Engineering