

# David I. Schuster

ASSOCIATE PROFESSOR OF PHYSICS · QUANTUM INFORMATION AND QUANTUM OPTICS

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## Education

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### Yale University

PH.D. IN PHYSICS

- Ph.D. Thesis - Circuit Quantum Electrodynamics

New Haven, CT

May 2007

### Brown University

SC.B. IN MATHEMATICS-PHYSICS

- Honors Thesis - An Interactive Environment for Real-Time Object Recognition in Video Streams

Providence, RI

May 2001

## Experience

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### Associate Professor of Physics and the James Franck Institute

UNIVERSITY OF CHICAGO

- Hybrid quantum computation architectures
- Circuit quantum electrodynamics (quantum optics and cavity QED)
- Quantum simulation of topological and strongly interacting systems

Chicago, IL

2017-present

### Assistant Professor of Physics and the James Franck Institute

UNIVERSITY OF CHICAGO

- Realized topological circuits
- Developed random access quantum information architecture
- Theoretical and experimental studies of protected superconducting qubits

Chicago, IL

2010-2017

### Prize Postdoctoral Associate with Professor Robert Schoelkopf

APPLIED PHYSICS DEPARTMENT, YALE UNIVERSITY

- Demonstrated first high-cooperativity coupling of superconducting cavity to electron spin ensemble
- Developed theoretical proposals for hybrid quantum information currently pursued around the world

New Haven, CT

2008-2010

### Visiting Postdoctoral Associate with Professor Isaac Chuang

CENTER FOR ULTRACOLD ATOMS, MIT

- Developed theory of molecular ions coupled to superconducting cavities
- Developed cryogenic ion trap using close cycle cryostat

Cambridge, MA

June-Dec. 2007

### Graduate Research Assistant with Professor Robert Schoelkopf

APPLIED PHYSICS DEPARTMENT, YALE UNIVERSITY

- Thesis - Circuit Quantum Electrodynamics
- Realized measurement of vacuum Rabi effect previously only achievable in atomic systems
- Utilized qubit to perform non-demolition measurement of individual microwave photon number states
- Developed transmon qubit, used in all QC efforts

New Haven, CT

2001-2007

## Honors & Awards

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National Academies of Sciences, Kavli Frontiers Fellow

2015

Packard Fellowship

2013

Sloan Fellowship

2012

NSF CAREER Award

2012

William L. McMillan Prize (Top condensed matter prize for junior faculty)

2011

DARPA Young Faculty Award

2011

Yale Prize Postdoctoral Fellowship

2008-2010

Northeastern Association of Graduate Schools Dissertation Award

2007

DOD Quantum Computing Graduate Research Fellowship

2003-2005

## Academic Service

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|---|--------------|
| Chicago Quantum Exchange steering committee   | 2017-present |
| Co-director of MRSEC Quantum Materials IRG / member of steering committee                             | 2014-present |
| Pritzker Nanofabrication Cleanroom Faculty Board  | 2016-present |
| Fellow of the Institute for Molecular Engineering   | 2015-present |
| APS Division of Quantum Information (DQI) steering committee  | 2017         |
| Faculty Mentor for high school Summerlink program   | 2011-present |
| Reviewer for Nature, Science, Physical Review, New Journal of Physics, Quantum Information Processing | ongoing      |

## Publications

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### PUBLICATIONS

1. Coherent Control of Spins with Gaussian Acoustics. Samuel J. Whiteley, Gary Wolfowicz, Christopher P. Anderson, Alexandre Bourassa, He Ma, Meng Ye, Gerwin Koolstra, Kevin J. Satzinger, Martin V. Holt, F. Joseph Heremans, Andrew N. Cleland, David I. Schuster, Giulia Galli, David D. Awschalom. arXiv:1804.10996
2. Quantum control of surface acoustic wave phonons. K. J. Satzinger, Y. P. Zhong, H. -S. Chang, G. A. Pears, A. Bienfait, Ming-Han Chou, A. Y. Cleland, C. R. Conner, E. Dumur, J. Grebel, I. Gutierrez, B. H. November, R. G. Povey, S. J. Whiteley, D. D. Awschalom, D. I. Schuster, A. N. Cleland. arXiv:1804.07308
3. Deterministic Bidirectional Communication and Remote Entanglement Generation Between Superconducting Quantum Processors. N. Leung, Y. Lu, S. Chakram, R. K. Naik, N. Earnest, R. Ma, K. Jacobs, A. N. Cleland, D. I. Schuster. arXiv:1804.02028
4. Input-output theory for superconducting and photonic circuits that contain weak retro-reflections and other weak pseudo-cavities. Robert Cook, David Schuster, Andrew Cleland, Kurt Jacobs. arXiv:1803.04763
5. Topological Photonics. Tomoki Ozawa, Hannah M. Price, Alberto Amo, Nathan Goldman, Mohammad Hafezi, Ling Lu, Mikael Rechtsman, David Schuster, Jonathan Simon, Oded Zilberberg, Jacopo Carusotto. arXiv:1802.04173 (submitted RMP)
6. Coherence properties of the 0- $\pi$  qubit. Peter Groszkowski, A. Di Paolo, A. L. Grimsmo, A. Blais, D. I. Schuster, A. A. Houck, Jens Koch. arXiv:1708.02886 (accepted NJP)
7. Quarter-Flux Hofstadter Lattice in Qubit-Compatible Microwave Cavity Array. Clai Owens, Aman LaChapelle, Brendan Saxberg, Brandon Anderson, Ruichao Ma, Jonathan Simon, David I. Schuster. Phys. Rev. A 97, 013818 (2017)
8. Universal stabilization of a parametrically coupled qubit. Yao Lu, Srivatsan Chakram, Nelson Leung, Nathan Earnest, Ravi K. Naik, Ziwen Huang, Peter Groszkowski, Eliot Kapit, Jens Koch, David I. Schuster. Phys. Rev. Lett. 119, 150502
9. Realization of a  $\Lambda$  system with metastable states of a capacitively-shunted fluxonium. Nathan Earnest, Srivatsan Chakram, Yao Lu, Nicholas Irons, Ravi K. Naik, Nelson Leung, Jay Lawrence, Jens Koch, David I. Schuster. Phys. Rev. Lett. 120, 150504
10. Nature of the Low Field Q Degradation in Superconducting Niobium Cavities. A. Romanenko, D. I. Schuster. Phys. Rev. Lett. 119, 264801 (2017)
11. Continuously cycling adsorption-dilution refrigerator. A. Oriani, D. I. Schuster. Patent pending (2017)
12. Random access quantum information processors. R. K. Naik, N. Leung, S. Chakram, P. Groszkowski, Y. Lu, N. Earnest, D. C. McKay, Jens Koch, D. I. Schuster. Nature Communications 8, 1904 (2017)
13. Hamiltonian Tomography of Photonic Lattices. Ruichao Ma, Clai Owens, Aman LaChapelle, David I. Schuster, Jonathan Simon. Phys. Rev. A 95, 062120

14. Speedup for quantum optimal control from automatic differentiation based on graphics processing units. Nelson Leung, Mohamed Abdelhafez, Jens Koch, and David Schuster. *Phys. Rev. A* 95, 042318 (2017)
15. Autonomous stabilizer for incompressible photon fluids and solids. Ruichao Ma, Clai Owens, Andrew Houck, David I. Schuster, and Jonathan Simon. *Phys. Rev. A* 95, 043811 (2017)
16. Engineering topological materials in microwave cavity arrays.. Brandon M. Anderson, Ruichao Ma, Clai Owens, David I. Schuster, Jonathan Simon. *Phys. Rev. X* 6, 041043 (2016)
17. Coupling an Ensemble of Electrons on Superfluid Helium to a Superconducting Circuit. Ge Yang, A. Fragner, G. Koolstra, L. Ocola, D. A. Czaplewski, R. J. Schoelkopf, and D. I. Schuster. *Phys. Rev. X* 6, 011031 (2016)
18. Time Reversal Invariant Topologically Insulating Circuits. Ningyuan Jia, Clai Owens, Ariel Sommer, David Schuster, Jonathan Simon. *Phys. Rev. X* 5, 021031 (2015)
19. High-Contrast Qubit Interactions Using Multimode Cavity QED. D. C. McKay, R. Naik, P. Reinhold, L. S. Bishop, and D. I. Schuster. *Phys. Rev. Lett.* 114, 080501 (2015)
20. Understanding degenerate ground states of a protected quantum circuit in the presence of disorder. Joshua Dempster, Bo Fu, David G. Ferguson, D. I. Schuster, Jens Koch. *Phys. Rev. B* 90, 094518 (2014)
21. Fast, low-power manipulation of spin ensembles in superconducting microresonators. A. J. Sigillito, H. Malissa, A. M. Tyryshkin, H. Riemann, N. V. Abrosimov, P. Becker, H.-J. Pohl, M. L. W. Thewalt, K. M. Itoh, J. J. L. Morton, A. A. Houck, D. I. Schuster and S. A. Lyon. *Appl. Phys. Lett.* 104, 222407 (2014)
22. Superconducting coplanar waveguide resonators for low temperature pulsed electron spin resonance spectroscopy. H. Malissa, D. I. Schuster, A. M. Tyryshkin, A. A. Houck, and S. A. Lyon. *Rev. Sci. Instrum.* 84, 025116 (2013)
23. Measurements of Quasiparticle Tunneling Dynamics in a Band-Gap-Engineered Transmon Qubit. L. Sun, L. DiCarlo, M. D. Reed, G. Catelani, Lev S. Bishop, D. I. Schuster, B. R. Johnson, Ge A. Yang, L. Frunzio, L. Glazman, M. H. Devoret, and R. J. Schoelkopf. *PRL* 108, 230509 (2012)
24. Observation of High Coherence in Josephson Junction Qubits Measured in a Three-Dimensional Circuit QED Architecture. Hanhee Paik, D. I. Schuster, Lev 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, and R. J. Schoelkopf. *Phys. Rev. Lett.* 107, 240501 (2011)
25. Cavity QED in a molecular ion trap. D. I. Schuster, Lev S. Bishop, I. L. Chuang, D. DeMille, and R. J. Schoelkopf. *Phys. Rev. A* 83, 012311 (2011)
26. High-fidelity readout in circuit quantum electrodynamics using the Jaynes-Cummings nonlinearity. M. D. Reed, L. DiCarlo, B. R. Johnson, L. Sun, D. I. Schuster, L. Frunzio, R. J. Schoelkopf. *Phys. Rev. Lett.* 105, 173601 (2010)
27. High-Cooperativity Coupling of Electron-Spin Ensembles to Superconducting Cavities. D. I. Schuster, A. P. Sears, E. Ginossar, L. DiCarlo, L. Frunzio, J. J. L. Morton, H. Wu, G. A. D. Briggs, R. J. Schoelkopf. *Phys. Rev. Lett.* 105, 140501 (2010)
28. Storage of Multiple Coherent Microwave Excitations in an Electron Spin Ensemble. H. Wu, R. E. George, J. H. Wesenberg, K. Moelmer, D. I. Schuster, R. J. Schoelkopf, Kohei M. Itoh, A. Ardavan, J. J. L. Morton, and G. A. D. Briggs. *Phys. Rev. Lett.* 105, 140503 (2010)
29. Protocol for high-fidelity readout in the photon-blockade regime of circuit QED. E. Ginossar, Lev S. Bishop, D. I. Schuster, and S. M. Girvin. *Phys. Rev. A* 82, 022335 (2010)
30. Proposal for manipulating and detecting spin and orbital states of trapped electrons on helium using cavity quantum electrodynamics. D. I. Schuster, A. Fragner, M. I. Dykman, S. A. Lyon, and R. J. Schoelkopf. *Phys. Rev. Lett.*, 105, 040503 (2010)

31. Quantum non-demolition detection of single microwave photons in a circuit. B. R. Johnson, M. D. Reed, A. A. Houck, D. I. Schuster, Lev S. Bishop, E. Ginossar, J. M. Gambetta, L. DiCarlo, L. Frunzio, S. M. Girvin, R. J. Schoelkopf. *Nature Physics* 6 , 663 2013667 (2010)
32. Fast reset and suppressing spontaneous emission of a superconducting qubit. M. D. Reed, B. R. Johnson, A. A. Houck, L. DiCarlo, J. M. Chow, D. I. Schuster, L. Frunzio, and R. J. Schoelkopf. *Appl. Phys. Lett.* 96, 203110 (2010)
33. Quantum Computing with an Electron Spin Ensemble. J. H. Wesenberg, A. Ardavan, G. A. D. Briggs, J. J. L. Morton, R. J. Schoelkopf, D. I. Schuster, and K. Moelmer". *Phys. Rev. Lett.* 103, 070502 (2009)
34. Demonstration of two-qubit algorithms with a superconducting quantum processor. L. DiCarlo, J. M. Chow, J. M. Gambetta, Lev S. Bishop, B. R. Johnson, D. I. Schuster, J. Majer, A. Blais, L. Frunzio, S. M. Girvin and R. J. Schoelkopf. *Nature* 460, 240-244 (2009)
35. Cryogenic Ion Trapping Systems with Surface-Electrode Traps. P. B. Antohi, D. Schuster, G. M. Akselrod, J. Labaziewicz, Y. Ge, Z. Lin, W. S. Bakr, I. L. Chuang. *Rev. Sci. Inst.*, vol. 80, 013103 (2009)
36. Controlling the spontaneous emission of a superconducting transmon qubit. A. Houck, J. A. Schreier, B. R. Johnson, J. M. Chow, Jens Koch, J. M. Gambetta, D. I. Schuster, L. Frunzio, M. H. Devoret, S. M. Girvin, and R. J. Schoelkopf. *Phys. Rev. Lett.* 101, 080502 (2008)
37. Suppressing charge noise decoherence in superconducting charge qubits. J. A. Schreier, A. A. Houck, Jens Koch, D. I. Schuster, B. R. Johnson, J. M. Chow, J. M. Gambetta, J. Majer, L. Frunzio, M. H. Devoret, S. M. Girvin, and R. J. Schoelkopf. *Phys. Rev. B* 77, 180502(R) (2008)
38. Quantum Trajectory Approach to Circuit QED- Quantum Jumps and the Zeno Effect. Gambetta, J., Blais, A., Boissonneault, M., Houck, A. A., Schuster, D. I., and Girvin, S. M.. *Phys. Rev. A* 77, 012112 (2008)
39. Charge-insensitive qubit design derived from the Cooper pair box. Jens Koch, Terri M. Yu, Jay Gambetta, A. A. Houck, D. I. Schuster, J. Majer, Alexandre Blais, M. H. Devoret, S. M. Girvin, and R. J. Schoelkopf. *Phys. Rev. A* 76, 042319 (2007)
40. Observation of Berry's Phase in a Solid-State Qubit. P. J. Leek, J. M. Fink, A. Blais, R. Bianchetti, M. Geoppl, J. M. Gambetta, D. I. Schuster, L. Frunzio, R. J. Schoelkopf, and A. Wallraff. *Science* 21 V318 5858, 1889 - 189 (2007)
41. Coupling superconducting qubits via a cavity bus. J. Majer, J. M. Chow, J. M. Gambetta, Jens Koch, B. R. Johnson, J. A. Schreier, L. Frunzio, D. I. Schuster, A. A. Houck, A. Wallraff, A. Blais, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. *Nature* 449, 443-447 (2007)
42. Generating single microwave photons in a circuit. A. Houck\*, D. I. Schuster\*, J. M. Gambetta, J. A. Schreier, B. R. Johnson, J. M. Chow, L. Frunzio, J. Majer, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. *Nature* 449, 328-331 (2007)
43. Sideband Transitions and Two-Tone Spectroscopy of a Superconducting Qubit Strongly Coupled to an On-Chip Cavity. Wallraff, D. I. Schuster, A. Blais, J. M. Gambetta, J. Schreier, L. Frunzio, M. H. Devoret, S. M. Girvin, and R. J. Schoelkopf. *Phys. Rev. Lett.* 99, 050501 (2007)
44. Quantum-information processing with circuit quantum electrodynamics. Alexandre Blais, Jay Gambetta, A. Wallraff, D. I. Schuster, S. M. Girvin, M. H. Devoret, and R. J. Schoelkopf. *Phys. Rev. A* 75, 032329 (2007)
45. Circuit Quantum Electrodynamics. D. I. Schuster. Thesis
46. Resolving photon number states in a superconducting circuit. D. I. Schuster\*, A. A. Houck\*, J. A. Schreier, A. Wallraff, J. M. Gambetta, A. Blais, L. Frunzio, J. Majer, B. Johnson, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. *Nature (London) Vol* 445 515 (2007)
47. Quantum trajectory approach to circuit QED - Quantum jumps and the Zeno effect. Jay Gambetta, Alexandre Blais, M. Boissonneault, A. A. Houck, D. I. Schuster, and S. M. Girvin. *Phys. Rev. A* 77, 012112 (2008)

48. Qubit-photon interactions in a cavity - Measurement dephasing and number splitting. J. M. Gambetta, A. Blais, D. I. Schuster, A. Wallraff, L. Frunzio, J. Majer, B. Johnson, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. *Physical Review A* Vol 74, 042318 (2006)
49. Approaching Unit Visibility for Control of a Superconducting Qubit with Dispersive Readout. Wallraff, D. I. Schuster, A. Blais, L. Frunzio, J. Majer, M. H. Devoret, S. M. Girvin and R. J. Schoelkopf. *Physical Review Letters*, Vol 95, 6 060501 (2005)
50. Fabrication and characterization of superconducting circuit QED devices for quantum computation. L. Frunzio, A. Wallraff, D. Schuster, J. Majer, R. Schoelkopf. *Applied Superconductivity, IEEE Transactions* Vol 15, 2 860-863 (2005)
51. AC-Stark Shift and Dephasing of a Superconducting Qubit Strongly Coupled to a Cavity Field. D. I. Schuster, A. Wallraff, A. Blais, L. Frunzio, R.-S. Huang, J. Majer, S. M. Girvin and R. J. Schoelkopf. *Physical Review Letters* Vol 94, 090501 (2005)
52. Circuit quantum electrodynamics - Coherent coupling of a single photon to a Cooper pair box. Wallraff, D. I. Schuster, A. Blais, L. Frunzio, R.-S. Huang, J. Majer, S. Kumar, S. M. Girvin and R. J. Schoelkopf. *Nature (London)* 431 162 (2004)
53. Measurement of the excited-state lifetime of a microelectronic circuit. K. W. Lehnert, K. Bladh, L. F. Spietz, D. Gunnarsson, D. I. Schuster, P. Delsing, and R. J. Schoelkopf. *Physical Review Letters* 90(2):027002 (2003)
54. A recognition system that uses saccades to detect cars from real-time video streams. Predrag Neskovic, David Schuster, and Leon N Cooper. *Proceedings of International Conference on Neural Information Processing* (2002)
55. Localized measurements of ECCD using MSE spectroscopy on the DIII-D Tokamak. C.C. Petty, Y.R. Lin-Liu, T.C. Luce, M.A. Makowski, R. Prater, D.I. Schuster, et al.. *Nuclear Fusion* 41(5):551-566 (2001)

#### PUBLICATION STATISTICS

- h-index: 33
- Total citations: 12603
- Most citations for single paper: 2998

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