Eli Levenson-Falk

CURRICULUM VITAE

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RESEACH INTERESTS

My research focuses on the development and use of superconducting electronics for quantum computing, quantum simulation, ultra-low-noise amplification, precision measurements, and foundational quantum physics research. This work includes extensions of my graduate and postdoctoral research on superconducting quantum computing, unconventional superconductivity, and axion detection. I am also focusing on new areas such as open quantum systems, quantum many-body physics, and quantum sensing. I am particularly interested in experiments that use superconducting circuits to study foundational physics, such as the quantum measurement problem: how does *deterministic* interaction with a quantum *superposition* result in our classical reality of a *single*, *stochastic* measurement outcome?

APPOINTMENTS

Assistant Professor (2017 –)
Department of Physics and Astronomy, University of Southern California
Los Angeles, CA
Research topics: Quantum computing, quantum simulation, and quantum information technologies. Superconducting qubits and artificial atoms. Microwave-frequency resonators and resonant circuits. Ultra-sensitive detectors and continuous sensors. Quantum-limited amplification, weak measurement, and quantum feedback.

Postdoctoral Scholar (2013 – 2017)
Physics Department, Stanford University
Stanford, CA
Research topics: Studies of the gravitational force at sub-millimeter length scales. Ultra-sensitive metrology for axion detection. Optical Kerr effect studies of time reversal symmetry breaking in unconventional superconductors. Thermal transport measurements of strange metals.

EDUCATION

University of California Berkeley, Ph.D. in Physics (2013)
Dissertation*: Static and Microwave Transport Properties of Aluminum Nanobridge Josephson Junctions*
University of California Berkeley, M.A. in Physics (2010)
Harvard University, A.B. *magna cum laude* in Physics (2008)

HONORS, FELLOWSHIPS, and MEMBERSHIPS

ONR Young Investigator	(2021)
Cottrell Scholar	(2021)
Sigma Xi elected full member	(2020)
AFOSR Young Investigator	(2019)
Lawrence Postdoctoral Fellowship, Lawrence Livermore National Lab (*declined*)	(2017)
NSF Graduate Research Fellow	(2009 – 2013)
ASEE National Defense Science and Engineering Graduate Fellow	(2009 – 2012)

PUBLICATIONS (*reverse chronological order)*

In Preparation

27. "A validated design database and simulation workflow for superconducting qubit design"
    A. Kuo, S. Shanto, C. Miyamoto, H. Zhang, V. Maurya, E. Vlachos, M. Hecht, **E. M. Levenson-Falk**

Submitted, Under Review

26. "On-demand driven dissipation for qubit reset and cavity cooling"
    V. Maurya, H. Zhang, A. Kuo, D. Kowsari, D. M. Hartsell, C. Miyamoto, J. Liu, S. Shanto, A. Zarassi, K. W. Murch, **E. M. Levenson-Falk,** arXiv:2310.16785, *under review at Phys. Rev. Appl.*
25. "Stabilizing two-qubit entanglement with dynamically decoupled active feedback"
    S. Greenfield, L. Martin, F. Motzoi, K. B. Whaley, J. Dressel, **E. M. Levenson-Falk**, arXiv:2308.03923, *under review at Phys. Rev. Lett.*
24. "Modeling low- and high-frequency noise in transmon qubits with resource-efficient measurement"
    V. Tripathi, H. Chen, **E. M. Levenson-Falk,** D. A. Lidar, arXiv:2303.00095, *under review at Phys. Rev. X Quant.*

Published

23. "Quasiparticle dynamics in epitaxial Al-InAs planar Josephson junctions"
    B. H. Elfeky, W. M. Strickland, J. Lee, J. T. Farmer, S. Shanto, A. Zarassi, D. Langone, M. G. Vavilov, **E. M. Levenson-Falk**, J. Shabani, *PRX Quantum* **4**, 030339 (2023)
22. "Electron-phonon interactions in the Andreev Bound States of aluminum nanobridge Josephson junctions"
    J. T. Farmer, A. Zarassi, S. Shanto, D. M. Hartsell, **E. M. Levenson-Falk,** *Phys. Rev. B* **107**, L140506 (2023)
21. "Master equation emulation and coherence preservation with classical control of a superconducting qubit"
    E. Vlachos, H. Zhang, J. M. Marshall, V. Maurya, J. T. Farmer, T. Albash, **E. M. Levenson-Falk,** *Phys. Rev. A* **106**, 062620 (2022)
20. "Suppression of crosstalk in superconducting circuits using dynamical decoupling"

V. Tripathi, H. Chen, M. Khezri, K. W. Yip, **E. M. Levenson-Falk**, D. A. Lidar, *Phys. Rev. Appl.* **18**, 024068 (2022)

19. "Predicting non-Markovian superconducting-qubit dynamics from tomographic reconstruction"
    H. Zhang, B. Pokharel, **E. M. Levenson-Falk**, D. A. Lidar, *Phys. Rev. Appl.* **17**, 054018 (2022)
18. "Continuous real-time detection of quasiparticle trapping in aluminum nanobridge Josephson junctions"
    J. T. Farmer, A. Zarassi, D. M. Hartsell, E. Vlachos, H. Zhang, **E. M. Levenson-Falk**, *Appl. Phys. Lett.* **119** (12), 122601 (2021)
17. "A method for controlling the magnetic field near a superconducting boundary in the ARIADNE axion experiment"
    H. Fosbinder-Elkins, Y. Kim, J. Dargert, M. Harkness, A. Geraci, **E. Levenson-Falk**, S. Mumford, A. Fang, A. Kapitulnik, A. N. Matlashov, D. Kim, Y. Shin, Y. K. Semertzidis, Y.-H. Lee, N. Aggarwal, C. Lohmeyer, A. Reid, J. Shortino, I. Lee, J. Long, C.-Y. Liu, W. Snow, *Quantum Sci. and Tech.* (2021)
16. "Thermal diffusivity above the Mott-Ioffe-Regel limit"
    J.-C. Zhang, E. D. Kountz, **E. M. Levenson-Falk,** R. L. Greene, A. Kapitulnik, *Phys. Rev. B **100** (24), 241114 (2019)*
15. "High-efficiency measurement of an artificial atom inside a parametric amplifier"
    A. Eddins, J. M. Kreikebaum, D. M. Toyli, **E. M. Levenson-Falk**, A. Dove, W. Livingston, B. A. Levitan, L. C. G. Govia, A. A. Clerk, and I. Siddiqi, *Phys. Rev. X* **9,** 1 011004 (2019)
14. "Progress on the ARIADNE axion experiment"
    A. A. Geraci for the ARIADNE Collaboration, In: "Microwave Cavities and Detectors for Axion Research," *Springer Proc. in Phys.*, **211** (2018)
13. "Polar Kerr effect from time-reversal symmetry breaking in the heavy-fermion superconductor $PrOs_4Sb_{12}$"
    E. M. Levenson-Falk, E. R. Schemm, M. B. Maple, Y. Aoki, A. Kapitulnik, *Phys. Rev. Lett.* **120**, 187004 (2018)
12. "Polar Kerr effect studies of time reversal symmetry breaking states in heavy fermion superconductors"
    E. R. Schemm, **E. M. Levenson-Falk**, A. Kapitulnik, *Physica C* **535**, 13-19 (2017)
11. "Anomalous thermal diffusivity in underdoped $YBa_2Cu_3O_{6+x}$"
    J.-C. Zhang, **E. M. Levenson-Falk**, B. J. Ramshaw, D. A. Bonn, R. Liang, W. N. Hardy, S. A. Hartnoll, A. Kapitulnik, *PNAS* **114,** (21) 5378 (2017)
10. "Dispersive NanoSQUID Magnetometry" *(invited peer-reviewed review article)*
    E. M. Levenson-Falk, N. Antler, I. Siddiqi, *Supercond. Sci. Technol.* **29**, 113003 (2016)
9. "Single quasiparticle trapping in aluminum nanobridge Josephson junctions"

E. M. Levenson-Falk, F. Kos, R. Vijay, L. Glazman, I. Siddiqi, *Phys. Rev. Lett.* **112**, 047002 (2014)

8. "A dispersive nanoSQUID magnetometer for ultra-low noise, high bandwidth flux detection"
   E. M. Levenson-Falk, R. Vijay, N. Antler, I. Siddiqi, *Supercond Sci. Technol.* **26**, 055015 (2013)
7. "In-plane magnetic field tolerance of a dispersive aluminum nanobridge SQUID magnetometer"
   N. Antler, **E. M. Levenson-Falk**, R. Naik, Y.-D. Sun, R. Vijay, I. Siddiqi, *Appl. Phys. Lett.* **102**, 232602 (2013)
6. "1/f noise of Josephson-junction-embedded microwave resonators at single photon energies and millikelvin temperatures"
   K. W. Murch, S. J. Weber, **E. M. Levenson-Falk**, R. Vijay, I. Siddiqi, *Appl. Phys. Lett.* **100**, 142601 (2012)
5. "Nonlinear microwave response of aluminum weak-link Josephson oscillators"
   E. M. Levenson-Falk, R. Vijay, I. Siddiqi, *Appl. Phys. Lett.* **98**, 123115 (2011)
4. "Approaching ideal weak link behavior with three dimensional aluminum nanobridges"
   R. Vijay, **E. M. Levenson-Falk**, D. H. Slichter, I. Siddiqi, *Appl. Phys. Lett.* **96**, 223112 (2010)
3. "Edge state velocity and coherence in a quantum Hall Fabry-Perot interferometer"
   D. T. McClure, Yiming Zhang, B. Rosenow, **E. M. Levenson-Falk**, C. M. Marcus, L. N. Pfeiffer, K. W. West, *Phys. Rev. Lett.* **103**, 206806 (2009)
2. "Distinct signatures for coulomb blockade and Aharaonov-Bohm interference in electronic Fabry-Perot interferometers"
   Yiming Zhang, D. T. McClure, **E. M. Levenson-Falk**, C. M. Marcus, L. N. Pfeiffer, K. W. West, *Phys. Rev. B (RC)* **79**, 241304 (2009)
1. "Fractional quantum Hall effect in a quantum point contact at filling fraction 5/2"
   J. B. Miller, I. P. Radu, D. M. Zumbühl, **E. M. Levenson-Falk**, M. A. Kastner, C. M. Marcus, L. N. Pfeiffer, K. W. West, *Nat. Phys.* **3**, 561-565 (2007)

FUNDED PROPOSALS (*reverse chronological order*)

"A Cryogen-Free Helium Dilution Refrigerator for Quantum Information Science" (2023 – 2024)
AFOSR DURIP Equipment Grant $683k for equipment

"Suppressing Quasiparticle Generation and Transport in Superconducting Circuits" (2023 – 2026)
AFOSR QIS program grant $511k over 3 years

"Creating an Open Quantum Systems Engineering Toolkit with Superconducting Qubits" (2021 – 2024)
ONR Young Investigator Award $510k over 3 years

"A Superconducting Qubit Measurement, Control, and Feedback System" (2021 – 2022)
AFOSR DURIP Equipment Grant $248k for equipment

"Creating Custom Quantum Environments with Superconducting Circuits (for Beginners)" (2021 – 2024)
RCSA Cottrell Scholar Grant $100k over 3 years

"Suppressing and Correcting Errors in Hybrid Quantum Circuits" (2020 – 2024)
NSF QII-TAQS Grant $2.08M over 5 years

"Reducing Quasiparticle Decoherence in Superconducting Quantum Circuits" (2019 – 2023)
NSF DMR Condensed Matter Physics Grant $450k over 4 years

"Quasiparticles in Superconducting Quantum Circuits" (2018 – 2023)
AFOSR Young Investigator Program $950k over 4 years

"Adding Noise to Preserve Quantum Process Fidelity" (02/2019 – 10/2019)
ARO Short-Term Innovative Research Grant $60k over 9 months

INVITED TALKS

"Creating on-demand dissipation with superconducting quantum circuits"
Princeton Quantum Signals (PQS) Seminar, 2023, Princeton University, Princeton, NJ

"Exploring Quantum Measurement and Dissipation with Superconducting Circuits"
Quantum Information Seminar, 2023, Washington University, St Louis, MO

"Using loss to preserve coherence in superconducting qubits"
National Quantum Technology Forum, 2023, Clemson, SC

"Open quantum systems engineering with superconducting circuits"
Dept. of Physics Colloquium, 2022, Cal State University Long Beach, Long Beach, CA

"Open quantum systems engineering with superconducting circuits"
Quantum Information Science and Engineering (iQuISE) Seminar, 2022, MIT (remote)

"Andreev trapping measurements of quasiparticles in superconducting quantum circuits"
Quantum Information Seminar, 2022, Syracuse University, Syracuse, NY

"Quasiparticles, phonons, and photons in superconducting quantum circuits"
South Carolina Quantum Technology Forum, 2022, Clemson University, Clemson, SC

"Real-time single-shot detection of quasiparticle trapping"
Condensed Matter Seminar, 2022, University of California Berkeley, Berkeley, CA

"Continuous single-shot detection of quasiparticle trapping"
Condensed Matter Seminar, 2021, University of Pittsburgh, Pittsburgh, PA

"How supernovae break your quantum computer: quasiparticles in superconducting circuits"
Dept. of Physics & Astronomy Colloquium, 2021, Washington University, St. Louis, MO

"Harnessing noise in superconducting quantum circuits"
Condensed Matter Seminar, 2019, CNRS Grenoble, Grenoble, France

"Quasiparticles in quantum circuits"
Quantum Measurement Group Seminar, 2019, Jet Propulsion Laboratory, Pasadena, CA

"Probing quasiparticle properties in superconducting quantum circuits"
Special Seminar, 2019, MIT-Lincoln Laboratories, Lexington, MA

"Decoherence in superconducting quantum circuits"
Department of Physics Colloquium, 2018, CSU Los Angeles, Los Angeles, CA

"Fleas on Schrödinger's cat: eliminating quasiparticles from superconducting quantum circuits"
Department of Physics Colloquium, 2018, Chapman University, Orange, CA

"Quasiparticles in superconducting quantum circuits"
Department of Physics Condensed Matter Seminar, 2017, UC Irvine, Irvine, CA

"Quasiparticles in qubits"
The 20th Workshop on Superconductor Electronics: Devices, Circuits, and Systems, 2017, Santa Cruz, CA

"Superconducting quantum electronics"
CAPP Special Seminar, 2017, KAIST, Daejeon, Korea

"Resonant detection of short-range gravitational forces"
New Ideas in Low Energy Tests of Fundamental Physics Conference 2014, Perimeter Institute, Waterloo, ON

"Characterization and application of aluminum nanobridge Josephson junctions"
Department of Physics Condensed Matter Seminar, 2014, UC Berkeley, Berkeley, CA

CONTRIBUTED TALKS (**denotes talk on my group's research presented by my advisee*)

"Active, on-demand dissipation for qubit reset and coherence preservation"
Superconducting Qubits and Algorithms Conference, 2023, Munich, Germany

"Quasiparticle dynamics in Andreev bound states"* (*2-part talk*)
American Physical Society March Meeting 2023, Las Vegas, NV

"Noise suppression in superconducting qubits through on-demand cavity cooling and optimal control"*
American Physical Society March Meeting 2023, Las Vegas, NV

"Weak measurement feedback and Zeno pinning for remote entanglement generation and stabilization in superconducting qubits"*
American Physical Society March Meeting 2023, Las Vegas, NV

"Master equation emulation and coherence preservation with classical control of a superconducting qubit"*
American Physical Society March Meeting 2023, Las Vegas, NV

"Engineering and harnessing noisy environments to preserve quantum process fidelity in superconducting qubits"
Superconducting Qubits and Algorithms Conference, 2022, Helsinki, Finland

"On-demand cavity cooling and reset with a modular dissipator"*
American Physical Society March Meeting 2022, Chicago, IL

"Non-Markovian noise as a resource for suppressing Markovian errors in superconducting qubits"*
American Physical Society March Meeting 2022, Chicago, IL

"Continuous Real-Time Detection of Quasiparticle Trapping"* (*two-part talk*)
American Physical Society March Meeting 2022, Chicago, IL

"Tomographic construction and prediction of superconducting qubit dynamics using the post-Markovian master equation"*
American Physical Society March Meeting 2022, Chicago, IL

"Continuous measurement of quasiparticle trapping in aluminum nanobridge Josephson junctions"*
American Physical Society March Meeting 2021, virtual conference

"Generalized Markovian noise as a resource for suppressing Markovian errors in superconducting qubits"* (*two-part talk*)
American Physical Society March Meeting 2021, virtual conference

"Probing non-equilibrium quasiparticle populations in superconducting quantum circuits"*
American Physical Society March Meeting 2020, Denver, CO (cancelled, talk given remotely)

"Engineering quantum process fidelity via generalized Markovian noise"*
American Physical Society March Meeting 2020, Denver, CO (cancelled, talk given remotely)

"Time reversal symmetry of A and B phases of $PrOs_4Sb_{12}$"
American Physical Society March Meeting 2017, New Orleans, LA

"Hot soup: thermal transport without quasiparticles in underdoped YBCO"
Moore EPiQS Postdoctoral Symposium 2017, Aspen, CO

"Optical Kerr measurements of $PrOs_4Sb_{12}$"
American Physical Society March Meeting 2016, Baltimore, MD

"Kerr effect measurements of time-reversal symmetry breaking in heavy fermion superconductors"
American Physical Society March Meeting 2015, San Antonio, TX

"Quasiparticle trapping and dynamics in superconducting nanobridges"
American Physical Society March Meeting 2014, Denver, CO

"Quasiparticle noise in aluminum nanobridge Josephson junctions"
American Physical Society March Meeting 2013, Baltimore, MD

"Microwave frequency loss in aluminum nanobridge Josephson junctions"
American Physical Society March Meeting 2012, Boston, MA

"Microwave response of superconducting resonant circuits based on 3D aluminum nanobridge Josephson junctions"
American Physical Society March Meeting 2011, Dallas, TX

"Aluminum nanobridge Josephson junctions for molecular magnetometry"
Applied Superconductivity Conference 2010, Washington, DC

TEACHING

Physics 151: Mechanics and Thermodynamics (F2017, S2019, F2019, S2020)
Physics 438a: Introduction to Quantum Mechanics and its Applications A (S2021, S2022)
Physics 438b: Introduction to Quantum Mechanics and its Applications B (F2020, F2022)
Physics 559: Quantum Devices (F2021, F2023)

STUDENTS SUPERVISED (reverse chronological order, *italics* indicate current student)

Primary PhD research advisor (*also qual and thesis committees chair/co-chair)*

Evangelos Vlachos (PhD Physics expected Spring 2024)
Sacha Greenfield (PhD Physics expected Spring 2025)
Vivek Maurya (PhD Physics expected Spring 2026)
Sadman Shanto (PhD Physics expected Spring 2026)
Malida Hecht (PhD Physics expected Spring 2027)
Haimeng Zhang (PhD EE Summer 2023)
James Farmer (PhD Physics Spring 2023)

Secondary PhD research advisor

Vinay Tripathi (USC, PhD expected Spring 2024)
Bassel Elfeky (NYU, PhD expected Spring 2024)
Daria Kowsari (WashU, PhD Physics Spring 2023)

Primary master's research advisor

Darian Hartsell (MA Physics Spring 2022)
Revanth Kondaveti (MS EE 2021)
Crystal Roybal (MS Applied Physics expected Spring 2025)

Primary undergraduate research advisor

Matthew Ai (BS EE expected Spring 2024)
Margo Collins (BS EE expected Spring 2024)

Andre Kuo (BS Physics expected Spring 2024)
Richard Dong (BS Physics Spring 2023)
Jocelyn Liu (BS EE Spring 2023)
Clark Miyamoto (BS Physics Spring 2023)
Steven Shum (BS Physics Spring 2022)
Amara Anderson (BS Physics 2021)
William Sager (BS EE 2019)

Undergraduate research project supervisor

Kojo Boakye-Nimako (BS Physics-CS Spring 2023)
Allison Ohara (BS Physics-CS 2022)
Josie Alvarez (BS Physics-CS 2021)
Marisa Class (BS Physics-CS 2021)
Angel Flores (BS Physics-CS 2021)
Aitor Amatriain Martinez (BS Physics-CS 2021)
Rahel Yimenu (BS Physics-CS 2021)

Graduate student committees (not including primary advisees)

Thesis: Max Lien (USC 2023), Daria Kowsari (WashU 2023), John Niman (USC 2023), Jack Lashner (USC 2023), Bibek Pokharel (USC 2022), Aaron Wirthwein (USC 2022), Zhihao Jiang (USC 2021), Gautam Rai (USC 2021), Patrick Edwards (USC 2021), Yi-Hsiang Chen (USC 2020)

Qualifying Exam (all at USC): Bruno Avritzer (2023), Haowei Shi (2023), Bingzhi Zhang (2023), Abelrahman O. Haridy (2023), Bo Shrewsbury (2023), Vinay Tripathi (2023), Prithviraj Prabhu (2023), Sourav Kundu (2022), Michael Coumans (2022), Aaron Wirthwein (2021), Bibek Pokharel (2020), John Niman (2020), Yi Hsiang Chen (2019), Jack Lashner (2019), Gautam Rai (2019), Huo Chen (2018), Zhihao Jiang (2018), Patrick Edwards (2018)

OUTREACH AND PRESS

Founding Editor, QuBytes.org (2020 –)
Lead organizer, "How to prepare for, get into, and succeed at physics grad school" (2021 –)
Featured in Nature "Daily Briefing" 2022
Interview in USC Dornsife Magazine, "A Brighter Tomorrow" 2020
Scientific consultant on untitled Illumination Entertainment project 2018
Scientific consultant on Lauren Kleeman album "Stardust" 2018

SERVICE TO THE PROFESSION

Editor, Materials Science and Engineering B (2018 – 2021)

Peer reviewer
Nature, Nature Communications, npj Quantum Information, npj Quantum Materials, Physical Review Research, Physical Review Applied, Quantum Science and Technology, Applied Physics Letters, Journal of Superconductivity and Novel Magnetism

Grant/fellowship reviewer

ARO QIS program, AFOSR QIS program, NSF DMR program, NRC Postdoctoral Fellowship, NDSEG Fellowship, NSF GRF, US-Israel BSF (international), King Fahd University (international)

SERVICE TO THE UNIVERSITY

Physics & Astronomy Colloquium Committee	(2017 – 19, 2023 –)
Physics & Astronomy Faculty Search Committees	(2018 – 19, 2020 – 21, 2022, 2023 –)
Physics & Astronomy Climate Committee	(2020 –)
Cleanroom Advisory Board	(2021 –)
Photonics Packaging Lab Design Committee	(2021 –)
Physics & Astronomy Graduate Affairs Committee	(2020 – 2023)
MS in Quantum Information Science Curriculum Committee	(2019 – 2020)
Dornsife Faculty Council Diversity Caucus	(2018 – 2019)