Sisira Kanhirathingal

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RESEARCH INTERESTS

I am currently a doctoral student at Dartmouth College working in ultra-sensitive near quantum-limited electrometry and low-frequency noise suppression. My broad research interests include circuit-QED, control and readout of quantum computing hardware, and quantum-limited amplification.

Areas of expertise:

Tunable superconducting microwave resonators, Josephson junctions, feedback-assisted noise characterization and control, dispersive single-photon measurements, and charge sensing.

EDUCATION

Dartmouth College, Hanover, USA

Ph.D. in Physics Sep 2015 – Present

Adviser: Prof.Alexander Rimberg

Co-Adviser: Prof. Miles Blencowe

Thesis: Using Feedback Stabilization to Achieve Quantum-Limited Charge Sensing at Single-Photon Level

Indian Institute of Science Education and Research, Thiruvananthapuram, Kerala, India

Integrated B.S./M.S. in Physics (Major) and Mathematics (Minor) Aug 2010 – Jun 2015

Adviser: Dr. Joy Mitra

Thesis: The physics of one-dimensional Tellurium nanostructures

SELECTED RESEARCH PROJECTS

Feedback assisted $1/f$-noise suppression in tunable microwave cavities

- Supervisor: Prof. Alexander Rimberg (Dartmouth College, Jun 2020 – Oct 2021)
- Demonstrated effective decoupling of intrinsic charge/flux noise and suppression of $1/f$-noise in the resonance frequency fluctuations of a cavity-embedded Cooper pair transistor (cCPT), driven at a single photon occupancy. The method may be generalized to achieve low frequency noise reduction caused due to both charge and flux noise in tunable microwave cavities.

Boosting the near quantum-limited linear charge sensitivity at single photon level using feedback stablisation

- Supervisor: Prof. Alexander Rimberg (Dartmouth College, Ongoing)
- We demonstrate near-quantum limited charge sensitivity in cCPT, a fast and ultrasensitive electrometer. Using feedback techniques, we effectively decouple the gate charge noise induced by two-level system (TLS) defects in the sample, thus stablizing associated resonant fluctuations in the cavity.

cCPT open system dynamics and its photon shot noise-limited charge sensitivity

- Supervisor: Prof. Miles Blencowe (Dartmouth College, Jun 2018 – Aug 2020)
- Using an operator scattering approach, we analyzed the quantum dynamics of cCPT and discussed its tunable and strongly nonlinear resonant properties. We conducted a first principles theoretical investigation of its linear charge sensing capabilities, when the cavity is driven at less than a single photon occupancy.

Detection of low-frequency noise in superconducting resonators

- Supervisor: Dr. Josh Mutus (Google Quantum AI, Summer 2019)
- Built a customized setup suiting the requirements of the research team to detect low-frequency noise in superconducting microwave resonators in real time. The setup was based on Pound-Drever-Hall technique extensively used to stabilize laser sources by locking it to the cavity resonant frequency.

PUBLICATIONS

- S. Kanhirathingal, B. Thyagarajan, B. L. Brock, J. Y. Mutus, Juliang Li, E. Jeffrey, M. P. Blencowe, A. J. Rimberg, "Feedback stabilization of low-frequency bias-noise in tunable microwave cavities with a single-photon occupancy" (*Manuscript under preparation*).
- S. Kanhirathingal, B. L. Brock, A. J. Rimberg, and M. P. Blencowe, "Charge Sensitivity of a Cavity-Embedded Cooper Pair Transistor Limited by Single-Photon Shot Noise", *Journal of Applied Physics*, 130, 114401, Jul 2021.
- B. L. Brock, Juliang Li, S. Kanhirathingal, B. Thyagarajan, M. P. Blencowe, A. J. Rimberg, "A Fast and Ultrasensitive Electrometer Operating at the Single-Photon Level", *Phys. Rev. Applied*, 16, L051004, Nov 2021.
- B.L. Brock, Juliang Li, S. Kanhirathingal, B. Thyagarajan, William F. Braasch, Jr., M.P. Blencowe, and A.J. Rimberg, "Nonlinear Charge- and Flux-Tunable Cavity Derived From an Embedded Cooper-Pair Transistor", *Phys. Rev. Applied*, 15, 044009, Apr 2021.
- A. Som, D. Sarkar, S. Kanhirathingal and T. Pradeep, "Atomically Precise Transformations and Millimeter Scale Patterning of Nanoscale Assemblies by Ambient Electrospray Deposition", *Particle and Particle Systems Characterization*, 34 (7), 1700101, Jul 2017.

PROFESSIONAL EXPERIENCE

Google Quantum AI, Santa Barbara
Research Intern, Summer 2019

- Worked at Google's quantum computing hardware lab as part of a research internship (in person) hosted by Dr. Josh Mutus. Project involved conducting research in close association with physicists, engineers and computer scientists in industry.
- Built a customized feedback-based setup for noise characterization. Set up an extensive microwave hardware SNR-optimized at each stage, and wrote up the data acquisition and analysis code using LabRAD server.

Dartmouth College, Hanover
Teaching Assistant, Department of Physics and Astronomy (14 Quarters)

- Introductory level courses in Electromagnetism and Mechanics; undergraduate and graduate level courses in Classical Mechanics
- Responsibilities included being head TA, conducting lab sessions and office hours, grading and proctoring, preparing homework solutions and simulations etc.

AWARDS & SCHOLARSHIPS

- Gordon F. Hull Fellow, Dept. of Physics and Astronomy, Dartmouth College (2021-2022).
- Student recipient of Google Faculty Research Award ($80k); Co-author of the winning grant proposal (2020-21).
- All India Rank 55 (25k participants) in Physics Junior Research Fellowship Exam, CSIR, Govt. of India (2013).
- INSPIRE Fellow, Dept. of Science and Technology, Govt. of India (2010-2015).

TECHNICAL SKILLS

Instrumentation: Microwave electronics, dilution refrigeration, various fabrication and microscopy techniques.
Programming: Python, Matlab, Mathematica, LabRAD Server, Sonnet.