AKSHAY KOOTTANDAVIDA

Ph.D. candidate in Applied Physics
Devoret group at Yale University

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📍 New Haven, CT, USA

SUMMARY

Experimental physicist working on quantum error correction experiments with 3D superconducting microwave circuits. Expert in bosonic error correction codes and fault-tolerant quantum computation. Developed novel codes and experimentally implemented protocols for control and measurements of logical qubits using parametric processes.

INTERESTS

Quantum error correction with superconducting qubits and cavities, Quantum control, RF measurements, Low temperature experimental techniques, Fault-tolerance, Erasure qubits

RESEARCH EXPERIENCE

8/2018-present **Graduate Researcher**   **Yale University, USA**
PI : Prof. Michel Devoret

- Experimentally implemented an erasure qubit based on the dual-rail code in 3D superconducting cavities. Demonstrated high-fidelity erasure conversion of photon losses using ancilla transmon such that it can be incorporated in a surface code to increase code distance and thresholds.
- Developed a novel protocol to perform joint-Wigner tomography in bosonic systems by parametrically matching the cross-Kerr rates between a transmon and two bosonic modes.
- Implement a fully error correcting code in two bosonic modes – the pair-cat code, and measure the photon number difference error syndrome. Dynamically tune the cross-Kerr rates between the bosonic modes and a transmon to perform syndrome measurements transparent to ancilla errors.
- Designed a novel, hybrid SQUID-SNAIL device and experimentally demonstrated cross-Kerr cancellation between a high-Q cavity and the non-linear modes of the system, while preserving four-wave mixing properties.
- Designed and fabricated the flux transformer – a novel device to deliver DC magnetic flux in a high-Q superconducting 3D cavity architecture. It is now widely used to flux bias Josephson junction based coupling circuits for parametrically activated interactions and gates between logical qubits in bosonic modes.

1/2018-8/2018 **Research Staff**   **RIKEN, Japan**
PI : Prof. Franco Nori

- Implemented a custom Monte Carlo quantum master equation simulator to model the Su-Schreiffer-Heeger model in the presence of local and collective dissipation and measurements.
- Investigated the robustness of topological phase transitions in such systems.

5/2016-12/2016 **Undergraduate Research Assistant**   **EPFL, Switzerland**
PI : Prof. Tobias Kippenberg

- Designed a microwave optomechanical circuit based on aluminium drum capacitors for an experiment to demonstrate nonreciprocal signal transmission.
- Modelled the system and provided theory support for the experimental team.
- Investigated the nonlinear properties of a capacitor formed out of two-dimensional layers of graphene and boron nitride.

6/2015-7/2015 **Undergraduate Research Assistant**   **Wolfram Inc, USA**
PI : Stephen Wolfram

- Simulated the Ising model in Mathematica to mimic the quench dynamics of a D-wave quantum chip.
- Investigated properties of 2D cellular automata

EDUCATION

8/2018 - present **Ph.D. Applied Physics, Yale University**
PI : Prof. Michel Devoret
Thesis title : Quantum error correction using two bosonic modes
Expected graduation date : 8/2024

8/2015 - 6/2017 **M.Sc. Physics, University of Mumbai - DAE - CEBS**
Thesis title: Nonreciprocal Devices in Microwave Circuit Optomechanics.

8/2012 - 6/2015 **B.Sc. Physics, University of Mumbai - DAE - CEBS**

PUBLICATIONS

- A. Koottandavida, I. Tsioutsios, A. Kargioti, C. R. Smith, V. R. Joshi, W. Dai, J. D. Teoh, J. C. Curtis, L. Frunzio, R. J. Schoelkopf, and M. H. Devoret, **"Erasure detection of a dual-rail qubit encoded in a double-post superconducting cavity,"** 2024. Phys. Rev. Lett. 132, 180601 (Editor's Suggestion).

- B. J. Chapman, S. J. de Graaf, S. H. Xue, Y. Zhang, J. Teoh, J. C. Curtis, T. Tsunoda, A. Eickbusch, A. P. Read, A. Koottandavida, S. O. Mundhada, L. Frunzio, M. Devoret, S. Girvin, and R. Schoelkopf, **"High-On-Off-Ratio Beam-Splitter Interaction for Gates on Bosonically Encoded Qubits,"** PRX Quantum, p. 020 355, 2023.

- C. Gneiting, A. Koottandavida, A. V. Rozhkov, and F. Nori, **"Unraveling the topology of dissipative quantum systems,"** Physical Review Research, p. 023 036, 2022.

- N. R. Bernier, L. D. Tóth, A. Koottandavida, M. A. Ioannou, D. Malz, A. Nunnenkamp, A. K. Feofanov, and T. J. Kippenberg, **"Nonreciprocal reconfigurable microwave optomechanical circuit,"** Nature Communications, 2017, issn: 2041-1723.

- S. Khorasani and A. Koottandavida, **"Nonlinear graphene quantum capacitors for electro-optics,"** npj 2D Materials and Applications, pp. 1–7, 2017.

SKILLS

| Quantum measurements | • Experienced in low temperature, low noise-high bandwidth RF/microwave measurement techniques for quantum control and readout. |
| | • Experienced in fast feedback FPGA based RF electronics for quantum error correction experiments. |

| Dilution refrigerator | • Proficient in handling dilution refrigerators and equipment troubleshooting, installation and upkeep. |
| | • In charge of maintaining a dozen dilution refrigerators in Devoret and Schoelkopf lab at Yale university. |

Simulation	• Programming languages : Python (advanced), Mathematica (advanced)
	• Quantum simulation packages : QuTiP (advanced), Tensorflow (intermediate)
	• Circuit design and simulation : HFSS (advanced), Sonnet (intermediate), AWR (intermediate), pyEPR (advanced)
	• Version control : Git, Github (advanced)

| Nanofabrication | • Electron beam lithography, scanning electron microscopy, deposition. |
| | • Experienced in fabricating Josephson junction based circuits including transmons, SQUID, SNAIL. |

CONFERENCE PRESENTATIONS

11/2023	Erasure detection of a dual-rail qubit in a 3D superconducting cavity. Contributed talk, QEC23, Sydney, Australia
03/2023	Quantum control and error correction with two bosonic modes. Session talk, APS March meeting, Las Vegas, USA
07/2022	Autonomous quantum error correction with pair-cat code. Poster, Gordon Research Conference, Boston, USA
03/2022	Experimental implementation of pair-cat code with superconducting microwave circuits. Session talk, APS March meeting, Chicago, USA
06/2021	Autonomous quantum error correction with pair-cat code in superconducting microwave circuits. Invited talk, International Conference on Complex Quantum Systems, BARC, Mumbai,India
04/2021	Autonomous quantum error correction with pair-cat code in superconducting microwave circuits. Invited talk, Workshop on Enabling Technology and Algorithms for Quantum Computing, WACQT, Chalmers, Sweden
03/2021	Experimental implementation of pair-cat code with superconducting microwave circuits. Session talk, APS March meeting, Online

MEDIA HIGHLIGHTS

- *Quantum errors raise a flag*, Yale Quantum Institute, 2024

- *One-way track for microwaves based on mechanical interference*, Ecole Polytechnique Federale de Lausanne, 2017

AWARDS & HONORS

8/2012 - 5/2017 **INSPIRE Scholarship**
Awarded to outstanding students pursuing undergraduate degree in STEM, Department of Science and Technology, Government of India.

1/2012 **Best Student Award for Innovative Science**

LANGUAGES

English - native, **Hindi** - Expert, **Malayalam** - native

OTHER INTERESTS

Soccer - Captained the undergraduate college soccer team.

Volleyball - Played for the undergraduate college volleyball team.

Chess - 1700 Elo rating in classical and blitz formats.