

# Keerthi Kumaran A M

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## Summary

I am a fourth-year PhD student in Physics specializing in Quantum Computing, with expertise in quantum simulations, error mitigation, and quantum circuit optimization. My research focuses on developing scalable quantum algorithms and improving hardware-aware techniques for simulating complex quantum systems. I have contributed to high-impact projects at IBM Quantum and Purdue University, implementing advanced error suppression methods and designing efficient quantum ansätze for near-term devices. Passionate about pushing the boundaries of quantum technology, I actively collaborate with interdisciplinary teams and also develop open-source tools for the research community.

## Education

### Purdue University, West Lafayette campus

Physics graduate student (GPA 3.9/4.0)

United States

Aug-2022 - Present

### Indian Institue of Science (IISc)

BS-Physics (CGPA-9.3/10.0)

Bengaluru, India

Aug-2018 - July 2022

### Maharishi Vidya Mandir

High School (486/500)

Chennai, India

Apr 2016 - Apr 2018

## Skills

**Programming** Python, R, C/C++, Matlab, Mathematica

### Libraries

*Machine learning:* Pandas, PyTorch, NumPy, Scikit-learn, Keras, TensorFlow; *Hardware simulation:* qutip, sqcubits;

*Quantum-Programming:* Qiskit, PennyLane, Cirq

**Software & Tools**  $\LaTeX$ (Overleaf/R Markdown), Github, Origin, SciDavis

## Relevant Research Experience

### Improving Sample-Based Quantum Diagonalization (SQD) techniques (In progress, details are not be disclosed yet)

IBM Quantum

- Improved the energy estimation of current SQD sub-routines.

Yorktown Heights, New York

May 2025 - July 2025

### Quantum Simulation of Superdiffusive Breakdown ([arxiv.org/abs/2503.14371](https://arxiv.org/abs/2503.14371))

IBM Quantum

- Simulated superdiffusion breakdown in 2D Heisenberg chains with quantum circuits.
- Applied error mitigation techniques, including Probabilistic Error Cancellation and Amplification.
- Built an internal software package for correlation function computations, incorporating Travis and tox testing.

Yorktown Heights, New York

May 2024 - Feb 2025

### Transmon Qutrit-Based Simulation of Spin-1 AKLT Systems ([arxiv.org/abs/2412.19786](https://arxiv.org/abs/2412.19786))

IBM Quantum

- Performed qutrit gate calibration using Rabi and Ramsey techniques on IBM superconducting transmons.
- Simulated the spin-1 AKLT model using calibrated qutrit gates.
- Used tensor network simulations to demonstrate qutrits' advantages over qubits in a simplified noise model.

Yorktown Heights, New York

Aug 2023 - Dec 2024

### Physics-Inspired Quantum Simulation of Resonating Valence Bond States ([pubs.acs.org/doi/10.1021/acs.jpca.3c05172](https://pubs.acs.org/doi/10.1021/acs.jpca.3c05172))

Purdue University

- Used Density-Matrix Renormalization Group (DMRG) to identify ground state properties via matrix-product states.
- Designed an auxiliary Hamiltonian with reduced measurables and a modular, gate-efficient ansatz.
- Achieved <1% ground-state energy accuracy on IBMQ hardware with robust error mitigation.

West Lafayette, Indiana

April 2023 - June 2023

- Applied local random quantum circuits for dimensionality reduction of large low-rank datasets.
- Benchmarked quantum random projection against classical PCA on MNIST and CIFAR-100.
- Used variational quantum SVD to extract dominant singular vectors post-quantum projection.

## Other Quantum Computing Experience

### MIT-iQuHack

Virtual

MIT-IonQ

Jan-23

- Image Classification using Quantum Classifier post encoding classically preprocessed image into quantum circuits.

### QHack-2023

Virtual

Xanadu

Feb-23

- Our team was placed 112th out of 800 teams that participated

### PennyLane Coding Camp 2022

Virtual

Xanadu

Nov-22

- Successfully finished 14 out of 16 coding challenges. My team was placed 59th position out of 450+ teams that participated

### IBM Fall 2022 Quantum Challenge

Virtual

IBM-Q

Nov-22

- Successfully finished 4 out of 4 labs and secured the Advanced(best) badge.

### IBM 2021 Quantum Machine Learning Summer School

Virtual

IBM-Q

July-21

- Got an in depth understanding of all the Quantum Machine Learning Algorithms from the experts.

## Achievements

2023	<b>Reviewer</b> , Journal of Physics A: Mathematical and Theoretical	-
2021	<b>Research Scholar</b> , DAAD WISE Scholar	Germany-India
2018-2022	<b>Student Scholar</b> , KVPY	India
2018	<b>All India Rank -850</b> , Joint Entrance Examination (JEE)	India
2016	<b>Student Scholar</b> , National Talent Search Examination	India
2021	<b>106/120</b> , TOEFL	India

## Publications

### JOURNAL ARTICLES

Robust Chiral Edge Dynamics of a Kitaev Honeycomb on a Trapped Ion Processor (arXiv:2507.08939)

Ammar Ali, Joe Gibbs, Keerthi Kumaran, Varadharajan Muruganandam, Bo Xiao, Paul Kairys, Gábor Halász, Arnab Banerjee, Phillip C. Lotshaw

2025

Quantum simulation of superdiffusion breakdown in Heisenberg chains via 2D interactions (arXiv:2503.14371)

Keerthi Kumaran, Manas Sajjan, Bibek Pokharel, Joe Gibbs, Jeffrey Cohn, Barbara Jones, Sarah Mostame, Sabre Kais, Arnab Banerjee

2025

Transmon qutrit-based simulation of spin-1 AKLT systems (arXiv:2412.19786)

Keerthi Kumaran, Faisal Alam, Norhan Eassa, Kaelyn Ferris, Xiao Xiao, Lukasz Cincio, Nicholas Bronn, Arnab Banerjee

2025

Random projection using random quantum circuits

Keerthi Kumaran, Manas Sajjan, Sangchul Oh, Sabre Kais

Phys. Rev. Res. 6 (1 Jan. 2024) p. 013010. American Physical Society, 2024

Physics-Inspired Quantum Simulation of Resonating Valence Bond States: A Prototypical Template for a Spin-Liquid Ground State

Manas Sajjan, Rishabh Gupta, Sumit Suresh Kale, Vinit Singh, Keerthi Kumaran, Sabre Kais

Journal of Physical Chemistry A 127.41 (Oct. 2023) pp. 8751–8764. 2023