




# 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 circuit optimization. My research at IBM Quantum and Purdue University focuses on scalable quantum algorithms and hardware-aware techniques. I have applied advanced error suppression methods and contributed to open-source tools. Additionally, I have built a strong foundation in Quantum Error Correction (QEC) through coursework and research on quantum simulation of non-Abelian anyons, quasiparticles that serve as building blocks for topological QEC schemes. This experience prepares me to excel in QEC-focused roles and to contribute to the development of fault-tolerant quantum systems.

## Education

### Purdue University

*PhD, Physics (Quantum Computing), GPA: 3.9/4.0*

**West Lafayette, USA**

*Aug 2022 – Present*

### Indian Institute of Science (IISc) Bengaluru

*BS in Physics, CGPA: 9.3/10.0*

**Bengaluru, India**

*Aug 2018 – Jul 2022*

## Work Experience

### IBM Quantum

*Quantum Research Intern*

**Yorktown Heights, NY**

*May 2025 – July 2025*

- Improved energy estimation algorithms for Sample-Based Quantum Diagonalization (SQD) subroutines, boosting accuracy and noise resilience.
- Performed GPU-parallelized diagonalization routines for large quantum bitstring outputs, enabling high-throughput assessment of circuit outputs.
- Developed and maintained internal tools for quantum algorithm research within a team of researchers.
- Worked on proprietary projects related to quantum chemistry (details confidential).

### IBM Quantum

*Quantum Research Intern*

**Yorktown Heights, NY**

*May 2024 – Feb 2025*

- Simulated superdiffusion breakdown in 2D Heisenberg spin chains using high depth quantum circuits in IBM hardware.
- Applied advanced error mitigation, including Probabilistic Error Cancellation and error amplification, to improve quantum simulation results.
- Built an internal software package to compute two-body correlation functions with automated testing (Travis, tox).
- Implemented transmon qutrit calibration (Rabi/Ramsey) and simulated AKLT chains to demonstrate advantages of using qutrits over qubits (arXiv:2412.19786).

## Relevant Research Experience

### Quantum Simulation

*Graduate Research Assistant*

**Purdue University**

*Aug 2022 - Present*

- Simulated the physics of spin-1 AKLT models using both calibrated qutrit gates (on IBM transmons) and tensor networks, demonstrating advantages of using qutrits over qubits (arXiv:2412.19786).
- Investigated robust chiral edge dynamics of Kitaev honeycomb lattice models on a trapped ion processor (arXiv:2507.08939).
- Quantum simulation of superdiffusive breakdown in Heisenberg chains using quantum circuits, leveraging error mitigation protocols to improve the results (arXiv:2503.14371).
- Physics-inspired quantum simulation of resonating valence bond ground states: Designed auxiliary Hamiltonians and modular, gate-efficient ansatz for high-accuracy simulation results; achieved  $< 1\%$  ground-state energy accuracy on IBMQ hardware. Published in J. Phys. Chem. A 2023.

## Quantum Algorithms

Purdue University

Graduate Research Assistant

Aug 2022 - Present

- Developed improved sample-based quantum diagonalization (SQD) routines and variational quantum algorithms, integrating Qiskit, PennyLane, and custom tensor network algorithms.
- Benchmarked quantum random projection for dimensionality reduction and compared against classical PCA for MNIST/CIFAR100; extracted dominant singular vectors using variational quantum SVD (Phys. Rev. Research 2024).
- Designed accurate time-evolution circuits for non-Abelian anyon simulation, advancing topological quantum error correction schemes.
- Built automated internal tools and test suites for scalable quantum algorithm research (Travis, tox).

## HPC and GPU Acceleration

Purdue University

Graduate Research Assistant

Aug 2022 - Present

- Utilized Purdue's NVIDIA A30 GPUs and SLURM cluster to run large-scale quantum simulations (including spin transport and ground state circuit optimization).
- Worked with CUDA-Q libraries and open-source quantum error correction (QEC) toolkits for syndrome decoding and fault-tolerant circuit simulation workflows.
- Accelerated matrix product state simulations and quantum algorithm workflows using GPU resources.

## Skills

- **Programming:** Python, R, C/C++, Matlab, Mathematica
- **Libraries:** Pandas, PyTorch, NumPy, Scikit-learn, Keras, TensorFlow
- **Quantum Programming:** Qiskit, PennyLane, Cirq, CUDA-Q
- **HPC Tools:** SLURM, CUDA, tensor networks, DMRG, variational algorithms
- **Hardware simulation:** qutip, squbits
- **Benchmarking:** Tensor networks, DMRG, Variational algorithms
- **Tools:** Git, Visual Studio Code, Jupyter

## Publications and Preprints

1. Robust Chiral Edge Dynamics of Kitaev Honeycomb on a Trapped Ion Processor, arXiv:2507.08939, 2025
2. Quantum simulation of superdiffusion breakdown in Heisenberg chains, arXiv:2503.14371, 2025
3. Transmon qutrit-based simulation of spin-1 AKLT systems, arXiv:2412.19786, 2025
4. Random projection using random quantum circuits, Phys. Rev. Res. 6, 2024
5. Physics-Inspired Quantum Simulation of RVB States, J. Phys. Chem. A, 127(41), 2023

## Achievements

- Reviewer, Journal of Physics A: Mathematical and Theoretical (2023)
- DAAD WISE Scholar (2021), KVPY Scholar (2018–22)
- JEE All India Rank 850 (2018)
- NTSE Student Scholar (2016)
- TOEFL Score: 106/120 (2021)

## Mentoring, Teaching and Extracurricular Involvement

- QSTEP 2025 Workshop Instructor: Taught a select group of undergraduates core quantum computing concepts and hands-on skills at the QSTEP 2025 Workshop at Purdue.
- Teaching Assistant — Purdue University (Aug 2021 May 2023)
- MITiQuHack — Built quantum classifier for image classification
- QHack 2023 — Ranked 112th of 800 teams
- PennyLane Coding Camp — Completed 14/16 challenges, ranked 59th/450
- IBM Fall Quantum Challenge, Quantum ML Summer School