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https://scholar.google.com/citations?hl=enuser=DK3QFcQAAAAJ

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, exotic quasiparticles that serve as building blocks for topological QEC schemes. This experience equips me to adapt quickly to QEC-focused roles and contribute to the development of fault-tolerant quantum systems.

Education

Purdue University, West Lafayette campus — *United States*

Physics graduate student (GPA 3.9/4.0) — *Aug 2022 – Present*

Indian Institute of Science (IISc) — *Bengaluru, India*

BS-Physics (CGPA 9.3/10.0) — *Aug 2018 – Jul 2022*

Skills

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

Libraries *Machine learning:* Pandas, PyTorch, NumPy, Scikit-learn, Keras, TensorFlow; *Hardware simulation:* qutip, scqubits; *Quantum-Programming:* Qiskit, PennyLane, Cirq, CUDA-Q

Tools *HPC Tools*: SLURM, CUDA; *Benchmarking methods:* Tensor networks, DMRG, variational algorithms

Relevant Research Experience

Sample-Based Quantum Diagonalization (SQD)techniques (In progress, details are not be disclosed yet) — *Yorktown Heights, New York*

IBM Quantum — *May 2025 - July 2025*

- Improved the energy estimation in current SQD sub-routines.
- Performed GPU-parallelized diagonalization routines for quantum bitstring outputs

Quantum Simulation of Superdiffusive Breakdown (arxiv.org/abs/2503.14371) — *Yorktown Heights, New York*

IBM Quantum — *May 2024 - Feb 2025*

- 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.

Transmon Qutrit-Based Simulation of Spin-1 AKLT Systems (arxiv.org/abs/2412.19786) — *Yorktown Heights, New York*

IBM Quantum — *Aug 2023 - Dec 2024*

- 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.

Physics-Inspired Quantum Simulation of Resonating Valence Bond States (pubs.acs.org/doi/10.1021/acs.jpca.3c05172) — *West Lafayette, Indiana*

Purdue University — *April 2023 - June 2023*

- 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.

Random Projection Using Random Quantum Circuits
(journals.aps.org/prresearch/abstract/10.1103/PhysRevResearch.6.013010) *West Lafayette, Indiana*

Purdue University *Nov 2022 - 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.

HPC and GPU Acceleration for Quantum Simulations *West Lafayette, Indiana*

Purdue University *2023 - Present*

- Used NVIDIA A30 GPUs on Purdue's HPC cluster to run quantum simulations of spin transport studies.
- Worked with CUDA-based QEC libraries for syndrome decoding and fault-tolerant quantum simulation workflows.

Other Quantum Computing Experience

MIT-iQuHack (MIT-IonQ, Jan 2023) — Built a quantum classifier for image classification using classically preprocessed data.
QHack 2023 (Xanadu, Feb 2023) — Ranked 112th out of 800+ teams.
PennyLane Coding Camp (Xanadu, Nov 2022) — Completed 14/16 challenges; team ranked 59th out of 450+.
IBM Fall Quantum Challenge (Nov 2022) — Completed all four labs; earned Advanced (best) badge.
IBM Quantum ML Summer School (Jul 2021) — Gained in-depth knowledge of quantum ML algorithms.

Achievements

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

Publications

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