Anuj Apte

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apteanuj

Education

University of Chicago **Chicago, IL**
Ph.D. Candidate in Physics *2022–June 2025*
Research Interests: Deep Learning, AI for Science, Quantum Computing

University of Chicago **Chicago, IL**
M.S. in Physics *2020–2022*
Selected Coursework:
Generative Models · Deep Learning Systems · Machine Learning for Molecular Modeling
Quantum Information and Computation · Implementation of Quantum Processors

Massachusetts Institute of Technology **Cambridge, MA**
B.S. in Physics and Philosophy *2016–2020*

Skills

Programming Languages: Python, C++, CUDA, Mathematica
Deep Learning Libraries: JAX, Pytorch, TensorFlow
Quantum Computing Libraries: Qiskit, Cirq, Pennylane
Tools and Platforms: Git, Slurm, AWS EC2

Research Experience

Department of Physics, University of Chicago **Chicago, IL**
Graduate Research Fellow *07/2020–Present*
- Developed Equivariant **Convolutional Neural Networks** using **JAX** for precise learning of lattice quantum systems, achieving state-of-the-art performance.
- Used Optax to train these models, leveraging **Slurm** for managing the training runs on Midway supercomputer.
- Applied **transfer learning** to compute the phase diagram, showing for the very first time showed that critical exponents can be calculated to high accuracy.

Applied Research, JP Morgan Chase **New York, NY**
Summer Research Associate *06/2024–09/2024*
- Devised novel quantum algorithms for solving complex combinatorial optimization problems, using Chebyshev interpolation to achieve better performance in fewer circuit evaluations.
- Conducted large-scale **parallelized GPU simulations** of quantum algorithms on EC2 servers, optimizing resource allocation.

IBM Research **Yorktown Heights, NY**
Research Intern *05/2023–08/2023*
- Developed a deterministic technique for **measurement error mitigation**, leading to a 10x reduction in errors on quantum hardware.
- Implemented a Python software tool focusing on performance optimization and scalability to hundreds of qubits, ensuring compatibility with **Qiskit** runtime environments.
- Demonstrated the use of this method on IBM's largest 433-qubit **'Osprey'** quantum processor, validating effectiveness at scale.

Xanadu Quantum Technologies **Toronto, ON**
Research Resident *05/2022–08/2022*

- Designed an algorithm for faster simulations of Gaussian photonic circuits, achieving a **quadratic speedup** over state-of-the-art methods.
- Developed a Python software package implementing this algorithm, ensuring end-to-end differentiability for integration with machine learning models.
- Achieved a **100x speedup** in circuit simulation for GKP qubit preparation, facilitating more efficient quantum simulation.

NASA Quantum Artificial Intelligence Laboratory (QuAIL) **Mountain View, CA**
Research Intern *06/2021–09/2021*

- Developed theoretical models to explain surprising behavior of **Quantum Approximate Optimization Algorithm (QAOA)** circuits at large depth.
- Conducted extensive simulations on Bridges-2 supercomputer, enabling large scale study of quantum optimization algorithms.
- Analyzed simuations results to provide insights into the scalability and efficiency of pulse-level **Variational Quantum Eigensolver (VQE)** algorithm.

Kavli Institute for Astrophysics and Space Research, MIT **Cambridge, MA**
Researcher *12/2016–02/2018*

- Developed a framework to compute inclined inspiral trajectories into Kerr black holes, enabling a deeper analysis of binary geometries from gravitational wave signals.
- Implemented high-performance **C++** and **CUDA** code to calculate these trajectories and gravitational wave modes efficiently, improving simulations for extreme mass-ratio binaries.

Honors and Awards

2022: **Nambu Fellowship**, awarded to the highest-rated Ph.D. applicant at the University of Chicago

2020: Inducted into **Phi Beta Kappa**, Massachusetts Institute of Technology

2015: **Gold Medal**, Asian Physics Olympiad, Hangzhou, China

2015: **Silver Medal**, International Physics Olympiad, Mumbai, India

2014: Awarded **National Talent Search Examination (NTSE)** Scholarship by the Government of India

Selected Publications

[1] **Apte, A.**, Córdova, C., Huang, T.-C., Ashmore, A., "Deep learning lattice gauge theories". In: *Physical Review B* (2024).

[2] **Apte, A.**, Córdova, C., Lam, H. T., "Obstructions to gapped phases from noninvertible symmetries". In: *Physical Review B* (2023).

[3] De Prins, R., Yao, Y., **Apte, A.**, Miatto, F. M., "A Quadratic Speedup in the Optimization of Noisy Quantum Optical Circuits". In: *Quantum* (2023).

[4] Kremenetski, V., **Apte, A.**, Hogg, T., Hadfield, S., Tubman, N. M., "Quantum Alternating Operator Ansatz (QAOA) beyond low depth with gradually changing unitaries". In: *arXiv preprint arXiv:2305.04455* (2023).

[5] Liu, M., Liu, J., Liu, R., Makhanov, H., Lykov, D., **Apte, A.**, Alexeev, Y., "Embedding learning in hybrid quantum-classical neural networks". In: *IEEE International Conference on Quantum Computing and Engineering (QCE)*. 2022.

[6] Nguyen, T., Han, F., Andrejevic, N., Pablo-Pedro, R., **Apte, A.**, Tsurimaki, Y., Ding, Z., Zhang, K., Alatas, A., Alp, E. E., "Topological singularity induced chiral Kohn anomaly in a Weyl semimetal". In: *Physical Review Letters* (2020).

[7] Hughes, S. A., **Apte, A.**, Khanna, G., Lim, H., "Learning about black hole binaries from their ringdown spectra". In: *Physical Review Letters* (2019).