Anuj Apte

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Summary

Senior Research Associate at JPMorgan Chase working on **deep learning** and **quantum computing**. Background as a theoretical physicist with strong expertise in high-performance computing, mathematics, and numerical simulation.

Skills

DL: PyTorch, JAX/Flax **Systems**: Git, Slurm **Languages**: Python, C++

Experience

Senior Research Associate — JPMorgan Chase Jul 2025 – Present (New York, NY)

- Researching spectral matrix-aware optimizers such as Muon and Shampoo to understand their token efficiency and ways of reducing the computational overhead.
- Designed scalable warm-start method for Quantum approximate optimization algorithm and benchmarked performance on trapped-ion hardware, achieving Max-Cut values exceeding classical state of the art.
- Rigorously proved that there are continuous optimization problems for which Quantum adiabatic algorithm converges exponentially faster than classical gradient based methods (SGD) [1].

Graduate Research Fellow — University of Chicago Jul 2020 – Jun 2025

- Built equivariant CNNs in JAX/Flax for learning lattice quantum systems, achieving state-of-the-art ground state predictions. Applied transfer learning to compute phase diagrams and critical exponents [2].
- Proved that quantum systems with certain topological symmetries cannot form simple stable phases, establishing rigorous limits on their physical and computational behavior [3].

Internships — MIT, NASA, Xanadu, IBM Research, JPMorgan 2020–2024

- **JPMorgan:** Researched quantum optimization via Chebyshev interpolation, reducing circuit evaluations. Built parallel GPU simulation pipelines on AWS EC2, with Slurm-style scheduling and resource optimization for large-scale experiments [4].
- **IBM Research:** Developed a deterministic measurement error mitigation technique, achieving 10× error reduction on 433-qubit hardware. Integrated into scalable Python tools compatible with IBM quantum runtime.
- **Xanadu:** Designed algorithms for Gaussian photonic circuit simulation with quadratic speedup. Packaged into a differentiable Python library enabling ML integration. Achieved **100**× runtime improvement for GKP state preparation [5].
- **NASA QuAIL:** Developed theoretical models to explain surprising behavior of QAOA circuits at large depth, providing insights into convergence of the algorithm [6].
- **MIT Kavli Astrophysics:** Computed inclined inspiral trajectories into Kerr black holes; accelerated waveform simulations for extreme mass-ratio binaries with C++ code [7].

Education

2020 – 2025 **Ph.D. in Physics**, University of Chicago, Chicago, IL GPA: 4.0/4.0
Dissertation: Deep Learning and Non-Invertible Symmetries in Gauge Theories
Selected Graduate Coursework:
Machine Learning: Deep Learning Systems; Foundations of Machine Learning; Machine Learning for Molecular Modeling
Quantum Computing: Implementation of Quantum Information Processors; Quantum Complexity Theory; Quantum Computing
Mathematics: Algebraic Topology; Differential Geometry

2016 – 2020 **B.S. in Physics and Philosophy**, MIT, Cambridge, MA GPA: 4.9/5.0
Minors in **Mathematics** and **Music**

Honors & Awards

2022 **Nambu Fellowship** — awarded to the top-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
2011 **National Talent Search Examination (NTSE)** Scholar, Government of India

Selected Publications

[1] Dylan Herman, Guneykan Ozgul, **Anuj Apte**, Junhyung Lyle Kim, Anupam Prakash, Jiayu Shen, Shouvanik Chakrabarti. "Mechanisms for Quantum Advantage in Global Optimization of Nonconvex Functions". In: *QIP 2026* (2025). URL: https://arxiv.org/abs/2510.03385.

[2] **Anuj Apte**, Clay Córdova, Tzu-Chen Huang, Anthony Ashmore. "Deep learning lattice gauge theories". In: *Physical Review B* 110.16 (2024), p. 165133. DOI: 10.1103/PhysRevB.110.165133.

[3] **Anuj Apte**, Clay Córdova, Ho Tat Lam. "Obstructions to gapped phases from noninvertible symmetries". In: *Physical Review B* 108.4 (2023), p. 045134. DOI: 10.1103/PhysRevB.108.045134.

[4] **Anuj Apte**, Shree Hari Sureshbabu, Ruslan Shaydulin, Sami Boulebnane, Zichang He, Dylan Herman, James Sud, Marco Pistoia. "Iterative Interpolation Schedules for Quantum Approximate Optimization Algorithm". In: *arXiv preprint arXiv:2504.01694* (2025). URL: https://arxiv.org/abs/2504.01694.

[5] Robbe De Prins, Yuan Yao, **Anuj Apte**, Filippo M. Miatto. "A Quadratic Speedup in the Optimization of Noisy Quantum Optical Circuits". In: *Quantum* 7 (2023), p. 1097. DOI: 10.22331/q-2023-10-23-1097.

[6] Vladimir Kremenetski, **Anuj Apte**, Tad Hogg, Stuart Hadfield, Norm M Tubman. "Quantum alternating operator ansatz (QAOA) beyond low depth with gradually changing unitaries". In: *arXiv preprint arXiv:2305.04455* (2023). URL: https://arxiv.org/abs/2305.04455.

[7] Scott A Hughes, **Anuj Apte**, Gaurav Khanna, Halston Lim. "Learning about black hole binaries from their ringdown spectra". In: *Physical Review Letters* 123.16 (2019), p. 161101. DOI: 10.1103/PhysRevLett.123.161101.

[8] Thanh Nguyen, Fei Han, Nina Andrejevic, Ricardo Pablo-Pedro, **Anuj Apte**, Yoichiro Tsurimaki, Zhiwei Ding, Kunyan Zhang, Ahmet Alatas, Ercan E Alp. "Topological singularity induced chiral Kohn anomaly in a Weyl semimetal". In: *Physical Review Letters* 124.23 (2020), p. 236401. DOI: 10.1103/PhysRevLett.124.236401.