Joel Rajakumar

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Professional Summary

Graduating Ph.D. with corporate and academic research experience in quantum computation, specializing in the theoretical foundations of near-term quantum advantage. I am motivated by the challenge of turning quantum speedups into practical reality and am excited to contribute across a range of applied research areas, including quantum algorithms, complexity theory, error correction, architecture, and experimental implementation.

Education

University of Maryland, College Park, MD — Expected May 2026
Ph.D. Computer Science, co-advised by Yi-kai Liu and Michael Gullans
Awarded NSF Graduate Research Fellowship

Georgia Institute of Technology, Atlanta, GA — Aug 2017 - May 2021
B.S. Computer Science, minor in Physics, GPA: 3.87
Honor's Program

Research Experience

University of Maryland, QuICS, College Park, MD — Aug 2021 - Present
Graduate Research Assistant, Principal Investigator: Yi-kai Liu, Michael Gullans

- Proved no-go results on quantum advantage and fault tolerance in a variety of settings
- Proved the existence of quantum advantage in recent quantum algorithms (Gibbs samplers)

Georgia Tech Research Institute, Atlanta, GA — Aug 2018 - May 2021
Undergraduate Research Assistant, Principal Investigator: Creston Herold and Swati Gupta

- Helped set up a trapped ion quantum device (calibration, characterization, compilation of .qasm to pulses)
- Developed novel circuit compilation techniques for all-to-all coupling operations (published in PRA)

University of Waterloo, Institute for Quantum Computing, Waterloo, Canada — May - Aug 2020
Undergraduate Research Assistant, Principal Investigator: Joel Wallman

- Analyzed noise characterization techniques for quantum computers (randomized benchmarking)

Industry Experience

IBM Quantum, New York, NY — May 2025 – Aug 2025
Research Intern, Principal Investigator: Abhinav Deshpande and Kunal Sharma

- Studied candidate circuits for verifiable quantum advantage, showed classical simulability in some cases
- Investigated classical hardness of recent quantum algorithm proposals (SQKD)

JPMorganChase, New York, NY — Jun 2024 – Aug 2024
Quantum Computing Summer Associate, Principal Investigator: Ruslan Shaydulin, Atithi Acharya, Zichang He

- Developed tensor network simulations to validate experiments on quantum devices

Los Alamos National Laboratory, Los Alamos, NM — May 2023 – Aug 2023
Quantum Summer School Fellow, Principal Investigator: Stephen Eidenbenz, John Golden, Andreas Bartschi

- Numerically explored hardness of training QAOA using HPC simulations

Publications

* represents equal contribution

1. Jon Nelson*, **Joel Rajakumar***, Michael Gullans, Dominik Hangleiter, "Polynomial-Time Classical Simulation of Noisy Quantum Circuits with Naturally Fault-Tolerant Gates." *Proceedings of SODA 2026* [arXiv:2411.02535]

2. **Joel Rajakumar**, James Watson, "Gibbs Sampling gives Quantum Advantage at Constant Temperatures with O(1)-Local Hamiltonians." *Accepted Talk at QIP 2025. Quantum Journal* [arXiv:2408.01516]
3. **Joel Rajakumar**, James Watson, Yi-kai Liu. "Polynomial-Time Classical Simulation of Noisy IQP Circuits with Constant Depth." *Accepted Talk at TQC 2024, Proceedings of SODA 2025* [arXiv:2403.14607]
4. **Joel Rajakumar**, John Golden, Andreas Bärtschi, Stephan Eidenbenz. "Trainability Barriers in Low-Depth QAOA Landscapes." *Proceedings of ACM Computing Frontiers 2024* [arXiv:2402.10188]
5. **Joel Rajakumar**, Jai Moondra, Bryan Gard, Swati Gupta, Creston D. Herold. "Generating Target Graph Couplings for QAOA from Native Quantum Hardware Couplings." *Phys. Rev. A* 106 (2), 022606 (2022) [arXiv:2011.08165]

Preprints

* represents equal contribution

1. Jon Nelson*, **Joel Rajakumar***, Michael Gullans, "Limitations of Noisy Geometrically Local Quantum Circuits." *Accepted Talk at TQC 2026. Preprint* [arXiv: 2510.06346]
2. Jon Nelson*, **Joel Rajakumar***, Michael Gullans, "Non-Clifford Gates are Required for Long-Term Memory." *Accepted Talk at QCTiP 2026, Preprint* [arXiv:2510.08451]
3. Jon Nelson*, **Joel Rajakumar***, Michael Gullans, "Error Correction Phase Transition in Noisy Random Quantum Circuits." *Accepted Talk at QCTiP 2026, Preprint* [arXiv:2510.07512]
4. Zhi-Yuan Wei, Jon Nelson, **Joel Rajakumar**, Esther Cruz, Alexey Gorshkov, Michael J. Gullans, Daniel Malz, "Measurement-induced entanglement in noisy random 2D Clifford circuits." *Preprint* [arXiv: 2510.12743]

Invited Talks

- "Limitations of Noisy Geometrically Local Quantum Circuits."
  - Harvard, Misha Lukin's Group Meeting. Mar 2026
  - NYU, Theory Seminar. Feb 2026
  - U Chicago, Bill Fefferman/Liang Jiang's Group Meeting. Feb 2026
  - Princeton University, Sarang Gopalakrishnan's Group Meeting. Feb 2026
  - Caltech. IQIM Seminar. Jan 2026
- "Polynomial-Time Classical Simulation of Noisy Circuits with Naturally Fault-Tolerant Gates."
  - RQS (Robust Quantum Simulation) Seminar. Dec 2025
  - Univ. of Oslo, QOMBINE seminar. May 2025
  - FU Berlin, Jens Eisert's Group Meeting. Jan 2025
- "Quantum Advantage from Gibbs Sampling at Finite Temperatures."
  - Los Alamos National Lab, Physics-Informed ML. Oct 2024
- "Polynomial-Time Classical Simulation of Noisy IQP Circuits with Constant Depth."
  - RQS (Robust Quantum Simulation) Seminar. Sep 2024
  - UT Austin, Scott Aaronson's Group Meeting. Sep 2024
  - HonHai (Foxconn) QC meeting. Jul 2024
  - Simons Institute Workshop on Quantum Algorithms, Complexity, and Fault Tolerance. Mar 2024

Mentoring & Leadership

Peer Mentoring Program at UMD CS GradCo, College Park, MD — May 2022 – Aug 2023

Organizing Member

- Paired incoming grad students with older students, created incentives for mentorship (2 mentees of my own)
- Led workshops and seminars on early grad school activities, such as applying for research funding and jobs

Quantum Computing Association at Georgia Tech, Atlanta, GA — Oct 2019 - May 2021

Founder and First President

- Started a student organization to create a community of students interested in quantum computing
- Taught weekly lecture series, invited speakers, organized talks, conducted paper reviews, and led projects