

Abhinav Deshpande

Research Scientist
Quantum computing theory

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Education

- 2015 – 2021 **Ph.D in Physics**, *University of Maryland*, College Park, USA
Dissertation title: “The complexity of simulating quantum physics: dynamics and equilibrium”
Advisor: Prof. Alexey V. Gorshkov
Co-advisor: Prof. Bill Fefferman
- 2010 – 2015 **Integrated B.Sc-M.Sc in Physics**, *Indian Institute of Technology (IIT) Kanpur*, Kanpur, India
M.Sc project advisor: Prof. Saikat Ghosh

Experience

- 2023 – ongoing **Research Scientist**, *IBM Quantum*, San Jose
- 2021 – 2023 **IQIM Postdoctoral Scholar**, *Research Associate in Theoretical Physics*, *California Institute of Technology*, Pasadena
- 2015 – 2021 **Research Assistant**, *Department of Physics*, *University of Maryland*, College Park
Affiliations:
○ Joint Center for Quantum Information and Computer Science (QIICS)
○ Joint Quantum Institute (JQI)
- Jul – Dec 2020 **Independent contractor**, *Xanadu Quantum Technologies*, Toronto
- Jun – Aug 2019 **Visitor**, *Institute for Quantum Information and Matter*, *California Institute of Technology*, Pasadena
- May – Jul 2014 **Visiting Scientist**, *Max Planck Institute for Quantum Optics*, Munich
- May – Jul 2013 **Summer Intern**, *Technische Universität (TU) Dortmund*, Dortmund

Research Interests

Quantum complexity theory, especially the boundary between classical and quantum complexity, Classical simulation of quantum systems, Quantum algorithms and use cases, Ground states and Gibbs states of local Hamiltonians, and (lately) variational quantum algorithms

Awards and Achievements

- 2022 Chicago Quantum Creators Prize
- 2015 Dean’s Fellowship, Graduate School, University of Maryland
Awarded to outstanding incoming graduate students
- 2015 General Proficiency Medal, IIT Kanpur
Awarded for best academic performance in the physics department among graduating students

- 2010 – 2013 Academic Excellence Award, IIT Kanpur
Awarded for being among the top 7% out of 820 students across all disciplines (won three consecutive years)
- 2010 Rank 54, Joint Entrance Examination
Out of approximately 472,000 nation-wide applicants to the Indian Institutes of Technology
- 2010 Gold medal, Indian Association of Physics Teachers
Awarded to the top 35 out of 30,000 in the Indian National Physics Olympiad
- 2010 – 2015 Fellow, *Kishore Vaigyanik Protsahan Yojana*, Department of Science and Technology, Government of India
Awarded \$8000 under a scheme to “attract exceptionally highly motivated students for pursuing basic science courses and research careers in science.”

Long-term programs/workshops

- 2024 Statistical Methods and Mathematical Analysis for Quantum Information Science, Institute for Mathematical and Statistical Innovation (IMSI), Chicago
- 2023 Out-of-equilibrium Dynamics and Quantum Information of Many-body Systems with Long-range Interactions, Kavli Institute for Theoretical Physics (KITP)
- 2023 Summer Cluster on Quantum Computing, Simons Institute
- 2022 Quantum Many-Body Dynamics and Noisy Intermediate-Scale Quantum Systems, KITP
- 2022 Towards Classically Intractable Quantum Simulations of Physics and Chemistry, KITP
- 2021 Quantum Complexity: Theory and Application, Dagstuhl

Service

- 2025 Program Committee member, Theory of Quantum Computation, Communication and Cryptography (TQC) 2025, Quantum Techniques in Machine Learning (QTML) 2025, and Quantum Information Processing (QIP) 2026
- 2022 – Editor at *Quantum* journal
ongoing
- 2017 – Reviewed/sub-reviewed for:
ongoing **Conferences:** Computational Complexity Conference (CCC), Innovations in Theoretical Computer Science (ITCS), IEEE Symposium on Foundations of Computer Science (FOCS), Quantum Computing Theory in Practice (QCTIP), Quantum Error Correction (QEC), Quantum Information Processing (QIP), Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC)
- Journals:** Annals of Physics, Foundations of Physics, Nature Communications, Nature Physics, NPJ Quantum Information, Physical Review A, Physical Review Applied, Physical Review B, Physical Review Letters, Physical Review Research, PRX, PRX Quantum, Quantum, Quantum Information & Computation, Quantum Information Processing, SciPost, Science Advances, Science Bulletin
- Others:** NSF PFI, NSF SBTR/STTR
- 2022 Served on programme committee of NSF Workshop on Quantum Advantage and Next Steps, UChicago

Patents/Patent Applications

M. C. Tran, [A. D.](#), A. Y. Guo, A. Lucas, A. V. Gorshkov,
Optimal state transfer and entanglement generation in power-law interacting systems, U.S. Provisional Patent Application 63/262085, filed Oct 4, 2021.

A. Lucas, M. C. Tran, A. Ehrenberg, A. Y. Guo, [A. D.](#), A. V. Gorshkov, Z.-X. Gong, C.-F. Chen, Y. Hong,
Quantum State Transfer, U.S. Patent US12333381B2, granted Jun 17, 2025.

Publications

27. [A. D.](#), B. Fefferman, S. Ghosh, M. Gullans, D. Hangleiter,
"Peaked quantum advantage using error correction", [arXiv:2510.05262](#)
26. B. Pokharel, H. Pan, K. Aziz, L. C. G. Govia, S. Ganeshan, T. Iadecola, J. H. Wilson, B. A. Jones, [A. D.](#), J. H. Pixley, M. Takita,
"Order from chaos with adaptive circuits on quantum hardware", [arXiv:2509.18259](#)
25. D. Hahn, R. Sweke, [A. D.](#), O. Shtanko,
"Efficient Quantum Gibbs Sampling with Local Circuits", [arXiv:2506.04321](#)
24. [A. D.](#), M. Hinsche, S. Najafi, K. Sharma, R. Sweke, C. Zoufal,
"Dynamic parameterized quantum circuits: expressive and barren-plateau free",
[arXiv:2411.05760](#)
23. A. Ehrenberg, J. T. Iosue, [A. D.](#), D. Hangleiter, A. V. Gorshkov,
"The Second Moment of Hafnians in Gaussian Boson Sampling", *Physical Review A* **111**, 042412 (2025); [arXiv:2403.13878](#)
22. A. Ehrenberg, J. T. Iosue, [A. D.](#), D. Hangleiter, A. V. Gorshkov,
"Transition of Anticoncentration in Gaussian Boson Sampling", *Physical Review Letters* **134**, 140601 (2025); [arXiv:2312.08433](#)
21. B. Ware, [A. D.](#), D. Hangleiter, P. Niroula, B. Fefferman, A. V. Gorshkov, M. J. Gullans,
"A sharp phase transition in linear cross-entropy benchmarking", [arXiv:2305.04954](#)
20. S. Ghosh, [A. D.](#), D. Hangleiter, A. V. Gorshkov, B. Fefferman,
"Sharp complexity phase transitions generated by entanglement", *Physical Review Letters* **131**, 030601 (2023); [arXiv:2212.10582](#)
19. J. T. Iosue, A. Ehrenberg, D. Hangleiter, [A. D.](#), A. V. Gorshkov,
"Page curves and typical entanglement in linear optics", *Quantum* **7**, 1017 (2023);
[arXiv:2209.06838](#)
18. U. Chabaud, [A. D.](#), and S. Mehraban,
"Quantum-inspired permanent identities", *Quantum* **6**, 877 (2022); [arXiv:2208.00327](#)
17. A. Ehrenberg, [A. D.](#), C. L. Baldwin, D. A. Abanin, and A. V. Gorshkov,
"Simulation Complexity of Many-Body Localized Systems", [arXiv:2205.12967](#)
Accepted in QIP 2023.
16. M. Van Regemortel, O. Shtanko, L. P. Garcia-Pintos, [A. D.](#), H. Dehghani, A. V. Gorshkov, and M. Hafezi,
"Monitoring-induced Entanglement Entropy and Sampling Complexity", *Physical Review Research* **4**, L032021 (2022); [arXiv:2201.12672](#)

15. A. D., P. Niroula, O. Shtanko, A. V. Gorshkov, B. Fefferman, and M. J. Gullans,
 “Tight bounds on the convergence of noisy random circuits to the uniform distribution”, PRX
 Quantum **3**, 040329 (2022); arXiv:2112.00716
 Accepted in QIP 2022.
14. A. D.^{*}, A. Mehta^{*}, T. Vincent, N. Quesada, M. Hinsche, M. Ioannou, L. Madsen, J. Lavoie,
 H. Qi, J. Eisert, D. Hangleiter, B. Fefferman, and I. Dhand,
 “Quantum computational advantage via high-dimensional Gaussian Boson Sampling”, Science
 Advances **8**, eabi7894 (2022); arXiv:2102.12474
13. M. C. Tran, A. Y. Guo, A. D., A. Lucas, and A. V. Gorshkov,
 “Optimal state transfer and entanglement generation in power-law interacting systems”,
 Physical Review X **11**, 031016 (2021); arXiv:2010.02930
 Accepted in QIP 2021.
12. A. D., A. V. Gorshkov, and B. Fefferman,
 “The importance of the spectral gap in estimating ground-state energies”, PRX Quantum **3**,
 040327 (2022); arXiv:2007.11582
 Accepted in ITCS 2022, QIP 2021, Q-Turn 2020.
11. A. Y. Guo, A. D., S.-K. Chu, Z. Eldredge, P. Bienias, D. Devulapalli, Y. Su, A. M. Childs,
 and A. V. Gorshkov,
 “Implementing a fast unbounded quantum fanout gate using power-law interactions”, Physical
 Review Research **4**, L042016; arXiv:2007.00662
 Accepted in TQC 2021.
10. O. Shtanko, A. D., P. S. Julianne, and A. V. Gorshkov,
 “Complexity of Fermionic Dissipative Interactions and Applications to Quantum Computing”,
 PRX Quantum **2**, 030350 (2021); arXiv:2005.10840
9. M. C. Tran, C.-F. Chen, A. Ehrenberg, A. Y. Guo, A. D., Y. Hong, Z.-X. Gong, A. V.
 Gorshkov, and A. Lucas,
 “Hierarchy of linear light cones with long-range interactions”, Physical Review X **10**, 031009
 (2020); arXiv:2001.11509
8. Z. Eldredge, L. Zhou, A. Bapat, J. R. Garrison, A. D., F. T. Chong, and A. V. Gorshkov,
 “Entanglement bounds on the performance of quantum computing architectures”, Physical
 Review Research **2**, 033316 (2020); arXiv:1908.04802
7. G. Pagano, A. Bapat, P. Becker, K. S. Collins, A. De, P. W. Hess, H. B. Kaplan, A. Kyprianidis,
 W. L. Tan, C. Baldwin, L. T. Brady, A. D., F. Liu, S. Jordan, A. V. Gorshkov, and C. Monroe,
 “Quantum approximate optimization of the long-range Ising model with a trapped-ion quan-
 tum simulator”, Proceedings of the National Academy of Sciences, 202006373 (2020);
 arXiv:1906.02700
6. N. Maskara^{*}, A. D.^{*}, A. Ehrenberg, M. C. Tran, B. Fefferman, and A. V. Gorshkov,
 “Complexity phase diagram for interacting and long-range bosonic Hamiltonians”, Physical
 Review Letters **129**, 150604 (2022); arXiv:1906.04178
5. V. V. Orre, E. A. Goldschmidt, A. D., A. V. Gorshkov, V. Tamma, M. Hafezi, and S. Mittal,
 “Interference of temporally distinguishable photons using frequency-resolved detection”, Physi-
 cal Review Letters **123**, 123603 (2019); arXiv:1904.03222

^{*} These authors contributed equally.

4. A. Bapat, Z. Eldredge, J. R. Garrison, [A. D.](#), F. T. Chong, and A. V. Gorshkov, "Unitary entanglement construction in hierarchical networks", *Physical Review A* **98**, 062328 (2018); [arXiv:1808.07876](#)
3. [A. D.](#), B. Fefferman, M. C. Tran, M. Foss-Feig, and A. V. Gorshkov, "Dynamical phase transitions in sampling complexity", *Physical Review Letters* **121**, 030501 (2018); [arXiv:1703.05332](#)
2. [A. D.](#) and A. E. B. Nielsen, "Lattice Laughlin states on the torus from conformal field theory", *Journal of Statistical Mechanics: Theory and Experiment* 2016 (1), 013102; [arXiv:1507.04335](#)
1. S. M. Roy, [A. D.](#), and N. Sakharwade, "Remote tomography and entanglement swapping via von Neumann-Arthurs-Kelly interaction", *Physical Review A* **89**, 052107; [arXiv:1308.2852](#)

See also: [Google Scholar](#), [arXiv](#), [ORCID](#)

Talks

- *Absence of barren plateaus in circuits with feedforward operations*
 - The Power of Near-Term Quantum Experiments; Algorithms, Noise, and Quantum Advantage beyond NISQ (IMSI)
- *A Phase Transition in Linear Cross-Entropy Benchmarking*
 - Quantum Summer Cluster Workshop, Simons Institute for the Theory of Computing
- *Complexity phase diagrams in bosonic Hamiltonians with long-range hopping*
 - KITP Program on Out-of-equilibrium Dynamics and Quantum Information of Many-body Systems with Long-range Interactions
- *Gaussian Boson Sampling and Random Matrix Theory*
 - Shenzhen Conference on Random Matrix Theory and Applications
- *The complexity of simulating quantum dynamics*
 - Quantum Creators Prize Symposium 2022, Chicago
- *Noisy random circuits: properties and applications in quantum computing*
 - Quantum Information Processing (QIP) 2022
 - NSF Workshop on Quantum Advantage and Next Steps
- *Am I living in the post-quantum-advantage era?*
 - Noisy intermediate scale quantum advantage journal club, University of Maryland
 - UCL-Bristol visit day at AWS/IQIM Caltech
 - Summer School on Quantum Computing and Its Applications (QCA'22) at Jaypee Institute of Information Technology
- *The importance of the spectral gap in estimating ground-state energies*
 - Quantum information theory seminar at University College London
 - JQI-QulCS-CMTC seminar
 - Q-Turn workshop
 - Quantum Information Processing 2021
 - APS March Meeting 2021
 - Innovations in Theoretical Computer Science (ITCS) 2022
- *Quantum Computing: Where we are headed*
 - Keynote talk at Manipal Institute of Technology

- *Gaussian Boson Sampling and its complexity*
 - Quantum information seminar at UT Austin
 - Dagstuhl workshop on Quantum Complexity: Theory and Application
- *Sampling-complexity phase diagrams*
 - IQI seminar, California Institute of Technology, 2019
- *Complexity phase transition in interacting and long-range bosonic Hamiltonians*
 - APS March Meeting, 2019
- *Sampling from ground states of local Hamiltonians*
 - Workshop on Challenges in Quantum Computation, Simons Institute, 2018
- *Complexity of sampling as an order parameter*
 - JQI-QulCS-CMTC seminar, 2017

Outreach

- 2022 Volunteered at a workshop on graduate school applications organized by Gender Minorities and Women in Physics, Math and Astronomy (GWiPMA) at Caltech
- 2022 Volunteer at QIP 2022
- 2019 Volunteer at TQC 2019 + NISQ conference and workshop
- 2018 Volunteer at the USA Science and Engineering Festival for the JQI and the American Physical Society (APS)
- 2017 Volunteer at QIP 2017
- Oct 2016 – Part of the Mental Health Task Force, a team formed to raise awareness about mental health in the physics community at UMD
- Feb 2018
- 2016 Volunteer at Maryland Day for the JQI
- 2015 Volunteered with Graduate Resources Advancing Diversity with Maryland Astronomy and Physics (GRAD-MAP) to assist with a bootcamp on Python for undergraduate students
- 2015 Member of core grading committee, International Physics Olympiad 2015, Mumbai
- 2012 Member of core grading committee, Asian Physics Olympiad 2012, New Delhi

Mentoring

- 2022 Serving as mentor in the Caltech Accountability Partners Program, a program to advise undergraduate students through the graduate admissions process, in collaboration with Future Ignited, a program to diversify STEM
- Jun – Aug 2018 Co-supervised (with Prof. Alexey V. Gorshkov) Nishad Maskara, a Caltech undergraduate, through the SURF program. Co-authored a paper “Complexity phase diagram for interacting and long-range bosonic Hamiltonians”
- 2012 – 2013 Served as an Academic Mentor in the Counselling Service of IIT Kanpur, tutoring students on academic probation

Press

- 2021 “New Approach to Information Transfer Reaches Quantum Speed Limit”, [press release](#)
- 2020 “A Speed Test for Ripples in a Quantum System”, *Physics*
- 2020 “New Quantum Information Speed Limits Depend on the Task at Hand”, [press release](#)
- 2019 “Stretched photons recover lost interference”, [press release](#)
- 2018 “Complexity test offers new perspective on small quantum computers”, [press release](#)