LEO ZHOU

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🔗 https://leoxzhou.github.io/

POSITIONS

University of California, Los Angeles — *Los Angeles, CA*
Assistant Professor, Department of Electrical and Computer Engineering — 2024–Present

BlueQubit, Inc. — *Los Angeles, CA*
Quantum R&D Scientist — 2023–Present

California Institute of Technology – Walter Burke Institute for Theoretical Physics — *Pasadena, CA*
DuBridge Postdoctoral Scholar — 2021–24

EDUCATION

Ph.D. in Physics, Harvard University — *Cambridge, MA*
Advisor: Mikhail Lukin — 2014–21
Thesis: Complexity, Algorithms, and Applications of Programmable Quantum Many-Body Systems

B.Sc. in Physics and Mathematics, Massachusetts Institute of Technology — *Cambridge, MA*
Advisor: Edward Farhi – Minor in Economics; GPA: 5.0/5.0 — 2010–14
Thesis: Error-Suppression by Energy-Gap Protection for Quantum Computation in Open Systems

RESEARCH EXPERIENCE

Phasecraft, Ltd. — *Bristol, United Kingdom*
Visiting Fellow (Host: Ashley Montanaro) — 2024

Google Quantum AI — *Venice, CA*
Research Intern (Host: Edward Farhi) — 2019

Hebrew University – Department of Computer Science and Engineering — *Jerusalem, Israel*
Visiting Researcher (Host: Dorit Aharonov) — 2014 & 2015

AWARDS AND HONORS

- Outstanding Paper Award at the 17th Conference on Theory of Quantum Computation, Communication and Cryptography (TQC'22) — 2022
- Winner ($5k grant) of Excellent Contributed Talk at QC40: Physics of Computation Conference — 2021
- Burke Prize Fellowship at the California Institute of Technology — 2021
- Bloch Fellowship at Stanford University (declined) — 2021
- Hartree Fellowship at the Institute of Advanced Computer Studies, University of Maryland (declined) — 2021
- Martin & Beate Block Award (for best poster presented by co-author S.-T. Wang) at the Aspen Conference on Advances in Quantum Algorithms and Computation — 2018
- National Science Foundation (NSF) Graduate Research Fellowship — 2014–17
- Phi Beta Kappa (Academic Honor Society), MIT Xi Chapter — 2014
- MIT Junior Lab Edward C. Pickering Award for Outstanding Original Project, Honorable Mention — 2013

PUBLICATIONS

- I. Kannan, R. King, **L. Zhou**. *A Quantum Approximate Optimization Algorithm for Local Hamiltonian Problems*. Preprint on arXiv:2412.09221, (2024).

[LAST UPDATED: JAN 26, 2025]

- A. Montanaro, **L. Zhou**†. *Quantum speedups in solving near-symmetric optimization problems by low-depth QAOA*. QIP'25 (2025). arXiv:2411.04979.

- **L. Zhou**, J. Basso, S. Mei. *Statistical Estimation in the Spiked Tensor Model via the Quantum Approximate Optimization Algorithm*. In Proceedings of the 38th Annual Conference on Neural Information Processing NeurIPS'24 (2024). arXiv:2402.19456.

- C.-F. Chen, H.-Y. Huang, J. Preskill, **L. Zhou**†. *Local minima in quantum systems*. In Proceedings of the 56th Symposium on Theory of Computing, STOC'24 (2024). Also appearing in Nature Physics (2025). arXiv:2309.16596.

- J. Basso, D. Gamarnik, S. Mei, **L. Zhou**†. *Performance and limitations of the QAOA at constant levels on large sparse hypergraphs and spin glass models*. In Proceedings of the 63rd Symposium on Foundations of Computer Science, FOCS'22 (2022). arXiv:2204.10306.

- S. Ebadi, …, **L. Zhou**, …, M.D. Lukin. *Quantum Optimization of Maximum Independent Set using Rydberg Atom Arrays*. Science 376, 1209 (2022). arXiv:2202.09372.

- J. Basso, E. Farhi, K. Marwaha, B. Villalonga, **L. Zhou**†. *The Quantum Approximate Optimization Algorithm at High Depth for MaxCut on Large-Girth Regular Graphs and the Sherrington-Kirkpatrick Model*. In Proceedings of the 17th Conference on the Theory of Quantum Computation, Communication and Cryptography, TQC'22 (2022), Outstanding Paper Award. arXiv:2110.14206.

- **L. Zhou**, D. Aharonov. *Strongly Universal Hamiltonian Simulators*. QIP'21 (2021). arXiv:2102.02991.

- M.P. Harrigan, …, **L. Zhou**, …, R. Babbush. *Quantum Approximate Optimization of Non-Planar Graph Problems on a Planar Superconducting Processor*. Nature Physics 17, 332 (2021). arXiv:2004.04197.

- S.H. Cantu, A.V. Venkatramani, W. Xu, **L. Zhou**, B. Jelenković, M.D. Lukin, V. Vuletić. *Repulsive photons in a quantum nonlinear medium*. Nature Physics 16, 921 (2020). arXiv:1911.02586.

- E. Farhi, J. Goldstone, S. Gutmann, **L. Zhou**†. *The Quantum Approximate Optimization Algorithm and the Sherrington-Kirkpatrick Model at Infinite Size*. Quantum 6, 759 (2022). Also in QIP'21. arXiv:1910.08187.

- Z. Eldredge, **L. Zhou**, A. Bapat, J.R. Garrison, A. Deshpande, F.T. Chong, A.V. Gorshkov. *Entanglement bounds on the performance of quantum computing architectures*. Phys. Rev. Research 2, 033316 (2020). arXiv:1908.04802.

- **L. Zhou***, S.-T. Wang*, S. Choi, H. Pichler, and M.D. Lukin. *Quantum Approximate Optimization Algorithm: Performance, Mechanism, and Implementation on Near-Term Devices*. Phys. Rev. X 10, 021067 (2020). arXiv:1812.01041.

- H. Pichler*, S.-T. Wang*, **L. Zhou***, S. Choi, and M.D. Lukin. *Computational complexity of the Rydberg blockade in two dimensions*. Preprint on arXiv:1809.04954, (2018).

- H. Pichler*, S.-T. Wang*, **L. Zhou**, S. Choi, and M.D. Lukin. *Quantum Optimization for Maximum Independent Set Using Rydberg Atom Arrays*. Preprint on arXiv:1808.10816, (2018).

- D. Aharonov and **L. Zhou**†. *Hamiltonian Sparsification and Gap-Simulation*. In Proceedings of the 2019 ACM Conference on Innovations in Theoretical Computer Science, ITCS'19 (2019). arXiv:1804.11084.

- **L. Zhou***, S. Choi*, and M.D. Lukin. *Symmetry-protected dissipative preparation of matrix product states*. Phys. Rev. A (2021). arXiv:1706.01995.

- A.D. Bookatz, E. Farhi, and **L. Zhou**†. *Error suppression in Hamiltonian based quantum computation using energy penalties*. Phys. Rev. A 92, 022317 (2015). arXiv:1407.1485.

- **L. Zhou** and G.S.F. Stephans. *Energy and centrality dependence of particle multiplicity in heavy ion collisions from $\sqrt{s_{NN}}$ = 20 to 2760 GeV*. <u>Phys. Rev. C 90, 0149902 (2014)</u>. <u>arXiv:1312.3656</u>.

- N. Sinenian, ..., **L. Zhou**, ..., R.J. Leeper, *Upgrade of the MIT Linear Electrostatic Ion Accelerator (LEIA) for nuclear diagnostics development for Omega, Z and the NIF*. <u>Rev. Sci. Instrum. **83**, 043502 (2012)</u>. <u>doi:10.1063/1.3703315</u>.

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* indicates equal contribution / co-first authorship
† indicates alphabetical ordering of authors

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PRESENTATIONS

- *Quantum speedups in solving near-symmetric optimization problems by low-depth QAOA*
  - Accepted talk, 28th Annual Conference on Quantum Information Processing (QIP)   02.2025
  - Invited talk at the MIT Center for Theoretical Physics   11.2024
- *Statistical Estimation in the Spiked Tensor model via the QAOA*
  - Invited talk at Google Quantum AI   12.2024
  - Accepted talk, 38th Annual Conference on Neural Information Processing (NeurIPS)   12.2024
- *Local minima in quantum systems*
  - Invited talk at Oxford University   10.2024
  - Accepted talk, 56th ACM Symposium on Theory of Computing (STOC) [video]   06.2024
  - Invited talk at Institut de Recherche en Informatique Fondamentale (IRIF), Paris   05.2024
  - Accepted talk, 27th Annual Conference on Quantum Information Processing (QIP) [video]   01.2024
  - Invited talk at the Max Planck Institute of Quantum Optics   11.2023
- *Prospects of Variational Quantum Advantages in Optimization and Learning Problems*
  - Invited talk at the Phasecraft Quantum Algorithms Workshop   05.2024
- *Quantum Computational Advantages in Energy Minimization*
  - Invited talk at the Institute for Quantum Computing, University of Waterloo   04.2024
  - Invited talk at the University of Maryland, College Park   03.2024
  - Invited talk at the University of California, Los Angeles   03.2024
  - Invited talk at the University of Michigan   03.2024
  - Invited talk at Purdue University   02.2024
  - Invited talk at the Perimeter Institute for Theoretical Physics   02.2024
  - Invited talk at the C.N. Yang Institute for Theoretical Physics at Stony Brook University   02.2024
  - Invited colloquium at the University of Southern California   11.2023
  - Invited talk for the "Mathematical and Computational Challenges in Quantum Computing" program at the Institute for Pure and Applied Mathematics   11.2023
- *Performance and limitations of the QAOA at constant levels on large sparse hypergraphs and spin glass models*
  - Accepted talk, 18th Conference on Theory of Quantum Computation, Communication and Cryptography (TQC) [video]   07.2023
  - Accepted talk, 63rd Annual Symposium on Foundations of Computer Science (FOCS)   11.2022
- *Exploring Quantum Advantages in Optimization Problems*
  - Invited talk at the NISQ Algorithms and Hardware (NISQAH 2023) conference [video]   06.2023
- *Quantum computing with Rydberg atom arrays*
  - Tutorial talk at the 2023 APS March Meeting   03.2023
- *Advantages and Limitations of the Quantum Approximate Optimization Algorithm*
  - Invited talk at the 2023 Information: Theory and Applications (ITA) workshop   02.2023
  - Invited talks at the MIT Center for Theoretical Physics and QuEra Computing, Inc.   06.2022

- *The QAOA at High Depth for MaxCut on Large-Girth Regular Graphs and the SK Model*
  - Outstanding Paper Award talk at the 17th Conference on Theory of Quantum Computation, Communication and Cryptography (TQC) [video] 07.2022
- *Quantum Approximate Optimization: Challenges and Opportunities*
  - Invited talk at the 2021 INFORMS Annual Meeting 10.2021
- *Strongly Universal Hamiltonian Simulators*
  - Invited talk at the Simons Institute Quantum Wave in Computing Reunion Workshop 07.2021
  - Accepted talk at QC40: Physics of Computation Conference 40th Anniversary 05.2021
  - Invited talk at the QCDA (Quantum Code Design and Architecture) seminar 04.2021
  - Accepted talk, 24th Annual Conference on Quantum Information Processing (QIP) [video] 02.2021
- *The QAOA and the Sherrington-Kirkpatrick Model at Infinite Size*
  - Accepted talk, 24th Annual Conference on Quantum Information Processing (QIP) [video] 02.2021
- *Quantum Simulation and Optimization in Near-Term Quantum Computers*
  - Invited talk at the Stanford Q-FARM Special Seminar 12.2020
  - Invited talk at the MIT Center for Theoretical Physics 12.2020
  - Invited talk at the QM seminar, UC Berkeley [video] 12.2020
  - Invited talk at the Institute for Quantum Information (IQI) Seminar, Caltech 12.2020
- *Hamiltonian Sparsification and Gap-Simulation*
  - Accepted talk, 22nd Annual Conference on Quantum Information Processing (QIP) [video] 01.2019
  - Accepted talk, 10th Innovations in Theoretical Computer Science conference (ITCS) 01.2019
- *Quantum Approximate Optimization: Performance and Applications with MaxCut and Maximum Independent Set Problems*
  - Talk at the 50th Meeting of APS Division of Atomic, Molecular & Optical Physics 05.2019
  - Poster at the Quantum Science Gordon Research Conference 08.2018
  - Poster at the Aspen Conference on Advances in Quantum Algorithms and Computation 03.2018
- *Symmetry-protected dissipative preparation of matrix product state*
  - Invited talk at the Mathematical Picture Language Project Seminar, Harvard University 11.2019
  - Poster at the 48th Meeting of APS Division of Atomic, Molecular & Optical Physics 06.2017
  - Talk at the Quantum Science: Implementation workshop in Benasque, Spain 07.2016
- *Robust quantum information processing with atomic cat states*
  - Poster at the Atomic Physics Gordon Research Conference 06.2015

SERVICE AND OUTREACH

- Peer Reviewer for academic journals (Nature, Nature Communications, Physical Review, Quantum, ACM Transactions on Quantum Computing) and quantum computer science conferences (QIP, TQC, STOC, SODA) 2019–present
- Program committee for TQC'23 (18th conference on Theory of Quantum Computation) 2023
- Science talk for the MNTEC program at the Pasadena City College 2023
- MIT Society of Physics Students, Executive Council 2011–14
- Camp Mentor at MIT China Development Initiative's Service Leadership Program 2013
- Teaching high school students at Splash 2011 via the MIT Educational Studies Program 2011

TEACHING

- Instructor for **Physics of Quantum Information and Quantum Computation** (ECE 279AS) at University of California, Los Angeles 2025

- Lecturer for the "Rydberg Computers" tutorial at the 2023 APS March Meeting — 2023
- Supporting Teaching Fellow for *Physics of Quantum Information* (Physics 271) and *Modern Atomic and Optical Physics II* (Physics 285b) at Harvard University — 2016–20
- Teaching Fellow for *Electrodynamics* (Physics 153) at Harvard University — 2018
- Visiting high school teacher in Gaildorf, Germany through MIT's Global Teaching Lab — 2012

MENTORING

- Sara Vanovac, graduate student at Caltech — 2023–24
- Chi-Fang (Anthony) Chen, graduate student at Caltech — 2022–24
- Ishaan Kannan, undergraduate student at Caltech — 2021–24
- William (Robbie) King, graduate student at Caltech — 2021–24
- Hsin-Yuan (Robert) Huang, graduate student at Caltech (now at Google, future Caltech faculty) — 2021–23
- Joao Basso, undergraduate student at Tufts (now UC Berkeley graduate student) — 2019–23
- Beatrice Nash, graduate student at Harvard — 2020–21
- Katherine van Kirk, graduate student at Harvard — 2020–21
- Madelyn Cain, graduate student at Harvard — 2019–21
- Dylan Li, undergraduate student at Harvard — Fall 2020
- Amir Shanehsazzadeh, undergraduate student at Harvard — Fall 2020
- Abhishek Anand, undergraduate student at Harvard (now Caltech graduate student) — 2018–19