

Xun Gao

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Associate Fellow, JILA

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Research interests

Application of near-term quantum devices · Quantum machine learning · Quantum computational advantage · Quantum error correction · Quantum optimization algorithm · Tensor Networks

Positions

- 2023/08/21 – **Assistant Professor** – University of Colorado at Boulder
Department of Physics.
- 2023/08/21 – **Associate Fellow** – JILA
- 2018/09/01 – **Postdoctoral Fellow** – Harvard University
2023/08/31 Max-Planck Harvard Research Center for Quantum Optics (MPHQ)
Advised by Mikhail Lukin and Ignacio Cirac.
- 2018/05 – **Simons Visiting Scholar** – University of California, Berkeley
2018/06 Simons Institute for the Theory of Computing

Education

- 2013 – 2018 **Tsinghua University** – Beijing, China
PhD in Physics
Advised by Luming Duan.
- 2009 – 2013 **Peking University** – Beijing, China
BA in Physics

Invited Talks

Interpretable Quantum Advantage in Neural Sequence Learning

- 2023/01 52nd Winter Colloquium on the Physics of Quantum Electronics (PQE), Snowbird

Limitations of Linear Cross Entropy Benchmark as a Measure for Quantum Advantage

- 2022/09 Mathematical Results in Quantum Theory (QMATH), UC Davis
- 2022/08 The NSF Workshop on Quantum Advantage and Next Steps, University of Chicago
- 2021/12 Quantum Seminar Series, Rice University
- 2021/12 Mathematical Picture Language Seminar, Harvard

Efficient Classical Simulation of Noisy Quantum Circuit

- 2019/10 QuICS Seminar, University of Maryland
- 2017/11 IQIM Seminar, Caltech

Quantum Generative Models

- 2017/12 Artificial Intelligence and Quantum Physics (AIQP) Workshop, Nanjing University
- 2017/07 Quantum Machine Learning in Workshop on Machine Learning and Many-Body Physics, Chinese Academy of Science, Beijing

Professional Service

- Program Committee: QIP 2024, QTML 2023
- Reviewer: Conference: STOC, FOCS, QIP
Journal: PRX, PRX Quantum, PRL, PRRsearch, PRA, Nature Physics, Nature Communications, Quantum
- Organizer: Harvard Quantum Information Theory Seminar, 10/01-12/01, 2022
- Tutorial: Quantum Machine Learning in Workshop on Machine Learning and Many-Body Physics (06/28 - 07/07, 2017, Beijing)

Teaching and Mentoring

- 2019-present Co-supervision of MIT graduate student, Eric R. Anschuetz
- 2020-present Co-supervision of Harvard graduate students, Chi-Ning Chou, Rodrigo A. Bravo, and Taylor L. Patti

2016 Teaching Assistant (Quantum Mechanics for Yao class), Tsinghua

Selected Publications

Quantum Computational Advantage (Quantum Supremacy):

- 2022 **A polynomial-time classical algorithm for noisy random circuit sampling**
Dorit Aharonov, Xun Gao, Zeph Landau, Yunchao Liu, Umesh Vazirani.
STOC (2023); QIP 2023, plenary talk; Highlighted in Quanta Magazine.
- 2021 **Limitations of Linear Cross-Entropy as a Measure for Quantum Advantage**
Xun Gao, Marcin Kalinowski, Chi-Ning Chou, Mikhail D Lukin, Boaz Barak, Soonwon Choi.
PRX Quantum (2024).
- 2019 **Spoofing Linear Cross-Entropy Benchmarking in Shallow Quantum Circuits**
Boaz Barak, Chi-Ning Chou, Xun Gao.
Innovations in Theoretical Computer Science (ITCS 2020).
- 2018 **Efficient classical simulation of noisy quantum computation**
Xun Gao, Lu-Ming Duan.
arXiv:1810.03176 (2018).
- 2017 **Quantum supremacy for simulating a translation-invariant Ising spin model**
Xun Gao, Sheng-Tao Wang, Lu-Ming Duan.
Physical review letters (2017).
- Quantum Generative Models:
- 2024 **Arbitrary Polynomial Separations in Trainable Quantum Machine Learning**
Eric R. Anschuetz, Xun Gao.
arXiv:2402.08606.
- 2022 **Interpretable Quantum Advantage in Neural Sequence Learning**
Eric R. Anschuetz, Hong-Ye Hu, Jin-Long Huang, Xun Gao.
PRX Quantum (2023).
- 2021 **Enhancing generative models via quantum correlations**
Xun Gao, Eric R Anschuetz, Sheng-Tao Wang, J Ignacio Cirac, Mikhail D Lukin.
Physical review X (2022); Highlighted in Nature Review Physics.

- 2018 **A quantum machine learning algorithm based on generative models**
Xun Gao, Zhen-Yu Zhang, Lu-Ming Duan.
Science advances (2018).
- 2017 **Efficient representation of quantum many-body states with deep neural networks**
Xun Gao, Lu-Ming Duan.
Nature communications (2017).
- Quantum Brain-inspired computing:
- 2022 **Universal Quantum Perceptrons for Quantum Machine Learning**
Rodrigo Araiza Bravo, Khadijeh Najafi, Taylor L. Patti, Xun Gao, and Susanne F. Yelin.
ArXiv:2211.07075 (2022).
- 2021 **Quantum reservoir computing using arrays of Rydberg atoms**
Rodrigo Araiza Bravo, Khadijeh Najafi, Xun Gao, Susanne F Yelin.
PRX Quantum (2021); Highlighted in New Scientist.
- 2022 **The Development of Quantum Machine Learning**
Khadijeh Najafi, Susanne F. Yelin , Xun Gao.
Harvard Data Science Review (2022).
- Collaboration with Experimental Groups:
- 2023 **Logical quantum processor based on reconfigurable atom arrays**
Bluvstein, Dolev, et al.
Nature (2023).
- 2022 **Quantum optimization of maximum independent set using Rydberg atom arrays**
Ebadi, Sepehr, et al.
Science (2022).