Shi-Xin Zhang（张士欣）

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Experience

Institute of Physics, Chinese Academy of Sciences Associate Professor 2024 –

- Research on quantum physics and condensed matter physics: Principal Investigator

Tencent Quantum Laboratory Senior Research Scientist 2021 – 2024

- Quantum algorithms and applications: Project Owner / Research Scientist

  Led a small group of talented people focusing on the research, analysis, and design for near term quantum algorithms and quantum simulation schemes. Also collaborated with top commercial partners from the finance/biology/energy/material/IT sectors, exploring industry solutions with potential quantum advantage.
- Quantum Software R&D: Project Owner / Software Creator / Platform Architect / Core Author and Maintainer

  Created and developed a high performance open-source and full-featured quantum software framework: TensorCircuit. The software is empowered by an advanced tensor network engine, and directly built on top of machine learning frameworks: TensorFlow, PyTorch, and Jax with the vision of unifying quantum programming.

Education

Tsinghua University PhD in Physics 2016 – 2021

Institute for Advanced Study Advisor: Prof. Hong Yao
PhD Thesis: Differentiable Programming in Quantum Physics
Outstanding PhD Award (87 amongst 2981) / Outstanding PhD thesis at Tsinghua University

Tsinghua University BSc in Physics 2012 – 2016

Department of Physics GPA: 95/100 Rank: **1**/95
Top 1 in 2012 National College Entrance Examination in Hebei Province

Research

Interests

- Quantum computing: quantum algorithm, quantum simulation, quantum noise, quantum software, quantum information.
- Non-equilibrium physics: novel phases and phase transitions in non-equilibrium quantum systems including quantum chaos, many-body localization, time crystal, (monitored) random quantum circuits, etc.
- Artificial intelligence: the interplay between machine learning infrastructure/models/philosophy with quantum many-body physics, quantum machine learning.

Publications

38 publications and preprints in total (31 as the first or corresponding author), 26 published in peer-reviewed journals (22 as the first or corresponding author), including 6 in Physical Review Letters (2 as the first author and 3 as the corresponding author). Selected works as the **first**, **joint first**† and **corresponding*** author are listed below, please see my Google Scholar profile for the full publication list.

1. Shuo Liu, Hao-Kai Zhang, Shuai Yin, and **Shi-Xin Zhang***, *Symmetry restoration and quantum Mpemba effect in symmetric random circuits*, Physical Review Letters **133**, 140405 (2024).
2. Shuo Liu, Ming-Rui Li, **Shi-Xin Zhang***, and Shao-Kai Jian*, *Entanglement structure and information protection in noisy hybrid quantum circuits*, Physical Review Letters, **132**, 240402 (2024).
3. Shuo Liu, **Shi-Xin Zhang***, Chang-Yu Hsieh, Shengyu Zhang, and Hong Yao*, *Discrete time crystal enabled by Stark many-body localization*, Physical Review Letters **130**, 120403 (2023).
4. **Shi-Xin Zhang**, Zhou-Quan Wan, Chee-Kong Lee, Chang-Yu Hsieh*, Shengyu Zhang, and Hong Yao*, *Variational quantum-neural hybrid eigensolver*, Physical Review Letters **128**, 120502 (2022).

5. **Shi-Xin Zhang** and Hong Yao*, *Universal properties of many-body localization transitions in quasiperiodic systems*, Physical Review Letters **121**, 206601 (2018).
6. **Shi-Xin Zhang**, Jiaqi Miao, and Chang-Yu Hsieh*, *Variational post-selection for ground states and thermal states simulation*, arXiv:2402.07605 (2024). (Quantum Science and Technology accepted)
7. Yi-Ming Ding*, Yan-Cheng Wang, **Shi-Xin Zhang***, and Zheng Yan*, *Exploring the topological sector optimization on quantum computers*, Physical Review Applied **22**, 034031 (2024) .
8. Shuo Liu, Ming-Rui Li, **Shi-Xin Zhang***, Shao-Kai Jian*, and Hong Yao* *Noise-induced phase transitions in hybrid quantum circuits*, Physical Review B **110**, 064323 (2024).
9. **Shi-Xin Zhang*** and Shuai Yin*, *Universal imaginary-time critical dynamics on a quantum computer*, Physical Review B **109**, 134309 (2024).
10. Lixue Cheng, Yu-Qin Chen, **Shi-Xin Zhang***, and Shengyu Zhang*, *Quantum approximate optimization via learning-based adaptive optimization*, Communications Physics **7**, 83 (2024).
11. Jiaqi Miao, Chang-Yu Hsieh*, and **Shi-Xin Zhang***, *Neural network encoded variational quantum algorithms*, Physical Review Applied **21**, 014053 (2024).
12. Shuo Liu, **Shi-Xin Zhang***, Shao-Kai Jian*, and Hong Yao*, *Training variational quantum algorithms with random gate activation*, Physical Review Research **5**, L032040 (2023).
13. **Shi-Xin Zhang**, Zhou-Quan Wan, Chang-Yu Hsieh*, Hong Yao*, and Shengyu Zhang*, *Variational quantum-neural hybrid error mitigation*, Advanced Quantum Technologies, **6**, 2300147 (2023).
14. **Shi-Xin Zhang**, Zhou-Quan Wan, and Hong Yao*, *Automatic differentiable Monte Carlo: theory and application*, Physical Review Research **5**, 033041 (2023).
15. Shuo Liu, Ming-Rui Li, **Shi-Xin Zhang***, Shao-Kai Jian*, and Hong Yao*, *Universal KPZ scaling in noisy hybrid quantum circuits*, Physical Review B **107**, L201113 (2023).
16. **Shi-Xin Zhang**, et al., *TensorCircuit: a quantum software framework for the NISQ era*, Quantum **7**, 912 (2023).
17. Shuo Liu, **Shi-Xin Zhang***, Chang-Yu Hsieh*, Shengyu Zhang, and Hong Yao*, *Probing many-body localization by excited-state variational quantum eigensolver*, Physical Review B **107**, 024204 (2023).
18. **Shi-Xin Zhang**, Chang-Yu Hsieh*, Shengyu Zhang, and Hong Yao*, *Differentiable quantum architecture search*, Quantum Science and Technology **7**, 045023 (2022).
19. Zhou-Quan Wan, **Shi-Xin Zhang***, and Hong Yao*, *Mitigating the fermion sign problem by automatic differentiation*, Physical Review B **106**, L241109 (2022).
20. **Shi-Xin Zhang**, Chang-Yu Hsieh*, Shengyu Zhang, and Hong Yao*, *Neural predictor based quantum architecture search*, Machine Learning: Science and Technology **2**, 045027 (2021).
21. **Shi-Xin Zhang**, Shao-Kai Jian, and Hong Yao*, *Quantum criticality preempted by nematicity*, Physical Review B **103**, 165129 (2021).
22. **Shi-Xin Zhang**, Shao-Kai Jian, and Hong Yao*, *Correlated triple-Weyl semimetals with Coulomb interactions*, Physical Review B (Rapid Communication) **96**, 241111 (2017).
23. Yu-Qin Chen* and **Shi-Xin Zhang***, *Effective temperature in approximate quantum many-body states*, arXiv:2411.18921 (2024).
24. Shuo Liu, Zhengzhi Wu, **Shi-Xin Zhang***, and Hong Yao*, *Supersymmetry dynamics on Rydberg atom arrays*, arXiv:2410.21386 (2024).
25. Wei-Xuan Chang, Shuai Yin*, **Shi-Xin Zhang***, and Zi-Xiang Li*, *Imaginary-time Mpemba effect in quantum many-body systems* , arXiv:2409.06547 (2024).
26. Shuo Liu, Hao-Kai Zhang, Shuai Yin, **Shi-Xin Zhang*** and Hong Yao*, *Quantum Mpemba effects in many-body localization systems* , arXiv:2408.07750 (2024).
27. Yu-Qin Chen, Shuo Liu, and **Shi-Xin Zhang***, *Subsystem information capacity in random circuits and Hamiltonian dynamics*, arXiv:2405.05076 (2024).
28. Yu-Qin Chen*, **Shi-Xin Zhang**†, and Shengyu Zhang*, *Non-Markovianity benefits quantum dynamics simulation*, arXiv:2311.17622 (2023).
29. **Shi-Xin Zhang**, *Classification on the computational complexity of spin models*, arXiv:1911.04122 (2019).
30. Zhou-Quan Wan and **Shi-Xin Zhang***, *Automatic differentiation for complex valued SVD*, arXiv:1909.02659 (2019).
31. **Shi-Xin Zhang** and Hong Yao*, *Strong and weak many-body localizations*, arXiv:1906.00971 (2019).

Patents

40+ domestic and international patent applications (30+ as the first inventor) in the fields of quantum circuit design automation, quantum AI hybrid solutions, and quantum simulation.

HONORS

- At Tsinghua University, won awards including National Scholarship, National Encouragement Scholarship, Future Scholar Scholarship, First Class Freshmen Scholarship, Zhang Mingwei Scholarship, Xuetang Talent Program Scholarship, etc.
- At Tencent, rated as outstanding (10%) and selected as the outstanding individual of the lab. Also won the Tencent Outstanding R&D award for development of the quantum computing platform and the Tencent Outstanding Course Award for variational quantum computing lectures.

SKILLS

- The interplay between quantum physics and computer science: Familiar with quantum computation, quantum artificial intelligence, and machine learning in quantum physics.
- Condensed matter physics: Familiar with the basic theory and methods for quantum many-body physics. Know about numerical methods including tensor network, quantum Monte Carlo, mean field, variational approach, and exact diagonalization.
- High-performance computation: Built the full-stack cluster in IASTU. Familiar with toolchains and the ecosystem in Ops, HPC, GPU, and cloud computation.
- Python: Familiar with Python language and third-party packages for scientific computing, data science, machine learning, web development, web crawling, software engineering, etc.
- Differentiable programming, probabilistic programming and quantum programming: Familiar with the programming paradigm and ecosystem: TensorFlow, Jax, PyTorch, Keras, TensorNetwork, Qiskit, Cirq, TensorFlow Quantum, Pennylane, Mitiq, etc.
- Programming language: Python, Mathematica, C++, Julia, JavaScript, Bash; Markup language: HTML, CSS, Markdown, reStructuredText, LaTeX; Natural language: Chinese, English, Korean.

OPEN SOURCE CONTRIBUTIONS

Familiar with the open source practice and created many popular open-source projects and platforms related to HPC, computational physics, finance, and web with **2800+** stars and forks and 200+ followers. Also contributed to several large open-source projects including NumPy, TensorFlow, Autograd, TensorNetwork, TensorFlow Quantum, and conda-smithy. Please refer to my GitHub Profile for details.

Projects

- TensorCircuit & TensorCircuit-NG: Full-featured, high-performance quantum software framework designed for the NISQ era. The package receives **700k** downloads and 90+ academic citations. TensorCircuit is top 10 events for quantum industry in 2022 by QuantumChina, recommended quantum software in Google Summer of Code 2023, and hackathon projects in Unitary Hack 2024.
- TensorNetwork-NG: This is a continuously maintained fork of the popular tensor network package, originally released by Google and designed for the machine learning era.
- qop: The software supports algebra on complex number, quaternion, boson, hardcore boson, fermion, spin, and einsum on symbols.
- realspace-RG: Numerical implementation of renormalization group on many-body localization phase transition. Highly parallelized C++ code used on Tianhe II Supercomputer.
- xalpha: Analysis, management and backtest on financial investment. The software has **160k** downloads with a relatively large open-source community.
- hpc-ansible: This toolset provides all components required to build the supercomputer from bootstrap. With vm-cluster toolset, users can build a KVM cluster in one click.
- subway: The software enables HPC job management in an automatic fashion, by providing a highly customized pipeline from data management to job submission.

- myarxiv-app: The project builds the full-stack web for arXiv papers, utilizing techniques including Vue, Webpack, Flask, Docker Compose, web crawler, and NLP algorithms.