Shi-Xin Zhang（张士欣）

znfesnpbh@gmail.com · refraction-ray · re-ra.xyz

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

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. The package provides a great solution to utilize hybrid computational resources including CPU, GPU, and QPU, and a universal platform for quantum-classical hybrid tasks.

Research

Interests

- Quantum computing: quantum algorithm, quantum simulation, quantum noise, quantum software.
- Non-equilibrium physics: novel phases and phase transitions in non-equilibrium quantum systems including many-body localization, time crystal, random quantum circuits, measurement induced entanglement phase transition, information scrambling and protection.
- Artificial intelligence: the interplay between machine learning infrastructure and models with quantum physics, quantum machine learning.

Publications

34 publications and preprints in total (28 as the first or corresponding author), 24 published in peer-reviewed journals (20 as the first or corresponding author), including 5 in Physical Review Letters (2 as the first author and 2 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, 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).
2. 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).
3. **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).

4. **Shi-Xin Zhang** and Hong Yao*, *Universal properties of many-body localization transitions in quasiperiodic systems*, Physical Review Letters **121**, 206601 (2018).
5. Yi-Ming Ding, Yan-Cheng Wang, **Shi-Xin Zhang***, and Zheng Yan*, *Quantum imaginary time evolution and quantum annealing meet topological sector optimization*, arXiv:2310.04291 (2023) (PRApplied accepted).
6. Shuo Liu, Ming-Rui Li, **Shi-Xin Zhang***, Shao-Kai Jian*, and Hong Yao* *Noise-induced phase transitions in hybrid quantum circuits*, arXiv:2401.16631 (2024) (PRB accepted).
7. **Shi-Xin Zhang*** and Shuai Yin*, *Universal imaginary-time critical dynamics on a quantum computer*, Physical Review B **109**, 134309 (2024).
8. Lixue Cheng, Yu-Qin Chen, **Shi-Xin Zhang***, and Shengyu Zhang*, *Error-mitigated quantum approximate optimization via learning-based adaptive optimization*, Communications Physics **7**, 83 (2024).
9. Jiaqi Miao, Chang-Yu Hsieh*, and **Shi-Xin Zhang***, *Neural network encoded variational quantum algorithms*, Physical Review Applied **21**, 014053 (2024).
10. 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).
11. **Shi-Xin Zhang**, Zhou-Quan Wan, Chang-Yu Hsieh*, Hong Yao*, and Shengyu Zhang*, *Variational quantum-neural hybrid error mitigation*, Advanced Quantum Technologies, 202300147 (2023).
12. **Shi-Xin Zhang**, Zhou-Quan Wan, and Hong Yao*, *Automatic differentiable Monte Carlo: theory and application*, Physical Review Research **5**, 033041 (2023).
13. 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).
14. **Shi-Xin Zhang**, et al., *TensorCircuit: a quantum software framework for the NISQ era*, Quantum **7**, 912 (2023).
15. 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).
16. **Shi-Xin Zhang**, Chang-Yu Hsieh*, Shengyu Zhang, and Hong Yao*, *Differentiable quantum architecture search*, Quantum Science and Technology **7**, 045023 (2022).
17. Zhou-Quan Wan, **Shi-Xin Zhang***, and Hong Yao*, *Mitigating the fermion sign problem by automatic differentiation*, Physical Review B **106**, L241109 (2022).
18. **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).
19. **Shi-Xin Zhang**, Shao-Kai Jian, and Hong Yao*, *Quantum criticality preempted by nematicity*, Physical Review B **103**, 165129 (2021).
20. **Shi-Xin Zhang**, Shao-Kai Jian, and Hong Yao*, *Correlated triple-Weyl semimetals with Coulomb interactions*, Physical Review B (Rapid Communication) **96**, 241111 (2017).
21. 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).
22. Yu-Qin Chen, Shuo Liu, and **Shi-Xin Zhang***, *Subsystem information capacity in random circuits and Hamiltonian dynamics*, arXiv:2405.05076 (2024).
23. Shuo Liu, Hao-Kai Zhang, Shuai Yin, and **Shi-Xin Zhang***, *Symmetry restoration and quantum Mpemba effect in symmetric random circuits*, arXiv:2403.08459 (2024).
24. **Shi-Xin Zhang**, Jiaqi Miao, and Chang-Yu Hsieh*, *Variational post-selection for ground states and thermal states simulation*, arXiv:2402.07605 (2024).
25. Yu-Qin Chen*, **Shi-Xin Zhang**†, and Shengyu Zhang*, *Non-Markovianity benefits quantum dynamics simulation*, arXiv:2311.17622 (2023).
26. **Shi-Xin Zhang**, *Classification on the computational complexity of spin models*, arXiv:1911.04122 (2019).
27. Zhou-Quan Wan and **Shi-Xin Zhang***, *Automatic differentiation for complex valued SVD*, arXiv:1909.02659 (2019).
28. **Shi-Xin Zhang** and Hong Yao*, *Strong and weak many-body localizations*, arXiv:1906.00971 (2019).

Patents

46 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: Full-featured, high-performance quantum software framework designed for the NISQ era. It receives **500k** downloads and 60+ 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.
- admc: The software enables infinite order AD-aware Monte Carlo estimator and provides an end-to-end differentiable framework to carry out variational Monte Carlo calculation.
- 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.