

Sirui Lu

Webpages: <http://sirui-lu.com>, [Google scholar](#)

Email: sirui.lu.phys@gmail.com

EDUCATION

Tsinghua University(Beijing, China)
Undergraduate Student
B.S. in Math and Physics, Dept. of Physics

August 2015 - July 2019

Massachusetts Institute of Technology
Undergraduate Special Student
Department of Physics

August 2017 - May 2018

RESEARCH EXPERIENCE

Tsinghua University
Prof. Luming Duan's group (Tsinghua & Michigan)

April 2017 - present

Bachelor thesis:

- Applications and Implementation of Quantum Random Unitaries.

With Dr. Xun Gao:

- Derived neural network representations for many topologically-ordered states [1].

With Dr. Sheng-Tao Wang:

- Studied diabatic annealing and QAOA in the random transverse Ising model and the hard core boson model.

With Dr. Sheng-Tao Wang and Prof. Dong-Ling Deng:

- Implemented a convolutional neural network based method for measuring the topological number for chiral topological insulators (with a solid-state quantum simulator) [2].

Tsinghua University

August 2016 - present

Prof. Bei Zeng's Group (University of Guelph & Institute for Quantum Computing)

- Wrote a program to search quantum codes that allow to transmit both quantum and classical information. The obtained codes can encode more information compared with hybrid codes obtained from the best-known stabilizer codes. Enhanced linear programming bounds with shadow enumerators [4].
- Conceived a convex hull approx. method and a machine learning algorithm to separability problem [3].
- Implemented the machine learning based method for local quantum state tomography [6].
- Performed numerical simulation for simulating quantum spin network – the fundamental building block of quantum spacetime at Planck scale [7].

CURRENT RESEARCH INTERESTS

- Quantum error correction & fault tolerance
- Many-body physics, tensor network and topological phases
- Quantum quantum algorithms & complexity
- Quantum simulation on AMO platforms

PAPERS

- [1] **Sirui Lu**, Xun Gao, L.-M. Duan. Efficient Representation of Topologically Ordered States with Restricted Boltzmann Machines. *Phys. Rev. B*, **99**:155136, April 2019.
- [2] W.-Q. Lian*, S.-T. Wang*, **S.-R. Lu**, Y.-Y. Huang, F. Wang, X.-X. Yuan, W.-G. Zhang, X.-L. Ouyang, X. Wang, X.-Z. Huang, L. He, X.-Y. Chang, D.-L. Deng, and L.-M. Duan. Machine learning topological phases with a solid-state quantum simulator. *Phys. Rev. Lett*, **122**,:210503, May 2019.
- [3] **Sirui Lu***, Shilin Huang*, Keren Li, Jun Li, Jianxin Chen, Dawei Lu, Zhengfeng Ji, Yi Shen, Duanlu Zhou, and Bei Zeng. Separability-entanglement classifier via machine learning. *Phys. Rev. A*, **98**:012315, Jul 2018.
- [4] Markus Grassl, **Sirui Lu**, and Bei Zeng. Codes for simultaneous transmission of quantum and classical information. IEEE International Symposium on *Information Theory Proceedings (ISIT)*, 2017, pages 1718–1722. IEEE, 2017, doi.org/10.1109/ISIT.2017.8006823.
- [5] Murphy Yuezhen Niu, **Sirui Lu**, Issac L. Chuang. Optimizing QAOA: Success Probability and Runtime Dependence on Circuit Depth. [arXiv:quant-ph/1905.12134](https://arxiv.org/abs/1905.12134), 2019.
- [6] Tao Xin*, **Sirui Lu***, Ningping Cao*, Galit Anikeeva, Dawei Lu, Jun Li, Guilu Long, Bei Zeng. Local-measurement-based quantum state tomography via neural networks. [arXiv:quant-ph/1807.07445](https://arxiv.org/abs/1807.07445), 2018.
- [7] Keren Li*, Youning Li*, Muxin Han*, **Sirui Lu**, Jie Zhou, Dong Ruan, Guilu Long, Yidun Wan, Dawei Lu, Bei Zeng, Raymond Laflamme. Quantum Spacetime on a Quantum Simulator. *To appear in Communications Physics*. [arXiv:quant-ph/1712.08711](https://arxiv.org/abs/1712.08711), 2017.
- [8] Shi-Yao Hou, Ningping Cao, **Sirui Lu**, Yi Shen, Yiu-Tung Poon, Bei Zeng. Determining system Hamiltonian from eigenstate measurements without correlation functions. arXiv preprint [arXiv:1903.06569](https://arxiv.org/abs/1903.06569), 2019.

TALKS

- [1] **Sirui Lu**. Codes for simultaneous transmission of quantum and classical information. [ISIT201706.HQEC.pdf](https://arxiv.org/abs/1706.08654). 2017 IEEE International Symposium on *Information Theory (ISIT)*, Aachen, Germany, June. 25-30 2017.
- [2] **Sirui Lu**. A separability-entanglement classifier via machine learning. [QuIST_201707_Sep_ML.pdf](https://arxiv.org/abs/1707.08654). The 2nd International Conference on *Quantum Information, Spacetime, and Topological Matter*, Zhangjiajie, China, July. 3-7 2017.

RELEVANT GRADUATE COURSES

Harvard University, Fall 2017

Phys285b Modern Atomic and Optical Physics II, Prof. Mikhail Lukin: 5.0/5.0

MIT, Fall 2017

8.513 Many-Body Theory for Condensed Matter Systems, Prof. Xiao-Gang Wen: 5.0/5.0

MIT, Spring 2018

8.371 Quantum Information Science II, Prof. Aram Harrow & Isaac Chuang: 5.0/5.0

6.645 Phys. and engineering of superconducting qubits for QIP, Prof. William Oliver: 5.0/5.0

6.883 Science of Deep Learning: 5.0/5.0

Tsinghua University, 2015-2017

Quantum Information: Prof. Gui-lu Long, 4.0/4.0

Cold Atom Physics: Prof. Hui Zhai, 4.0/4.0

Quantum Entanglement and Quantum Error Correction, Prof. Bei Zeng

COURSES PROJECTS

Towards fault-tolerance with non-stabilizer codes

Course Project for "MIT 8.371 Quantum Information Science II"

2018 Spring

- Survey of existing results on fault tolerance with non-stabilizer codes.
- Generalized Shor's fault-tolerant error correction method to XS-stabilizer codes.

Studying SPT phases with TRS under interaction using quantum coding theory

Course project for "MIT 8.513 Many-Body Theory for Condensed Matter Systems"

2017 Fall

- Proposed an information-theoretic method for studying effect of interaction on time reversal symmetry-protected topological phases.

Presentation on cat state quantum error correction and its physical implementation

Course Project for "Harvard Phys285b: Modern Atomic and Optical Physics II"

2017 Fall

- Presentation on quantum error correction with cat codes.

AWARDS & HONORS

2019 Chi-Sun Yeh Prize (Highest honor for physics undergraduates at Tsinghua University)

Tsinghua Xuetao Talents Program

Qualcomm Scholarship

PROFESSIONAL ACTIVITIES

Referee for Physical Review Letters and ISIT 2018.

SKILLS

Computer Languages

Python, C/C++, Julia, Matlab, Mathematica

Softwares

L^AT_EX, Linux, TensorFlow, Tensor Networks (e.g., ITensor)

Quantum Tools

Qiskit, Project-Q, Yao.jl, CirQ, QuTiP, ...

Hobbies

Go (5d amateur)