北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Locality in quantum dynamics with measurement

Chao Yin

University of Colorado Boulder

Time: 10:00am, June. 2, 2023 (Friday)

时间：2023年6月2日 （周五）上午10:00

Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

In nonrelativistic quantum systems, the Lieb-Robinson Theorem [1-2] imposes an emergent speed limit v, establishing locality under unitary evolution and constraining the time needed to perform useful quantum tasks. In this talk, I will introduce our work [3] on extending the Lieb-Robinson Theorem to quantum dynamics with measurements and adaptive feedback. In contrast to the expectation that measurements can arbitrarily violate spatial locality, we find at most an (M+1)-fold enhancement to the speed of quantum information, provided the outcomes of M local measurements are known; this holds even when classical communication is instantaneous. Our bound is asymptotically optimal, and saturated by existing measurement-based protocols [4]. We tightly constrain the resource requirements for quantum computation, error correction, teleportation, and generating entangled resource states (Bell, GHZ, Dicke, W, and spin-squeezed states) from short-range-entangled initial states. Our results impose limits on the use of measurements and active feedback to speed up quantum information processing, and constrain the scalability of a wide range of proposed quantum technologies.

Refs:

[1] Lieb and Robinson, “The finite group velocity of quantum spin systems," Comm. Math. Phys. 28, 251 (1972).

[2] Chen, Lucas and Yin, “Speed limits and locality in many-body quantum dynamics”, arXiv: 2303.07386.

[3] Friedman, Yin, Hong and Lucas, “Locality and error correction in quantum dynamics with measurement”, arXiv: 2206.09929.

[4] Briegel, Dur, Cirac, and Zoller, “Quantum repeaters: The role of imperfect local operations in quantum communication," Phys. Rev. Lett. 81, 5932 (1998).

About the speaker

Chao Yin is a PhD candidate in the Physics Department, University of Colorado Boulder. He got his bachelor’s degree from the School of Physics, Peking University in 2020, and started doctoral research on the interface of quantum information and condensed matter theory. His research interests include speed limits and entanglement structure in quantum many-body systems.

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