北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Fundamental Limitation on the Detectability of Entanglement

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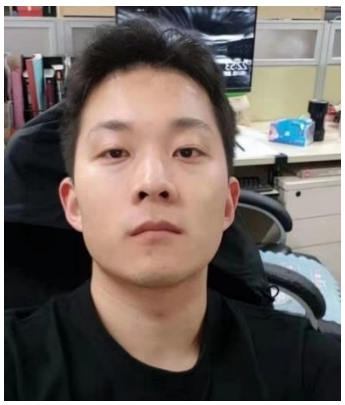

Time: 10:00am, Mar. 2, 2023 (Thursday)

时间: 2023年3月2日 （周四）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

Entanglement detection is essential in quantum information science and quantum many-body physics. It has been proved that entanglement exists almost surely for a random quantum state, while the realizations of effective entanglement criteria usually consume exponential resources, and efficient criteria often perform poorly without prior knowledge. This fact implies a fundamental limitation might exist in the detectability of entanglement. In this work, we formalize this limitation as a fundamental trade-off between the efficiency and effectiveness of entanglement criteria via a systematic method to theoretically evaluate the detection capability of entanglement criteria. For a system coupled to an environment, we prove that any entanglement criterion needs exponentially many observables to detect the entanglement effectively when restricted to single-copy operations. Otherwise, the detection capability of the criterion will decay double-exponentially. Furthermore, if multi-copy joint measurements are allowed, the effectiveness of entanglement detection can be exponentially improved, which implies a quantum advantage in entanglement detection problems.

In this talk, I will review some widely-used entanglement detection criteria including our earlier work [1] to introduce the problem we study: why entanglement detection is hard. Then I will demonstrate how we solve this problem in [2].

Ref:

[1] Liu Z, Tang Y, Dai H, et al. Detecting entanglement in quantum many-body systems via permutation moments[J]. Physical Review Letters, 2022, 129(26): 260501.

[2] Liu P, Liu Z, Chen S, et al. Fundamental Limitation on the Detectability of Entanglement[J]. Physical Review Letters, 2022, 129(23): 230503.

About the speaker

Zhenhuan Liu is a third-year PhD candidate in the Institute for Interdisciplinary Information Science, Tsinghua University. He received his bachelor's degree from the School of Physics, Peking University in 2020. His research interests include entanglement detection, quantum system benchmarking and quantum algorithm.

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