



复旦大学数学科学学院 数学综合报告会

报告题目: Near-Term Quantum Simulation Algorithms for the Dynamics of Open Quantum Systems

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时间: 2026-08-31 星期一 11:00-12:00

地点: 光华楼东主楼1801

报告摘要:

Open quantum systems exhibit a wide range of physically significant phenomena, yet their simulation remains challenging due to the exponential scaling of the Hilbert space and the intrinsically non-unitary nature of their dynamics. While numerous approaches have been proposed, few are compatible with the constraints of near-term quantum hardware. To address this issue, we develop several algorithms for simulating many-body dissipative dynamics on near-term quantum devices. First, we show that for a broad class of dissipation channels, Lindbladian dynamics can be mapped to a mixed-unitary adjoint channel, enabling direct implementation using unitary circuits. Second, we introduce a contour-based matrix decomposition technique that represents non-unitary evolution as a linear combination of unitary operations, achieving optimal complexity compared to existing LCHS-based methods. Third, we propose a variational quantum algorithm for simulating non-Hermitian dynamics, significantly reducing circuit depth and hardware overhead. These results advance the feasibility of simulating realistic open-system dynamics on near-term quantum processors and provide practical tools for quantum simulation in the NISQ era.

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