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Quantum Algorithms for the Quantum Simulation of Closed and Open Quantum Systems

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Quantum Simulation, the emulation of quantum system dynamics with quantum computers, is an application of quantum computing which showcases a clear advantage over classical computing. This advantage arises from the inherent difficulty in simulating quantum dynamics on classical systems, a challenge that originally inspired Feynman and others to propose quantum computing.
The efficient simulation of quantum dynamics on quantum computers promises profound insights into various physical systems including many-body physics, quantum chemistry and quantum field theory. Quantum Simulation has also been pivotal in developing new quantum algorithms for state preparation and for solving both ordinary and partial differential equations on quantum computers.
The goal of quantum simulation is to construct a quantum channel that approximates the evolution operator of a quantum system within some specified precision. This channel should be constructed such that it can be efficiently implemented on a quantum computer. We focus on two primary types of quantum systems: closed quantum systems, which evolve via unitary evolution, and open quantum systems, which interact with their environment and experience dissipation and decoherence.

This talk will convey the essential concepts and principles underlying the quantum simulation of both closed and open quantum systems. It will also cover some novel results in our recent work.

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