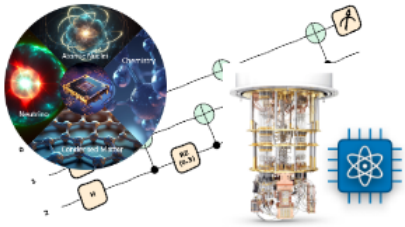

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Double-bracket quantum algorithms for ground-state preparation via cooling

Wednesday, November 19, 2025 2:30 PM (45 minutes)

Preparing ground-states of Hamiltonians is a fundamental task in quantum computation with wide-ranging applications. While efficiently preparing approximate ground-states of large, strongly-correlated systems on quantum hardware is challenging, nature is innately adept at this. This has motivated the study of thermodynamically-inspired approaches to ground-state preparation that aim to replicate cooling, such as imaginary-time evolution (ITE). However, synthesizing quantum circuits that efficiently implement such cooling methods is itself difficult. In this work, we propose quantum algorithms for preparing ground-states of many-body systems by exploiting recently-established Double-Bracket Quantum Algorithms (DBQA). More specifically, we propose a new algorithm called Double-Bracket Quantum Imaginary-Time Evolution (DB-QITE) that compiles quantum circuits for ITE without requiring measurements. We then provide rigorous guarantees that DB-QITE systematically lowers the energy of a state and increases its fidelity with the ground-state. Moreover, we develop a more general framework called Double-Bracket Quantum Signal Processing (DB QSP), which realizes quantum circuits for ground state preparation and extends to broader tasks involving polynomial transformations of Hamiltonians. We expect our algorithm to be used as a standalone method in the early fault-tolerant era, as well as in conjunction with more established and heuristic approaches to ground-state preparation for many-body systems.

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