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State preparation in quantum simulations of lattice gauge theories

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State preparation is a crucial aspect of quantum simulation of quantum field theories. When aiming to simulate Standard Model physics, it is likely that fault-tolerant quantum computers will be required. In this regime, it is beneficial to consider algorithms that exhibit nearly optimal scaling with the problem parameters. Many of these algorithms rely on repeated calls to a block encoding of the Hamiltonian of interest. However, the construction of this block encoding is often a bottleneck in these algorithms, resulting in a large prefactor in the overall gate cost. To overcome this challenge, recent research has introduced several algorithms based on the Hamiltonian time evolution input model. In this approach, instead of querying the block encoding subroutine, one queries an exact time evolution circuit for some short period of time. In this talk, we will focus on one such algorithm called the Quantum Eigenvalue Transformation for Unitary Matrices (QETU). The physical system we consider is a particular formulation of U(1) lattice gauge theory in two spatial dimensions. In practice, we employ product formulas to approximate the time evolution circuit. By employing QETU, we are able to prepare the ground state of this system. Furthermore, we discuss how the gate count scales with the problem size, as well as discuss the effects of approximate implementation of time evolution via product formulas.

Topical area

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