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Real-Time Dynamics and Flux-Tube fluctuation in SU(2) Pure Gauge Theory using Quantum Simulation

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Content

Traditional lattice simulations of quantum chromodynamics based on Monte Carlo methods are limited to equilibrium properties due to the sign problem, preventing access to real-time dynamics. In this work, we employ the Hamiltonian formulation of lattice gauge theory to study the real-time evolution of excitations of SU(2) Yang-Mills theory consisting of a one-dimensional line of plaquettes in two spatial dimensions. The dynamics are implemented on a quantum computer, where an initial gauge-invariant state is evolved under the Kogut-Susskind Hamiltonian, and the probabilities of the final states are measured. The results are compared with exact calculations to validate the quantum simulation. This approach enables the study of excitation propagation, flux-tube fluctuations, and possible flux-tube rearrangement between two quark–antiquark pairs, providing insight into the dynamical aspects of confinement and the potential of quantum devices for real-time gauge theory simulations.

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