Real-time Dynamics in U(1) Lattice Gauge Theories with Tensor Networks

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Author(s):
T. Pichler, M. Dalmonte, E. Rico, P. Zoller, S. Montangero

Reference:
arXiv:1505.04440

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http://arxiv.org/abs/1505.04440 [2]

Tensor network algorithms provide a suitable route for tackling real-time dependent problems in lattice gauge theories, enabling the investigation of out-of-equilibrium dynamics. We analyze a U(1) lattice gauge theory in (1+1) dimensions in the presence of dynamical matter for different mass and electric field couplings, a theory akin to quantum-electrodynamics in one-dimension, which displays string-breaking: the confining string between charges can spontaneously break during quench experiments, giving rise to charge-anticharge pairs according to the Schwinger mechanism. We study the real-time spreading of excitations in the system by means of electric field and particle fluctuations: we determine a dynamical state diagram for string breaking and quantitatively evaluate the time-scales for mass production. We also show that the time evolution of the quantum correlations can be detected via bipartite von Neumann entropies, thus demonstrating that the Schwinger mechanism is tightly linked to entanglement spreading. To present the variety of possible applications of this simulation platform, we show how one could follow the real-time scattering processes between mesons and the creation of entanglement during scattering processes. Finally, we test the quality of quantum simulations of these dynamics, quantifying the role of possible imperfections in cold atoms, trapped ions, and superconducting circuit systems. Our results demonstrate how entanglement properties can be used to deepen our understanding of basic phenomena in the real-time dynamics of gauge theories such as string breaking and collisions.

- 12.10.+i Simulations of many-body interactions [3]
- H2020 [4]
- QIPC [5]
- RySQ [6]
- 04. ENTANGLEMENT IN MANY-BODY SYSTEMS [7]
- Result [8]
- SIQS [9]
- 04.50.+m Efficient simulation of quantum many-body systems [10]

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