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Matrix-product-state approach for real-space qubits-wavegudie systems

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We present a matrix-product-state-based approach for simulating a qubits-waveguide system in real space. In this representation, the photon mode is described as a Bogoliubov mode, and the vacuum of the waveguide also becomes the Bogoliubov vacuum. This entangled Bogoliubov vacuum makes a simulation difficult because it requires large bosonic degrees of freedom for a faithful representation of the vacuum. The presented approach overcomes this difficulty by using single-site update schemes based on the controlled-bond expansion. We simulate a system consisting of four qubits and 400 bosonic waveguide modes and reproduce the qubit decay rate expected from superradiance phenomena.

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