Quantum Technology Initiative Journal Club

Report of Contributions

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Thursday 3 October 2024 16:00 (40 minutes)

TITLE: Gate-based quantum simulation of Gaussian bosonic circuits on exponentially many modes
Link to the paper: https://arxiv.org/abs/2407.06290

Abstract:
We introduce a framework for simulating, on an (n+1)-qubit quantum computer, the action of a Gaussian Bosonic (GB) circuit on a state over 2n modes. Specifically, we encode the initial bosonic state's expectation values over quadrature operators (and their covariance matrix) as an input qubit-state. This is then evolved by a quantum circuit that effectively implements the symplectic propagators induced by the GB gates. We find families of GB circuits and initial states leading to efficient quantum simulations. For this purpose, we introduce a dictionary that maps between GB and qubit gates such that particle- (non-particle-) preserving GB gates lead to real (imaginary) time evolutions at the qubit level. For the special case of particle-preserving circuits, we present a BQP-complete GB decision problem, indicating that GB evolutions of Gaussian states on exponentially many modes are as powerful as universal quantum computers. We also perform numerical simulations of an interferometer on ~8 billion modes, illustrating the power of our framework.

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