

N-point correlation functions on ancilla-free quantum circuits and neural networks

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The n-point real-time correlation function is pivotal for establishing connections between experimental observations and theoretical predictions using field theories. Conventional methods for computing n-point correlation functions on quantum computers generally require an ancilla qubit that controls the entire system – an approach that poses challenges for digital quantum devices with limited qubit connectivity, as well as for analog quantum platforms lacking controlled operations. Here, we introduce a method to compute n-point correlation functions using only unitary evolutions on the system of interest, thereby eliminating the need for ancillas and the control operations. We demonstrate our protocol on IBM quantum hardware up to 12 qubits to measure the single-particle spectrum of the Schwinger model and the out-of-time-order correlator (OTOC) in the transverse-field Ising model, where the noiseless simulation results are successfully reproduced from the noisy hardware. Additionally, I will talk about our recent work on predicting the long-time dynamics of the correlation function from short-time quantum data using NeuralODE.

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