Adaptively partitioned analog quantum simulation for the nonclassical free induction decay of NV centers on near-term quantum computers

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The idea of simulating quantum physics with controllable quantum devices had been proposed several decades ago. With the extensive development of quantum technology, large-scale simulation, such as the analog quantum simulation tailoring an artificial Hamiltonian mimicking the system of interest, has been implemented on elaborate quantum experimental platforms. However, due to the limitations caused by the significant noises and the connectivity, analog simulation is generically infeasible on near-term quantum computing platforms. Here we propose an alternative analog simulation approach on near-term quantum devices. Our approach circumvents the limitations by adaptively partitioning the bath into several groups based on the performance of the quantum devices. We apply our approach to simulate the free induction decay of the electron spin in a diamond NV^- center coupled to a huge number of nuclei and investigate the nonclassicality induced by the nuclear spin polarization. The simulation is implemented collaboratively with authentic devices and quantum simulators on IBMQ. This work sheds light on a flexible approach to simulate large-scale materials on noisy near-term quantum computers.

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