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# Quantum many-body scars as protected subgraph in the Fock space lattice: A study in 2D constraint system

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Understanding the fundamental theory of preventing thermalization is crucial for practical quantum device development. In this study, we delve into prior research on quantum many-body scars in the U(1) lattice gauge theory. By interpreting the Hamiltonian as the adjacency matrix defining an undirected graph, we pinpoint these scars as subgraphs exhibiting perfect destructive interference at the boundaries. Consequently, they are confined from exploring the entire graph, thereby violating the Eigenstate Thermalization Hypothesis (ETH). Remarkably, the Cauchy interlacing theorem ensures that these subgraphs can still share identical eigenpairs with the entire graph, even in the absence of any associated global symmetries. Leveraging this insight, we devise an efficient algorithm for scar detection. Furthermore, we assess the dynamics of these scars through numerical tests, evaluating their robustness against noise and exploring other aspects of long-time physics.

Keywords: Quantum many-body scars, eigenstate thermalization hypothesis, graph theory

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