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Qubits with always-on couplings and gates based on decoupling pulse sequences: fault tolerance with quantum LDPC codes KATHLEEN HAMILTON, University of California Riverside, ALEXEY KOVALEV, University of Nebraska Lincoln, AMRIT DE, LEONID PRYADKO, University of California Riverside — Universal gate sets based on decoupling pulse sequences can be efficiently constructed to a given order of the Magnus series by working with small qubit clusters. However, the most likely systematic errors of such gates typically involve few qubits, with a possibility of run-away large error cluster formation when scaled to large systems. We analyze the existence of a fault-tolerant decoding threshold when such gate sets are used with a quantum low-density parity check (LDPC) code. In particular, we show that the existence of such a threshold when the code is used for quantum memory can be related to the existence of a finite percolation transition between random clusters on a graph associated with the code. The results also apply to other systems where gates are constructed perturbatively, e.g., by tuning qubits in and out of resonance.

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