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Nonlinear Optics Quantum Computing and Quantum Simulation with Circuit-QED PRABIN ADHIKARI, Joint Quantum Institute, University of Maryland, College Park, MOHAMMAD HAFEZI, JACOB TAYLOR, Joint Quantum Institute, University of Maryland, College Park/NIST — One approach to quantum information processing is to use photons as quantum bits and rely on linear optical elements for most operations. However, some optical nonlinearity is necessary to enable universal quantum computing. Here, we suggest a circuit-QED approach to photon-based quantum processors and quantum simulators in the microwave regime, including a deterministic two-photon interaction. Our specific example uses a hybrid quantum system comprising a LC resonator coupled to a superconducting flux qubit to implement a nonlinear coupling. Compared to the self-Kerr nonlinearity, we find that our approach has improved tolerance to noise in the qubit while maintaining fast operation. We also envision using a similar resonator and fluxonium qubit system to create higher order photon nonlinearities, which is a generalization of effective two-photon interactions and opens the range of potential Hamiltonians that can be efficiently simulated.

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