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Site-wise manipulations induced phase transitions of interacting photons using superconducting circuit simulators[1] XIUHAO DENG, School of Natural Sciences, University of California Merced, CHUNJING JIA, Department of Applied Physics, Stanford University; Stanford Institute for Materials and Energy Sciences, SLAC National Accelerator, CHIH-CHUN CHIEN, School of Natural Sciences, University of California Merced — The Bose Hubbard model (BHM) of interacting bosons in a lattice has been a paradigm in many body physics. Here a quantum simulator of the BHM using a superconducting circuit is proposed. Specifically, a superconducting transmission line resonator supporting microwave photons is coupled to a charge qubit to form one site of the BHM, and adjacent sites are connected by a tunable coupler. To obtain a mapping from the superconducting circuit to the BHM, we focus on the dispersive regime where the excitations remain photon-like. Standard perturbation theory is implemented to locate the parameter range where the BHM can be simulated. This simulator allows single-site manipulations and we illustrate this feature by considering two scenarios where a single-site manipulation can drive a Mott insulator-superfluid transition. The critical point of the transition can be located by mean-field analyses and the exact diagonalization method was implemented to provide accurate results. The variance of the density and the fidelity metric clearly show signatures of this transition. Experimental realizations and other possible applications of this simulator are also discussed.

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Xiuhao Deng
Univ of California - Merced

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