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Site-Resolved Microscopy of a Photonic Mott Insulator RUICHAO MA, CLAI OWENS, BRENDAN SAXBERG, DAVID SCHUSTER, JONATHAN SIMON, James Frank Institute, University of Chicago — Superconducting circuits have emerged as a competitive platform for realizing a practical quantum computer, satisfying the challenges of controllability, long coherence and strong interactions between individual systems. In this work, we apply this well-developed toolbox to a different problem: the exploration of strongly correlated phases of photonic quantum matter. The qubits of the quantum circuit become the sites of a Bose Hubbard lattice - their anharmonicity provides the on-site photon-photon interaction, couplings between them generates inter-site tunneling, while multiplexed qubit readout provides time- and site- resolved microscopy of the Bose Hubbard system. We further develop a new method for dissipative preparation and stabilization of incompressible phases of matter, achieved through reservoir engineering. We characterize our Bose-Hubbard system through coherent lattice dynamics including quantum random walks, and then connect it to the dissipative stabilizer to realize and investigate a Mott insulator of photons. These experiments demonstrate the power of superconducting circuits for studying strongly correlated physics, and with the recently demonstrated low-loss microwave Chern insulators could point the way to topological many-body states of photons.

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