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Exploring Synthetic Quantum Materials in Superconducting Circuits

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Superconducting circuits have emerged as a competitive platform for quantum computation, satisfying the challenges of controllability, long coherence and strong interactions. Here we apply this toolbox to the exploration of strongly correlated quantum materials made of microwave photons. We build a Chern insulator lattice for microwave photons, and observe topologically protected edge states using time- and site- resolved measurements. I will show our progress towards strong coherent interactions by coupling the lattice sites to superconducting qubits. In another experiment, we develop a new approach for preparing photonic many-body phases, where engineered dissipation is used as a resource to protect the fragile quantum states against intrinsic losses. We apply it to a strongly interacting Bose-Hubbard lattice and realize a dissipatively stabilized Mott insulator of photons. Our circuit experiments open many possibilities for exploration of strongly interacting topological phases, and quantum dynamics in driven-dissipative settings.

Orateur: M. MA, Alex Ruichao (University of Chicago)