Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Quantum Many-Body Physics with Photons[1] NINGYUAN JIA, NATHAN SCHINE, ALEXANDROS GEORGAKOPOULOS, ALBERT RYOU, CLAIRE BAUM, LOGAN W. CLARK, ARIEL SOMMER, JONATHAN SIMON, Univ of Chicago — We present our apparatus for synthesizing topological quantum materials using photons in an optical resonator. Photons in a planar cavity undergo transverse oscillations analogous to massive particles in a harmonic trap. Twisting the cavity out of the plane introduces a geometric phase for photons in the cavity waist, and the resulting photon modes can be mapped onto Landau levels. By transporting an ensemble of cold rubidium atoms to the cavity waist, we hybridize the cavity photons with atomic Rydberg excitations to create polaritons with strong interactions at the level of single quanta. Modulating the excited state allows us to observe the interaction induced quantum dynamics in a multimode resonator showing the building block for studying quantum many-body physics. Combining these capabilities, we can create a photonic Laughlin state in a curved manifold. We characterize the properties of many-body states by measuring the correlation between different spatial modes. This setup also allows us to use novel dissipative pumping to realize a chemical potential for photons and stabilize the many-body system.

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Date submitted: 06 Feb 2018 Electronic form version 1.4