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**Many- and Few-Body Physics with Rydberg Polaritons in an Optical Resonator**[1] ARIEL SOMMER, JONATHAN SIMON, University of Chicago — Under conditions of electromagnetically induced transparency (EIT) with a Rydberg state, photons propagate as Rydberg polaritons–superpositions of a photon and a Rydberg excitation. We are building an experiment to study Rydberg polaritons in an optical cavity. In a near-degenerate cavity, the manifold of cavity modes provides a transverse kinetic energy and trapping potential. In this configuration, long range interactions between Rydberg polaritons give access to the crystal to superfluid phase transition. Meanwhile, working with a single or a few cavity modes yields the Rydberg blockade as a source of non-classical light, as well as few-body physics with hopping between cavity modes. The use of a high-finesse optical cavity leads to strong atom-photon coupling, protecting the polaritons from decoherence under the action of external forces and collisions. Because the kinetic energy derives from the photons, gauge fields can be introduced by engineering the cavity modes. We describe the physics of this novel system, and provide an update on the experimental progress.

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Ariel Sommer
University of Chicago

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