Few-body and many-body physics with Rydberg polaritons.

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Under the conditions of electromagnetically induced transparency (EIT) in a Rydberg medium, photons and Rydberg atoms form strongly interacting atom-photon superpositions called Rydberg polaritons. This talk will explore exotic few-body and many-body physics with such polaritons. On the front of few-body physics, we show how to design both attractive and repulsive interactions between polaritons. For the case of attractive interactions, we propose schemes for preparing and studying various two-polariton bound-states. We also show that for some choices of experimental parameters, polaritons interact via an effective attractive Coulomb potential, giving rise to a photonic analogue of the hydrogen atom. On the front of many-body physics, we propose a scheme for realizing fractional quantum Hall states of Rydberg polaritons in an array of microcavities. Polaritons of two flavors play the role of spin up and spin down in each microcavity, while polariton-polariton interactions give rise to a spin model with a ground state analogous to the $\nu = \frac{1}{2}$ Laughlin state.