Abstract Submitted
for the DAMOP14 Meeting of
The American Physical Society

An Apparatus for Studying Rydberg Polaritons in an Optical Resonator[1] ALEXANDER GEORGAKOPOULOS, ALBERT RYOU, NINGYUAN JIA, NATHAN SCHINE, AARON KRAHN, GRAHAM GREVE, ARIEL SOMMER, JONATHAN SIMON, LINDSAY BASSMAN, University of Chicago — In electromagnetically induced transparency (EIT) involving a Rydberg state, the dark state polaritons, or Rydberg polaritons, consist of a superposition of an atomic Rydberg excitation and a photon. Rydberg polaritons offer a route towards realizing long-range interactions in a quantum-degenerate atomic and optical system. The Rydberg component gives rise to strong, long-range van der Waals interactions between polaritons, while the photonic component determines the kinetic energy of the polaritons. We report on progress towards the realization of a two-dimensional quantum gas of Rydberg polaritons in a high finesse optical cavity. The strong atom-light coupling in the cavity suppresses decoherence arising from atomic motion, polariton collisions, and the photonic kinetic energy. A sufficient polariton lifetime gives access to coherent quantum many-body physics, including the phase transition between a superfluid and crystalline ground state and few-body blockade effects.

[1]We acknowledge support from the AFOSR and DARPA

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Date submitted: 21 Feb 2014 Electronic form version 1.4