Abstract Submitted
for the DAMOP16 Meeting of
The American Physical Society

Three-photon interactions and spin exchange in a quantum nonlinear medium SERGIO CANTU, QI-YU LIANG, JEFF THOMPSON, TRAVIS NICHOLSON, MIT, Department of Physics and RLE, ADITYA VENKATRAMANI, Harvard, Department of Physics, MICHAEL GULLANS, ALEXEY GORSHKOV, Joint Quantum Institute and Joint Center for Quantum Information and Computer Science, NIST/University of Maryland, SOONWON CHOI, MIKHAIL LUKIN, Harvard, Department of Physics, VLADAN VULETIC, MIT, Department of Physics and RLE — Robust quantum gates for photonic qubits are a longstanding goal of quantum information science. One promising approach to achieve this goal requires strong nonlinear interactions between single photons, which is impossible with conventional optical media. We realize these interactions with electromagnetically induced transparency (EIT), and strongly interacting Rydberg states to mediate strong interactions between photons [1]. Operating in the dispersive regime of EIT, we have recently shown that two photons propagating in our system can bind into a photonic molecule [2]. Extending these two-photon experiments to many-body physics would lead to exotic phenomena like photon crystallization. To that end, we have scaled up our two-photon measurements to three-photon experiments. We are now able to discern signatures of three-photon molecules from a variety of two- and three-photon interactions. Three-photon bound states manifest as an increase in photon bunching in $g^{(3)}$ correlation measurements. We also present a recent observation of coherent spin exchange interactions in Rydberg EIT. [1] Peyronel, et al Nature **488**, 5760 (2012) [2] Firstenberg, et al Nature **502**, 71-75 (2013)

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Date submitted: 29 Jan 2016 Electronic form version 1.4