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Repulsive photons via interaction engineering in a quantum nonlinear medium WENCHAO XU, SERGIO CANTU, Massachusetts Institute of Technology, ADITYA VENKATRAMANI, LEO ZHOU, MIKHAIL LUKIN, Harvard University, VLADAN VULETIC, Massachusetts Institute of Technology — Being able to manipulate interactions between single photons is significant for both fundamental studies and applications in quantum information and metrology. Photons do not typically interact with each other; however, special optical media can be engineered to achieve large non-linearity at the single photon level. Here, we control photon-photon interactions and demonstrate both repulsion and attraction between photons. We achieve this by coupling photons to two distinct atomic states in a cold atomic gas with one of the states being a strongly interacting Rydberg state. We demonstrate both repulsive and attractive interactions as characterized by the measured two- and three-photon correlation functions. These observations of repulsion between single photons and the ability to control the nature of interactions open a route to creating quantum matter composed of light such as a crystal of photons.

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