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Storage enhanced non-linearities in a cold Rydberg ensemble[1]
EMANUELE DISTANTE, AUXILIADORA PADRON-BRITO, MATTEO CRISTIANI, DAVID PAREDES-BARATO, HUGUES DE RIEDMATTEN, ICFO-The Institute of Photonic Sciences — The possibility to control the interaction between photons provided by highly nonlinear media is a key ingredient to the goal of quantum information processing using photons and a unique tool to study the dynamics of the many-body correlated system. To mediate this interaction, one can exploit electromagnetically induced transparency (EIT) to map the state of the photons into atomic coherence in the form of Rydberg dark-state polaritons. The combination of EIT with the nonlinear interaction between Rydberg atoms provides and effective interaction between photons. By measuring the dynamics of stored Rydberg polaritons, we experimentally demonstrate that storing a probe pulse as Rydberg polaritons strongly enhances the Rydberg mediated interaction compared to the slow-propagation case. We show that the process is characterized by two time scales. We measure a strong enhancement of the interaction at short time scales. By measuring the time-dependent coherence of the stored polariton, we also show that the long time scale dynamics is dominated by Rydberg induced dephasing of the multiparticle components of the state. Our results have a direct consequence in Rydberg quantum optics and enable the test of new theories of strongly interacting Rydberg systems.

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