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Towards single-photon optical nonlinearities using cold Rydberg atoms THIBAULT PEYRONEL, MIT, OFER FIRSTENBERG, Harvard, QIYU LIANG, VLADAN VULETIC, MIT, MIKHAIL LUKIN, Harvard — Effects of the Rydberg blockade in cold atomic clouds have been intensively explored over the last few years. Optical fields can be coherently mapped onto atomic states with a Rydberg component using EIT techniques thanks to the long lifetime of the Rydberg states. As the dipole-dipole interaction between Rydberg atoms prevents several polaritons from propagating simultaneously within a Rydberg volume, it gives rise to strong non-linearities which are mapped back on the probe optical field. We aim at bringing the Rydberg-EIT into the single-photon regime in order to produce non-classical highly correlated states of light. Rubidium atoms are loaded in a far off-resonant (1064nm) optical dipole trap, where densities are typically large enough to reach high optical depths within a single blockade volume. In this regime, the outcoming photon-photon correlation function is expected to exhibit highly non-classical behavior, corresponding to trains of spatially separated single-photons. Moreover, EIT techniques together with a high-resolution imaging system allow the observation of Rydberg excitations in the quasi-1D configuration, and should pave the way to in-situ monitoring of strongly correlated many-body states such as the crystallisation of Rydberg atoms.

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