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Dark-State Polaritons with Rydberg Interactions JOHANNES OTTERBACH, TU Kaiserslautern, ALEXEY V. GORSHKOV, IQI, California Institute of Technology, THOMAS POHL, Max-Planck Institute for the Physics of Complex Systems, MIKHAIL D. LUKIN, Harvard University, MICHAEL FLEISCHHAUER, TU Kaiserslautern — Due to their strong long-range interaction and high level of controllability Rydberg-atoms are especially well suited for applications in quantum-information [1]. We study the interaction of single- or few-photon pulses in a coherently driven ensemble of Rydberg atoms exhibiting a ladder-like linkage pattern. Under conditions of electromagnetically induced transparency the photons form quasi-particles, so-called dark-state polaritons [2]. We investigate the effect of the strong Rydberg interactions on the polaritons. In particular we discuss two-particle correlations which are shown to decay very quickly to zero within the so-called blockade radius if the lower transition is close to resonance. Away from resonance temporary two-polariton bound states are formed. On length scales large compared to the blockade radius the Rydberg polaritons experience a repulsive interaction.

[1] M. Saffman et al., Rev. Mod. Phys. 82, 2313 (2010).
[2] M. Fleischhauer et al., Rev. Mod. Phys. 77, 633 (2005).

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