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Dissipative Many-body Quantum Optics in Rydberg Media ALEXEY GORSHKOV, California Institute of Technology, REJISH NATH, University of Innsbruck, JOHANNES OTTERBACH, Harvard University, MICHAEL FLEISCHHAUER, Technische Universitat Kaiserslautern, MIKHAIL LUKIN, Harvard University, THOMAS POHL, Max Planck Institute for the Physics of Complex Systems — We develop the theory of light propagation under the conditions of electromagnetically induced transparency in systems involving strongly interacting Rydberg states. Taking into account the quantum nature of light, we compute the propagation of an arbitrary input pulse in the limit of strong Rydberg-Rydberg interactions. We also solve the case of a few-photon pulse for arbitrary Rydberg-Rydberg interaction strengths [PRL 107, 133602 (2011)]. We show that this system can be used for the generation of nonclassical states of light including single photons and trains of single photons with an avoided volume between them, for implementing photon-photon gates, as well as for studying many-body phenomena with strongly correlated photons.

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