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Interacting Rydberg Polaritons for Photonic Quantum Logic STEFFEN SCHMIDT-EBERLE, DANIEL TIARKS, THOMAS STOLZ, STEPHAN DÜRR, GERHARD REMPE, Max-Planck-Institute of Quantum Optics, Garching, Germany — The strong dipole-dipole interaction between Rydberg atoms has enabled remarkable experimental success ranging from quantum information processing with single atoms to observation of exotic many-body states. The interaction between Rydberg excitations can also be used to create a large effective interaction between photons. To this end, one addresses Rydberg states with electromagnetically induced transparency. This creates a quasiparticle, called Rydberg polariton, which consists of a photonic component and a co-propagating atomic Rydberg excitation. The large interaction between the Rydberg components manifests itself in the form of a giant optical nonlinearity. A central goal in the field of Rydberg polaritons is the realization of photonic quantum logic. This line of research has seen impressive progress in the last few years, including the demonstration of single-photon transistors and the observation of large conditional phase shifts at the single photon level. We describe our recent progress on using Rydberg polaritons for photonic quantum logic.

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