Abstract Submitted
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A Photon-Photon Quantum Gate Based on Rydberg Polaritons STEFFEN SCHMIDT-EBERLE, DANIEL TIARKS, THOMAS STOLZ, STEPHAN DUERR, GERHARD REMPE, Max-Planck-Institute of Quantum Optics, Garching, Germany — Rydberg polaritons offer a unique way to create strong interactions for photons. We utilize these interactions to demonstrate a photon-photon quantum gate. To achieve this, a photonic control qubit is stored in a quantum memory consisting of a superposition of a ground state and a Rydberg state in an ultracold atomic gas. This qubit interacts with a photonic target qubit in the form of a propagating Rydberg polariton to generate a conditional pi phase shift.[1] Finally, the control photon is retrieved. We measure two controlled-NOT truth tables and the two-photon state after an entangling-gate operation. This work is an important step toward applications in optical quantum information processing, such as deterministic photonic Bell-state detection which is crucial for quantum repeaters.

[1]D. Tiarks et al., Science Advances 2, 1600036 (2016)

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