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Controlled-phase gate for photons based on stationary light IVAN IAKOUPOV, Niels Bohr Institute, JOHANNES BORREGAARD, Harvard University, ANDERS S. SØRENSEN, Niels Bohr Institute — We propose a controlled-phase gate for optical photons based on an atomic ensemble coupled to a one-dimensional waveguide. When an ensemble of Λ-type atoms is subject to a standing wave control field, it creates a *stationary light* [1] effect where the ensemble develops a band gap for light propagation. For frequencies close to the band gap, the light-matter interactions are enhanced due to the reduced group velocity of the light pulses. Changing the internal state of one of the atoms, such that it behaves as an absorbing two-level atom instead of a transparent Λ-type atom, can change the scattering properties of the whole ensemble, switching it from being completely transmissive to being completely reflective. To realize a controlled-phase gate between photons, we store one of the photons inside the atomic ensemble (thereby changing the internal state of one of the atoms), scatter a second photon off the ensemble, and retrieve the first photon. Finally, we consider an application of the proposed controlled-phase gate – a quantum repeater.

References

[1] M. Bajcsy, A. S. Zibrov, M. D. Lukin, *Nature* **426**, 638-641 (2003).

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