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Single-photon Swap Gate Using Electromagnetically Induced Transparency parency DENIZ YAVUZ, University of Wisconsin at Madison — We propose a scheme to swap the quantum states of two different photons at different wavelengths (colors). We consider a four level atomic system interacting with four fields in a double lambda configuration. Two of the fields are strong and form a traditional electromagnetically induced transparency (EIT) scheme. These fields drive the atoms to a dark state and prepare the coherence (off-diagonal density matrix element) of the non-allowed Raman transition. Two single photons, whose frequencies are separated by the frequency of the Raman transition then interact with each other through the established coherence of the atomic system. Under appropriate conditions, the interaction between the two photons becomes identical to a conventional beam-splitter between two spatial modes. The rotation angle of the beam-splitter is determined by the density-length product of the atomic medium. For a specific density-length product, such a system can perform the swap gate between the two photons. The fidelity of the gate is directly related to the magnitude of the established Raman coherence.

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