Light -by-light control at quantum level mediated by flying atoms

Heng Shen
Clarendon Laboratory, University of Oxford, Parks Road, Oxford, OX1 3PU, UK
E-mail: *heng.shen@physics.ox.ac.uk*

Quantum interface between photons is a long- standing goal of fundamental significance, and also serves as powerful tools for quantum technologies. Remarkable advances in quantum optics have recently developed in several platforms to demonstrate the generation of optical nonlinearities at the level of individual photons, which enable a number of unique applications such as quantum-by-quantum control of light fields. Here, we present two examples based on the platform of flying atoms where thermal motion of atoms with long-lived coherence of ground state mediate the coupling between the spatially separated optical channels.

Firstly, we report the realization of spatially-multiplexed coherent beam-splitter for squeezed light array in an anti-relaxation coated ^{87}Rb vapor cell. In such a scheme, the quantum state of the optical field in a target optical channel can be fully controlled by other spatially separated light beams, which is mediated by the flying atoms with long-lived ground state coherence and carrying light information. The created one-dimensional and two-dimensional arrays of squeezed light with reconfigurable geometry and low light power requirements,squeezed light array can be directly applied in quantum imaging and metrology with high-spatial resolution, and in quantum network with more nodes.

Secondly, we present nonlocal four wave mixing usingresonant Λ type electromagnetically induced transparency (EIT) configuration, but with two spatially separated optical channels coupled by moving atoms, which effiectively form a double-Λ cycle. This scheme can enable steady state entanglement between spatially separated laser beams, and loosen requirement on energy levels and laser power. Experimental verfication of entangelemnt is underway.

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