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Paired Photons with Controllable Waveforms[1]

DANIELLE BRAJE, Reed College

The major theme of this talk is the incorporation of electromagnetically induced transparency (EIT) with nonlinear optics in atoms to achieve efficient processes at low-light levels, particularly the generation and manipulation of correlated photon pairs. Entangled photons are an ideal tool for quantum information processing; they are now routinely used in experiments on quantum measurement, quantum teleportation, and quantum information processing. Principle limitations of existing sources of paired photons are two-fold. First, the wide bandwidth of paired photons encumbers resonant interactions with atoms, which is the most promising avenue for photon storage and quantum repeaters as well as for entanglement of atomic ensembles. Second, conventional paired photons' coherence length is prohibitively short for long-distance quantum communication. An experiment requiring the transmission of a simultaneous pair of photons over many kilometers necessitates a length difference of the transmitting fibers *less than* the coherence length of the spontaneous parametric source (~ 30 μm for traditional paired photons created in a BBO crystal). Electromagnetically induced transparency in cold atomic ensembles enables the creation of paired photons which decisively overcome these limitations. This talk will describe experiments and theory showing the generation of counterpropagating paired photons with waveforms that are controllable by using EIT to vary the optical group velocity. Typical waveform lengths are tens of nanoseconds.

[1]Experimental work completed at Stanford University with S.E. Harris.