Hong-Ou-Mandel Interference Between Triggered And Heralded Single Photons From Separate Atomic Systems

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The realization of quantum networks and long distance quantum communication rely on the capability of generating entanglement between separated nodes. This can be achieved if the separated nodes generate indistinguishable photons, independently of the physical processes on which they are based [1,2]. We demonstrate the compatibility of two different sources of single photons: a single atom and four-wave mixing in a cold cloud of atoms. The four-wave mixing process in a cloud of cold ^{87}Rb generates photon pairs. The cascade level scheme used ensures the generation of heralded single photons with exponentially decaying temporal envelope [3]. The temporal shape of the heralding photons matches the shape of photons emitted by spontaneous decay but for the coherence time, shortened because of the collective effects in the atomic cloud [4].

A single ^{87}Rb atom is trapped in an far-off-resonance optical dipole trap and can be excited with high probability using a short ($\approx$3 ns) intense pulse of resonant light. emitting a single photon by spontaneous decay. A large numerical aperture lens collects $\approx$4% of the total fluorescence [5].

The heralded and the triggered photons are launched into a Houng-Ou-Mandel interferometer: a symmetrical beam-splitter with outputs connected to single photon detectors. The rate of coincidence events at the two outputs varies depending on the relative delay time between the detection of the heralding photon and the optical excitation pulse, and on the relative polarization of the input modes. Controlling these parameters, we observe a maximum visibility of 70±4%.

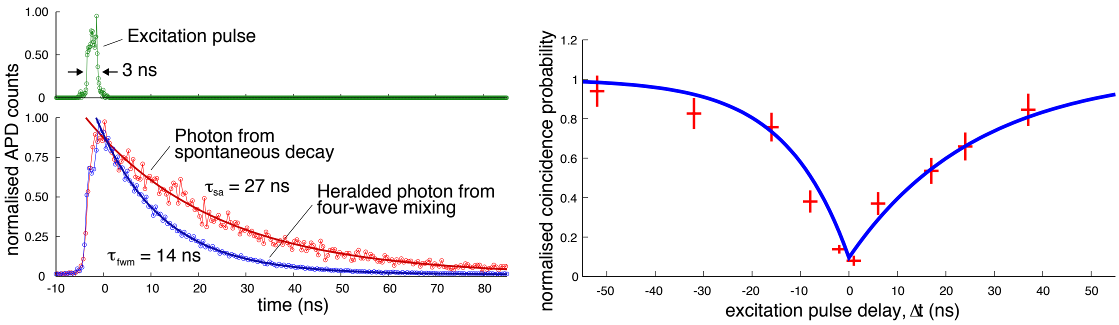

Fig. 1 In the left panel, the temporal envelope of the photons generated by the spontaneous decay from the single atom and the heralded photon originating from the four-wave mixing in the cold atomic cloud. Both photons are resonant with the $5S_{1/2}$,F=2 to $5P_{3/2}$,F=3 transition. On the right, the HOM dip, obtained by varying the relative delay between the detection of the heralding signal and the generation of the excitation pulse for the single atom.

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