Spin-rephased storage of single photons in a Pr3+:YSO quantum memory

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The realization of large-scale quantum networks requires the distribution of entanglement over large distances [1]. Such quantum networks will rely on quantum memories to store entanglement while it is distributed over the full network [2,3]. The realization of an efficient, yet long-lived and multimode quantum memory is one of the challenges this architecture proposes. Solid-state quantum memories offer intrinsically multimode storage in many degrees of freedom [4], and can be made highly efficient when embedded in a cavity [5]. However, the achievable communication distance is bounded by the storage time, that needs to exceed the photon travel time over the network links. In this talk I will present an important step towards a long-lived quantum memory, showing the first spin-rephased storage of single photons in an atomic ensemble, on a Pr-doped crystal.

Spin rephasing is a technique used to increase the spin coherence by correcting for the dephasing resulting in the spin inhomogeneous broadening. It consists on a series of RF pulses sent during the storage of the photon in the spin state, allowing for longer storage times reaching the coherence limit of the crystal's homogeneous linewidth [6]. In this work, we prove spin-rephased storage of heralded single photons generated by a cavity-enhanced SPDC photon pair source. At 90µs of storage time we show a second-order cross-correlation $g_{SR}^{(2)} = 4.8 \pm 0.4$, well above the non-classical bound of 2. This is the first spin-rephased storage of single photons in any atomic ensemble, opening the way for long distance entanglement, a significant step towards a real quantum network.

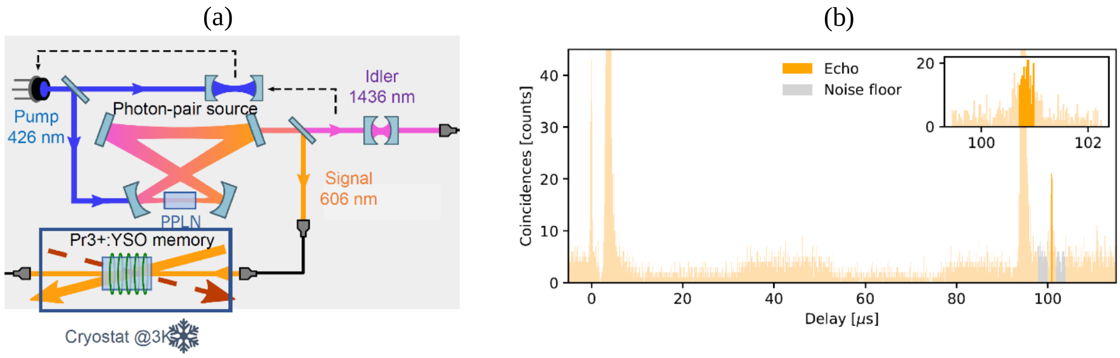

Fig. 1: *(a) Sketch of the setup used in the experiment, involving a cavity-enhanced SPDC photon pair source and a quantum memory inside a cryostat. A coil surrounding the memory sends the RF pulses necessary for spin rephasing (b) Spin-wave echo of spin-rephased single photons stored in a solid-state quantum memory. A cross-correlation* $g_{DD}^{(2)} = 4.8 \pm 0.4$ *was measured, proving non-classical correlation between the two single photons from the source.*

References

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