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Controlled rephasing of single spin-waves in a quantum memory based on cold atoms[1] PAU FARRERA, BORIS ALBRECHT, GEORG HEINZE, MATTEO CRISTIANI, HUGUES DE RIEDMATTEN, ICFO-The Institute of Photonic Sciences, QUANTUM PHOTONICS WITH SOLIDS AND ATOMS TEAM
— Quantum memories for light allow a reversible transfer of quantum information between photons and long lived matter quantum bits. In atomic ensembles, this information is commonly stored in the form of single collective spin excitations (spin-waves). In this work we demonstrate that we can actively control the dephasing of the spin-waves created in a quantum memory based on a cold Rb87 atomic ensemble. The control is provided by an external magnetic field gradient, which induces an inhomogeneous broadening of the atomic hyperfine levels. We show that acting on this gradient allows to control the dephasing of individual spin-waves and to induce later a rephasing. The spin-waves are then mapped into single photons, and we demonstrate experimentally that the active rephasing preserves the sub-Poissonian statistics of the retrieved photons. Finally we show that this rephasing control enables the creation and storage of multiple spin-waves in different temporal modes, which can be selectively readout. This is an important step towards the implementation of a functional temporally multiplexed quantum memory for quantum repeaters.

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