Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Decoherence-protected storage of a photonic polarization qubit in a single atom MATTHIAS KOERBER, OLIVIER MORIN, STEFAN LANGENFELD, ANDREAS NEUZNER, STEPHAN RITTER, GERHARD REMPE, Max Planck Institute for Quantum Optics, Hans-Kopfermann-Str. 1, 85748 Garching, Germany — The ability to faithfully store quantum information is a key requirements for many quantum technologies. Here, we present a quantum memory based on a single ^{87}Rb atom in a high-finesse optical resonator, capable of storing and retrieving single-photon polarization qubits with an overall efficiency of 18% when probed with coherent laser pulses containing one photon on average. Initially the polarization of the photon is mapped onto the atom via a stimulated Raman adiabatic passage (STIRAP). Because the two atomic levels used to encode the qubit shift in opposite directions in the presence of a magnetic field the memory is susceptible to magnetic field fluctuations. This limits the coherence time to a few hundred microseconds. Using an optical Raman transfer we temporarily map the qubit to a protected subspace, thereby extending the coherence time to tens of milliseconds. It can be further increased to more than 100 milliseconds by means of a spin-echo technique. Our results are an important milestone towards the implementation of a quantum repeater allowing for long-distance quantum communication.

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Date submitted: 07 Feb 2017 Electronic form version 1.4