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Analysis of decoherence mechanisms in a single-atom quantum memory MATTHIAS KOERBER, STEFAN LANGENFELD, OLIVIER MORIN, ANDREAS NEUZNER, STEPHAN RITTER, GERHARD REMPE, Max Planck Institute for Quantum Optics, Hans-Kopfermann Str. 1, 85748 Garching — While photons are ideal for the transmission of quantum information, they require dedicated memories for long-term storage. The challenge for such a photonic quantum memory is the combination of an efficient light-matter interface with a low-decoherence encoding. To increase the time before the quantum information is lost, a thorough analysis of the relevant decoherence mechanisms is indispensable. Our optical quantum memory consists of a single rubidium atom trapped in a two dimensional optical lattice in a high-finesse Fabry-Perot-type optical resonator. The qubit is initially stored in a superposition of Zeeman states, making magnetic field fluctuations the dominant source of decoherence. The impact to this type of noise is greatly reduced by transferring the qubit into a subspace less susceptible to magnetic field fluctuations. In this configuration, the achievable coherence times are no longer limited by those fluctuations, but decoherence mechanisms induced by the trapping beams pose a new limit. We will discuss the origin and magnitude of the relevant effects and strategies for possible resolutions.

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