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Intrinsic Retrieval Efficiency for Quantum Memory: A Three Dimensional Theory of Light Interaction with an Atomic Ensemble TANVI GUJARATI, YUKAI WU, LUMING DUAN, The University of Michigan, Ann Arbor — Duan-Lukin-Cirac-Zoller (DLCZ) quantum repeater protocol, which was proposed to realize long distance quantum communication, requires usage of quantum memories. Atomic ensembles interacting with optical beams based on off-resonant Raman scattering serve as convenient on-demand quantum memories. Here, a complete free space, three-dimensional theory of the associated read and write process for this quantum memory is worked out with the aim of understanding intrinsic retrieval efficiency. We develop a formalism to calculate the transverse mode structure for the signal and the idler photons and use the formalism to study the intrinsic retrieval efficiency under various configurations. The effects of atomic density fluctuations and atomic motion are incorporated by numerically simulating this system for a range of realistic experimental parameters. We obtain results that describe the variation in the intrinsic retrieval efficiency as a function of the memory storage time for skewed beam configuration at a finite temperature, which provides valuable information for optimization of the retrieval efficiency in experiments.

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