Abstract Submitted
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Squeezing of Spin Waves in a Three-Dimensional Atomic Ensemble[1] LEIGH NORRIS, BEN BARAGIOLA, CQuIC University of New Mexico, ENRIQUE MONTANO, PASCAL MICHELSON, POUL JESSEN, CQuIC University of Arizona, IVAN DEUTSCH, CQuIC University of New Mexico — Spin squeezed states (SSS) have generated considerable interest for their potential applications in quantum metrology and quantum information processing. Many protocols for generating SSS in atomic gases rely on the Faraday interaction that creates entanglement between atoms through the coupling of the collective spin of the ensemble to polarization modes of an optical field. Most descriptions of this process rely on an idealized one-dimensional plane wave model of light-matter interactions that is not appropriate for describing a real system consisting of a cigar-shaped cold atomic cloud in dipole trap interacting with a probe laser beam. We provide a first principles three-dimensional model of squeezing via a quantum nondemolition measurement of the collective magnetization for an ensemble of atoms with hyperfine spin f. The model includes spin waves, diffraction, paraxial modes, and optical pumping, derived by a full master equation description. Including dissipative dynamics, we find the optimal ensemble geometry and input Gaussian beam parameters for generating spin squeezing. We also study the effect of enhancing the atom-light interface using internal hyperfine control of atoms with large spin f.

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