Abstract Submitted
for the DAMOP13 Meeting of
The American Physical Society

**Squeezing of Spin Waves in Atomic Ensembles** BEN BARAGIOLA, LEIGH NORRIS, CQuIC, University of New Mexico, ENRIQUE MONTANO, PASCAL MICHELSON, POUL JESSEN, CQuIC, University of Arizona, IVAN DEUTSCH, CQuIC, University of New Mexico — Squeezing the collective spin of an atomic ensemble via QND measurement is based on the lighhift interaction between a cloud of atoms and a laser probe. When the shot noise resolution of the laser probe is below the projection noise of the atoms, the resulting backaction can reduce the uncertainty for a collective atomic observable. Most current models of this process rely on idealized one-dimensional plane wave approximations of the underlying light-matter interaction, which are not appropriate for describing a real system consisting of an atomic cloud in dipole trap interacting with a paraxial probe laser. We derive from first principles a model for three-dimensional QND spin squeezing of an ensemble of alkali atoms. The model includes spin waves, diffraction, propagation phase, paraxial modes, and optical pumping, based on a full master equation description. Our model easily generalizes to atoms with hyperfine spin f >1/2, for which initial state preparation of the ensemble using internal hyperfine control can enhance the entangling power of the Faraday interaction [Norris et al., PRL 109, 173603 (2012)]. Including dissipative dynamics, we find optimal geometries to maximize spin squeezing for a variety of state preparations and spin sizes.

Ben Baragiola
Center for Quantum Information and Control (CQuIC),
University of New Mexico

Date submitted: 30 Jan 2013 Electronic form version 1.4