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Quantum control and squeezing of collective spin DANIEL HEMMER, ENRIQUE MONTANO, POUL JESSEN, University of Arizona, IVAN DEUTSCH, University of New Mexico — Quantum control of many body atomic spins is often pursued in the context of an atom-light quantum interface, where a quantized light field can be used to entangle distant atoms. We are currently exploring new ways to improve the coherence and the amount of atom-light entanglement by optimizing the spatial geometry of the atomic ensemble and light fields, and through the control and optimization of the internal atomic state. Our basic setup consists of a quantized probe beam passing through an atom cloud held in a dipole trap, first generating spin-probe entanglement through the Faraday interaction, and then using backaction from a measurement of the probe polarization to squeeze the collective atomic spin. Using an optimized geometry and a 2-color probe scheme to suppress tensor light shifts we achieve 7 dB of spin noise reduction and 5 dB of metrological squeezing at the optimal measurement time. It is possible to further increase atom-light coupling by "amplifying" the initial projection noise per atom through a suitable internal state preparation. In principle we can use internal-state control to map this entanglement back to a basis where it corresponds to improved squeezing.

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