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Quantum Eraser and Phase-Matching for Exponential Spin-Squeezing via Coherent Optical Feedback COLLIN TRAIL, IVAN DEUTSCH, University of New Mexico, POUL JESSEN, University of Arizona, LEIGH NORRIS, University of New Mexico — A scheme for squeezing collective atomic spin states via coherent optical feedback was proposed by M. Takeuchi et. al., Phys. Rev. Lett. 94, 023003, 2005. In the first pass, the Faraday effect acts to entangle the light with the atoms. In a coherent second pass, this information is imprinted back onto the atoms, creating an effective nonlinear interaction and entanglement between atoms. However, the light is still entangled to the atoms when it escapes, leading to substantial decoherence, and moreover, the interaction slowly rotates the system out of sync with the squeezing axis, both of which result in suboptimal squeezing. We show how the addition of a quantum eraser and phase matching can lead to radically improved exponential scaling. We analyze this system in the presence of realistic imperfections such as photon scattering, optical pumping, losses in transmission and reflection, finite detector efficiency, and nonprojective measurements, and show that spin squeezing near 10 dB should be possible.

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