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Improved spin squeezing of an atomic ensemble through internal state control DANIEL HEMMER, ENRIQUE MONTANO, University of Arizona, IVAN DEUTSCH, University of New Mexico, POUL JESSEN, University of Arizona — Squeezing of collective atomic spins is typically generated by quantum backaction from a QND measurement of the relevant spin component. In this scenario the degree of squeezing is determined by the measurement resolution relative to the quantum projection noise (QPN) of a spin coherent state (SCS). Greater squeezing can be achieved through optimization of the 3D geometry of probe and atom cloud, or by placing the atoms in an optical cavity. We explore here a complementary strategy that relies on quantum control of the large internal spin available in alkali atoms such as Cs. Using a combination of rf and uw magnetic fields, we coherently map the internal spins in our ensemble from the SCS ($|f=4, m=4>$) to a "cat" state which is an equal superposition of $|f=4, m=4>$and $|f=4, m=-4>$. This increases QPN by a factor of $2f=8$ relative to the SCS, and therefore the amount of backaction and spin-spin entanglement produced by our QND measurement. In a final step, squeezing generated in the cat state basis can be mapped back to the SCS basis, where it corresponds to increased squeezing of the physical spin. Our experiments suggest that up to 8dB of metrologically useful squeezing can be generated in this way, compared to ~3dB in an otherwise identical experiment starting from a SCS.

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