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Enhanced Spin Squeezing via Collective and Individual Atomic Control[1]

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Spin squeezed states of atomic ensembles are of interest for their application in quantum metrology and their connection with continuous variable quantum information processing. We study new mechanisms for strongly enhancing the degree of squeezing that can be achieved by employing the tools of quantum control. Through coherent quantum feedback, a laser pulse acts as a quantum bus with creates entanglement between atoms. By employing a quantum eraser and phase-matching, we can realize exponential growth of the squeezing for a time short compared to decoherence. Through initial quantum control on the individual atomic hyperfine spins, we can further enhance the squeezing parameter by increasing the resolvable quantum fluctuations. Final quantum control multiplicatively increases the squeezing on the individual atoms. We predict >10 dB squeezing, including decoherence and loss.

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