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Phonon-induced spin-spin interactions in diamond nanostructures: application to spin squeezing STEVEN BENNETT, NORMAN YAO, JOHANNES OTTERBACH, Harvard University, PETER ZOLLER, University of Innsbruck, PETER RABL, TU Vienna, MIKHAIL LUKIN, Harvard University —
We propose a novel mechanism for long-range spin-spin interactions in diamond nanostructures. The interactions are mediated by the coupling of electronic spins, associated with nitrogen vacancy centers, to the vibrational mode of a diamond mechanical nanoresonator. This results in phonon-mediated effective spin-spin interactions that can be used to generate squeezed states of a spin ensemble. We develop an approach combining spin echo techniques and coherent mechanical driving to suppress spin dephasing and relaxation, and find that substantial squeezing is possible under realistic experimental conditions. Our results have implications for spin-ensemble magnetometry, as well as phonon-mediated quantum information processing with spin qubits.

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