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Towards a Quantum Spin Transducer with Mechanical Resonators EMMA ROSENFELD, JAN GIESELER, ARTHUR SAFIRA, AARON KABCENELL, MARTIN SCHUETZ, Harvard Univ, JACK HARRIS, Yale Univ, MIKHAIL LUKIN, Harvard Univ — Interfacing spins and mechanical degrees of freedom allows for a variety of applications and experimental observations. For example, one can deterministically entangle pairs of spins through their coherent coupling with the dynamics of a resonator, even for large spin-spin distance separations and thermal resonator states. Additionally, the resonator could be cooled close to the quantum ground state by bringing a strongly coupled bath of spins into resonance, introducing the possibility of single phonon experiments and quantum state preparation of a mesoscopic object. Here, we describe technical progress towards strong, coherent coupling of Nitrogen Vacancy (NV) center spin qubits in diamond, to a mechanical resonator, via a magnetic field gradient. Using the NVs as sensors, we observe the AC motion of a silicon nitride, double-clamped, beam resonator. We also propose a scheme to use an ensemble of NV defects to cool the resonator close to its quantum ground state, using technically feasible parameters (Q of about one million, resonator frequency of 1 MHz, at a temperature of about 4 K).

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