

Abstract Submitted
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Spin-mediated optomechanics : A hybrid quantum system for quantum sensing and transduction HIL F H CHEUNG, YOGESH S PATIL, JIALUN LUO, MUKUND VENGALATTORE, Cornell University — We describe our realization of a hybrid quantum system consisting of a mesoscopic mechanical resonator optically interfaced to an ultracold spin ensemble. Combining ultrahigh quality factor resonators with the strong optical interactions and low decoherence rates of the ultracold gas, we show that the parameters of our system ensure the operation of this hybrid quantum system in the strong coupling regime. We demonstrate that the optical coupling between the resonator and the quantum spins realizes a powerful 'spin-photon-phonon' interface for applications to quantum sensing and quantum state preparation. Furthermore, we show that the ultracold spin ensemble can enhance and dynamically tune the optomechanical coupling to create effective nonlinear interactions between the resonator and the quantum spins.

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