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Reservoir Engineering of Two-mode Correlations in Mechanical Resonators[1] LAURA CHANG, YOGESH SHARAD PATIL, SRIVATSAN CHAKRAM, MUKUND VENGALATTORE, Cornell University — Nonlinear mechanical interactions in the quantum limit enable the manipulation and control of phonons in a manner akin to quantum optics in nonlinear media. We demonstrate, for the first time, strong quantum-compatible multimode nonlinearities in a low-loss mechanical resonator that is amenable to ground state optomechanical cooling, room temperature quantum control and quantum limited detection. These nonlinearities arise from substrate-mediated interactions between distinct modes of the resonator. We develop a model for this nonlinearity that accurately describes the experimental observations over three orders of magnitude in dynamic range, demonstrating the robustness and fidelity of the engineered nonlinear interactions. We use this nonlinearity to realize a mechanical nondegenerate parametric amplifier, and use it to demonstrate two-mode thermomechanical noise squeezing [1]. Our work opens new opportunities for nonlinear approaches to quantum metrology, transduction between optical and phononic fields, and the quantum manipulation of phononic degrees of freedom.

[1] Y. S. Patil *et al.* arXiv:1410.7109

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