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**Linear and nonlinear optomechanics in a cryogenic membrane-in-the-middle system** DONGHUN LEE, MITCHELL UNDERWOOD, DAVID MASON, ALEXEY SHKARIN, SCOTT HOCH, JACK HARRIS, Yale University Department of Physics — In cavity optomechanics, linear optomechanical interactions have been used to readout and cool the motion of mechanical oscillators, while nonlinear interactions have been proposed to study quantum non-demolition measurements of mechanical oscillators and the production of non-Gaussian mechanical states. A membrane-in-the-middle system can provide both types of interactions. In this talk, we will present recent results measured in both linear and nonlinear interaction regimes with a membrane-in-the-middle system operating at 500 mK. Linear coupling in this device enables us to cool the mechanical mode of a SiN membrane at 705 kHz to roughly one phonon. During the cooling measurement, we also observed strong asymmetry between the mechanical sidebands, in agreement with the phonon number inferred from other measurements. We also measured nonlinear optomechanics, in particular the quadratic interaction. With a simple theoretical model, we systematically characterized the classical dynamics arising from this quadratic optomechanical interaction. We expect that by combining quadratic coupling with resolved-sideband laser cooling, this device will be able to explore the aforementioned quantum phenomena. We gracefully acknowledge financial support from AFOSR (No. FA9550-90-1-0484).

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