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Two-mode back-action-evading measurements in cavity optomechanics MATTHEW WOOLLEY, UNSW Canberra, AASHISH CLERK, McGill University — The field of cavity optomechanics aims to achieve the quantum measurement and control of macroscopic mechanical resonators via coupled, cavity-enhanced electromagnetic fields. Here, we study a system composed of two mechanical oscillators independently coupled to a common electromagnetic cavity mode. By driving the cavity at frequencies both above and below the cavity resonance frequency, with a detuning equal to the average of the two mechanical oscillator frequencies, it is possible to couple a quadrature of the cavity mode to a joint quadrature of the two mechanical modes. This allows a back-action-evading measurement of the joint quadrature of the mechanical oscillators to be performed. If the output of the coupled cavity is continuously monitored, in the regime where the effective joint oscillator frequency greatly exceeds the average damping rate of the mechanical oscillators, it is possible to conditionally generate an all-mechanical, entangled two-mode squeezed state. This conditional entanglement may be verified from the measurement record, and converted to unconditional squeezing via the application of feedback. The same system may be employed for force sensing beyond the standard quantum limit. The experimental prospects for such a system are considered.

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