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Beating the standard quantum limit for force sensing with a coupled two-mode optomechanical system XUNNONG XU, JACOB M. TAYLOR, Joint Quantum Institute, University of Maryland/National Institute of Standards and Technology, College Park, Maryland 20742, USA — The scheme of optomechanical sensing of weak forces with a coupled two-mode cavity is presented. We consider the mirror-in-the-middle setup and use the two coupled cavity modes originated from normal mode splitting as pump and probe to realize force detection. We find that this two-mode model can be reduced to an effective single-mode model, if we drive the pump mode strongly and detect the signal from the weak probe mode. The optimal force detection sensitivity at zero frequency (DC) is calculated and we show that we would be able to beat the standard quantum limit by detuning the cavity far away from resonance. Furthermore, we find that the laser input power requirement will depend linearly on the cavity detuning, if the cavity mode coupling is close to cavity detuning, which is a great advantage over conventional single-mode force sensing scheme where the laser power has a cubic dependence on the cavity detuning.

Xunnong Xu
Joint Quantum Institute, University of Maryland/National Institute of Standards and Technology, College Park, Maryland 20742, USA

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