Tailoring the Dynamics of a Nanomechanical Resonator with (Anti-)squashed Light

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Optomechanics is the study of the interaction of light and mechanical objects. In conjunction with light, nanomechanical systems have set a benchmark in testing the limits of the quantum theory, very sensitive force and displacement measurements, while also showing great potentiality from the aspect of quantum information technology. Specifically, we have designed and implemented a phase–sensitive closed–loop control scheme to engineer the fluctuations of the pump field which drives an optomechanical system. The feedback loop can be engineered to modify the effect of radiation pressure on the mechanical resonator. We show that, at room temperature, operating in the counter-intuitive “anti-squashing” regime of positive feedback and increased field fluctuations, sideband cooling of a nanomechanical membrane within an optical cavity is improved by 7.5 dB with respect to the case without feedback. Conversely, close to the quantum regime of reduced thermal noise, the scheme would allow using squashed light to go well below the quantum backaction cooling limit, by a margin even larger than that achievable by injecting squeezed light.

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