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Quantum-limited amplification and parametric instability in the reversed dissipation regime of cavity optomechanics ALEXEY FEOFANOV, Ecole Polytech Fed de Lausanne, ANDREAS NUNNENKAMP, Department of Physics, University of Basel, VIVISHEK SUDHIR, ALEXANDRE ROULET, TOBIAS KIPPENBERG, Ecole Polytech Fed de Lausanne — Cavity optomechanical phenomena, such as cooling, amplification or optomechanically induced transparency, emerge due to a strong imbalance in the dissipation rates of the parametrically coupled electromagnetic and mechanical resonators. Here we explore for the first time the reversed dissipation regime where the mechanical energy relaxation rate exceeds the energy decay rate of the electromagnetic cavity. We demonstrate that this regime allows for mechanically-induced amplification (or cooling) of the electromagnetic mode. Gain, bandwidth, and added noise of this amplifier are derived and compared to amplification in the normal dissipation regime. In addition, we analyze the parametric instability, i.e. optomechanical Brillouin lasing, in this regime and contrast it to conventional optomechanical phonon lasing. Finally, we propose an experimental scheme that realizes the reversed dissipation regime using parametric coupling and optomechanical cooling with a second electromagnetic mode enabling quantum-limited amplification. Recent advances in high-Q superconducting microwave resonators make the reversed dissipation regime experimentally realizable.

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