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Correlated anomalous phase diffusion of sideband-excited phonons in an electromechanical resonator XIAOSHI DONG, FENGPEI SUN, JIE ZOU, Hong Kong University of Science and Technology, MARK DYKMAN, Michigan State University, HOBUN CHAN, Hong Kong University of Science and Technology — We study the phase fluctuations of self-sustained oscillations induced by dynamical backaction in a micromechanical resonator. The resonatorhas two vibrational modes with strongly differing frequencies and decay rates. The high-frequency mode acts as a phonon cavity mode, playing a similar role as photon modes in optomechanical systems. When sufficiently strong pumping is applied at the blue-detuned sideband of the cavity, the dynamical backaction leads to a parametric instability accompanied by self-sustained oscillations. We find that self-sustained oscillations are induced not only in the low frequency mechanical mode, but also in the high frequency cavity mode. The nonlinear nature of the backaction leads to hysteresis of this self-sustained oscillations. In each mode, the phase undergoes anomalous diffusion, where the mean square phase change in time follows a superlinear power law. The exponent of this power law is determined by the 1/f-type intrinsic frequency noise of the resonator. Remarkably, the phase fluctuation of the two modes show near perfect anti-correlation, our findings show that self-sustained oscillations induced by dynamical backaction offer new opportunities of phase manipulation and investigation of fundamental properties of resonating.

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