Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Phonon mechanisms of nonlinear decay and dephasing of mesoscopic vibrational systems JUAN ATALAYA, Michigan State University, THOMAS W. KENNY, Stanford University, MARK I. DYKMAN, Michigan State University — The frequencies and the decay rates of mesoscopic oscillators depend on vibration amplitudes. Nonlinear decay has been seen recently in various nano- and micro-mechanical systems. Here we consider a microscopic mechanism of nonlinear decay, the nonlinear coupling of the vibrational mode of interest, for example, a flexural mode, to other vibrations. Typically, the modes of interest have low eigenfrequencies ω_0. Their decay comes from the coupling to acoustic-phonon type vibrations with much higher frequency and density of states. Thus, nonlinear decay requires quartic anharmonic coupling or cubic anharmonicity in the higher order. We find the decay rate for the inverse lifetime of the involved phonons, which is determined by the internal nonlinearity and the boundary scattering, being either much larger or smaller than ω_0. The results extend the thermo-elastic, Akhiezer, and Landau-Rumer decay theory to nonlinear decay of mesoscopic modes and make specific predictions on the temperature and frequency dependence of the decay rate for different types of systems. We show that nonlinear decay is invariably accompanied by dephasing. We also show that in nano-electro-mechanical systems the decay rate can be electrostatically controlled.

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Date submitted: 13 Nov 2014 Electronic form version 1.4