

## Phonon Mediated Dissipation in Micro- and Nano-Mechanical Systems.\*

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We have begun a theoretical study of phonon-mediated dissipation mechanisms in small-scale mechanical resonators, in light of recent efforts to design high- $Q$  micrometer- and nanometer-scale electro-mechanical systems (MEMS and NEMS). We investigate the high-temperature large-scale regime where thermal phonons can be considered as forming a temperature field and dissipation occurs through the process of thermoelastic damping [1], as well as other regimes where thermal phonons are considered as a viscous gas or treated as individual particles and dissipation occurs via such mechanisms as the Akhiezer and the Landau-Rumer effects [2]. We also consider the loss of energy in the resonator due to radiation of sound waves or transmission of phonons through the supports of the resonator [3]. In all cases we focus on the effects of system size on the dissipation and on its temperature dependence, in order to evaluate their relevance for MEMS and NEMS and determine whether they impose any fundamental limits on the value of  $Q$ .

[1] Ron Lifshitz and M. L. Roukes, Phys. Rev. B **61**, 5600 (2000).

[2] Ron Lifshitz and Yair Goldfarb, unpublished.

[3] M. C. Cross and Ron Lifshitz, submitted to Phys. Rev. B (cond-mat/0011501).

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