Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Strong nonlinearity of mesoscopic vibrational modes induced by electron-phonon coupling KIRILL MOSKOVTSEV, M. I. DYKMAN, Michigan State University — We show that the electron-phonon coupling can lead to a strong nonlinearity of vibrational modes in semiconductor nano- and micro-resonators. For typical mode frequencies, the electron distribution adiabatically follows lattice strain. Therefore strain leads to redistribution of the electron density over the valleys of the conduction band. It also leads to the onset of a spatial charge. The parameter that controls the distribution is the ratio of the deformation potential to the electron chemical potential or temperature. It is $\sim 10^2$ for many semiconductors of interest even when they are heavily doped. Therefore the change of the electron distribution is strongly nonlinear in the strain. As a consequence, the stress induced by the electron-phonon coupling is also strongly nonlinear. We have found the vibration nonlinearity parameters for n-doped Si and calculated the amplitude dependence of the frequencies of several low-lying Si resonator modes with account taken of their spatial structure. The results are compared with the recent experimental data that shows strong effect of doping on the vibration nonlinearity.

Kirill Moskovtsev
Michigan State University

Date submitted: 05 Nov 2015

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