B. Perrin, R. Legrand, A. Huynh

andrea.cepellotti@epfl.ch

Institut des NanoSciences de Paris, UMR 7588 CNRS/Université Pierre & Marie Curie, 4 place Jussieu 75005 Paris, France

Breakdown of Herring processes for subterahertz longitudinal acoustic phonons

Conyers Herring [1] suggested that thermal transverse phonons with wave vectors close to high symmetry axes could have a drastic effect on the anharmonic scattering of low-energy longitudinal acoustic phonons. Close to these axes, there is a splitting of the transverse modes and large wave vector phonons can efficiently interact with low frequency longitudinal phonons. Neglecting phonon dispersion and owing to group theory considerations, he could predict power law behaviour of the inverse phonon lifetime in terms of frequency and temperature depending on crystal classes. Later on, Simons [2] could give an expression of the prefactor for cubic crystals. We will show that the frequency and temperature ranges where these laws are valid are very limited and that subterahertz phonons are far beyond these limits. Furthermore the coupling of the longitudinal phonon with highenergy transverse phonons gives rise to a breakdown of these interactions processes when the frequency of the acoustic wave under consideration goes beyond a limit related to the frequency cutoff of the transverse phonons. We check this general statement by detailed calculations in Gallium Arsenide and we will show that this breakdown could explain the unexpected plateau in the frequency dependence of the absorption length of subterahertz coherent acoustic waves [3-4] which has been recently observed, in this material, between 0.6 and 1 THz.

References:

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