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Under the harmonic approximation (or equivalently, as the temperature approaches 0K), the phonons are non-interacting and have no transient response

Where is related to the initial phonon mode population (amplitude). Ignoring negative frequencies

Where . This expression for the spectral energy density will be a superposition of delta peaks at the phonon frequencies . At finite temperature, these delta peaks will broaden and are undetermined up to the factor . The orthonormality of the eigenvector, , does not allow the expression to be reduced any further. At finite temperature, the phonon spectral energy in eq. does not cannot calculate the spectral linewidth, and thus cannot estimate the phonon lifetime . The expression for the

autocorr

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