Thermal Conductivity of Graphene and Graphite: Collective Excitations and Mean Free Paths

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I will present a complete characterization of the thermal conductivity of graphite, graphene and related compounds, solving exactly [1] the Boltzmann transport equation (BTE) for phonons in the framework of density functional perturbation theory. For graphite, the results are found to be in excellent agreement with experiments and 1 order of magnitude larger than what found by solving the BTE in the standard relaxation time approximation. For graphene, a meaningful value of intrinsic thermal conductivity at room temperature can be obtained only for sample sizes of the order of 1 mm, something not considered previously [2]. This unusual requirement is because collective phonon excitations, and not single phonons, are the main heat carriers in these materials [2,3]; these excitations are characterized by mean free paths of the order of hundreds of micrometers. As a result i) the thermal conductivity is high but does not diverge in infinitely large systems and ii) the Fourier's law becomes questionable in typical sample size.

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