Inelastic Light Scattering Measurements of Phonon and Magnon Transport in Materials with Unusual Thermal Properties

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We have investigated the use of Brillouin light scattering (BLS) and Raman scattering to probe the transport of phonons and magnons in materials with unusual thermal properties. A modulated heating approach has allowed us to improve the temperature sensitivity of the inelastic light scattering peaks to be better than 1 K. We find that the low-frequency BLS and high-frequency Raman peaks contain rich insights into not only the thermal conductivity but also the fundamental coupling lengths scales between different phonon and magnon populations. In particular, within a tightly focused laser spot on the sample, the acoustic phonons are not thermalized with optical phonons in BAs with potentially ultrahigh thermal conductivity, the flexural phonon polarization in suspended graphene is very underpopulated compared to other polarizations, and magnons and phonons are driven out of local equilibrium in yttrium iron garnet (YIG). The observed local non-equilibrium phenomena are used to verify long energy relaxation lengths between acoustic and optical phonons in BAs and between flexural modes and other excitations in graphene, and to extract a long magnon spin relaxation length in YIG.