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Unraveling the interlayer-related phonon self-energy renormalization in bilayer graphene PAULO ARAUJO, DANIELA MAFRA, MIT, KENTARO SATO, RICHIIRO SAITO, Tohoku University, JING KONG, MILDRED DRESSELHAUS, MIT — In this work, we present a step towards further understanding of the bilayer graphene (2LG) interlayer (IL)-related phonon combination modes and overtones as well as their phonon self-energy renormalizations by using both gate-modulated and laser-energy dependent inelastic scattering spectroscopy. We show that although the IL interactions are weak, their respective phonon renormalization response is significant. Particularly special, the IL interactions are mediated by Van der Waals forces and are fundamental for understanding low-energy phenomena such as transport and infrared optics. Our approach opens up a new route to understanding fundamental properties of IL interactions which can be extended to any graphene-like material, such as MoS_2, WSe_2, oxides and hydroxides. Furthermore, we report a previously elusive crossing between IL-related phonon combination modes in 2LG, which might have important technological applications.

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