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Raman scattering in bilayer graphene: probing phonons, electrons and electron-phonon interactions

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The application of resonance Raman spectroscopy to study the electronic, vibrational and electron-phonon interaction properties in bilayer graphene will be presented. From the dependence of the second-order Raman bands on the laser excitation energy, we obtain experimental values for the Slonczewski-Weiss-McClure band parameters of bilayer graphene. We will discuss in detail the effect of each one of the tight band parameters on the electronic structure, showing that bilayer graphene has a larger electron-hole asymmetry compared to graphite. We will also present experimental results for the phonon dispersion relations near the K point, showing a strong Kohn anomaly for one of the phonon branches. In a gating experiment, the change in Fermi level of bilayer graphene gives rise to a symmetry breaking, allowing the observation of both the symmetric (S) and anti-symmetric (AS) phonon modes. The dependence of the energy and damping of these phonons modes on the Fermi level energy is explained in terms of distinct couplings of the S and AS phonons with intra- and inter-band electron-hole transitions.