Resonance Raman Spectroscopy with infrared lasers: Novel Insights into 2D Materials

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Resonance Raman spectroscopy has been instrumental in advancing our understanding of semiconductor physics [1] and has since become a key tool for the study of two-dimensional materials [2]. By examining the intensity, linewidth, and excitation-energy dispersion of Raman peaks, valuable information on structural properties, vibrational modes, and electronic structure can be obtained [3]. Although infrared excitation poses challenges due to the reduced Raman cross-section of non-resonant peaks, resonant Raman spectroscopy in this regime enables the selective probing of low-energy carrier scattering processes, such as those involving electrons in narrow-gap semiconductors and Dirac materials including graphene [4, 5] and Weyl semimetals.

We investigate scattering processes in $MoTe_2$ crystals near its indirect bandgap. To this aim we have employed a custom-built Raman microscopy setup working with excitation at 0.8 eV, a wavelength seldom used for Raman spectroscopy. Supported by *ab initio* calculations of second-order Raman features, we identify the phonon branches involved in the scattering processes and show that second-order Raman modes are resonantly enhanced when the laser energy approaches the bandgap, while first-order modes remain non-resonant. Together with previous results obtained in graphene [4,5], these results suggest that resonance Raman spectroscopy with excitation energies in the infrared can provide deeper insight into low-energy carrier scattering channels in infrared-gap semiconductors, as well as in semimetals and topological insulators.

References

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