Optical properties of graphene mono- and bilayers

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Graphene, a genuine two-dimensional material formed by carbon atoms, has remarkable electronic and optical properties. It is a transparent semimetal and colorless because its optical properties are independent of the frequency of the transmitted light. This is very different from the conventional Drude-type behavior of other materials.

The properties of mono- and bilayer graphene are intimately related to the existence of a spinor wave function and a nodal structure in the quasiparticle spectrum. The spinor is associated with a number of interesting features such as Klein scattering, a minimal conductivity and a constant optical conductivity. The optical properties are strongly affected by a change of the spectral properties though. For instance, opening of a gap in the electronic spectrum creates a frequency-dependent transmittance. This enables us to design the optical properties of graphene. Here we discuss the optical properties of mono- and bilayer graphene with gapless and gapped spectra. Our study includes an analysis of the effect of disorder, a periodic potential and electron-phonon interaction.

Figure 1: Optical conductivity (left) and optical Hall conductivity (right) in gapped graphene. left panel: the optical conductivity of graphene with a fixed gap decreases with increasing Fermi energy. right panel: The optical Hall conductivity has a characteristic singularity at the gap $2m$ and is thermally very robust.