Electronic Raman scattering in graphite thin films with a twisted interface

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The discovery of superconductivity and correlated states in twisted bilayer graphene [1] and other related systems with small-angle twists [2] has sparked an enormous interest in graphene materials with a twisted interface. These phenomena are linked to the existence of a long-wavelength moire potential, which induces important changes in the band structure, such as gaps, flattening of bands or the emergence of saddle points, reflected in the density of states as sharp peaks, or van Hove singularities (vHSs).
On the other hand, Raman spectroscopy provides a wealth of information about graphene materials, and it has been used to estimate defect concentration, determine number of layers or study the presence of strain in graphene samples. In these cases, the difference in energy between the incoming and outgoing light is spent in exciting the crystal lattice. However, there is another type of Raman event, in which light-matter interaction results directly and exclusively in the creation of an electron-hole pair [3]. Owing to its purely electronic nature, this type of electronic Raman scattering (ERS) provides direct information about the band structure of graphene materials [4,5].
Here, we use the continuum model to describe the band structure of graphite thin films with the top layer rotated by a small angle and investigate theoretically the ERS contribution in these systems. We found that ERS events give rise to features that are linked to band anti-crossing and the formation of a mini-band dispersion. These features are in close connection to the density of states and can be used to study the band width and the position of vHSs, which allows us to determine the misalignment angle.

References

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Figures

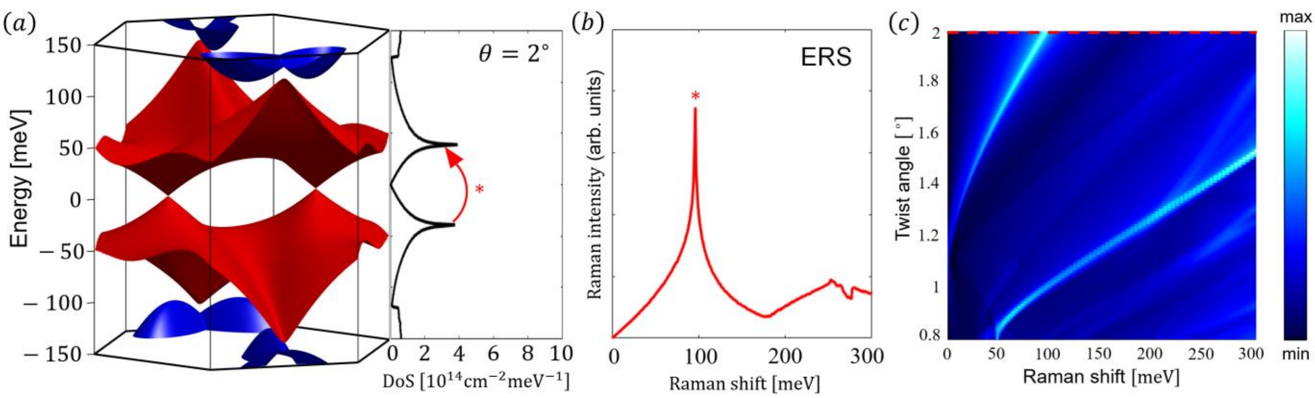

Figure 1: (a) Band structure and electronic density of states of twisted bilayer graphene, with a twist angle of θ = 2°. (b) Simulated electronic Raman scattering of twisted bilayer graphene. (c) ERS intensity maps for a continuous range of small twist angle.