Cascades: the unconventional normal state of twisted bilayer graphene

Leni Bascones

Among the variety of correlated states found in twisted bilayer graphene (TBG), the cascades happen in a much larger energy, twist angle and temperature range than other effects, pointing to a hierarchy of phenomena [1]. The cascades manifest in different measurements, including the strong reorganization of the density of states, up to tenths of meV, and the oscillations of the remote bands energies in Scanning Tunneling Microscope experiments, the sawtooth peaks in the inverse compressibility and anomalies in the transport properties. Previous proposals to explain the cascades involve in one way or another a symmetry breaking process. Using Dynamical Mean Field Theory (DMFT) calculations we have shown [2] that the cascades are a property of the normal state, associated to the formation of local moments and heavy quasiparticles, and not a symmetry breaking process. The phenomena reproduced by our calculations include the cascade flow of spectral weight, the oscillations of the remote band energies, the asymmetric jumps of the inverse compressibility and signatures in the transport and has consequences in other experiments and in the stability of the symmetry breaking phases. Due to the fragile topology of TBG, we predict a strong momentum differentiation in the incoherent spectral weight. In the talk I will also show how optical measurements may help distinguishing the phenomenology of the cascades discussed here from proposals involving symmetry breaking.

[1] Wong et al, Nature 582, 198 (2020), Zondiner et al, Nature 582, 203 (2020). Polski et al, arXiv:2205.05225

[2] A. Datta, M.J. Calderón, A. Camjayi, and E. Bascones, Nature Communications 14, 5036 (2023)