Optical probes for the Unconventional Normal State of Twisted Bilayer Graphene

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Twisted bilayer graphene (TBG) shows a great variety of correlated states such as superconducting, insulating, magnetic or intervalley coherent phases. We have recently shown [1] that the observed cascades in the spectroscopic properties [2] and in the compressibility [3] in a large range of temperatures are associated to the formation of local moments and heavy quasiparticles and not to symmetry broken orders, which occur at lower temperatures. Our results, which account for the dynamical correlations, are based on Dynamical Mean Field Theory plus Hartree calculations. We reproduce the cascade flow of spectral weight, the oscillations of the remote band energies, the asymmetric jumps of the inverse compressibility, the presence of resistive states at integer fillings, and predict a strong momentum differentiation in the incoherent spectral weight associated to the fragile topology of TBG [1].

The strong correlations behind this complex phenomenology may also impact other measurements that can be used to characterize the normal state from which the low temperature orders emerge. In particular, optical probes, which connect states with the same momentum spin and valley, may reveal complementary information about the nature of the electronic states involved at different frequencies. In this talk I will introduce the properties of the peculiar normal state of TBG and will show how the cascades manifest in the optical spectrum.

References

[1] A. Datta, A. Camjayi, M.J. Calderón and E. Bascones, Nature Comm. 14, 5036 (2023)
[2] D. Wong et al, Nature 582, 198 (2020); Y. Choi et al, Nature 589, 536 (2021).
[3] U. Zondiner et al, Nature 582, 203 (2020).

Figures

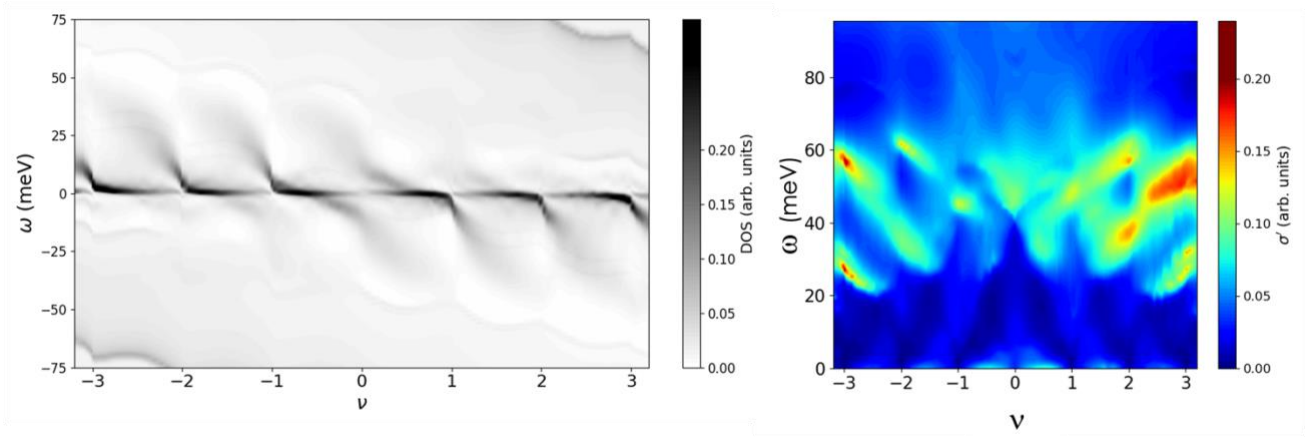

Figure 1: (Left) Gradient map of the density of states as a function of frequency and filling of the flat bands showing the cascades of spectral weight with resets at integers. (Right) Corresponding optical conductivity. The cascades show up in the intensity and frequency of the transitions.