Flat bands in twisted materials

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Abstract:

Graphene moiré superlattices display electronic flat bands. At integer fillings of these flat bands, insulating states due to strong electron–electron interactions are generally observed. However, the presence of other correlation-driven phases in twisted graphitic systems at non-integer fillings is unclear. We report the existence of three-fold rotational (C3) symmetry breaking in twisted double bilayer graphene. Using spectroscopic imaging over large and uniform areas to characterize the direction and degree of C3 symmetry breaking, we find it to be prominent only at energies corresponding to the flat bands and nearly absent in the remote bands. We demonstrate that the magnitude of the rotational symmetry breaking does not depend on the degree of the heterostrain or the displacement field, being instead a manifestation of an interaction-driven electronic nematic phase. We show that the nematic phase is a primary order that arises from the normal metal state over a wide range of doping away from charge neutrality. Our modelling suggests that the nematic instability is not associated with the local scale of the graphene lattice, but is an emergent phenomenon at the scale of the moiré lattice. This suggest that nematic instabilities are common in moiré systems and may be universal elements of their phase diagrams.

Biography:

Carmen Rubio-Verdú is a Group Leader at ICFO (Barcelona). Her research focuses on the correlated phases that emerge in two-dimensional materials. She is currently working in the field of moiré quantum matter. She is an expert in Scanning Tunneling Microscopy and Spectroscopy and she investigates the correlated phases that emerge in twisted graphene structures, such as superconductivity.