Invited speaker

Broken symmetries in nanostructures based on quantum materials

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Two-dimensional (2D) crystals are particularly well suited for studying the interplay between symmetry and nonlinearity due to their high level of ordering. Remarkably, electronic states in these systems display quantum effects that give rise to novel and intriguing nonlinear effects simplifying further symmetry analysis.

In addition to the spin degeneracy, charge carriers in graphene have an additional degree of freedom called valley pseudospin. At the corners of the Brillouin zone (K and K' points), the electronic states on the two sublattices in pristine graphene are decoupled and have the same energy, giving rise to the so-called valley degeneracy. This degeneracy can be lifted, as for example, by stacking graphene with hexagonal boron nitride (hBN) and twisting properly the layers of the heterostructure leading to the appearance of an angle-dependent Moiré pattern. Such effect can break several symmetries and enhances collective interactions, providing the appearance of a plethora of exotic states of matter [1-9].

We have fabricated several hBN/graphene/hBN heterostructures where the relative rotation angle between the flakes has been controlled and released on a graphite back gate placed over standard SiO2/Si substrates. We will present detailed local and non-local magneto-transport measurements at low-temperatures demonstrating the occurrence of exotic quantum edge states due to the angle-dependent Moiré pattern [10]. We will also present the capabilities of such heterostructures for THz detection [11]. Finally we will present preliminary measurements as evidence of unconventional photoresponse in other 2D heterostructures with broken symmetries.

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