Coupled Fermi seas: remotely inducing a moiré potential on a 2D semiconductor

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Artificially inducing lattices in electronic and photonic systems is a powerful tool to engineer material properties with applications ranging from crystal cavities to superconductivity. Here, we present a new way of inducing a lattice in the electronic states of a 2D semiconductor. Transition metal dichalcogenides (TMDs) are a class of 2D semiconductors that can be exfoliated down to the monolayer limit, yielding strong interactions between electrons whose motion is restricted to 2D. Because of the layered nature of exfoliatable 2D materials, TMDs can be combined with insulators (hBN) and conductors (graphene) to form complex nanostructures, exploring the ultimate limit of electronics by precise control over atomic thickness.

We fabricate a heterostructure consisting of a 2D semiconductor in close proximity to an angle-aligned combination of hBN and graphene. We show that the superlattice potential from hBN-graphene is imprinted onto the TMD via Coulomb interaction, leading to miniband formation and characteristic spectroscopic signatures of step-like charging upon electrostatic doping. This is a system of two different Fermi seas which are coupled via Coulomb interaction. This uncharted territory enables explorations in many directions.