Moire superlattices in Dirac crystals

When atomically thin two-dimensional materials are layered, they often form incommensurable noncrystalline structures that exhibit long-period moire patterns when examined by scanning probes. The difficulty of describing the electronic structure of noncrystalline lattices resides in the impossibility of using conventional Bloch’s theorem assumed for periodic crystals. In this talk I will explain how this difficulty can be circumvented to obtain the electronic structure of incommensurable crystals in the limit of large moire supercells by representing the band structure in the moire Brillouin zone that uses the Bloch's theorem on the moire superlattices. We will show that calculations performed on locally commensurate crystalline structures can be used to derive effective Hamiltonians that are able to efficiently describe the influence of the moire pattern superlattices on electronic properties. We applied our approach to obtain the Hamiltonian of semimetal and gapped layered Dirac crystal combinations, among which we focus on the properties of hexagonal boron nitride (G/BN) as a representative system consisting of moiré superlattice pattern of pseudospin fields with domains of different topology. We show that the moiré strain fields can play an important role in reconfiguring the mechanical and electronic properties of G/BN in the limit of long moiré pattern periods and leads to the emergence of a global band gap.