Low dimensional moire crystals of carbon atoms

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Twisted bilayer graphene (TBG) is a prototypical example showing interesting interplay between the long range lattice structures and their effects on electronic properties. Using effective model Hamiltonians for TBGs and their variations, we investigate atypical electronic structures of a few carbon nanostructures without any definite atomic periodicities. The first examples are the band structure and the optical absorption spectrum of TBG with changing interlayer bias and Fermi energy simultaneously. The second example is the electornic structures of incommensurate double-walled carbon nanotubes. For both examples, we highlight the usefulness of concept of moire crystals and moire periodicity to understand 'quasi' energy bands of incommensurate lattice systems.

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