MAR12-2011-020194

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Moire Bloch Bands in Twisted Bilayer Graphene

ALLAN MACDONALD, University of Texas at Austin

A moiré superlattice pattern is formed when two copies of a periodic lattice are overlaid with a relative twist. I will address the electronic structure of a twisted two-layer graphene system by generalizing the Dirac equation continuum models that are used to describe single-layer graphene and untwisted bilayers. In the Dirac model electrons in graphene have a pseudospin degree-of-freedom corresponding to the honeycomb sublattice dependence of wavefunction amplitudes. The continuum model of twisted bilayers can be derived systematically [1] by assuming that interlayer tunneling amplitudes are non-nocal with a range that is large compared to the honeycomb lattice constant, and leads to an appealing picture in which the tunneling operator has a position-dependent pseudospin dependence that simply reflects the local registry between the two honeycombs. The continuum model twisted bilayer Hamiltonian is therefore periodic, with the periodicity of the moiré pattern, and insensitive to the incommensurability of the microscopic Hamiltonian. I will discuss the properties of the Bloch bands of this periodic Hamiltonian, which become highly non-trivial at small twist angles. In particular the Dirac velocity crosses zero several times as the twist angle is reduced and vanishes at a discrete set of magic angles. I will also briefly discuss the Hofstadter butterfly spectral patterns [2] created by incommensurability between the moiré pattern and magnetic lengths when a twisted bilayer is placed in an external magnetic field, and the electronic structure [3] of a single graphene layer that is twisted with respect to a boron nitride substrate.

[1] R. Bistritzer and A.H. MacDonald, PNAS **108**, 12233 (2011).
[2] R. Bistritzer and A.H. MacDonald, Phys. Rev. B **84**, 035440 (2011).
[3] A. Raoux and A.H. MacDonald, arXiv:1112.nnnn.