Electronic properties in moiré superlattice

in rotationally stacked atomic layers

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We report recent theoretical studies on the electronic properties of rotationally stacked atomic layer systems, including graphene-graphene bilayer, and graphene-hBN (hexagonal boron nitride) composite bilayer. The misoriented atomic structure gives rise to a moiré superlattice structure with a long spatial period, and it strongly modifies the band structure in the low-energy region. We develop an effective continuum model based the tight-binding Hamiltonian, which correctly describes the electronic structure of moiré superlattice [1]. In a magnetic field, the coexistence of the moiré pattern and the Landau quantization causes the fractal energy spectrum so-called Hofstadter's butterfly. We calculate the spectral evolution as a function of magnetic field, and demonstrate that the quantized Hall conductivity changes in a complicated manner in changing Fermi energy and the magnetic field amplitude [2]. We also calculate the optical absorption in the fractal band regime, and find that the absorption spectrum and the optical selection rule exhibit recursive self-similar structure as well, reflecting the fractal nature of the energy spectrum.[3]

[1] P. Moon and M. Koshino, Phys. Rev. B 87, 205404 (2013)

[2] P. Moon and M. Koshino, Phys. Rev. B 85, 195458 (2012).

[3] P. Moon and M. Koshino, Phys. Rev. B **88**, 241412(R) (2013).