MAR15-2014-000411
Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Graphene superlattices in van der Waals heterostructures

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The technological development of graphene has generated new high-quality systems offer access to the earlier inaccessible extremes of quantum physics. When graphene is placed on an atomically flat substrate with hexagonal lattice with a close lattice constant, such as boron nitride (hBN), and their crystalline axes are aligned, a long-wavelength perfectly periodic moiré pattern forms for electrons in graphene. Various regimes of possible moiré minibands at zero magnetic field [Phys. Rev. B 87, 245408 (2013); Phys. Rev. B 88, 205418; Phys. Rev. B 88, 155415 (2013); New J. Phys, 15, 123009 (2013)] and strong magnetic field [Nature 497, 594 (2013), Nature Physics 10, 525 (2014); Phys Rev B 89, 075401 (2014)] will be discussed. Experimentally available magnetic fields are enough to provide flux φ through the moiré superlattice cell comparable to the magnetic flux quantum φ_0 and reach the regime of fractal Hofstadter spectra. As a result, a single device can offer a multiplicity of two-dimensional electron systems, realised at rational flux values $\varphi = \varphi_0$, $\varphi_0/2$, $2\varphi_0/3$, etc., each with its own intricate topological properties, including quantum Hall effect physics related to the effective Landau levels emerging from these magnetic minibands at the nearby range of magnetic fields.