# Minibands for Dirac electrons in moiré superlattices

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When graphene lattice is aligned with the hBN lattice, a long-wavelength periodic moiré pattern forms due to a weak incommensurability of the two lattice structures, leading to a long-range superlattice affecting properties of electrons in graphene, including formation of miniband spectra for Dirac electrons [1-3] and reappearance of magnetic minibands [4,5] at the rational values of magnetic field flux through the supercell area (in units of $\varphi_0=h/e$), also known as Hofstadter butterfly [6].

Here, we show that the miniband in long-period moiré superlattices (mSL) in graphene/hBN heterostructures affect their transport measurements up to the room temperature. In relation to the low-field behavior, we find that the overall temperature dependence of resistivity displays the opening in a new scattering process: the umklapp electron-electron scattering in which two electrons coherently transfer the mSL Bragg momentum to the crystal [7]. The formation magnetic minbands and their manifestation in magneto-oscillation of the diagonal conductivity tensor persist up to the room temperature [8], too, with full hierarchy of features that are attributed to the rational flux values $\varphi=(p/q)\varphi_0$, with p=1, 2 and up to 3 (and $7<q<1$), now, observed [9] at the intermediate range of $50K<T<200K$.

## References

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