Moiré effects in graphene-hBN heterostructures

Yongping Du[1,2,3]
Antti-Pekka Jauho[1,2]
[1]*Center for Nanostructured Graphene, Technical University of Denmark, DK 2800 Lyngby, Denmark*
[2]*DTU Physics, Technical University of Denmark, DK-2800 Lyngby, Denmark*
[3]*Department of Applied Physics and Institution of Energy and Microstructure, Nanjing University of Science and Technology, Nanjing 210094, China*
Email: antti@dtu.dk

Abstract

Recent findings, like unconventional superconductivity and correlated insulator behavior, in twisted bilayer graphene make twistronics a rising star in two-dimensional material science [1, 2]. The tunable gap, which is the driving force of the exciting behavior of bilayers, can also be seen in antidot lattices defined in graphene (GAL) [3, 4]. However, the dependence of the properties of the antidot lattice on the twist angle between the encapsulating hBN layers and the nanostructured graphene has not yet been the subject of a systematical experimental study. It has already been shown that the moiré interaction between graphene and hBN can induce a satellite peak in magnetoconductivity of GALs [4]. Here, we perform a theoretical investigation of GALs in twisted heterostructures consisting of graphene and hexagonal boron nitride (G/hBN) [5]. By using a tight-binding model and first-principles calculations, we systematically investigate how the twist angle and antidot lattice affect the electronic structure and the electronic transport phenomena in G/hBN. Our magnetotransport simulations reproduce the experimental measurements very well (Figure 1 a). More interestingly, our numerical results show that this moiré effect with satellite peak is robust with respect to disorder (Figure 1 b) and that its salient features should survive even a nonideal fabrication process. In addition, the antidot lattice will tune the transport properties of G/hBN. Further calculations show that the competition between the period of the antidot lattice and Moiré wave length will determine the emergence of the satellite peak in magnetoconductance of G/hBN (Figures 1 c and d). Theoretical studies as the ones described here are essential in the design of twistronic devices.

References

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Figures

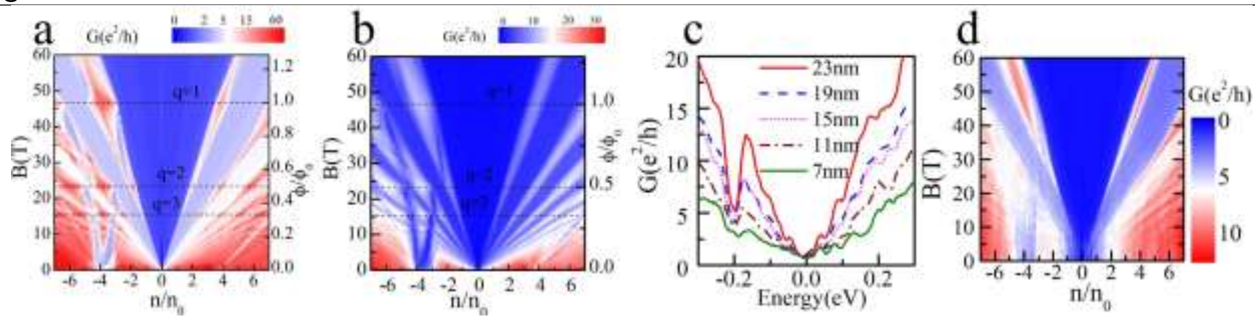

Figure 1: Magnetotransport properties of G/hBN with twist angle θ = 1.0047°. **a.** Longitudinal magnetoconductance as a function of magnetic field and electron density. **b.** Magneto-conductance for a disordered sample. **c.** Conductance for antidot lattices with varying neck lengths d_N. For neck length d_N smaller than the moiré length λ(10.1nm), the secondary feature vanishes. **d.** Landau fan diagram with antidot lattice (d_N=15nm). Further details are given in [5].