Mapping commensurability orbits in graphene antidot lattices

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Recent advances in the fabrication of high quality nanostructured graphene samples have enabled the investigation of mesoscopic phenomena requiring long range ballistic behaviour. An excellent example of this is the demonstration of multiple pronounced commensurability peaks in the magnetotransport response of graphene antidot lattices encapsulated in hexagonal Boron Nitride[1].

Such peaks are predicted to occur when the cyclotron radius is tuned to match important length scales in the system, so that electrons are pinned in orbits around single or groups of antidots or skip regularly between neighbouring antidots.

In this work[2], we demonstrate that the experimental measurements are captured with remarkable accuracy by a fully quantum-mechanical multiprobe transport simulation. Furthermore, by mapping local current behaviour, we can associate specific commensurability peaks with different electron trajectory types and explore their dependence on the antidot geometry. Finally, by tuning the Fermi wavelength we can move between the semiclassical and quantum regimes and demonstrate the suppression of commensurability effects.

References

[1] A. Sandner et al, Nano Letters 15 (2015) 8402
[2] S.R. Power et al, *in preparation* (2017)

Figures

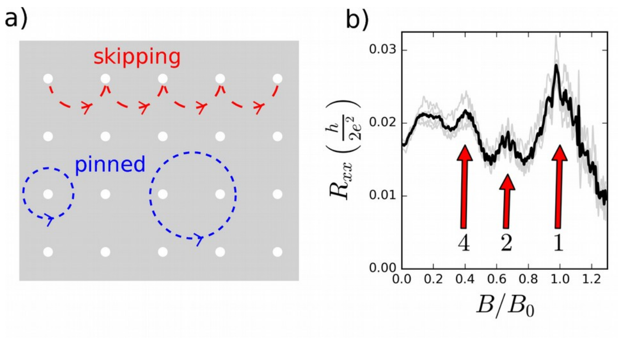

Figure 1: a) Schematic of pinned and skipping orbits in an antidot lattice. b) Simulated commensurability peaks in the longitudinal resistance of a graphene antidot lattice Hall bar device. Red arrows highlight expected positions of pinned orbits around 1,2 or 4 antidots.

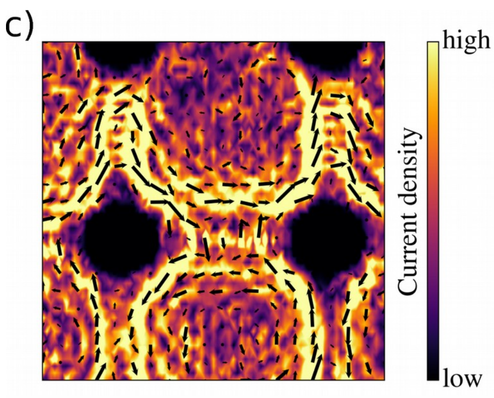

Figure 2: Local current behaviour in the device at the principal commensurability peak ('1') - skipping-type orbits are noted between neighbouring antidots