Transport through a network of topological states in twisted bilayer graphene

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We show experimental transport data [1] on a particular interesting carbon system: Two minimally twisted layers of graphene [2,3]. Such a system exhibits a moiré superlattice with alternating AB and BA regions. For bernal-stacked bilayer graphene, first evidence of the Quantum valley hall effect along AB/BA stacking faults [4] has been reported recently. Similarly, a network of topological channels is predicted to occur in twisted bilayer graphene under a large interlayer bias [5]. We probe such a network with an electronic Fabry-Pérot interferometer [6,7]. The observed Fabry-Pérot and Aharanov-Bohm oscillations are robust in magnetic fields ranging from 0 to 8T, i.e. the trajectories in the bulk of the system cannot be bent by the Lorentz force. By extracting the enclosed length and area we find that the major contribution originates from trajectories encircling one row of AB/BA regions. The robustness in magnetic field and the linear spacing in density testifies to the fact that charge carriers flow in one-dimensional, topologically protected channels.

References

[1] P. Rickhaus, et.al. arXiv:1802.07317 (2018)
[2] Y. Cao et. al. arXiv:1802.00553v1 (2018).
[3] K. Kim et. al. Proc. Natl. Acad. Sci., 114(13):3364–3369, 2017.
[4] L. Ju, et.al. Nature, 520(7549):650–655, 2015.
[5] P. San-Jose and Elsa Prada. Phys. Rev. B, 88, 2013.
[6] P. Rickhaus et. al. Nat. Commun. **4**, 1 (2013).
[7] P. Rickhaus et. al., Nat. Commun. **6**, 6470 (2015)

Figures

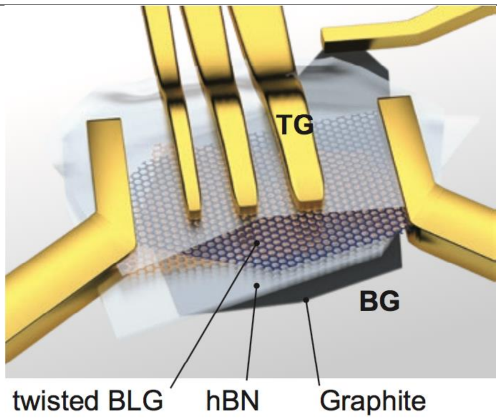

Figure 1: *Twisted bilayer graphene is encapsulated in hBN. Current is measured by two contacts and the density and displacement field can be adjusted by a top-gate and a back-gate.*

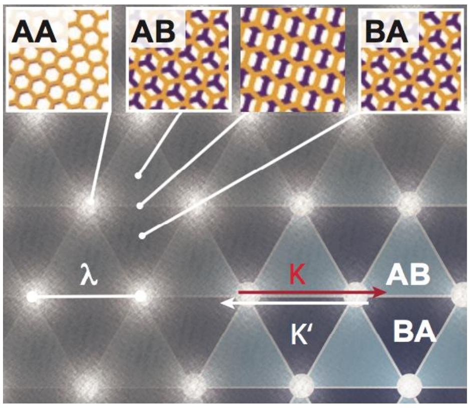

Figure 2: *The moiré periodicity gets very large for small twist angles, leading to large areas of*

AB and BA stacking. Between the AB and BA regions, topological channels emerge.