Contacts and upstream modes explain the electron-hole asymmetry in the graphene quantum Hall regime

Nicolas Moreau[1]
B. Brun[1], S. Somanchi[2], K. Watanabe[3], T. Taniguchi[4], C. Stampfer[2] and B. Hackens[1]
[1]*IMCN/NAPS, Université catholique de Louvain (UCLouvain), B-1348 Louvain-la-Neuve, Belgium*
[2]*JARA-FIT and 2nd Institute of Physics - RWTH Aachen, Germany*
[3]*Research Center for Functional Materials, NIMS, Namiki, Japan*
[4]*International Center for Materials Nanoarchitectonics, NIMS, Namiki, Japan*
nic.moreau@uclouvain.be; benoit.hackens@uclouvain.be

Observations of electron-hole asymmetry in transport through graphene devices at high magnetic field challenge prevalent models of the graphene quantum Hall effect [1]. We have used scanning gate microscopy to highlight the origin of this asymmetry in an encapsulated graphene device (Fig. 1a). We found that the locations where topological breakdown occurs, revealed by the contrast in SGM maps [2,3], are different for electrons and holes (Figs. 1b-c). We relate this observation to local doping in the vicinity of electrical contacts, and to the co-existence of up- and downstream quantum Hall edge channels. modes along. Contact doping results in a different spatial configuration of upstream QHECs for both types of charge carriers (Figs. 1d-e). This yields a totally different picture of topological breakdown: it is triggered by antidots located along the edges in the case of holes (Fig. 1d), while it occurs in the vicinity of the constriction in the case of electrons (Fig. 1e). We have confirmed our findings with thight-binding simulations [4] (Figs. 1f-g).

References

[1] Y.-T. Cui, *et al.*, Phys. Rev. Lett. 117 (2016) 186601
[2] A. Marguerite, *et al.*, Nature 575 (2019) 628
[3] N. Moreau, *et al.*, arXiv:2010.12499 (2020)
[4] C. W. Groth, *et al.*, New J. Phys. 26 (2014) 063065

Figures