Switchable valley filter based on a graphene *p-n* junction in a magnetic field

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Low-energy excitations in graphene exhibit relativistic properties due to the linear dispersion relation close to the Dirac points in the first Brillouin zone. Two of the cones located at opposite corners of the first Brillouin zone can be chosen as inequivalent, representing a new *valley* degree of freedom, in addition to the charge and spin of an electron. Using the valley degree of freedom to encode information aroused significant interest, both theoretically and experimentally, and gave rise to the field of *valleytronics* [1].

We study a graphene *p-n* junction in an out-of-plane uniform magnetic field as a platform to generate and controllably manipulate the valley polarization of electrons. We show that by tuning the external potential giving rise to the *p-n* junction we can switch the current from one valley polarization to the other. We also consider the effect of different types of edge terminations and present a setup, where we can partition an incoming valley-unpolarized current into two branches of valley-polarized currents. The branching ratio can be chosen by changing the location of the *p-n* junction using a gate.

References

[1] J. R. Schaibley, H. Yu, G. Clark, P. Rivera, J. S. Ross, K. L. Seyler, W. Yao, and X. Xu, Nat. Rev. Matter. **1**, 16055 (2016).

[2] Y. Liu, R. P. Tiwari, M. Brada, C. Bruder, F. V. Kusmartsev, and E. J. Mele, Phys. Rev. B 92, 235438 (2015).

Figures

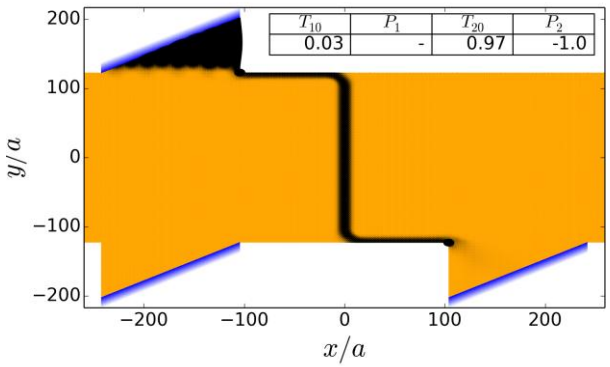

Figure 1: Three-terminal device used as a switchable valley filter. Valley-unpolarized electrons injected from the upper lead are collected in the two lower leads with high valley polarization. Here the parameters are such that electrons travel via snake states [2] along the *p-n* interface and end up with high probability in the lower right lead. The valley polarization of the collected electrons is controlled by switching the *p-n* junction on and off, while the partitioning of the electron density between the two lower leads is controlled by the edge termination and the width of the central region close to the *p-n* interface.