Towards quantum interference assisted graphene electronics

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Abstract

Graphene quantum junctions exhibit transmission antiresonances which we identify as fingerprints of destructive quantum interference (QI). Such QI features survive in the presence of interactions and their existence can be rationalized in terms of symmetries. We support analytical results with numerical simulations, which reveal the generality and the robustness of the phenomenon, and at the same time allow to predict its occurrence in a wide range of graphene nanostructures.
We also demonstrate that destructive QI can be exploited in order to achieve a nearly-perfect spin and valley filtering effect. When either the spin or valley symmetry is lifted, the QI antiresonances in the corresponding channel are split, resulting in energy windows which display strongly selective transport proprerties.
We propose a protocol to achieve an electrostatic control of the spin- and valley- filtering effect by deposition of graphene on a suitabe substrate, such as h-BN. thus paving the path towards the realization of QI-assisted graphene electronic devices.

References

[1] A. Valli, A. Amaricci, V. Brosco, and M. Capone, Nano Lett. **18** (3) 2158 (2018).
[2] A. Valli, A. Amaricci, V. Brosco, and M. Capone, arXiv:1810.11307 (2018).

Figures

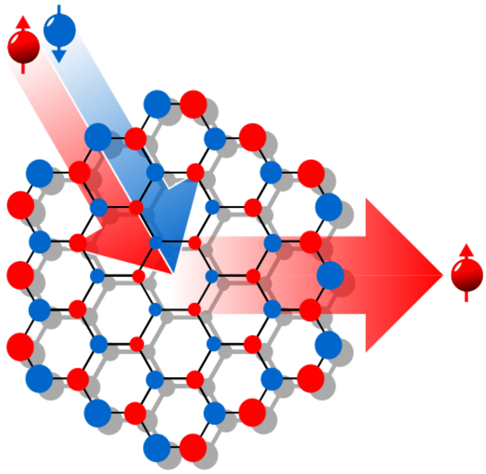

Figure 1: Realization of nearly perfect spin-filtering via spin-selective destructive quantum interference in graphene quantum junctions.

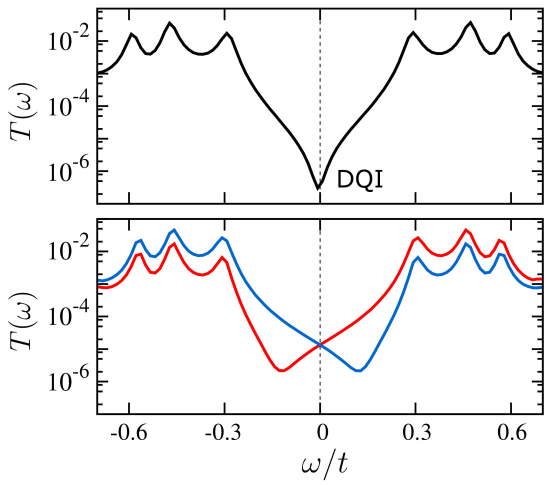

Figure 2: [top] quantum interference antiresonance in the transmission function (in the symmetric case); [bottom] lifting either the spin- or valley-degeneracy yields a splitting of the antiresonance and results in strongly selective transport in that channel.