Quantum interferences and spin orbit interactions in Graphene/TMD heterostructures

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Abstract

We present low temperature magnetotransport measurements on TMD/Graphene heterostructures where TMD consists either in MoS2 or WS2 monolayers. These experiments reveal antilocalization peaks as the signature of spin orbit (SO) interactions induced in graphene by the TMD layer. From the detailed analysis of the data obtained in a large range of temperature and gate voltage doping, we could deduce the strong anisotropy and amplitudes of these SO interactions dominated by out-of-plane components in agreement with recent theoretical predictions[1,2].

When electrodes are made from a superconducting material, proximity induced superconductivity is observed. The field dependence of the critical current is also found to be strongly modified by SO interactions provided that the junction is sufficiently long, showing evidence of a strongly non-uniform spatial distribution of the supercurrent through the sample which exhibits quasi-periodic oscillations up to few Tesla. These results can be interpreted via the formation of magnetic field robust spin polarized subgap Andreev states localised along the edges of the samples.

References

[1]Strong Anisotropic Spin-Orbit Interaction Induced in Graphene by Monolayer WS2
T. Wakamura, F. Reale, P. Palczynski , S. Guéron, C. Mattevi and H. Bouchiat Phys. Rev. Lett. (2018)

[2] Spin-orbit interaction induced in graphene by transition metal dichalcogenidesT. Wakamura, F. Reale, P. Palczynski, M. Q. Zhao, A. T. C. Johnson, S. Guéron, C. Mattevi, A. Ouerghi, and H. Bouchiat Phys. Rev. B 99, 245402 (2019)

[3]T.Wakamura et al. (to be published)