Spin phenomena in van der Waals heterostructures

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Abstract

Graphene has weak spin-orbit coupling and no magnetic order. But when placed in contact with a strong spin-orbit coupling material, such as a TMDC, or a ferromagnet, such as Cr2Ge2Te6, Dirac electrons acquire strong spin-orbit or exchange coupling, respectively. Such proximity effects render graphene suitable for spintronic applications that require spin manipulation [1]. In addition, graphene with strong proximity spin interactions can host novel topological states [2]. Fascinating new phenomena appear when bilayer graphene gets encapsulated by a TMDC from one side, and a ferromagnet from another. The resulting, so called ex-so-tic structure [3], offers spin swap functionality: switching spin-orbit and exchange coupling on demand by gate. In this talk I will review the recent developments in the proximity phenomena in graphene, and present some recent theoretical results on the control of the proximity spin-orbit and exchange coupling by twisting the van der Waals layers. I will show that the signature proximity spin-orbit coupling in graphene---valley Zeeman coupling---can be efficiently tuned by the twist angle [4], and that proximity exchange coupling can be switched by the twist angle, and even morph from ferromagnetic to antiferromagnetic [5], see Fig. 1. Support from DFG SPP1244, SFB 1277, and EU Graphene Flagship is acknowledged.

References

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Figures

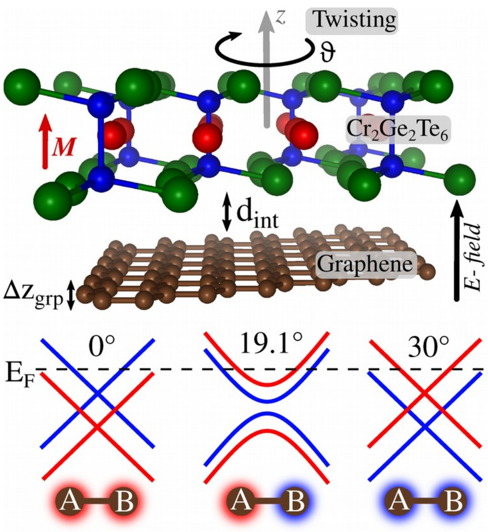

Figure 1: Graphene placed on a ferromagnet (such as CGT) acquires magnetization. The spin polarization of the Dirac electrons depends on the twist angle: it is opposite ferromagnetic for 0 and 30 degrees, while it can be antiferromagnetic at around 20 degrees. So far this is a theory prediction [5].