Spintronics at the interface

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The interface between materials can be considered as the ultimate spintronics device, not only in terms of miniaturization but also to unlock unique design possibilities and new physical properties which are unattainable in the individual bulk materials. As device dimensions are constantly shrinking, understanding the physical properties emerging at interfaces is crucial to exploit them for applications.

Graphene and magnetoelectric multiferroics are promising materials for spintronic devices with high performance and low energy consumption. We combine the features of both materials by investigating from first principles and Monte Carlo simulations the interface between graphene and $BaMnO_3$, a magnetoelectric multiferroic. We show [1] that electron charge is transferred across the interface and magnetization is induced in the graphene sheet due to the strong interaction between C and Mn. A remarkably large proximity induced spin splitting of the Dirac cones ($\sim$ 300 meV) is achieved and doping can make the high-mobility region of the electronic bands experimentally accessible.

Spin-Orbit Coupling calculations reveal that graphene deeply affects the magnetic state of the substrate, down to several layers below the interface, by inducing an overall magnetic softening, and switching the in-plane magnetic ordering from anti- to ferromagnetic. The graphene-$BaMnO_3$ system presents a Rashba gap 300 times larger than in pristine graphene, leading to a new flavor of Quantum Anomalous Hall effect (QAHE), a hybrid QAHE, characterized by the coexistence of metallic and topological insulating states. These findings could be exploited to fabricate novel devices that use graphene to control the magnetic configuration of a substrate [2].

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