Spin-orbit driven phenomena due to proximity-induced spin-orbit coupling and magnetism in graphene deposited on various substrates

Anna Dyrdal
Jozef Barnas

Faculty of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznan, Poland

adyrdal@amu.edu.pl

Hybrid systems based on graphene deposited on various substrates (e.g. transition metal dichalcogenides or ferromagnetic thin films) as well as graphene decorated by adatoms are currently extensively studied both experimentally and theoretically [1-3], mainly due to the possibility of using graphene as an active element of spintronics devices. Owing to the magnetic and spin-orbit proximity effects, enhanced spin-orbit interaction and magnetic moment in the graphene layer may be then induced.
Within the linear response theory and Green function formalism we have studied several spin-orbit driven phenomena in graphene-based hybrid structures. To describe these phenomena theoretically we have used various forms of the low-energy effective Hamiltonians, that have been derived recently from first-principle calculations (see e.g. [3,4]). We will present our recent results concerning the anomalous and spin Hall effects as well as current-induced nonequilibrium spin polarization for graphene deposited on yttrium iron garnet ferromagnetic thin film and for graphene exchange-coupled to cobalt or nickel layer via a few atomic layers of hexagonal boron nitride. The effects under considerations are important for graphene-based spintronics as an effective source of spin currents and spin-orbit torques, which, in turn, may be responsible for spin dynamics and/or magnetic switching in the low-dimensional structures [5].

References

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Figures

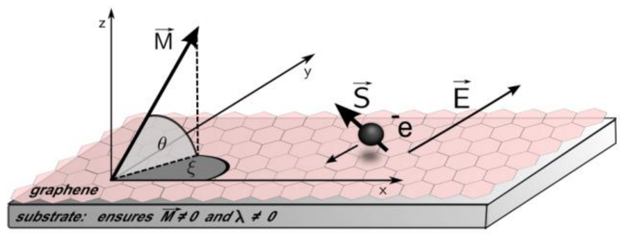

Figure 1: Schematic of the system under consideration. Graphene is on a substrate which assures a nonzero proximity-induced magnetization (M) and spin-orbit coupling (constant λ) [5]. Magnetization can be oriented arbitrarily and this orientation is described by the polar θ and azimuthal ξ angles. E stands for an external electric field.