Current-induced spin polarization in topological insulators and its role in magnetotransport

Anna Dyrdał[1]

[1] *Department of Mesoscopic Physics, ISQI, Faculty of Physics, Adam Mickiewicz University, ul. Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland*

The current-induced spin polarization (CISP) has become a hallmark of spin-orbitronics and one of the most efficient spin-to-charge interconversion mechanisms. CISP is especially strong in topological insulators (TIs) due to the spin-momentum locking. Interestingly, the nonequilibrium spin polarization is at the origin of various phenomena such as spin-orbital and bilinear magnetoresistance as well as spin-orbit torques. Moreover, the fact that CISP in TIs strongly depends on the position of chemical potential makes the spin-orbit torque and magnetoresistance phenomena strongly tunable by gating or doping.

I will review the most important consequences of nonequilibrium spin polarization in TIs. First, I will describe the nature of magnetoresistance effects induced by CISP. In particular, I will explain, among others, how CISP results in a strong BMR signal in TIs with isotropic Fermi contours. Then, I will discuss spin-orbit torque in TIs and will focus on the case of thin films of TIs attached to ferromagnetic layers. In such systems, the simultaneous presence of the hybridization between the surface states and the in-plane magnetization leads to a giant anisotropic magnetoresistance and highly tunable spin-orbit torque.

References:

[1] Y. Lv, et al., Nature Communications 9, 111 (2018);
[2] Y. Wang, et al., Nature Communications 8, 1364 (2017) ;
[3] A. Dyrdał, J. Barnaś, A. Fert, Phys. Rev. Lett. 124,046802 (2020);
[4] A.G. Moghaddam, A. Qaiumzadeh, A. Dyrdał, J. Berakdar, Phys. Rev. Lett. 125, 196801 (2020);

Acknowledgements: This work was partially supported by the National Science Center in Poland as a research Project No. UMO-2018/31/D/ST3/02351: 'Theoretical study of the magnetoresistance phenomena in 2D structures with strong spin-orbit interaction'.