Pozvánka na seminář oddělení 15

V pátek 23. října 2015 v 14:00

v zasedací místnosti budovy A v Cukrovarnické

Friday 23/10/2015 at 2pm

in the meeting room, A building, Cukrovarnicka

Kevin Garello (ETH Zurich):

Manipulation of magnetization by spin-orbit torques

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Recent demonstrations of perpendicular magnetization switching induced by in-plane current injection in ferromagnetic heterostructures [1] have drawn attention to a class of spin torques based on orbital-to-spin momentum transfer (SOTs), which is alternative to pure spin transfer torque (STT) between noncollinear magnetic layers and amenable to more diversified device functions. An electrical current flowing in the plane of a trilayer with structural inversion asymmetry such as Pt/Co/AlOx creates two torques originating from the spin orbit interaction in Pt and at the Pt/Co interface [2]: an field like torque $\boldsymbol{T^{FL}} \sim \boldsymbol{m} \times \boldsymbol{y}$ equivalent to an effective field $\boldsymbol{B^{FL}}$ perpendicular to the current direction and an anti-damping torque $\boldsymbol{T^{AD}} \sim \boldsymbol{m} \times (\boldsymbol{y} \times \boldsymbol{m})$ equivalent to a rotating magnetic field $\boldsymbol{B^{AD}}$ perpendicular to the magnetization $\boldsymbol{m}$ [1]. $\boldsymbol{T^{AD}}$ is responsible of switching and the final state is dictated by the polarity of the bias field applied along the current direction. Consequently, switching is bipolar with respect to both current and bias magnetic field.

After describing the main spin-orbit interactions observed in ferromagnetic heterostructures and some of our latest measurements, I will present their straightforward impact on magnetic memory technologies and recent advances to build the first SOT-based perpendicular magnetic tunnel junctions [3], which presents an interesting alternative to STT to build MRAM cells.

Finally, I will address writing current and speed by presenting a study of magnetization reversal induced by current pulses of ms to sub-200 ps duration in square Pt/Co/AlOx dots [4]. I will discuss the comparison between our experimental results and macrospin simulations, and conclude that magnetization reversal proceeds via nucleation and propagation of domains, which is supported by micromagnetic simulations. In such a scenario, once a reverse domain nucleates, switching is achieved by the propagation of a domain wall through the dot.

[1] I. M. Miron, K. Garello, et. al, Perpendicular switching of a single ferromagnetic layer induced by in-plane current injection , Nature 476, 189 (2011)

[2] K. Garello, I. M. Miron, et. al, Symmetry and magnitude of spin–orbit torques in ferromagnetic heterostructures, Nature Nanotech. 8, 587 (2013)

[3] M. Cubukcu, K. Garello et al., Spin-orbit torque magnetization switching of a three-terminal perpendicular magnetic tunnel junction, Appl. Phys. Lett. 104, 042406 (2014)

[4] K. Garello et al., Ultrafast magnetization switching by spin-orbit torques, Appl. Phys. Lett., 105, 212402 (2014)