On-line SPICE-SPIN+X Seminars

Wednesday, 18th May 2022, 15:00 (CET)

The seminar will be via Zoom (Meeting ID: 854 4675 3375) and live streamed in the SPICE YouTube Channel.

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Ferrimagnetic spintronics and self-torque

Two-dimensional spin-textured materials or interfaces are expected to exhibit high efficiency for the interconversion of spin current into charge current, even more efficient than conventional non-magnetic heavy metals [1,2]. Additionally, magnetic materials possessing strong spin-orbit coupling such as GdFeCo can also efficiently generate spin currents of different symmetries, spin anomalous Hall effect SAHE-like, and spin Hall effect SHE-like [3-5]. And one such symmetry, SHE-like, could produce what we have coined "self-torque" [6].

In the first part of the talk, I will show an example of “standard” or “external” spin-orbit torque in a W/CoTb/AlOx system. We use the strong spin-orbit coupling from W to exert spin-orbit torque and manipulate the perpendicular magnetization of CoTb amorphous ferrimagnetic layer [2] .

In the second part, I will show our study on ferrimagnetic FiM GdFeCo alloys in which the 5d band of Gd induces large spin-orbit coupling. We demonstrate the giant spin current emission (SAHE+SHE) by GdFeCo from the current-induced modulation of the ferromagnetic resonance linewidth of NiFe in GdFeCo/Cu/NiFe. Overall efficiency is 25 times more important in GdFeCo/Cu/NiFe than in Pt/Cu/NiFe [3].

The study of the self-torque is carried out by harmonic Hall voltage measurements in samples where the GdFeCo layer exhibits out-of-plane magnetization. We compare the self-torque in GdFeCo/Cu with torques induced by Pt or Ta in Pt/Cu/GdFeCo and Ta/Cu/GdFeCo [3]. Thus, These “self-torques” can be tuned by adjusting the spin absorption outside the GdFeCo layer. Moreover, taking advantage of the different characteristics temperatures in ferrimagnets [2,6,7], we show the features that differentiate self-torque from what we know so far, the "external" spin-orbit torque [6].

These results pave the way for new architectures to achieve switching by self-SOT and skyrmions manipulation.

Work performed with co-authors in Refs. 1,2,6 and 7. This work was supported from Agence Nationale de la Recherche (France) under contract ANR-19-CE24-0016-01 (TOPTRONIC), and related projects in Ref. 2,6-7.

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[2] Pham, TH et al, Thermal contribution to the spin-orbit torque in metallic-ferrimagnetic systems. Phys. Rev. Appl. 9, 064032 (2018).
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[4] Amin et al., Intrinsic spin current in ferromagnets. Phys. Rev. B 99, 220405 (2019)
[5] Kim & Lee, Generalized Spin Drift-Diffusion Formalism in the Presence of Spin-Orbit Interaction of Ferromagnets. Phys. Rev. L 125, 207205 (2020)
[6] Céspedes-Berrocal D., Damas H. et al. Current-Induced Spin Torques on Single GdFeCo Magnetic Layers. Adv. Materials 33, 2007047 (2021)
[7] Damas H. et al. PSS-Rapid Res. Lett., https://doi.org/10.1002/pssr.202200035