Stage N° : 8

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Title

Magnon Transport

Summary

The recent demonstrations that spin orbit torques (SOT) in non-magnetic materials allow one to generate and detect pure spin currents has triggered a renewed effort to develop communication technologies based on the spin degree of freedom. Within this new paradigm, magnetic materials play the role of spin conductors, since they can propagate spin waves (or their quanta, magnons), which are the information carriers. Interestingly, magnetic insulators are usually better spin conductors than magnetic metals, and amongst them yttrium iron garnet (YIG) is the best material, as it is famous for having the lowest known magnetic damping parameter [1-4].
From a purely fundamental point of view, this topic is very interesting because, in contrast to spin transfer process in confined geometries (*e.g.* nano-pillars or nano-contacts) where usually the uniform magnon mode dominate the dynamics, very little is known about spin transfer in extended geometries, which have continuous spin-wave spectra containing many modes which can take part in the magnon-magnon interactions. The studies of magnon transport in YIG by means of the direct and inverse spin Hall effects provide new means to alter efficiently the energy distribution of magnons and, potentially, even to trigger Bose condensation [5,6].
This topic is currently recognized as one of the important emerging research direction in modern magnetism [7]

The studies in this internship will concentrate on the characterization of the propagation and control of spin waves via the spin Hall effect in YIG devices that have been realized within our group. This work will introduce the student to the topic of magnetization dynamics, the concepts of propagating spin waves, and the concept of spintronics (spin polarized transport, pure spin currents, spin Hall effect).

Bibliography :

[1] Y. Kajiwara, et al., Nature 464, 262 (2010).
[2] A. Hamadeh et al. Phys. Rev. Lett. 113, 197203 (2014).
[3] M. Collet, et al. Nature Commun. 7, 10377 (2016).
[4] N. Thiery et al. arXiv:1702.05226 [cond- mat.mtrl-sci].
[5] S. A. Bender, R. A. Duine, and Y. Tserkovnyak, Phys. Rev. Lett. 108, 246601 (2012).
[6] S. O. Demokritov, et al. Nature 443, 430 (2006).
[7] E.G. Sander et al. Journal of Physics D: Applied Physics 50, 363001 (2017).

Requested skills
M2 level, sound knowledge of solid state physics and/or Nanophysics and Nanosciences

Possibility to follow with a PhD: Yes