Spin-wave propagation at variable temperature

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Understanding the interplay between spin dynamics and electron transport in itinerant ferromagnetic metals such as Fe, Co and Ni remains a very challenging task [1] because of the strong intrication of magnetism and electron band structure in these materials. This type of physics can be addressed with the help of spin-wave spectroscopy, which allows one to probe directly the nature of the interaction between spins [2] and its interplay with external electrical currents [3-5].

In this PhD project, we propose to perform accurate measurements of propagating spin wave spectroscopy (1-50 GHz) at variable temperature (5-300K). In a first time, such measurements will be used to determine experimentally the phonon and magnon contribution to the spin-dependent electrical conductivities in iron-vanadium thin films, resorting to the technique of current-induced spin-wave Doppler shift we have developed in the last years [3-5]. In a second time, we will use spin wave spectroscopy to quantify the antisymmetric exchange interaction in some ferromagnetic metal thin film with a low symmetry crystal structure [2] and track the unconventional magnetic phase called skyrmion-network, which is expected to appear in the low temperature range [6].

The proposed project is mainly experimental. The focus will be put on nanofabrication and microwave measurements in a newly installed cryogenic environment. The young researcher will acquire experience in instrumentation and a very strong background in magnetization dynamics and spin-polarized transport.

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[2] Seki et al., Phys. Rev. B 93, 235131 (2016)
[3] Vlaminck & Bailleul, Science 322, 410 (2008)
[4] Bailleul & Vlaminck,
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[5] Gladii et al., Phys. Rev. B 96, 174420 (2017)
[6] Garst et al., J. Phys. D: Appl. Phys. 50, 293002 (2017)

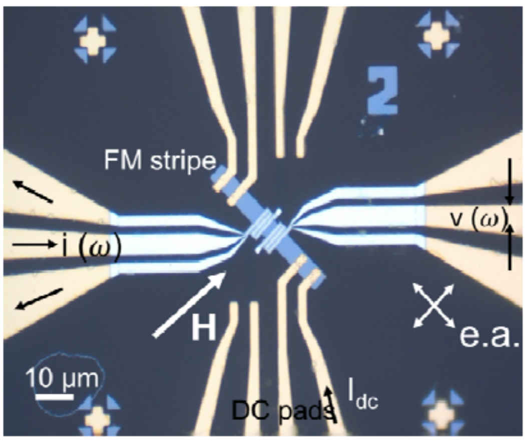

Figure: (Left) Optical microscope picture of a typical propagating spin-wave propagation device. The pair of spin-wave nano-antennae (in white) allows one to excite and detect spin-waves with a wave-length of about 1µm. (Right) Photograph of the experimental set-up showing the electromagnet (bottom), the cryostat (top) and the microwave network analyzer (top left).