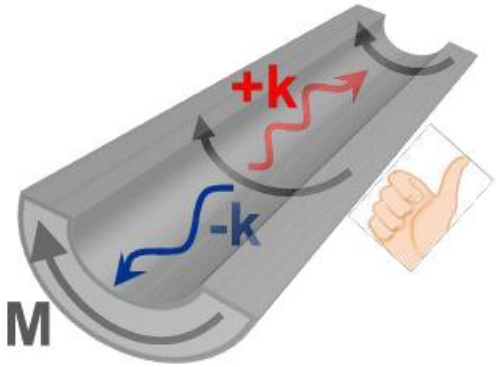
PhD position in Physics at IPCMS, Strasbourg (France)

Spin-wave propagation along curved magnets

The spin-waves (or magnons) are the low-energy excitations of magnetically ordered materials. In typical ferromagnets, they exist over a range of frequencies (1 GHz – 1THz) and wavelengths (1µm-1nm) which correspond precisely to the time- and length- scales relevant for modern electronics. This suggests the possibility to use spin waves for developing new architectures for data processing, which motivates the emergence of a new field of nanomagnetism and spintronics called "magnonics" [1].

Up to now, spin-waves have been studied in flat geometries (ferromagnetic thin films and planar elements fabricated from them). However, a number of novel phenomena have recently been predicted in curved nanomagnets. Among those, one of the most intringuing one is the so-called curvature-induced non-reciprocal spin-wave propagation [2]. This effect is sketched in the figure below: consider a curved nanomagnet magnetized along the curvature direction and spin-waves propagating perpendicular to it (see figure). Due to the chiral nature of the dipolar interaction which govern them, spin-waves happen to propagate faster in one direction (say "right-hand") than in the opposite one ("left-hand"). Beside the fundamental interest of this subtle physics of symmetry-breaking, such chiral propagation could be used to build miniaturized non-reciprocal devices of interest for wireless communication technology



The aim of the PhD project is to realize experimentally suitable curved ferromagnetic tracks and to measure spin-wave propagation along them. This doctoral project is part of the French-Austrian ANR-FWF research project MagFunc "Non-Reciprocal 3D Architectures for Magnonic Functionalities". The nanofabrication work (lithography, etching, film deposition, scanning electron microscopy) will be conducted in the STnano plat-form [3]. The spin-wave measurements [4] will be carried out using the microwave instrumentation of the research team and complementary equipments available in the partner labs. Data interpretation will involve a constant dialog with a theory team.

[1] The 2021 Magnonics Roadmap, A. Barman et al., https://doi.org/10.1088/1361-648X/abec1a (2021)
[2] Curvature-Induced Asymmetric Spin-Wave Dispersion, Otalora et al., Phys. Rev. Lett. 117, 227203 (2016).
[3] http://www.ipcms.unistra.fr/?page_id=23285&lang=en
[4] Slow-Wave-Based Nanomagnonic Diode, Grassi et al., Phys. Rev. Applied 14, 024047 (2020).

The 3 years PhD position will start in October 2021. Motivated candidates enrolled to obtain a Master's degree in Physics are asked to email their CV and grades before June 11th to **matthieu.bailleul@ipcms.unistra.fr** and **yves.henry@ipcms.unistra.fr.**

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