PhD thesis project

Modeling of a magnonic diode based on spin-wave non-reciprocity in nanowires and nanotubes

General Scope:

Spin waves, also called magnons, are excitations of magnetic systems, which have been proposed to transport information. The PhD project addresses the emerging phenomenon of spin-wave non-reciprocity in a three-dimensional nanomagnetic system. The topic is at the crossroads of quantum condensed-matter physics, nanomagnetism, computational modeling, and device spintronics. It is proposed in a working team bringing together experimentalists and theoreticians from two laboratories in Grenoble with possible international collaborations, working collaboratively on topic from fundamentals to applied spintronics. It is a stimulating environment from a human point of view, and ideal to foster the emergence of new concepts and their applications.

PhD Subject:

Cylindrical magnetic nanowires are a textbook situation for 3D nanomagnetism physics, providing ingredients such as 3D magnetization maps and curvature, yet keeping it simple thanks to the rotational invariance. Recent experiments conducted at SPINTEC on such wires with a 3D distribution of magnetization revealed a giant non-reciprocal effect (non-symmetrical dispersion curves with different speeds and periods for left- and right-propagating waves), up to an extent of creating a band gap for a given direction of motion (right or left). This particular situation and the resulting quantum magnon transport regime have not been yet described theoretically or modeled, which sets an unexplored and promising ground for this PhD project. We propose to model spin-wave propagation and derive dispersion curves using complementary numerical tools: the in-house finite element micromagnetic code feeLLGood (https://feellgood.neel.cnrs.fr/) and the open-source 2D TetraX package (https://www.tetrax.software/), dedicated to eigen modes calculations. The work will be conducted in tight collaboration with experimentalists, both to explain experimental results and to guide further experiments and research directions.

Required Skills:

- Robust background in condensed matter physics in general, if possible incl. magnetism.
- Ability to develop theoretical models and numerical tools, incl. using Python C/C++
- Ability for team work, with autonomy but reporting-oriented, scientific curiosity

Laboratory: SPINTEC, Institut NEEL. Collaborations with Completense Madrid and HZDR Dresden.

PhD Supervisors:

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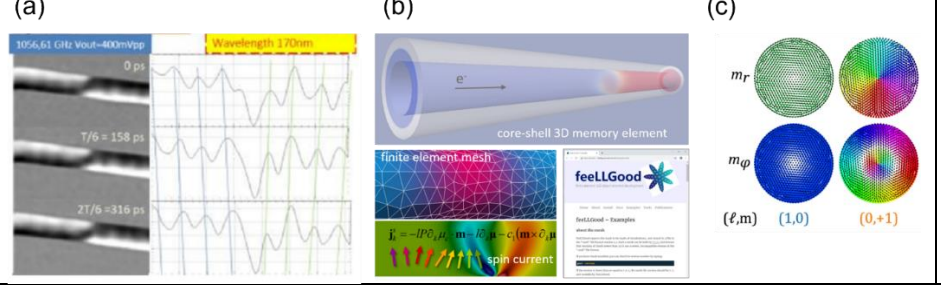

(a) Experimental imaging of an ac-excited domain wall emitting spin-waves within cylindrical wire, (b) illustration of functionalities of our in-house 3D micromagnetic solver feeLLGood, (c) illustration of eigen modes of a magnetic nanocylinder calculated using TetraX.

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