# ***INTERNSHIP PROPOSAL***

*(One page maximum)*

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Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ANR

**Nonlinear magnetization dynamics triggered by surface acoustic waves**

RF signals are everywhere in today's connected society. On one side, surface acoustic wave (SAW) devices built on piezo-electric substrates are widely used to distinguish between frequencies. While quite energy efficient, SAW devices mostly operate in narrowband applications and perform linear, frequency-conserving operations. On the other side, magnonic devices rely on the specific properties of spin-waves (SW) in ferromagnetic materials and are highly tunable and nonlinear, but suffer from significant insertion losses. Fortunately, magneto-elastic and magneto-rotation effects can couple the dynamics of magnetization in a thin ferromagnetic film deposited on top of a piezo-electric substrate to the one of its lattice. For instance, we have recently demonstrated that it is possible to excite the linear magnetization dynamics of a ferromagnetic CoFeB nanodisk thanks to SAW electrically actuated in the underlying LiNbO3 substrate [1].

The objective of this internship will be to demonstrate that this can also be achieved in a nonlinear regime. For this, we will magnetize the ferromagnetic disk in the plane. In this configuration, the precession of magnetization is elliptical, which allows to excite parametrically spin-wave eigenmodes of the disk using an RF magnetic field parallel to the disk's magnetization with a frequency close to twice the eigenfrequencies [2]. The originality here will be to replace the RF excitation field usually produced by an inductive antenna by the effective tickle and rolling fields associated to the magneto-elastic and magneto-rotation terms active when a SAW is excited in the substrate. These measurements will be performed on samples fabricated in collaboration with another laboratory (C2N) and thanks to a highly sensitive magnetic resonance force microscopy technique developed at SPEC. Micromagnetic simulations using Mumax3 will also be conducted to understand the SAW excitation threshold to be overcome to excite parametric modes in the disk.

This internship will take place in the context of the recently funded project NELSON (« Non-Linear Surface acoustic wave platform enabled by spin wave hybridizatiON ») by the French ANR.

[1] R. Lopes Seeger et al., Phys. Rev. Lett. 134, 176704 (2025)
[2] T. Srivastava et al., Phys. Rev. Appl. 19, 064078 (2023)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: NO