INTERNSHIP PROPOSAL

(One page maximum)

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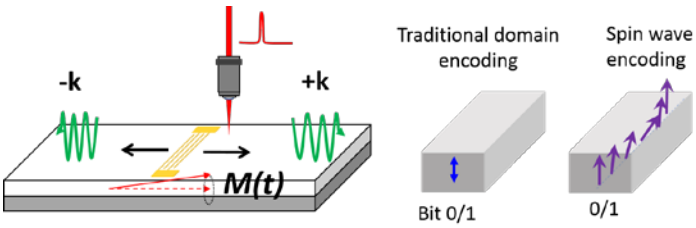
Internship location: Sorbonne Université, tour 22-23

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ED397

Time- and space-resolved detection of GHz magnetization dynamics

In computers magnetism intervenes in the *data storage* components, with information coded by the magnetization direction of submicronic magnetic domains. The *calculations* are instead done using semiconducting materials, with transistors performing logical operations ("NOT", "AND" etc.). A whole new paradigm proposes to use magnetic materials to perform these operations, by encoding the information on the amplitude and phase of so-called "spin-waves", magnetic excitations. Their frequencies are around the GHz, and wavelength from a few microns down to a few hundreds of nanometers. They can be excited by RF antennas, or more recently by surface acoustic waves, thanks to magneto-elasticity (an effect coupling magnetization and strain[1]). Foreseen advantages are a higher integrability, a higher tunability and even a lower consumption of devices for our increasingly energy-greedy digital world.

Most groups detect these spin waves electrically, after propagation along a wave-guide, or a delay line. While these measurements are ideal for a commercial device, they do not provide information about the physics at play between the excitation and detection of the waves. The aim of this internship will therefore be to improve an existing set-up[2] capable of synchronizing an RF excitation with short laser pulses probing the magnetization dynamics induced by the resulting GHz RF field or strain wave. The challenge will be to improve the signal to noise ratio, and increase the maximum (minimum) spin wave detectable frequency (wavelength).



Techniques/methods in use: time-resolved Kerr effect using a pulsed laser, RF circuitry and electronics, clean-room nano- and microfabrication,

Applicant skills: Strong motivation for experimental work, a background in magnetism and/or optics would help

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: NO Theoretical Physics: NO

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[1] *"Symmetry of the coupling between surface acoustic waves and spin waves in synthetic antiferromagnets"* , R. Lopes Seeger, L. La Spina, V. Laude, F. Millo, A. Bartasyte, S. Margueron, A. Solignac, G. de Loubens, L. Thevenard, C. Gourdon, C. Chappert, and T. Devolder , Phys. Rev. B 109, 104416 (2024)

[2] *"Time- and space-resolved nonlinear magnetoacoustic dynamics"*, M. Kraimia, P. Kuszewski, J.-Y. Duquesne, A. Lemaître, F. Margaillan, C. Gourdon, and L. Thevenard, Phys. Rev. B **101**, 144425 (2020)