New experimental methods for Nuclear Magnetic Resonance in ferromagnetic heterostructures

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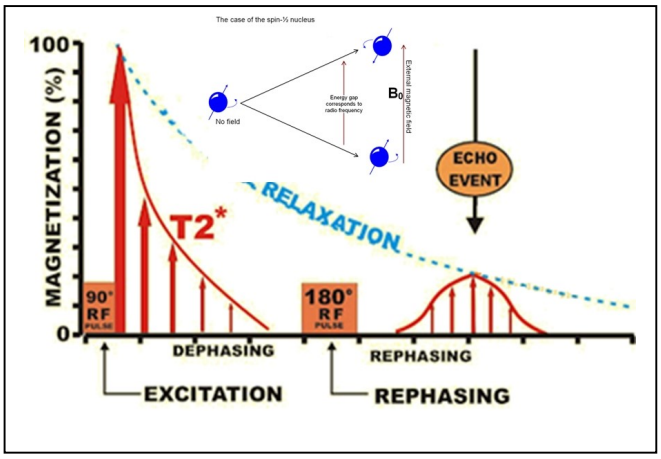
Nuclear Magnetic Resonance is very commonly used in chemistry or biology however Its use for studying ferromagnetic materials is much more confidential. The reason is that when performed on ferromagnets, the NMR signal shows specific properties that require the development of dedicated experimental set ups as well as analyses methods. Therefore, to describe this technique an alternate name is often used: Ferromagnetic Nuclear Resonance (FNR). The spectrometers and methods developed in the team during the last decades [1] allowed successfully studying the structure the morphology and the magnetic properties of ferromagnetic materials ranging from new permanent magnets [2] to multilayers, thin films and hybrid heterostructures [3]. In order to further increase our understanding in the properties of ferromagnetic systems we have developed very recently a new state of the art FNR spectrometer. Compared to the previous generation of spectrometer its operating modes can be easily re-configurated. In particular, while up to now FNR experiments have been done by using very simple nuclear spin polarization sequences, the new spectrometer will allow investigating the use of more complex sequences like in multidimensional non-ferromagnetic NMR. Considering the broad use of multidimensional NMR, the versatility of our new spectrometer opens up a completely new and very broad field of investigation for FNR.



For this project we will focus on metal/organic heterostructures. The samples will be grown in the UHV system of the laboratory and analyzed with conventional techniques (XRD, Magnetometry…) simultaneously to the development of new spin polarization FNR sequences. New analyses methods and accompanying software might have to be developed also.

[1] C. MENY, P. PANISSOD. Nuclear magnetic resonance in ferromagnets: Ferromagnetic nuclear resonance; a very broadband approach, Annual Reports on NMR Spectroscopy 103, 47-96, (2021)

[2] H. NAKAMURA, H. OHTA, R. KOBAYASHI, T. WAKI, Y. TABATA, H. IKENO, C. MENY. Site-selective cobalt substitution in La-Co co-substituted magnetoplumbite-type ferrites: ^{59}Co-NMR and DFT calculation study. J. Phys. Mater. 7 025012 (2024)

[3] G. AVEDISSIAN, J. ARABSKI, J. A. WYTKO, J. WEISS, C. MENY. Revealing the morphology and the magnetic properties of single buried cobalt-ZnTPP hybrid interfaces by ferromagnetic nuclear resonance spectroscopy. Phys. Rev. B 102, 184114 (2020)