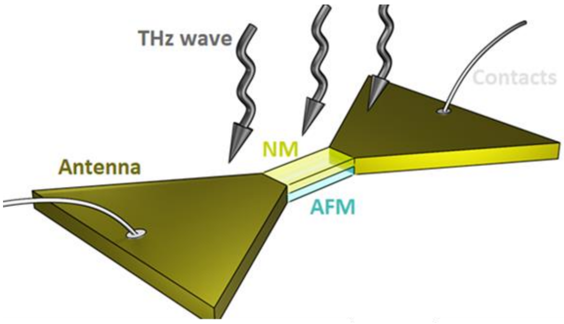
THz detection using spintronic mechanisms

Electromagnetic waves in the frequency range 300 GHz -30 THz have various applications for imaging, chemical detection or high-speed communication. However, convenient emitters and detectors are still missing in this range, known as the THz gap. Existing devices are mostly based on semiconductors and have limited performances. The use of new physical mechanisms, not relying on semiconductors structures, appears as a possible route for the further development of the field of THz physics. In this context, spintronic based technologies appear particularly promising. The discovery of spintronics THz emitters shows that it is possible to outperform laser driven semiconductor THz sources when using a different, spin based, emission scheme. This discovery lead to an unprecedented development of **THz spintronics** [1]. However, these works are mostly focused on emission and there is a clear need for efficient scheme for THz detection. In this PhD project, we propose to use the antiferromagnetic resonance [2] for **spintronic THz detection**.

Antiferromagnets have their natural resonance mode in the THz range, due to the strong exchange interaction between their magnetic sub-lattices. In this PhD thesis, we propose to design and use a novel detection scheme consisting in integrating the antiferromagnet within a micrometer scale electromagnetic antenna structure [3] to concentrate the THz field and access antiferromagnetic resonance at a reduced scale. In addition, we will take advantage of the so-called inverse spin Hall effect occurring in a heavy metal layer adjacent to the antiferromagnet to detect the interfacial spin current generated at resonance [2].



The aim of the PhD project is to study experimentally the antiferromagnetic resonance in microstructures. The project includes design and simulation work aiming at optimizing THz confinement. In a second step the most promising devices will be fabricated onto selected antiferromagnetic systems using cleanroom facilities (STnano). The structures will then be characterized using both a time-resolved optical set-up and a continuous wave THz platform (0-1.2 THz). During the thesis, a secondment at SPINTEC and LNCMI in Grenoble will aim at adapting the design for measurements at the high magnetic field THz set-up of LNCMI. [4]

[1] T. Seifert et al. Nature Photonics 10, 483 (2016)
[2] P. Vaidya et al. Science 368, 160 (2020)
[3] M. Pacé et al. APL Mater. 12, 051113 (2024) (2024)
[4] R. Lebrun et al. Nature Communications 11, 6332 (2020) ; S. Das et al. ibid 13, 6140 (2022)

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The 3 years PhD position will start in October 2024. Motivated candidates enrolled to obtain a Master's degree in Physics are asked to email their CV and grades.

Candidates should apply on the cnrs website here.

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