Minicolloque n° 21 ■ **Oral** ☐ **Poster**

Spin absorption anisotropy in lateral spin valves

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While classical electronics focuses on the control of the charge current, spintronics aims at using a spin current, e.g. a flow of angular momentum for logical and memory applications. One of the main use of such a spin current is magnetization switching used for writing in memory devices. Indeed, when a spin current enters into a ferromagnet, its angular momentum (or polarization) is transmitted to the magnetization, and possibly changes its orientation.

The transfer of angular momentum from the spin current to the magnetization can be done in two ways depending on the relative orientation between the polarization and the magnetization direction. If they are collinear, the polarization is absorbed by the ferromagnet through diffusive processes originating from the spin switchings during scattering on defects. However, when the magnetization and polarization are transverse, ballistic processes originating from the conduction electron's spin rotation around the exchange field of the ferromagnet drive the polarization absorption.

Understanding the mechanisms of the spin current relaxation into a ferromagnet is therefore of crucial interest for spintronics applications, and remain a seldom explored fundamental question.

One of the main difficulty in studying spin current relaxation in a ferromagnetic material is the fact that a charge current generates parasitic effects through the anisotropic magnetoresistance and planar Hall effect. We consequently used lateral spin valves, allowing the measurement of the spin relaxation in a ferromagnet with different relative magnetization direction using a pure spin current, e.g. a flow of angular momentum in the absence of charge current. This measurement allowed us to observe the spin-current relaxation anisotropy in a ferromagnet and to extract the spin mixing conductance, an elusive but fundamental parameter of the spin-dependent transport [1]. Finally, these results allows us to move toward the study of magnetization dependent Spin Hall Effect in ferromagnetic materials.

[1] M. Cosset-Chéneau et al, Phys. Rev. Lett. 126, 027201 (2021)