Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique des Solides
CNRS identification code: UMR8502
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Internship location: LPS, Université Paris Saclay, plateau du Moulon

Thesis possibility after internship: YES
Funding already obtained for a PhD: YES If YES, which type of funding: ANR

Magnetic interactions and textures in 2D ferromagnetic systems

The exotic properties of van der Waals (vdW) 2D materials, along with the simple fabrication of atomically-thin but wide heterostructures, have set in motion a small revolution in research and opened the way to systems with completely new functionalities. In magnetism, in particular, the recent discovery of ferromagnetic (FM) order in vdW materials allows for the study of purely 2D magnets either isolated or integrated in heterostructures [Fig a]. In these systems, interfacial magnetic effects like Dzyaloshinskii-Moriya interaction (DMI) and perpendicular magnetic anisotropy (PMA), which stabilize chiral spin textures like skyrmions, can be strengthened and modified well beyond what is possible in metals [Gong19,Li22]. VdW heterostructures constitute a vast class of systems in nanomagnetism that remain essentially uncharted.
The internship will focus on vdW magnets containing heavy elements like Fe_xGeTe_2 (F_xGT) compounds – hence with potentially a sizable spin-orbit coupling (SOC) – that are strong candidates for hosting PMA and DMI. A variety of magnetic behaviors have been reported in F_xGT: ferrimagnetism or ferromagnetism, metastable magnetic configurations dependent on the thermal history, and a significant influence of Fe vacancies or oxidation. We intend to explore how the interfaces in F_xGT can be engineered to control the magnetic interactions (DMI, PMA, exchange) with the final aim to move skyrmions.
This work will rely on complementary techniques (growth, magneto-optics, imaging, spin waves…) and various types of samples (epitaxial grown films, exfoliated crystals, different compositions) to determine the roles of key parameters (crystallinity, interface hybridization, band structures etc) and compare them to the current theoretical understanding. This work will follow our first experiments that demonstrated ferromagnetism and textures in exfoliated flakes [Fig b].
The internship will be done in the frame of an ANR project, with the possibility of collaborating with several partners and of continuing with a PhD project with existing funding.

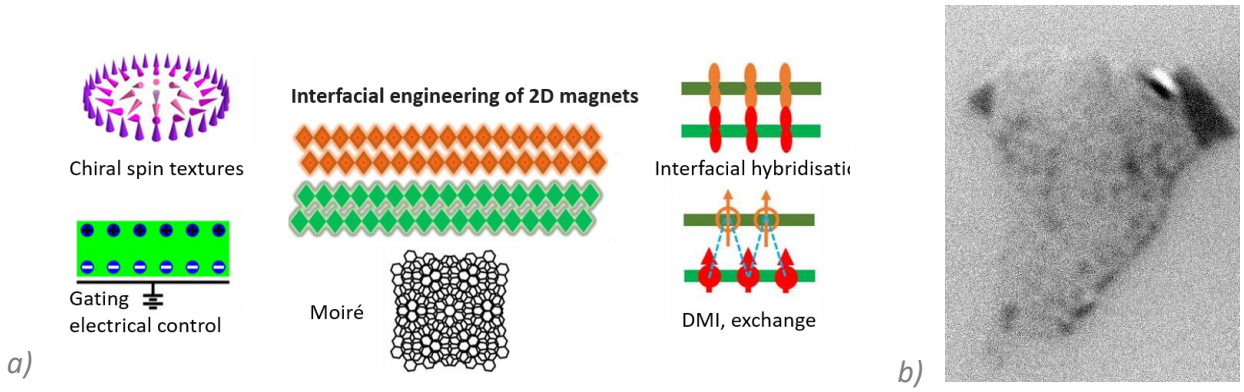

Figure: a) Explored concepts of interfacial engineering in 2D magnets in heterostructures. Adapted from [Gong19, Li22]. b) Magnetic textures in a F3GT flake 25 µm wide at 110K imaged by magneto-optical microscopy (LPS).

[Gong19] C. Gong & X. Zhang, Science 363, 706 (2019)
[Li22] Y. Li et al., ACS Appl. Electron. Mater. 4, 3278 (2022)

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