Phd on the manipulation of spin textures in bidimensional magnets

Van der Waals 2D magnetic materials (2DM) are composed of two-dimensional magnetic layers weakly linked by Van der Waals interactions. The possibilities offered by 2D magnets are huge, ranging from the possibility of exploiting a plethora of different 2D magnetic states, to stacking layers with unique magnetic and electronic properties. The magnetization of these 2DM materials can be manipulated by weak electrical currents, for instance by using a topological insulator in contact with the 2DM material, enabling highly efficient conversion of electric current into spin current [2]. This can be used to write information with low electrical currents in magnetic memories where the information is stored in the direction of magnetization.

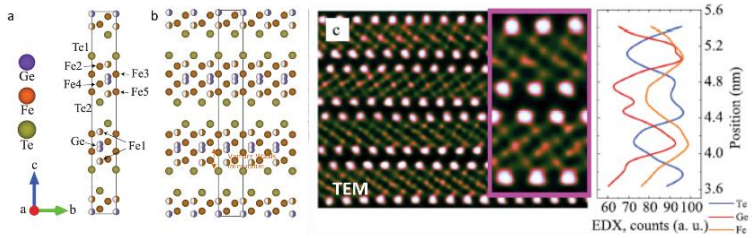

Figure 1 Exemple of a 2D Van der Waals ferromagnet Fe_5GeTe_2 [1]

Magnetic layers can be antiferromagnetically (AF) coupled, forming a zero-magnetization material. These materials are particularly interesting for storing information, as the absence of a stray field means that memory density can be greatly increased. Finally, they can be manipulated much more efficiently by electric currents, and much more rapidly. For instance, we demonstrated at Spintec that magnetic nanobubbles, known as skyrmions, could be moved 10 x faster in AF materials than in ferromagnetic materials [3].

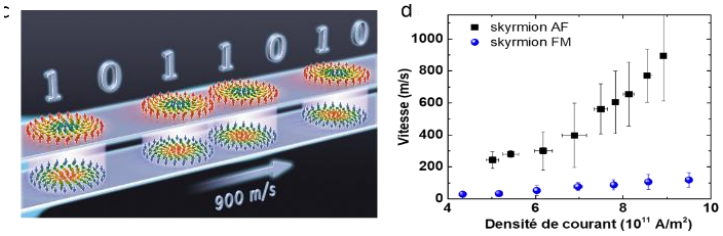

Figure 2 Skyrmions (magnetic nanobubbles) in AF materials move 10x faster than in ferromagnetic materials.

The aim of this PhD is to exploit the properties of 2D magnets to demonstrate chiral spin textures (domain walls, skyrmions) at room temperature and control them efficiently by current. In particular, we aim to demonstrate the fast motion of topological spin textures induced by electric current at room temperature in 2D AFM. To this end, we will design 2D magnets using molecular beam epitaxy (MBE). Materials development will be accompanied by in-depth characterization structural, electronic and magnetic properties, using a wide variety of experimental techniques. Topological spin textures will be observed using a wide variety of magnetic microscopy techniques. The PhD will be will be co-supervised by O. Boulle and M. Jamet, researchers at the Spintec laboratory.

More information: Olivier Boulle, olivier.boulle@cea.fr.

[1] M. Ribeiro *et al.*, Npj 2D Mater. Appl. **6**, 1 (2022)

[1] T. Guillet *et al.*, Nano Lett. (2024)

[1] V. T. Pham,…, *O.* Boulle, Science **384**, 307 (2024).