Master Thesis Project

Laboratoire: CINaM

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Theory of chiral spin textures in 2D van der Waals magnets

The magnetic configuration of magnetic materials is usually determined by the competition between magnetic exchange and anisotropy. In magnets lacking inversion symmetry, e.g., at interfaces, an unusual interaction arises, called the Dzyaloshinskii-Moriya interaction. In contrast with Heisenberg exchange that favors either parallel or antiparallel configuration of neighboring spins, the Dzyaloshinskii-Moriya interaction favors *perpendicular* orientation. When strong enough, this interaction stabilizes chiral magnetic textures, such as magnetic skyrmions, which opens high expectations for applications [1].

The recent experimental realization of two-dimensional van der Waals magnets, i.e., magnetic materials composed of a single atomic layer [2], has boosted the research in chiral magnetism. As a matter of fact, in certain van der Waals magnets, the Dzyaloshinskii-Moriya interaction adopts a very unusual form, far from the one conventionally observed at interfaces [3]. This unique interaction stems from specific broken symmetries in such van der Waals layers. The objective of this Master thesis is to theoretically study the onset of magnetic chiralities in selected van der Waals materials of interest to experimentalists. To do so, the student will develop tight-binding models of such two-dimensional systems. He/she will then investigate the dispersion of spin spirals and the stability conditions of chiral textures using the generalized Bloch theorem. This internship is sponsored by a FLAG-ERA project involving experimentalists from SPINTEC, France and ICN2, Spain.

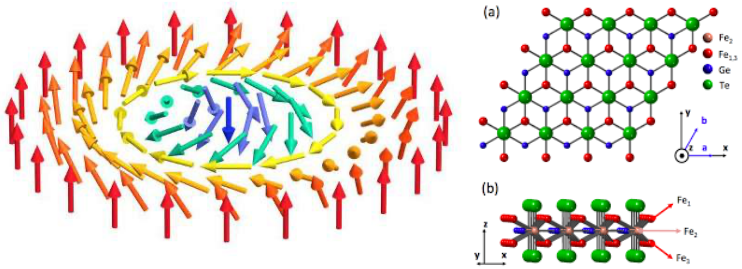

Figure 1 : (Left) Example of a magnetic skyrmion stabilized by interfacial Dzyaloshinskii-Moriya interaction; (right) Crystal structure of the van der Waals ferromagnet, Fe_3GeTe_2.

[1] Fert et al., Magnetic skyrmions : advances in physics and potential applications, Nature Review Materials 2, 17031 (2017)
[2] Belabbes et al., Hund's rule-driven Dzyaloshinskii-Moriya interaction at 3d-5d interfaces, Physical Review Letters 117, 247202 (2016)
[3] Gibertini et al., Magnetic 2D materials and heterostructures, Nature Nanotechnology 14, 408 (2019)
[4] Laref et al., Elusive Dzyaloshinskii-Moriya interaction in monolayer Fe_3GeTe_2, Physical Review B 102, 060402(R) (2020)