Chiral Magnets with Dzyaloshinskii-Moriya Interaction

Javier CAMPO[1]

[1]Aragón Nanoscience and Materials Institute (INMA) Spanish National Research Council (CSIC) and University of Zaragoza. C/Pedro Cerbuna 12, 50009 Zaragoza (Spain)

Chiral magnets are very promising building blocks to design new spintronic devices since they can host magnetic textures protected by topology that can be controlled by magnetic fields or electric currents, which made of them excellent candidates for a new generation of a smart and more efficient spintronics. On the other hand, besides the applications to spintronics, chiral magnets are interesting from a fundamental point of view because the chiral symmetry, and its breaking and restoration, are ubiquitous phenomena appearing virtually in any domain of science, from particle physics to astrophysics, and including chemistry, biology, and geology.

The Dzyaloshinskii-Moriya (DM) interaction, present in non-centrosymmetric magnetic materials, often originates canted or helimagnetic structures depending on the DM vector (~Dij) and the dimensionality of the interactions. In helical monoaxial magnets, for which the strong magnetic anisotropies fix the helical axis along a unique crystallographic axis, several magnetic structures (chiral soliton lattices, helical, conical) can appear depending on the orientation of the applied magnetic field respect to the helical axis. In cubic DM magnets also skyrmionics phases have been found.

Here we will summarize several results obtained by our research group concerning the phase diagram of the monoaxial chiral helimagnet as a function of temperature T and magnetic field with components perpendicular (Hx) and parallel (Hz) to the chiral axis. Also, the stability of the skyrmion textures and the role of the thermal fluctuations in cubic helimagnets has been theoretically investigated by our group. It is show that a skyrmionic "A-phase" might exist as a stable, or metastable, state at low temperatures. We also predicted that a new state ("unknown-state"), different from the typical hexagonal skyrmionic phase, might emerge in the low temperature region of the phase diagram.

This talk also will show that chiral solitons in monoaxial helimagnets can be stabilized with external magnetic fields. Once created, the soliton moves steadily in response to a polarized electric current, provided the induced spin-transfer torque has a dissipative (nonadiabatic) component. We show that using spin-polarized currents chiral solitons in the chiral soliton lattice can be pushed against each other and it is possible to annihilate the solitons one-by-one in a controlled way.

Finally, we will talk about our recent results concerning magnonics. It is a subject of much interest in recent years since it is a promising field that could transform the design of devices for information technology by replacing electric currents by spin waves as information carriers. Focusing on the isolated solitons of monoaxial helimagnets, it is shown that the spin waves scattered (reflected and transmitted) by the soliton suffer a lateral displacement analogous to the Goos-Hänchen effect of optics.