CONDENSED MATTER SCIENCES SEMINAR

Dr Luis Balicas

FSU/ NHMFL

Host

Dr Cyprian Lewandowski

Title

Origin of topological spin textures in centrosymmetric layered ferromagnets

Friday, November 21st, 2025

1st Floor – B101

15:00-16:00

Abstract

In this seminar, I will discuss of our work on centrosymmetric layered ferromagnets1-3 that display topological spin textures, such as skyrmions, merons, etc. despite being centrosymmetric and a priori not subjected to the Dzyaloshinskii–Moriya interaction. For example, Fe3GaTe2 is attracting attention due to its high Curie temperature, low dimensionality, and the presence of topological spin textures above room temperature, making Fe3GaTe2 a good candidate for applications in spintronics. Here, we show, through transmission electron microscopy (TEM) techniques, that Fe3GaTe2 single crystals break local inversion symmetry while maintaining global inversion symmetry according to X-ray diffraction. Coupled to the observation of Néel skyrmions via Lorentz-TEM, our structural analysis provides a convincing explanation for their presence in centrosymmetric materials4,5. Magnetization measurements as a function of the temperature imply that the ground state of Fe3GaTe2 is globally ferrimagnetic and not a glassy magnetic state composed of ferrimagnetic, and ferromagnetic domains as claimed by other groups. Neutron diffraction studies indicate that the ferromagnetic to ferrimagnetic transition upon reducing the external magnetic field is associated with a change in the magnetic configuration/coupling between Fe1 and Fe2 moments. We observe a clear correlation between the hysteresis observed in both the skyrmion density and the magnetization of Fe3GaTe2. This indicates that its topological spin textures are affected by the development of ferrimagnetism upon cooling and suggests that skyrmions are stabilized by competing magnetic phases and distinct exchange interactions. Our study provides an explanation for the observation of Néel skyrmions in centrosymmetric systems, while exposing a correlation between the distinct magnetic phases in Fe3GaTe2 and its topological spin textures. Finally, we will show preliminary data indicating that the coercive fields of Fe3GaTe2 for magnetic fields applied along a planar direction, increase by over one order of magnitude upon exfoliation. This leads to coercive fields comparable to those displayed by commercial hard magnets such as the Nd2Fe14B or Sm2Co17 families of compounds and also to a remarkably large magnetic anisotropy at room temperature.6

[1] J. Macy et al., Appl. Phys. Rev. 8, 041401 (2021)

[2] B. W. Casas *et al.*, Adv. Mater. 35, 202212087 (2023).

[3] A. Moon *et al.*, ACS Nano 18, 4216 (2024).

[4] Sang-Eon Lee *et al*, ACS Nano 19, 28702 (2025).

[5] Sang-Eon Lee *et al*., Phys. Rev. B 111, 184438 (2025).

[6] L. Mei *et al*., (unpublished)