UNL Department of Physics and Astronomy presents:

Curvilinear Magnetism

PRESENTED BY

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THURSDAY

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VIA ZOOM

Refreshments will be served in the JH 1st Floor Vending Area at 3:30

ABSTRACT

Conventionally, tailoring of the Dzyaloshinskii-Moriya interaction (DMI) is done by optimizing materials, either doping a bulk single crystal or adjusting interface properties of thin films and multilayers. A viable alternative to the conventional material screening approach is to explore the interplay between the sample geometry and topology of the order parameter. The research field in magnetism, which is dealing with the study of the impact of geometrical curvature on magnetic responses of curved 1D wires and 2D shells is known as curvilinear magnetism [1-4]. The lack of the inversion symmetry and the emergence of a curvature induced effective anisotropy and DMI stemming from the exchange interaction [5,6] are characteristic of curved surfaces, leading to curvature-driven magnetochiral effects. Volkov et al. has proven that the exchange-driven chiral effects in curvilinear ferromagnets are experimental observables [7] and can be used to realize nanostructures with tunable magnetochiral properties from standard magnetic materials.

A counterpart of the intrinsic DMI for the case of curvilinear magnets is the mesoscale Dzyaloshinskii-Moriya interaction, which is a result of the interplay between the intrinsic (spin-orbit-driven) and extrinsic (curvature-driven) DMI terms [8]. The mesoscale DMI governs the magnetochiral properties of any curvilinear ferromagnetic nanosystem and depends both on the material and geometrical parameters. Its strength and orientation can be tailored by properly choosing the geometry, which allows stabilizing distinct magnetic chiral textures including skyrmion and skyrmionium states as well as skyrmion lattices [9-11]. Interestingly, skyrmion states can be formed in a material even without an intrinsic DMI [9,11]. Very recently, Sheka et al. discovered a novel non-local chiral symmetry breaking effect, which does not exist in planar thin film magnets: it is essentially non-local and manifests itself even in static spin textures living in curvilinear magnetic nanoshells [6].

The field of curvilinear magnetism was recently extended towards curvilinear antiferromagnets. Pylypovskyi et al. demonstrated that intrinsically achiral one-dimensional curvilinear antiferromagnet behaves as a chiral helimagnet with geometrically tunable DMI, orientation of the Neel vector and the helimagnetic phase transition [12,13]. This positions curvilinear antiferromagnets as a novel platform for the realization of geometrically tunable chiral antiferromagnets for antiferromagnetic spinorbitronics.

The application potential of 3D-shaped magnetic thin films is currently being explored as mechanically shapeable magnetic field sensors [14,15] for automotive applications, magnetoelectrics for memory devices, spin-wave filters, high-speed racetrack memory devices as well as on-skin interactive electronics [16-18].

The fundamentals as well as application relevant aspects of curvilinear ferro - and antiferromagnets will be covered in this presentation.

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