Magnetism in curved geometries

Robert Streubel

Lawrence Berkeley National Laboratory

Extending planar two-dimensional structures into the three-dimensional (3D) space has become a general trend in multiple disciplines, including electronics, photonics, plasmonics and magnetics. This approach provides means to modify conventional or to launch novel functionalities by tailoring the geometry of an object, e.g. its local curvature. In a generic electronic system curvature results in the appearance of scalar and vector geometric potentials, which lead to the induced anisotropic and chiral effects. In the specific case of magnetism, even in the simplest case of a curved anisotropic Heisenberg magnet, curvilinear geometry invokes two exchange-driven interactions, namely effective anisotropy and antisymmetric vector exchange, i.e. Dzyaloshinskii-Moriya-like interaction [1]. The family of novel curvature-driven effects, namely magnetochiral effects [2] and topologically induced magnetization patterning [3], causes theoretically predicted unlimited domain wall velocities, spin chirality symmetry breaking and Cherenkov-like effects for magnons. The broad range of altered physical properties makes these curved architectures appealing in view of fundamental research on e.g. skyrmionic systems, magnonic crystals or exotic spin configurations. In addition to these rich physics, the application potential of 3D-shaped objects is currently being explored as magnetic field sensorics for magnetofluidic applications, spin-wave filters, advanced magneto-encephalography devices [4] for diagnosis of epilepsy or for energy-efficient racetrack memory devices. These recent developments starting from the theoretical predictions to the fabrication of three-dimensionally curved magnetic thin films [5], hollow cylinders [6] or wires as well as their characterization using integral means, microscopy and advanced tomography imaging facilitating electrons [8] and X-rays [9] will be addressed.

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