Magnetic antiskyrmions in tetragonal Heusler materials with D_{2d} symmetry

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Skyrmions are magnetic nano-objects with distinct chiral, noncollinear spin textures found in various magnetic systems with crystal symmetries that give rise to specific Dzyaloshinskii–Moriya (DMI) exchange vectors. In previous studies, depending on the crystal symmetry, two distinct types of skyrmions were observed experimentally, namely, Bloch and Néel skyrmions. An important goal is to find new material systems that can host new magnetic topological structures.

A very interesting skyrmionic structure, the magnetic antiskyrmion, was only recently experimentally observed in acentric tetragonal Heusler compounds with D_{2d} crystal symmetry [1]. Antiskyrmions are characterized by boundaries that have alternating Bloch and Néel type wall components as one traces around the boundary. Direct imaging by Lorentz transmission electron microscopy (LTEM) shows field stabilized antiskyrmion over a wide temperature range. These results enlarge the family of magnetic skyrmions and pave the way to the engineering of complex bespoke designed skyrmionic structures.

We have shown that antiskyrmions have unique properties derived from the unique DMI exchange interaction. We have shown that antiskyrmions are much more robust compared to the Bloch skyrmions in the cubic B20 compounds. For example, the field-temperature phase stability window for antiskyrmions, that we have determined from LTEM, is largely insensitive to the sample thickness in contrast to B20 materials [2]. We have carried out detailed micromagnetic simulations that confirm our experimental observations.

Another important property of antiskyrmions that we have discovered [3] is that their size increases by more than an order of magnitude from around 100 nm to more than 1.1 micrometer as the thickness increased. This extreme size tunability is shown to arise from long-range magnetic dipolar interactions, which typically play a much less important role for B20 skyrmions. This tunability in size makes antiskyrmions very attractive for technological applications.

References:

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