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# Magnetic disorder in ferrite nanoparticles: a neutron view beyond the classical picture

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Magnetic iron oxide nanoparticles offer unique magnetic properties attractive for data storage, spintronics, and biomedical applications. Disorder effects are ubiquitous for nanostructured materials and they crucially influence relevant parameters, like the relaxation dynamics and magnetic hyperthermia performance. Despite the technological relevance, a quantitative interpretation of these perturbances of the spin structure remains a key challenge.

Small-angle neutron scattering is a powerful technique to investigate the structure and dynamics of magnetic materials on length scales between about one – 100 nm [1]. Typical investigated systems cover bulk material like chiral magnets and skyrmion hosting materials, shape-memory alloys, Nd-Fe-B based permanent magnets. For magnetic nanocrystals in ferrofluidic dispersion or assembled in densely packed powders, SANS can help to resolve characteristic spin arrangements e.g. reveal the transition from a single-domain to a multidomain state in iron oxide nanoparticles [2].

In this contribution, I will demonstrate how magnetic-field-dependent SANS allows accessing more quantitative information on the spin structure of magnetic nanoparticles. With nm resolution and employing a micromagnetic description of the magnetic structure, neutrons allow distinguishing surface spin disorder from intra-particle disorder contributions in ferrite nanoparticles [3]. Analysis of the data indicates that the total magnetic moment of the particle is strongly field-dependent as the thickness of the magnetically disordered shell reduces with magnetic field.

Figure 1: Representation of the structure (vertical cut) and magnetic (horizontal) morphology of Co ferrite NP [3]. Blue arrows indicate surface spin disorder.


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