Contribution ID: **73** Type: **Poster**

Topology and Origin of Complex Nano-Scale Spin Textures

Friday 10 October 2025 13:00 (30 minutes)

Topology is a powerful concept for describing material properties. In magnetism, topological phenomena emerge when spins within a material point in different directions, giving rise to three-dimensional non-coplanar magnetic order. A prominent example is the magnetic skyrmion, a particle-like state in which the spins wrap around the unit sphere. Such non-coplanar spin textures can result from the competition between different magnetic interactions. Another origin is geometric frustration, as found, for instance, in antiferromagnets on triangular lattices. Non-coplanar magnetic states are characterized by a finite scalar spin chirality, which can manifest in an additional, topological contribution to the Hall effect as well as in an orbital magnetization.
Here, we present spin-polarized scanning tunneling microscopy experiments on systems with complex spin textures, enabling real-space imaging of these magnetic structures at the atomic scale [1]. The driving forces behind the formation of such exotic ground states are revealed through density functional theory calculations combined with atomistic modeling. The magnetic structures we address range from ferromagnetic to nanoscale non-coplanar and collinear antiferromagnetic states. Particle-like magnetic objects such as skyrmions and merons are observed both as isolated entities that can be created and annihilated individually [2-3] and as assemblies that form chains or two-dimensional periodic arrays [4-8]. Two examples of complex topological magnetic domain walls that emerge in otherwise simple magnets will be presented. Additionally, we identify magnetism-driven structural modifications that can be exploited to generate antiferromagnetic domain-wall networks [9] or to act as templates for magnetism-induced anisotropic growth [10]. Taken together, our work on model-type systems provides a versatile toolbox for tailoring magnetic order with respect to length scale, dimensionality, and spin arrangement which are key ingredients for advancing future spintronic applications.

Authors: Dr KUBETZKA, André (Department of Physics, University of Hamburg); HEILMANN, Arved (Department of Physics, University of Hamburg); ZAHNER, Felix (Department of Physics, University of Hamburg); Dr BERGMANN, Kirsten (Department of Physics, University of Hamburg); Prof. WIESENDANGER, Roland (Department of Physics, University of Hamburg)

Presenter: HEILMANN, Arved (Department of Physics, University of Hamburg)

Session Classification: Poster Presentation - DESY Foyer (Building 5)

Track Classification: MIN Materials of the Future