

TUT 1: Tutorial: Ferroics and Skyrmions

This tutorial combines the field of ferroics and domain engineering, their key concepts and materials with recent developments in strongly correlated systems, mainly focusing on skyrmions with polar textures. The basic concepts are introduced which intend to help non-specialists to get informed and involved in these interesting topics. This tutorial launches a 4-day focus (Plenary, Symposium, Focus Sessions and Posters) on ferroics, domain walls, multiferroics and skyrmion systems aiming at inspiring topical discussions to stimulate a vivid scientific exchange.

Organizers: Stephan Krohns, Dennis Meier, Elisabeth Soergel

Time: Sunday 16:00–18:30

Location: HSZ 304

Tutorial TUT 1.1 Sun 16:00 HSZ 304
Introduction to ferroic materials — •CLAUDE EDERER — Materials Theory, ETH Zürich, Switzerland

In this tutorial talk I will give a general introduction to the physics of ferroic materials. I will discuss different cases such as ferro- and antiferromagnets, ferroelectrics, ferroelastics, and multiferroics. The basic phenomenology of ferroics will be introduced on the level of Landau theory, which allows to distinguish proper and improper ferroics and also to describe possible coupling between different ferroic order parameters. The important role of symmetry will be highlighted and microscopic mechanisms that drive the formation of ferroic orders will be mentioned.

Tutorial TUT 1.2 Sun 16:50 HSZ 304
Skyrmions with ferroelectric polarization in multiferroic lacunar spinels — •ALOIS LOIDL — Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, Germany

This tutorial will provide an introductory discussion of polar properties induced by topological spin order. Lacunar spinels will be taken as illuminating examples. They undergo orbital ordering and at low temperatures reveal complex magnetic phases. GaV_4S_8 and GaV_4Se_8 show ferromagnetic, cycloidal and Néel-type skyrmion lattice phases [1,2]. We provide a thorough study of the polar properties and show that the orbitally ordered phases are ferroelectric [3]. Moreover, spin-driven

excess polarizations emerge in all magnetic phases. Hence, they host a zoo of multiferroic phases including the skyrmion lattice of spin vortices dressed with ferroelectric polarization [3]. The low-temperature magnetic phase diagrams document the importance of anisotropy: GaV_4S_8 is an easy axis magnet with a narrow skyrmion-lattice pocket only. In clear distinction, GaV_4Se_8 is governed by easy plane anisotropy, its skyrmion phase is drastically extended and reaches from the magnetic phase boundary down to the lowest temperatures.

[1] I. Kézsmárki *et al.*, Nature Materials **14**, 1116 (2015).

[2] S. Widmann *et al.*, Phil. Mag. (2016), in press.

[3] E. Ruff *et al.*, Science Advances **1**, E1500916 (2015).

Tutorial TUT 1.3 Sun 17:40 HSZ 304
Skyrmions in magnetic materials — •JONATHAN WHITE — Paul Scherrer Institut, Switzerland

Research into magnetic Skyrmions currently attracts significant attention in topological condensed matter physics. Individual Skyrmions display a non-trivial twisted spin structure which, unlike simple ferromagnetic and antiferromagnetic spin structures, is described in terms of a finite topological index. We will introduce how this finite topology endows Skyrmions with remarkable properties, which moreover display a novel interplay with the general properties and dimensionality of the host magnet. We will also explain how the fascinating aspects of the physics of Skyrmions motivates the general expectation that topological spin structures will become pivotal components for future information technology and data storage.