PHYSIKALISCHES KOLLOQUIUM

Wintersemester 2018/19

Das Kolloquium findet (soweit unten nicht anders angegeben) jeweils montags 17:15 Uhr im Hörsaal P des Physikalischen Instituts auf dem Hubland Campus Süd der Universität Würzburg statt.

21. Januar 2019

Prof. Dr. Lukas M. Eng
Technische Universität Dresden
Institut of Applied Physics

Nanoscale Topologies in (Multi) Ferroics: from Bloch & Neel-Type Skyrmions to Conductive Domain Walls

Abstract

Topologies are known to play a prominent role in next-generation nanoscale devices. This talk will focus on two such areas, addressing on the one hand magnetic textures in multiferroic skyrmions materials, while focusing on the other hand on the domain wall (DW) topologies in these ferroelectric nanosystems.
Skyrmion crystals are regular arrangements of magnetic whirls that exist in a wide range of chiral systems such as $Fe_xCo_{1-x}Si$ [1]. Of interest are multiferroic materials as are GaV_4S_8 [2], and $CuOSeO_3$ [3,4] offering the potential for coupled dielectric and magnetic order parameters. We applied here a variety of scanning probe (SPM) techniques (such as MFM, PFM, KPFM, etc.) but equally near-field optical microscopy down to the 1 THz wavelength [5] in order to deduce the local magneto-electric coupling constants and to differentiate between both Bloch- and Néel-type skyrmion lattices (SkX). Also, our SPM methods allow to both create and annihilate single such skyrmions in the mentioned nanosystems, paving the way to SkX-based racetrack memories. – The second type of topological peculiarity in the focus here, are charged ferroic domain walls (DWs) in such ferroelectric materials. Using $LiNbO_3$ (LNO), wide-bandgap semiconductor, we show how such Dirac-type singularities can be rendered permanently conductive, similar to topological insulators. As a consequence, these charged domain walls (CDWs) penetrate across mm-thick LNO single crystal, allowing for both AC [6] and DC [7] electron transport at room temperature. I will show how to optimize these 2D sheet conductors [8,9,10]. Since such metallic-like, 2D sheets can be engineered practically on will, they provide a novel and elegant way not only for exploring

fundamental 2D electron gases at room temperature, but equally also for assembling top-modern nano-electronic devices.

References:

[1] P. Milde et al., *Science* **340**, 6136 (2013).
[2] I. Készmárki, et al., *Nature Materials* **14**, 1116 (2015).
[3] S. Zhang, et al., *Nano Lett.* **16**, 3285 (2016).
[4] P. Milde et al., *Nano Lett.* **16**, 5612 (2016).
[5] S.C. Kehr et al., *ACS Photonics* **3**, 20 (2016).
[6] M. Schröder et al., *Adv. Funct. Mater.* **22**, 3936 (2012).
[7] M. Schröder et al., *Mater. Res. Express* **1**, 035012 (2014).
[8] Ch. Godau et al., *ACS Nano* **11**, 4816 (2017).
[9] T. Kämpfe et al., *Appl. Phys. Lett.* **107**, 152905 (2015).
[10] A.-S. Pawlik et al., *Nanoscale* **9**, 10933 (2017).

Für die Dozenten der Fakultät für Physik und Astronomie

Frau Prof. Dr. Erdmenger, Prof. Dr. Bode, PD Dr. Behr und Herrn Steppert