On-line SPICE-SPIN+X Seminars

Wednesday, 13th October 2021, 15:00 (CET)

The seminar will be via Zoom (Meeting ID: 837 9828 0554) and live streamed in the SPICE YouTube Channel.

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Magnetic skyrmion strings: how they bend, twist and vibrate

Magnetic skyrmions are smooth topological textures of the magnetization that are localized within a two-dimensional plane. In bulk materials, they extend in the third direction forming an effective string. Such skyrmion strings either arise as excitations or they condense and form a crystal.

These strings can be dynamically excited resulting in various vibrational modes. We provide an overview of the dynamics of skrymion strings [1], that can be found in chiral magnets, and we compare theoretical predictions with magnetic resonance spectroscopy [2], spin-wave spectroscopy [3] and inelastic neutron scattering. At high energies, the spin-wave dynamics is governed by an emergent orbital magnetic field that is directly linked to the topological density of the skyrmions. As a result, magnon Landau levels emerge in skyrmion crystals. At low-energies the dynamics is determined by an effective elasticity theory of the strings. We focus, in particular, on the low-energy theory of a single string and demonstrate that it supports non-linear solitary waves [4] similar to vortex filaments in fluids. Finally, we discuss the influence of spin-transfer torques. Whereas it is well-known that a spin current flowing perpendicular to the string results in a skyrmion string motion, we demonstrate that a longitudinal current destabilizes the string.

[1] M. Garst, J. Waizner, and D. Grundler, J. Phys. D: Appl. Phys. 50, 293002 (2017).
[2] T. Schwarze et al., Nat. Mater. 14, 478 (2015).
[3] S. Seki et al., Nat. Commun. 11, 256 (2020).
[4] V. P. Kravchuk et al., Phys. Rev. B 102, 220408(R) (2020).