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Fachbereich Physik, Universität Stuttgart
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Magnetic skyrmion strings: how they bend, twist and vibrate

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Abstract

Topological strings are effectively one-dimensional objects that can be found in diverse systems such as domain walls in magnetic films, vortex filaments in fluids or, potentially, cosmic strings in the universe. Usually, these stringlike objects can elastically bend and twist, and this elasticity also determines their dynamical behavior at low energies. A particular example are magnetic skyrmions that are smooth topological textures of the magnetization that are localized within a two-dimensional plane. They arise in magnetic systems that lack inversion symmetry where they are stabilized by the Dzyaloshinskii-Moriya interaction. In bulk materials, magnetic skyrmions extend in the third direction forming an effective string.

These strings can be dynamically excited resulting in various vibrational modes. We provide an overview of the dynamics of skrymion strings, that can be found in chiral magnets like MnSi or FeGe, and we compare theoretical predictions with magnetic resonance spectroscopy, spin-wave spectroscopy, inelastic neutron scattering and Brillouin light 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 giving rise to magnon Landau levels. At low-energies the dynamics is determined by an effective elasticity theory. We show that a single string supports non-linear solitary waves similar to vortex filaments in fluids.