Departamento de Física de Materiales

SEMINARIO

Skyrmion Lattices in Random and Ordered Potential Landscapes

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Since the initial discovery of skyrmion lattices in chiral magnets [1], there has been a tremendous growth in this field as an increasing number of compounds are found to have extended regions of stable skyrmion lattices [2] even close to room temperature [3]. These systems have significant promise for applications due to their size scale and the low currents or drives needed to move the skyrmions [4]. Another interesting aspect of skyrmions is that the equations of motion have significant non-dissipative terms or a Magnus effect which makes them unique in terms of collective driven dynamics as compared to other systems such as vortex lattices in type-II superconductors, sliding charge density waves, and frictional systems. We examine the driven dynamics of skyrmions interacting with random and periodic substrate potentials using both continuum based modelling and particle based simulations. In clean systems we examine the range in which skyrmion motion can be explored as a function of the magnetic field and current and show that there can be a current-induced creation or destruction of skyrmions. In systems with random pinning we find that there is a finite depinning threshold and that the Hall angle shows a strong dependence on the disorder strength. We also show that features in the transport curves correlate with different types of skyrmion flow regimes including a skyrmion glass depinning/skyrmion plastic flow region as well as a transition to a dynamically reordered skyrmion crystal at higher drives. We find that increasing the Magnus term produces a low depinning threshold which is due to a combination of skyrmions forming complex orbits within the pinning sites and skyrmion-skyrmion scattering effects. If the skyrmions are moving over a periodic substrate, with increasing drive the Hall angle changes in quantized steps which correspond to periodic trajectories of the skyrmion that lock to symmetry directions of the substrate potential.

[1] S. Muhlbauer et al Science 323 915 (2009).
[2] X. Z. Yu *et al*. Nature 465, 901–904 (2010).
[3] X.Z. Yu et al Nature Materials, 10, 106 (2011).
[4] A. Fert, V. Cros, and J. Sampaio Nature Nanotechnology 8, 152 (2013).