Colloquium
Dahlem Center for Complex Quantum Systems

Exciting skyrmions in chiral magnets

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Abstract:

Chiral magnets, encompassing the metal MnSi, the semiconductor $Fe_{1-x}Co_xSi$ and the insulator Cu_2OSeO_3, gain Dzyaloshinskii-Moriya spin-orbit energy by twisting the magnetization on a long length scale giving rise to spatially modulated magnetic textures like helices and skyrmion lattices. Originally conceived by Tony Skyrme in the context of nuclear physics as a model for baryons, skyrmions are topologically protected structures, here, of the magnetization and characterized by a winding number. The topological nature of these objects gives rise to various interesting phenomena like a topological Hall effect, a Skyrmion-flow Hall effect and spin-torque effects at ultralow threshold currents. After an introductory overview, we focus in this talk on the excitations of magnetic skyrmions and their interaction with spin-waves. We first discuss the excitations of the skyrmion lattice phase, which possesses three magnetic resonance frequencies previously identified to be two gyration modes and a single breathing mode. Taking into account long-range dipolar interactions and demagnetization effects, we find quantitative agreement with experimental data obtained with the help of a coplanar waveguide geometry [1]. Afterwards, we explore the excitation modes of a single skyrmion and its scattering of spin-waves.

[1] "Universal helimagnon and Skyrmion excitations in metallic, semiconducting, and insulating chiral magnets",
T. Schwarze, J. Waizner, M. Garst, A. Bauer, I. Stasinopoulos, H. Berger, C. Pfleiderer and D. Grundler, submitted.