Nonlinear Spin Waves in Micro-Nanostructures

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Abstract:

In this talk we discuss our recent experiments on nonlinear spin waves in microscopic magnetic structures based on thin Permalloy films. The experiments were performed with the help of space- and time-resolved micro-focus Brillouin light scattering spectroscopy enabling visualization of spin-wave propagation with sub-micrometer spatial and nanosecond temporal resolutions. We show that the nonlinearity of the spin-system of metallic magnetic films together with microscopic-scale confinement effects lead to anomalous nonlinear magnetic phenomena, which do not appear on the macroscopic scale. In particular, we present experimental results on nonlinear spatial self-modulation of spin-wave beams observed for propagation geometry characterized by the repulsive nonlinearity, nonlinear hybridization of the eigenmodes of microscopic Permalloy ellipses, and spin-wave confluence processes resulting in an efficient nonlinear excitation of higher-order propagating spin-wave modes of microscopic waveguides. These experimental findings contribute to the recently established scientific field of spin-wave nano-optics, as well as to the general physics of strongly dissipative nonlinear systems. We believe that the presented results will stimulate further theoretical studies in the nonlinear physics and bring new ideas for technical applications of high-frequency magnetization dynamics in magnetic nanostructures.

References:

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