Magnetic field-induced spin wave freezing in magnetic films

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Spin waves (SW), collective oscillations of magnetization, propagating in magnetic materials, are perspective for future logic and data storage systems. The spin-wave-mediated spin reorientation transition (SRT) from perpendicular to in-plane magnetization arrangement occurs at the critical external magnetic field H^* applied in the plane of magnetic films with uniaxial magnetic anisotropy and Dzyaloshinskii-Moriya interaction (DMI). The effect of „spin wave freezing“ can be observed at H^* (depending on the magnetic anisotropy and the film thickness), when the phase and group velocity of a SW in a uniformly magnetized structure drops to zero, and the waveform is frozen, giving rise to a stripe domain structure [1]. The theory of SW freezing is universal, and expected to be applied in a large class of materials with uniaxial anisotropy. It allows to understand better the connection between magnetization statics and dynamics in magnetic materials. SW freezing was studied using complementary techniques: superconducting quantum interference device (SQUID), vector-network-analyzer ferromagnetic resonance (VNA-FMR), and Brillouin Light Scattering (BLS), in the real system of $(Re/Co/Pt)_{20}$ magnetic multilayers with DMI [2]. The experimental results of static and dynamic behavior, supported by micromagnetic simulations, create an overall consistent picture of the investigated phenomenon.

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[1] J. Kisielewski, P. Gruszecki ,M. Krawczyk, V. Zablotskii, and A. Maziewski, “Between waves and patterns: Spin wave freezing in films with Dzyaloshinskii-Moriya interaction” Physical Review B 107, 134416 (2023)

[2] J.Kisielewski, K. Lenz, P. Gruszecki, R. Gieniusz, U. Guzowska, M. Kisielewski, A. Lynnyk, A. Pietruczik, A. Wawro, and A. Maziewski, “Spin wave freezing in Re/Co/Pt multilayers”, submitted