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Photo-magnonics: excitation of magnonic materials by femtosecond laser pulses

MARKUS MUENZENBERG, I. Phys. Institute, Goettingen University

Analogue the photonic crystals, a periodic modification of a magnetic material is prepared by forming an anti-dot lattice for spin waves. The resulting bands are generally complex in the magnetic case because of different dispersions along different magnetization directions (backward volume and Damon-Eshbach mode). They depend on the variation strength of the periodic magnetostatic potential. All-optical femtosecond laser experiments allow the excitation of spin-waves with comparable amplitudes as field pulse and resonance techniques today. It is a promising valuable alternative method to study spin-waves and their relaxation paths in a magnonic material. Laser pulses with a duration of 60 fs from a Ti:Sapphire regenerative laser system are used for optical excitation (pump pulse) as well as for the observation of the subsequent magnetic relaxation (probe pulse). The initial local single spin-flip excitation is subsequently decaying into spin waves lower in energy within the pico- and nanosecond regime over a wide spectral range. In focus of our investigation is the propagation and localization of dipolar surface modes (Damon-Eshbach) in thin Nickel and (low damped) CoFeB film cubic and hexagonal lattice structures. Their mode dispersion is measured by applying different magnetic fields which shift the energy of the mode and allows identifying them. We find well defined modes in the condensed state with a specific pronounced k-value determining the properties of the propagating spin wave. One example for a distinct modification of the magnonic periodic structure is a line defect that can function as a wave guide inside the magnonic gap region. An increased intensity of the Damon Eshbach mode by a factor of two is found in the wave guide region. A study of these wave guides will allow to specifically design the material properties, making magnonic materials the material of choice for advanced spin computing devices.