Micromagnetic study of bright and dark solitons in ultra-thin films of iron garnets

A. Janutka[1]

[1] *Department of Theoretical Physics, Wrocław University of Science and Technology, 50-370 Wrocław, Poland*

Author's micromagnetic model [1] of thin (10 nm thickness) films of ferrimagnetic YIG and GdIG with (interface induced) perpendicular magnetic anisotropy is applied to numerically study the propagation and collisions of very (down to 2 ns) narrow spin-wave pulses in 500 nm wide nanostripes. The bright and dark pulses are simulated on the background of different GHz modes which are created from model (periodically driven) antennas at the ends of the nanostripes. The spin-wave pulses exhibit nonlinear properties; temporal increase of their heights at certain distances of the propagation as well as stability against collisions with other pulses. Similar to previous observations, the bright and dark solitons can be created in the very same systems just via changing the way of the pulse excitation [2]. The ferromagnetic-like modes in YIG nanostripes are stable above a threshold frequency. Below the threshold, solitons on ferrimagnetic-mode background are created. The former-type mode is not relevant to GdIG at the magnetic moment compensation regime of temperatures. Moreover, relatively small changes in material parameters of GdIG compared to YIG are found to make pulsed excitations in the compensated ferrimagnet not to be stable beyond a very narrow range of frequencies.

References:

[1] A. Janutka and C. A. Ross, *J. Appl. Phys.* **138** (2025) 063904
[2] M. M. Scott, et al., *Phys. Rev. B* **71** (2005) 174440