PT-symmetric magnonic waveguides

X.G. Wang [1], G.H. Guo [1], and J. Berakdar [2]

[1]*School of Physics and Electronics, Central South University, Changsha 410083, China*
[2]*Institut für Physik, Martin-Luther Universität Halle-Wittenberg, D-06120 Halle/Saale, Germany*

Controlling the low-energy excitations in magnetic nanostructures is the key to magnonic-based computing and data transfer. A study is presented that demonstrates a scheme for an efficient control of magnonic signals in a stack of magnetic slabs separated by current-carrying metallic nanoscale spacer layers. Analytical and full numerically analysis shows that proposed structure has a magnonic spectrum that is highly susceptible to external perturbations and is governed by a parity-time (PT) symmetric Hamiltonian. The nonlinearity can be tuned by the dc charge currents, the number of stacking layers or/and by the intrinsic properties of the stacking layers. The method is applicable to ferro- and antiferromagnetic coupling. Physically, the currents in the spacer layers act with spin-orbit torques on adjacent magnetic layers. These torques may damp or antidamp magnonic excitations, depending on the spacer-charge current density and the number of stacking layers, a point can be reached where damping and antidamping are balanced. Beyond this exceptional point (EP) the magnonic system enters a PT -symmetry-broken phase. We discuss the behaviour of the system near the EP in particular the high sensitivity even to weak perturbing fields. Scanning the external fields in a loop that encloses the EP in the dispersion manifold, we identify a nonreciprocal topological energy transfer between different magnon modes.

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