

Vertical control in Magnonics for tunable magnon-magnon interaction, magnonic metal-to-insulator transition, and magnon population transfer

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In Magnonics, the combination of layers with different geometric patterns offers a variety of dynamic degrees of freedom for magnon control at the nanoscale, leading to versatile, miniaturized and extremely low dissipation devices for information transport and manipulation. We show by micromagnetic simulations and experimental evidence how, in coupled artificial spin ice (ASI) and film layers, a frequency selective magnon-magnon interaction arises between the film spin wave and the ASI modes [1]. The ASI modes which are involved (either edge or bulk) can be selected by the choice of the materials, mainly based on the saturation magnetization values [2]. Then, we investigate a straight film layer with an undulated, periodic magnetization distribution created, through inverse magnetostriction, by the coupling with a ferroelectric layer with a periodic polarization direction [3]. The result is a dynamic magnonic crystal displaying a magnonic band structure, with a frequency gap and a dispersion curvature which can be finely tuned by varying the electric field applied on the ferroelectric layer, which we simulate through a variable uniaxial magnetic anisotropy [4]. We discuss the transition between a magnonic metal state, interpreted within the Dirac's magnon picture, and an insulator state, with controllable frequency gap position and width. Finally, in the context of magnonic directional couplers, we show how the magnon population transfer can be finely adjusted from 0 to 100% by varying the anisotropy coefficient only, in a limited interval, without any external applied magnetic field. All these results are particularly interesting in the prospect of next generation highly efficient and extremely low power magnonic devices.

References:

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