Towards graded-index magnonics: Steering spin waves in networks of magnonic waveguides

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The spin-wave dispersion is inherently complex and anisotropic, depending on both several magnetic parameters of the magnonic medium and the angle between the spin-wave vector and effective magnetic field. We have used time-resolved scanning Kerr microscopy and micromagnetic simulations to study the propagation of spin waves across Permalloy and yttrium-iron-garnet (YIG) waveguides, arranged to form junction structures and biased asymmetrically. We demonstrate that the non-uniformity of the internal magnetic field and magnetization inherent to patterned magnetic structures (Fig. 1(a)) can create a medium of graded refractive index for propagating magnetostatic waves and can be used to steer their propagation in magnonic architectures (Fig. 1(b)-(c)). The character of the non-uniformity can be tuned and potentially programmed using the applied magnetic field. Thus, our findings suggest a possibility of a novel reconfigurable computing and / or signal processing technology based on the principles of the graded-index magnonics.

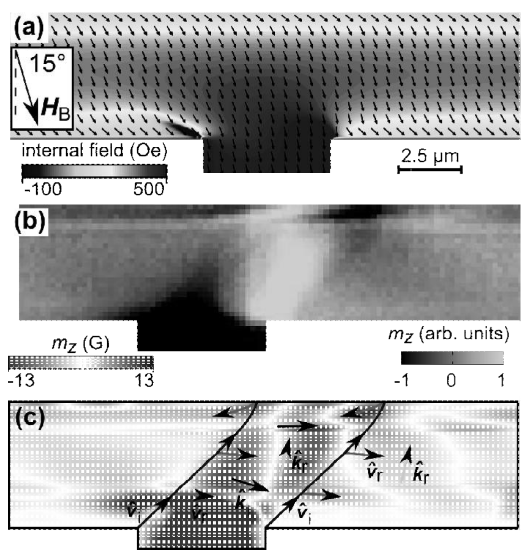

Fig. 1 (a) The calculated distribution of the static magnetization (arrows) and the projection of the internal field on to the magnetization (colour) in a 5 μm wide T-junction structure. The global bias field $\boldsymbol{H}_B$ = 500 Oe is applied at 15° to the "leg" of the T-junction. (b) An experimental snapshot of spin wave propagation. (c) The calculated variation of the initial/reflected magnonic group velocity $(\boldsymbol{v}_i)/(\boldsymbol{v}_r)$ and wave vector $(\boldsymbol{k}_i)/(\boldsymbol{k}_r)$ overlaid on a snapshot of similar spin wave propagation obtained from micromagnetic simulation.