



Non-Reciprocal Spin Wave Beams in Out-Of-Plane Magnetized Films from Circular Antennas

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Spin waves constitute the building blocks of novel wave computing methods such as spectral analysis [1], and neuromorphic computing [2], which are all interference based techniques. Recently, basics concepts of optics applied to spin waves demonstrated the possibility to shape and stir spin wave beams, suggesting prominent performance in particular tasks such as image processing and speech recognition.

Along these ideas, we demonstrated that the beamforming of spin waves in a ferromagnetic thin films follows directly the near-field interference pattern of the excitation geometry [3, 4]. In this communication, we investigate the interference of magnetostatic forward volume waves excited by a quarter circular antenna, which acts as a spin wave concentrator amplifying the magnetization dynamic at its focal point (see Fig. 1). We first measure via spin wave spectroscopy the radius and frequency dependence of the amplification ratio in the vicinity of the focal point, and obtain good agreement with the corresponding near-field diffraction [4] and micromagnetic simulations in the linear regime. Secondly, we observe a distortion of the diffraction pattern around the focal point above a certain input power that nevertheless remains below the non-linear threshold of the antenna. This distortion is likely due to a non-linear dynamics at the focal due to the concentration effect. Thirdly, despite the isotropic dispersion relation for these spin wave modes, we observe an asymmetry in the diffraction pattern, which is reversed upon switching the bias field polarity. We attribute this unexpected non-reciprocal effect results to the curvilinear excitation geometry combined with the gyrotropic nature of the spin wave response. We anticipate that these findings open up new perspectives for the exploration of non-reciprocal magnonic devices.

This work was supported by the French ANR project "MagFunc" and the Département du Finistère through the project "SOSMAG".

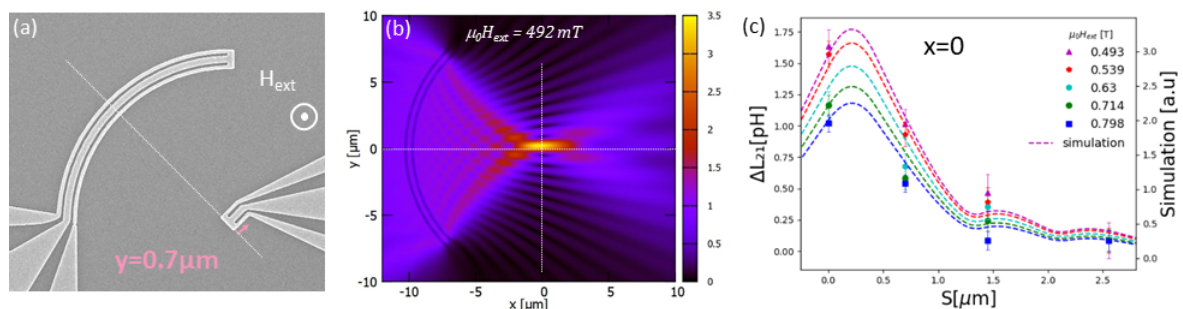


Figure 1: (a) SEM image of a spin wave concentrator. (b) Near-field diffraction simulation at $\mu_0 H_{ext} = +492 \text{ mT}$ showing an up-shift of the spin wave beam. (c) Discrete mapping of the spin wave amplitude across the focal point.

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