Controlling Spin-Wave Frequency and Trajectory Through Inelastic Scattering on Localized Modes

(preliminary report)

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Spin waves (SWs) are captivating phenomena in the realm of magnetic materials, holding promise as potential low-energy consuming carriers of information. Their inherent nonlinear dynamics facilitate access to intriguing phenomena such as confluence and stimulated splitting processes. In this study, we investigate the intricate interaction between incident SW beams and localized SW modes at the edge of ferromagnetic film. We employ the demagnetizing field dip at the film's edge to localize the SW modes [1]. Our investigation reveals the emergence of new beams due to confluence and stimulated splitting processes, as depicted in Fig 1. Consequently, two additional beams with altered frequencies and angles of propagation relative to the incident beam frequency are generated, driven by the frequency of the localized mode. Our study entails a comparative analysis of the efficiency of both inelastic scattering processes and demonstrates the higher efficiency of the stimulated splitting process over confluence. Additionally, we explore the lateral displacement of inelastically scattered SW beams along the interface, which we interpret as a magnonic counterpart to the Goos-Hänchen effect. Here observed for inelastically scattered beams [2], as illustrated in the inset of Fig 1. We establish a correlation between the lateral shift of inelastically scattered beams and the edge mode frequency. In conclusion, our research enhances the understanding of nonlinear processes involving SWs, potentially catalysing the development of magnonic systems harnessing nonlinear SW

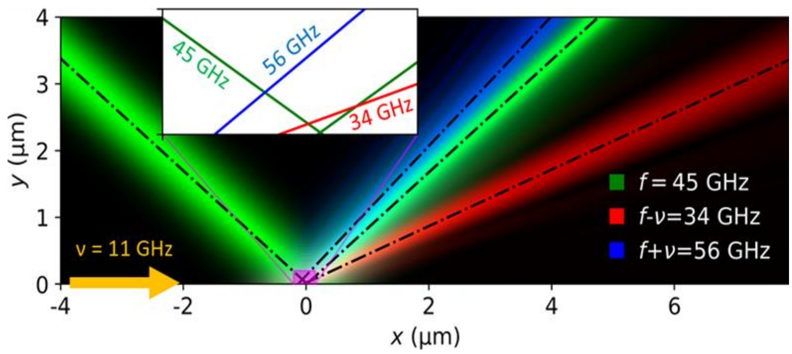

Fig. 1. Example of the inelastic scattering of a SW beam (frequency 45 GHz, green colour) on an edge mode (frequency 11 GHz, orange colour). The inelastic scattering results in creation of two new SW beams with new frequencies, 32 GHz (stimulated splitting process, red colour) and 56 GHz (confluence process, blue colour). The inset shows trajectories of the beams, derived in the far field, at the system's edge. The spatial shift of scattered beams is evident.

dynamics.

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[1] P. Gruszecki, et al., Phys. Rev. Applied 17, 044038 (2022)
[2] Y. S. Dadoenkova, et al., Optical Materials Express 12, 717, (2022)