DOMAIN WALL MOTION DUE TO STRAY MAGNETIC FIELD FROM SPIN WAVES

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In this study, we use micromagnetic simulations [1, 2] to investigate the dynamics of a domain wall (DW) within a ferromagnetic Ni strip deposited on a yttrium-iron-garnet (YIG) thin film. The aim is to initiate and control the displacement of the DW by the stray magnetic field generated by spin waves (SW) propagating in the YIG layer. By comparing the ferromagnetic resonance (FMR) frequency spectra in the strip and a DW displacement over different SW frequencies (Fig. 1), we uncovered interesting correlations. Specifically, we found that at certain SW frequencies - 3.96 GHz and 6.26 GHz - the DW shows a pronounced shift up to 150 and 200 nm from the equilibrium position, and these frequencies coincide with selected resonance peaks in the FMR spectra. We attribute this effect to the spatial localisation of the SW oscillations exclusively in the DW at these frequencies. In contrast, at other FMR peaks, the SW amplitude is distributed throughout the strip or is restricted to end regions, and the resulting DW motion remains insignificant. Interestingly, when the stray magnetic field from the SWs is removed, the DWs return to equilibrium.

These findings are promising for the development compact memory and logic elements for magnonic circuits, laying the groundwork for SW data storage and processing units, including magnetic data flip-flops for sequential logic operations and magnonic artificial neural networks.

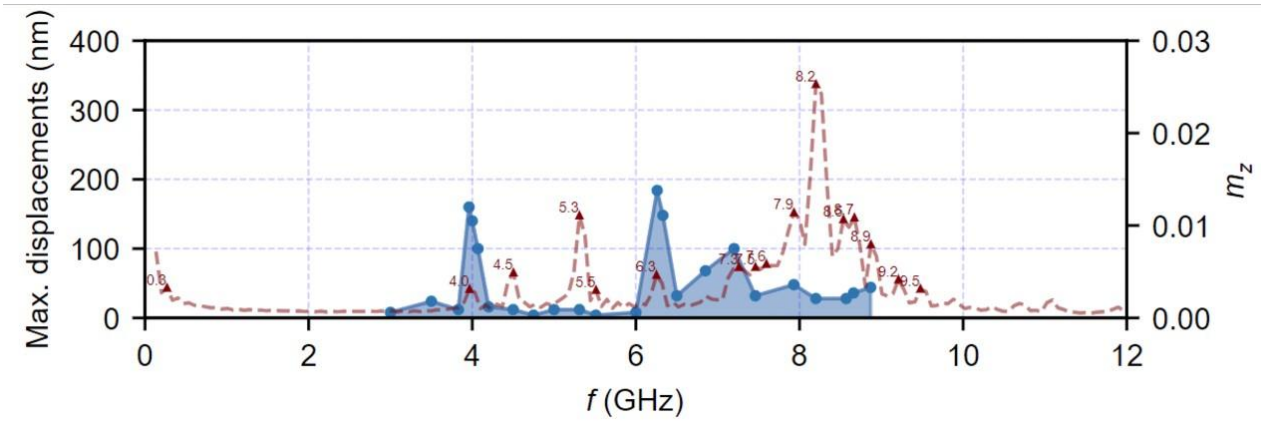

Fig. 1: DW displacement versus frequency (0–12 GHz) [blue data point and left axis], highlighting peaks at 3.96 GHz and 6.26 GHz where SW induce a significant shift of the DW. Red dashed line (and right axis) indicates FMR spectra in the Ni strip.

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References:

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