Half-metallic Co_2MnSi microstructures as a versatile platform for nonlinear magnetisation dynamics

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Half-metallic Heusler compounds combine sought-after material properties for spintronics and magnonics, particularly promising to bridge efficient spintronic manipulation with decent spin wave propagation characteristics [1,2]. Nonlinear magnetisation dynamics are increasingly exploited in both fields, largely motivated by an application towards unconventional computing [3,4]. Here, we report on the potential in half-metallic, $L2_1$-ordered Co_2MnSi microstructures for versatile applications of nonlinear magnetisation dynamics.

We study microsized Co_2MnSi waveguides by microfocused Brillouin light scattering spectroscopy. We observe a significant nonlinear frequency shift and investigate the nonlinear scattering into secondary spin wave modes. We find a first order instability exclusion range even towards vanishing external bias fields, which we link to the intrinsic cubic magnetocrystalline anisotropy of the material. We observe an excitation and suppression of secondary spin wave modes for certain power ranges and study these as a function of the bias field, driving frequency and excitation power. Additionally, we observe the generation of multiple higher harmonic spin wave modes for driving frequencies below the spin wave band bottom. Moreover, nonlinear dynamics are obtained for excitation powers of $P \leq 0.1\,\mathrm{mW}$ across various investigated device geometries, and we partly attribute these low threshold powers in comparison to other conductive materials [5] to the record-low damping in the half-metallic compound Co_2MnSi [1]. Our findings point towards a low-power nonlinear device operation with various functionalities even towards vanishing external bias field, opening perspectives for versatile hybrid applications of half-metallic Co_2MnSi microstructures at the intersection between magnonics and spintronics.

References:

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