All-Magnonic Frequency Combs in Softmagnetic Structures

Alexandra Schrader[a] , Chris Körner[a], Rouven Dreyer[a], and Georg Woltersdorf[a]
a: Martin Luther University Halle-Wittenberg, Germany

Invited Talk - In-Depth Report

We have observed the emergence of a magnonic frequency comb in extended Permalloy films [1] as well as in microstructures of Permalloy and CoFeB. Since the frequency comb generation appears to be a unique feature of softmagnetic materials at very low bias fields, we presume a strong correlation between the static ground state and the emerging dynamics.
In the case of microstructures, the higher harmonic generation is indeed connected to the non-uniform domain structure at the edges. However, the presence of these edge effects reduces the frequency multiplication efficiency.

During this talk, various magnetic imaging techniques will be discussed in relation to the investigation of magnonic frequency combs. Static Kerr microscopy is employed to analyze the magnetic ground state and obtain hysteresis curves, exploiting the Kerr effect in longitudinal geometry. For the dynamic imaging of spin waves, two techniques will be examined in detail. Firstly, Super-Nyquist-Sampling (SNS) magneto-optical Kerr effect (MOKE) microscopy utilizes the polar Kerr effect to detect the dynamic magnetization component stroboscopically, providing a diffraction-limited mapping of coherent spin waves [2]. Secondly, a microscopy setup based on nitrogen vacancy (NV) centers will be presented. This technique is capable of detecting larger wavevectors because the NV centers function as local probes; however, this comes at the expense of reduced spatial resolution.

The aim is to combine the information gathered by these different techniques to quantify the impact of material, sample layout and fabrication and experimental conditions in terms of the efficiency of magnonic comb generation.

[1] Koerner et al., Science **375** (2022)

[2] Dreyer et al., Phys. Rev. Mat. **5** (2021)