INSTITUT JEAN LAMOUR

UNIVERSITÉ DE LORRAINE

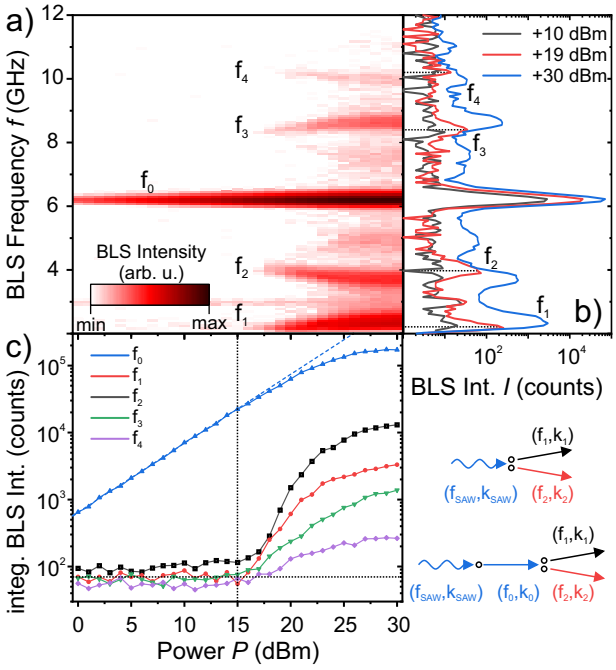
Seminar: Jun-Prof. Dr. Philipp Pirro – T.U. Kaiserslautern

Thursday March 17th 2022 at 14h30- Salle Patrick Alnot (4-A014)

Nonlinear magnon-phonon process in coherently driven microstructures

Magnetoelasticity, the interaction between magnetism and elastic strain, is a promising mechanism for compact and energy-efficient spintronic devices. In particular, the interaction between the fundamental excitations in a magnetic solid, the magnons and the phonons, is of high relevance for future hybrid devices for data processing and computing.

In this contribution, we present recent results on nonlinear magnon-phonon processes in strongly excited thin film microstructures. First, we present the generation of spin-wave instabilities by coherent surface acoustic waves in a thin metallic ferromagnetic film of CoFeB [1]. Micro-focused Brillouin light scattering spectroscopy (see Figure) and analytical modelling combined with micromagnetic simulations are used to reveal the different instability processes by identifying the involved mechanisms and magnon modes. Depending on the experimental conditions, a four-magnon instability of the magnon mode or a direct first-order parametric phonon-to-magnon instability is observed. The latter is enhanced by three-magnon splitting of the non-resonantly driven magnon.



Parametric phonon-to-magnon instability in a CoFeB thin film excited by SAW at frequency f_0. (a) and (b) BLS spectra (c) intensity of the involved modes as a function of SAW driving power.

Second, we investigate the influence of the magnon-phonon interaction on nonlinear redistribution processes in microstructures of Yttrium Iron Garnet (YIG) coherently excited by microwave antennas. Using coupled simulations of the micromagnetic and elastic domain [2], we demonstrate that the experimentally observed magnon accumulation at the band bottom of the first perpendicular standing spin waves mode can be related the to the magnetoelastic interaction.

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[1] M. Geilen et al., "*Parametric Excitation and Instabilities of Spin Waves driven by Surface Acoustic Waves*" arXiv:2201.04033 (2022).
[2] F. Vanderveken, et al. *Finite difference magnetoelastic simulator,* Open Research Europe **1**, 35 (2021).

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