Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

Friday, March 17th 2017 – 10:00
CFEL Seminar room IV, O1.111 (Bldg. 99)

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Transient Grating Spectroscopy in Magnetic Thin Films: Elastic Excitation of a Transient Magnonic Crystal

Control of material properties is one of the driving forces in ultrafast optical sciences. The notion that light can influence material parameters is founded on a wide range of experiments demonstrating opto-magnetic control, light induced superconductivity, and the photo induced insulator to metal transition in a wide range of materials. A recent addition to the tool chest of control methodologies is the excitation of acoustic waves, and their effect on intrinsic materials properties; particularly the material magnetization via magnetostrictive effects.

In this talk I will describe our experimental approach to optically study magnetoelastic interactions in ferromagnetic films. Using the ultrafast transient grating (TG) and Faraday techniques, I will show that the induced spatial variation in magnetization profile results in a spectrum of localized spin wave modes, a (transient) magnonic crystal, that can be driven resonantly by the underlying elastic waves. The localization of the spin wave mode is determined by the orientation of the applied magnetic field. As a second topic of discussion, I will expand beyond linear resonant magnetoelastic interactions to highlight the onset of nonlinear and parametric interactions, which provide for a range of frequency conversion capabilities. In these scenarios, the ferromagnetic precession occurs at frequency multiples of the underlying elastic waves.

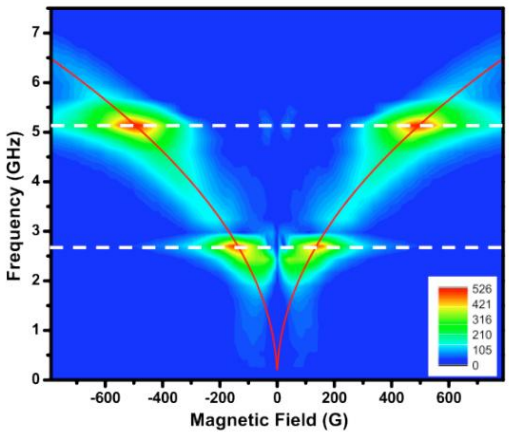

Figure: Magnetic precession frequency as a function of in-plane applied magnetic field.
The oscillation amplitude is maximized when the acoustic frequencies (white horizontal lines) match the FMR resonance (red line) and demonstrates the resonant coupling between elastic and magnetic degrees of freedom.

Host: Andrea Cavalleri

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