Elastic Activation of Localized Spin Wave Modes in a Transient Magnonic Crystal

C.L. Chang[1], S. Mieszczak[2], R.R. Tamming[1], J. Janusonis[1], P. Graczyk[2], J.W. Klos[2], and R.I. Tobey[1]

[1] *University of Groningen, Zernike Institute for Advanced Materials, Groningen, The Netherlands*
[2] *Faculty of Physics, Adam Mickiewicz University in Poznan, Poznan, Poland*
r.i.tobey@rug.nl

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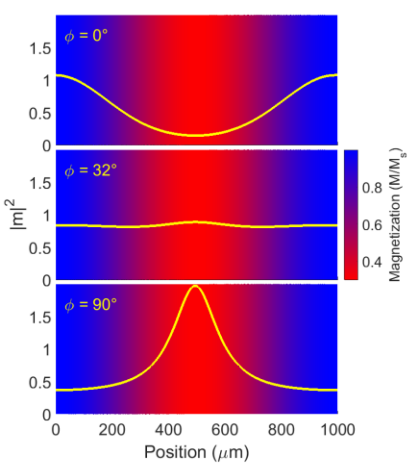
In this talk I will describe our experimental efforts to apply ultrafast optical techniques to study magnetoelasticity, the interaction between coherent structural deformations and material magnetization [1]. We utilize the ultrafast optical transient grating (TG) technique, where a spatially tailored optical pulse impulsively generates narrowband acoustic waves, which propagate along the surface of the sample and resonantly drive magnetization dynamics via inverse magnetostriction. The experimental approach allows us to monitor the elastic and magnetic dynamics simultaneously and provides a unique, real-time view of their coupling.

I will describe the basics of ultrafast magnetoelastics including optical geometries and experimental results in the linear magnetoelastic regime before presenting more recent results where we include an understanding of the effects of the spatially modulated magnetization profile. Modulations in the material magnetic properties, such as saturated magnetization or anisotropy, behave as an optically configurable magnonic crystal, capable of localizing spin wave modes in different regions of the sample. The localized spin wave modes are then resonantly driven by the underlying elastic waves present in the system. Taken in combination, the elastic actuation of magnonic modes heralds the emergence of elasto-magnonics, where user defined spatially localized spin wave modes can be driven by structural deformations of materials.



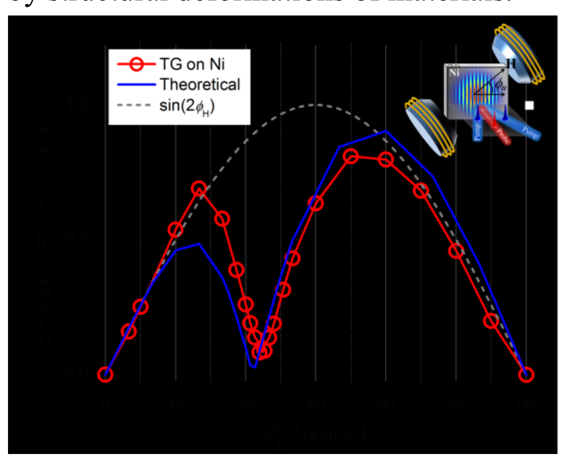


Figure: (left) Spin wave modes in a sinusoidally varying magnetization profile. (right) The magnetoelastic excitation cross section of the spin wave modes is suppressed in a wide angular range around 30degrees, which is well represented in a calculation based on the Plane Wave Method for calculating the spin wave localization.

[1] J. Janušonis *et. al.*, *Transient Grating Spectroscopy in Magnetic Thin Films: Simultaneous Detection of Elastic and Magnetic Dynamics*, Sci. Rep. 6, 29143 (2016).