Launching magnons and switching magnetization with light pulses

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The interaction of laser pulses with magnetically ordered materials has developed into a fascinating research topic in modern magnetism. From the discovery of ultrafast demagnetization over two decades ago to the demonstration of magnetization reversal by single femtosecond laser pulses, the manipulation of magnetic order by ultrashort laser pulses has become a fundamentally challenging topic with a potentially high impact for future spintronics, data storage and processing. [1].

Thus, laser pulses were shown to launch both homogeneous magnetic precession and propagating spin waves, modify magnetic anisotropy and exchange interaction, and ultimately lead to an all-optical reversal of magnetization direction. Various mechanisms, from thermal to purely polarization-dependent, were shown to be efficient stimuli.

As one of the highlights, it has been demonstrated that the magnetization of ferrimagnetic RE-TM alloys and multilayers can be reversed by the purely heating effect of single fs laser pulses, without any applied magnetic field [2]. This switching is found to follow a very peculiar pathway, that crucially depends on the dynamic balance of net angular momentum, set by the two sublattices.

On the other hand, a purely non-thermal all-optical switching was demonstrated in transparent films of magnetic dielectrics [3]. A linearly polarized fs laser pulse resonantly pumps specific *d-d* transitions, creating strong transient magneto-crystalline anisotropy. Selecting the polarization of the pulse changes the direction of magnetic precession. This mechanism outperforms existing alternatives in terms of the speed (less than 20 ps) and the unprecedentedly low heat load.

In this talk various mechanisms for excitation of coherent precessional motion and full magnetization reversal will be considered and compared, with the goal to provide a clear picture of the processes accompanying the reversal at these ultrafast time scales.

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