THz control of spins with light

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I will discuss some of the knobs to tune dynamics at ultrafast time scales, where a control of spins and spin dynamics is possible by light [1]. The dynamics of the spin response depends on the energy transfer from the laser excited electrons to the spins within the first femtoseconds. This determines the speed of the ultrafast demagnetization: if the electrons are driven to a strong excitation density, a second slower process is found, a signature of the intrinsic ferromagnetic electron correlations in a ferromagnet. A special material of interest for magnetic storage development is FePt. The electron temperature shoots to higher values above the Curie temperature, a precondition for all-optical writing by light using magnetic quenching [2]. Not only magnetic nanoparticles can be reversibly written. Also vortex, antivortex networks can be written in standard thin Fe films [3].

On the other side, due to the non-equilibrium electron distribution in layered nanoscale spintronic devices, also ultrafast spin currents are generated and contribute to the laser driven spin dynamics. Layers of a noble metals like Pt, Au or transition metals like W, Ta, Ru can convert ultrafast laser-driven spin currents via the ultrafast spin-Hall effect into a charge current burst [4]. This opens a way towards novel THz spintronic devices: optimizing thicknesses and layers, we can realize efficient metallic THz spintronic emitters of ultra-broadband terahertz radiation [5], and sets the stage of first applications in the field of ultrafast magnetism.

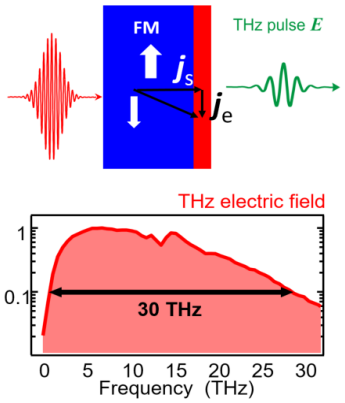

Fig. 1. Spintronic THz emitter based on ultrafast laser excited spin current bunches, driving the inverse spin Hall effect (ISHE) and subsequent THz emission

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