MAR13-2012-020072

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Laser-induced magnetization switching in ferrimagnetic alloys

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This talk will discuss the recent studies of ultrafast switching of magnetization and the role of angular momentum in this process in ferrimagnetic rare-earth - transition metal alloys, e.g. GdFeCo, where both magnetization and angular momenta are temperature dependent. It has been experimentally demonstrated that the magnetization can be manipulated and even reversed by a single 40 fs laser pulse, without any applied magnetic field [1]. This switching is found to follow a novel reversal pathway [2], that is shown to depend crucially on the net angular momentum, reflecting the balance of the two opposite sublattices [3,4]. In particular, optical excitation of ferrimagnetic GdFeCo on a time-scale pertinent to the characteristic time of the exchange interaction between the rare earth (RE) and transition metal (TM) spins, i.e. on the time scale of tens of femtoseconds, pushes the spin dynamics into a yet unexplored regime, where the two exchange coupled magnetic sublattices demonstrate substantially different dynamics [3]. As a result, the reversal of spins appears to proceed via a novel transient state characterized by a ferromagnetic alignment of the Gd and Fe magnetic moments, despite their ground-state antiferromagnetic coupling [4]. This process is fully modeled by a system of coupled equations for the longitudinal relaxation of the sublattices [5]. The role of light helicity in this process, being a controversial issue for many years, is clarified as well [6].

[1] C.D. Stanciu et al., Phys. Rev. Lett. 99, 047601 (2007).
[2] K. Vahaplar et al., Phys. Rev. Lett. 103, 117201 (2009).
[3] I. Radu et al., Nature 472, 205 (2011)
[4] T.A. Ostler et al., Nature Comm. 3, 666 (2012).
[5] J.H. Mentink et al., Phys. Rev. Lett. 108, 057202 (2012).
[6] A.R. Khorsand et al., Phys. Rev. Lett. 108, 127205 (2012).