MAR11-2010-005036

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Ultrafast magnetization dynamics in a system with tunable angular momentum

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Many peculiarities of the magnetization dynamics are related to the fact that a certain amount of angular momentum is associated with magnetic moment. Here the dynamics of angular momentum is studied in ferrimagnetic rare-earth – transition metal alloys, e.g. GdFeCo, where both magnetization and angular momenta are temperature dependent. Depending on their composition, such ferrimagnets can exhibit a magnetization compensation temperature TM where the magnetizations of the sublattices cancel each other and similarly, an angular momentum compensation temperature TA where the net angular momentum vanishes. At the latter point, the frequency of the homogeneous spin precession diverges. As a consequence, ultrafast heating of a ferrimagnet across its compensation points may result in a subpicosecond magnetization reversal [1]. Moreover, we have experimentally demonstrated that the magnetization can be manipulated and even reversed by a single 40 femtosecond circularly polarized laser pulse, without any applied magnetic field [2,3]. This optically induced ultrafast magnetization reversal is the combined result of laser heating of the magnetic system and circularly polarized light acting as a magnetic field with amplitudes of up to several Teslas. The direction of this opto-magnetic switching is determined only by the helicity, i.e. angular momentum, of light. This novel reversal pathway (see [4]) is shown to crucially depend on the net angular momentum reflecting the balance of the two opposite sublattices.

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