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Separating spin-dependent interaction mechanisms in femtosecond optical pulse excitation of ferromagnetic metals VLADIMIR STOICA, CHRISTIAN SCHLEPUETZ, LYNN ENDICOTT, University of Michigan, DONALD WALKO, YUELIN LI, Argonne National Laboratory, ERIC LANDAHL, DePaul University, ROY CLARKE, University of Michigan — Coherent spin dynamics phenomena in ferromagnetic metals can be excited and observed using femtosecond lasers. Several interaction mechanisms are presently considered as the dominant driving force in influencing the spin direction trough optical pulses. These include ultrafast heating and the spin-photon, spin-orbit, and spin-lattice coupling. We employ epitaxial films and multilayers that are suitable for optical studies of the role of magnetic anisotropy combined with picosecond X-ray diffraction observation of the lattice dynamics. By using temporal and spatial separation of the excitation and detection mechanisms, we are able to show that coherent excitations are possible without the need of direct spin-photon interaction. We demonstrate that when diminishing the heating of the lattice, one can study the spin interaction with elastic waves. At large laser fluences, we observe anisotropic nonlinear behavior that is related with the magnetic field dependency of the lattice relaxation.

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