

# Ultrafast spin dynamics in paramagnets and Heisenberg ferromagnets

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Microscopic understanding of the interaction between spins and the charge and lattice degrees of freedom can be furthered by pump-probe experiments with femtosecond time resolution because on these ultrafast time scales the inverse rates of electron-magnon, phonon-magnon, and electron-phonon scattering can be distinguished directly in the time domain.

In this talk two examples of recent studies are discussed. (1) In Au/Fe/MgO(001) layered structures ballistic spin-polarized carriers are injected by optical excitation in Fe into the paramagnetic Au. Using time-resolved magnetic second harmonic generation we find that minority and majority carriers follow different scattering pathways. In particular the majority carriers propagate diffusively to the Au surface, while minority carriers face a significantly smaller scattering probability and hence traverse the Au layer ballistically. (2) Lanthanides carry a strong magnetic moment in the 4f shell, which is localized at the ion core and spin-polarizes the 5d conduction band. By combining femtosecond time-resolved x-ray magnetic dichroism and magneto-optical Kerr effect we study the optically excited 4f and 5d spin dynamics in Gd with femtosecond time-resolution. We find that the 5d and 4f spin dynamics proceed simultaneously and that demagnetization occurs only at time delays at which interaction with the lattice facilitates momentum transfer to the lattice.