MAR08-2007-001578

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Ultrafast Photoinduced Demagnetization in (III,Mn)V Ferromagnetic Semiconductors[1]

LUKASZ CYWINSKI, Condensed Matter Theory Center, University of Maryland

Ultrafast light-induced demagnetization, in which photoexcitation leads to a decay of magnetization in less than a picosecond, has been recently observed in (III,Mn)V materials [1]. To explain these measurements, we have proposed a theory of ultrafast magnetization dynamics within the sp-d model [2]. We have calculated the spin-flip scattering between the localized spins and the carriers strongly excited by the laser pulse. In this process the energy is pumped into the localized spin system, while the angular momentum is transferred to the carriers, leading to their dynamical spin polarization. For significant ultrafast demagnetization, this polarization has to be efficiently relaxed by spin-orbit assisted scattering of carriers - otherwise a "spin bottleneck" can occur, in which the carriers' spin polarization quickly becomes large enough to suppress further spin-flip scattering. Because of that, and also due to their larger exchange coupling to Mn spins, the holes (having a very short spin relaxation time) are much more important than photoelectrons for demagnetization. Since the spin-flip transition rate is proportional to the carrier temperature, the time-scale for this two-step process of demagnetization is given by the energy relaxation time of very hot holes. I will discuss in detail the application of this theory to (III,Mn)V semiconductors taking into account their valence band structure, and the fact that their optical properties are strongly affected by disorder inherent to these materials.

1. J. Wang, C. Sun, J. Kono, A. Oiwa, H. Munekata, L. Cywinski, and L.J. Sham, Phys. Rev. Lett. **95**, 167401 (2005) 2. L. Cywinski and L.J. Sham, Phys. Rev. B, **76**, 045205 (2007)

[1]This research was done at University of California, San Diego and it was supported by NSF.