Ultrafast Spin-Photon Interaction

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The aim of the present thesis is to explore the fundamental mechanisms associated to the interaction between photons and spins. In previous studies, performed in metallic nanostructures, we have shown that coherent processes precede the ultrafast demagnetization induced by femtosecond laser pulses. This ultrafast demagnetization occurs in a timescale of 100 fs, corresponding to the thermalization of the spins [1,2]. Such dynamics can be modeled by a thermal excitation of the charges and spins of the electrons, which are out of equilibrium with respect to the lattice. The equilibrium between the spins and lattice occurs later, in a timescale of 1 ps, involving the spin-phonon interaction. Such ultrafast change of temperature modifies the anisotropy of the material, which may induce a motion of precession [3], similar to the one observed in ferromagnetic resonance [4]. Regarding coherent processes, which take place typically within ~10fs, it has been shown that the spin-orbit interaction is a dominant mechanism [5]. In such conditions the intensity of the electromagnetic field should play an important role in the transfer of momentum to the spins.

In this thesis we propose to explore the interaction of spins with the electromagnetic field provided by a high intensity femtosecond laser source. These unique experiments will be performed in a pump probe configuration where the spins of electrons will be modified by the strong field and the spins momenta analyzed by an electron detector. It is expected that the observation of the relativistic electrons accelerated in the laser field, at the femtosecond time scale, will lead to new nonlinear phenomena usually neglected in the light matter interaction.

The PhD student will work at the new photonic facility UNION developed at IPCMS. The work will consist in both experimental studies and interpretation of the results in the context of relativistic electrodynamics. Knowledge in condensed matter physics and light-matter interaction is appreciated.

References

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