SCIENCES SORBONNE UNIVERSITÉ

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PhD proposal

Campus Pierre et Marie Curie
Tour 23 – 2ème étage – 22-23
Directeur: Massimiliano Marangolo

Title: Spin properties in Free-Pb perovskite materials

Key-words: Halide perovskite, spintronic, ultrafast dynamics, photo-induced Faraday rotation

Scientific description:

In recent years, lead halide perovskite have attracted the attention of researchers due to their outstanding photovoltaic and optoelectronic properties. These materials have demonstrated huge potential in solar cells and light emitting devices applications. They also exhibit other very interesting properties that have been less explored until nown, as for exemple, strong spin-orbit coupling allowing the optical initialization of electronic spins and their manipulation by magnetic, electric or optical fields. In addition, thanks to their « inverted » band structure, perovskite are very promising materials for semiconductor spintronic devices and applications exploiting valence band hole spins and not conduction band electron spins, as usually, in more conventional semiconductors. However, the more studied materials contains lead and that compromises their environemental impact.

The main objective of this PhD proposal is to study the coherent dynamics of carriers spins, so far poorly studied, in hybrid or completely inorganic perovskite-based materials and to obtain a fundamental understanding of spin-dependent physics. We chose to focus our study on perovskites based on free-lead and a halide, of formula ASnX3 with A = organic group or X = Cl, Br, I. Because these compounds give the possibility of tuning the bandgap and the spin-orbit coupling by means of a simple chemical substitution. The use of Sn^{2+} will also make it possible to obtain longer spin lifetimes than in compounds based on $Pb^{2+.}$

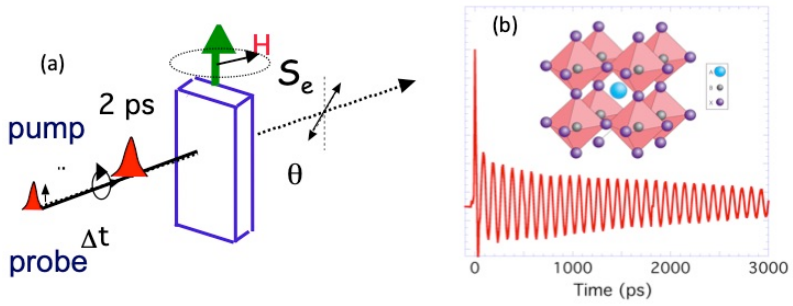

Figure-a) Scheme of photo-induced Faraday rotation (PFR). b) PFR signal versus pump-probe delay : spin precession around the magnetic field, H. Inset perovskite crystal structure : A=organic/inorganic atom,B=Pb and C=halogen atom.

A part of the research work will be dedicated to experimental measurements and modelization of the spin dynamics, with a focus on the relaxation and decoherence processes (hyperfine interaction, spin-orbit coupling…). For comparaison, Pb-based and free-Pb halide perovskites will be investigated.

Techniques/methods in use: We will use a pump-probe (ps-femto) optical experimental tecniques (photo-induced Faraday rotation) to optically initialize and detect the temporal evolution of carriers spins.

Applicant skills: Good background on solid physics and to be familiar with optical experiments

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