"Laser-driven (ultra)fast dynamics: from molecules to materials (I & II)"

Organisateurs :
Brice Arnaud (IMMM-CNRS, Le Mans Université)
Stefan Haacke (IPCMS, Université Strasbourg)
Valérie Halté (IPCMS, Université Strasbourg)
Claire Laulhé (Synchrotron Soleil, Université Paris-Saclay)
Maciej Lorenc (IPR, Université Rennes 1)
Luca Perfetti (LSI-CNRS, Ecole Polytechnique).
Pascal Ruello (IMMM-CNRS, Le Mans Université)

Parrainage ou lien avec des sociétés savantes, des GDR ou autres structures :
GdR UP (http://gdrupilm.univ-lyon1.fr/), GdR MEEtiCC (http://gdr-meeticc.cnrs.fr/), GdR REST (http://gdr-rest.polytechnique.fr/), GdR MCM-2 (http://www.gdr-mcm2.cnrs.fr), GdRI XFEL-Science (https://ipr.univ-rennes1.fr/gdri-xfel-science-0), Laboratoire International Associé CNRS France-Japon (LIA IM-LED).

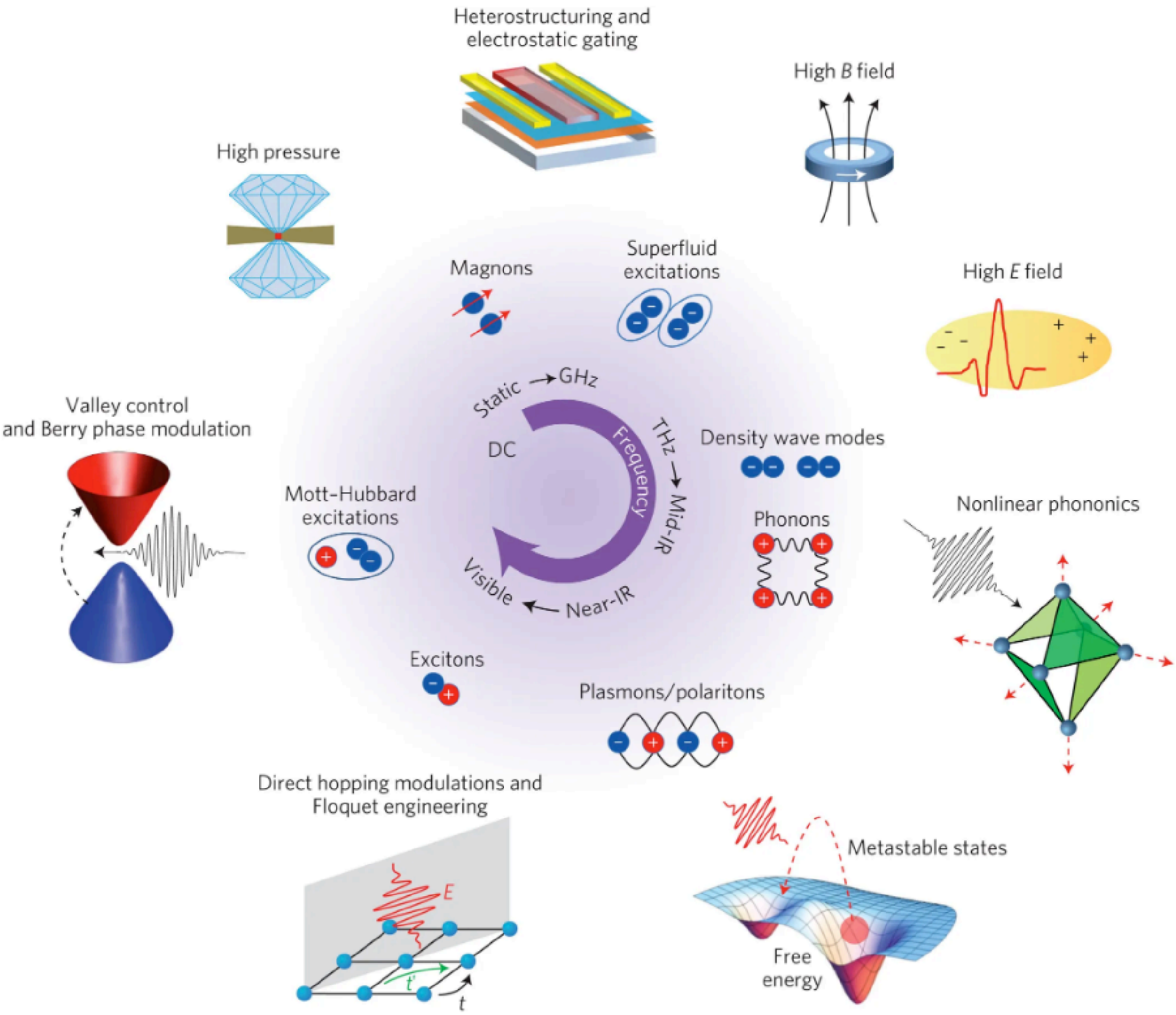
Résumé

Spectacular technological advances, such as ultrafast lasers in 80's, synchrotrons in 90's and XFELs and electron sources in the last decade, have led to unprecedented experimental feats across fields of physics, chemistry and biology. Various time-resolved techniques have been developed, which allow probing (ultra)fast changes of the atomic and electronic structures, as well as spin dynamics, on the relevant timescales [10 fs - 1µs].

These state-of-the-art means of investigation have been applied to probe hot electron dynamics in complex materials (nanostructures, 2D systems), photodeformation processes in correlated materials, light-control of magneto-acoustic effects, spin-charge conversion for spintronic applications, photoinduced phase transitions and molecular switching, ultrafast dynamics of atomic magnetic moments, as well as dynamics of magnetic domains and magnetic singularities. Recently, THz-pulse excitations have also been used to directly excite infrared-active vibrational modes or spin excitations. In the intense THz-excitation regime, anharmonic couplings between vibrational modes occur, termed "non-linear phononics". In parallel, advanced numerical methods have been developed, in order to describe the coupling between all the particles and quasi-particles.

Time-resolved studies not only allow observing the elementary processes during multiscale dynamics, they also laid the foundations for a dynamical control of the functionality of molecules, macromolecules and materials (***Figure 1***). The intrinsic couplings between electronic, magnetic and structural degrees of freedom provide the control knobs over various coherent, ultrafast, collective and/or cooperative dynamics, markedly different from thermal processes. In particular, the former are essential for driving macroscopic photoinduced phase transitions in solid state.

During this workshop we would like to cover, albeit non-exhaustively, recent examples in the below mentioned topical areas:
- Photochemical dynamics in macromolecules and in solid state on different scales,
- Tuning with laser pulse of the electronic and magnetic states,
- Charge and hot electron dynamics,
- Coherent and dynamical control by the generation of structural or magnetic oscillations and strain waves,
- Theoretical description of laser-induced phenomena in the solid state.



<u>Figure 1</u>: Elementary excitations in quantum materials and selected control techniques arranged clockwise in order of ascending frequency. Figure taken from Ref. [1]

Références :

[1] Basov *et al.*, Nature Materials **16**, 1077 (2017)