Plenary Speakers

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Biography

Eric COLLET conducts research on photoinduced phase transitions in materials. He seeks to understand and control these mechanisms, using femtosecond laser pulses, by combining optical spectroscopy and ultra-fast structural analyzes with synchrotron and X-FEL. Such techniques make it possible to understand how functions emerge through the coupling between electronic excited state and structural relaxation, on the elementary time scales of electronic dynamics and atomic motions. He is interested in non-equilibrium mechanisms driven by light excitation and non-linear response and cooperative response of materials, where one photon can transform several molecules from microscopic to nanoscale.
Eric Collet is professor at University Rennes 1 and director of the International Research Laboratory DYNACOM with the University of Tokyo. He received the Ancel prize of the SFP (2018), the CNRS silver medal (2020), the Kalman prize of the ECA (2022). He is currently appointed as senior fundamental chair of the Institut Universitaire de France (2022-27).

Ultrafast control of materials down to nanoscale

The advent of control science for directing matter and energy represents an important challenge for material science, especially at nanoscale. Indeed, it is now possible to control materials by light for generating remarkable properties on ultrafast timescale (ferroelecticity, conductivity, magnetism, photochromism…) [1,2]. These result from complex couplings between electronic and atomic constituents of matter.
X-ray free electron lasers (X-FEL) open new possibilities for probing ultrafast photoinduced phenomena in order to disentangle, understand and control electronic and structural dynamics down to femtosecond timescale [3]. Ultrafast photoswitching in bistable molecular-based crystals is associated with a complex transformation pathway, multiscale in nature, where both molecular photo-switching (100 fs) and nanoscale elastic (ns) or thermal (µs) transformation of crystals play their role [4,5].
We have studied the basic mechanisms allowing light to switch molecular materials between different magnetic states, by using femtosecond x-ray diffraction & absorption and optical spectroscopy. The stabilization of the photoinduced magnetic state results from the activation and damping of a molecular breathing mode. We gained experimental insights of this process, beyond the Born–Oppenheimer approximation, by disentangling the electronic charge-transfer excitation from the structural trapping dynamics [6,7]. We have demonstrated that in the active crystalline medium cooperative elastic effects can drive self-amplified and coherent response to light excitation [4]. The self-amplification process results from the elastic field induced by light, coupled to the molecular volume change, allowing the transformation of several molecules from a single photon at nanoscale. This elastic dynamics scales with systems' sizes [8].

Keywords:

Photoinduced phase transition; Ultrafast phenomena; out-of-equilibrium dynamics; Spectroscopies; Crystallography

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