LAPHIA
Laser & Photonics
in Aquitaine

université de BORDEAUX

Cluster of Excellence LAPHIA
Seminar

« Probing molecular chirality with high-order harmonics and intense laser fields : towards attosecond chiroptics»

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Auditorium - Institut d'Optique d'Aquitaine - Talence
May 21, 2015 from 1 :15 pm to 2 :15 pm

Abstract :

Molecular chirality plays a crucial role in many chemical and biological processes. Chiral molecules exist as two forms, called enantiomers, which are mirror images of each other but are not superposable (like the left and right human hand). They can be distinguished through their interaction with another chiral system, like circularly polarized light. Ultrashort circular light pulses can thus in principle be used to study the ultrafast dynamics of chiral molecules, on the picosecond to femtosecond timescale. However, chiral discrimination is often related to non-dipolar effects, such that the measured signals are very weak, preventing ultrafast dynamical studies in the gas phase where isolated compounds can be studied. I will present different ways to solve this issue, using intense laser fields and high-order harmonic generation.

When an intense laser pulse is focused into a gaseuous medium, high-order harmonics of the fundamental frequency can be generated. The light emission results from radiative recombination of attosecond electron wavepacket driven by the strong laser field. While high-order harmonic generation is a unique source of femtosecond and attosecond pulses in the extreme ultraviolet, it has long been considered as a bad candidate for the generation of circularly polarized light. Indeed, the harmonic conversion efficiency decays exponentially with laser ellipticity. We have recently found out a solution to this problem by using atomic or molecular resonances to shape the polarization of the emitted light and produce quasi-circular ultrashort pulses in the extreme ultraviolet [1,2]. I will show how these pulses can be used to distinguish molecular enantiomers with very high contrast by photoelectron circular dichroism.

Next, I will show an alternative way of probing chiral molecules by directly using them to generate high-order harmonics. When driven by a strong elliptical laser fields, the harmonic generation process from chiral molecules becomes extremely sensitive to the molecular handedness because of laser-induced attosecond dynamics.

[1] A. Ferré et al., Nature Communications 6, 5952 (2015)
[2] A. Ferré et al., Nature Photonics 9, 93 (2015)

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