SEMINAIRE ISMO

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New Tools for Investigating Ultrafast Dynamics of Biologically Relevant Molecules

In the last decade, the high harmonic generation (HHG) has emerged as a novel light source and spectroscopic technique capable of providing structural and dynamical information, including (sub)-femtosecond arrangements of nuclei and electrons. Recently, it was employed to study molecular systems of interest for chemistry and biology.

We have employed HHG to produce high energy photons in the XUV domain to study the fragmentation and dynamics of 5-Halouracils (5XU). 5XU belongs to a particular class of biomolecules called radiosensitisers that enables the use of the radiation damage for therapeutic purposes when used in combined chemo- and radio-therapy treatments to replace the Thymine in the DNA of the tumour cells and to enhance the lethal effects of the UV, X-ray, proton and α radiations on these cells. In order to understand at the molecular level the 5XU interaction with the XUV radiation, we have investigated the ionisation and fragmentation of 5FU and 5BrU induced by HH (9-35 eV) and synchrotron radiation (9-26 eV). The energy-resolved experiments were performed in order to identify the cation states accessed in the ionisation and the fragmentations steps. Some ultrafast dynamics occurring on timescales of 10-30 fs was revealed by pump-probe measurements where HH were used as source of femtosecond or attosecond XUV radiation. For both FU and BrU, proton migration dynamics were observed for the time dependences of couples of fragments separated by one mass unit.

Another example of employing HH as a new spectroscopic tool concerns the investigation of chirality on femtosecond scales. In these experiments, we show that a slight disparity in the laser-driven electron dynamics in the two enantiomers is recorded and amplified by several orders of magnitude in their harmonic spectra that display elliptical dichroism of opposite sign. Furthermore, the absolute value of the ellipticity maximising the yield of individual harmonics reflects the electronic chiral dynamics.

Mardi 1er décembre 2015 à 11h
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