EUROPHOTONICS-POESII MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: April 1st, 2016 – September 30th, 2016

Laboratory: Attoscience and Ultrafast Optics
City, Country: Barcelona, Spain

Title of the master thesis: Attosecond Spectroscopy

Name of the tutor of the master thesis : Dr. Iker León (co-tutor Prof. Jend Biegert)
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Summary of the subject (maximum 1 page):

The Attoscience and Ultrafast Optics group of Prof. Jens Biegert at the Institute of Photonics and Science (ICFO) in Barcelona offers a masters project which is concerned with resolving atomic inner shell dynamics with attosecond precision via covariance mapping.

Nothing in the world that surrounds us is static. In order to understand basic processes such as chemical change or biological function, we have to be able to watch the transformation of atoms molecules or even proteins. Attosecond pulses are the only tools fast enough to image even the fastest events, electronic motion, which triggers such transformations.
One of the key questions to address is the dynamic of excited electrons, which typically evolves on timescales of a few to hundred attoseconds. Our group has developed tools which can investigate these ultrafast events, but a limitation is still to associate a certain electronic motion with a single atom or molecule under investigation. Measurement techniques such as electron ion coincidence are a solution, but the low count rates limit their use in atomic and molecular physics. Covariant mapping is a technique which uses statistical functions to provide information about the significance of correlated events without the need for single particle detection.
The aim of the masters project is to implement covariance mapping together with our detection apparatus which combined attosecond soft X-ray pulses with velocity map imaging (VMI). Covariance mapping will allow disentangling the different contributions hidden on the conventional coincidence maps. Examples are the study the Coulomb explosion dynamics of N_2 and I_2 molecules [O. Kornilov et al. J. Phys. B: At. Mol. Opt. Phys. 46, 164028 (2013)] as well as to detect the electron emission processes of Ne atoms [V. Zhaunerchyk et al. J. Phys. B: At. Mol. Opt. Phys. 46, 164034 (2013)] and N_2 [L. J. Fransinski et al. PRL 111, 073002

(2013)]. Within this masters project, the successful applicant implement the covariance mapping technique with our VMI. The applicant will be actively involved in both, the experiment and the data analysis, thereby getting a comprehensive view of attoscience research.
Our group at ICFO is the first group which has the combination of isolated soft X-ray pulses and advanced imaging techniques at our disposal [see e.g. Opt. Lett. 39, 5383 (2014), Nature Commun. 6, 6611 (2015) or Nature Commun. 6, 7262 (2015)].
The candidate will be under the direct supervision of Prof. Jens Biegert and Dr. Iker León in the investigation of covariance mapping analysis for disentangling several multi-photon processes generated during the Auger dynamics. Apart from identifying the photoionization and Auger sequences this project will offer a unique chance to characterize their branching ratios and sub-femtosecond dynamics.

Keywords : ultrashort, attosecond, coincidence, covariance, Auger, Coulomb, Valence, multiphoton, broadband, dynamics, strong laser field.

Additional information :
* Required skills :
• Dedication and curiosity for forefront science
• Interest in statistics/math and interest in programming.