

Single-shot Femtosecond Electron diffraction

Citation for published version (APA):

Luiten, O. J. (2010). Single-shot Femtosecond Electron diffraction. In *Laboratoire de Spectroscopie Ultrarapide / École Polytechnique Fédérale de Lausanne (EPFL/LSU)*, 17 november 2010, Lausanne, Switzerland

Document status and date:

Published: 01/01/2010

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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Seminars

Polyatomic Molecules in Laser Fields: Dynamics, Control, Strong Fields

Professor Albert Stolow

Steacie Institute for Molecular Sciences, National Research Council

The most general molecular dynamic processes involve the coupled flow of both valence electronic charge and vibrational energy. Time-Resolved Photoelectron Spectroscopy (TRPES) is a powerful probe of ultrafast non-adiabatic dynamics in polyatomic molecules, as it simultaneously observes both electronic and vibrational dynamics. Time-Resolved Coincidence Imaging Spectroscopy (TRCIS) further permits direct time-resolved imaging of electronic dynamics in the Molecular Frame during a chemical reaction. We can actively control molecular dynamics without any net absorption of light, using the non-perturbative Dynamic Stark Effect. As laser fields get stronger still, a new Nonadiabatic Multi-Electron (NME) dynamics emerges and has important consequences for all strong field processes in polyatomic molecules, including high harmonic generation and attosecond spectroscopy.

Lundi 11 avril 2011 à 14 heures, en salle CH G1 495
 Monday, 11 April 2011, at 14 PM in room CH G1 495

Biological nanowires involved in mineral respiration

Dr Tom Clarke

University of East Anglia, School of Biological Sciences

In the absence of oxygen, some bacterial species can couple oxidation of organic matter to reduction of oxidized metals, such as iron [Fe(III)] and manganese [Mn(IV)] (hydr)oxides, via a biological process termed dissimilatory metal reduction (DMR) that can be coupled to energy conservation. It is becoming increasingly apparent that this process is not confined to the reduction of insoluble minerals, but is also used by some bacteria to reduce or oxidise soluble electron acceptors into insoluble precipitates. The electron transfer pathway of these bacteria requires a number of multi-heme cytochromes that are assembled in the periplasm and transported to the outside of the cell, but key questions are yet to be resolved, in particular how electrons are passed through the outer membrane to the extracellular multi-heme cytochromes and ultimately to the mineral surface. We propose that a system typically consisting of a three component - protein system containing an integral membrane 24-28 strand porin, a periplasmic decaheme cytochrome and an outer membrane decaheme cytochrome is responsible for electron transfer through the membrane. Our spectro-potentiometric characterisation of these complexes has shown how these systems are organised for efficient electron transfer while the molecular resolution of an outer membrane cytochrome provides molecular insight into how reduction of insoluble substrate (e.g. minerals), soluble substrates (e.g. flavins) and cytochrome redox partners might be possible in tandem at different termini of a electron transport chain on the cell surface.

Jeudi 17 mars 2011 à 10 heures, en salle CH G1 495
 Thursday, 17 March 2011, at 10 AM in room CH G1 495

High Harmonic spectroscopy of electron dynamics in molecules

Watching Ultrafast Motion:

High Harmonic spectroscopy of electron dynamics in molecules

Highlights

Ultrafast spectroscopy with femtosecond laser and fs/ps X-ray pulses

Condensed-phase dynamics

Dynamics of Biomolecules

CONTACTS

Laboratory of Ultrafast Spectroscopy (LSU) Tel: +41 (0) 21 693 0447
 Fax: +41 (0) 21 693 0365

EPFL-SB-ISIC-LSU
 Station 6
 CH-1015 Lausanne
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Professor Olga Smirnova
Max Born Institut, Berlin

High harmonic emission occurs when an electron, liberated from a molecule by an incident intense laser field, gains energy from the field and recombines with the parent molecular ion. High harmonic spectroscopy carries the potential of combining sub-Å spatial and attosecond temporal resolution of electronic structures and dynamics in molecules. Spatial resolution in high harmonic generation comes from the Angstrom scale of the de-Broglie wavelength of the recombining electron. Temporal resolution comes from the attosecond duration of the recollision event and attosecond temporal correlation between the energy of the emitted photon (harmonic number) and the moments of ionization and recombination. We use high harmonic spectroscopy to characterize the attosecond dynamics of multi-electron re-arrangement during strong-field ionization of molecules. We reconstruct the relative phase between different ionization continua to characterize the hole left upon ionization. The analysis has led us to an unexpected conclusion regarding the hole left in N₂ molecules: the initial phase between the dominant channels (X and A states of the cation) appears to be close to π . Theoretical analysis shows that a new channel in electron tunneling from the molecule could be responsible for this surprising result. This new channel includes correlation –induced excitations of the electrons left in the ion.

Vendredi, 28 janvier 2011 à 11 heures en salle CH G1 495

Friday, 28 January 2011 at 11 AM in room CH G1 495

Single-shot Femtosecond Electron Diffraction

le mercredi 17 novembre à 11h00 en salle G1 495

Jom Luiten

Eindhoven University of Technology

Single-shot Femtosecond Electron Diffraction

In 2009 the first hard X-ray Free Electron Laser has become operational – LCLS at Stanford University – which enables recording the full diffraction pattern of a tiny protein crystal in a single, few-femtosecond shot. Why bother about electrons anymore? Electrons and X-rays both enable the study of structural dynamics at atomic length scales, yet the information that can be extracted by probing with either electrons or X-rays is quite different and, in fact, complementary. A pulsed electron source with the X-ray Free Electron Laser capability of performing single-shot, femtosecond diffraction would therefore be highly desirable, if only because of practical considerations of size, costs, and accessibility of the setup.

The primary obstacle facing the realization of such an electron source is the space charge problem: packing the number of electrons required for recording a full diffraction pattern in a single sub-picosecond pulse will inevitably lead to a rapid Coulomb expansion of the pulse and therefore loss of temporal resolution. We have developed a method, based on radio-frequency (RF) techniques, to invert the Coulomb expansion. We will report on the first experiments demonstrating RF compression of 0.25 pC, 100 keV electron bunches to sub-100 fs bunch lengths. We have used these bunches to produce high-quality, single-shot diffraction patterns of poly-crystalline gold.

In all ultrafast electron diffraction experiments up to now electron bunches have been generated by femtosecond photoemission from metal cathodes. The transverse coherence length of the resulting beams is fundamentally limited to ~1 nm for crystal samples of ~100 micron size, and therefore generally does not allow the study of, e.g., protein samples. We have developed a new, ultracold pulsed electron source, based on near-threshold photo-ionization of a laser-cooled gas. The source is characterized by an effective electron temperature of ~10 K, almost three orders of magnitude lower than conventional sources. This should enable coherence lengths of a few tens of nm for crystal samples with a size of ~100 micron. By combining the ultracold electron source with RF acceleration and bunch compression techniques, single-shot, femtosecond studies of the structural dynamics of macromolecular crystals will become possible.

Ultrafast aqueous proton transfer

Mercredi 17 novembre à 15h00

salle CH B 30

Dr Erik Nibbering

Max-Born-Institut, Berlin

Ultrafast aqueous proton transfer

