A 17: Interaction with strong or short laser pulses II

Time: Tuesday 14:00–16:00 Location: B 302

Invited Talk A 17.1 Tue 14:00 B 302

Ultrafast dynamics in molecular systems and clusters — •Maria Krikunova[1], Theophilos Maltezopoulos[2], Philipp Wessels[2], Ulrike Frühling[2], Marek Wieland[2], Markus Drescher[2], Alaa Al-Shemmary[3], Nikola Stojanovic[3], Maria Müller[1], Jan P. Müller[1], Bernd Schütte[4], and Thomas Möller[1] — [1]Technische Universität, Berlin — [2]Universität Hamburg — [3]HASYLAB, DESY — [4]Max-Born-Institut Berlin

Intense light fields can produce highly excited non-equilibrium states of matter ultimately causing the explosion of molecules and nanoparticles into atomic fragments. Understanding these processes in even simple systems is challenging because it requires experiments that can follow the dynamics on extremely short time-scales. Novel light sources, such as the free-electron laser (FEL) facility in Hamburg, FLASH, now deliver synchronized ultra-short pulses in the soft X-ray, near-infrared (NIR) and far-infrared (terahertz, THz) spectral ranges allowing the realization of new types of pump-probe schemes.

Due to the different interaction mechanisms of pump and probe pulses with the target the tracing of dynamical details within the envelope of the exciting pulse itself becomes possible. With the soft X-ray pulses from FLASH we were able to track the electron redistribution in iodine molecules exposed to a strong NIR field. Utilization of a THz-field driven streak camera principle allowed the access to nanoplasma dynamics in rare gas clusters upon ionization with soft X-ray FEL pulses.

A 17.2 Tue 14:30 B 302

Generation of High Harmonics with 100 μJ Femto Second Pulses at 100 kHz Repetition Rate — •Philipp Klaus[1], Martin Laux[2], Christian Ott[2], Maksim Kunitski[1], Robert Wallauer[1], Thomas Pfeifer[2], and Reinhard Dörner[1] — [1]Institut für Kernphysik, Goethe Universität, Frankfurt, Deutschland — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

The setup for the generation of high harmonics (HHG) using the output of an amplified Ti:sapphire laser with a repetition rate of 100 kHz will be presented. High harmonic generation with a high repetition rate is rather challenging since the pulse energy is limited, in our case to 100 μJ. Usually pulse energies lie in the mJ range. The high repetition rate is however desirable for coincidence single molecule studies on gas and solid-state targets. First tests of the HHG setup with Ar gas showed a total harmonics yield of $4 \cdot 10^9$ photons per second.

A 17.3 Tue 14:45 B 302

Covariance mapping of Coulomb explosion in N_2 and I_2 after excitation with 90 eV XUV pulses at FLASH — •Oleg Kornilov[1], Leszek J. Frasinski[2], Claus Peter Schulz[1], and Marc J.J. Vrakking[1] — [1]Max Born Institute, Max-Born-Str. 2a, 12489 Berlin, Germany — [2]Imperial College London, South Kensington Campus, London, United Kingdom

Intense femtosecond XUV pulses produced by Free Electron Lasers can remove many electrons from inner-shell and valence molecular orbitals. The ensuing dynamics lead to Coulomb explosion due to separation of charges on constituent molecular fragments. In this contribution we report detailed measurements of Coulomb explosion in N_2 and I_2 at 91 eV recorded at FLASH by ion time-of-flight technique. The correlation of the different ionic fragments is evaluated using partial covariance mapping, a technique that allows to extract information on correlated detection events, where conventional coincidence methods cannot be applied. Different ionic fragment pairs $N^{+q}+N^{+q'}$ are identified and their kinetic energy distributions are extracted with help of the covariance maps. The results are compared to a model calculation, which implements classical trajectories for description of the Coulomb explosion dynamics.

A 17.4 Tue 15:00 B 302

Signatures of Interchannel Interactions in the High-Harmonics Spectrum of Krypton and Xenon – An Ab-Initio Study — •Stefan Pabst[1,2], Arina Sytcheva[1], and Robin Santra[1,2] — [1]Center for Free-Electron Laser Science, DESY, Notkestrasse 85, 22607 Hamburg — [2]Department of Physics, University of Hamburg, Jungiusstrasse 9, 20355 Hamburg

We investigate the relevance of multiorbital effects during high-harmonic generation (HHG) in krypton and xenon with an ab-initio time-dependent configuration-interaction singles (TDCIS) approach. With this approach, we are studying many-body effects in the presence of a strong laser field from first principle. We show that spin-orbit splitting within the outermost p-shell and the electronic dynamics within theses shells is reflected the HHG spectrum. Also the giant dipole resonance in xenon is studied where the strong resonance involving the 4d shell influences the recombination of the field-driven photoelectron with the 5p hole. The direct contribution of the 4d shell to the HHG yield is, however, negligibly small. This work has been supported by the DFG under Grant No. SFB 925/A5.

A 17.5 Tue 15:15 B 302

Characterization of high harmonic beam generated in a gas-filled capillary for seeding of free-electron lasers — •siew jean goh[1], yin tao[1], bert bastiaens[1], peter van der slot[1], jennifer herek[1], sandra biedron[2], steven milton[2], miltcho danailov[3], and klaus boller[1] — [1]Laser Physics and Nonlinear Optics, Optical Sciences, Mesa+ Institute for Nanotechnology, University of Twente, Enschede, The Netherlands — [2]Colorado State University, Colorado, USA — [3]FERMI@Elettra, Sincrotrone Trieste S.C.p.A., Basovizza, Trieste, Italy

We study the beam characteristics of a gas filled capillary based high harmonic source for seeding of the free-electron laser FERMI@Elettra. The stability requirements for seeding include pointing stability, divergence and energy jitter. These parameters are important due to the large distance between the source and the undulator where the seed needs to overlap with the electron beam of the free-electron laser. Here, we investigate the influence of the gas pressure and drive laser energy on the high harmonic generation in an Argon-filled capillary, driven by a Ti:Sapphire laser with 45 fs pulses. We report on the optimization of the harmonic yield as well as the properties of the harmonic beam, and compare our experimental results with the requirements of the FERMI@Elettra laser. To scale up the yield further, the build-up of a new high harmonic source with larger capillary diameter, suited for higher drive laser energy, is currently in progress.

A 17.6 Tue 15:30 B 302

Strong Field Ionization as Inhomogeneous Schroedinger Equation — •Zachary Walters and Jan-Michael Rost — Max Planck Institute for Physics of Complex Systems, Dresden

The ionization of an atom or molecule by an intense laser field is difficult to describe theoretically, due to the different approaches needed to describe a molecular bound state on one hand and a time dependent continuum state on the other. This talk shows how the time dependent Schroedinger equation can be decomposed into an inhomogeneous equation in which a previously computed initial state acts as a source term for a time dependent tunneling component. By using an improved Hamiltonian approximation to calculate the initial state, a major source of wavefunction error can be reduced or eliminated at a relatively minor computational cost. The gauge invariance of the resulting theory is used to clarify an apparent gauge dependence which has long been noted in the context of strong field S-matrix theory.

A 17.7 Tue 15:45 B 302

Time-resolved imaging of ulra-fast collective electron motion in argon — •Lutz Fechner[1], Nicolas Camus[1], Thomas Pfeifer[1], Joachim Ullrich[1,2], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

Using a pump-probe scheme for sequential double ionization of Ar-atoms in strong few-cycle laser pulses we prepare and probe electronic Spin-Orbit Wavepackets in singly charged Ar-ions[1]. As a result of the first ionization step, a multi-electron bound-state wavepacket is launched in the ion that gives rise to a time-delay dependant $Ar^+ \rightarrow Ar^{++}$ yield for ionization within the second pulse[2] and thus allows us to probe the electronic motion as a function of time. Performing $Ar^{++}/2e^-$ triple-coincidence measurements utilizing a Reaction Microscope (REMI) we obtain kinematically complete, time-resolved photoelectron spectra. This enables us to uncover the periodic redistribution of population in different electronic orbitals and hence the multi-electron dynamics. A comparison of the experimental data with simple model calculations supports our interpretation. In addition, the method enables us to extract state-selective information about the tunnelling process itself.

[1] H.J. Wörner & P.B. Corkum, J. Phys. B **44** (2011), 041001

[2] A. Fleischer *et al.*, Phys. Rev. Lett. **107** (2011), 113003