A 11: Interaction with VUV and X-Ray Light I

Time: Wednesday 10:30–12:30 Location: B 302

A 11.1 We 10:30 B 302

Two-Photon double ionization of He at FLASH — •Moritz Kurka[1], Artem Rudenko[2], Lutz Foucar[2], Kai-Uwe Kühnel[1], Yuhai Jiang[1], Oliver Herrwerth[3], Matthias Lezius[3], Matthias Kling[3], Jeroen van Tilborg[4], Ali Belkacem[4], Michael Schulz[5], Stefan Düsterer[6], Rolf Treusch[6], Claus Dieter Schröter[1], Robert Moshammer[1], and Joachim Ullrich[1,2] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Max-Planck Advanced Study Group at CFEL, 22607 Hamburg, Germany — [3]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany — [4]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA — [5]Physics Department and LAMOR, University of Missouri-Rolla, Rolla, MO 65409, USA — [6]DESY, 22607 Hamburg, Germany

Free electron lasers such as the FLASH which started operation in 2005 deliver light at unprecedented intensities in the VUV region. Hence they enable for the first time to probe fundamental non-linear few-photon processes in this spectral region. One prominent example is the so called direct channel in two-photon double ionization of Helium, where the absorption of two photons leads to a direct transition from the ground state of the neutral atom to the doubly ionized continuum. This channel serves as an ideal testing ground for effects due to electron-electron correlation in non-linear ionization reactions and therefore sparked substantial theoretical interest in the last few years [1]. Here we report on the first differential measurements on this reaction at two different photon energies.

[1] J. Feist et al., PRA 77, 043420 (2008).

A 11.2 We 10:45 B 302

Two-Photon Inner Shell Ionization in the Extreme-Ultraviolet — •Vincent Richardson[1], John T. Costello[1], Denis Cubaynes[2], Stefan Düsterer[3], Josef Feldhaus[3], Hugo van der Hart[4], Pavle Juranic[3], Wenbin Li[3], Michael Meyer[2], Mathias Richter[5], Andrey A. Sorokin[3,5,6], and Kai Tiedtke[3] — [1]National Centre for Plasma Science and Technology, Dublin City University, Dublin 9, Ireland — [2]LIXAM/CNRS, Centre Universitaire Paris-Sud, Bâtiment 350, 91405 Orsay Cedex, France — [3]Deutsches Elektronen-Synchrotron, DESY, Notkestrasse 85, 22603 Hamburg, Germany — [4]Dept. of Appl. Mathematics and Theoretical Physics, David Bates Bldg., Queen's University Belfast — [5]Physikalisch-Technische Bundesanstalt, PTB, Abbestraße 2-12, 10587 Berlin, Germany — [6]Ioffe Physico-Technical Institute, Polytekhnicheskaya 26, 194021 St. Petersburg, Russia

We have observed the simultaneous inner-shell absorption of two extreme-ultraviolet (EUV) photons by a Xe atom in an experiment performed at the short-wavelength free-electron laser (FEL) facility FLASH in Hamburg. Photoelectron measurements permitted us to unambiguously identify a feature resulting from the single ionization of the 4d sub-shell of Xe by two photons each of energy 93 eV. In addition, we were able to track its intensity dependence which varies quadratically with the pulse energy. The results are discussed and interpreted within the framework of recent results of ion spectroscopy on Xe obtained at ultra-high EUV irradiance (PRL 99 (2007) 213002; PRL 102 (2009) 163002).

A 11.3 We 11:00 B 302

Measurement of the angular correlation function of photoelectrons and dispersed fluorescence photons on rare gas atoms after excitation with synchrotron radiation — •Andre Knie[1], Rainer Hentges[1], Markus Braune[2], Markus Ilchen[3], Ingo Holtkoetter[4], Sascha Deinert[3], Andre Meissner[2], Sanja Korica[2], Uwe Becker[2], and Arno Ehresmann[1] — [1]Institute of Physics and CINSaT, University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Fritz-Haber-Institut der MPG, 14195 Berlin — [3]DESY, 22607 Hamburg — [4]WWU Muenster, 48149 Muenster

For the first time an angle-resolving photoelectron spectrometer was used in coincidence with an angle-resolving dispersed fluorescence spectrometer. The experiment is equipped with five electron TOFs and - via a parabolic mirror - with a 0.5 m Wadsworth mount-like monochromator and was performed with synchrotron radiation from the UE 56/2 PGM1 beamline at BESSY II.

While the angle information of the electrons is collected traditionally, the fluorescence photons are reflected by a parabolic mirror. This mirror translates the angular information into position information within a parallel fluorescence light beam. After being dispersed it is possible to record wavelength selectively and angle resolved fluorescence in coincidence with angle resolved photoelectrons.

A 11.4 We 11:15 B 302

Study of multiple ionization of Ne, Ar and Xe induced by intense XUV femtosecond laser pulse — •Roland Guichard, Myroslav Zapukhlyak, Ulf Saalmann, and Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany

Recently, an experiment performed at FLASH in Hamburg showed that xenon atoms irradiated with intense XUV femtosecond laser pulses can be ionized up to Xe+21 [1]. In order to shed more light onto these processes, we have performed ab-inito calculations based on time-dependent density functional theory. Additionally, we present results on two less involved cases, namely Ne and Ar for which experimental data have also been recorded [2,3]. Taking into account the spatio-temporal pulse dependence is required for a reliable comparison of the experimental data with the theory.

[1] A. Sorokin et al., Phys. Rev. Lett. 99, 213002 (2007)
[2] M. Richter et al., Phys. Rev. Lett. 102, 163002 (2009)
[3] K. Motomura et al., J. Phys. B 42, 221003 (2009)

A 11.5 We 11:30 B 302

First results of the CAMP Instrument Commissioning at LCLS — •Benjamin Erk[1], Daniel Rolles[1], Artem Rudenko[1], Sascha W. Epp[1], Lutz Foucar[1], Benedikt Rudek[1], Robert Hartmann[2], Nils Kimmel[2], Christian Reich[2], Peter Holl[2], Lothar Strüder[1,2], Ilme Schlichting[1,3], and Joachim Ullrich[1,4] — [1]Max Planck Advanced Study Group at CFEL, Hamburg, Germany — [2]Max Planck Halbleiterlabor, München, Germany — [3]Max-Planck-Institut für medizinische Forschung, Heidelberg, Germany — [4]Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The first x-ray Free-Electron Laser came online this fall at the SLAC National Accelerator Laboratory. The AMO beamline of the Linac Coherent Light Source (LCLS) delivers ultra-intense extremely short x-ray pulses down to a few femtoseconds pulse duration at photon energies of 0.8 to 2 keV. The Max Planck Advanced Study Group (ASG) at the Center for Free Electron Laser Science (CFEL) has designed a multi-purpose experimental end station (CFEL-ASG Multi-Purpose chamber - CAMP) especially adapted for the use of unique large-area, single-photon counting pnCCD detectors, developed by the Max Planck Institute semiconductor laboratory, together with advanced many-particle ion and electron imaging spectrometers (reaction microscope; velocity map imaging). The general layout and capabilities of the CAMP instrument will be reviewed and results of the successful instrument commissioning that took place during early LCLS user runs in fall 2009 will be reported. In addition, a brief overview of the first LCLS experiments conducted in CAMP will be given.

A 11.6 We 11:45 B 302

Correlated measurements of fluorescence and ion spectra after X-FEL Ionization of Atoms and Molecules — •Benedikt Rudek[1], Daniel Rolles[1], Artem Rudenko[1], Sascha W. Epp[1], Lutz Foucar[1], Benjamin Erk[1], Robert Hartmann[2], Nils Kimmel[2], Christian Reich[2], Peter Holl[2], Lothar Strüder[1,2], Ilme Schlichting[1,3], and Joachim Ullrich[1,4] — [1]Max Planck Advanced Study Group at CFEL, Hamburg — [2]Max-Planck Halbleiterlabor, München — [3]Max-Planck-Institut für medizinische Forschung, Heidelberg — [4]Max-Planck-Institut für Kernphysik, Heidelberg

With its combination of unique large-solid-angle photon and state of the art charged particle detection devices the CFEL-ASG Multi-Purpose (CAMP) instrument is designed to house a broad variety of experiments at x-ray free electron lasers.

The CAMP chamber was recently commissioned at the first X-ray FEL, the LCLS at SLAC. Its capability for correlated measurements of fluorescence, photo diffraction, ion time of flight and ion momentum distribution was examined by the Max Planck Advanced Study Group and then employed during the first two very successful runs using a

variety of different targets and detector combinations.

In the particular setup discussed in this talk pnCCDs and time and space resolving spectrometers were grouped around the intersection of the X-FEL beam and a supersonic gas jet to simultaneously collect data on fluorescent photons and recoil ions respectively. Preliminary results for X-ray ionization of rare gases and molecules will be reported.

A 11.7 We 12:00 B 302

Nonperturbative multiphoton electron-positron pair creation in strong laser fields — •Matthias Ruf, Guido R. Mocken, Carsten Müller, Antonino Di Piazza, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg

The generation of electron-positron pairs from vacuum in counterpropagating laser beams is investigated [1]. Our particular interest lies in the nonperturbative multiphoton regime and the resonance structure of the process. By combining analytical and numerical methods we obtain rich information on momentum spectra, resonance widths, and the time dependence of the creation probability, both on and off the resonance. The impact of the laser magnetic field is also addressed [2].

Moreover, we discuss tunneling pair production in a sub-critical laser field and a nuclear field, and demonstrate the possibility of controlling the tunneling barrier by the assistance of a high-energy photon [3].

[1] G. R. Mocken *et al.*, Phys. Rev. A, in print
[2] M. Ruf *et al.*, Phys. Rev. Lett. 102, 080402 (2009)
[3] A. Di Piazza *et al.*, Phys. Rev. Lett. 103, 170403 (2009)

A 11.8 We 12:15 B 302

From wave packet dynamics in MgH ions to X-ray structural analysis — •Steffen Kahra[1], Günther Leschhorn[1], Tobias Schaetz[1], Agustin Schiffrin[2], Ralph Ernstorfer[2], Reinhard Kienberger[2], Markus Kowalewski[3], and Regina de Vivie-Riedle[3] — [1]MPQ, Garching, TIaMo — [2]MPQ, Garching, AS beam lines — [3]Chemie und Biochemie, LMU München

We report measurements that demonstrate the combination of precise spatial control and initialization of single molecular ions in a Paul trap with temporal resolution provided by <5 fs UV laser pulses. In this proof of method experiment we show how the temporal evolution of a vibrational wave packet in a few distinguishable isolated molecules can be followed by a dissociative pump probe scheme. This experiment can be seen as a first step on the way towards time resolved diffraction experimentes on single particles since it contains important functional components of the envisioned machine already. It is our aim to load, trap, cool and initialize molecular ions at a well defined (<1 micrometer) and known position in space in a repeatable manner in order to prepare the most suitable target for, e.g. structural analysis of molecular ions by diffraction of short and intense X-ray pulses. We describe the way to load and identify individual molecular ions in our trap and especially concentrate on how to count them reliably before and after the pump probe delay dependent dissociation. But other building blocks needed to realize the ideal target for diffraction experiments will be highlighted as well. Some of them are already proven to work in our apparatus others are prepared but still need to be connected.