A 19: Interaction with VUV and X-ray light II

Time: Tuesday 14:00–16:00 Location: F 428

A 19.1 Tue 14:00 F 428

First direct seeding at FLASH — •Theophilos Maltezopoulos[1], Sven Ackermann[2], Armin Azima[1], Sasa Bajt[2], Joern Boedewadt[1], Francesca Curbis[1], Hossein Delsim-Hashemi[1], Markus Drescher[1], Stefan Duesterer[2], Bart Faatz[2], Matthias Felber[2], Josef Feldhaus[2], Eugen Hass[1], Ulrich Hipp[1], Katja Honkavaara[2], Rasmus Ischebeck[3], Shaukat Khan[4], Tim Laarmann[2], Christoph Lechner[1], Velizar Miltchev[1], Manuel Mittenzwey[1], Marie Rehders[1], Juliane Roensch-Schulenburg[1], Joerg Rossbach[1], Holger Schlarb[2], Siegfried Schreiber[2], Lasse Schroedter[2], Michael Schulz[1], Roxana Tarkeshian[1], Markus Tischer[2], and Marek Wieland[1] — [1]University of Hamburg and CFEL — [2]DESY, Hamburg — [3]PSI, Villigen, Switzerland — [4]DELTA, Dortmund

Direct seeding with a high-harmonic generation source can improve the spectral, temporal, and coherence properties of a free-electron-laser (FEL) and reduces intensity- and arrival-time fluctuations. In the seeding experiment at the XUV-FEL in Hamburg, FLASH, which is normally operated in the self-amplified spontaneous emission mode, the 21st harmonic of an 800 nm laser is focused into a dedicated seeding undulator. The interaction with the relativistic electrons acts as an amplifier for the seed radiation. We present the setup of the seeding section of FLASH and first experimental results. This work is supported by the Federal Ministry of Education and Research in the framework of the FSP301 program.

A 19.2 Tue 14:15 F 428

Spontaneously Generated Coherences in the X-ray regime — •Kilian Heeg[1], Ralf Röhlsberger[2], Hans-Christian Wille[2], Kai Schlage[2], Tatyana Guryeva[2], Ingo Uschmann[3], Berit Marx[3], Kai-Sven Schulze[4], Tino Kämpfer[4], and Jörg Evers[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität Jena, Germany — [4]Helmholtz-Institut Jena, Germany

We investigate the reflected signal of a thin film cavity [1] probed by hard x-rays. For the interaction of the photons and resonant Mößbauer nuclei ^{57}Fe under the influence of a magnetic field, a consistent quantum optical description is established. By this we can identify the fundamental interaction processes on a quantum level. We find that Spontaneously Generated Coherences (SGC, [2,3]) emerge in our system and can give rise to pronounced interference minima. SGC arise due to vacuum-induced couplings, but most of their effects and consequences only appear in level schemes which do not exist in real atomic systems. The effective level scheme in our cavity, however, permits the direct observation of SGC, rendering it a powerful device to observe advanced quantum optical effects.

[1] R. Röhlsberger et al., Science 328, 1248-1251 (2010)
[2] G. S. Agarwal, Springer Tracts in Modern Physics 70, 1-128 (1974)
[3] M. Kiffner et al., Progress in Optics 55, 85-197 (2010)

A 19.3 Tue 14:30 F 428

Coherent storage and phase modulation of single hard-x-ray photons — •wen-te liao, adriana pálffy, and christoph h. keitel — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg

Forwarding optics and quantum information to shorter wavelengths in the x-ray region has the potential of shrinking computing elements in future photonic devices such as the quantum photonic circuit. Here we present two important control tools for single hard-x-ray photons using resonant scattering of light off nuclei in a nuclear forward scattering setup: coherent storage and phase modulation of x-ray single-photon wave packets. The formation of a nuclear exciton consisting of a single delocalized excitation opens the possibility to control the coherent decay and therefore emission of the scattered photon. We theoretically show that by switching off and on again the magnetic field in the nuclear sample, phase-sensitive storage of photons in the keV regime can be achieved. Furthermore, a PI phase modulation of the stored photon can be accomplished if the retrieving magnetic field is rotated by 180 degrees [1,2].

[1] W.-T. Liao, A. Pálffy, and C. H. Keitel, Phys. Rev. Lett. 109, 197403 (2012).
[2] Focus: Storing an X-ray Photon, D. Lindley, Physics 5, 125 (2012).

A 19.4 Tue 14:45 F 428

Inner-shell multiphoton multiple ionization dynamics of xenon atoms by x-ray free-electron laser pulses — •Sang-Kil Son[1] and Robin Santra[1,2] — [1]Center for Free-Electron Laser Science, DESY, Germany — [2]Department of Physics, University of Hamburg, Germany

When atoms and molecules are irradiated by an x-ray free-electron laser (XFEL), they are highly ionized via a sequence of one-photon ionization and relaxation processes. To describe the ionization dynamics during XFEL pulses, a rate equation model has been employed. Even though this model is straightforward for the case of light atoms, it generates a huge number of coupled rate equations for heavy atoms like xenon, which are not trivial to solve directly. Here, we employ the Monte Carlo method to address this problem and investigate multiphoton multiple ionization dynamics of xenon atoms induced by XFEL pulses. The photon energy used ranges from 1.5 keV to 5.5 keV, which can initially ionize M-shell and/or L-shell electrons of xenon atoms, respectively. We present charge state distributions, photoelectron and Auger electron spectra, and fluorescence spectra from the ionization dynamics of xenon atoms and compare them with recent XFEL experiments conducted at LCLS and SACLA.

A 19.5 Tue 15:00 F 428

Revealing the structure of large water clusters with x-ray scattering at the FLASH free-electron laser — •Leonie Flückiger[1], Daniela Rupp[1], Mario Sauppe[1], Tim Oelze[1], Sebastian Schorb[2], Rolf Treusch[3], Christoph Bostedt[2], Maria Krikunova[1], and Thomas Möller[1] — [1]Technische Universität, Berlin — [2]LCLS, SLAC National Accelerator Laboratory — [3]Deutsches Elektronen-Synchrotron, Hamburg

With brilliant x-ray pulses of free-electron-lasers the structure of nanoparticles can be imaged by means of x-ray scattering. The diffraction patterns are recorded on the femtosecond timescale during the intense light pulse. Especially water is a hot topic target with its unique physical, chemical, and thermodynamic properties resulting from its three-dimensional hydrogen bond network.

For the first time water clusters have been imaged at the free-electron laser in Hamburg FLASH. The scattering patterns reveal the geometry of single water particles with various sizes in the range from nanometers to mircrometers and from different aggregation states. Upon illumination with the strong FEL pulse the sample becomes completely destroyed. Therefore, the dynamics of radiation damage - which is mostly driven by Coulomb explosion - was studied by coinsident measurement of fragment ion spectra.

A 19.6 Tue 15:15 F 428

Tracing Interatomic Coulombic Decay of Ne_2 by XUV-pump–XUV-probe Experiments at FLASH — •Kirsten Schnorr[1], Arne Senftleben[1], Moritz Kurka[1], Artem Rudenko[2], Alexander Broska[1], Lutz Foucar[2], Matthias Kübel[3], Denis Anieleski[2], Thomas Pfeifer[1], Kristina Meyer[1], Georg Schmid[1], Matthias Kling[3], Joachim Ullrich[1], Claus-Dieter Schröter[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Max Planck Advanced Study Group, Hamburg — [3]Max-Planck-Institut für Quantenoptik

We present the first time-resolved measurement of Interatomic Coulombic Decay (ICD) in Ne_2 using a XUV-pump–XUV-probe scheme at FLASH. ICD is a radiationless decay mechanism where de-excitation of one atom is achieved via an energy transfer to a van-der-Waals–bound neighbouring atom which then emits an electron. The process has been theoretically predicted and experimentally confirmed in clusters and molecules. Although the decay time of ICD is a crucial parameter for understanding the underlying mechanism, no time-resolved investigation has been performed so far.

In our measurement a 58 eV pump pulse of approximately 60 fs creates a 2s hole, initiating the decay process which is probed after an adjustable time delay by an exact copy of the first pulse. Only if the decay has happened by the time the probe pulse arrives, a certain energy level is populated. The resluting fragmentation channel can be seperated by using a Reaction Micrsoscope which allows us to study charged particles in coincidence.

A 19.7 Tue 15:30 F 428

Multiphoton inner-shell excitation in rare gas atoms — •Tommaso Mazza[1], Markus Ilchen[1], Thomas J. Kelly[2], Sadegh Bakhtiarzadeh[1], Amir Jones Rafipoor[1], John Costello[2], Stefan Dusterer[3], Peter Lambropoulos[4], Stephan Fritzsche[5], and Michael Meyer[1] — [1]European XFEL GmbH, Hamburg, Germany — [2]DCU, Dublin, Ireland — [3]Hasylab@DESY, Hamburg, Germany — [4]University of Crete, Heraklion, Greece — [5]GSI, Darmstadt, Germany

We present a study of direct and resonant two- and multi-photon ionization processes in the XUV regime in Xe and Ar, performed at the Free electron LASer in Hamburg (FLASH). The strong interaction of short wavelength intense radiation with the strongly bound core electron results in new and mostly unexplored photoexcitation phenomena through the simultaneous absorption of two (or more) photons. These are responsible for the highly charged states observed earlier by ion spectroscopy, and are investigated here in detail by means of photoelectron spectroscopy. In particular, we were able to unambiguously identify the signatures of direct 2-photon as well as sequential multiphoton ionization processes of Ar3p and Xe4d, and of the Auger decay of the (1photon forbidden) 2-photon Ar2p-4p resonance excitation.

Detailed understanding of these non-linear processes, which are driven by the very intense FEL radiation and which have been almost completely unexplored up to now in the XUV wavelength regime to date, is crucial not only for gas phase experiments, but also for FEL-based studies in all other targets from molecules to solids.

A 19.8 Tue 15:45 F 428

Deexcitation Cascade effects in Xe II observed by fluorescence spectroscopy after excitation by synchrotron radiation — •Christian Ozga[1], Witoslaw Kielich[1], Philipp Reiss[1], Stefan Klumpp[2], André Knie[1], and Arno Ehresmann[1] — [1]Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology, Universität Kassel, Heinrich-Plett Straße 40, D-34132 Kassel, Germany — [2]Institute for Experimental Physics University of Hamburg Faculty of Mathematics, Informatics and Natural Sciences Department of Physics, Luruper Chaussee 149, D-22761 Hamburg, Germany

Due to the high number of electrons and their interdependency within the electron shells xenon atoms provide a good benchmark system to investigate quantum mechanical correlation effects. For example cascade effects in the de-excitation process can be investigated providing information of the relaxation dynamics of electron correlation effected systems. Typically these cascade effects are observed by electron or ion spectroscopy yielding data about electron systems successively losing electrons. Here we show that it is possible to observe cascade effects with constant electron numbers directly by fluorescence spectroscopy after excitation of Xe I ground state [Kr] $5s^2$ $5p^6$ $^1S_0$ to a doubly excited state [Kr] $5s^2$ $5p^4(^3P_2)$nln*l* and subsequent autoionization.