A 22: Interaction with VUV and X-ray light

Time: Tuesday 16:30–19:00 Location: Empore Lichthof

A 22.1 Tue 16:30 Empore Lichthof

Complete characterization of the Lyman band continuum emissions of molecular hydrogen and deuterium by photon-induced fluorescence spectrometry — •Philipp Schmidt[1], Andreas Hans[1], Christian Ozga[1], Philipp Reiss[1], Ltaief Ben Ltaief[1], Arno Ehresmann[1], André Knie[1], and Michèle Glass-Maujean[2] — [1]Institut für Physik and Center for Interdisciplinary Nanostructure Science and Technology, Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany — [2]Laboratoire de Physique Moléculaire pour l'Atmosphère et l'Astrophysique, Université P. et M. Curie/CNRS, 4 pl Jussieu, 75252 Paris Cedex 05, France

The emission of molecular hydrogen and its isotopes in the far ultraviolet regime contains a continuous spectrum with particular fluctuations next to the discrete band transitions from the B and C electronic states. While these have been attributed to the dissociative transition into the continuum of the X ground state for quite some time, the investigations with simulated spectra are severely limited at these wavelengths due to a multitude of overlapping features. Here we present a complete analysis of these continuous emission features after selective excitation by photoexcitation with monochromatized synchrotron radiation as part of a greater investigation encompassing all the emission features and electronic transitions in the far ultraviolet regime. Separated by their electronic state and upper vibrational level, the individual spectra are compared to theoretical calculations and their effect on the emission in general are discussed.

A 22.2 Tue 16:30 Empore Lichthof

Time domain interferometry with Mössbauer nuclei — •Salvatore Castrignano and Jörg Evers — Max Planck Institute for Nuclear Physics, Heidelberg

We will present our recent results on time domain interferometry [1] with Mössbauer nuclei driven by hard x-ray light. This technique enables one to measure the intermediate scattering function to determine the dynamics of a given sample. In particular, we discuss novel interferometry schemes and extensions to other types of dynamics.
[1] A. Q. R. Baron et al, Phys. Rev. Lett 79, 2823 (1997)

A 22.3 Tue 16:30 Empore Lichthof

Spatial overlap for XUV pump-probe experiments using the permanently installed split and delay unit DESC at the FLASH FEL — •J Zimbalski[1], L Flückiger[2,1], K Kolatzki[1], B Langbehn[1], M Müller[1], M Sauppe[1], B Senfftleben[1], A Ulmer[1], J Zimmermann[1], T Zimmermann[1], T Gorkhover[1,3], C Bostedt[3,4], C Bomme[5], S Düsterer[5], B Erk[5], M Kuhlmann[5], D Rolles[5,6], D Rompotis[5], R Treusch[5], T Feigl[7], T Möller[1], and D Rupp[1] — [1]TU Berlin — [2]La Trobe University, Melbourne — [3]SLAC — [4]Argonne National Lab, Northwestern University, Chicago — [5]DESY — [6]Kansas State University — [7]optiX fab

Short wavelength free-electron lasers (FELs) enable novel experiments with a very high temporal and spatial resolution. Interaction of the ultra intense light pulses with matter results in complex dynamics on different timescales. To investigate such processes on a very broad timescale, long range split and delay units are required. The **DE**lay **S**tage for **C**AMP *DESC* uses multilayer mirrors at almost perpendicular incidence to enable XUV-XUV pump-probe experiments with delays ranging from 0 fs to 650 ps.

A common problem when operating split and delay units is the loss of beam alignment and thus spatial overlap in the focus when changing the delay due to inaccuracies of the mirror actuators. In DESC a closed-loop mirror mount allows for fast beam realignment. Therefore a compensation curve was measured by establishing overlap on a YAG-screen using a high resolution microscope as well as optimizing time-of-flight spectra of Xe clusters on high kinetic energies.

A 22.4 Tue 16:30 Empore Lichthof

Transition probabilities of the titanium L3 fluorescence lines as a function of the oxidation state — •Rainer Unterumsberger, Matthias Müller, and Burkhard Beckhoff — Physikalisch-Technische Bundesanstalt, Abbestrasse 2-12, 10587 Berlin, Deutschland

The increase of the sensitivity of a wavelength-dispersive spectrometer (WDS) [1] in the soft X-ray range enables the access to high resolved X-ray emission spectrometry at nanoscaled materials like lights elements and transition metals. The increase could be achieved by focusing of the incident undulator radiation using a single bounce monocapillary [2]. The spectrometer was well characterized and the response behavior was experimentally determined. Due to the knowledge of the response function of the spectrometer, a reliable deconvolution of the emission spectra is possible. That enables the determination of the fluorescence intensity of each emission line with low uncertainties. Here, the relative intensity was estimated to 15 %. The transition probabilities of the titanium L3 fluorescence lines were determined as a function of the oxidation state. The measurements were carried out at the plane-grating monochromator (PGM) beamline in the PTB laboratory at BESSY II using monochromatized undulator radiation and calibrated instrumentation [3,4].

[1] R. Unterumsberger et al., Spectrochim. Acta B 78 (2012) 37-41
[2] M. Müller et al., Phys. Rev. A 79, 032503 (2009)
[3] B. Beckhoff et al., Anal. Chem. 79, 7873 (2007)
[4] B. Beckhoff, J. Anal. At. Spectrom. 23, 845 (2008)

A 22.5 Tue 16:30 Empore Lichthof

Phase modulated harmonic detection to facilitate time-resolved coherent XUV spectroscopy — •Ulrich Bangert, Lukas Bruder, Marcel Binz, Marcel Mudrich, and Frank Stienkemeier — Physikalisches Institut, Universität Freiburg, 79104 Freiburg

Coherent time-resolved spectroscopy is a powerful tool to study ultrafast dynamics in complex systems. Extending these techniques to the XUV spectral region would allow studying core excitations, thus providing site specific information. However, demands on phase stability increase significantly when going to short wavelengths and advanced pulse manipulation in the XUV is challenging. We suggest an approach based on acousto-optical phase modulation on the fundamental frequency combined with lock-in detection at the harmonics. In this way, pulse manipulation can be performed with standard optics. Moreover, demands on phase stability are drastically reduced and signals are efficiently isolated and amplified. We demonstrate this scheme in a proof of principle experiment incorporating second harmonic generation to measure electronic wave packet dynamics in atomic systems. The high quality of our data shows promise for implementation of the scheme in table top HHG or seeded FEL sources.

A 22.6 Tue 16:30 Empore Lichthof

Probing O_2^+ potential curves with an XUV–IR pump–probe experiment — •Philipp Cörlin[1], Andreas Fischer[1], Tomoya Mizuno[1], Michael Schönwald[1], Uwe Thumm[2], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Insitut für Kernphysik — [2]Kansas State University

We study dissociative photo-ionization of O_2 in a kinematically complete XUV–IR pump–probe experiment, preparing a vibrational wave packet in the potential of the binding $O_2^+(a\,^4\Pi_u)$ state by ionization with a single XUV photon. After a variable time–delay the wave packet is promoted to the repulsive $O_2^+(f\,^4\Pi_g)$ state by a weak IR probe pulse. Comparing the results of a coupled–channel simulation with the experimental kinetic–energy-release and quantum–beat spectra, we are able to discriminate between the adiabatic O_2^+ potential–energy curves (PECs) calculated by Marian et al., Mol. Phys. 46, 779 (1982) and Magrakvelidze et al., Phys. Rev. A 86, 023402 (2012). The overall agreement between simulated and experimental results is good; however, not all features of the experimental spectra could be reproduced using these PECs. Using a Morse potential adjusted to the experimental data instead, most features of the experimental spectra are well reproduced by our simulation. This optimized Morse potential is remarkably similar to the theoretically predicted PECs, demonstrating the sensitivity of our experimental method to small changes in the shape of the binding potential.

A 22.7 Tue 16:30 Empore Lichthof

Real time observation of Interatomic Coulombic decay (ICD) in Ar dimers with XUV-pump IR-probe experiments — •Tomoya Mizuno, Philipp Cörlin, Andreas Fischer, Michael Schönwald, Lukas Palm, Thomas Pfeifer, and Robert Moshammer — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

We determined the ICD lifetime of Ar dimers by using XUV-pump IR-probe experiments. The first XUV pulse, which is generated from a 10 fs IR laser pulse via HHG in Ar gas, creates the lowly excited ionic states, which can decay rapidly via ICD leading to a dissociative kinetic energy release (KER) of 3.8 eV. Afterwards, the delayed IR probe pulse further ionizes into dicationic states at one site (Ar^{2+}-Ar) or excite into highly excited states if the ICD did not occur yet. These states are long lived, therefore contraction of the dimers occurs. Then these states decay via radiative charge transfer and ICD respectively, resulting in a high KER of 5.2 eV. Finally, the ion pair emerging from the Ar dimer is detected by a reaction microscope. The apparatus enables us to record the ion yield of $Ar^+ + Ar^+$ ion pairs as a function of the pump-probe delay and KER. We found that the delay-dependent ion yield at a KER of 5.2 eV shows an exponential decay with a time constant of 30.1±8.4 fs. We assigned this time constant to the ICD lifetime of the $Ar^{+*}(3p^{-2}(1D)3d\ 2D)$-Ar state based on the photoionization cross section and the potential energy curves. This is in good agreement with previous calculations of 28 fs [1].

[1]T. Miteva et. al. JCP 141, 064307 (2014)

A 22.8 Tue 16:30 Empore Lichthof

Electron-Ion Coincidence Studies on Multiphoton Ionization of Krypton — •Hannes Lindenblatt[1], Kirsten Schnorr[1], Sven Augustin[1], Georg Schmid[1], Severin Meister[1], Arne Senftleben[1,2], Moritz Kurka[1], Artem Rudenko[3], Tatiana Marchenko[4], Marc Simon[4], Benjamin Erk[5], Rolf Treusch[5], Joachim Ullrich[6], Thomas Pfeifer[1], Claus-Dieter Schröter[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Universität Kassel — [3]J.R. Macdonald Laboratory, Kansas State University — [4]UPMC and CNRS, Paris — [5]DESY, Hamburg — [6]PTB, Braunschweig

For all applications of XUV and X-ray free-electron lasers (FELs), in particular imaging of single-molecules, detailed understanding of multiphoton absorption and secondary relaxation processes in those wavelength regimes is mandatory. Here, we investigate electron-ion coincidences in multiphoton ionization of krypton by 210 eV FEL pulses delivered by FLASH using a reaction microscope. The production yields of charge states up to Kr^{11+} are analyzed by intensity-dependent ion spectra. The involved mechanisms are studied by charge state selective electron energy spectra.

A 22.9 Tue 16:30 Empore Lichthof

X-Ray Movie Camera for time resolved single particle imaging: raytracing the focussing multilayer optics — •Björn Senfftleben[1], Leonie Flückiger[1,2], Katharina Kolatzki[1], Bruno Langbehn[1], Maria Müller[1], Mario Sauppe[1], Anatoli Ulmer[1], Jannis Zimbalski[1], Julian Zimmermann[1], Tobias Zimmermann[1], Cédric Bomme[3], Stefan Düsterer[3], Benjamin Erk[3], Marion Kuhlmann[3], Daniel Rolles[3,4], Dimitrios Rompotis[3], Rolf Treusch[3], Christoph Bostedt[5,7], Tais Gorkhover[5], Torsten Feigl[6], Thomas Möller[1], and Daniela Rupp[1] — [1]TU Berlin — [2]La Trobe University, Melbourne — [3]DESY, Hamburg — [4]Kansas State University — [5]SLAC, Menlo Park — [6]optiX fab, Jena — [7]Northwerstern University / Argonne National Lab, Chicago

Short wavelength free-electron lasers (FELs) can be used to image nanostructures via x-ray scattering. Time-resolved studies of non-reproducible structures often lack of information on the initial state of the structure. A novel setup named x-ray movie camera overcomes this limitation by taking two separate time-delayed images of the same gas-phase particle by two beams from different directions. To optimize and overlap the micron foci, which are created by two opposed ellipsoidal multilayer mirrors, precise alignment is required. Raytracing the setup allows to simulate the experimental alignment and reveals the quality and shape of desired focus. By taking the adjustment operations and their effect into account the experiment's and the simulation's data can be compared. The results from raytracing are presented.

A 22.10 Tue 16:30 Empore Lichthof

An Experimental Setup for Multidimensional XUV/soft X-Ray Spectroscopy — •Lennart Aufleger, Thomas Ding, Marc Rebholz, Veit Stooss, Alexander Blättermann, Kristina Meyer, Christian Ott, and Thomas Pfeifer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

In recent years multidimensional spectroscopy with visible and ultraviolet light has given insight into the structure and dynamics of electronic excitations in both atoms as well as in larger molecular systems. In particular the XUV spectral range is of high interest since it represents the photo-excitation region of spatially localized inner-valence electrons. However, due to the increased technical demands of creating adequate multi-pulse sequences in this energy domain and the low photon flux of laboratory-based sources, the extension of two-dimensional absorption spectroscopy to the XUV has, to the best of our knowledge, not yet been realized. Here we present an experimental setup for a multidimensional XUV/soft x-ray spectroscopy scheme suitable for both attosecond high-harmonic sources and ultra-intense free-electron lasers. The heart of the setup is a dynamic monolithic four-segment mirror generating four identical and temporally well-controlled pulses with independent time delays as well as high phase stability out of one incoming pulse, allowing 4-wave mixing experiments with both homodyne and heterodyne detection techniques. The next step will be the femtosecond-time-resolved and site-specific multidimensional spectroscopy of inner-valence electron excitation and charge migration in molecules as a function of time.

A 22.11 Tue 16:30 Empore Lichthof

Stepwise contraction of the nf Rydberg shells in the 3d photoionization of multiply-charged xenon ions — •S. Schippers[1], A. Borovik Jr.[1], T. Buhr[2], J. Hellhund[1], K. Holste[1], A. L. D. Kilcoyne[3], S. Klumpp[4], M. Martins[4], A. Müller[1], S. Ricz[5], and S. Fritzsche[6,7] — [1]Justus-Liebig-Universität Gießen — [2]PTB, Braunschweig — [3]Lawrence Berkeley National Laboratory, USA — [4]Universität Hamburg — [5]ATOMKI, Debrecen, Hungary — [6]Helmholtz-Institut Jena — [7]Friedrich-Schiller-Universität Jena

We report on recent experimental and theoretical results for triple photoionization of Xe^{q+} ($3 \le q \le 5$) ions [1]. The measurements were carried out using the photon-ion spectrometer PIPE [2] at the Hamburg PETRA III synchrotron light source. The strongest photoionization resonances are associated with the photoexcitation of a $3d$ electron to an atomic nf subshell ($n = 4, 5, 6, ...$) and the subsequent multiple autoionization of the associated hole states. The $3d_{3/2}^{-1} - 3d_{5/2}^{-1}$ fine structure splitting ($\sim$ 13 eV) of the $3d$ hole leads to two distinct Rydberg series of resonances in each spectrum. Progressively more ionization-resonance structures are observed as the primary charge state of the ions is increased. This visualizes the re-ordering of the εf continuum into a regular series of (bound) Rydberg orbitals as the ionic core becomes more attractive.

[1] S. Schippers et al., J. Phys. B **48** (2015) 144003.
[2] S. Schippers et al., J. Phys. B **47** (2014) 115602.

A 22.12 Tue 16:30 Empore Lichthof

Observation of four-electron Auger processes — A. Müller[1], A. Borovik Jr.[1], T. Buhr[2], J. Hellhund[1], K. Holste[1], A. L. D. Kilcoyne[3], S. Klumpp[4], M. Martins[4], S. Ricz[5], J. Viefhaus[6], and •S. Schippers[1] — [1]Justus-Liebig-Universität Gießen — [2]PTB, Braunschweig — [3]Lawrence Berkeley National Laboratory, USA — [4]Universität Hamburg — [5]ATOMKI, Debrecen, Hungary — [6]FS-PE, DESY, Hamburg

We report on the observation of triple-Auger decay processes [1] in which $C^+(1s2s^22p^2\ ^2D,^2P)$ terms were selectively excited by irradiating singly charged carbon ions by VUV photons at the PETRA III synchrotron light source. Subsequent to the decay of the intermediate resonantly excited K-vacancy terms, product ions C^{2+}, C^{3+} and C^{4+} were recorded. Absolute cross sections for processes $\gamma + C^+(1s^22s^22p\ ^2P) \rightarrow C^+(1s2s^22p^2\ ^2D,^2P) \rightarrow C^{1+m+}(1s^22\ell^{3-m}) + me$ leading to net photoionization with $m = 1, 2, 3$ were determined. In addition, the natural linewidths of the intermediate resonant states could be measured. By combining all this information, the absolute transition rates for radiative as well as single and multiple Auger decays were inferred. The triple-Auger decay rate was found to be 2.0×10^{10} s^{-1} for the $C^+(1s2s^22p^2\ ^2D)$ and 9.7×10^9 s^{-1} for the $C^+(1s2s^22p^2\ ^2P)$ intermediate resonantly-excited terms investigated in this study. The ratios of single- to double- to triple-Auger rates of the ^2D and ^2P terms are about 100 : 2.7 : 0.013 and 100 : 3.3 : 0.013, respectively.

[1] A. Müller et al., Phys. Rev. Lett. **114** (2015) 013002.

A 22.13 Tue 16:30 Empore Lichthof

Experimental determination of Oxygen K-shell fluorescence yield of different Silicon sub-oxides — •Malte L. Wansleben, Philipp Hönicke, Michael Kolbe, and Burkhard Beckhoff — Physikalisch-Technische Bundesanstalt, 10587 Berlin, Germany

The ongoing development of thin film materials for applications in different fields of research and production requires an accurate and

reliable composition analysis. If a non destructive quantitative characterization of the elemental composition is needed, often only fundamental parameter based - or even reference free X-ray fluorescence (XRF) spectroscopy is a suitable analytical method. This is due to the extremely low availability of reference materials with sufficient similarity to the analytical problem.

The accuracy of the quantitative results highly depends on the availability of atomic fundamental parameters with uncertainties as low as possible. Especially tabulated fundamental parameters for low Z elements are only available with insufficient large uncertainties. In addition, the question if fundamental parameters of an element are influenced by its chemical environment has to be answered.

To address this question here, the dependency of the oxygen K-shell fluorescence yield - being one of the atomic fundamental parameters - as a function of the oxidation state of silicon is experimentally determined. The experiments were carried out at the plane grating monochromator beamline in the PTB laboratory at the electron storage ring BESSY II, where monochromatized synchrotron radiation of high spectral purity was employed.

A 22.14 Tue 16:30 Empore Lichthof

Gas Monitor Detector (GMD) for FEL, Synchrotron and Laser Sources — •Stephan Klumpp, Markus Braune, Andrey A. Sorokin, and Kai Tiedtke — FS-FL, DESY, Hamburg

The users at different radiation facilities like PETRA III, FLASH or ELI need for the evaluation of their data the intensity of the exciting radiation with low uncertainty, but measuring the intensity of a photon beam in the soft and hard x-ray regime is a non-trivial task. For soft x-rays like e.g. at P04, PETRA III, calibrated photo diodes will be sufficient to determine the intensity on absolute scale. They work on radiation sources with stable beam conditions. For the ever changing pulses of FLASH the non-destructive gas monitor detectors (GMD) were developed, but the concept is based on a high number of photons, above 10^{10} photons per pulse, to create data having a good signal-to-noise ratio. At a FEL this condition is fulfilled, but not necessarily for HHG laser sources, for example. The aim of the "Pulse Characterization and Control" (PUCCA) work package of the European Cluster of Advanced Laser Light Sources (EUCALL) is to realize, beside wavefront sensors and timing tools, an intensity monitor bridging from the soft to the hard x-ray regime and from low intensity sources, below 10^6 photons per pulse, to high intensity sources, above 10^{10} photons per pulse. We will discuss different approaches to meet the challenge.

EUCALL and WP7 PUCCA has received funding from the European Unions Horizon 2020 research and innovation program under grant agreement No 654220.

A 22.15 Tue 16:30 Empore Lichthof

High-intensity narrow-band x-ray lasing with highly charged ions — •Chunhai Lyu, Zoltán Harman, Stefano M. Cavaletto, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Intense ultrashort x-ray free electron laser (XFEL) pulses can create population inversion through K-shell ionization of highly charged ions. This allows the generation of an x-ray laser pulse with better coherence properties than the original XFEL pulse. Our time-depenent density matrix simulations show that the bandwidth of the x-ray laser can be reduced if one uses certain highly charged ions. The saturation intensity of the x-ray laser is no longer limited by the lifetime of the upper lasing level, and can be increased significantly by implementing more intense XFEL pulses. Furthermore, the frequency of the laser can be extended to the hard x-ray regime when heavy ions are employed.

A 22.16 Tue 16:30 Empore Lichthof

Directional control of the photodissociation of SF6 by using THz and XUV fields — •Severin Meister[1], Georg Schmid[1], Sven Augustin[1], Kirsten Schnorr[1], Hannes Lindenblatt[1], Yifan Liu[1], Viktor Adam[1], Ann-Sophie Hilkert[1], Patrick Paluch[1], Artem Rudenko[2], Matthias Kübel[3], Christian Burger[3], William Okell[3], Matthias Kling[3], Torsten Golz[4], Nikola Stojanovic[4], Thomas Pfeifer[1], Claus-Dieter Schröter[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland — [2]Kansas State University, Manhattan, USA — [3]Ludwig Maximilians Universität, München, Deutschland — [4]DESY, Hamburg, Deutschland

In a two-color coherent-control experiment at FLASH, we used a THz pulse to excite anti-symmetric vibrational modes in SF_6 and singly ionized the molecule with a delayed 60 eV XUV pulse. The emission direction of the emitted F atom is controlled by the phase of the superimposed stretching vibrational modes. The ionization leads to a Coulomb explosion, fragmenting mainly in SF_5^+ and F. As a result the directionality of the de-halogenation can be controlled, which manifests as an asymmetric ejection of F atoms along the laser polarization. The experiment was performed with a Reaction Microscope (REMI), where all charged fragments (e^-, F, SF_5^+) can be detected in coincidence and their associated momenta reconstructed. An oscillation in the preferential direction (along the polarization direction of the THz pulse) of the F emission, as a function of pulse delay Δt, serves as the signature of the successful control of the dissociation direction.

A 22.17 Tue 16:30 Empore Lichthof

IR-assisted XUV Multiphoton Ionization of Noble Gases at FLASH — •Georg Schmid[1], Kirsten Schnorr[1], Sven Augustin[1], Severin Meister[1], Hannes Lindenblatt[1], Defu Luo[1], Patrick Paluch[1], Lutz Fechner[1], Thomas Ding[1], Yifan Liu[1], Rolf Treusch[2], Stefan Düsterer[2], Harald Redlin[2], Christian Ott[3], Kamal P. Singh[4], Mathieu Gisselbrecht[5], Claus-Dieter Schröter[1], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]DESY, Hamburg, Germany — [3]UC Berkely, USA — [4]IISER, Mohali, India — [5]Lund University, Sweden

IR-XUV pump-probe experiments on atomic noble gases were performed at the free-electron laser in Hamburg (FLASH). Using a reaction microscope, we were able to measure photoions and -electrons as a function of the delay between intense IR ($\sim 10^{14}$ W/cm^2) and XUV pulses. For delay values with IR being present, an enhancement in the yield of Ar ions produced by multiple absorption of 27 eV photons is observed up to high ionic charge states (Ar^{5+}). The increase is especially pronounced in the Ar^{2+} channel. Sequential absorption of two XUV photons excites Ar^{+*} ($3s^23p^4(^1D)3d$) states which are further ionized by the IR pulse to Ar^{2+}. The ion yield dependence on the XUV and IR intensity is investigated and different IR-assisted XUV multiphoton ionization pathways are distinguished. Our findings show how XUV multiphoton ionization can be controlled by IR laser pulses. For Helium at 24 eV, differences in the He^+ photoion and -electron momentum distributions are observed with and without IR laser.

A 22.18 Tue 16:30 Empore Lichthof

Inner shell excitation of Mn with short intense x-ray pulses — •Stephan Klumpp[1,2], Karolin Mertens[1], Nils Gerken[1], Bernd Sonntag[1], Mathias Richter[3], Andrey Sorokin[2], Markus Braune[2], Kai Tiedtke[2], Peter Zimmermann[4], and Michael Martins[1] — [1]Dept. Physik, UHH — [2]FS-FL, DESY — [3]PTB — [4]TU Berlin

Within one single pulse of a FEL like FLASH at DESY in Hamburg, with a duration in the order of 10 fs the neutral xenon atom can absorb more than 50 photons and hence can be ionised up to Xe^{21+}. The physics driving the ionisation to this high charge state is still under debate, but it is presumed that the existence of resonances of the neutral atom and the intermediate (highly charged) ions play an important role in the sequential absorption process of so many photons. By varying the atomic target from Xe, with its completely filled 4d subshell, to Mn, with its half filled 3d subshell, we study the influence of the correlative nature of the resonances involved in the photoionisation process. The atomic manganese was therefore excited with two different photon energies using high flux FEL pulses from the BL2 beamline of FLASH. With photons of 23.8 nm (52.1 eV) Mn was excited resonantly in its giant resonance, with photons of 20.3 nm (61.2 eV) non-resonantly above it. m/q spectra were obtained by the means of ion time-of-flight spectrometer depending on the irradiance of the FEL pulses. Charge states of Mn ions up to Mn^{6+} have been observed at resonant excitation and even up to Mn^{7+} for non-resonant excitation. The dependence of the m/q spectra can be explained in a sequential excitation scheme.

A 22.19 Tue 16:30 Empore Lichthof

Cross sections of iodine-containing molecular ions after inner-shell excitation — •Stephan Klumpp[1], Kaja Schubert[1], Karolin Mertens[1], Alexander Guda[2], Sadia Bari[3], Jonas Hellhund[4], Stefan Schippers[4], Alfred Müller[4], and Michael Martins[1] — [1]Department Physik, University of Hamburg — [2]Southern Federal University, Rostov-on-Don, Russia — [3]FS-SCS, DESY, Hamburg — [4]Justus-Liebig-Universität Giessen

We have measured partial cross sections for the production of atomic fragments I^{q+} (q=2..5) by photofragmentation of the parent ion IH^{1+}

with the Photon-Ion-Spectrometer (PIPE) at P04 of PETRA III at DESY in Hamburg. The molecular ion parent has been excited with x-ray photons in the energy range of the iodine 3d excitation threshold. The cross sections show two broad prominent features similar to the cross sections of Xe. In contrast, the partial cross sections of the fragments I^{q+} (q=2..5) for the atomic parent ion I^{1+} are much more structured.

Determining absolute absorption cross sections of atomic ions in a merged-beam set-up is a well established method. For molecular ions the kinetic energy release (KER) of each fragmentation process has to be taken into account, in addition because the charged molecular fragments are driven apart. We introduce a kinematic model regarding the KER for IH^{1+} calculating the ratio between the atomic I^{n+} (n=2..5) fragments hitting the detector and the ones hitting the chamber walls. The ratio is then used to calibrate the measured spectra. The obtained values are compared to DFT calculations.