A 23: Interaction with VUV and X-ray light I

Time: Thursday 11:00–13:00 Location: f107

Invited Talk A 23.1 Thu 11:00 f107

Manipulating dissipative channels of highly excited systems — •Stefan Yoshi Buhmann — University of Freiburg, Germany

Highly excited atomic of molecular systems can loose their energy by a range of dissipative channels: via spontaneous or Auger decay for isolated systems or by means of interatomic Coulombic decay in the presence of neighbours.

We give an overview over how these competing channels can be manipulated by environments such as media or surfaces [1] in a generalised Purcell effect [2]. The basis for our investigation is coupling of charged matter with the environment-assisted quantised electromagnetic field within the framework of macroscopic quantum electrodynamics (QED) [3]. Inter alia, we show that Auger decay is much less susceptible to environment effects than radiative or interatomic Coulombic decay; that local-field effects need to be taken into account when considering systems embedded in media; and that some of the investigated channels can be enhanced by collective, superradiance-type effects [4].

[1] J.L. Hemmerich, R.Bennett, S.Y. Buhmann, Nat. Commun. **9**, 2934 (2018).
[2] E. M. Purcell, Phys. Rev. **69**, 674 (1946).
[3] S. Y. Buhmann, Dispersion forces I (Springer, Heidelberg, 2013).
[4] S. Fuchs, S. Y. Buhmann, Europhys. Lett. **124**, 34003 (2018).

A 23.2 Thu 11:30 f107

Cooper minimum in multi-photon ionization — •Jiri Hofbrucker[1,2,3], Andrey Volotka[2,3], and Stephan Fritzsche[1,2,3] — [1]Friedrich-Schiller University, Jena, Germany — [2]Helmholtz Institute, Jena, Germany — [3]GSI, Darmstadt, Germany

In one-photon ionization, the photon energy for which the dominant ionization channel vanishes is called the Cooper minimum. This concept is extended to nonlinear ionization of atoms. We study this *nonlinear Cooper minimum* in the two-photon ionization process. In our talk it will be shown that the nonlinear Cooper minimum leads to strong variation in practically all observable quantities of the two-photon ionization process. For example, by tuning the incident photon energy to the nonlinear Cooper minimum, it is possible to enhance the polarization transfer from the incident light to the photoion. The ion polarization can be observed either directly, or in the case of inner-shell ionization, via polarization of subsequent fluorescence and Auger decay particles. The nonlinear Cooper minimum also leads to the maximum elliptical dichroism in photoelectron angular distributions. As all the mentioned quantities are normalized quantities, they are less sensitive to experimental uncertainties. It is theorized that detection of the energy position of the nonlinear Cooper minimum via one of the mentioned methods could lead to comparison of experimental measurements and theoretical calculations at hitherto unreachable accuracy.

A 23.3 Thu 11:45 f107

K-shell photoionization of silicon ions — •Ticia Buhr[1], Sebastian Stock[2,3], Alexander Perry-Sassmannshausen[1], Simon Reinwardt[4], Michael Martins[4], Sándor Ricz[5], Alfred Müller[1], Stephan Fritzsche[2,3], and Stefan Schippers[1] — [1]Justus-Liebig-Universität Gießen, Germany — [2]Helmholtz-Institut Jena, Germany — [3]Friedrich-Schiller-Universität Jena, Germany — [4]Universität Hamburg, Germany — [5]Institute for Nuclear Research, Hungarian Academy of Sciences, Debrecen, Hungary

Silicon is one of the most abundant heavy elements in the Universe. Therefore, the investigation of the electronic structure of the silicon atom, its ions and their response to radiation is fundamental from an astrophysical point of view. Single and multiple photoionization of Si^{q+} ($q = 1, 2, 3$) ions have been experimentally investigated in the photon energy range 1830 eV to 2100 eV using the PIPE setup [1, 2] at the synchrotron light source PETRA III. $Si^{q+} \rightarrow Si^{(q+n)+}$ reaction channels with n up to 4 were studied. Pronounced resonance structures are observed for all ions and are associated with excitation or ionization of a K-shell electron. The experimental cross sections are compared with the results of multiconfiguration Dirac–Hartree–Fock calculations (MCDHF). The theoretical description accounts for initial excitation or ionization and the subsequent cascade of Auger processes.

[1] S. Schippers *et al.*, J. Phys. B **47**, 115602 (2014).
[2] S. Schippers *et al.*, X-Ray Spectrometry, DOI:10.1002/xrs.3035.

A 23.4 Thu 12:00 f107

Inner-Shell Multiple Photodetachment of Silicon Anions — •Alexander Perry-Sassmannshausen[1], Ticia Buhr[1], Alfred Müller[1], Simon Reinwardt[2], Florian Trinter[3,4], and Stefan Schippers[1] — [1]Justus-Liebig-Universität Gießen, Germany — [2]Universität Hamburg, Germany — [3]FS-PETRA-S, DESY, Hamburg, Germany — [4]Molecular Physics, Fritz-Haber-Institut, Berlin, Germany

Negative atomic ions play an important role in low-temperature plasmas such as Earth's upper atmosphere or the interstellar medium [1,2]. A sensitive tool for studying the interactions between the valence and the core electrons is inner-shell ionization of negative ions [3]. The inner-shell photoionization dynamics is particularly rich since it is governed by strong multiple relaxation effects of the valence electrons upon creation of the inner-shell hole [4,5].

Here, we report on preliminary results from a recent beam time at the Photon-Ion-Spectrometer at beamline P04 at PETRA III (PIPE) [6]. We investigated multiple photodetachment of silicon anions which led to final charge states up to Si^{5+}. Relative cross sections for all measured product ion channels will be presented and discussed.

[1] T. Andersen, Phys. Rep. **394**, 157 (2004)
[2] T. J. Millar et al., Chem. Rev. **117**, 1765 (2017)
[3] S. Schippers et al., Phys. Rev. A **94** 041401(R) (2016)
[4] T. Gorczyca, Rad. Phys. Chem. **70**, 407 (2004)
[5] S. Schippers et al., Phys. Rev. A **94**, 041401 (R) (2016)
[6] S. Schippers et al., J. Phys. B **47**, 115602 (2014)

A 23.5 Thu 12:15 f107

XUV Transient Absorption Spectroscopy on Neon at FLASH — •Thomas Ding[1], Marc Rebholz[1], Lennart Aufleger[1], Maximilian Hartmann[1], Kristina Meyer[1], Alexander Magunia[1], David Wachs[1], Veit Stooss[1], Paul Birk[1], Gergana Borisova[1], Patrick Rupprecht[1], Yonghao Mi[1], Andrew Attar[2], Thomas Gaumnitz[3], Zhi Heng Loh[4], Sebastian Roling[5], Marco Butz[5], Helmut Zacharias[5], Stefan Düsterer[6], Rolf Treusch[6], Stefano Cavaletto[1], Christian Ott[1], and Thomas Pfeifer[1] — [1]Max Planck Institut für Kernphysik, Heidelberg, Germany — [2]University of California Berkeley, Berkeley, USA — [3]Eidgenössische Technische Hochschule Zürich, Zürich, Switzerland — [4]Nanyang Technological University Singapore, Singapore — [5]Westfälische Wilhelms-Universität Münster, Münster, Germany — [6]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

We present transient absorption spectroscopy employing extreme ultraviolet (XUV) pump and probe pulses delivered by the free-electron laser FLASH. We target the neon atom and trace its nonlinear XUV (photon energy 50 eV) interaction with joint high spectral and temporal resolution. This allows us to trace the time-dependent sequential two-photon ionization of neon, transient (2.4-fs time scale) coherence effects near resonances in the produced doubly-charged neon ions (Ne^{2+}), and the XUV-induced Stark shift of those ionic resonances. Furthermore, we show how this technique can be used to measure the frequency chirp of XUV-FEL pulses.

A 23.6 Thu 12:30 f107

Determination of the electric and magnetic Rayleigh scattering amplitudes — •Andrey Volotka[1], Andrey Surzhykov[2,3], and Stephan Fritzsche[1,4] — [1]Helmholtz-Institut Jena, 07743 Jena, Germany — [2]Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany — [3]Technische Universität Braunschweig, 38106 Braunschweig, Germany — [4]Theoretisch-Physikalisches Institut, Friedrich–Schiller-Universität Jena, 07743 Jena, Germany

The Rayleigh scattering being a dominant elastic-scattering process for a wide range of photon energies extensively investigated theoretically. Relativistic calculations based on the second-order S-matrix amplitude is accepted now as a benchmark for treating the Rayleigh scattering. However, its superior to other, simpler techniques, was mainly demonstrated for the case of the angle-differential cross sections. In contrast, much less attention has been paid to the polarization studies, especially in the case of initially polarized light. Within the present studies, we investigate the possibilities for separate extraction of the electric and magnetic scattering amplitudes as well as the phase difference between them. This "complete" experiment becomes possible now with the re-

cent advent of novel solid-state photon detectors, which provide a good energy resolution in combination with submillimeter position resolution over a large detection area.

A 23.7 Thu 12:45 f107

Tabletop Intensity Interferometry of a Femtosecond Hard X-ray Source — •Leon Merten Lohse, Malte Vassholz, Hannes Hoeppe, and Tim Salditt — Institut für Röntgenphysik, Universität Göttingen, Deutschland

Laser-driven femtosecond Plasma X-ray sources (PXS) with solid targets offer a unique opportunity to produce hard X-ray pulses of a few 100fs with kHz repetition rate in the lab. In contrast to X-ray free electron lasers, the radiation from such a source consists of bremsstrahlung and characteristic radiation (fluorescence) and is fully (first-order) incoherent as such. The pulse lengths in the order of 100fs are, compared to the fluorescence lifetime in the order of 1fs, in principle short enough to produce intensity correlations and speckle patterns on a 2D detector. Using novel energy-resolving pixel detectors with kHz frame rate in the single photon regime allows to reliably discriminate between the fluorescence signal and the bremsstrahlung background on a single shot basis.

Here we present recent results from measurements with a charge-integrating hybrid pixel detector at our PXS.