A 19: Cluster I (joint session A/MO)

Time: Wednesday 14:00–16:15 Location: S HS 3 Physik

Invited Talk A 19.1 Wed 14:00 S HS 3 Physik

Imaging ultrafast dynamics in nanoparticles with resonant multicolor XUV pulses — L Hecht[2], B Langbehn[2], J Zimmermann[1], J Jordan[2], K Kolatzki[1], N Monserud[1], Y Ovcharenko[3], M Sauppe[1], B Schütte[1], R Tanyag[1], A Ulmer[2], B Kruse[4], K Sander[4], C Peltz[4], A Colombo[5], A D'Elia[6], M diFraia[7], L Giannessi[7], P Piseri[5], O Plekan[7], K Prince[7], M Zangrando[7], C Callegari[7], MJJ Vrakking[1], A Rouzée[1], T Möller[2], T Fennel[2], and •D Rupp[1] — [1]MBI Berlin, Germany — [2]TU Berlin, Germany — [3]E-XFEL, Schenefeld, Germany — [4]Uni Rostock, Germany — [5]Uni Milano, Italy — [6]Uni Trieste, Italy — [7]Elettra, Trieste, Italy

Diffraction imaging with intense, coherent, short-wavelength light pulses is a unique method to determine the structure of individual nanometer-sized objects such as viruses or fragile superfluid helium nanodroplets. In addition, diffraction imaging can be also used as a probe for ultrafast electronic processes within the particle. As the photons are elastically scattered by the electrons bound to the particle, the scattering response will be altered if the particle's electronic structure changes, with particularly strong effects at electronic resonances. In two experiments we employed this concept using extreme ultraviolet (XUV) multicolor pulses from an intense high-harmonic generation source and two-color pulses from the FERMI free-electron laser, respectively, to resonantly image helium nanodroplets and trace light induced excitation and ionization processes within them.

Invited Talk A 19.2 Wed 14:30 S HS 3 Physik

Multi-coincidence experiments on electron and photon emission — •Andre Knie — Institut für Physik und CINSaT, Universität Kassel

The coincident detection of particles is a powerful method in experimental physics, enabling the reconstruction of diverse projectile-target interactions. The overwhelming majority of coincidence experiments is performed detecting exclusively charged particles. When neutrals or photons are of interest, experiments typically suffer from small solid angles. Here, a new approach is shown maximizing the available solid angle for photon detection, confining the interaction volume within focusing optics. With it a series of experiments was performed on atomic and cluster samples to underline its capabilities. With this technique it was possible to disentangle Auger processes in argon otherwise unresolvable by spectroscopic means. Additionally, the coincident detection was used to circumvent the typical signal to noise ratio of an ultra low cross section process, e.g. luminescent shake up satellites in helium. The final example shows that completely new processes can be unraveled with this technique: A new energy transfer process in weakly bound heterogeneous noble gas clusters will be presented.

A 19.3 Wed 15:00 S HS 3 Physik

Auger Emission from the Coulomb Explosion of Helium Nanoplasmas — •Michael Zabel, Michael Kelbg, Bennet Krebs, Josef Tiggesbäümker, and Karl-Heinz Meiwes-Broer — Universität Rostock, Institut für Physik, Albert-Einstein-Strasse 23-24, 18059 Rostock

The long-time correlated decay dynamics of strong-field exposed helium nanodroplets is studied by means of angular resolved electron spectroscopy. As a result of the adiabatic expansion of the fully inerionized plasma, delocalized electrons in the laser-produced deep confining mean field potential are shifted towards the vacuum level, whereas some electrons may localize in bound levels of the helium ion. The simple hydrogen-like electronic structure of He^+ results in clear signatures in the experimental electron spectra. The pronounced features in the electron yields can be traced back to bound-free and bound-bound transitions in He^+. Auger electron emission takes place as a result of the transfer of the excess energy to weakly bound electrons in the quasifree electron band. Hence, the spacial and temporal development of the nanoplasma cloud is encoded in the experimental spectra, whereas the special electronic properties of helium helps to clearly resolve the different contributions.

A 19.4 Wed 15:15 S HS 3 Physik

Plasmon resonances of polyanionic metal clusters — •Klara Raspe[1], Norman Iwe[1], Madlen Müller[2], Franklin Martinez[1], Josef Tiggesbäumker[1], Lutz Schweikhard[2], and Karl-Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23-24, 18059 Rostock — [2]Institut für Physik, Universität Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald

In the interaction of metal clusters with light the occurrence of plasmon resonances is a well known effect. We present photoelectron spectra of negatively charged silver clusters which indicate such a plasmon resonance, and - in the case of higher charge states - show also the Coulomb Cut-Off. In this contribution we discuss the plasmon energies with respect to well-defined cluster sizes and charge states and compare them to literature values of smaller silver clusters. The project has been supported by the collaborative research center SFB 652 of the DFG.

A 19.5 Wed 15:30 S HS 3 Physik

Time-resolved coherent diffraction imaging of helium nanodroplets in free flight with intense high-harmonic XUV-pulses — •J Zimmermann[1], K. Kolatzki[1], N. Monserud[1], M. Sauppe[1], B. Schütte[1], R. M. Tanyag[1], M.J.J. Vrakking[1], A. Rouzee[1], J. Jordan[2], B. Langbehn[2], A. Ulmer[2], T. Möller[2], B. Kruse[3], T. Fennel[3], and D. Rupp[1] — [1]MBI Berlin — [2]IOAP, TU Berlin — [3]Univ. Rostock

Coherent diffraction imaging (CDI) of single particles in free flight enables studying the structural composition of fragile nano-scaled matter. Such experiments demand high-intensity extreme ultraviolet or X-ray light pulses, until recently only achievable at large-scale free-electron laser (FEL) facilities. We have demonstrated [1] that high harmonic generation (HHG) sources can be used for single-shot single-particle CDI with great prospects for time-resolved experiments due to high stability and extremely short pulse durations. Here we report on the first time-resolved CDI measurements using a HHG laser system on helium nanodroplets in an IR pump - XUV probe scheme. We obtained bright multicolor diffraction patterns in a setup that allowed for few femtoseconds time-resolution. First results of the ongoing analysis will be presented and discussed. [1] Rupp et al., Nat.Com.8,493(2017)

A 19.6 Wed 15:45 S HS 3 Physik

Investigation of polyanionic metal clusters by photoelectron spectroscopy — •Madlen Müller[1], Franklin Martinez[2], Norman Iwe[2], Klara Raspe[2], Steffi Bandelow[1], Josef Tiggesbäumker[2], Lutz Schweikhard[1], and Karl-Heinz Meiwes-Broer[2] — [1]Institute of Physics, University of Greifswald, Germany — [2]Institute of Physics, University of Rostock, Germany

One of the most prominent features of polyanionic systems is the Coulomb barrier (CB), already confirmed by photoelectron spectroscopy (PES) on molecules and fullerenes. Recently such studies have been extended to the field of polyanionic metal clusters. While offering a variety of sizes and charge states to analyze, metal clusters also serve as model systems with a simplified access e.g. by the liquid drop model (LDM).

The contribution presents an overview of our measurements on polyanionic metal clusters. The study includes the determination of threshold binding energies, that support the LDM along a wide range of cluster sizes and extending to negative binding energies. Furthermore, multiphoton processes and the Coulomb cut-off dominate the structure of the PE spectra. In particular, the evolution of the Coulomb cut-off with charge state and cluster size leads to further insights into the nature of the Coulomb barrier. The project has been funded by the collaborative research center SFB 652 of DFG.

A 19.7 Wed 16:00 S HS 3 Physik

Ultrafast Ionization Dynamics of Methane Clusters — •A. Heilrath[1], M. Sauppe[1,2], K. Kolatzki[1,2], B. Langbehn[1], B. Senfftleben[2], A. Ulmer[1], J. Zimmermann[1,2], L. Flückiger[3], T. Gorkhover[4], C. Bostedt[5], Y. Kumagai[6], S. Düsterer[7], B. Erk[7], C. Passow[7], D. Ramm[7], D. Rolles[7,8], D. Rompotis[7], R. Treusch[7], T. Feigl[9], T. Möller[1], and D. Rupp[1,2] — [1]Technische Universität Berlin — [2]Max-Born-Institut, Berlin — [3]La Trobe University, Australia — [4]SLAC Menlo Park, USA — [5]Paul Scherrer Institut, Switzerland — [6]Argonne National Lab, USA — [7]FLASH@DESY — [8]Kansas State University, USA — [9]optiX fab, Jena

Intense short wavelength femtosecond pulses from free-electron lasers (FELs) allow to study individual nanoparticles with high resolution

in time and space. Exposing samples to intense extreme ultraviolet (XUV) pulses is inevitably linked to ionization and subsequent disintegration of the sample, limiting the accuracy of diffraction imaging. Molecular clusters are an ideal sample system to approach light-induced dynamics of large heteronuclear systems. We studied methane clusters in an XUV pump - XUV probe experiment with 90 eV photon energy at CAMP@FLASH with delays up to 650 ps. Ionic fragments were measured with a time-of-flight spectrometer and diffraction images were taken simultaneously. The ion spectra exhibit a variety of fragments, including higher adducts forming in molecular recombination processes. A general increase of the ion yield with delay as well as the delay-dependencies of fragments will be discussed.