A 6: Atomic clusters (joint session A/MO)

Time: Monday 14:00–16:15 Location: a320

Invited Talk A 6.1 Mon 14:00 a320

Time-resolved X-ray Imaging of Anisotropic Nanoplasma Expansion — •Christian Peltz[1], Christoph Bostedt[2], Mathias Kling[3], Thomas Brabec[4], Eckart Ruehl[5], Artem Rudenko[6], Tais Gorkhover[7], and Thomas Fennel[1] — [1]Institute of Physics, University of Rostock, Germany — [2]Paul Scherrer Institute, Villigen, Switzerland — [3]Faculty of Physics, LMU Munich, Germany — [4]Department of Physics and Centre for Photonics Research, University of Ottawa, Canada — [5]Physical Chemistry, FU Berlin, Germany — [6]Department of Physics, Kansas-State University, USA — [7]LCLS, SLAC National Accelerator Laboratory, Menlo Park, USA

We investigate the time-dependent evolution of laser-heated solid-density nanoparticles via coherent diffractive x-ray imaging, theoretically and experimentally. Our microscopic particle-in-cell calculations for R = 25 nm hydrogen clusters reveal that infrared laser excitation induces continuous ion ablation on the cluster surface. This process generates an anisotropic nanoplasma expansion that can be accurately described by a simple self-similar radial density profile. It's time evolution can be reconstructed precisely by fitting the time-resolved scattering images using a simplified scattering model in Born approximation [1]. Here we present the first successful high resolution reconstruction of corresponding experimental results, obtained at the LCLS facility with SiO2 nanoparticles (D=120 nm), giving unprecedented insight into the spatio-temporal evolution of the nanoplasma expansion.

[1] C. Peltz, C. Varin, T. Brabec and T. Fennel , Phys. Rev. Lett. **113**, 133401 (2014)

Invited Talk A 6.2 Mon 14:30 a320

Imaging anisotropic dynamics in superfluid helium nanodroplets — •B. Langbehn[1], K. Sander[2], Y. Ovcharenko[1,3], C. Peltz[2], A. Clark[4], M. Coreno[5], R. Cucini[6], A. Demidovich[6], M. Drabbels[4], P. Finetti[6], M. Di Fraia[6,5], L. Giannessi[6], C. Grazioli[5], D. Iablonskyi[7], A. C. LaForge[8], T. Nishiyama[9], V. Oliver Álvarez de Lara[4], P. Piseri[10], O. Plekan[6], K. Ueda[7], J. Zimmermann[1,11], K. C. Prince[6,12], F. Stienkemeier[8], C. Callegari[6,5], T. Fennel[2,11], D. Rupp[1,11,13], and T. Möller[1] — [1]TU Berlin — [2]Univ. Rostock — [3]European XFEL — [4]EPFL Lausanne — [5]ISM-CNR Trieste — [6]Elettra-Sincrotrone Trieste — [7]Tohoku Univ. Sendai — [8]Univ. Freiburg — [9]Kyoto Univ. — [10]Univ. di Milano — [11]MBI Berlin — [12]Swinburne Univ. of Tech. — [13]ETH Zürich

Intense short-wavelength light pulses from free-electron lasers (FELs) enable the study of the structure and dynamics of nanometer-sized particles in the gas phase using coherent diffraction imaging methods. In our experiment, we explored the light induced dynamics of xenon doped helium nanodroplets. We used intense near-infrared pulses to ignite a nanoplasma inside the droplets. After a variable time delay of up to 800 ps, we imaged the dynamics triggered by the nanoplasma using extreme ultraviolet pulses from the FERMI FEL. The recorded scattering patterns exhibit pronounced directionalities that can be attributed to anisotropic changes of the droplet surface. A possible connection of these directed dynamics to the droplet's vortex structure will be discussed.

A 6.3 Mon 15:00 a320

Setup and characterization of a helium liquid jet for diffraction experiments — •K. Kolatzki[1,2], R. M. P. Tanyag[2], G. Noffz[2], A. Ulmer[2], T. Möller[2], and D. Rupp[1,3] — [1]LFKP, ETH Zurich, Switzerland — [2]IOAP, TU Berlin — [3]Max-Born-Institut Berlin

When conducting coherent diffractive imaging experiments at XUV and X-ray facilities with atomic clusters as targets, it is desirable that these targets are constant in size and spacing. Large helium droplets produced via Rayleigh-type breakup of a liquid jet meet these requirements: Compared to other types of clusters or droplets, they can exhibit very narrow size distributions and even spacing. Helium droplets also have a simple electronic structure, show interesting properties like superfluidity and can be used as a cooling matrix for embedded atoms and molecules.

Recently, we have constructed and characterized a source for a helium liquid jet and subsequent droplets, which is available for user experiments at the European XFEL's SQS endstation. Via shadowgraphy methods, we have analyzed the jet's shape and the droplet size distributions. Results from these measurements and an improved setup will be presented.

A 6.4 Mon 15:15 a320

Solvation and desorption dynamics of Cs atoms attached to He nanodroplets — •Nicolas Rendler, Audrey Scognamiglio, Lukas Bruder, Katrin Dulitz, and Frank Stienkemeier — University of Freiburg, Freiburg, Germany

Despite the low perturbative environment provided by the superfluidity of helium nanodroplets, excited or charged dopants can be strongly affected by the surrounding helium atoms. Numerous processes can be triggered by the electronic excitation and ionization of the dopant. For example, the repulsive electron-He interaction can result in the ejection of electronically excited dopants [1] which can be accompanied by electronic relaxation induced by the He environment [2]. In some cases, pairwise He-dopant interaction can also lead to the formation of He-dopant exciplexes [2,3]. Desorption dynamics, electronic relaxation as well as exciplex formation, strongly depend on the dopant species and still lack a complete understanding. We present an experimental study of the desorption dynamics of photo-excited Cs atoms attached to He nanodroplets using femtosecond pump-probe spectroscopy in combination with velocity-map imaging detection.

[1] M. Mudrich, F. Stienkemeier, Int. Rev. Phys. Chem. 33, 301-339, (2014).

[2] E. Loginov, M. Drabbels, J. Phys. Chem. A 111, 7504-7515, (2007).

[3] J. von Vangerow et al., J. Phys. Chem. Lett. 8 (1), 307-312, (2017).

A 6.5 Mon 15:30 a320

Coherent diffractive imaging of excited state population dynamics in a helium droplet — •Björn Kruse[1], Benjamin Liewehr[1], Christian Peltz[1], and Thomas Fennel[1,2] — [1]Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23, D-18059 Rostock — [2]Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max-Born-Str. 2A, D-12489 Berlin

Coherent diffractive imaging (CDI) of isolated helium nanodroplets has been successfully demonstrated with a lab-based HHG source [1] operating in the vicinity of the 1s - 2p transition of helium. To reconstruct the shape and orientation of nanoparticles, CDI experiments have so far been analyzed in terms of a classical linear response description [2]. However, for high intensities and especially for resonant excitation, population dynamics of bound electrons and stimulated emissions may become important, violating the assumptions underlying a linear description. To what extend and how nonlinear processes influence CDI scattering images is currently largely unknown. In our theoretical analysis, we describe the quantum-mechanical few-level bound state dynamics using a density matrix formalism and incorporate this into a 3D Maxwell solver based on the finite-difference time-domain method (FDTD). We discuss the spatio-temporal population dynamics and its impact on scattering images.

[1] D. Rupp et al., Nat. Commun. **8**, 493 (2017)

[2] I. Barke et al., Nat. Commun. **6**, 6187 (2015)

A 6.6 Mon 15:45 a320

Development of core-level binding energies of mass-selected lead clusters — •Klara Raspe[1], Norman Iwe[1], Fabian Bär[2], Kariman Elshimi[2], Simon Dold[2], Franklin Martinez[1], Steffen Palutke[3], Marion Kuhlmann[3], Sven Toleikis[3], Josef Tiggesbäumker[1], Bernd von Issendorff[2], and Karl-Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23-24, 18059 Rostock, Germany — [2]Fakultät für Physik, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg, Germany

The high photon flux and the photon energies of several tens of eV as delivered by FLASH allow to conduct core-level photoemission studies on size-selected metal clusters in the gas phase. Interesting aspects are phenomena like core-hole screening and the subsequent dynamics triggered by the core electron emission. However, probing these nanometer-sized targets requires the preparation of a sufficiently high

target density in the FEL interaction region. This condition is met by an experimental setup, which includes a high-current cluster source, a quadrupole mass filter and a radio-frequency ion trap. Photoelectron spectra of lead cluster anions have been recorded in the size range of N = 3 up to 50 atoms. The spectra show a size-dependent shift of the binding energies of the 5d electrons towards the bulk work function, which is compared to the metallic sphere model.

A 6.7 Mon 16:00 a320

Coulomb interaction in the photoemission of polyanionic silver clusters — •Norman Iwe[1], Franklin Martinez[1], Madlen Müller[2], Klara Raspe[1], Lutz Schweikhard[2], Josef Tiggesbäumker[1], and Karl-Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, Rostock, Deutschland — [2]Institut für Physik, Universität Greifswald, Greifswald, Deutschland

Multiply negatively charged, nano-sized particles are characterized by a barrier potential, given by the Coulomb interaction between the excess electrons. In order to extract details of this barrier with unprecedented quality, photoelectron spectroscopy is combined with tunable laser pulse excitation. The emitted photoelectron interacts with the remaining negatively charged system, which leads to a specific Coulomb cut-off in the photoelectron spectra, as known from molecular polyanions.

In this contribution, we present experimental spectra of mass- and charge-selected silver clusters, Ag_{800}^{z-} (z=2-6), which show a characteristic dependence on the laser wavelength. The photoelectron spectra are qualitatively described by electrons coming from a Fermi distribution in a jellium-like potential, while direct emission as well as tunneling through the Coulomb barrier are taken into account.