A 2: Atomic clusters (with MO)

Time: Monday 11:30–13:15 Location: M/HS1

Invited Talk A 2.1 Mon 11:30 M/HS1

Dynamic x-ray imaging of clusters in strong fields — •Thomas Fennel — University of Rostock, 18051, Rostock, Germany

Intense laser-cluster interactions allow the fundamental investigation of collective and correlated processes in nanoscale plasmas, including ionization avalanching, plasmon-assisted electron acceleration, attosecond plasma wave dynamics, and plasma expansion. With the rapidly developing capabilities of FELs, novel routes to the direct time-resolved imaging of the underlying dynamics are emerging [1]. I will discuss the feasibility of pump - probe scattering experiments for tracing cluster dynamics via diffractive imaging with (sub?)femtosecond resolution. The recently developed microscopic particle-in-cell approach (MicPIC) accounts simultaneously for both the correlated (classical) atomic scale plasma dynamics and electromagnetic wave propagation [2]. Complete MicPIC simulations of NIR pump - x-ray probe experiments on Hydrogen clusters are used to (i) identify relevant signatures in the scattering images and to (ii) benchmark a simplified reconstruction scheme to retrieve the (ultra)fast evolution of the cluster density profile [3]. The results suggest the potential to illuminate the dynamics of laser ablation and anisotropic plasma expansion with unprecedented detail. An outlook on routes to attosecond-resolved diffractive imaging and subcycle photonic streaking via inelastic x-ray scattering will be given.

[1] I. Barke *et al.*, Nat. Commun. (accepted)
[2] C. Varin *et al.*, Phys. Rev. Lett. **108**, 175007 (2012)
[3] C. Peltz *et al.*, Phys. Rev. Lett **113**, 133401 (2014)

A 2.2 Mon 12:00 M/HS1

Experimental determination of absolute cross sections for cluster-specific decay mechanisms — •Andreas Hans[1], André Knie[1], Marko Förstel[2], Philipp Schmidt[1], Uwe Hergenhahn[2], and Arno Ehresmann[1] — [1]Institut für Physik, Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel — [2]Max-Planck-Institut für Plasmaphysik, c/o HZB-Bessy II, Albert-Einstein-Straße 15, 12489 Berlin

The knowledge of absolute values for cross sections of specific processes is of high interest in many fields of physics and especially for applications. In atomic clusters, decay mechanisms can differ significantly from those dominant in atoms. Absolute cross sections of these processes are attractive in many contexts, e.g. in astrophysics or applications of interatomic Coulombic decay (ICD). We present a new method to determine absolute cross sections for cluster-specific decay mechanisms using photon-induced fluorescence spectroscopy of a partially condensed gas jet. Once calibrated, this method also allows the characterization of cluster jets. In a first experiment, absolute cross sections of resonant ICD in Ne clusters and photon emission after inner-valence excitation in Ar clusters were measured.

A 2.3 Mon 12:15 M/HS1

Investigation of resonant interatomic coulombic decay in neon clusters by dispersed fluorescence spectroscopy — •Ltaief Ben Ltaief[1], Andreas Hans[1], Philipp Schmidt[1], Philipp Reiss[1], Marko Förstel[2], Uwe Hergenhahn[2], Till Jahnke[3], Reinhard Dörner[3], André Knie[1], and Arno Ehresmann[1] — [1]Universität Kassel, Heinrich-Plett Straß 40, D-34132 Kassel, Germany — [2]Max-Planck- Institut für Plasmaphysik, EURATOM Association, Wendelsteinstr. 1, 17491 Greifswald, Germany — [3]Institut für Kernphysik Goethe- Universität Max-von-Laue-Str.1 60438 Frankfurt am Main, Germany

Interatomic Coulombic Decay (ICD) in weakly bound systems, e.g. van-der-Waals clusters or hydrogen bonded clusters, has recently attracted much interest as an efficient and ultrafast process by which the excess energy of electronically excited atoms or molecules is transferred to a neighboring site, thereby, ionizing it. Since its discovery ICD is considered to be a relevant process in radiation chemistry and living tissues by producing low kinetic energy electrons and radical cations which may induce irreparable damage to DNA. So far, most of experiments aiming at ICD-processes used charged particles as probe of the process. Recently we have successfully demonstrated a first unambiguous proof of ICD by undispersed measurements of the emitted photons from neon clusters [1]. Here we report the use of dispersed-fluorescence spectrometry to investigate ICD after resonant excitation in neon clusters.

[1] Knie, A. *et al.* New. J. Phys. **16** 102002 (2014)

A 2.4 Mon 12:30 M/HS1

Tracing efficient autoionization processes in nanoplasmas — •Bernd Schütte[1,2], Mathias Arbeiter[3], Thomas Fennel[3], Ghazal Jabbari[4], Kirill Gokhberg[4], Alexander I. Kuleff[4], Jan Lahl[5], Tim Oelze[5], Maria Krikunova[5], Marc J. J. Vrakking[1], and Arnaud Rouzée[1] — [1]Max-Born-Institut, Berlin, Germany — [2]Imperial College London, United Kingdom — [3]Universität Rostock, Germany — [4]Universität Heidelberg, Germany — [5]Technische Universität Berlin, Germany

Nanoplasmas are generated during the interaction of clusters and large molecules with intense laser pulses from the NIR to the X-ray regime. It was shown that electron-ion recombination leads to a substantial excited state population in nanoplasmas. At sufficiently high laser intensities, multiply-excited atoms and ions can be formed and decay via autoionization. Here we demonstrate an efficient autoionization process in molecular oxygen and atomic clusters interacting with intense NIR pulses. In the case of oxygen clusters, superexcited atoms are formed during the cluster expansion that decay on a time scale of 1 ns. THz streaking reveals that a substantial portion of the electron emission is delayed, which is explained by autoionization processes on (sub-)ps to ns scales. Furthermore, we show that singly-excited Rydberg atoms decay by transferring the excess energy to an electron or to a second Rydberg atom in the environment that gets ionized, similar to interatomic Coulombic decay. The results demonstrate that autoionization processes are crucial for the understanding of nanoplasma dynamics and may strongly influence ion charge state distributions.

A 2.5 Mon 12:45 M/HS1

Laser-induced delayed electron emission of Co_4^- anions — •Christian Breitenfeldt[1,2], Klaus Blaum[2], Sebastian George[2], Jürgen Göck[2], Jonas Karthein[2], Thomas Kolling[3], Christian Meyer[2], Jennifer Mohrbach[3], Gereon Niedner-Schatteburg[3], Lutz Schweikhard[1], and Andreas Wolf[2] — [1]Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorff-Str. 6, 17487 Greifswald, Germany — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [3]Fachbereich Chemie, Universität Kaiserslautern, Germany

The Cryogenic Trap for Fast ion beams CTF located at the Max-Planck-Institut für Kernphysik is an electrostatic ion beam trap (EIBT) setup. It is well suited to investigate dynamical processes of stored ion beams. Vibrational electron autodetachment (also called delayed electron detachment) is followed by monitoring the rate of neutral particles escaping from the EIBT either as a function of storage time or, in case of laser-induced electron loss processes as a function of the time after laser excitation. Two different ion sources were used: First, a cesium ion sputter source, producing ions with vibrational temperatures up to several hundred Kelvin, second, a laser vaporization source with helium expansion to produce Co_4^- anions where the vibrational excitation levels correspond to cryogenic temperatures. The ions were stored in the CTF and the cooling and heating of the ions was probed by the change in the delayed electron detachment rate. The photo excitation measurements were performed as a function of storage time and wavelengths of the laser. Recent results are presented and discussed.

A 2.6 Mon 13:00 M/HS1

Wide angle X-ray scattering of silica nanoparticles — •Burkhard Langer[1], Christian Goroncy[1], Christopher Raschpichler[1], Felix Gerke[1], Toralf Lischke[2], Bernhard Wassermann[1], Christina Graf[1], and Eckart Rühl[1] — [1]Physikalische Chemie, Freie Universität Berlin — [2]Max-Planck-Institut für Mikrostrukturphysik, Halle

Amorphous silica nanoparticles are widely used as model systems in materials and life sciences as well as in industrial and pharmaceutical applications. The structure of these particles consists of an amorphous network of SiO_2 containing pores in the nanometer range (1-10 nm). Chemically synthesized silica nanoparticles with a diameter between 150 and 350 nm which are prepared with porous layers are focused with an aerodynamical lens into the interaction region with synchrotron radiation from BESSY II. The experiments were performed in the energy

range of the Si 2p regime ($E \approx 100$ eV), where the photon wavelength is comparable to the pore sizes. Deviations in the angle dependent scattering intensity compared to calculations obtained by pure Mie theory for spherical particles are attributed to Rayleigh scattering at the pores of the nanoparticles. Calculations using Discrete Dipole Approximation Scattering Theory (DDSCAT) and a modified Mie algorithm, both using realistic pore sizes and size distributions, are successfully applied to describe the wide angle X-ray scattering intensities.