A 36: Atomic clusters II (with MO)

Time: Thursday 14:00–15:30 Location: F 428

Invited Talk A 36.1 Thu 14:00 F 428

Size selective vibrational spectroscopy of strongly bound neutral clusters — •ANDRE FIELICKE — Institut für Optik und atomare Physik, TU Berlin

Properties of small clusters are often not only strongly dependent on their size but also on their charge state. A prominent example for this is the transition from 2D to 3D structures for gold clusters which is observed to occur at n=8 for the cations and at n=12 for the anions. While such ionic clusters are susceptible to common mass spectrometric techniques for size selection and storage similar manipulations are more difficult for neutral species and, hence, different experimental techniques need to be applied to obtain cluster size specific information. Recently, different methods have been developed that apply resonant vibrational excitation of strongly bound neutral clusters in molecular beams with infrared Free Electron Lasers. These IR sources provide intense and tunable radiation even in the far-IR region where the vibrational fundamentals of metal or semi-metal clusters are located. Size selectivity is obtained by coupling the IR excitation with a subsequent soft ionization step, i.e. avoiding fragmentation, and mass spectrometric analysis of the ionic distribution. Examples of such action spectroscopic IR studies on neutral clusters are the dissociation of messenger complexes of metal clusters,[1] IR-UV two color ionization of semi-metal and oxide clusters [2] and IR resonant enhanced multiple photon ionization of clusters of refractory materials. [1] P. Gruene et al., Science 321, 674 (2008); [2] M. Haertelt et al., Phys. Chem. Chem. Phys. 14, 2849 (2012).

A 36.2 Thu 14:30 F 428

Time resolved ionization dynamics of Xe clusters investigated with XUV-NIR pump-probe experiments at the FLASH free-electron laser — •M SAUPPE[1], M ADOLPH[1], L FLÜCKIGER[1], T GORKHOVER[1], D RUPP[1], S SCHORB[2], S DÜSTERER[3], M HARMAND[3], R TREUSCH[3], C BOSTEDT[2], M KRIKUNOVA[1], and T MÖLLER[1] — [1]IOAP, TUB — [2]LCLS, SLAC — [3]HASYLAB, DESY

Clusters irradiated by intense femtosecond extreme ultraviolet (XUV) light pulses from the FLASH free-electron laser are transformed into a highly excited non-equilibrium state resulting in complex electron and expansion dynamics. We used XUV and near infrared (NIR) pulses with pump-probe technique in order to get insight into the dynamics. The XUV pump pulse creates a nanoplasma of quasi-free electrons and initiates the expansion process of the cluster. The dynamics is probed with the time delayed NIR pulse.

Xenon clusters were produced by supersonic expansion of Xe gas. Ions and scattered photons from large single xenon clusters were recorded in coincidence. The scattering pattern gives us the possibility to determine and sort for cluster size. With the expansion of the clusters, the density of the generated quasi-free electrons of the produced nano plasma decreases. At well defined delay after the first pulse, the resonant frequency of the nanoplasma meets the frequency of the NIR-probe pulse, known as plasma resonance. These optimal conditions for energy absorption from the NIR pulse into the cluster lead to a simultaneous increase of the ion yield as observed in our experiment. The relationship between cluster size and ion yield will be discussed.

A 36.3 Thu 14:45 F 428

Spin Coupling and Orbital Angular Momentum Quenching in Free Iron, Cobalt, and Nickel Clusters — ANDREAS LANGENBERG[1,2], KONSTANTIN HIRSCH[1,2], ARKADIUSZ ŁAWICKI[1], VICENTE ZAMUDIO-BAYER[1,2], MARKUS NIEMEYER[1,2], PATRICK CHMIELA[1,2], BRUNO LANGBEHN[1,2], AKIRA TERASAKI[3,4], THOMAS MÖLLER[2], BERND VON ISSENDORFF[5], and •TOBIAS LAU[1] — [1]Institut für Methoden und Instrumentierung der Forschung mit Synchrotronstrahlung, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin — [2]Institut für Optik und Atomare Physik, Technische Universität Berlin, 10623 Berlin — [3]Cluster Research Laboratory, Toyota Technological Institute, Chiba, Japan — [4]Department of Chemistry, Kyushu University, Fukuoka, Japan — [5]Fakultät für Physik, Universität Freiburg, 79104 Freiburg

The peculiar magnetic behavior of the cationic thirteen iron atom icosahedron [1] is investigated in a comparative x-ray magnetic circular dichroism study of size-selected free iron, cobalt, and nickel clusters in the size range of 10–15 atoms per cluster. While the magnetic spin moment of cationic Fe_{13}^{+} is quenched significantly, no such quenching was observed for Co_{13}^{+} or Ni_{13}^{+}. This can most likely be correlated to the high symmetry in the case of iron.

[1] M. Niemeyer *et al.*, Phys. Rev. Lett. **108**, 057201 (2012).

A 36.4 Thu 15:00 F 428

XUV-Fluorescence spectroscopy of Argon clusters excited by intense XUV pulses and high kinetic electrons — •T OELZE[1], M ADOLPH[1], L FLÜCKIGER[1], T GORKHOVER[1], M KRIKUNOVA[1], M MÜLLER[1], L NÖSEL[1], Y OVCHARENKO[1], R RICHTER[1], D RUPP[1], M SAUPPE[1], S SCHORB[1,3], D WOLTER[1], A PRZYSTAWIK[2], L SCHRÖDTER[2], C BOSTEDT[1,3], T LAARMANN[2], and T MÖLLER[1] — [1]TU-Berlin — [2]HASYLAB@DESY — [3]LCLS@SLAC

Free-electron lasers (FELs) in the short wavelength regime, such as FLASH, combine a high photon flux with fs pulse length, thus enabling us to study the interaction between intense light and matter in new ways. Rare gas clusters as size scalable nano-objects are used as model systems to study this interaction. When the clusters get hit by an FEL pulse, a nanoplasma is created within the cluster. Finally the clusters disintegrate into highly charged ions while emitting electrons and photons. The residues, yielding information of mechanisms and time scales, can be analyzed. Fluorescence spectra of rare gas clusters taken at FLASH at an excitation energy of 90 eV revealed a large number of lines between 10 and 75 nm. To further investigate the cluster size dependent development of those lines, a subsequent experiment using high kinetic electrons for excitation, has been realized. A corresponding dependency of the fluorescence spectra on the electron energy was found, which points to strong influence of the nanoplasma in the fluorescence process. The setup will be discussed and results will be shown.

A 36.5 Thu 15:15 F 428

Impact of electron-ion recombination on the ionization dynamics of Xenon clusters under XUV pump-probe excitation — •MATHIAS ARBEITER and THOMAS FENNEL — Institute of Physics, University of Rostock

A theoretical analysis of the ionization dynamics of Xenon clusters under XUV pump-probe excitation is presented for the parameter range studied in a recent experiment at $\hbar\omega = 92$eV [1]. In this scenario, the nanoplasma evolution in the pump-induced cluster expansion is probed by a delayed second pulse that further ionizes the target. The pump-probe experiments have shown that the average charge state of the fragment ions increases with delay [2]. This enhancement was interpreted as direct photoemission due to global cluster potential lowering within cluster expansion. The theoretical analysis verifies the presence of this effect. However, our simulations show that the contribution of the direct emission is too weak to explain the observations. Our simulations predict that the decrease of electron-ion recombination for longer delays is the dominant process. The theory results are in good agreement with the experiment for both absolute charge states and timescales.

[1] M. Arbeiter, Th. Fennel, to be submitted

[2] M. Krikunova, M. Adolph, T. Gorkhover, D. Rupp, S. Schorb, C. Bostedt, S. Roling, B. Siemer, R. Mitzner, H. Zacharias and T. Möller, J. Phys. B: At. Mol. Opt. Phys. 45, 105101 (2012)