# A 39: Poster: Atomic clusters

Time: Thursday 16:30–19:00 Location: Poster.V

A 39.1 Thu 16:30 Poster.V

**Electron emission from $C_{60}$ in strong FEL pulses** — •Abraham Camacho, Ulf Saalman, and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Electron-energy spectra of $C_{60}$ molecules induced by strong FEL radiation over a wide range of (currently experimentally available) photon energies and intensities is studied theoretically. Our microscopic model includes inner-shell photo-ionization and Auger decays and, most importantly, the dynamics due to Coulomb interaction of the released electrons. On the ground of this model, particular attention is given to two clearly identifiable limiting cases. On the one hand, for long and weak pulses, electron emission takes place sequentially leading to small interactions between outgoing electrons. On the other hand, for short and intense pulses, all the photo-electrons are emitted simultaneously and thus interaction between them is enforced. By switching on and off this interaction, we observe that the electron spectra are qualitatively different. Furthermore, a simple analytical model is proposed, which is found to be in good agreement with the microscopic model.

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**Asymmetric ion emission from Xe-clusters in intense near-few-cycle-pulses** — •Alexander Breier, Christian Peltz, and Thomas Fennel — Universität Rostock, 18051 Rostock, Germany

Atomic clusters in intense laser fields are an area of high interest for very different scientific areas, ranging from plasma physics to applied laser-matter research. Phenomena like high energy absorption, rapid cluster explosion, the emission of highly charged and energetic ions and fast electrons as well as the emission of energetic photons from the vacuum ultraviolet up to the xray range have been observed [1]. Most of the available data has been measured using relativly short pulses with durations $\tau > 50$fs. The availability of even shorter pulses down to the few-cycle-regime makes it possible to explore new response regimes or even control the cluster dynamics. For example, enhanced ion emission in the laser polarization direction has been observed in the long pulse regime (many cycles)[2], whereas enhanced emission perpendicular to the polarization direction was found for near few-cycle excitation [3]. In this contribution we present a systematic molecular dynamics analysis of the ion emission from medium sized Xe-clusters in infrared laser pulses as function of laser intensity and pulse duration. Our analyses shows an energy-dependent anisotropy of the ion emission.

[1] Th.Fennel et al., Rev. Mod. Phys. 82:1793 (2010)
[2] V. Kumarappan et al, Phys. Rev. Lett. 87:85005 (2001)
[3] E. Skopalová et al., Phys. Rev. Lett. 104:203401 (2010)

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**Observation of single and multiple ionization by electron impact ionization of small noble gas clusters** — Thomas Pflüger, Arne Senftleben, Xueguang Ren, •Alexander Dorn, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, 69117 Heidelberg

A kinematically complete experiment for 100 eV electron-impact ionization of small argon and neon clusters was realized. For argon the triple coincidence detection of both outgoing electrons and the residual ion allows the discrimination between single ionization of atoms, dimers and non-mass-selected small clusters as well as between pure ionization and ionization with additional excitation within the same cluster. Comparison of fully differential ionization cross sections for clusters with those of atoms reveals clear signatures of multiple-scattering reactions. For ionization with excitation, an almost isotropic electron emission pattern is observed.
Ionization of dimers and trimers with subsequent Coulomb explosion resulting in two charged fragments shows interisting collisional ionization mechanisms as the interatomic Coulombic decay (ICD) and sequential ionization of two cluster atoms by the projectile.

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**XUV-fluorescence spectroscopy on rare gas clusters irradiated by intense XUV radiation** — •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]TUB — [2]FLASH@DESY — [3]LCLS@SLAC

Free-electron lasers like FLASH combine short wavelengths with a high number of photons in ultrashort coherent pulses, extending the possibilities to study the interaction between intense light and matter. Rare gas clusters as size scalable gas phase objects are used in our studies. By analyzing different ionization products such as charged particles as well as scattered and fluorescence light we strive to achieve a complete picture of ionization and disintegration dynamics and of the corresponding time scales. In a recent experiment at FLASH the fluorescence spectra of rare gas clusters excited with 90 eV photons exhibited a large number of lines between 10 nm and 70 nm. In order to understand their origin, we plan to analyze the fluorescence of the clusters in an altered setup where clusters are excited by high kinetic energy electrons from an electron gun. By tuning the energy, selected charge states can be addressed. The transitions can be used to assign the lines measured at FLASH to the different charge states and to gain further insight into the charge distribution of the nanoplasma. The setups will be discussed and first results will be shown.

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**Experimente an der Greifswalder EBIT** — •Birgit Schabinger[1], Christoph Biedermann[2], Stephan Gierke[1], Gerrit Marx[1], Rainer Radtke[1,2] und Lutz Schweikhard[1] — [1]Institut für Physik, Universität Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald — [2]Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, 17491 Greifswald

Mit einer Elektronenstrahl-Ionenfalle (EBIT, electron beam ion trap) können hochgeladene Ionen bis zu H-artigem Uran [1] erzeugt und erforscht werden [2]. Dazu wird durch ein Magnetfeld von einigen Tesla, welches durch supraleitende Helmholtzspulen erzeugt wird, eine Kompression eines Elektronenstrahls herbeigeführt. So werden Stromdichten von einigen tausend A/cm$^2$ erreicht. Der Einschluss der Ionen erfolgt in axialer Richtung durch ein Speicherpotential, erzeugt durch drei segmentierte Driftröhren, und radial durch das attraktive Potential des Elektronenstrahls. Durch Elektronenstoßionisation werden Atome und niedrig geladene Ionen schrittweise höher geladen.
Es wird über die Wiederinbetriebnahme der vormals Berliner EBIT [3] berichtet, die in Zukunft u.a. hochgeladene Ionen für die Wechselwirkung mit atomaren Clustern zur Verfügung stellen soll.

[1]R. E. Marrs *et.* al, Phys. Rev. Lett. 72 (1994) 4082
[2]F. Currell *et.* al, IEEE Trans. Plasma Sci., 33 (2005) 1763
[3]C. Biedermann *et.* al, Phys. Scr. T. 73 (1997) 360

A 39.6 Thu 16:30 Poster.V

**Collective electron dynamics in xenon clusters, studied with XUV-IR pump-probe experiments at FLASH** — •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

Femtosecond short and intense light pulses are able to transform matter into a highly excited non-equilibrium state. Clusters, exposed to short and intense XUV pulses reveal complex electron and nuclear dynamics. By using XUV radiation from FLASH synchronized to IR pulses in pump-probe configuration it is possible to gain information about the expansion and desintegration dynamics of the clusters. In our setup the XUV pump pulse creates a nano plasma of quasi-free electrons and the cluster expansion process is iniciated. The time delayed IR pulse probes the dynamics of the quasi-free electrons.
The clusters were produced by supersonic expansion of xenon gas into vacuum. We recorded ions and scattered XUV photons of single clusters simultaneously. The scattering pattern allows us to sort for cluster size. In the produced nano plasma the density of the generated quasi-free electrons decreases with the cluster expansion. At some point the plasma frequency gets in resonance with the frequency of the IR pulse. This results in optimum condition for energy absorption of cluster for which reason the degree of cluster ionization and fluorescence yield on the scattering pattern increases substantially. We discuss the relationship between cluster size and delay time.

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**Photoelectron spectroscopy of large water clusters** — •Kiran Majer und Bernd von Issendorff — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

The excess electron of a singly charged water droplet or cluster has been the subject of many experiments and research groups in the past decades. Although progress has been made recently in determine the vertical electron binding energy of water beams and water clusters, the development of the binding energy from the different isomers found for small water cluster, to the bulk solvated electron is still unknown.

We present results of a photoelectron spectroscopy study of large water clusters, which aims at closing the gap in the size distribution of present measurements.

A 39.8 Thu 16:30 Poster.V

**Charging energies of medium-sized potassium clusters** — •Jacob Chapman, Sebastian Illner, Holger Beh, Kiran Majer, Lei Ma, and Bernd von Issendorff — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

We present measurements of the charging energies of medium-sized potassium clusters in the size range between 55 and 310 potassium atoms. A general size dependent trend of the charging energy can be drawn and correlated with a simple spherical droplet model. The results will be compared with charging energy measurements of sodium clusters.

The charging energy of a cluster can be determined by photoelectron spectroscopy (PES) with varying laser intensities. In oder to obtain the underlying data, PES of potassium clusters were recorded for a wide size range and at cluster temperatures of about 10K and 80K respectively.