# A 29: Atomic clusters (with MO)

Time: Wednesday 16:30–19:00 Location: Empore Lichthof

A 29.1 Wed 16:30 Empore Lichthof

**Cooling Dynamics of Superheated Nanoplasmas** — •Theresia Ziegs, Christian Peltz, and Thomas Fennel — Universität Rostock, Insitut für Physik, Germany

When atomic clusters are irradiated with short and intense laser pulses they are turned into highly excited nanoplasmas on the sub-picosecond time scale, eventually resulting in the emission of fast electrons, highly charged and energetic ions and high energy radiation [1, 2]. Theoretical studies concentrated on the early phase of the laser driven cluster dynamics (<1ps), shining light on the fundamental laser-cluster interaction processes and thereby allowing to understand and interpret a multitude of experimental observations. In the subsequent cluster relaxation the dynamics is mainly dictated by expansion cooling of the electrons and electron-ion recombination, which significantly influences the final energy and charge spectra [3, 4, 5]. In this work we analyze the so far barely studied long-term relaxation of laser-driven rare gas clusters with molecular dynamics simulation. Irrespective of the particular expansion conditions we observe an abrupt change of the electron cooling rate after roughly 1 ps that can be attributed to a transition from weak to strong coupling [6].

[1] U. Saalmann et al., J. Phys. B 39, R39 (2006)
[2] T. Fennel et al., Rev. Mod. Phys. 82, 1793 (2010)
[3] M. Arbeiter et al., Phys. Rev. A 89, 043428 (2014)
[4] B. Schütte et al., Phys. Rev. Lett. 112, 253401 (2014)
[5] T. Gorkhover et al., Phys. Rev. Lett. 108, 245005 (2012)
[6] Yu. V. Dumin, Plasma Phys. Rep. 37, 858 (2011)

A 29.2 Wed 16:30 Empore Lichthof

**X-Ray Movie Camera: First results and analysis of single cluster images** — •Katharina Kolatzki[1], Mario Sauppe[1], Leonie Flückinger[1,2], Bruno Langbehn[1], Björn Senfftleben[1], Jannis Zimbalski[1], Maria Müller[1], Anatoli Ulmer[1], Tobias Zimmermann[1], Julian Zimmermann[1], Tais Gorkhover[5], Christoph Bostedt[5], Benjamin Erk[3], Marion Kuhlmann[3], Daniel Rolles[3,4], Dimitrios Rompotis[3], Rolf Treusch[3], Stefan Düsterer[3], Cédrik Bomme[3], Torsten Feigl[6], Thomas Möller[1], and Daniela Rupp[1] — [1]TU Berlin — [2]La Trobe University — [3]DESY — [4]Kansas State University — [5]SLAC — [6]optiX fab

Free-electron lasers with high spatial and temporal resolution open a completely new field of atomic frontier physics. In order to get further insights into the generation and light-induced dynamics of large xenon clusters, we performed an XUV pump-probe experiment. In this novel two detector set-up, we were able to capture a "two-frame movie" with delays of 0 ps, 70 ps and 650 ps. The data sets that were taken at the free-electron laser FLASH in Hamburg consist of an ion spectrum and two scattering images: The first one pictures the intact initial xenon cluster and the second one images the exploding cluster. The analysis of the single-shot data will be discussed and first results will be presented.

A 29.3 Wed 16:30 Empore Lichthof

**A new He droplet spectrometer for nanoplasma experiments** — •Dominik Schomas[1], Robert Moshammer[2], Thomas Pfeifer[2], and Marcel Mudrich[1] — [1]Albert-Ludwigs-Universtität, Freiburg — [2]Max-Planck-Institut für Kernphysik, Heidelberg

Ultrashort laser pulses have opened up a new field of ultrafast spectroscopy with femtosecond and even attosecond time resolution. With such short pulses we want to explore the ultrafast ignition dynamics of He nanodroplets turning into a nanoplasma induced by dopant atoms such as other rare gases. The dynamics of ignition and explosion of the plasma depends on the number and the kind of dopants but also on the droplet size. We want to build a new apparatus to investigate those dependencies and to resolve the ignition dynamics in real time on an attosecond time scale via pump probe experiments. For our experiments we have designed a velocity-map imaging (VMI) spectrometer which is capable of mapping the occurring high-energy electrons from Coulomb-exploded clusters. Furthermore, the VMI technique allows us to investigate anisotropy effects in photoelectron emission.

A 29.4 Wed 16:30 Empore Lichthof

**Production of size and charge-state selected poly-anionic metal clusters with a multipole RF-trap** — •Stefan Knauer, Gerrit Marx, and Lutz Schweikhard — Institut für Physik, Universität Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald

Poly-anionic metal clusters are experimentally not yet investigated to large extent, they may well reveal particularly interesting properties and behavior [1]. The aim is to lift initially mono-anionic clusters to higher charge states by subsequent electron attachment inside a RF-trap [2-4]. These traps cannot store electrons and clusters at the same time. However, electron attachment is facilitated by providing field-free conditions for the passage of an electron beam. This can be accomplished by use of a multipole ring-electrode trap, which provides continuously an almost field free region [5]. The experiment is build to provide defined charge states for laser interaction experiments. The contribution will present the ring-electrode trap mentioned above as well as first cluster confinement tests. The project is supported by a Collaborative Research Center 652 of the DFG.

[1] A. Herlert et al., New J. Phys. 14, 055015 (2012), DOI: 10.1088/1367-2630/14/5/055015 [2] C.Yannouleas et al., Phys. Rev. Lett. 86 2996 (2001), DOI: 10.1103/PhysRevLett.86.2996 [3] F. Martinez et al., Int. J. Mass Spectrom. 365, 266 (2014), DOI: 10.1016/j.ijms.2013.12.018 [4] S. Bandelow et al., Int. J. Mass Spectrom. 336, 47 (2013), DOI: 10.1016/j.ijms.2012.12.013 [5] D. Neuwirth et al., Int. J. Mass Spectrom 387, 8 (2015), DOI: 10.1016/j.ijms.2015.06.011

A 29.5 Wed 16:30 Empore Lichthof

**Time-resolved X-ray Imaging of Anisotropic Nanoplasma Expansion** — •Christian Peltz[1], Christoph Bostedt[2], Mathias Kling[3], Thomas Brabec[4], Björn Kruse[1], Eckart Rühl[5], Artem Rudenko[6], Tais Gorkhover[7], and Thomas Fennel[1] — [1]Institute of Physics, University of Rostock, Germany — [2]Argonne National Laboratory, Argonne, USA — [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 which 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]. In addition corresponding experimental results, obtained just recently at the LCLS facility with SiO2 nanoparticles (R=100 nm), are presented and compared to the theoretical findings above.

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

A 29.6 Wed 16:30 Empore Lichthof

**Photobleaching in the XUV: A test for XUV-cluster collective phenomena** — •Edward Ackad[1], Kasey Barrington[1], Rishi Pandit[1], Nicolas Bigaouette[2], and Lora Ramunno[2] — [1]Department of Physics, Southern Illinois University Edwardsville, Edwardsville Il, USA — [2]Department of Physics, University of Ottawa, Ottawa, On, Canada

The XUV offers an ideal regime to test collective phenomena since the laser communication with rare gas clusters is almost exclusively through single photon ionization. We propose and model an experiment to test whether any collective phenomena do occur by saturating the single photon ionization channel, inducing transparency termed photobleaching. This is done with an XUV pump pulse of sufficient intensity to saturate the single photon ionization channel. A second equally intense XUV probe pulse then follows. Any collective phenomena will deviate from the current atomistic model, if any exist. Results are presented for the clusters at peak intensity and expected time-of-flight signals for Argon and Xenon.