A 26: Atomic Clusters III

Zeit: Donnerstag 14:00–16:00 Raum: VMP 6 HS-B

Hauptvortrag A 26.1 Do 14:00 VMP 6 HS-B

X-ray spectroscopy in an ion trap: doped semiconductor cages, transition metal molecules, and water clusters — •Tobias Lau[1], Konstantin Hirsch[1], Philipp Klar[1], Andreas Langenberg[1], Fabian Lofink[1], Jürgen Probst[1], Robert Richter[1], Jochen Rittmann[1], Marlene Vogel[1], Vicente Zamudio-Bayer[1], Bernd von Issendorff[2], and Thomas Möller[1] — [1]Technische Universität Berlin, Institut für Optik und Atomare Physik, EW 3-1, Hardenbergstraße 36, D-10623 Berlin — [2]Universität Freiburg, Fakultät für Physik, Stefan-Meier-Straße 21, D-79104 Freiburg

With the development of ion traps for core level excitation, X-ray absorption spectroscopy on size-selected gas phase clusters has come into reach. For the first time, local electronic properties of isolated clusters and nanoparticles can be accessed with element specificity. For doped semiconductor clusters, XAS provides the key to understanding the electronic structure and the nature of bonding, elucidating electronic shells in highly symmetric cages. In transition metal dimers, core level excitation revealed atomic localization of 3d valence electrons in Cr_2^+, Mn_2^+, and CrMn^+ dimers. In protonated water clusters, hydrogen bonding is studied via oxygen 1s excitation. Very recently, even direct core-level photoionization could be accessed in silicon and aluminum clusters. We will give an overview of the experimental technique and present highlights from recent results.

Hauptvortrag A 26.2 Do 14:30 VMP 6 HS-B

Electron and ion emission from clusters in intense laser pulses — •Thomas Fennel — Institute of Physics, University of Rostock, Germany

A fascinating aspect of the interaction of intense laser pulses with atomic clusters is the creation of transient nanoplasmas. Whereas the efficient energy absorption by clusters, i.e. through collective electron excitations, is well understood these days, detailed insight into the nanoplasma dynamics underlying the generation of highly charged ions and energetic electron remains a challenge. Recently, electron rescattering in clusters, which can be driven by dynamic polarization fields as well as by the laser field itself, has been identified as the central mechanism for high energy electron generation [1,2]. Corresponding experimental and simulation results on metal and rare-gas clusters as well as perspectives for future experiments with few-cycle pulses will be discussed. The prediction of ion charge spectra requires the modelling of ionization and recombination processes [3]. New data on the intensity dependent charging of rare-gas clusters will be presented, revealing signatures of cluster avalanche ionization near the threshold for atomic barrier suppression [4].

[1] Th. Fennel et al., Phys. Rev. Lett. **98**, 143401, 2007
[2] U. Saalmann et al. Phys. Rev. Lett. **100**, 133006, 2008
[3] Th. Fennel et al., Phys. Rev. Lett. **99**, 233401, 2007
[4] T. Döppner et al., in preparation

Hauptvortrag A 26.3 Do 15:00 VMP 6 HS-B

Helium-embedded clusters exposed to intense laser pulses: From “local ignition” to “global cooling” — •Ulf Saalmann — MPI-PKS, Nöthnitzer Str. 38, 01187 Dresden

As well known intense-laser interaction with matter strongly depends on the laser frequency. For atoms and molecules the famous Keldysh parameter is used in order to quantify the transition from tunneling to multi-photon ionization, which occurs for a fixed intensity by increasing the frequency.

In clusters, where a strong laser quickly creates a nano-plasma inside the cluster, we will show that the response is better characterized by the quiver amplitude $x_{\mathrm{quiv}} = F/\omega^2$, the amplitude of a free electron oscillating in the field of a laser with strength F and frequency ω. This amplitude has to be compared to the cluster radius r. Whereas for large amplitudes $x_{\mathrm{quiv}} \geq r$ collective plasma oscillations dominate, electronic charge migration occurs when the quiver amplitude is small or neglible $x_{\mathrm{quiv}} \ll r$. Since x_{quiv} shrinks quadratically with ω, samples exposed to free-electron laser radiation (either UV or X-ray) will, despite the high field strengths available, show charge migration, as has recently been seen in experiments at FLASH.

We present microscopic calculations for clusters embedded in helium nano-droplets where both mechanism — collective excitations and charge migration — can be clearly identified. They have profound consequences like igniting a helium droplet with a handful of xenon atoms or slowing down the Coulomb explosion of a highly-charged sample.

Hauptvortrag A 26.4 Do 15:30 VMP 6 HS-B

Resonant amplification of quantum fluctuations with a spinor gas — Carsten Klempt[1], Oliver Topic[1], Manuel Scherer[1], Thorsten Henniger[1], Garu Gebreyesus[1], Philipp Hyllus[2], Wolfgang Ertmer[1], Luis Santos[2], and •Jan Arlt[1] — [1]Institut für Quantenoptik — [2]Institut für Theoretische Physik, Leibniz Universität Hannover, D-30167 Hannover

Bose-Einstein condensates of atoms with non-zero spin constitute not only an optimal scenario to investigate fundamental properties of magnetic superfluids, but also an ideal system to study amplification of quantum and classical fluctuations. This is strikingly manifested in a sample initially prepared in the $m = 0$ state, where spin-changing collisions triggered by quantum fluctuations may lead to the creation of correlated pairs in $m = \pm 1$. We show that the pair creation efficiency is strongly influenced by the interplay between the external trapping potential and the Zeeman effect and reflects the confinement-induced magnetic-field dependence of elementary spin excitations of the trapped condensate. Remarkably, pair creation in our experiments is characterized by a multi-resonant dependence on the magnetic field. Pair creation at these resonances acts as strong parametric matter-wave amplifier. Depending on the resonance condition, this amplification can be extremely sensitive or insensitive to the presence of seed atoms. We show that pair creation at a resonance which is insensitive to the presence of seed atoms is triggered by quantum fluctuations and thus the system acts as a matter-wave amplifier for the vacuum state.