A 38: Atomic Clusters IV

Zeit: Freitag 14:00–15:15 Raum: VMP 6 HS-C

A 38.1 Fr 14:00 VMP 6 HS-C

Collision frequency of electrons in laser excited expanding small clusters — •Thomas Raitza, Heidi Reinholz, and Gerd Röpke — Universität Rostock

One of the fundamental quantities in the physics of strongly coupled Coulomb systems is the dynamical collision frequency. Collisions are of relevance for emission, absorption, reflection and scattering of light. Analytical as well as MD simulation techniques have been applied to evaluate the dynamical collision frequency for homogeneous systems, with special application to optical properties. Recently, clusters at nearly solid densities are more accessible to experimental investigations using laser intensities of $10^{13} - 10^{16}\mathrm{Wcm}^{-2}$. Here, we present theoretical results for finite Coulomb systems. In particular, we are interested in the cluster size dependence of the collisional damping rates in comparison to bulk systems.

Properties of laser excited small metallic clusters are calculated using a classical MD simulations code. Results for the electron phase space distribution are analyzed, comparing the simulated profiles with predictions from equilibrium statistical physics. We are interested in time dependent density and temperature profiles as well as optical properties. The question of local thermodynamic equilibrium (LTE) is addressed, and size effects are considered. For this, a restricted MD simulation scheme has been developed, where the ion positions are frozen at given times, and the electrons are treated as an equilibrated subsystem. Collective modes of the excited electron system have been investigated in order to deduct the dynamical collision frequency.

A 38.2 Fr 14:15 VMP 6 HS-C

Optimal Control of the Ionization of embedded Silver Clusters in Strong Femtosecond Laser Fields — •Nguyen Xuan Truong[1], Paul Hilse[2], Sebastian Göde[1], Andreas Przystawik[1], Tilo Döppner[1], Thomas Fennel[1], Thomas Bornath[1], Josef Tiggesbäumker[1], Manfred Schlanges[2], Gustav Gerber[3], and Karl Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, D-18051 Rostock — [2]Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, D-17489 Greifswald — [3]Physikalisches Institut, Universität Würzburg, D-97074 Würzburg

Optimal control techniques combined with femtosecond laser pulse shaping are applied to enhance the strong-field induced emission of highly charged atomic ions from silver clusters isolated in helium nanodroplets. We report on a substantial increase of the yield of Ag^{z+} ($z \geq 10$) with the optmized pulses when comparing to single bandwidth-limited or down-chirped pulses at constant fluence. A remarkable simple double-pulse structure containing a low-intensity prepulse and a stronger post-pulse turns out to produce the highest atomic charge states up to $z = 20$. A numerical control experiment based on a modified version of the nanoplasma model converge to a similar pulse envelope, underlining the leading role of plasmons in the generation of highly charged ions from intense laser-cluster interaction.

A 38.3 Fr 14:30 VMP 6 HS-C

Local ignition and anisotropic nanoplasma growth in laser-driven composite clusters — •Alexey Mikaberidze, Ulf Saalmann, and Jan M. Rost — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Doping a helium nanodroplet with a tiny xenon cluster of a few atoms only, sparks complete ionization of the droplet at laser intensities below the ionization threshold of helium atoms. As a result, the intrinsically inert and transparent droplet turns into a fast and strong absorber of infrared light.

Microscopic calculations reveal a two-step mechanism to be responsible for the dramatic change: Avalanche-like ionization of the helium atoms on a femtosecond time scale, driven by field ionization due to the quickly charged xenon core is followed by resonant absorption enabled by an unusual cigar-shaped nanoplasma within the droplet [1]. In contrast to the well known resonant absorption during the Coulomb explosion of both homogeneous [2] and composite [3] clusters, the resonance here occurs on an *electronic* time scale. We have indications that similar effects can be found in composite clusters of other species.

[1] A. Mikaberidze, U. Saalmann, and J. M. Rost, submitted, 2008.
[2] U. Saalmann and J. M. Rost, Phys. Rev. Lett. 91, 223401 (2003).
[3] A. Mikaberidze, U. Saalmann, and J. M. Rost, Phys. Rev. A **77**, 041201(R) (2008).

A 38.4 Fr 14:45 VMP 6 HS-C

Directed Electron Emission from Resonantly Excited Metal Nanoparticles — •Johannes Passig, Thomas Fennel, Xuan Truong Nguyen, Slawomir Skruszewicz, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, www.physik.uni-rostock.de\cluster

Experiments on metal particles exposed to intense ultrashort dual laser pulses reveal a strong asymmetric electron emission giving electron kinetic energies of up to 1.3 keV in the direction of the laser polarization axis. Conventional hydrodynamical or purely coulomb driven expansion processes fail to explain the kinetic energy values and the asymmetry in the electron emission. The energy transfer from the laser field to the fast electrons can be assigned to rescattering processes of weakly bound electrons in the resonant driven plasmon field, called SPARC [1]. Recently, the scattering of electrons in the mean field potential was identified as an alternative mechanism for the electron acceleration, particularly in Xe-clusters [2]. The influence of the particle size, laser intensity and pulse delay time on the observed electron emission is discussed in the context of both theoretical models.

[1] T. Fennel et al., Phys. Rev. Lett. 98(14), 2007 [2] U. Saalmann et al., Phys. Rev. Lett. 100(13), 2008

A 38.5 Fr 15:00 VMP 6 HS-C

Observation of giant dipole plasmon resonance in electron spectrum from C_{60} in fast ion-impact — Aditya Kelkar, D. Misra, and •Lokesh C. Tribedi — Tata Institute of Fundamental Research, Colaba, Mumbai 400005, India

Fullerenes are known to exhibit collective excitation i.e., the giant dipole plasmon resonance (GDPR). The GDPR has been observed earlier in photoionization through the detection of photoions. Its effect on multiple ionization and electron capture have also been reported [1,2]. However, a direct evidence of this process in fast ion-collisions is awaited. The GDPR de-excites through the emission of electrons with a characteristic energy. This presents a unique possibility of observing the GDPR state directly in the low energy electron spectrum of C_{60}. We measured the low energy (1-300 eV) e^- DDCS spectrum from C_{60} in collisions with 4 MeV/u bare F ions at various angles. A careful measurement shows a broad peak like structure near the expected GDPR peak position (i.e. $\hbar\omega - I_p \sim 10$ eV) in all the electron spectra taken for different angles. The distribution shows a dip around 90°, which is in contrary to the expected behaviour in case of ion-atom collisions. The angular distribution suggests that the dipole oscillations are induced preferably along the projectile beam direction.

[1] U. Kadhane et al. Phys. Rev. Lett. **90**, 093401 (2003).
[2] U. Kadhane et al. Phys. Rev. A (Rapd comm.) **75**, 041201 (R) (2007).