A 31: Interaction with strong or short laser pulses IV

Time: Thursday 10:30–12:30 Location: V57.05

Invited Talk A 31.1 Thu 10:30 V57.05

Coulomb potential effect on the tunneling electron from molecules — •Jian Wu and Reinhard Dörner — Institut für Kernphysik, Goethe Universität, Max-von-Laue-Strasse 1, D-60438 Frankfurt, Germany

What is the influence of the remaining ionic core on an electron wave emitted from an atom or molecule and on the ionization process itself? This question is general across all ionization phenomena. We study the electron recapture and Coulomb asymmetry in the strong field ionization of diatomic molecules. By measuring the kinetic energy release and angular distribution of the multiply ionized argon dimers, we can trace the recapture of up to two electrons by the highly charged compound at the end of the laser pulse. The trapping of the electron leads to population of a Rydberg orbital of the charged dimer. Subsequently the system dissociates. Upon its dissociation, the Rydberg electron prefers to localize at the atomic ion with the higher charge state. We further study the Coulomb asymmetric effect in the strong field ionization of molecules. We measure the angular distribution of an electron emitted from exploding doubly charged molecular nitrogen. The emission from the down-field core leads to a slight rotation with respect to the internuclear axis in the direction expected by the Coulomb effect of the remaining ion; while for emission from the up-field core this direction is inversed. Our semi-classical simulations suggest that this unexpected rotation is caused by an initial longitudinal momentum of the electron freed by over the barrier ionization above the inner barrier in the molecule.

A 31.2 Thu 11:00 V57.05

Charge selective ion energy distributions generated in the Coulomb explosion of Ag clusters — •Christian Schaal, Robert Irsig, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, Universitätsplatz 3, D-18051 Rostock, Germany

There are only a few number of attempts to simultaneously analyze energetic ions from clusters exposed to strong laser fields for their specific charge state and energy. Therefore the contribution of a single charge state to the whole energy distribution is not studied in detail so far. The main problem is the low transmission of ions, since small appertures have to be used. We use the method of Magnetic Deflection TOF to obtain charge state selective energy spectra. Instead of recording ion spectra at certain energies, a position and time sensitive detector is used, which allows to record the impact of all transmitted ions at all energies in each shot. This results in a strong decrease in the exposure time, making this method feasible to also study low density cluster targets. The influence of the pulse parameters on the energy distributions are discussed.

A 31.3 Thu 11:15 V57.05

Time-resolved Dynamics after fs-excitation of Magnesium embedded in Helium Nanodroplets — •Sebastian Göde, Robert Irsig, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock, D

Magnesium atoms embedded in droplets show an interesting spectroscopic pattern when excited with ns laser pulses. An absorption feature near the atomic $3\ ^1P_1^0 \leftarrow 3\ ^1S_0$ transition is obtained, irrespective on the doping level. This observation is consistent with the assumption of a metastable foam like structure, where the helium prevents a relaxation into the structural ground state [1].

In the present study we conducted off-resonance fs pump-probe experiments to analyze the real time dynamics. By varying the pulse energy and ratio of the subpulses, different excitation regimes have been investigated. At low intensities 10^{12}W/cm^2, the cluster ion signals show a notable dependence on the order when unbalanced pulses are used. A weaker prepulse favors the appearance of cluster ions, while fragments are enhanced when stronger prepulses are used. When increasing the laser intensity a clear pump-probe signature evolves. Possible ionisation scenarios for compact clusters and a foam like constitution are discussed.

[1] A. Przystawik, S. Göde et. al., PRA **78**, 021202 (2008)

A 31.4 Thu 11:30 V57.05

Time-resolved nanoplasma dynamics in single xenon clusters driven by intense XUV and NIR pulses — •L. Flückiger[1], M. Adolph[1], T. Gorkhover[1], D. Rupp[1], M. Sauppe[1], S. Schorb[2], S. Düsterer[3], M. Harmand[3], H. Redlin[3], R. Treusch[3], C. Bostedt[2], M. Krikunova[1], and T. Möller[1] — [1]Technische Universität, Berlin — [2]LCLS, SLAC National Accelerator Laboratory — [3]Deutsches Elektronen-Synchrotron, Hamburg

We performed first two-colour pump-probe experiments on individual free xenon clusters at FLASH. New insight into the timescales of ionization dynamics, thermalization and fragmentation was achieved by simultaneous measurements of scattering patterns and ion time-of-flight spectra. Both, intense NIR and XUV pulses can highly ionize clusters and create a nanoplasma. However, only the radiation field of a NIR pulse couples strongly to the quasi-free electrons within the cluster. Therefore, the dynamics depend on the relative timing of the pulses.

With NIR as pump and FEL as probe pulse we follow the cluster fragmentation in real time by taking snapshots of the disintegrating sample while ion spectra provide information about the degree of cluster ionization. By reversing the temporal order of the beams, resonance conditions are reached - where the laser frequency corresponds to the plasma frequency - resulting in an enhanced energy absorption. A clear time and cluster size dependent signature was revealed by the charge state distribution and the flourescence yield detected.

A 31.5 Thu 11:45 V57.05

Angular-Resolved Electron Spectroscopy on Metal Clusters Exposed to Intense Laser Fields — •Johannes Passig, Dzimitri Komar, Robert Irsig, Thomas Fennel, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Cluster & Nanostrukturen, Institut für Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock, Germany, www.physik.uni-rostock.de/cluster

Collective electron motion induces strong polarization fields in metal clusters exposed to intense IR-pulses. By resonant excitation of the cluster plasmon mode via an optimized pump-probe sequence, strong energy capture from the laser field and subsequent emission of highly charged and energetic species. We present first full angular-resolved electron spectra from silver nanoparticles exceeding 1keV (100 Up) at moderate laser intensities of 10^{14} W/cm^2. The emission shows a pronounced alignment along the laser polarization axis. Comparison of the experimental data with molecular dynamical simulations gives evidence, that the efficient acceleration proceeds via surface plasmon assisted rescattering, a mechanism unique for small particles [Fennel et al., Phys. Rev. Lett. 98, 143401 (2007)].

A 31.6 Thu 12:00 V57.05

Parametric studies of high-order harmonic generation in liquid water droplets — •H. G. Kurz[1,2], D. S. Steingrube[1,2], D. Ristau[2,3], M. Lein[4], U. Morgner[1,2,3], and M. Kovačev[1,2] — [1]Leibniz Universität Hannover, Institut für Quantenoptik, Welfengarten 1, D-30167 Hannover — [2]QUEST - Centre for Quantum Engineering and Space-Time Research, Welfengarten 1, D-30167 Hannover — [3]Laser Zentrum Hannover e.V., Hollerithallee 8, D-30419 Hannover — [4]Leibniz Universität Hannover, Institut für theoretische Physik, Appelstrasse 2, D-30167 Hannover

We report on high-order harmonic generation (HHG) in micrometer-sized liquid water droplets under vacuum condition. A chirped pulse amplification laser system delivers 100 fs-pulses with energies up to 5 mJ for HHG in an ensemble of emitters. The coherent sum of all emitters within the droplet forms the harmonic signal. Therefore, macroscopic effects have to be taken into account. To maximize the harmonic yield, the phases of all these emitters have to be matched. The influence of phase-matching aspects onto HHG are demonstrated by different parameters. Additionally, a pump-probe setup allows for the observation of the spatiotemporal evolution of the target. When the droplet is hit by the pump pulse it starts evaporating, while the probe pulse creates the harmonic radiation. Thus, different pump-probe time delays give access to different states of the target during HHG. Results of phase-matching experiments and the spatiotemporal evolution of the target will be presented.

A 31.7 Thu 12:15 V57.05

Dopant-induced ignition and expansion dynamics of He nanodroplets in intense few-cycle NIR pulses — •Siva Rama Krishnan[1], Lutz Fechner[1], Manuel Kremer[1], Vandana Sharma[1], Bettina Fischer[1], Nicolas Camus[1], Thomas Pfeifer[1], Jagannath Jha[2], Krishnamurthi Manchikanti[2], Claus-Dieter Schröter[1], Robert Moshammer[1], Joachim Ullrich[1], Frank Stienkemeier[3], and Marcel Mudrich[3] — [1]Max Planck Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Tata Institute of Fundamental Research, 1 Homi Bhabha Road, Mumbai 400005, India — [3]Physikalisches Institut, Universität Freiburg, Hermann-Herder-Straße 3, 79104 Freiburg, Germany

We report our investigations on dopant-induced ignition (DII) of He nanodroplets by intense few-cycle (10 fs) near-infrared (NIR) pulses. DII is triggered by less than 10 dopant Xe atoms residing at the center of the nanodroplet. This results in the complete ionization of a nanodroplet containing about 10000 He atoms, which is otherwise transparent to these pulses. Our studies demonstrate a very efficient energy transfer from intense NIR laser fields to the droplet nanoplasma on a sub-10 fs timescale for the first time. Further, the consequences of DII on the ionic expansion dynamics of these doped nanodroplets occurring on ps timescales is also examined. Thus, we present a complete picture of the intense NIR ionization dynamics of doped He nanodroplets from sub-10fs to a few picoseconds.