A 17 Hauptvorträge: Cluster in starken Laserfeldern

Zeit: Donnerstag 10:40–12:40 Raum: H7

Hauptvortrag A 17.1 Do 10:40 H7

Properties of X-Ray Emission during Laser-Cluster Interaction — •Emily Lamour — Universites Paris 6 et 7, INSP, campus Boucicaut, 40 rue de Lourmel, 75015 Paris

When large rare gas clusters are submitted to intense femtosecond laser pulses, the experimental results show a strong energetic coupling between radiation and matter leading to the observation of atomic ions with up to MeV energies, hot electrons of few keV, as well as X-rays in the keV range. We have measured *absolute* X-ray yields as a function of physical parameters governing the interaction; namely laser intensity, pulse duration, wavelength or polarization state of the laser light, size and nature of the clusters (Ar, Kr, Xe). The X-ray emission is related to the production of highly stripped ions giving, hence, a direct signature of inner shell vacancies creation on a very short time scale (down to few fs). Indeed, we have studied de-excitation of species from Ar^{12+} to Ar^{16+} with K vacancy for Ar clusters and from Xe^{24+} to Xe^{34+} with L vacancies for Xe clusters. We have highlighted, for the first time, a laser intensity threshold in the X-ray production very low (for instance $\sim 2.10^{14} W/cm^2$ for a pulse duration of 300 fs); well below the laser intensity where the ponderomotive energy of the electrons is sufficient to create inner shell vacancies. This effect may be explained by the role of electron-ion collisions inside the cluster. In addition, to better understand the role of electron heating mechanisms involved, the influence of the pulse duration and of the wavelength (400 nm / 800 nm) has been investigated under well controlled conditions. Finally, a saturation of the X-ray emission probability above a critical cluster size ($\sim$ 5 10^5 atoms per cluster for Ar) has been found.

Hauptvortrag A 17.2 Do 11:10 H7

The photophysics of C_{60}: Analysis and control of non-adiabatic multi-electron dynamics — •T. Laarmann, I. Shchatsinin, A. Stalmashonak, N. Zhavoronkov, G. Stibenz, G. Steinmeyer, C. P. Schulz, and I. V. Hertel — Max-Born-Institut, Max-Born Str. 2a, D-12489 Berlin, Germany

Non-adiabatic multi-electron dynamics (NMED) of molecules in intense laser fields has recently attracted great interest. C_{60} can be regarded as an ideal model system for the investigation of strong-field phenomena in molecules with extended π electron system [1]. Under the influence of a fs-laser pulse the 240 valence electrons couple strongly among each other and with the nuclear degrees of freedom of the system. Recent model calculations have shown that many electrons may be excited even at relatively moderate intensities above some 10^{10} Wcm^{-2}: the single active electron (SAE) picture commonly used for atoms and small molecules cannot be used to explain details of the photophysics of many-body systems in strong electromagnetic fields. We have studied the energetic and dynamics of C_{60} with laser pulses of different wavelength, at laser intensities ranging from 10^{10} to 10^{14} Wcm^{-2} and pulse durations as short as 9 fs. By photoelectron and photoion spectroscopy in combination with pump-probe and optimal control schemes, new insights into the basic mechanisms of energy deposition, redistribution, ionisation and fragmentation are obtained.

[1] I. V. Hertel, T. Laarmann, and C. P. Schulz, Ad. At. Mol. and Opt. Phys. 50, 219 (2005)

Hauptvortrag A 17.3 Do 11:40 H7

Ultrafast Processes in Photoexcited Metal Cluster studied by Pump-Probe Photoelectron Spectroscopy — •M. Neeb, J. Stanzel, F. Burmeister, and W. Eberhardt — BESSY, Albert-Einstein Str. 15, D-12489 Berlin

Pump-Probe photoelectron spectroscopy with ultrashort laser pulses is a unique tool to receive real-time information on the excited-state dynamics such as nuclear motion and electron relaxation of photoexcited species. In this respect metal clusters have attracted considerable attention as their size-dependent properties address the gap between the discrete nature of atoms and molecules and the continuous band structure associated with condensed materials. For transition metal clusters with an open d-shell, such as W_n, Ni_n, Pd_n, Pt_n, it turns out that even very small clusters show ultrafast electron dynamics, thermalisation and photodesorption of ligand molecules which are typically for bulk systems. Time scales of tens to hundreds of femtoseconds have been measured. On the other hand, photoexcited states of noble metal clusters with a large HOMO-LUMO band gap, e.g. Au_n, show a typical molecular-like dynamical behaviour, which is mainly attributed to configurational changes of the geometry such as wavepacket motion and isomerisation of the photoexcited species. In this contribution the dynamics of different metal cluster anions will be discussed by means of time-resolved photoelectron spectroscopy with femtosecond laser pulses.

Hauptvortrag A 17.4 Do 12:10 H7

Metal clusters in intense laser fields: semiclassical modelling of the ion and electron emission — •Thomas Fennel, Jörg Köhn, Tilo Döppner, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock

The response of small metal clusters subject to strong laser excitation is investigated using a microscopic simulation including electron-electron collisions. The theoretical model is based on semiclassical time-dependent density-functional theory. The self-consistent electron dynamics are described on the level of the semiclassical Vlasov approach including exchange and correlations in LDA [1] linked to a velocity dependent Vlasov-Ühling-Uhlenbeck collision term to mimic dynamical correlations. In particular we focus on the ion and electron emission following the excitation of Na_N clusters with dual pulses. In accordance with the experimental results [2] a dramatic increase both in the atomic charge state of the ions and the maximum electron kinetic energy is observed for a certain delay of the pulses. Results of the calculations are discussed which indicate that enhanced cluster ionization as well as the generation of fast electrons coincide with resonant plasmon excitation.

[1] T. Fennel, G.F. Bertsch, and K.-H. Meiwes-Broer, Eur. Phys. J. D 29, 367 (2004)

[2] T. Döppner Th. Fennel, P. Radcliffe, J. Tiggesbäumker and K.H. Meiwes-Broer (submitted to Phys. Rev. A)