A 32: Interaction with strong or short laser pulses III

Time: Thursday 14:30–16:30 Location: C/HSW

Invited Talk A 32.1 Thu 14:30 C/HSW

Time-Resolved Measurement of Interatomic Coulombic Decay in Ne_2 — •Kirsten Schnorr — Max-Planck-Institut für Kernphysik, Heidelberg

Interatomic Coulombic Decay (ICD) is a radiationless relaxation mechanism where deexcitation of one atom is achieved via energy transfer to a weakly bound neighbouring atom, which then emits an electron. The process has been theoretically predicted by Cederbaum *et al.* in 1997 and experimentally confirmed in clusters and molecules a few years later. Although the decay time of ICD is a crucial parameter for understanding the underlying mechanism, no time-resolved investigation was performed so far.

In our measurement we determine the ICD lifetime in Ne_2: A 58 eV pump pulse of approximately 60 fs creates a 2*s* hole at one of the Ne atoms, thereby initiating the decay process, which is then probed after an adjustable time delay by an exact copy of the first pulse. Only if the decay has happened by the time the probe pulse arrives, a certain energy level may be populated. This leads to a characteristic fragmentation channel that can be separated by using a Reaction Micrsoscope, which allows us to study charged particles in coincidence.

A 32.2 Thu 15:00 C/HSW

Inversion symmetry breaking of atomic bound states in strong laser fields — •Veit Stooss[1], Andreas Kaldun[1], Alexander Blättermann[1], Thomas Ding[1], Christian Ott[2], and Thomas Pfeifer[1] — [1]Max Planck Institut für Kernphysik, Heidelberg, Deutschland — [2]University of California, Berkeley, USA

Light induced states represent one of the most prominent features appearing in transient-absorption spectroscopy and contain a lot of information about dynamic processes. Disentangling and understanding the various contributions to these features is essential in order to gain information about the induced couplings and electronic dynamics of atomic and molecular systems in strong external fields. We present an explanation for the physical origin of spectral features arising at one photon energy around dipole-forbidden states in transient-absorption spectra. The results are based on experiments in singly-excited Helium and a few-level model calculation. The features appear due to instantaneous polarization and breaking of the symmetry of the atom following the infrared-fs pulse used in the transient-absorption scheme. Using this effect the onset of symmetry-breaking for low-lying states in Helium by tuning from a weak to a strong electric field was directly observed.

A 32.3 Thu 15:15 C/HSW

Quantum oscillations between close-by states mediated by the electronic continuum in intense high-frequency pulses — •Philipp V Demekhin[1] and Lorenz S Cederbaum[2] — [1]Institut für Physik, Universität Kassel, Heinrich-Plett-Strasse 40, D-34132 Kassel, Germany — [2]Theoretische Chemie, Physikalisch-Chemisches Institut, Universität Heidelberg, Im Neuenheimer Feld 229, D-69120 Heidelberg, Germany

The dynamics of neighboring states exposed to short intense laser pulses of carrier frequencies well above the ionization threshold of the system is investigated from first principles. It is shown that the pulse induces a time-dependent non-hermitian coupling between these states determined by the AC Stark effect in the electronic continuum and the direct ionization probability. This coupling induces quantum oscillations between the neighboring states while the strong pulse is on. The phenomenon opens the possibility to achieve a coherent control over the populations of neighboring states by strongly off-resonant ionizing pulses. Numerical exemplifications of the present analytical results suggest exciting applications for experiments.

A 32.4 Thu 15:30 C/HSW

Explosion dynamics of single clusters resolved for particle size and laser power density — •D. Rupp[1], L. Flückiger[1], M. Adolph[1], T. Gorkhover[1,2], M. Krikunova[1], M. Müller[1], J. Müller[1], T. Oelze[1], Y. Ovcharenko[1], M. Sauppe[1], B. Röben[1], S. Schorb[1,2], D. Wolter[1], R. Treusch[3], C. Bostedt[1,2], and T. Möller[1] — [1]TU Berlin — [2]LCLS@SLAC — [3]FLASH@DESY

Direct imaging and simultaneous ion spectroscopy of single clusters with x-ray free-electron lasers such as FLASH in Hamburg allows for analyzing ion spectra of a single cluster of *known size irradiated with defined laser intensity* [1]. The averaging over focal intensity profile and cluster size distribution - experimental reality in almost all previous studies of lasers with gas-phase targets - typically leads to wash-out of the key signatures. From the x-ray scattering patterns of single clusters the initial state of the cluster can be deduced, its size and shape, as well as the FEL power density the cluster has been exposed to. Our results give strong evidence that the ions from XUV-irradiated large xenon clusters expand only from the surface of a super-dense, almost neutral nanoplasma, while recombination within the fully screened core competes with the expansion process, ultimately bringing it to halt. The dominant recombination strongly shapes the measured ion kinetic energies, resulting in narrow distributions of only fast ions with about a factor of 25 higher ion than electron energies. The size and laser intensity resolved ion spectra allow for detailed studying of the acceleration mechanism and disentangling hydrodynamic and Coulombic contributions. [1] T. Gorkhover *et al.*, PRL **108**, 245005 (2012)

A 32.5 Thu 15:45 C/HSW

XUV spectroscopy on argon micro droplets in intense NIR laser fields — •Robert Irsig, Lev Kazak, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Universität Rostock, Institut für Physik, Universitätsplatz 3, 18051 Rostock, Germany

We investigate the emission of soft x-ray radiation from liquid microsized argon droplets. The droplets are irradiated by ultra-short intense laser pulses with a center wavelength at 810nm. Due to efficient heating, highly charged ions with a characteristic plasma emission pattern are produced. With the use of a home-build flat-field XUV spectrometer, various atomic transitions can be identified allowing to study the nanoplasma properties. We present first results of the influence of the laser pulse parameters such as pulse length and pulse energy on the XUV emission.

A 32.6 Thu 16:00 C/HSW

Robust signatures of quantum radiation reaction in focused ultrashort laser pulses — •jian-xing li, karen z. hatsagortsyan, and christoph h. keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69029 Heidelberg, Germany

Radiation reaction effects in the interaction of an electron bunch with a superstrong focused ultrashort laser pulse are investigated in the quantum radiation dominated regime. In dependence of the laser pulse duration we find signatures of quantum radiation reaction in the radiation spectra, which are characteristic for the focused laser beam and visible in the qualitative behaviour of both the angular spread and the spectral bandwidth of the radiation spectra. The signatures are robust with respect to the variation of the electron and laser beam parameters in a large range. They fully differ qualitatively from those in the classical radiation reaction regime and are measurable with presently available laser technology [1].

[1] Jian-Xing Li, Karen Z. Hatsagortsyan, Christoph H. Keitel. Phys. Rev. Lett., **113, 044801 (2014).**

A 32.7 Thu 16:15 C/HSW

The tunneling picture of electron-positron pair creation — •Anton Wöllert, Michael Klaiber, Heiko Bauke, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The common tunneling picture of electron-positron pair creation in a strong electric field is generalized to pair creation in combined crossed electric and magnetic fields [1]. This new picture is formulated in a gauge invariant and Lorentz invariant manner for quasistatic fields. It may be used to infer qualitative features of the pair creation process. In particular, it allows for an intuitive interpretation of how the presence of a magnetic field modifies and in particular cases even enhances pair creation. The enhanced picture makes it easy to understand how an energetic photon, which may assist the creation of electrons and positrons from the vacuum, modifies pair creation by lowering the potential barrier but also increasing the relativistic mass of the created particles.

[1] A. Wöllert, M. Klaiber, H. Bauke, C. H. Keitel, "The tunneling picture of electron-positron pair creation", arXiv:1410.2401