Q 45: Attosekundenphysik (gemeinsam mit A)

Zeit: Mittwoch 14:00–16:00 Raum: 6G

Hauptvortrag Q 45.1 Mi 14:00 6G

Multielectron wave-packet propagation for electron dynamics following ionization: Basics and explicit applications — •Alexander Kuleff and Lorenz Cederbaum — Theoretische Chemie, PCI, Universität Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg, Germany

An *ab initio* method for multielectron wave-packet propagation is presented [1]. It gives the possibility to describe fully *ab initio* the dynamics of various de-excitation processes taking into account *all* electrons of the system and their correlation. The approach is equally suitable for tracing in real time and space the electron dynamics of both decaying and non-decaying electronic states. As an example for electron dynamics of non-decaying states, the charge migration solely driven by electron correlation and relaxation is studied. The method is also utilized for tracing in time and space the the evolution of the electronic cloud throughout the interatomic Coulombic decay (ICD) process in the rare gas cluster NeAr following Ne2*s* ionization [2].

[1] A. I. Kuleff, J. Breidbach and L. S. Cederbaum, J. Chem. Phys. **123** (2005) 044111.
[2] A. I. Kuleff and L. S. Cederbaum, arXiv:physics/0612061.

Q 45.2 Mi 14:30 6G

Attosecond Pulse Trains with Two Colors — •Marko Swoboda[1], Johan Mauritsson[1], Erik Gustafsson[1], Per Johnsson[1], Thomas Remetter[1], Thierry Ruchon[1], Anne L'Huillier[1], and Kenneth Schafer[2] — [1]Department of Physics, Lund University, P.O. Box 118, 221 00 Lund, Sweden — [2]Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803-4001, USA

We demonstrate how a sequence of identical attosecond pulses created with a two-color laser field can be used to release electron wave packets exactly once per laser cycle. The released electrons can then be used to steer and measure atomic processes on attosecond time scales. The pulses arriving at the frequency of the probing infrared field allow us to compare this to a stroboscope, each pulse identical to previous pulses and repeatedly performing measurements in the exact same conditions. Using this technique, we study the ionization of He in presence of a strong infrared laser field which shifts the electron momentum distribution depending on the vector potential of the light field. In this experiment, Coulomb-refocusing and other atomic effects can be observed from driving the electron wave packets back to the atomic core.

Q 45.3 Mi 14:45 6G

Vibration and laser dressing in molecular high-harmonic generation — •Ciprian Chirila and Manfred Lein — Universität Kassel, Fachbereich Physik 18, Heinrich-Plett-Str. 40, 34132 Kassel

We study high-harmonic generation in the H2 molecule, and its heavier isotope, D2, exposed to an intense, low-frequency laser pulse. The molecular vibration is taken into account. We investigate the effect of laser dressing of the two lowest-laying Born-Oppenheimer potentials in the molecular ion formed upon ionizaton. Conclusions are drown about the laser-frequency range and the range of molecular orientations where the dressing becomes relevant to the process.

Q 45.4 Mi 15:00 6G

Attosecond scattering of particles from quantum correlated condensed systems — •Chariton Aris C.-Dreismann — Institut für Chemie, TU Berlin, Sekr. C2, 10623 Berlin

Nuclei and electrons in condensed matter are usually entangled, due to the electromagnetic interaction. However, strong couplings with the "environment"cause an ultrafast decoherence, thus making entaglement effects not accessible to experiments. Recently, neutron [1a] and electron [1b,2] Compton scattering experiments from protons (H-atoms) in several condensed systems at room temperature demonstrated a striking effect, i.e. an "anomalous"decrease of scattering intensity. Due to the large energy (several eV) and momentum (20- 200 $\AA^{-1}$) transfers of these experiments, is the collisional (or scattering) time between the probe particle and the proton $100-1000$ as. The considered effect, which has no interpretation within conventional neutron scattering theory, is caused by the non-unitary quantum dynamics (due to decoherence) during the ultrashort, but finite, time-window of the scattering process. Examples of experimental results will be shown, and a theoretical outline "from first principles"[3] will be presented.

[1] C. A. C.-Dreismann et al., (a) Phys. Rev. Lett. 79, 2839 (1997); (b) Phys. Rev. Lett. 91, 057403 (2003). [2] Physics Today, p. 9,(Sept. 2003). [3] C. A. C.-Dreismann and S. Stenholm, in preparation.

Q 45.5 Mi 15:15 6G

Sub-cycle dynamics in the laser ionization of molecules — •Xinhua Xie, Marlene Wickenhauser, and Armin Scrinzi — TU Wien, Institut f. Photonik

During a single optical cycle of a strong laser pulse, electrons are driven out of a molecule, accelerated, and directed back onto their parent molecule, where they scatter or recombine. We present a precise definition of "emission time" and initial momentum distribution in the framework of the time-dependent Schrödinger equation (TDSE). Solving the TDSE numerically for two-dimensional model molecules, we find that electron emission from and re-collision with the molecule can develop pronounced time-structures that strongly depend on the molecular species, molecular orientation, and on laser intensity. The peak of emission can shift through a significant fraction of laser cycle. The structures are produced by laser-induced intra-molecular electron dynamics. The importance of these findings for high harmonic generation and molecular tomography will be discussed.

Q 45.6 Mi 15:30 6G

Heterodyne control of attosecond pulse generation — •Thomas Pfeifer[1,2], Lukas Gallmann[1,2], Mark J. Abel[1,2], Phillip M. Nagel[1,2], Aurélie Jullien[1,2], Daniel M. Neumark[1,2], and Stephen R. Leone[1,2] — [1]Departments of Chemistry and Physics, University of California, Berkeley, CA 94720, USA — [2]Chemical Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Adding a weak laser field at a different color to the fundamental in high-order harmonic generation results in a new type of heterodyne mixing in the kinetic energy term of the active electron. Analytical calculations and quantum simulations show that the effect of the weak field is amplified by the strong fundamental laser field that acts as the local oscillator [1]. The photon energies of different attosecond pulses within the produced pulse trains can thus be significantly modified. Two important applications for this phenomenon are the generation of isolated attosecond pulses with multi-cycle driving fields and the shaping of attosecond pulse trains.

Ref.: [1] T. Pfeifer et al., Phys. Rev. Lett. **97**, 163901 (2006)

Q 45.7 Mi 15:45 6G

High Harmonic Generation for attosecond pump-probe experiments — •Helga Rietz, Konstantin Simeonidis und Joachim Ullrich — Max-Planck-Institut für Kernphysik, 69117 Heidelberg

The generation of high harmonic (HHG) radiation in rare gases using ultrashort infrared laser pulses is a well proven method to provide an efficient way to produce attosecond light pulses, thus opening the door to direct investigation of dynamics on attosecond timescales, such as the electronic motion in atoms.

Here we report on the construction of the first stage of a new experiment that will combine attosecond light pulses from HHG with a so called "reaction microscope" to perform pump-probe measurements with attosecond resolution on atoms and molecules. An innovative, versatile vacuum chamber housing all necessary optics, a gas target for HHG and a spectrometer setup for XUV-characterisation have been designed and successfully put into operation. The harmonics are generated using 800nm Ti:Sapphire laser pulses produced by a commercially available Ti:Sa-amplifier system at a pulse repetiton frequency of 10 kHz, with a single pulse energy of 0.7 mJ and duration of approximately 25 fs. A further compression to 6 fs is planned. Particularly, the high repetition rate of the system is expected to increase experimental sensitivity. First examinations of the harmonics produced in Argon and Neon exhibit a promising yield of coherent soft-X-ray radiation and confirm our setup.