A 1: Attosecond electron dynamics

Zeit: Montag 14:00–15:45 Raum: 3C

Hauptvortrag A 1.1 Mo 14:00 3C

Fragmenting multi-electron atoms: from single photons to attosecond pulses — •Agapi Emmanouilidou — University of Oregon

Attosecond collisions govern the ionization of multi-electron atoms by single photon absorption. These collisional processes are consistent with the electronic break-up geometry we predict for energies close to threshold. Confirming the predicted break-up geometries and observing in time these collisional patterns will be the impetus for future experiments. In single photon ionization the electronic correlation is essential for full fragmentation of many electron atoms. This is not the case when the atoms are driven by ultra-short laser pulses. We also discuss the correlated motion of the escaping electrons in multi-electron atoms driven by attosecond pulses.

A 1.2 Mo 14:30 3C

Attosecond time resolved momentum spectroscopy — •Ram Gopal, Konstantinos Simeonidis, Claus Dieter Schröter, Helga Rietz, and Joachim Ullrich — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Electronic response times for outer-shell electrons in atoms or molecules, lie in the domain of tens to hundreds of attoseconds and are not accessible with 'conventional' ultra-fast laser technology, since the wavelength of visible lasers limits the pulse length to about 4 fs. Thus, attosecond pulses are required, successfully developed via high-harmonic generation (HHG) within the last five years and demonstrated to be able to trace electronic response times [1].We use ultra-short XUV pulses, typically hundreds of attoseconds long, to launch electronic wavepackets in atoms. Time delayed infrared pulses of moderate intensities(10^{13} to 10^{14} W/cm^2) probe the excited atoms by ionisation. In conjunction with 3D ion-electron coincidence momentum imaging of the products using a 'Reaction Microscope'[2], we setup a technique for the time-resolved observation of electronic dynamics.

[1] M. Uiberacker et. al., Nature, 446 627 (2007)
[2] J. Ullrich et al., Rep. Prog. Phys 66, 1463-1545 (2003).

A 1.3 Mo 14:45 3C

Composite quantum-mechanical and quasiclassical descriptions: Application to attosecond dynamics — •Ulrich Galster and Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Dresden

The emergence of attosecond laser pulses challenges theoreticians to describe electronic dynamics in the time-domain. Pure quantum mechanical long time propagation in multiple dimensions still suffer from enormous computational requirements. Quasiclassical methods are more feasible in terms of computational effort, but often fail to describe quantum effects accurately. A worthwhile alternative is to use the advantages of both descriptions in a composition. Short time-intervals which exhibit dynamics of dominant quantum character can be described quantum-mechanically, while for the remaining time a quasiclassical method is used. At the moment of switching between both descriptions, the instantaneous quantum state is transformed into a quasi-classical phase-space distribution using the Wigner function.

A 1.4 Mo 15:00 3C

Monte-Carlo study of electronic dynamics in semiconductors with an ultrashort XUV-laser pulse — •Nikita Medvedev and Baerbel Rethfeld — Technische Universitaet Kaiserslautern, Kaiserslautern, Germany

We study theoretically the interaction of condensed matter with a new kind of ultrashort high-intensity XUV laser pulses (new light source FLASH at DESY in Hamburg). In our contribution we present first numerical simulations of the excitation and ionization of the electronic subsystem within a solid silicon target, irradiated with femtosecond laser pulse (25 fs, $\hbar\omega = 38$ eV). The Classical Trajectory Monte Carlo method was extended in order to take into account the electronic band structure for electrons excited into the conduction band. Secondary excitation and ionization processes were included and simulated event by event as well. The influence of the band structure on the redistribution of free electrons on subpicosecond time-scale is analyzed. In the presented work the temporal distribution of the density, the energy of these electrons, and their energy distribution function were calculated. It is demonstrated that due to the fact that part of the energy is spended to overcome ionization potentials and is kept by holes, the final kinetic energy of free electrons is much less than the total energy provided by the laser pulse. The final total number of electrons excited by single photon is significantly less than estimated by simplest expression $n_e = \hbar\omega/E_{\mathrm{gap}}$. We introduce the concept of an "effective band gap"for collective electronic excitation, which can be applied to estimate the free electron density after high-intensity XUV laser pulse.

A 1.5 Mo 15:15 3C

Imaging Attosecond Electron Wavepackets Around The Ionization Threshold — •Marko Swoboda[1], Thomas Remetter[1], Johan Mauritsson[1], Anne l'Huillier[1], Kenneth J. Schafer[2], Freek Kelkensberg[3], Wing-Kiu Siu[3], Per Johnsson[3], Marc J. J. Vrakking[3], Matthias F. Kling[4], Irina Znakovskaya[4], Thorsten Uphues[4], Sergey Zherebtsov[4], Franck Lépine[5], Enrico Benedetti[6], Federico Ferrari[6], Giuseppe Sansone[6], and Mauro Nisoli[6] — [1]Dept. of Physics, LTH, Lund University, P.O. Box 118, 221 00 Lund, Sweden — [2]Louisiana State Univ., Baton Rouge, Louisiana 70803-4001, USA — [3]AMOLF Institute, P.O.Box 41883, 1009 DB Amsterdam, The Netherlands — [4]MPI für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany — [5]Univ. Lyon 1; CNRS; LASIM, UMR 5579,43 bvd. du 11 nov. 1918, 69622 Villeurbanne, France — [6]CUSBO, ULTRAS-INFM, Politecnico, Piazza Leonardo da Vinci 32, 20133 Milano, Italy

We image the momentum distributions of attosecond electron wavepackets generated from the ionization of Helium by attosecond XUV pulses. Using an infrared probing field, the evolution of these wavepackets can be captured in time and space. Tuning the central frequency of the pulses allows us to initiate a number of processes that originate from the interplay of partially bound and continuum wavepackets or returning electrons and the atomic potential. Using this attosecond pump-probe scheme, we can track electron dynamics around the ionization barrier, performing interferometric measurements of different ionization pathways.

A 1.6 Mo 15:30 3C

Creating and monitoring non-equillibrium plasmas with attosecond laser pulses — •Ionuţ Georgescu, Ulf Saalmann, and Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

It has been shown by means of microscopic calculations that the charging of rare-gas clusters exposed to VUV laser pulses from an FEL can be traced with attosecond XUV laser pulses by measuring the kinetic energy of the photo electrons detached by the latter in a pump-probe experiment [1]. Given the rapid development of high-harmonic sources, it will soon be possible to implement this scheme in a table-top experiment, where both the VUV pump and the XUV probe can be generated from the same IR pulse. We show that with pump pulses as short as one femtosecond the charging process is accompanied by the formation of a nano-plasma, whose properties leave a strong fingerprint on the result of the probe. We predict that pump and probe pulses as short as 250 attoseconds can induce a and monitor the dynamics of a nano-plasma far from equilibrium, whose relaxation patterns resemble those of ultra-cold "micro-plasmas"[2].

[1] I. Georgescu, U. Saalmann and J.M. Rost *Phys. Rev. Lett.* 99, 183002 (2007)
[2] T.C. Killian, T. Pattard, T. Pohl and J.M. Rost *Phys. Rep.* 449, 77 (2007)