A 32: Attosecond Physics III

Zeit: Donnerstag 16:30–18:00 Raum: VMP 6 HS-E

Hauptvortrag A 32.1 Do 16:30 VMP 6 HS-E

"And, action!"- Video clips of electron motion in molecules — •Matthias Kling — Max-Planck Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Germany

The control of the electric field waveform $E(t) = E_0(t)\cos(\omega t+\phi)$, with envelope $E_0(t)$, frequency ω, by the carrier envelope phase (CEP) ϕ constitutes a new paradigm of coherent control. This control became accessible with CEP-stabilization and opened the door for the direct manipulation of electron dynamics in atomic and molecular systems [1]. For frequencies in the range of visible light the electric field waveform changes on an attosecond time-scale. Waveform controlled few-cycle pulses have been used to control electron localization in the dissociative ionization of the prototype molecules D_2 and HD [2].

These experiments will be introduced together with recent efforts to record movies of the electron localization dynamics on attosecond timescales using attosecond XUV light pulses. The important question arises, whether the steering of electrons in more complex systems is feasible and — if yes — can we understand the role of the strong-field coupling of the various potential energy surfaces that follows an initial ionization / excitation and leads to the observed control? New results on the control of electron dynamics in a multi-electron molecule, carbon monoxide (CO), will be presented to shed light on these topics.

[1] Kling, M.F. and Vrakking, M.J.J., *Annu.Rev.Phys.Chem.* **59** (2008) 463.
[2] Kling, M.F. *et al.*, *Science* **312** (2006) 246; Kling, M.F. *et al.*, *Mol.Phys.* **106** (2008) 455.

Fachvortrag A 32.2 Do 17:00 VMP 6 HS-E

Anomalous quasi-elastic electron scattering and neutron Compton scattering from single nuclei of H2, D2 and HD molecules — C. Aris C.-Dreismann[1], Glyn Cooper[2], and •Adam P. Hitchcock[2] — [1]Institute of Chemistry, Technical University of Berlin, D-10623 Berlin — [2]Brockhouse Institute for Materials Research, McMaster University, Hamilton, ON, Canada L8S 4M1

Quasi-elastic electron scattering from gaseous H2, D2, a 50:50 mixture of H2 and D2 and HD is investigated with 2.25 keV impact energy, at a momentum transfer q of 19.7 a.u. [1]. The spectral positions of the H and D recoil peaks follow Rutherford scattering theory. Surprisingly, in the spectrum of the 50:50 H2-D2 mixture, the integrated intensity of the H peak is about 30 percent lower (as compared to that of D) than predicted by Rutherford scattering, despite equal screening of nuclear charges by the electrons in all molecules. In contrast, the ratio of scattering intensities from HD agrees with the predictions of Rutherford scattering. This result was recently confirmed with a second experiment (M. Vos, ANU) applyiing 6 keV electrons. Comparison is made with neutron Compton scattering (NCS) results, which showed the same anomaly in H2-D2 and HD (about 30 percent in both systems). This anomalous effect is proposed to be due to attosecond scattering dynamics from entangled particles, and can be understood with the aid of the Quantum Zeno Effect.

[1] G. Cooper, A. P. Hitchcock, C. A. Chatzidimitriou-Dreismann, PRL 100, 043204 (2008)

A 32.3 Do 17:30 VMP 6 HS-E

Strong field dynamics with electron wave packet replicas — •Paula Riviere, Olaf Uhden, Ulf Saalmann, and Jan-Michael Rost — MPI PKS, Dresden

We investigate theoretically the electron dynamics under a train of attosecond pulses (APT) and in the presence of a strong infrared (IR) laser field. Such a combined light field, where the phase of the APT with respect to the IR field can be controlled, has been experimentally realized [1]. Here, we are interested in the process where electron wave packet (EWP) replicas are created at a well defined phase in every cycle or half cycle of the IR field. Each EWP can then interfere with the others and, additionally, suffers a streaking due to the IR field. This process can be studied analytically.

As a function of the delay between APT and IR field we obtain the kinetic energy distribution of the electron as well as the ionization probability. We analyze their dependence on the number of replicas, the main attosecond pulse frequency and the IR field intensity, both for one or two attosecond pulses per IR period. The expression for the final wavepacket can be split into two factors: one that depends on the phase shift, and one that depends on the number of replicas. The ionization probability shows strong modulations as a function of the phase shift between APT and IR pulse for small mean energies of the continuum wave packets, while for higher energies the ionization probability does not depend on the shift, in line with the experimental observations for He and Ar, respectively [1].

[1] P. Johnsson *et al.*, *Phys. Rev. Lett.* **99**, 233001 (2007).

A 32.4 Do 17:45 VMP 6 HS-E

Higher-Order Effects in Attosecond Pulse Train Measurements — •Marko Swoboda[1], Thierry Ruchon[2], J. Marcus Dahlström[1], Johan Mauritsson[1], and Anne L'Huillier[1] — [1]Department of Physics, Lund University, P.O. Box 118, 221 00 Lund, Sweden — [2]Centre d'Etudes de Saclay, CEA/DRECAM/SPAM, 91191 Gif-sur-Yvette, France

Multiphoton processes are at the heart of most attosecond pulse characterization schemes. Due to the low availability of intense attosecond pulse sources, the combination of a single or train of attosecond pulses with a probing infrared field in an interferometric setup is the one most often employed. Using this scheme to characterize attosecond pulse trains generated in Argon, we study the influence of the probe field intensity on the measured phase of the final photo electron wave packet. We find that in the transition from RABBITT-like intensities to the range of attosecond streaking higher and higher orders of perturbation and photon numbers contribute to the final photo electron state until the classical limit is reached. A Fourier-type analysis attributes the each individual frequency to an additional perturbative order.