A 27: Poster: Attosecond physics

Time: Wednesday 17:00–19:00 Location: C/Foyer

A 27.1 Wed 17:00 C/Foyer

Tunneling time in Atto-Second Experiments and Time-Energy Uncertainty Relation — •Ossama Kullie — Institute für Physik, Universität Kassel

In this work [1] we suggest an analytical relation to calculate the tunneling time (TT) in attosecond and strong field experiments for the important case of the He-atom [2], precisely our TT was related to the time of passage similarly to the Einstein's *photon box Gedanken experiment*. This presents an important study case for the theory of time in quantum mechanics and is very promising for the search for a (general) time operator in quantum mechanics. The work can be seen as a fundamental step in dealing with the tunneling time in strong field and ultrafast science, and is appealing to more elaborate treatments, and especially for complex atom and molecules. [1] O. Kullie. Tunneling time in attosecond experiments and time-energy uncertainty relation, work in progress. [2] P. Eckle et al. Nat. Phys.**4** , 565 (2008).

A 27.2 Wed 17:00 C/Foyer

Classical analytical approach for Coulomb focusing of tunnelled electrons in intense laser fields. — •Jiří Daněk, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Recent high resolution experiments on the kinematically complete measurement of photoelectron spectra in the tunneling ionization in intense laser fields led to discovery of new low energy structures (LES), very low energy structures (VLES) and zero energy structures (ZES) in the spectra at energies of the order of electronvolts, lower than electronvolts and milielectronvolts, respectively. Although, investigations show that these structures are due to the role of the Coulomb field of the atomic core in the laser driven dynamics of the tunnelled electron, there is no clear unified picture for the dynamics.

In our poster, we present our classical analytic approach to this problem for a linearly polarized laser field, which allows us to determine the influence of the parent ion on the ionized electron due to Coulomb interaction. Restricting the Coulomb field effect to rescattering events of the freed electron with the atomic core, we derive analytical formulas for the longitudinal and transversal momentum changes for the electron due to the Coulomb field, with further aim to explain the final momentum distribution via the effect of multiple rescattering. We also discuss the possibility of trapping of the ionized electron in the Rydberg states and the role of the trapping on the final spectra.

A 27.3 Wed 17:00 C/Foyer

Core hole spectroscopy with XUV-initiated high harmonic generation — Doron Azoury, •Michael Krüger, Barry D. Bruner, and Nirit Dudovich — Weizmann Institute of Science, Rehovot 76100, Israel

High-harmonic spectroscopy is a powerful tool to image atomic and molecular structure on angstrom length and attosecond time scales (see, e.g., [1]). However, conventional high-harmonic generation (HHG) that employs tunneling ionization can only adress orbitals belonging to outer shell states. In XUV-initiated HHG, the tunneling ionization step is replaced by photoionization of electrons by an XUV attosecond pulse [2]. This enables the excitation of inner-shell electrons and core holes. The induced inner-shell dynamics can then be probed by the liberated electron which is brought to recollision by an infrared laser field at a well-defined time instant [3]. The technique should be applicable not only to atomic, but also to complex molecular targets such as hydrocarbons. Here we detail our setup for a proof-of-principle XUV-pump IR-probe experiment and report on its current status.

[1] O. Smirnova et al., Nature 460, 972 (2009).
[2] G. Gademann et al., NJP 13, 033002 (2011).
[3] J. Leeuwenburgh et al., PRL 111, 123002 (2013).

A 27.4 Wed 17:00 C/Foyer

Time Delays in Two-Photon Ionization — Jing Su[1], •Hongcheng Ni[2], Agnieszka Jaron-Becker[1], and Andreas Becker[1] — [1]JILA and Department of Physics, University of Colorado, Boulder, Colorado 80309-0440, USA — [2]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany

We study the time delays in two-photon ionization of the helium atom. We find that in the case of a nonresonant transition the absorption of the two photons occurs without time delay. In contrast, for a resonant transition a substantial absorption time delay is present, which scales linearly with the duration of the ionizing pulse. The two-photon absorption time delay can be related to the phase acquired during the transition of the electron from the initial ground state to the continuum.