A 3: Interaction with strong or short laser pulses I

Time: Monday 10:30–12:30 Location: BEBEL E44/46

A 3.1 Mon 10:30 BEBEL E44/46

Describing the phase of a tunneling electron wave packet by interference with an XUV electron — •Jost Henkel and Manfred Lein — Institut für Theoretische Physik and Centre for Quantum Engineering and Space-Time Research (QUEST), Leibniz Universität Hannover Appelstraße 2, 30167 Hannover, Germany

The interference pattern in the photoelectron momentum distribution created by ionization from an IR field and an XUV pulse encodes information about the phases for both ionization processes. Assuming knowledge of the XUV single-photon ionization properties, the interference pattern could provide access to the photoelectron phase in IR ionization. By comparing numerical and analytical solutions of the strong-field approximation (SFA) to numerical solutions of the time-dependent Schrödinger equation (TDSE) for the IR ionization process we can identify additional phase contributions not contained in the SFA. These phase shifts are caused by the core potential or Stark shifting of the ground state during ionization.

A 3.2 Mon 10:45 BEBEL E44/46

Off-axis low-energy structures in above threshold ionization with long wavelength — •Max Möller[1,2], Frank Meyer[1], A. Max Sayler[1,2], Dejan B. Milosevic[3], Wilhelm Becker[4], and Gerhard G. Paulus[1,2] — [1]Institute for Optics and Quantum Electronics, Friedrich Schiller University Jena, Germany — [2]Helmholtz Institute Jena, Germany — [3]Academy of Sciences and Arts of Bosnia and Herzegovina, Bosnia and Herzegovina — [4]Max Born Institute for Nonlinear Optics and Short-Pulse Spectroscopy, Germany

The angle-resolved above-threshold ionization spectra at wavelengths around 2 microns exhibit a characteristic fork-like structure perpendicular to the laser polarization. An extension of the simple-man's model to include angular rescattering and multiple returns reveals the electron trajectories which are responsible for the observed structures.

A 3.3 Mon 11:00 BEBEL E44/46

Laser field induced correlated tunneling of electrons — •Natalya Sheremetyeva, Mara Osswald, and Alejandro Saenz — AG Moderne Optik, Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin, Germany

Ionization is the central process that controls many phenomena occurring during the interaction of strong laser fields with matter. Often, only the ionization of valence electrons is considered. In reality, more electrons may be involved in the process and their dynamics is correlated. A theoretical description of this dynamics is complicated and in most cases some approximation has to be adopted.

Z. Walters and O. Smirnova proposed a semi-classical model, in which a weakly bound electron escapes from the nuclear potential via tunneling, generating an 'attosecond correlation pulse'. This pulse can excite a more strongly bound electron and can elevate it to the vacated energy level. Consequently, since the electrons are indistinguishable, it appears as if the more strongly bound electron has tunneled directly. Interestingly, it was found in [1] that this particular two-step process has a higher probability than direct tunnel ionization out of the deeper orbital.

We present a quantum-mechanical version of this model. Separate investigations of the influence of the external laser field and the electron interaction on the excitation probability of the more strongly bound electron allows us to search for specific effects due to tunneling. We find no evidence of a tunneling-specific 'attosecond correlation pulse'.

[1] Z. Walters and O. Smirnova, J. Phys. B, 43 (2010), p. 161002

A 3.4 Mon 11:15 BEBEL E44/46

Rydberg state distribution of neutral Helium atoms after frustrated tunneling ionization (FTI) — •Henri Zimmermann, Sebastian Eilzer, and Ulli Eichmann — Max-Born-Institut for Nonlinear Optics und Short Pulse Spectroscopy, Berlin, Germany

Excitation of neutral atoms by short intense laser pulses through the process of frustrated tunneling ionization (FTI) has been found to be one of the four dominant processes in the tunneling regime of strong-field ionization. Several numerical methods ranging from classical to fully correlated quantum mechanical calculations have been used for the prediction of the excited state distribution generated by this process but so far an experimental investigation is still missing. Here, we present the first experimental confirmation of the theoretical predictions for the surviving neutral atoms for Helium. Furthermore we show the presence of laser induced spin dynamics upon excitation as well as the possibility of their modification.

A 3.5 Mon 11:30 BEBEL E44/46

Time delay of laser-induced tunnel-ionization — •Enderalp Yakaboylu, Michael Klaiber, Heiko Bauke, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg,Germany

The tunneling time delay, stemming from Wigner's definition, is investigated for laser-induced tunnel-ionization. First, the concept of Wigner time delay is applied to one-dimensional model configurations of tunneling and it is compared with results obtained from the exact propagator. Then, by adapting Wigner's time delay definition, the tunneling time is investigated in the deep-tunneling and in the near-threshold-tunneling regimes of tunnel-ionization from a Coulomb potential. It is shown that while in the deep-tunneling regime signatures of the tunneling time delay are not measurable at remote distance, it is detectable, however, in the near-threshold-tunneling regime [1,2].

[1] E. Yakaboylu, M. Klaiber, H. Bauke, K. Z. Hatsagortsyan, and C. H. Keitel, preprint arXiv:1309.0610 (to be published in Phys. Rev. A.)

[2] M. Klaiber, E. Yakaboylu, H. Bauke, K. Z. Hatsagortsyan, and C. H. Keitel, Phys. Rev. Lett. 110, 053814 (2013)

A 3.6 Mon 11:45 BEBEL E44/46

Real-time tracking of two-electron dynamics in the ionization continuum of Xe — •Mursal Baggash and Horst Rottke — Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max-Born-Straße 2 A, 12489 Berlin, Germany

We present real-time tracking of atomic 2-electron coherent dynamics in excited autoionizing wavepackets in Xenon using a pump-probe detection scheme. An extreme-ultraviolet (xuv) radiation pulse coherently excites different Fano-resonances simultaneously. The excited resonances are of the type of a single inner-valence-shell and a double valence-shell excitation. The lunched wavepackets' evolution in time is probed with a delayed infrared (ir) laser pulse which further excites one of the electrons to the $(5s)^2(5p)^4 n l \epsilon l'$ ionization continuum where it is detected. We are able to track the oscillatory beating of the formed wavepackets that is imprinted on their decay through autoionization.

A 3.7 Mon 12:00 BEBEL E44/46

Ionization dynamics of atoms anc molecules in sculpted two-color laser fields — •Slawomir Skruszewicz, Robert Irsig, Mohammad Adel Almajid, Dieter Bauer, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universitätsplatz 3, 18051 Rostock, Germany

We present recent results on ionization of atoms and molecules in sculpted two-color laser fields. Technique enables to create electron wavepackets wit sub-fs duration by highly non-linear tunneling process [1] and actively control its dynamics on sub-fs time scale [2]. Consequently, the interference patter between wavepacket propagating in oscillatory laser field can be resolved by means of the angular-resolved photoelectron spectroscopy. Additionally, we identify the ionic Coulomb field influence on propagating electron wavepackets by comparing experimental data with results of strong-field approximation calculations and solving of time-dependent Schrödinger equation.

[1] P. B. Corkum and F.Krausz. Nature Physics 3, 381 (2007) [2] N. Dudovich et. al., Nature 2, 781 (2006)

A 3.8 Mon 12:15 BEBEL E44/46

Strong-field Ionization of Atomic Ions — •P. Wustelt[1,2], M. Möller[1,2], T. Rathje[1,2], S. Trotsenko[2,3], Th. Stöhlker[1,2,3], A.M. Sayler[1,2], and G.G. Paulus[1,2] — [1]Institute of Optics and Quantum Electronics, Friedrich Schiller University Jena, Germany — [2]Helmholtz Institute Jena, Germany — [3]GSI, Darmstadt, Germany

Using a fast ion beam, we investigate the multi-electron strong-field ionization dynamics of atomic ions, in particular in elliptically polarized pulsed laser fields.

In contrast to linear polarization, for elliptically polarized many-cycle pulses, the final ion momentum distribution in single ionization

provides direct and complete information on the ionizing field strength as well as the ionization time. Furthermore, we are able to reconstruct the electron momenta from the ion momentum distributions after multiple ionization and, therefore, gain information on the ionization field strength as well as on the release times for subsequent ionization steps.

The results are compared to predictions from classical Monte-Carlo simulations based on quasistatic ionization rates.

In addition, the subtle effects of the Coulomb interaction on the electron trajectory lead to a tilt in the observed momentum distribution. These effects can be used to study the kinematics and the initial conditions of the electron following tunnel ionization.