A 40: Strong laser fields - III

Time: Thursday 14:00–16:00 Location: K 2.019

Invited Talk A 40.1 Thu 14:00 K 2.019

Electron vortices — Dominik Pengel, Stefanie Kerbstadt, Lars Englert, Tim Bayer, and •Matthias Wollenhaupt — Carl von Ossietzky Universität, Oldenburg, Germany

Recently, the emergence of vortex structures in the momentum distribution of free electron wave packets from photoionization of atoms with sequences of two time-delayed counterrotating circularly polarized (CRCP) ultrashort laser pulses was predicted [1] and demonstrated experimentally [2]. Electron vortices arise from the superposition of two time-delayed free electron wave packets with different magnetic quantum numbers. In our experiment three-dimensional electron vortices are generated by multiphoton ionization of potassium atoms using CRCP femtosecond laser pulses from a polarization-shaped supercontinuum source [3] and reconstructed tomographically from velocity map imaging (VMI) measurements [4]. Absorption of another photon in the continuum changes the c_6 azimuthal symmetry of the threshold vortex into c_8 for above threshold ionization (ATI) [5]. Electron vortices from non-perturbative excitation show c_4 azimuthal symmetry and a π-phase jump in the polar direction. Currently, we study electron vortices generated by bichromatic polarization-shaped CEP-stable supercontinua [3].

[1]J. M. Ngoko Djiokap *et al.*, Phys. Rev. Lett. **115**, 113004 (2015).
[2]D. Pengel *et al.*, Phys. Rev. Lett. **118**, 053003 (2017).
[3]S. Kerbstadt *et al.*, Opt. Express **25**, 12518 (2017).
[4]S. Kerbstadt *et al.*, New J. Phys. **19**, 103017 (2017).
[5]D. Pengel *et al.*, Phys. Rev. A **96**, 043426 (2017).

Invited Talk A 40.2 Thu 14:30 K 2.019

Magnetic Quantum Number in Strong Field Ionizaton — •Sebastian Eckart[1], Maksim Kunitski[1], Martin Richter[1], Alexander Hartung[1], Jonas Rist[1], Florian Trinter[1], Kilian Fehre[1], Nikolai Schlott[1], Kevin Henrichs[1], Lothar Ph. H. Schmidt[1], Till Jahnke[1], Markus Schöffler[1], Kunlong Liu[2], Ingo Barth[2], Jivesh Kaushal[3], Felipe Morales[3], Misha Ivanov[3], Olga Smirnova[3], and Reinhard Dörner[1] — [1]Goethe-Universität, Frankfurt am Main, Germany — [2]Max Planck Institute of Microstructure Physics, Halle (Saale), Germany — [3]Max Born Institute, Berlin, Germany

Our experiment shows that elliptically polarized laser pulses selectively tunnel-ionize electrons with defined sign of the magnetic quantum number (m) leaving behind an ion with defined ring current confirming theoretic predictions. Further we find that the initial momentum distributions upon tunnel-ionization depends on m as well. This leads to a shifted energy dependent yield for ionization from m-prepared states. Finally we show how to demerge angular offsets for different m-states allowing for the preparation and detection of ring currents with sub-cycle temporal precision. The three-dimensional electron momenta have been measured in coincidence with their ionic cores using cold-target recoil-ion momentum spectroscopy (COLTRIMS).

A 40.3 Thu 15:00 K 2.019

Space-time-resolved UV-photoionization of rare gases — •Arne Baumann[1,2], Oliver Schepp[1,2], Dimitrios Rompotis[4], Marek Wieland[1,2,3], and Markus Drescher[1,2,3] — [1]Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany — [2]Hamburg Centre for Ultrafast Imaging - CUI, Hamburg, Germany — [3]Center for Free-Electron-Laser Science - CFEL, Hamburg, Germany — [4]Deutsches Elektronensynchrotron - DESY, Hamburg, Germany

The photoionization of Kr and Xe is studied in the presence of a strong UV-field, where multi-photon and tunneling ionization lead to the formation of high charge states.

The experimental scheme is based on wave-front splitting of intense Ti:Sa third harmonic pulses at 268 nm and a colliding pulse geometry. Individual pulses are focused antiparallely into a gas target and ions created are imaged onto a position-sensitive detector, thus retrieving the spatial distribution of charged particles and mapping the temporal delay between both pulses onto a spatial coordinate.

In the case of Kr, high-lying Rydberg states, which are affected by strong AC-Stark shifts, are excited through 3-photon absorption, and interrogated by UV and IR pulses. By these means, different time-domain superpositions of the present fields are imaged simultaneously. The extracted durations of UV and IR pulses are in good agreement with values expected from the perturbative model.

A 40.4 Thu 15:15 K 2.019

Reconstructing real-time quantum dynamics in strong and short laser fields — •Veit Stooss[1], Stefano M. Cavaletto[1], Stefan Donsa[2], Alexander Blättermann[1], Paul Birk[1], Christoph H. Keitel[1], Iva Brezinová[2], Joachim Burgdörfer[2], Christian Ott[1], and Thomas Pfeifer[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany, EU — [2]Institute for Theoretical Physics, Vienna University of Technology, Wiedner Hauptstraße 8, 1040 Vienna, Austria, EU

Recent results [1, 2, 3] suggest a link between the shape of spectral lines and strong-field-induced amplitude and phase shifts of the response function of the system. Here, we present a method which allows the retrieval of the entire holographic (amplitude and phase) time-resolved response function recording the transient absorption spectrum of an ultrashort probe signal. This still holds for the case of coherently excited systems which exhibit complex time dependence due to the interaction with strong fields. This finding is applied to a time-domain observation of Rabi cycling between doubly-excited atomic states in the few-femtosecond regime. The principle is shown to be viable also in much more complex systems and unlocks the real-time-resolved observation of theresponse function for non-equilibrium states of matter with a single-shot measurement.

[1] C. Ott et.al, Science 340, 716-720 (2013) [2] A. Kaldun, Phys. Rev. Lett. 112, 103001 (2014) [3] H. Mashiko et al., Nat. Comm. 5, 5599 (2014)

A 40.5 Thu 15:30 K 2.019

Suppression of strong-field effects in photoionization of ultracold alkali atoms — •Tobias Kroker[1,2], Philipp Wessels[1,2], Bernhard Ruff[1,2], Klaus Sengstock[1,2], Markus Drescher[1,2], and Juliette Simonet[1,2] — [1]Zentrum für Optische Quantentechnologien (ZOQ), Luruper Chaussee 149, 22761 Hamburg — [2]The Hamburg Centre for Ultrafast Imaging (CUI), Luruper Chaussee 149, 22761 Hamburg

We investigate experimentally the ionization of genuine single active electron atoms in strong light fields accessing a regime where the Keldysh parameter is close to unity and nominally all transition scenarios of multiphoton-, tunnel-, and over-the-barrier ionization can take place. Surprisingly, we observe a clear dominance of multiphoton ionization even at high peak intensities exceeding the over-the-barrier-ionization threshold.

Our fully quantitative approach relies on exposing trapped ultracold ^{87}Rb atoms to intense femtosecond laser pulses. Such targets indeed allow for the exact determination of atom numbers and densities and thus the atomic loss fraction can be directly measured.

This novel methodology enables the extraction of absolute ionization probabilities and cross-sections for testing the validity of theoretical models under debate in the so-called transitional non-adiabatic tunneling regime.

A 40.6 Thu 15:45 K 2.019

Coulomb-focusing in strong-field ionization and its effect in non-dipole interaction regime: analytical approach — •Jiří Daněk, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Strong field ionization with mid-infrared lasers offers new possibilities, such as time-resolved photoelectron holography[1], for atomic/molecular imaging. New discoveries, in particular the counterintuitive features of the photoelectron momentum distribution in the non-dipole regime[2], have shown that detailed understanding of the role of the Coulomb field of the atomic core on the underlying dynamics is missing.

In this work we put forward a perturbative analytical framework, which allows us to account for the momentum transfers between the electron and the atomic core. We restrict the interaction to specific and well defined recollision points on the electron's classical trajectory and obtain an analytical description of the final electron's momentum and hence of Coulomb focusing. Furthermore, we demonstrate the capability of our framework by analyzing the modification of the Coulomb focusing due to non-dipole effects. The latter allows us to explain the mechanism behind the energy-dependent counterintuitive bend of the cusp of the photoelectron momentum distribution in a linearly polarized mid-infrared laser fields.

[1] Y. Huismans et al., Science, **331**, 61 (2011).
[2] A. Ludwig et al., Phys. Rev. Lett. **113**, 243001 (2014).