A 36: Quantum dynamics in tailored waveforms

Time: Friday 10:30–12:15 Location: S HS 3 Physik

Invited Talk A 36.1 Fri 10:30 S HS 3 Physik

Attoclock with tailored polarization — Nicolas Eicke and •Manfred Lein — Institute for Theoretical Physics, Leibniz Universität Hannover, Appelstraße 2, 30167 Hannover

The term attoclock refers to the strong-field ionization of an atom and measurement of the resulting photoelectron momentum distribution in order to obtain the (most likely) time of electron departure. Previously, few-cycle circular or elliptical laser fields have been used to achieve a well-defined peak in the momentum distribution, at the price that the ionization timing in linear polarization was not accessible. We propose an attoclock with a bicircular field, i.e. a combination of two counter-rotating circularly polarized fields, tailored such that it mimics linear polarization during three time intervals per optical cycle. For the mapping between electron momentum and ionization time we use a trajectory-free method [N. Eicke, M. Lein, PRA 97, 031402(R) (2018)] based on finding the saddle points of the exact Dyson integral for the momentum-space wave function. From our calculations, we conclude that while ionization is nearly instantaneous for the circular attoclock, the (quasi)linear attoclock has its most likely time of ionization slightly (˜10 attoseconds) later than the maximum of the instantaneous field. The momentum-resolved ionization time can alternatively be measured by applying a linearly polarized streaking field parallel or orthogonal to the ionizing field. Parallel streaking yields results in good agreement with the saddle-point times, while orthogonal streaking appears to measure not the true ionization time but a 'Coulomb-free' time, as if the electron were removed from a short-range potential.

Invited Talk A 36.2 Fri 11:00 S HS 3 Physik

Chiral fragmentation of a planar molecule — •Kilian Fehre[1], Sebastian Eckart[1], Maksim Kunitski[1], Martin Pitzer[2], Stefan Zeller[1], Christian Janke[1], Daniel Trabert[1], Jonas Rist[1], Miriam Weller[1], Alexander Hartung[1], Lothar Schmidt[1], Till Jahnke[1], Robert Berger[3], Reinhard Dörner[1], and Markus Schöffler[1] — [1]Institut für Kernphysik Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt, Germany — [2]Chemical Physics Department Weizmann Institute of Science P.O. Box 26, 76100 Rehovot Israel — [3]Fachbereich Chemie, Philipps-Universität Marburg, Hans-Meerwein-Straße 4, 35032 Marburg, Germany

Most building blocks of living nature are chiral (their mirror image cannot be superimposed with the initial object). We investigate the fully detected five body break-up of formic acid with the COLTRIMS (CoLd Target Recoil Ion Momentum Spectroscopy) technology and discuss two exciting new effects. Firstly, upon n*π^* transition, the initially planar molecule becomes chiral. The observed enantiomer strongly depends on the orientation of the molecule with respect to the light propagation direction and the helicity of the ionizing light. This finding might pave the way for future, purely light-driven control of stereochemistry starting from achiral precursors. Secondly, we observe a very strong (up to 20 %) differential PICD (PhotoIon Circular Dichroism). Like PECD (PhotoElectron Circular Dichroism), PICD shows its self as sensitive probe for the molecular structure.

Invited Talk A 36.3 Fri 11:30 S HS 3 Physik

Simple and robust control of resonant few-photon ionization — •Ulf Saalmann — MPI for the Physics of Complex Systems

It is shown that resonant few-photon ionization can be easily controlled by means of chirped laser pulses. Simply by changing the chirp direction one can switch between excitation and ionization with very high contrast [U Saalmann, S Kumar Giri and J M Rost, PRL 121 (2018) 153203], as calculated paradigmatically for the two-photon ionization of helium. This is a surprising consequence if rapid adiabatic passage is extended to include transitions to the continuum. The chirp phase-locks the linear combination of two resonantly-coupled bound states, whose ionization amplitudes interfere constructively or destructively depending on the chirp direction under suitable conditions. The phenomenon is illustrated by means of a minimal model.

A 36.4 Fri 12:00 S HS 3 Physik

Enhanced Ionization of H_2^+ in Strong Laser Fields — •Philipp Wustelt[1,2], Max Möller[1,2], A. Max Sayler[1,2], Lun Yue[3], Stefanie Gräfe[3], and Gerhard G. Paulus[1,2] — [1]Institute of Optics and Quantum Electronics, Friedrich-Schiller-University Jena, D-07743 Jena, Germany — [2]Helmholtz Institute Jena, D-07743 Jena, Germany — [3]Institute of Physical Chemistry,Friedrich-Schiller University-Jena, Helmholtzweg 4, D-07743 Jena,Germany

Utilizing a benchmark measurement of laser-induced ionization of an H_2^+ molecular ion beam target at infrared wavelength around 2 μm, we demonstrate that the characteristic two-peak structure predicted for laser-induced enhanced ionization of H_2^+ and diatomic molecules in general [1], is a phenomenon which is confined to a small laser parameter space, where pulse duration and laser intensity are carefully balanced and the interplay between nuclear stretching dynamics and ionization allows for ionization from a broad nuclear wave packet.

Further, we control the effect experimentally and measure its imprint on the electron momentum. We replicate the behavior with simulations, which reproduce the measured kinetic-energy release as well as the correlated electron spectra. Based on this, a model, which both maps out the Goldilocks Zone and illustrates why enhanced ionization has proven so elusive in H_2^+, is derived. This directly address a longstanding debate, explains the elusive nature of enhanced ionization, and serves as a guide for how to manipulate laser parameters to coherently control the phenomenon.

[1] T. Zuo and A. D. Bandrauk, Phys. Rev. A **52**, 2511 (1955)