A 31: Strong laser fields - II

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

Invited Talk A 31.1 Wed 14:00 K 2.019

H_2^+ and HeH^+: Two fundamentally important molecules in strong laser fields — Philipp Wustelt[1], Max Möller[1], A. Max Sayler[1,2], and •Gerhard G. Paulus[1,2] — [1]Friedrich Schiller University, Jena, Germany — [2]Helmholtz Institute Jena, Germany

Ion beam experiments studying the fragmentation of HeH^+ and H_2^+ are performed and compared. The two molecules represent extreme instances of polar and non-polar molecules. Therefore, the behavior of most chemical bonds in strong fields can be expected to lie in between these extremes.

In the experiment, the fragments generated through the interaction with femtosecond laser pulses of wavelengths from 400 to 2400 nm and intensities up to 10^{17} W/cm^2 are recorded on a position- and time-sensitive detector such that the momenta of the fragments can be fully reconstructed.

The excitation and ionization dynamics in H_2^+ and HeH^+ is very different, particularly at low intensities. In the former, dissociation is strong and the molecule stretches due to coupling of electronic states before ionization. HeH^+, in contrast, can directly be vibrationally excited for sufficiently long wavelengths. Dissociation, on the other hand, is almost negligible for short wavelengths.

A 31.2 Wed 14:30 K 2.019

Two-color laser pulses and "the phase of the phase" — •Mohammad Adel Almajid and Dieter Bauer — Institute of Physics, University of Rostock, 18051 Rostock, Germany

Phase of the phase (PoP) spectroscopy using two-color colinearly polarized laser pulses has been introduced and applied to the tunneling regime of strong-field ionization [1]. PoP spectra represent concisely how much and with which phase lag the photoelectron yield changes as a function of the relative phase between the two colors.

In the multiphoton regime, we find an alternating PoP along the above-threshold ionization rings, generating a characteristic checkerboard pattern in the PoP spectra, which can analytically be described within the strong-field approximation [2].

In the case of counter-circularly polarized ω-2ω laser pulses a threefold symmetry in the PoP spectra is obtained, and there is a jump in the PoP signature at a particular radial photoelectron momentum, which can analytically be described using the saddle point equation.

[1] S. Skruszewicz *et al.*, *Two-Color Strong-Field Photoelectron Spectroscopy and the Phase of the Phase*, Phys. Rev. Lett. 115, 043001 (2015).
[2] M. A. Almajid *et al.*, *Two-color phase-of-the-phase spectroscopy in the multiphoton regime*, J. Phys. B: At. Mol. Opt. Phys. 50, 194001 (2017).

A 31.3 Wed 14:45 K 2.019

Towards phase-of-the-phase spectroscopy on atomic hydrogen — •Bennet Krebs, Dzmitry Komar, Konstantin Gröner, Michael Zabel, Lev Kazak, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Universitaet Rostock, Institut fuer Physik, Albert-Einstein-Str. 24, D-18059 Rostock

A hot capillary thermal atomic hydrogen source is used in order to extract angular resolved photoelectron signal from H_1. Near infrared laser light ($\lambda = 800$ nm, $\tau = 130$ fs, $I_f \approx 10^{14}$ W/cm^2) is used to ionize hydrogen in the tunneling regime. A serious problem with respect to strong field photoemission from atomic hydrogen is the background signal caused by the low efficiency in standard H_1-sources. Directional focused H_1 sources interact with the perpendicular aligned laser-field only within their cross section, while residual or recombined H_2 may be ionized over the whole laser volume. At high gas loads the H_2 signal may be orders of magnitude higher than the desired atomic signal. VMI spectra of H_1 are presented and compared to spectra of molecular hydrogen. By expanding the laser setup to $\omega/2\omega$ fields we plan conduct $\mathcal{PoP}$ Spectroscopy [1] on the simplest atomic system in order to contribute benchmark data for theory.

[1] S. Skruszewicz, et al. Phys. Rev. Lett. 115, 043001 (2015)

A 31.4 Wed 15:00 K 2.019

Strong field ionization dynamics of photoelectrons in parallel mid infrared two color laser fields — •Daniel Würzler[1,2], Slawomir Skruszewicz[1,2], Max Sayler[1,2], Danilo Zille[1,2], Yinyu Zhang[1,2], Daniel Adolph[1,2], Philipp Wustelt[1,2], Max Möller[1,2], Stephan Fritzsche[1,3], Josef Tiggesbäumker[4], Dieter Bauer[4], and Gerhard G. Paulus[1,2] — [1]Institute of Optics and Quantum-Electronics, Max-Wien-Platz 1, D-07743 Jena, Germany — [2]Helmholtz Institute Jena, Fröbelstieg 3, D-07743 Jena, Germany — [3]Institute of Theoretical Physics, Max-Wien-Platz 1, D-07743 Jena, Germany — [4]Institute of Physics, Albert-Einstein-Str. 24, D-18059 Rostock, Germany

Due to the nonlinearity of strong-field ionization processes, even small modifications of the ionizing laser field (ω) can have a significant impact on the resulting dynamics. Such modifications can be realized with subcycle precision by coherently superimposing the ionizing laser field with its second harmonic (2ω) [1-2]. Here, we apply this technique to the mid-IR wavelength regime ($\lambda_\omega = 1800$nm and $\lambda_{2\omega} = 900$nm) in parallel field configuration. By tuning the relative phase, φ_{rel}, of the two fields, we investigate phase-dependent photoelectron momenta spectra of Xe. Using the 'phase of the phase' [3] of the spectra, we discuss various contributions to forward scattering from trajectories revisiting the ion several times during ionization [4].

[1] C. Figueira de Morisson Faria et al. Phys. Rev. A 61, 063415 [2] D. Shafir et al. Nature 485, 343-346 [3] S. Skruszewicz et al. Phys. Rev. Lett. 115, 043001 [4] M. Möller et al. Phys. Rev. A 90, 023412

A 31.5 Wed 15:15 K 2.019

Phase resolved measurements of strong field photoionization in alkali metal vapor — •Philipp Kellner[1], Daniel Adolph[2], Yinyu Zhang[1,2], Danillo Zille[1], Philipp Wustelt[1], Max Moeller[1], A. Maxwell Sayler[1,2], and Gerhard G. Paulus[1,2] — [1]Institute of Optics and Quantumelectronics, Max-Wien-Platz 1, 07743 Jena — [2]Helmholtz-Institute, Fröbelstieg 3, 07743 Jena

The carrier-envelope phase (CEP) is a crucial parameter for experiments where ultrashort strong pulses of laserlight interact with matter such as high harmonic and attosecond-pulse generation or above-threshold ionization. The talk will present phase-resolved measurements of strong-field photoionization from alkali metal vapor induced by few-cycle pulses at 800 nm and 1800 nm center wavelength. These measurements pave the way towards single-shot CEP- and pulse duration measurements in the mid-IR-wavelength range. Unlike well established techniques of CEP-measurement e.g. f-2f interferometers or the xenon-based CE phasemeter, the alkali-phasemeter should allow precise, single-shot phase characterization with high repetition rates and low pulse energies. The key to reducing the pulse energy lies in the usage of materials with low ionization potential. Lower ionization potentials allow for longer wavelength and smaller intensities by staying in the tunneling-ionization-regime. The CE phasemeter based on alkali metalls can make pulse reconstruction in the shortwave IR-Regime possible and might also be an alternative for pulse duration measurements with FROG.

A 31.6 Wed 15:30 K 2.019

CEP-asymmetries from bichromatic multi-photon ionization of Xenon atoms — •Stefanie Kerbstadt, Dominik Pengel, Lars Englert, Tim-Daniel Bayer, and Matthias Wollenhaupt — Carl von Ossietzky Universität Oldenburg, Institut für Physik, Carl-von-Ossietzky-Straße 9-11, 26129 Oldenburg

Recently, we introduced a novel approach to the generation of polarization-tailored bichromatic fields, based on ultrafast pulse shaping of an octave-spanning Carrier Envelope Phase (CEP)-stable white light supercontinuum [1-2]. The bichromatic shaping scheme opens up an entirely new class of polarization-tailored optical waveforms for various applications including multi-pathway coherent control of ultrafast dynamics, high-order harmonics generation and the design of polarization-sensitive two-color pump-probe experiments with phase-locked CEP-stable laser pulses at a broad range of excitation wavelengths [3]. In this contribution, bichromatic pulse shaping is applied to study CEP-sensitive lateral asymmetries in the photoelectron angular distribution from 7- vs. 8-photon ionization of Xenon atoms. The physical mechanism is discussed in terms of the interference of states with opposite parity, addressed by the corresponding quantum path-

ways. In addition, we vary the polarization state of both colors from linear to circular, generating a CEP-sensitive 3D-photoelectron wave packets with 1-arm-vortex shape.

[1] S. Kerbstadt et al., J. Mod. Opt. 64 (2017) 1010.
[2] S. Kerbstadt et al., Opt. Expr. 25 (2017) 12518.
[3] S. Kerbstadt et al., New J. Phys. 19 (2017) 103017.

A 31.7 Wed 15:45 K 2.019

Strong-field photoemission from a one-dimensional nanometric blade structure — •Timo Paschen[1], Ryan Roussel[2], James Rosenzweig[2], and Peter Hommelhoff[1,3] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]UCLA Physics and Astronomy, Los Angeles, CA 90095-1547 — [3]Max-Planck Institut für die Physik des Lichts, 91058 Erlangen

We present femtosecond laser-induced electron emission from a nanometric one-dimensional blade structure. Due to the unique combination of silicon-based production technology and optical near-field properties well known from nanotip research [1,2] confined laser-induced electron emission can be achieved. By tightly focusing μJ-level few-cycle laser pulses onto the sample and harnessing local field enhancement at the structure the optical-field strength can reach up to 60 V/nm, turning the electron emission mechanism into strong-field photoemission. We will discuss energy-resolved electron spectra showing clear signs of strong-field effects such as the high-energy plateau and the intensity-dependent cut-off shift. The high total emitted charge of several thousand electrons per laser pulse and maximum achieved electron energies of more than 1 keV render the presented structure an excellent candidate as a line electron source for dielectric laser acceleration (DLA) [3], for example.

[1] M. Schenk et al., Phys. Rev. Lett., 105, 257601 (2010).
[2] M. Krüger et al., Nature 475, 78 (2011).
[3] J. Breuer et al., Phys. Rev. Lett., 111, 134803 (2013).