A 25: Interaction with strong or short laser pulses II

Time: Wednesday 14:30–16:30 Location: f107

Invited Talk A 25.1 Wed 14:30 f107

Describing the correlated electron dynamics in atoms and molecules — •Sebastian Bauch — Institut für Theoretische Physik und Astrophysik, CAU Kiel, Germany

The description of the correlated dynamics of electrons in atoms and molecules is a theoretically challenging task and, for systems consisting of more than two electrons, only possible by employing approximative schemes. Among these methods, time-dependent approaches based on the configuration-interaction (CI) expansion of the wave function play an important role. In particular, the time-dependent generalized-active-space CI method offers a promising possibility for the accurate description of the multi-electron dynamics which are initiated by external laser fields. This talk sketches the ideas of this recently established method, discusses its relation to alternative approaches, and reviews applications. These include photoionization of many-electron atoms [1], strong-field effects in molecular model systems [2,3], correlation effects in the enhanced ionization phenomenom of diatomic molecules [4], and the full-dimensional description of multi-electron molecules in strong laser fields [5].

[1] D. Hochstuhl, and M. Bonitz, Phys. Rev. A 86 053424 (2012) [2] S. Bauch, L.K. Sørensen, and L. B. Madsen, Phys. Rev. A 90 062508 (2014) [3] S. Bauch, H.R. Larsson, C. Hinz, and M. Bonitz, submitted (2015) [4] S. Chattopadhay, S. Bauch and L.B. Madsen, in press, Phys. Rev. A [5] H.R. Larsson, S. Bauch, L.K. Sørensen and M. Bonitz, submitted (2015)

A 25.2 Wed 15:00 f107

Novel experimental approach for the detection of correlated ionization dynamics — •Philipp Wustelt[1,2], Lukas Wolf[1], Max Möller[1,2], Tim Rathje[1,2], A. Max Sayler[1,2], and Gerhard G. Paulus[1,2] — [1]Institute of Optics and Quantum Electronics, Friedrich Schiller University Jena, Germany — [2]Helmholtz Institute Jena, Germany

The investigation of correlated ionization dynamics in the photoionization process of atoms in intensive laser fields has been the subject of many experimental as well as theoretical studies and is still not fully understood. The identification of possible ionization delays associated with multielectron dynamics in the strong-field ionization is part of intensive discussions.

Here, we present a novel experimental approach to study the multiple ionization process in a systematic way by comparing the double ionization process and the two individual single ionization steps. To this end, the momentum distribution of the fragments after ionization of the same atomic species, but with different initial charge state are measured in the identical experimental apparatus and under the same experimental conditions. In order to exclude correlation induced by recollision we apply elliptically polarized laser fields. The observed momenta spectra of He/He^+ and Ne/Ne^+ are discussed and compared to classical simulations.

A 25.3 Wed 15:15 f107

Exact simulation of intense-laser-driven helium using TDRNOT — •Julius Rapp, Martins Brics, and Dieter Bauer — Universität Rostock, Germany

Recently-introduced time-dependent renormalized-natural-orbital theory (TDRNOT) [1-4] is a method to simulate correlated dynamics of few-body quantum systems. In the case of two particles, the exact equations of motion for the natural orbitals are explicitly known [2]. Using the common 1D He model as a test case, TDRNOT has been proven to capture laser-atom-interaction phenomena including double excitation followed by autoionization [1], resonant interaction [2], non-sequential double ionization [3], and high-harmonic generation [4] with proper accuracy.

The extension to 3D is conceptionally simple and yet very desirable since it enables one to combine theoretical and experimental techniques when studying correlated electron dynamics. After an introduction to TDRNOT, this talk concerns the progress on reproducing the 1D benchmark results in full dimensionality.

We also compare effort and gain of TDRNOT to the imposing exact 3D two-electron calculations presented in Ref. [5].

[1] M. Brics and D. Bauer, Phys. Rev. A 88, 052514 (2013)
[2] J. Rapp, M. Brics, and D. Bauer, Phys. Rev. A 90, 012518 (2014)
[3] M. Brics, J. Rapp, and D. Bauer, Phys. Rev. A 90, 053418 (2014)
[4] M. Brics, J. Rapp, and D. Bauer, arXiv:1510.01682 (2015)
[5] A. Zielinski, V. Majety, and A. Scrinzi, arXiv:1511.06655 (2015)

A 25.4 Wed 15:30 f107

Towards Ionization Channel-Resolved Electron Rescattering in the Molecular Frame — •Felix Schell, Federico Furch, Serguei Patchkovskii, Marc Vrakking, Claus Peter Schulz, and Jochen Mikosch — Max Born Institute, Berlin, Germany

In laser-induced electron diffraction (LIED), the field of an intense fs laser pulse first ionizes a molecule and then accelerates the released electron back to the core, where an elastic scattering event can imprint structural information on the electron [1]. However, for polyatomic molecules, multiple continua originating from the ionization of states lying lower than the HOMO are expected to contribute to the signal of diffracted electrons and thus complicate the interpretation of LIED experiments. In order to separate contributions to electron rescattering from multiple channels, we extend the CRATI technique [2]. We align 1,3-butadiene molecules non-adiabatically using an 800nm laser pulse and drive strong-field ionization and electron rescattering with a subsequent laser pulse at 1.3μm. A reaction microscope is used to acquire electron momentum maps in coincidence with the parent ion and its fragments. Recording these maps in the molecular frame while varying the driving light's ellipticity is expected to yield insight into the shape of the electron continuum wavepackets emerging from different orbitals.

[1] Blaga *et al.*, Nature **483**, 194 (2012).
[2] Boguslavskiy *et al.*, Science **335**, 1336 (2012).

A 25.5 Wed 15:45 f107

Non-instantaneous nonlinear optical response in tailored dielectric media — •Chanteau Bruno[1], Jusko Chirstoph[1], Nagy Tamas[1,2], Tajalli Ayhan[1], Willemsen Thomas[3], Jupé Marco[3], Ristau Detlev[3], and Morgner Uwe[1] — [1]Leibniz Universität Hannover, Institut für Quantenoptik, Welfengarten 1, D-30167 Hannover, Germany — [2]Laser-Laboratorium Göttingen e.V., Hans-Adolf-Krebs-Weg 1, 37077 Göttingen, Germany — [3]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, Germany

Nowadays it is common to generate sub-10 fs pulses. When dealing with such short pulses, the third-order electronic polarization decay time, usually neglected because expected to be in the fs-range, becomes relevant for third-order nonlinear optical processes.

We investigate this non-instantaneous electronic polarization in the case of amorphous dielectrics. Since the decay time depends on the difference between the resonance frequency of the medium, i.e. optical bandgap, and the laser frequency, we use as non-linear medium ternary oxydes layers, in which, through the ratio of the oxydes, we can tune the bandgap.

The measurements are performed with a THG D-scan setup, with 6-fs TiSa femtosecond laser, on ScO2/SiO2 samples. The thickness of the samples is below 100 nm, in order to avoid any propagation effects. The different behavior of the polarizations of these samples, whose bandgaps range within 5.5 to 7 eV (compared to the third harmonic beam of 4.8 eV), will be shown.

A 25.6 Wed 16:00 f107

Phase-dependent photoemission from C_{60} in intense $\omega/2\omega$ fields — •Slawomir Skruszewicz, Michael Zabel, Mohammad-Adel Almajid, Dieter Bauer, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Universität Rostock, Institut für Physik, Albert-Einstein-Str. 23, 18059 Rostock, Deutschland

We present recent results on ionization of C_{60} in intense $\omega/2\omega$ fields. By applying phase-of-the-phase spectroscopy we are able to substract coheerent emission of photoelectrons from thermonic and statistical contributions. Phase-of-the-phase (PP) and Relative Phase Contrast (RPC) spectra reveals distinct nature of the rescattering process in such a large system which differs significantly of that from atoms. Possible expanation will be briefly discussed.

A 25.7 Wed 16:15 f107

Circularly polarized high harmonics from Ne atoms — •Lukas

Medišauskas[1,2,3], Jack Wragg[4], Hugo van der Hart[4], and Misha Ivanov[1,2,5] — [1]Imperial College London, United Kingdom — [2]Max-Born-Institute, Berlin, Germany — [3]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [4]Queens University Belfast, United Kingdom — [5]Humboldt University, Berlin, Germany

An elegant solution to generate circularly polarized harmonics relies on combining circularly polarized fundamental with counter-rotating second harmonic. The harmonic spectra generated by such driving field consists of pairs of left- and right- circularly polarized harmonics. Here, we theoretically investigate this process for a model Ne atoms.

We demonstrate that the harmonic spectra is distinctively different when atomic orbitals with non-zero angular momentum, e.g., 2p, and orbitals with zero angular momentum, e.g., 1s, are considered. Namely, the height of left- and right- circularly polarized harmonics is different by an order of magnitude when 2p orbitals are used. The effect is due the the suppression of the contribution from orbitals counter-rotating with the driving field, i.e., 2p-, and involves the interplay of ionization, recombination and continuum electron propagation dynamics.

In the time domain, the generated spectra from Ne corresponds to a train of attosecond pulses with close to circular polarization. Hence, we demonstrate an amplitude gating scheme that allows to isolate a single attosecond radiation burst and thus attain highly elliptical isolated attosecond pulses.