A 21: Interaction with Strong or Short Laser Pulses I

Time: Thursday 14:00–16:00 Location: F 107

Invited Talk A 21.1 Th 14:00 F 107

Acceleration of neutral atoms in strong short pulse laser fields — •Ulli Eichmann — Max Born Institut, D-12489 Berlin, Germany

Kinematic effects on neutral atoms in focused moderate laser fields have been well studied in the past and have led, for example, to the development of optical dipole traps. Here we report on unexpectedly strong kinematic forces on neutral atoms in strong short laser pulses with intensities up to 10^{16}Wcm^{-2}. We oberve accelerations with magnitudes as high as 10^{14} times Earth's gravity, which result in measurable deflection of atoms despite the short laser pulse duration in the range of 40 to 120 femtoseconds. An explanation of our findings can be given in terms of the ponderomotive force acting on the quasi free photoelectron in the focussed laser field. Due to the Coulomb force the electron drags the ionic core until the laser pulse is over and the electron is left in a long lived bound excited state. Our measurements for different atomic species and different laser parameters are in very good agreement with predictions based on this model. Implications of our results for strong field physics and further prospects will be discussed.

A 21.2 Th 14:30 F 107

On the Interference Picture in Molecular Intense-Laser Field Ionization — Yulian V. Vanne and •Alejandro Saenz — AG Moderne Optik, Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin

The solution of the complete time-dependent Schrödinger equation describing atoms or even molecules in ultrashort intense laser pulses is still limited to very small systems. In fact, only recently it became possible to describe both electrons of a hydrogen molecule exposed to an intense 800 nm laser pulse. However, these calculations were restricted to a parallel orientation of the molecular axis with respect to the laser field, reducing the dimensionality due to the preserved cylindrical symmetry. For the first time, we have now overcome this limitation and have investigated the alignment dependence of the strong-field ionization of H_2.

This work focuses on two aspects. First, the ratio of parallel to perpendicular ionization yields is calculated and compared to a recent experiment. Second, it is shown that a simple but popular interference picture suggested by a simplified intense-field ionization model, the strong-field approximation formulated in velocity gauge, can be tested with the aid of energy-resolved electron spectra obtained for a parallel and a perpendicular orientation. It is demonstrated that the interference picture is not supported by the full two-electron calculation.

A 21.3 Th 14:45 F 107

Raumaufgelöste Untersuchung der Ionisierung im Fokus hochintensiver Laserpulse — •Martin Schultze[1,2], Boris Bergues[1], Hartmut Schröder[1], Karl-Ludwig Kompa[1] und Ferenc Krausz[1,2] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-strasse 1, 85748 Garching — [2]Ludwig-Maximilians-Universität, Fakultät für Physik, Am Coulombwall 1, 85748 Garching

Wir präsentieren eine neuartige Technik zur räumlich aufgelösten Untersuchung des Ionisierungsverhaltens von Atomen im Fokus hochintensiver Kurzpulslaser. Die Methode unterliegt nicht den Limitierungen der bisherigen experimentellen Methoden die bei der Signalerfassung über ein ausgedehntes Volumen, typischerweise deutlich größer als der Laserfokus, integrieren. Das Messchema erlaubt damit präzisen Einblick in die Entwicklung der Ionisation oberhalb der Sättigungsintensität in einem weitem Intensitätsbereich zwischen dem einsetzen der Ionisierung und relativistischen Intensitäten

A 21.4 Th 15:00 F 107

An adiabatic approximation in time-dependent density functional theory based on ground-state spin-density functional theory — •Ingo Dreissigacker and Manfred Lein — Institut für Theoretische Physik and Centre for Quantum-Engineering and Space-Time Research (QUEST), Leibniz Universität Hannover, Appelstr. 2 , 30167 Hannover

We investigate strong-field ionization of the Helium atom within time-dependent density functional theory with adiabatic exchange correlation (xc) potentials. While simple adiabatic approximations such as the adiabatic local density approximation are known to fail badly for the double ionization process in Helium, it has been demonstrated that the exact adiabatic xc potential is close to the exact xc potential [1]. We report here a new adiabatic method in which the Hartree-xc-potential is obtained as the difference between the adiabatically exact Kohn-Sham potential and the external potential that yields the given density using ground-state exchange-only spin-density functional theory for the interacting system. In contrast to the exact adiabatic potential, our scheme does not require the solution of the interacting two-electron Schrödinger equation. We present results for a model Helium atom.

[1] M. Thiele, E. K. U. Gross, and S. Kümmel, Phys. Rev. Lett. **100**, 153004 (2008).

A 21.5 Th 15:15 F 107

HHG mit einem 2.1 μm Treiberlaser zur effizienten Erzeugung von weicher Röntgentstrahlung — •Wolfram Helml[1], Gilad Marcus[1], Yunpei Deng[1], Xun Gu[1], Reinhard Kienberger[2] und Ferenc Krausz[3] — [1]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching, Deutschland — [2]TU München, Physik-Department E11, James-Franck-Str., 85748 Garching, Deutschland — [3]Ludwig-Maximilians-Universität München, Fakultät für Physik, Am Coulombwall 1, 85748 Garching, Deutschland

Wir benutzen einen selbstgebauten OPCPA-Laser (500 μJ, 17 fs, 1 kHz, CEP-stabilisiert) zur Erzeugung von XUV-Strahlung im Energiebereich des Wasserfensters (283 - 532 eV) und darüber hinaus.

Theoretische Modelle sagen für den Prozess der Erzeugung Hoher Harmonischer (HHG) eine quadratische Zunahme der erreichbaren Photonenenergien mit der Wellenlänge des verwendeten Treiberlasers voraus. Um diese Vorhersage zu überprüfen wird der IR-Laser auf ein mit Edelgas (Ne) gefülltes Nickelröhrchen fokussiert und die erzeugte XUV-Strahlung in Abhängigkeit vom Druck des Gases gemessen.

Wir demonstrieren ein Hochenergie-Plateau, das weit über das Wasserfenster hinausreicht, und deutliche Hinweise darauf, dass der Energieabfall (high-energy cutoff) über die 1 keV-Grenze hinausgeschoben werden kann. Diese kohärenten, hochenergetischen XUV-Strahlen eignen sich ideal um Experimente an lebenden Geweben möglich zu machen und extrem kurze Attosekunden-Pulse für zeitaufgelöste Spektroskopie zur Verfügung zu stellen.

A 21.6 Th 15:30 F 107

Stern-Gerlach type analysis of atoms excited by a strong laser field — •Sebastian Eilzer[1], Thomas Nubbemeyer[1], Karsten Gorling[1], Ulli Eichmann[1,2], and Wolfgang Sandner[1,2] — [1]Max-Born-Institut for Nonlinear Optics und Short Pulse Spectroscopy, Berlin, Germany — [2]TU Berlin, Institut für Optik und Atomare Physik, Germany

Excitation of neutral atoms in strong laser fields in the tunnelling regime has recently been investigated [1]. A quantitative explanation of the process has been achieved by considering the ionic Coulomb potential in the three step model [2], which allows for bound trajectories. Based on the direct detection of excited neutral atoms we started a series of Stern-Gerlach type experiments. We placed emphasis on revealing possible spin effects in the interaction with the magnetic component of the strong laser field. We will discuss first experimental results.

[1] Nubbemeyer et al. PRL101 233001(2008)
[2] P.B.Corkum, PRL 71, 1994 (1993)

A 21.7 Th 15:45 F 107

The Rescattering Effect in Strong-Field Photodetachment of Negative Ions. — •Boris Bergues[1,2], Hannes Hultgren[1], Igor Kiyan[1], Azra Gazibegović-Busuladžić[3], Dejan Milošević[3,4], and Wilhelm Becker[4] — [1]Albert-Ludwigs-Universität, Freiburg, Germany. — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany. — [3]University of Sarajevo, Sarajevo, Bosnia and Herzegovina. — [4]Max-Born-Institut, Berlin, Germany.

We present experimental and theoretical results on photodetachment of negative ions in strong laser fields. Since in a negative ion the outer electron is bound to the atomic core by a short-range potential, such a system is best suited to verify predictions of Keldysh-Faisal-Reiss (KFR)-like theories. In our previous studies on F^- using lin-

early as well as circularly polarized light, we showed that the KFR theory for direct electrons quantitatively describes all the features of the measured potodetachment spectra. In the present work we expose Br^- to strong infrared laser pulses of linear polarization. The angle-resolved spectrum of photoelectrons is recorded using an electron imaging technique. The observed photoelectron spectra exhibit a high-energy plateau along the laser polarization direction, which is not described by the KFR-theory for direct electrons. In contrast, predictions of the rescattering theory are in very good agreement with the measured data. This fact enables us to assign the origin of the observed plateau to the rescattering effect. Our findings represent the first observation of electron rescattering in above-threshold photodetachment of an atomic system with a short-range potential.