A 10: Interaction with strong or short laser pulses II

Time: Monday 16:30–18:30 Location: V55.01

A 10.1 Mon 16:30 V55.01

Above threshold ionization of atomic hydrogen by an IR pulse using the time-scaled coordinate approach — •Johannes Eiglsperger[1], Ana Laura Frapiccini[2], Aliou Hamido[2], Javier Madroñero[3], Francisca Mota-Furtado[4], Patrick O'Mahony[4], and Bernard Piraux[2] — [1]Universität Regensburg, Germany — [2]Université catholique de Louvain, Berlgium — [3]Technische Universität München, Germany — [4]University of London, UK

The development of intense, ultrafast laser sources in the mid infrared (IR) region provides new opportunities in strong-filed physics. In recent experiments to study the electronic dynamics of atoms and molecules on time scale of the electronic motion, these sources play an essential role. Deep understanding of the IR-electron interaction poses a challenge: the simple semi-classical recollision model allows to understand basic mechanisms, the use of the strong field approximation is dubious, and currently available techniques for the solution of associated time-dependent Schrödinger equation are not efficient enough. In this contribution, we study the above threshold ionization spectrum resulting from the interaction of H with an intense very low frequency field. We draw our attention to the low-energy part of the spectrum and discuss the possible role of tunneling in this process. For that purpose, we use a highly efficient *ab initio* approach for solving the time-dependent Schrödinger equation which combines a high-order time propagator based on a parallelizable predictor-corrector scheme with the time-scaled coordinate method [1].

[1] A. Hamido *et al.*, Phys. Rev. A **84**, 013422 (2011).

A 10.2 Mon 16:45 V55.01

Complete dynamics of H_2^+ in strong laser fields — •Michael Fischer[1,2], Jan Handt[1], Sebastian Krause[3], Jan-Michael Rost[2], Frank Grossmann[1], and Rüdiger Schmidt[1] — [1]Institut für Theoretische Physik, Technische Universitaet Dresden, D-01062 Dresden, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Strasse 38, D-01187 Dresden, Germany — [3]Institute for Theoretical Physics, University of Bremen, Otto-Hahn-Allee, D-28359 Bremen

We present a complete study of the strong field dynamics of H_2^+, i.e. including all nuclear and electronic degrees of freedom as well as dissociation and ionization, based on a mixed quantum-classical treatment. We find that full-dimensional calculations are necessary to obtain qualitatively correct results for angularly resolved as well as for angularly integrated fragmentation probability densities respectively probabilities. Complementing recent results for the dissociation, we work out in detail the effect of nuclear rotation on ionization. It is found, that rotation generally increases the ionization probability, even up to an order of magnitude, due to dynamical alignment.

A 10.3 Mon 17:00 V55.01

Erzeugung harmonischer Strahlung in Femtosekunden-Laserfilamenten — •Tobias Vockerodt[1,2], Martin Kretschmar[1], Emilia Schulz[1,2], Daniel Steingrube[1,2], Uwe Morgner[1,2] und Milutin Kovacev[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover — [2]QUEST Centre of Quantum Engineering and Space-Time Research, Hannover

Der Kerr-Effekt in nichtlinearen optischen Medien führt bei intensiven, ultrakurzen Laserpulsen zu räumlicher (Selbstfokussierung) und zeitlicher (Selbstphasenmodulation) Veränderung des Laserpulses. Dabei führt die Kerr-Selbstfokussierung zur Erhöhung der Intensität, bis defokussierende Effekte wie Plasmabildung in einem dynamischen Gleichgewicht zur Selbstführung des Lichts in einem Filament führt. Dieses erstreckt sich über deutlich größere Distanzen als die Rayleigh-Länge.

Durch ein Pinhole wird das Filament an verschiedenen Positionen entlang der Propagationsachse beendet und die Strahlung extrahiert. Dabei wird neben der durch Selbstphasenmodulation verbreiterten fundamentalen Laserstrahlung auch die dritte Harmonische und hohe harmonische Ordnungen bis 25 beobachtet. Die ultraviolette Strahlung in der dritten Harmonischen besitzt eine spektrale Breite von 40 nm und ein Fourier-Limit unterhalb von 5 fs.

A 10.4 Mon 17:15 V55.01

Higher order Kerr terms vs. plasma: Saturation of the nonlinear refractive index — •Christian Köhler[1], Roland Guichard[2], Emmanuel Lorin[3], Szczepan Chelkowski[4], André D. Bandrauk[4], Luc Bergé[5], and Stefan Skupin[1,6] — [1]Max-Planck-Institute for the Physics of Complex Systems, 01187 Dresden, Germany — [2]CNRS, UMR 7614, LCPMR, 75231 Paris Cedex 05, France — [3]University of Montréal, Montréal (Québec) H3T 1J4, Canada — [4]Département de chimie, Université de Sherbrooke, Sherbrooke (Québec) J1K 2R1, Canada — [5]CEA-DAM, DIF, F-91297 Arpajon, France — [6]Friedrich-Schiller-University, Institute of Condensed Matter Theory and Solid State Optics, 07743 Jena, Germany

We numerically study the susceptibility of atomic hydrogen and several noble gases in a strong laser field. The susceptibility enters the laser pulse propagation equation via the effective refractive index, whose nonlinear part is found to saturate for intensities where the medium is partially ionized. This saturation can be due to either negatively-valued higher order Kerr terms [1] or plasma contributions [2]. In order to clarify the mechanism of saturation, we calculate the electronic dipole from numerical solutions of the time dependent Schrödinger equation. This non-perturbative method allows us to separate the optical responses from bound electrons and ionized contributions, and to clearly identify the mechanism responsible for saturation.

[1] V. Loriot et al., *Opt. Express* **17**, 13429 (2009).

[2] L. Bergé et al., *Reports on Progress in Physics* **70**, 1633 (2007).

A 10.5 Mon 17:30 V55.01

Low-energy directional asymmetry in CEP-dependent strong-field photoemission — •Martin Laux, Andreas Kaldun, Christian Ott, Philipp Raith, Kristina Meyer, Claus Dieter Schröter, Robert Moshammer, Joachim Ullrich, and Thomas Pfeifer — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The experimental setup of a newly-built Cold Target Recoil Ion Momentum Spectrometer (COLTRIMS), also termed as 'Reaction Microscope' (ReMi), together with first experimental data and simulations, will be presented. The COLTRIMS method has been in use for more than a decade and is a well established technique to completely resolve the kinematics of ionization reactions by interaction of atoms or molecules in a supersonic gas jet with an electronic, ionic or photonic projectile beam. The single ionization of xenon atoms by a few-femtosecond laser pulse was simulated in dependence on the carrier-envelope phase (CEP) using a model based on the strong-field approximation (SFA). The CEP- and electron-energy-dependent asymmetry of the emission direction strongly depends on pulse duration and intensity of the strong-field laser pulse. The calculated electron momentum distributions are compared to measurements carried out with the new setup. In particular, we focus on the measurement of low-energy photoelectron asymmetry, as it may carry important information about the atomic structure and should be most strongly affected by the Coulomb potential and structure of the remaining ion.

A 10.6 Mon 17:45 V55.01

Decoherence and energy increase in attosecond neutron-atom collisions — •C. Aris Dreismann[1], Evan MacA. Gray[2,3], and Tom P. Blach[2,3] — [1]Institute of Chemistry, TU Berlin — [2]Griffith University, Brisbane, Australia — [3]Queensland Micro- and Nanotechnology Centre, Australia

Due to the prevailing interactions, nuclei and electrons in condensed matter or molecules are usually entangled. However the "environment" of a microscopic system (e.g. a proton in a H2 molecule) may cause an ultrafast decoherence thus making atomic and/or nuclear entanglement effects not directly accessible to experiments. For neutron Compton scattering (NCS) in the energy transfer range of ca. 1-100 eV, the neutron-H scattering time lies in the attosecond time range. Results of recent and current NCS experiments [1] from H2 and D2 in the gas (at 40 K), liquid and solid state are reported, showing that the neutron-atom collision exhibits a striking increased energy transfer which stands in blatant contradiction to conventional theory. The experimental NCS setup is shortly introduced. The theoretical frame of "attosecond scattering from open quantum systems" is discussed", with particular focus on the decoherence process as described by the standard Lindblad equation and recent modern theoretical models [2,3].

[1] C. A. Chatzidimitriou-Dreismann, E. MacA. Gray and T. P. Blach, AIP Advances 1 (2011) 022118. [2] L. S. Schulman and B.

Gaveau, Phys. Rev. Lett. 97 (2006) 240405. [3] N. Erez et al. Nature 452 (2008) 724.

A 10.7 Mon 18:00 V55.01

Laser-assisted α decay — •Héctor Mauricio Castañeda Cortés[1], Sergey Popruzhenko[2], Adriana Pálffy[1], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Moscow State Engineering Physics Institute, Russia

The spontaneous emission of alpha particles by unstable nuclei was one of the first physical processes to be described by quantum tunneling of a quasistationary state, i.e. a long-lived state. The development of new powerful coherent light sources opens the possibility to study the direct interaction between strong laser fields and atomic nuclei, assisting the tunneling of the α particle through the nuclear barrier.

In this work we investigate for the first time the effect of strong laser fields on the tunneling and α particle emission of several medium-mass and heavy nuclei. To this end we make use of the formalism we have developed starting from the well-known Strong-Field Approximation and its complex trajectories formulation to describe the laser-assisted decay of quasistationary states [1]. The effect of a static as well as optical and x-ray monochromatic fields on the α decay lifetimes and α particle emission spectra is determined. We find that even at strong intensities, the laser-induced acceleration of the α decay is negligible, and only the spectra are significantly changed by the laser field. In particular, for optical fields, high laser intensities can lead to rescattering of the α particle off the daughter nucleus.

[1] H. M. Castañeda Cortés, S. V. Popruzhenko, D. Bauer and A. Pálffy, New J. Phys. 13, 063007 (2011).

A 10.8 Mon 18:15 V55.01

Electroweak Processes in Laser-Boosted Lepton Collisions — •Sarah J. Müller, Carsten Müller, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The advent of powerful laser facilities such as the ltra-high field project of ELI opens new prospect in many physics applications, in particular in high-energy physics. We study the possibility of utilizing strong laser fields for enhancing the center-of-mass energy of lepton collisions. It is shown that an addditional laser post-acceleration of relativistic lepton beams provided by conventional particle accelerators can in principle lead to higher collision energies in e.g. electronpositron colliders. We investigate this with theoretical means and find that laser post-acceleration might become an interesting complement to the existing methods in high-energy physics.