SYIF 1 Intense field interaction with molecules and clusters 1

Zeit: Freitag 14:00–16:00 Raum: HV

SYIF 1.1 Fr 14:00 HV

Introduction — •Ingolf Hertel — Max-Born-Institut, Max-Born-Str. 2 A, 12489 Berlin

Hauptvortrag

SYIF 1.2 Fr 14:08 HV

Maria Goeppert Mayer: Nobel Prize Woman in Science — •Sharon Bertsch McGrayne — Seattle, WA

Maria Goeppert Mayer, who shared the Nobel Prize in physics with Hans Jensen, was born and educated in Gottingen. There she fell in love with an American student. After their marriage, she moved with him to the United States in 1929 to have a career. Because of laws and university regulations against married women scientists, Maria Mayer worked at three major American universities as a volunteer faculty member without pay. She discovered the shell model of the nucleus as a volunteer professor at the University of Chicago, where she was a colleague of Enrico Fermi. She was not paid for her university research until ten years after her famous discovery. Letters from Jensen to Maria Mayer reveal their close friendship.

Hauptvortrag

SYIF 1.3 Fr 14:36 HV

Multiphoton photonics and applications in ultrafast chemical spectroscopies — •Margaret Murnane, Nick Wagner, Andrea Wuest, Ivan Christov, and Henry Kapteyn — Department of Physics and JILA, and NSF Engineering Research Center in Extreme-Ultraviolet Science and Technology, University of Colorado and National Institute of Standards and Technology, Boulder, CO 80309-0440

Coherent beams at soft-x-ray wavelengths[1] can be generated by focusing intense femtosecond, laser pulses into a gas. This process, called high-order harmonic generation (HHG), takes nonlinear optics to an extreme. By combining together tens to hundreds of visible laser photons, high harmonic generation upshifts laser light from the visible into the ultraviolet and soft-x-ray regions, to energies in excess of 1keV. High harmonics are usually generated from noble gas atoms. Recently however, there has been great interest in using high-harmonic generation from molecules as a probe of molecular structure and dynamics. To date, HHG from rotational wavepackets has been observed, and static, tomographic, structural information has been extracted in the case of a diatomic molecule.[2,3] In this talk, I will discuss the first observation of intramolecular dynamics using electrons rescattered during the process of high harmonic generation.[4] We first excite coherent vibrations in SF6 using impulsive Raman scattering with a short laser pulse. A second, more-intense laser pulse generates high-order harmonics of the fundamental laser, at wavelengths of 20-50 nm. The high-order harmonic yield is observed to oscillate, at frequencies corresponding to all the Raman-active modes of SF6, with an asymmetric breathing mode most visible. This is in contrast to conventional impulsive stimulated Raman spectroscopy where only the symmetric breathing mode of the molecule is easily observed. The data also show evidence of relaxation dynamics following impulsive excitation of the molecule. Our results indicate that high harmonic generation is a sensitive probe of vibrational dynamics and may yield more information simultaneously than conventional ultrafast spectroscopic techniques. Since the de Broglie wavelength of the recolliding electron is on the order of interatomic distances, i.e. 1.5 $\AA$, small changes in the shape of the molecule lead to large changes in the high harmonic yield. This work therefore demonstrates a new spectroscopic technique for probing ultrafast internal dynamics in molecules that uniquely combines ultrafast time resolution with atomic-scale structural information.

[1] H. Kapteyn et al., "Extreme Nonlinear Optics: Coherent X-Rays from Lasers", Physics Today, March (2006).
[2] R. Velotta et al., "High-order harmonic generation in aligned molecules", PRL 8718 (2001).
[3] J. Itatani et al. Tomographic imaging of molecular orbitals. Nature 432, 867-871 (2004).
[4] N. Wagner et al., "Monitoring Molecular Dynamics using Coherent Electrons from High-Harmonic Generation", submitted for publication (2005).

Hauptvortrag

SYIF 1.4 Fr 15:04 HV

Fragmentation of molecules in intense laser fields: imaging of ultrafast molecular dynamics with coincident momentum spectroscopy — •Artem A. Rudenko, Th. Ergler, B. Feuerstein, K. Zrost, C.D. Schroeter, R. Moshammer, and J. Ullrich — Max-Planck-Institut fuer Kernphysik, Postfach 103980, 69029 Heidelberg

Ultrafast molecular dynamics in strong laser fields attracts continuously increasing attention since modern lasers routinely provide pulses, which match the vibrational timescale even for the fastest molecular systems. In combination with state-of-the-art few-particle detection techniques, this offers a variety of possibilities to study molecular fragmentation with unprecedented precision. Using the so-called "Reaction Microscope", an apparatus which enables coincident measurements of the full momentum vectors of charged reaction products, we study the behaviour of the simplest molecules, H_2 and D_2, exposed to ultrashort (6-25 fs) intense laser pulses. We disentangle different fragmentation pathways, and show how they evolve when the pulse duration becomes shorter than the vibrational period. Detailed understanding of the fragmentation mechanisms allows us to map the time evolution of dissociating and bound nuclear wave packets using a pump-probe scheme and the so-called Coulomb explosion imaging. The structure of the H_2^+ (D_2^+) vibrational wave packet, its dephasing and subsequent revivals can be observed, as well as the signatures of vibrational and rotational motion of a neutral molecule. The experimental technique was also applied to larger molecules, such as N_2, CO_2, Ar_2.

Hauptvortrag

SYIF 1.5 Fr 15:32 HV

Atomic clusters in strong laser pulses: Energy spectra of emitted ions and electrons — •Ulf Saalmann — Max-Planck-Institut fuer Physik komplexer Systeme, Noethnitzer Str. 38 01187 Dresden

Being prototypes of atomic many-particle systems, the response of clusters to strong laser fields has been intensively investigated for the last decade. In particular the advent of femtosecond laser pulses allowed for time-resolved studies by using variable pulse lengths or pump-probe techniques.

Here, microscopic calculations based on a mixed quantum-classical description of the laser-cluster interaction are presented. They provide, along with the measurements, valuable insight into the complex many-particle dynamics and explain the very effective absorption mechanisms as well as how this renders measured energy spectra of ions, electrons or photons emitted by the cluster. Differences in the laser-induced dynamics for high-frequency pulses (as available from novel FEL machines) are discussed briefly.