SYIF 2 Intense field interaction with molecules and clusters 2

Zeit: Freitag 16:30–18:30 Raum: HV

Hauptvortrag SYIF 2.1 Fr 16:30 HV

Applications of Attosecond Lasers to Atoms and Molecules in Strong Laser Fields — •Marc Vrakking — FOM Institute for Atomic and Molecular Physics, P.O. Box 41883, 1009 DB, Amsterdam, NL

In the past two decades femtosecond time-resolved experiments have allowed the observation of molecular rotations and vibrations, and of photo-induced chemical processes. However, these experiments often tell only half the story: they show the motion of atoms moving under the influence of potential energy curves that result from a time-average over the motion of all electrons in the system. The natural time-unit for this electronic motion itself is the atomic unit of time (1 a.u. = 0.024 fsec = 24 attoseconds). Real-time observation of this motion therefore requires attosecond laser techniques. Recently the production and characterization of attosecond pulses has become possible. When considering motions of electrons we may distinguish between motion that results from driving the electrons with a strong laser field and motion that results from photo-absorption in a weak laser field. In strong laser fields the electron motion can be quite intuitive. On the other hand, studies of photo-absorption in weak laser fields are extremely important, since all photo-absorption processes in nature (i.e. outside a laser laboratory) occur in this regime. In my talk I will discuss experiments aimed at observing the motion of electrons on attosecond timescales in strong laser fields in situations where we believe that this motion explains previously made observations. An interesting example is so-called dynamic molecular alignment. For a number of years we have known that exposure of molecules to intense (femtosecond) laser fields leads to alignment of the molecule along the laser polarization axis. The accepted explanation for this phenomenon is that the electric field of the laser creates an oscillatory electron motion that generates a dipole and - in combination with the laser electric field - a torque that forces the molecule into alignment. I will discuss experiments that show very direct evidence for the existence of this oscillating dipole.

Hauptvortrag SYIF 2.2 Fr 17:00 HV

Excited state dynamics of nanostructures and biomolecules within TDDFT — •Angel Rubio — Dpto. Fisica de Materiales, Facultad de Quimicas, U. Pais Vasco, San Sebastian and European Theoretical Spectroscopy Facility (ETSF) and Institut fur Theoretische Physik, Freie Universitat Berlin, Arnimallee 14, D-14195 Berlin, Germany

We will review the recent implementations of TDDFT to study the optical absoprtion of biological chromophores, one-dimensional polymers and layered materials. In particular we will show the effect of electron-hole attraction in those systems. We will folow two routes: one based on solving the Bethe-Salpeter equation and the other on an orbital-dependent OEP method on top of the GW approximation for the self-energy. Virtues and deficiencies of both methods will be illustrated.

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Hauptvortrag SYIF 2.3 Fr 17:30 HV

Strong dual-pulse excitations of metal clusters — •Karl-Heinz Meiwes-Broer, Tilo Doeppner, Thomas Fennel, Johannes Passig, and Josef Tiggesbaeumker — Institute of Physics, University of Rostock, Universitaetsplatz 3, 18051 Rostock

Atomic clusters in intense laser fields are a nice playground to study the coupling of strong radiation into matter. In particular, non-stationary plasma effects lead to pronounced dynamics in the optical response. Recent experiments have shown that excitation with optically delayed dual pulses provides a powerful way to control the coupling of the radiation to these finite systems. Both the yield of highly charged atomic ions [1] as well as the kinetic energy of emitted electrons [2] are strongly enhanced for a particular optimal delay. After the first pulse initiates the cluster expansion the delay-dependent impact of the second pulse can be studied. In this contribution we will present experimental results on the charging dynamics by use of the femtosecond dual-pulse technique. Special emphasis will be put onto the role of the laser focus. The significance of the temporal structure of the laser field is demonstrated by complementary Vlasov calculations [3] on model systems. We attribute the distinct maximum in the charging efficiency to plasmon-enhanced ionization of the expanding cluster which is supported by the simulations [1]. Applying this method to free clusters and those which are embedded in helium droplets [4] reveals a significant influence of charge transfer processes which will be discussed.

[1] T. Doeppner, Th. Fennel, Th. Diederich et al., Phys. Rev. Lett. 94:013401, 2005
[2] T. Doeppner, Th. Fennel, P. Radcliffe et al., submitted
[3] Th. Fennel, G. Bertsch and K.H. Meiwes-Broer, Eur. Phys. J. D 29:367, 2004
[4] T. Doeppner, S. Teuber, Th. Diederich et al., Eur. Phys. J. D 24:157, 2003

Hauptvortrag SYIF 2.4 Fr 18:00 HV

New Perspectives Arising from Femtosecond Plasma Channels in Air. — •Ludger Woeste — Freie Universitaet Berlin, Institut fuer Experimentalphysik, Arnimallee 14, 14195 Berlin

When powerful femtosecond laser pulses interact with air, extended plasma channels can be formed. Their extraordinary physical properties open fascinating perspectives for the investigation of the atmosphere. The emitted white-light allows - for example - to retrieve information about the atmospheric composition including trace gases. On the other hand, non-linear light emission from the aerosol allows its remote elementary analysis, which so far is not possible by other optical methods. In addition, the phenomenon of radiation-induced nucleation can be used to withdraw information about optical super-saturation, which is also an optically inaccessible parameter so far. The electrical properties of the plasma channels open besides that fascinating perspectives with regard to lightning research. In the presentation the following aspects will be discussed:

- Conventional air monitoring methods and their limits
- Principle of the femtosecond LIDAR
- Formation and propagation of plasma channels in air
- Absorption measurements on atmospheric trace gases
- Measurements of the aerosol
- Electrical properties
- Outlook