# A 27: Visualizing Ultrafast Dynamics in atoms, molecules, and clusters

Time: Wednesday 14:00–16:00 Location: E 415

**Invited Talk** A 27.1 Wed 14:00 E 415

**Electron emission from nanospheres in strong, few-cycle laser fields** — •Matthias Kling[1,2], Frederik Süssmann[1], Sergey Zherebtsov[1], Johannes Stierle[1], Jürgen Plenge[3], Eckart Rühl[3], Lennart Seifert[4], and Thomas Fennel[4] — [1]Max-Planck-Institut für Quantenoptik, 85748 Garching, Germany — [2]Kansas-State University, Manhattan, KS66506, USA — [3]Freie Universität Berlin, 14195 Berlin, Germany — [4]Universität Rostock, 18051 Rostock, Germany

The interaction of nanometer sized materials with strong laser fields opens new avenues to control collective electron motion with attosecond precision and on nanometer length scales. Recent studies will be highlighted, where the electron emission from spherical nanoparticles of various dielectric and semiconducting materials in strong, few-cycle laser fields was explored. By using a beam of isolated nanoparticles, the target is replaced after every laser shot and we can explore the regime near, at and beyond the material damage threshold. The extremely short pulse duration of only a few cycles in our studies ensures that the electron dynamics responsible for the observed phenomena occurs before any nuclear dynamics. We have furthermore explored the effect of the carrier-envelope phase on the electron emission and studied propagation effects in large silica nanoparticles. The potential attosecond observation of the collective dynamics has been explored theoretically and will be outlined.

**Invited Talk** A 27.2 Wed 14:30 E 415

**Ultrafast dynamics of gas-phase anions** — •Jan R. R. Verlet — University of Durham, Durham, United Kingdom

Anions isolated in the gas-phase are studied using femtosecond photoelectron spectroscopy. The use of electrospray ionisation and mass-spectrometry prior to spectroscopy enables the study of a wide range of anionic species. Some recent results on specific systems will be presented. Specifically, the dynamics of polyanions will be discussed with a particular focus on recent developments on how these can provide a route to studying structural dynamics in real-time. We will also discuss results form recent work on molecules of biological importance such as quinones, nucleotides and chromophores of fluorescent protein .

**Invited Talk** A 27.3 Wed 15:00 E 415

**Attosecond Larmor Clock for Ionization** — •Olga Smirnova, Jivesh Kaushal, Ingo Barth, and Misha Ivanov — Max Born Institute, Berlin, Germany

How much time does it take to absorb a photon and remove an electron from an atom or a molecule, and how does this time depend on the number of photons required for ionization? Recent experiments suggest that it may take much less time to absorb many photons than it takes to absorb one, and that for the very large number of absorbed photons the required time tends to zero. Does it mean that, in this latter case, formation of the hole associated with electron rearrangement is instantaneous? Here we introduce a clock that resolves this paradox. We show that the spin-orbit interaction, which is the interaction of the spin of the liberated electron, or of the hole left behind, with the magnetic field created by their orbital motion, offers a built-in analogue of the famous Larmor clock for measuring time-delays during tunnelling. We calibrate the clock by first applying it to one-photon ionization and show that the time delays it measures is linked directly to the well-known Wigner-Smith time delays. We then apply the same clock to ionization in IR fields, which requires many photons. Using an example of a Krypton atom, we find delays in the hole formation and show how they depend on the number of absorbed photons. Larmor clock allows us to introduce the rigorous definition of time-delays in multi-photon ionization.

**Invited Talk** A 27.4 Wed 15:30 E 415

**Clusters in intense x-ray pulses** — •Christoph Bostedt — SLAC National Accelerator Laboratory, Stanford CA (USA)

Free-electron lasers deliver extremely intense, coherent x-ray flashes with femtosecond pulse length, opening the door for imaging single nanoscale objects in a single shot. All matter irradiated by these intense x-ray pulses, however, will be transformed into a highly-excited non-equilibrium plasma within femtoseconds. During the x-ray pulse complex electron dynamics and the onset of atomic disorder will be induced, leading to a time-varying sample.

We have performed experiments about intense x-ray pulse – matter interaction at both, the FLASH and LCLS x-ray free-electron lasers using atomic clusters. Imaging experiments with xenon clusters in the soft x-ray regime have revealed power-density dependent changes in the scattering patterns. The data show that the scattering signal carries information about transient charge states in the cluster. Single-shot single-particle experiments with keV x-rays reveal that for the highest power densities an highly excited and hot cluster plasma is formed for which recombination is suppressed. Studying the ionization dynamics of smaller clusters shows that the energy absorption depends on the particle size which is attributed to changing Auger rates in the x-ray induced nanoplasma. Recent single-shot experiments with hard x-rays yield insight into the crystalline order of the particles.