# A 1: COLTRIMS-based Collision Physics (exchanged with A4)

Time: Monday 14:00–16:00 Location: F 303

**Invited Talk** A 1.1 Mo 14:00 F 303

**Quantum Dynamics Visualized by Reaction Microscopes: From intense virtual towards real attosecond photon fields** — •Joachim Ullrich and Robert Moshammer — Max Planck Institut für Kernphysik; Heidelberg, Germany

Reaction Microscopes (REMI) image the vector momenta of low-energy electrons in coincidence with those of the ions (cold target recoil-ion momentum spectroscopy: COLTRIMS). They were developed in 1994 to explore the quantum dynamics of atomic or molecular fragmentation in fast heavy-ion collisions, motivated by tumour therapy at GSI. Ever since, kinematically complete experiments delivered surprising results, some of them understood by interpreting the field of the (relativistic) ion as a super-intense (up to 10**22 W/cm**2), attosecond virtual-photon field. About one decade later, the free-electron laser at Hamburg (FLASH) delivered first real-photon, few-femtosecond pulses. In summer 2009, up to 10**19 W/cm**2 at 2 keV photon energies were demonstrated at the LCLS (Stanford) with attosecond flashes coming into reach. Again, REMIs play a key role to investigate many-particle quantum dynamics: Multi-photon non-linear processes or time-dependent molecular reactions accessed in pioneering pump-probe experiments. In the talk, the two scenarios will be compared, key-experiments are highlighted and the rich future potential of the method is envisaged: Magneto-optical trap based REMIs in new storage rings promise achieving unprecedented momentum resolutions in ion collisions whereas REMIs completed by large-area scattered and fluorescent photon detectors deliver first exciting results at the LCLS.

**Invited Talk** A 1.2 Mo 14:30 F 303

**Strong Field Dynamics Studied with Ion and Electron Momentum Imaging** — •Lewis Cocke, Dipanwita Ray, Sankar De, Wei Cao, Guillaume Laurent, ChiiDong Lin, AT Le, Zhangjin Chen, Feng He, and Uwe Thumm — J.R.Macdonald Laboratory, Kansas State University, Manhattan,KS, USA

Some applications of momentum imaging of electrons and ions (Cold Target Recoil Ion Momentum Spectroscopy/Reaction Microcsope/Velocity Map Imaging) to problems in the interaction of short intense laser pulses with atoms and light molecules will be discussed. Examples include:

(1) Diffraction patterns characteristic of the elastic scattering of free electrons from singly ionized atoms are seen in the backscattering plateau of electrons ejected by intense lasers from rare-gas atoms. These can be analyzed in terms of the QRS (Quantitative Rescattering) model of Lin et al.

(2) The asymmetric dissociation of molecular deuterium by the combined action of a short EUV attosecond pulse train in the presence of a weak infrared field is observed when only one attosecond pulse per IR cycle is used.

(3) The dissociation of CO through autoionizing states of the cation is modified by the addition of an infrared field to the EUV attosecond pulse train which initially ionizes/excited the molecule.

**Invited Talk** A 1.3 Mo 15:00 F 303

**Breaking the longest bond – Photoionization of the Helium Dimer** — •R. Dörner[1], T. Havermeier[1], H. Sann[1], T. Jahnke[1], M. Schöffler[1], J. Titze[1], N. Neumann[1], K. Kreidi[1], R. Wallauer[1], S. Voss[1], L. Ph. H. Schmidt[1], H. Schmidt-Böcking[1], R. Grisenti[1] und W. Schöllkopf[2] — [1]J. W. Goethe-Universität Frankfurt, Max von Laue Str. 1, D-60438 Frankfurt am Main — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin

The Helium Dimer $He_2$ is an extreme quantum system, bound with only 100neV of binding energy and a widely smeared wavefunction, showing a mean internuclear distance of 52 Angstrom. We study the photoionization of this quantum system by means of the COLTRIMS technique. We find surprisingly efficient mechanisms by which a single photon can lead to ejection of two electrons, one from each of the distant atom of the dimer.

**Invited Talk** A 1.4 Mo 15:30 F 303

**Complete (e,2e) experiments with COLTRIMS** — •Alexander Dorn — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Due to the unique versatility of the COLTRIMS technique the dynamics of atomic and molecular reactions involving all kinds of projectiles covering charged particle- and photon-beams can be explored in utmost detail. Here its application to the study of electron collisions is reviewed. Some exemplary experiments include the investigation of strongly correlated few-body coulomb systems in the continuum which are produced close to the single- or double-ionization thresholds. For ionization of diatomic molecules the collision dynamics is observed to depend on the molecular axis alignment. Furthermore, collisions embedded in intense laser pulses were studied. Finally the current endeavors to perform experiments for ionization by positron impact will be discussed.