A 28: Attosecond Physics II / Interaction with Strong or Short Laser Pulses III

Time: Friday 14:00–15:45 Location: F 107

A 28.1 Fr 14:00 F 107

Calibration of a High Harmonic Spectrometer by Laser Induced Plasma Emission — •Markus Gühr[1,2], Joseph P. Farrell[1,2], Brian K. McFarland[1,2], and Philip H. Bucksbaum[1,2] — [1]Stanford PULSE Institute, SLAC National Accelerator Laboratory, Menlo Park, USA — [2]Physics and Applied Physics, Stanford University, USA

We present a method that allows for a convenient switching between high harmonic generation (HHG) and accurate calibration of the vacuum ultraviolet (VUV) spectrometer used to analyze the harmonic spectrum. The accurate calibration of HHG spectra is becoming increasingly important for the determination of electronic structures. However, the wavelength of the laser harmonics themselves depend on the details of the harmonic geometry and phase matching, making them unsuitable for calibration purposes. In our calibration mode, the target resides directly at the focus of the laser, thereby enhancing plasma emission and suppressing harmonic generation. In HHG spectroscopy mode, the source medium resides in front or after the focus, showing enhanced HHG and no plasma emission lines. The plasma lines can be used for calibrating the spectrometer and we achieve an accuracy of 0.1 nm, which is more than an order of magnitude more accurate than a calibration using the harmonics [1].

[1] J. P. Farrell, B. K. McFarland, P. H. Bucksbaum and M. Gühr, Optics Express, 17, 15142 (2009)

A 28.2 Fr 14:15 F 107

Isolated attosecond laser pulses tunable between 80 and 100 eV — •Markus Fiess[1], Balint Horvath[2], Reinhard Kienberger[1], and Ferenc Krausz[1] — [1]Max-Planck-Institut für Quantenoptik, Garching, Deutschland — [2]ABB, Baden-Dättwil, Schweiz

We report on the generation of isolated attosecond laser pulses tunable in the spectral range between 80 and 100 eV which are generated by high harmonic generation in Ne-gas with driving laser pulses and its second harmonic. We present XUV spectra for different fundamental waveforms which are synthesized by controlling the phase delay between the driving laser field and its second harmonic wave.

A 28.3 Fr 14:30 F 107

Quasi-elastic electron scattering from atoms and molecules — Adam P. Hitchcock[1], Glyn Cooper[1], Russ A. Bonham[2], and •Aris C. C.-Dreismann[3] — [1]Brockhouse Institute for Materials Research, McMaster University, Hamilton, ON, L8S 4M1, Canada — [2]Department of Biological, Chemical and Physical Sciences, Illinois Institute of Technology, Chicago, Illinois 60616, USA — [3]Institute of Chemistry, Sekr. C2, Technical University of Berlin, D-10623 Berlin

We have measured quasi-elastic electron scattering spectra from molecules and atoms at large momentum transfer Q (100 deg. angle, 2.25 keV incident energy, Q˜20 a.u.). The peak positions agree completely with those predicted by classical conservation of momentum and energy, assuming the electron scatters from each atom independently. However the peak intensities do not agree with expectations, particularly for light elements. According to classical electron Compton scattering, quasi-elastic peak intensities should be propotional to nuclear charge squared. However, our recent study [1] found a significant deviation (˜30%) in the intensities of the H versus D signals relative to this prediction. Here we present new quasi-elastic electron scattering data for H2/D2, Ar/H2, Ar/D2, He/H2 and Ar/He mixtures [2]. Large deviations from conventional theoretical expectations are obserded, for all samples. The possible connection of this striking effect with decoherence and the quantum Zeno effect is shortly mentioned.

[1] G. Cooper et al., PRL 100, 043204 (2008). [2] A. P. Hitchcock et al., J. Electron Spectrosc. Relat. Phenom., in press (2010)

A 28.4 Fr 14:45 F 107

Attosecond Transient Absorption Spectroscopy — •Adrian Wirth[1], Eleftherios Goulielmakis[1], Zhi-Heng Loh[2], Robin Santra[3], Nina Rohringer[4], Vladislav S. Yakovlev[5], Sergey Zherebtsov[1], Thomas Pfeifer[2], Abdallah M. Azzeer[6], Matthias F. Kling[1], Stephen R. Leone[2], and Ferenc Krausz[1,5] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Departments of Chemistry and Physics, University of California, Berkeley, USA — [3]Department of Physics, University of Chicago, Chicago, USA — [4]Lawrence Livermore National Laboratory, Livermore, USA — [5]Department für Physik, Ludwig-Maximilians-Universität, Garching, Germany — [6]Physics and Astronomy Department, King Saud University, Kingdom of Saudi Arabia

The electronvolt-scale energy spacing of quantum states in the valence shell of atoms and molecules implies electron motion which unfolds in the range of a few tens of attoseconds to a few femtoseconds. Efforts of accessing those ultrafast dynamics comprise the generation of isolated soft-x-ray attosecond pulses and the control of light fields. We show that a combination of attosecond technology and x-ray absorption spectroscopy is able to further expand the horizon of attosecond science. This opens the door for gaining direct, time-domain insight into quantum coherences and connected electron density motion in the valence shell of atoms and molecules. In a proof-of-principle experiment we traced for the first time valence electron motion in Kr ions in real time and could completely reconstruct the strong-field initiated spin-orbit wavepacket coherence and quantum level population.

A 28.5 Fr 15:00 F 107

Ion Microscopy with XUV-Radiation at FLASH — •Boris Bergues[1], Martin Schultze[1], Matthias Kling[1], Oliver Herrwerth[1], Adrian Wirth[1], Wolfram Helml[1], Matthias Lezius[1], Gilad Marcus[1], Michael Hofstetter[1], Peter Lang[1], Reinhard Kienberger[1], Karl-Ludwig Kompa[1], Ferenc Krausz[1], Artem Rudenko[2], Kai-Uwe Kühnel[3], Claus Dieter Schröter[3], Robert Moshammer[3], Joachim Ullrich[3], Rolf Treusch[4], Stefan Düsterer[4], and Hartmut Schröder[1] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany. — [2]Max-Planck Advanced Study Group at CFEL, Hamburg, Germany. — [3]Max-Planck-Institut für Kernphysik, Heidelberg, Germany. — [4]HASYLAB at DESY, Hamburg, Germany.

A novel technique is presented, that allows a spatially resolved photoionization-yield measurement of gas-phase ions created in the interaction volume of an intense-laser focus. The method termed 'ion microscopy' thus overcomes the limitations usually imposed by the integration of the ion yield over the focal volume. Moreover, the new technique represents a precise tool for non invasive, in situ focus diagnostics and is applied to characterize the focal geometry of focused XUV-radiation generated at the FLASH facility in Hamburg.

A 28.6 Fr 15:15 F 107

Studying dynamics of Xenon clusters in ultra high intense femtosecond Xray laser pulses via single shot single cluster imaging at LCLS and FLASH — •D. Rupp[1], M. Adolph[1], T. Gorkhover[1], S. Schorb[1], T. Möller[1], D. Rolles[3], A. Rudenko[3], S. Epp[3], R. Hartmann[3,4], L. Strüder[3,4], I. Schlichting[3,5], J. Ullrich[3,6], and C. Bostedt[2] — [1]TU Berlin — [2]LCLS — [3]ASG — [4]MP HLL — [5]MPI MF — [6]MPI K

With the recent rapid development of Free Electron Lasers (FELs) in the high energy photon range, unique novel experiments as imaging of single nanoscale objects down to atomic resolution come into reach. Due to the severe energy deposition in the imaged particles ultrafast electron and ion dynamics are initiated and the understanding of these processes is crucial for the success of such experiments. In a first experiment at FLASH at 90eV photon energy it has been shown that imaging of single Xenon clusters with ultrashort FEL pulses is possible and a promising method to study these dynamics on a femtosecond time scale. We now present latest results from the very first imaging experiments at LCLS. Xenon clusters were irradiated by pulses with photon energies up to 2 keV at varied pulse lengths from 400 down to 4 femtoseconds. The experiment was performed in the CFEL-ASG Multi-Purpose (CAMP) End Station, which provides a combined imaging and spectroscopic approach with new developed large area pnCCDs for scattered and fluorescence light complemented by electron and ion VMI-spectrometers.

A 28.7 Fr 15:30 F 107

The mechanisms underlying strong field double ionization of argon dimers — •Bastian Manschwetus[1], Horst Rottke[1], Günther Steinmeyer[1], Lutz Foucar[2], Armin

Czasch[3], Horst Schmidt-Böcking[3], Reinhard Dörner[3], and Wolfgang Sandner[1] — [1]Max-Born-Institut, Max-Born-Str. 2A, 12489 Berlin, Germany — [2]Max Planck Advanced Study Group, Center for FEL Science, 22761 Hamburg, Germany — [3]Inst. für Kernphysik, Goethe Univ. Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt, Germany

We investigate double ionization of argon dimers in high intensity ultra-short Ti:Sapphire laser pulses. We find atomic ion pairs from Coulomb explosion of the doubly charged dimer which can be attributed to two-site single ionization, and to one-site single ionized and exited configurations of the dimer which Coulomb explode after electron exchange accompanied by emission of a second electron at short internuclear separation. A possible excitation mechanism for this second channel is tunnel ionization of one electron accompanied by shake-up of a second one. High energy ion pairs are attributed to Coulomb explosion of the double ionized dimer after additional excitation of an electron to a Rydberg state by frustated tunnel ionization [1] or by inelastic scattering excitation of the ion by the returning laser accelerated electron. The dissociation of this exited double ionized dimer ion is similar to Coulomb explosion of a triple ionized dimer until shielding of the charge of the Ar^{++} ion by the Rydberg electron becomes significant at large internuclear separation.

[1] Eichmann *et al.* Phys. Rev. Lett. **101**, 233001 (*2008*)