A 34: Interaction with VUV and X-ray light

Time: Thursday 16:15–18:15 Location: S Fobau Physik

A 34.1 Thu 16:15 S Fobau Physik

X-ray pulse shaping by mechanical motion of resonant absorber and their applications — •Benedikt Herkommer and Jörg Evers — MPI für Kernphysik Heidelberg

For high-precision spectroscopy with highly energetic radiation as x-ray or gamma-rays it is necessary to have narrow resonances as those of Moessbauer nuclei. Despite the progress of modern x-ray sources it is still quite challenging to coherently control resonant interaction between x-rays and nuclei. In recent works it has been shown that it is possible to shape x-ray pulses in time [1] and frequency [2] domain. Theses works are based on mechanical motion of a resonant absorber.

Based on this methods this poster presents our work how different motion pattern can lead to interference of different frequencies of the the signal. This can lead to quite interesting phenomena which are discussed with regard to their use in spectroscopy applications.

[1] F. Vagizov et al., Nature 508, 80 - 83

[2] K. P. Heeg et al., Science 2017, 357, 375.

A 34.2 Thu 16:15 S Fobau Physik

Spatio- and time dependent Propagation Simulations of hard X-ray FEL radiation through the split-and-delay unit for the HED-instrument at the European XFEL — •Victor Kärcher[1], Sebastian Roling[1], Liubov Samoylova[2], Karen Appel[2], Frank Siewert[3], Ulf Zastrau[2], Frank Wahlert[1], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience, Münster, Germany — [2]European XFEL, Schenefeld, Germany — [3]Helmholtz-Zentrum für Materialien und Energie, Berlin, Germany

For the High Energy Density (HED) instrument at the SASE2 - Undulator at European XFEL an x-ray split-and-delay unit (SDU) is built covering photon energies from $h\nu = 5\,\mathrm{KeV}$ up to $h\nu = 24\,\mathrm{KeV}$. This SDU will enable time-resolved x-ray pump / x-ray probe experiments as well as sequential diffractive imaging on a femtosecond to picosecond time scale. In order to reach intensities on the order of 10^15 W/cm2 the XFEL pulses will be focused by means of compound refractive lenses (CRL) to a diameter of D = 24 μm. The influence of wavefront disturbances caused by height- and slope-errors of the mirrors inside the SDU on the quality of the two focused partial beams is studied by wavefront propagation simulations using the WPG-framework.

A 34.3 Thu 16:15 S Fobau Physik

An XUV and soft X-ray split-and-delay unit for FLASH II — •Patrick Oelpmann[1], Sebastian Roling[1], Matthias Rollnick[1], Marion Kuhlmann[2], Elke Plönjes[2], Frank Wahlert[1], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience (SoN) der WWU Münster, Busso-Peus Straße 10, 48149 Münster — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg

An XUV and soft X-ray split-and-delay unit is built that enables time-resolved experiments covering the whole spectral range of FLASH II from $h\nu = 30$ eV up to 2500 eV. With wave front beam splitting and grazing incidence angles a maximum delay of -6 ps $< \Delta t < +18$ ps will be possible with a sub-fs resolution. Two different coatings are required to cover the complete spectral range. Therefore, a design that is based on the three dimensional beam path of the SDU at BL2 at FLASH has been developed which allows choosing the propagation via two sets of mirrors with these coatings. A Ni-coating will allow a total transmission on the order of T = 55 % for photon energies between 30 eV and 600 eV at a grazing angle $\theta = 1.8°$ in the variable delay line. In the fixed delay line the grazing angle is set so $\theta = 1.3°$. With a Pt-coating a transmission of T > 13 % will be possible for photon energies up to 1500 eV.

A 34.4 Thu 16:15 S Fobau Physik

A split-and-delay unit for the European XFEL: Enabling hard x-ray pump/probe experiments at the HED instrument — •Dennis Eckermann[1], Sebastian Roling[1], Karen Appel[2], Matthias Rollnik[1], Frank Wahlert[1], Ulf Zastrau[2], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience (SoN) der WWU Münster, Busso-Peus Straße 10, 48149 Münster — [2]European XFEL GmbH, Holzkoppel 4, 22869 Schenefeld

For the High Energy Density (HED) instrument at the SASE2 - Undulator at the European XFEL an x-ray split-and-delay unit (SDU) is built covering photon energies from hν = 5 keV up to hν = 24 keV. This SDU will enable time-resolved x-ray pump / x-ray probe experiments as well as sequential diffractive imaging on a femtosecond to picosecond time scale. Further, direct measurements of the temporal coherence properties will be possible by making use of a linear autocorrelation. The x-ray FEL pulses are split by a sharp edge of a silicon mirror (BS) coated with Mo/B_4C and W/B_4C multilayers. Both partial beams then pass variable delay lines. For different wavelengths the angle of incidence onto the multilayer mirrors will be adjusted in order to match the Bragg condition. Because of the different incidence angles, the path lengths of the beams will differ as a function of wavelength. Hence, maximum delays between ± 1.0 ps at hν = 24 keV and up to ± 23 ps at hν = 5 keV are possible.

A 34.5 Thu 16:15 S Fobau Physik

Time-resolved coincidence measurements of interatomic Coulombic decays — •Sophie Walther, Anastasios Dimitriou, Markus Pfau, Mark J. Prandolini, Martin Ranke, and Ulrike Frühling — Universität Hamburg

Interatomic Coulombic Decay (ICD) is an efficient decay channel used by atoms in loosely bound van der Waals noble gas molecules and clusters. Here we present our experimental setup for the investigation of the ICD lifetime in neon dimers using the terahertz (THz)-streaking technique. The neon dimers are ionized with ultrashort extreme ultraviolet laser pulses and superimposed with intense THz fields. The momenta of all generated fragments are measured in coincidence using a Cold Target Recoil Ion Momentum Spectroscopy (COLTRIMS) detector.

A 34.6 Thu 16:15 S Fobau Physik

Relaxation dynamics of CH3I and CH2I2 following FEL-induced inner-shell ionisation — •Florian Trost[1], Kirsten Schnorr[1], Sven Augustin[1], Severin Meister[1], Hannes Lindenblatt[1], Yifan Liu[1], Marc Simon[2], Renaud Guillemin[2], Maria Novella Piancastelli[3], Farzad Hosseini[2], Mustafa Zmerli[2], Markus Braune[4], Marion Kuhlmann[4], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Université Pierre-et-Marie-Curie, Paris — [3]Uppsala Universitet, Uppsala — [4]DESY, Hamburg

Using the reaction microscope endstation at the free-electron laser (FEL) in Hamburg (FLASH), the relaxation dynamics of methyl iodide (CH3I) and diiodomethane (CH2I2) after inner-shell ionisation have been studied. FLASH2's XUV (12.7 nm) photons were used to ionise the iodine 4d inner shell electrons twice sequentially using an XUV pump - XUV probe technique with variable delay. The first XUV photon induces the dissociation of the doubly charged molecule. The absorption of the second photon, leading to quadruply charged ions, allows to probe the dissociation. The momentum-resolved data of the coincident fragments of the dissociated molecules will be presented.

A 34.7 Thu 16:15 S Fobau Physik

Two photon double ionization in Neon — •Severin Meister[1], Kirsten Schnorr[2], Sven Augustin[1], Hannes Lindenblatt[1], Florian Trost[1], Yifan Liu[1], Claus-Dieter Schröter[1], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik — [2]Paul Scherrer Institut

The angular distribution of electrons, which are emitted in the course of an ionization process, comprises much information about the atom. Double ionization of noble gases has been exclusively achieved by absorbing a single photon with an energy above the double ionization potential. However with the emergence of intense light sources in the extreme ultra violet regime, i.e. Free Electron Lasers, absorbing two photons became feasable. In addition, an adjustable time delay between the two photons allows to investigate time dependent effects. Therefore the presented experiment was carried out at the Free Electron Laser in Hamburg (FLASH2), with a split and delay mirror geometry. The Neon atom absorbes successively two photons, while their delay can be adjusted. In this manner the two electrons are also emitted successively, which discriminates the process from the single photon case. The scheme allows to investigate the dynamics of the two superposed states $^2P_{1/2}, ^2P_{2/3}$ in the intermediate Ne^+ ion by measuring the delay dependent angular distribution of the second electron. Another interesting aspect we are adressing is that the angular distribution of the first electron is predicted to depend on the emission angle of the second one, which stands in contrast to the simple picture of sequential ionization.

A 34.8 Thu 16:15 S Fobau Physik

XUV Pump-Probe Capabilities of the Reaction Microscope Endstation at FLASH2 — •Hannes Lindenblatt[1], Kirsten Schnorr[1], Sven Augustin[1], Georg Schmid[1], Severin Meister[1], Florian Trost[1], Yifan Liu[1], Patrizia Schoch[1], Markus Braune[2], Marion Kuhlmann[2], Rolf Treusch[2], Claus-Dieter Schröter[1], Thomas Pfeifer[1], and Robert Moshammer[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]DESY, Hamburg

Our group operates a Reaction Microscope as permanent endstation at FLASH2. During the last year, first experiments and several upgrades were performed. Most notably, an XUV split, delay and focusing unit was implemented with gracing incidence mirrors. The installed optics provide a very small focus ($\sim 5\,\mathrm{um}$) and large delay range ($\pm 2\,\mathrm{ps}$). However, the beam geometry requires to overlap the two focii under an angle proportional to the time delay. Thus, scanning the delay and maintaining spatial overlap becomes complex. In this poster, procedures to handle this will be presented. Furthermore, coincident data of Coulomb-explosion processes is shown demonstrating pump-probe capability over the full delay range.