O 46: Focus Session: THz meets X-ray

Time: Wednesday 10:30–12:30 Location: MA 001

Topical Talk O 46.1 Wed 10:30 MA 001

Opportunities for THz-pump x-ray-probe experiments at free-electron lasers — •Wilfried Wurth — Physik Department und CFEL, Universität Hamburg — DESY Photon Science, Hamburg

New light sources based on linear accelerators such as the free-electron laser FLASH at DESY in Hamburg in the extreme ultraviolet and soft x-ray regime provide ultrashort, extremely powerful short wavelength pulses with unprecedented coherence properties.

With these new sources it is possible to extend the well-established x-ray spectroscopy or scattering techniques for the investigation of the static electronic and geometric structure of matter to the time domain. The short electron bunches necessary to produce the short wavelength pulses can at the same time be used to generate coherent THz radiation which is fully synchronized to the XUV- or x-ray pulses.

In the talk the possibilities for THz-pump x-ray-probe at the FLASH facility will be reviewed and examples for THz-pump x-ray probe experiments performed at FLASH will be given.

Topical Talk O 46.2 Wed 11:00 MA 001

Understanding the Ultrafast Insulator-Metal Tranisition in Vanadium Dioxide: An Ultrabroadband Terahertz Perspective — •Alfred Leitenstorfer, Bernhard Mayer, and Alexej Pashkin — Department of Physics and Center for Applied Photonics, University of Konstanz, 78465 Konstanz, Germany

VO_2 is a prototypical oxide with strong electronic correlations. A transition from a dielectric phase to a metal of higher lattice symmetry occurs at 340 K. Interband excitation non-thermally triggers this process on a fs time scale. The multi-THz electronic conductivity sets in instantly after pumping with 12-fs near-infrared pulses. Below a temperature-dependent threshold fluence, the insulating character recovers within 200 fs. Above threshold, switching into the metallic phase occurs. A coherent wave packet motion in the excited state is detected via the anharmonic coupling of V-V stretch motion to optical phonons. The sub-ps damping of the lattice coherent signature is consistent with a retarded structural transition. Surprisingly, a transient metallic phase is reached also when exciting with few-cycle multi-THz pulses at similar fluences. A threshold electric field of 14 MV/cm fits excellently to a model of tunneling breakdown of a Mott insulator with a pair correlation length of 2 Å. The fast decay of conductivity below threshold under NIR excitation is absent: interband tunneling creates electrons and holes in different elementary cells. This fact prevents exciton selftrapping and explains the efficiency of non-resonant multi-THz switching. Resonant pumping of optical phonons is of minor importance as compared to direct tunneling breakdown of the elctronic energy gap.

Topical Talk O 46.3 Wed 11:30 MA 001

Magnetization Dynamics seen via Pump-Probe Holographic X-ray Imaging — •Stefan Eisebitt — Institut für Optik und Atomare Physik, Technische Universität Berlin — Division of Synchrotron Radiation Research, Lund University

Magnetism exhibits phenomena on intrinsic timescales spanning many orders of magnitude, due to its electronic nature including ultrafast phenomena on short length scales. I will demonstrate how x-ray Fourier transform holography (FTH) with magnetic dichroism contrast [1] can be used in pump-probe schemes to follow magnetization dynamics on the nano-, pico- and femtosecond time scale in real space. Specifically, results on the GHz dynamic behavior of magnetic bubbles (pumped by magnetic field pulses) [2] and on ultrafast optical demagnetization (pumped by localized IR pulses) [3] will be discussed.

[1] S. Eisebitt et al., *Lensless imaging of magnetic nanostructures by X-ray spectro-holography*, Nature **432**, 885 (2004).

[2] F. Büttner et al., *Dynamics and inertia of skyrmionic spin structures*, (Nature Physics, accepted)

[3] C. von Korff Schmising et al., *Imaging Ultrafast Demagnetization Dynamics after a Spatially Localized Optical Excitation*, Phys Rev Lett **112**, 217203 (2014)

Topical Talk O 46.4 Wed 12:00 MA 001

THz induced spin motions probed by x-rays — •Urs Staub — Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Multiferroics - materials with more than one type of ferric ordering - have attracted strong interest for potential applications where electric fields control magnetic order. The ultimate speed of control via magnetoelectric coupling, however, remains largely unexplored. I will discuss results on multiferroics that show distinct excitations in the THz absorption spectra that are called electromagnons. Intense few-cycle terahertz (THz) pulses can therefore excite both, the lattice (electric polarization) and the magnetic (spin) subsystems [1], and its motions observed using time-resolved x-ray diffraction. Such a selective excitation has very different impact on the system then the usual 800 nm light excitation. It opens up possible ways of manipulating magnetic and atomic structures using the electric field of light on a sub-picosecond timescale.

[1] T. Kubacka et al. Science 343, 1333 (2014).