PLENARY

M-Pl-1

The attosecond-science frontiers: metrology and potential applications

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Substantial progress in optical femtosecond (*fs*) pulse engineering has provided in the last 20 years the unique tool for the study and control of ultrafast dynamics in all states of matter in a number of disciplines. However, several natural processes evolve in characteristic times of a few *fs* or less. Exploration of dynamics at this temporal scale requires at first place *sub-fs* temporal resolution. In the early 90s higher order harmonic generation has been suggested as a potential process for XUV attosecond (*as*) pulse generation [1]. In the quest of laboratory *as* pulses persistent efforts have recently lead to the debut of *attoscience* [2–4].

Here, we review approaches in generating, characterizing and exploiting the so far ever shorter light pulses. Cross correlation approaches between the XUV radiation to be characterized and IR laser fields underlie the breadth of these studies [5, 6]. The first direct measurement of *sub-fs* light bunching has been achieved only in the last year, by effectively extending well established *fs* optical metrology to XUV as pulses [7]. The method is based on a nonlinear effect induced solely by the XUV radiation. Thus in itself it further initiates XUV-pump-XUV-probe studies of *sub-fs*-scale dynamics and at the same time becomes highly pertinent in connection with nonlinear experiments using XUV free - electron laser sources.

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M-Pl-2

Inner-shell photoionization with a VUV free-electron-laser

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Advances in linear accelerators, new developments in low-emittance electron guns, and the feasibility of ultra-precise long undulators open up the exciting possibility of building single pass Free Electron Lasers (FEL) based on self-amplified spontaneous emission (SASE). These FEL's promise to provide extremely intense, polarized ultra-short pulse radiation for the VUV and X-ray regimes. In addition their high peak and average brilliance, the tunability of the photon energy and the lateral coherence of the radiation will make the FEL's unique sources.

A SASE-FEL has been successfully tested in the vacuum ultraviolet (VUV) region [1]. Stimulated by this success FELs are in the planning or construction stage at several laboratories around the world. Within the next decade FELs will cover the photon energy range from the VUV to the X-ray region. Considerable progress in respect to the coherence, the power density and the pulse-length is foreseeable. The upgraded VUV-FEL at DESY providing photons of energies up to 194 eV will be the next in line. The first experiments are scheduled for next year. Dilute systems, non linear interactions, and ultrafast processes are the focus of many studies proposed for VUV-FELs. To highlight the opportunities and challenges of this new area of photon-matter-interactions, the characteristic parameters of FEL radiation and outstanding examples for experimental studies will be presented.

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W-Pl-1

Electrons from fixed in space molecules and clusters

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We use modern multi particle momentum imaging techniques (COLTRIMS) to measure the vector momenta of all charged fragements, ions, photoelectrons and Auger electrons for small molecules excited by synchrotron radiation. These complete images of the fragmentation give an umprecedented detailed insight in the molecular photoionization and Auger process. Also latest results on molecular double ionisation and on cluster fragmentation unveiling interatomic coulomb decay will be presented.

Th-Pl-1

What angle-resolved photoelectron spectroscopy tells us about high-temperature superconductors

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The high temperature superconductors present a challenge to our understanding of materials, as there appears to be no unified description of their behavior in most of parts of the phase diagram. This talk will show how angle resolved photoemission has greatly contributed to the limited understanding of these materials in different areas of the phase diagram, and the techniques developed to extract information from the spectral lineshape. Examples include the transition from a strange metal to a conventional metal, the properties of the pseudogap, the superconducting transition, Fermi arcs, coherence-incoherent crossover, the nature of the state below the superconducting transition with suppressed superconductivity, etc.

F-Pl-1

Soft X-ray Spectromicroscopy of Biological and Synthetic Polymer Systems

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Scanning transmission X-ray microscopy (STXM) and X-ray photoemission electron microscopy (X-PEEM) are synchrotron based, soft X-ray spectromicroscopy techniques[1] which provide chemical speciation at 50 nm spatial resolution based on near edge X-ray absorption spectral (NEXAFS) contrast. The instrumentation and techniques of soft X-ray spectromicroscopy will be described and illustrated with applications to wet biofilms[2], protein interactions with patterned polymer surfaces, and polymer microstructure optimization. STXM can be applied to samples in air, He, vacuum, or a fully hydrated environment. With many collaborators, my group is using STXM to study fundamental and applied aspects of polymer microstructure, to map metal ions and anti-microbial agents in wet biofilms, and to identify sites of selective adsorption of proteins on phase separated polymer thin films in the presence of an overlayer of protein solution[3]. X-PEEM has greater surface sensitivity than STXM but requires a flat, conductive, and vacuum-compatible sample. Comparison of X-PEEM and STXM for the same system - fibrinogen adsorption on a PS:PMMA blend [4], will be used to illustrate advantages and limitations of each technique.

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