Plenary Talk PV I Mon 10:00 RW 1

From extreme nonlinear optics to ultrafast atomic physics — •Anne L'Huillier — Department of Physics, Lund University, Sweden

The interaction of atoms with intense laser radiation leads to the generation of high-order harmonics of the laser field, which, in the time domain, corresponds to a train of pulses in the extreme ultraviolet (XUV) range and with attosecond duration. This presentation will introduce the physics of high-order harmonic generation (HHG) and describe recent developments concerning pulse energy and repetition rate of these sources. Compact high-repetition rate HHG set ups and in contrast long HHG beam lines with high pulse energy will be described and their applications briefly discussed.

The short pulse duration and broad bandwidth of attosecond pulses allow us to measure the phase and amplitude of an electronic wave packet using interferometric techniques. This gives us access to the temporal dynamics of the process that led to this wave-packet. We will describe some of these applications, and in particular recent results concerning dynamics of photoionization both in a flat continuum as well as close to resonant autoionization states.

Plenary Talk PV II Mon 10:45 RW 1

Materials, Devices, and Systems for Quantum Computation — •David DiVincenzo — Forschungszentrum Jülich, 52425 Jülich

We have known for twenty years that quantum computers would have unique powers for solving certain classes of computational problems. Throughout these twenty years, workers have striven to identify a physical setting in which high-quality qubits can be created and employed in a quantum computing system. Very promising devices have been identified in several different areas of low-temperature electronics, namely in superconductor and in single-electron semiconductor structures (e.g., quantum dots). Rudimentary efforts at scale-up are presently reported; even for modules of 10 qubits, the complexity of the classical electronic control system becomes one of the main barriers to further progress.

The specifications of this control system are now well defined, and are daunting. It must deliver very low noise, precisely shaped pulses in the GHz band for qubit gate control; it must deliver interrogating microwave pulses that sense the qubit state, which must be amplified at the quantum-limited level and delivered quickly back to the control system; because of the nature of the fine-grained error correction needed for reliable quantum algorithm operation, subsequent control pulses must be determined by a rapid (classical) calculation performed using the measurement outcomes as inputs. All this must be done for a very large number of channels (about one per qubit) with rigorous control of timings and crosstalk.

I will discuss the current state of experiments, and explain the efforts underway to understand and achieve this control system.

Discussion PV III Mon 13:30 P 7

AMOP research and teaching in Greece — •Andreas Buchleitner[1], Peter Rakitzis[2], and Wolf von Klitzing[3] — [1]Physikalisches Institut der Albert-Ludwigs-Universität Freiburg — [2]IESL-FORTH and Department of Physics, University of Crete, Heraklion — [3]IESL-FORTH, Heraklion

To intensify the scientific links between the Greek and the German AMOP communities, this year's AMOP spring meeting welcomes a delegation of junior and senior colleagues from the University of Crete at Heraklion and IESL-FORTH, the leading centre for AMOP research in Greece, with excellent teaching and research facilities. To foster mutual exchange and a substantial debate during the meeting, we will start with an informal get-together to discuss boundary conditions, perspectives, and needs for joint academic and research initiatives. AMOP research at Heraklion will furthermore be represented through various scientific contributions during the entire week in Mainz.

Plenary Talk PV IV Tue 9:00 RW 1

Intense laser cluster interactions: nanoscale plasmas in motion — •Thomas Fennel — Institut für Physik, Universität Rostock, Rostock, Germany — Max-Born-Institut, Berlin, Germany

Exposing matter to intense laser light leads to the ultrafast generation of transient finite plasmas. A detailed understanding of the involved nonlinear electron and ion dynamics promises a fundamental route towards realizing active control of the plasma evolution via appropriately structured light fields – with implications for a broad spectrum of applications, ranging from nanomachining over particle acceleration to high-harmonic generation. Atomic clusters provide ideal grounds to explore the correlated and collective laser-matter processes in a well-defined nanoscale plasma. This talk will highlight two advances in controlling and imaging cluster nanoplasmas using intense XUV and x-ray laser fields.

First, the combination of ultrashort IR and XUV fields enables the highly selective steering of laser-driven nanoplasmas via seeded avalanching. The resulting control capabilities mark an exciting new frontier in ultrafast nanoscience. The second part addresses the characterization of structural dynamics with nanometre spatial and femtosecond temporal resolution via single-shot x-ray diffraction, which is a major challenge of current x-ray science. Laser-driven atomic clusters provide a robust platform for developing and demonstrating the technology required to extract dynamical information from diffraction images. An outlook will sketch possible routes towards resolving electron dynamics with attosecond resolution.

Plenary Talk PV V Tue 9:45 RW 1

Precision measurements of fundamental properties of atomic particles in Penning traps — •Klaus Blaum — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland

This plenary talk will provide an overview on recent applications of precision measurements with cooled and stored ions in Penning traps. One the one hand, precision Penning-trap mass measurements provide indispensable information for atomic, nuclear and neutrino physics as well as for testing fundamental symmetries. On the other hand, in-trap measurements of the bound-electron g-factor in highly charged hydrogen-like ions allow for better determination of fundamental constants and for constraining Quantum Electrodynamics. Furthermore, ongoing preparations for the experimental comparison of the proton and antiproton g-factors will allow us to achieve a crucial test of the Charge-Parity-Time reversal (CPT) symmetry. Among others, a 13-fold improvement of the atomic mass of the electron by combining a very accurate measurement of the magnetic moment of a single electron bound to a carbon nucleus with a state-of-the-art calculation in the framework of bound-state Quantum Electrodynamics as well as the most stringent test of CPT symmetry on the baryonic sector by a charge-to-mass ratio comparison of the proton and antiproton will be presented.

Evening Talk PV VI Tue 19:30 RW 1

Quanten statt Karat: Edle Steine für die Forschung — •Jörg Wrachtrup — Institute for Quantum Science and Technology, IQST, Universität Stuttgart, Germany

Quantentechnologien, d.h. Quantencomputer oder Quantensensoren, benötigen die richtige Hardware. Diamanten haben die dazu notwendigen, höchst ungewöhnlichen physikalischen Eigenschaften. Sie sind extrem hart und leiten elektrischen Strom bzw. Wärme hervorragend. Quantenbits sind dadurch besser als in irgendeinem anderem Material abgeschirmt und lassen sich für eine Reihe von erstaunlichen Anwendungen, z.B. in der Medizin für die Krebsvorsorge oder für die präzise Navigation nutzen.

Plenary Talk PV VII Wed 9:00 RW 1

Femtosecond Opto-Magnetism: Controlling Magnetism by light — •Theo Rasing — Radboud University, Institute for Molecules and Materials

From the discovery of sub-picosecond demagnetization two decades ago to the more recent demonstration of magnetization reversal by a single 40 femtosecond laser pulse, the control and manipulation of spins by ultra short laser pulses has become a fundamentally challenging topic with a potentially high impact for future spintronics, data manipulation and storage and quantum computation. The realization that femtosecond laser induced all-optical switching (AOS) as observed in ferrimagnets exploits the exchange interaction between their sublattices, opens the way to engineer magnetic materials for AOS. Theoretically, this field is still in its infancy, using phenomenological descriptions of the none-equilibrium dynamics between electrons, spins and phonons. A proper description should include the time dependence of the exchange interaction and nucleation phenomena on the nanometer length scale. A practical challenge is how to bring the optical manipulation of magnetic media to the required nanoscale, which may be possible using plasmonic or wave-shaping techniques. This will allow to probe and control magnetic order on the combined femtosecond time and nanometer length scale.

Plenary Talk PV VIII Wed 9:45 RW 1

Two-dimensional electronic spectroscopy from the visible to the UV — •Giulio Cerullo — Politecnico di Milano, Milano, Italy

Two-dimensional electronic spectroscopy (2DES) is the ultimate ultrafast optical experiment, since it provides the maximum amount of information that can be extracted from a system within third-order nonlinear spectroscopy. 2DES allows fundamentally new insights into the structure and dynamics of multi-chromophore systems, measuring how the electronic states of molecules within a complex interact with one another and transfer electronic excitations [1].

This presentation will review the experimental techniques currently used to perform 2DES in the visible range and will introduce our approach to 2DES, based on a passive birefringent interferometer for the generation of phase-locked pump pulses [2]. We will present a few exemplary results on multi-chromophoric systems and nanostructures and finally discuss the prospects of extending 2D techniques to the UV range, of interest for biomolecules such as DNA and proteins.

[1] T. Brixner et al., Nature 2005, 434, 625.

[2] D. Brida, C. Manzoni, and G. Cerullo, Opt. Lett. 2012, 37, 3027.

Plenary Talk PV IX Thu 9:00 RW 1

Controlling atmospheric processes with high intensity lasers — •Jean-Pierre Wolf — Applied Physics, University of Geneva, Switzerland

Filamentation of multi TW-class lasers (1TW = 1e12 W) opened new perspectives in atmospheric research. Laser filaments are self-sustained light structures of typically 100 um diameter and up to hundreds of meters in length, widely extending the traditional linear diffraction limit. They stem from the dynamic balance between Kerr self-focusing and defocusing by the self-generated plasma and/or negative higher-order Kerr terms. While propagating non-linearly in air, laser filaments generate a coherent supercontinuum (from 230 nm to 4 um) by self-phase modulation (SPM), which has proven as an ideal source for Lidar remote sensing of air pollutants. But laser filaments are not only able to observe atmospheric processes, they are able to control atmospheric processes. Four spectacular examples will be highlighted in the present presentation: (1) lightning control, (2) laser induced water vapour condensation, (3) transmission of optical data through fogs and clouds, and (4) modulation of the radiative forcing properties of cirrus clouds.

Plenary Talk PV X Thu 9:45 RW 1

Cavity-based chiral polarimetry: Towards atomic parity nonconservation measurements — •T. Peter Rakitzis — IESL-FORTH, N. Plastira 100, 71110 Heraklion-Crete, Greece — Department of Physics, University of Crete, 71003 Heraklion-Crete, Greece

The measurement of (single-pass) chiral optical rotation or circular dichroism is the most widely used method for chirality sensing, and is of fundamental importance to many fields. However, these chiral signals are typically very weak, and their measurement is limited by larger time-dependent backgrounds (such as spurious birefringence) and by imperfect and slow subtraction procedures. Using a novel bow-tie cavity with an intracavity Faraday Effect, we demonstrate three important improvements: (a) the enhancement of the chiral optical rotation angle by the number of the cavity passes (typically about 1000); (b) the suppression of birefringent backgrounds; and (c) the ability to reverse the sign of the chiral signal rapidly, allowing the isolation of the chiral signal from backgrounds. Using chiral cavity ring-down polarimetry, we have demonstrated the measurement of chiral optical rotation in high-noise environments, such as for open-air gas samples, and for chiral liquids in the evanescent wave produced by total internal reflection at a prism surface. We discuss new fields of application of chiral sensing, and also report progress towards the measurement of parity nonconserving optical rotation in atomic iodine at 1315 nm.

Plenary Talk PV XI Fri 9:00 RW 1

Tracking electron dynamics induced by attosecond pulses in bio-relevant molecules — •Francesca Calegari — Center for Free-Electron Laser Science, DESY, Notkestr. 85, 22607 Hamburg, Germany

Dynamical processes in molecules occur on an ultrafast temporal scale, ranging from picoseconds to femtoseconds when concerning with a structural change, down to attoseconds when dealing with electrons. Electron dynamics plays a very important role in bond-formation and bond-breakage, thus determining the final chemical reactivity of a molecule. Recently, theoretical studies have pointed out that after sudden ionization of a large molecule very efficient charge migration, driven by purely electronic effects, can occur on a temporal scale ranging from few femtoseconds down to tens of attoseconds. In this talk I will present advancements in attosecond technology and the application of these ultrafast light transients for the investigation of electron dynamics initiated in bio-relevant molecules. I will show that attosecond light pulses can be used to watch in real time charge migration occurring between different functional groups of aromatic amino acids such as phenylalanine and tryptophan. The same experimental approach allowed us also to measure in real-time hydrogen migration and the combined electron and nuclear dynamics triggered by sudden ionization of halogenated uracils. These findings open new important perspectives for the future understanding of the role of the electron dynamics in the photochemistry of bio-relevant molecules.

Plenary Talk PV XII Fri 9:45 RW 1

Quantum Networks: The Missing Link — •Gerhard Rempe — Max-Planck Institute of Quantum Optics, Hans-Kopfermann-Straße 1, 85748 Garching, Germany

Quantum science and technology are most promising research fields with several subfields like quantum communication and quantum computation. Both of these subfields are highly successful, but seem incompatible, as communication and computation require open and closed platforms, respectively. Recent experiments have now demonstrated that optical cavity quantum electrodynamics constitutes a new platform that can efficiently execute both quantum communication and computation tasks with qubits of light, or matter, or both. This opens up a realistic avenue towards a scalable quantum information processing architecture in form of a distributed quantum network and eventually a global quantum internet with quantum repeaters on long distances [1].

[1] A. Reiserer and G. Rempe, Rev. Mod. Phys. 87, 1379 (2015).