Plenarvortrag PV I Mo 8:30 ESA-A

Accelerators - Engines of Discovery — •Albrecht Wagner — DESY, Hamburg

Accelerator based Science from Particle Physics to X-ray lasers - a review of 50 years of science at DESY.

Accelerators allow us to probe the structure of matter down to 10-18 m. The talk will review what we have learned about the world from the Nano- to the Attoscale. This includes major discoveries in particle physics and highlights in experiments using synchrotron radiation. X-ray lasers will be the future tool to explore matter and materials at the nanometer scale. These lasers are driven by accelerators and have unprecedented properties. First results from the FLASH facility and an outlook to the European XFEL will be presented.

Plenarvortrag PV II Mo 9:30 ESA-A

Energieversorgung in Europa - Herausforderungen, Optionen, Perspektiven — •Alfred Voss — Institut für Energiewirtschaft und Rationelle Energieanwendung, Universität Stuttgart, Heßbrühlstr. 49a , D-70565 Stuttgart

Die Europäische Union ist heute mit rund 450 Millionen Verbrauchern weltweit der zweit-größte Energiemarkt. Nicht nur durch die Preissituation bei Erdöl und Erdgas, sondern auch im Hinblick auf den Klimaschutz und bezüglich der Versorgungssicherheit steht die Energieversorgung in Europa vor erheblichen Herausforderungen.

Der Europäische Rat hat im Frühjahr 2007 mit seinen Beschlüssen, die Treibhausgasemissionen der EU bis 2020 um 30% gegenüber 1990 zu vermindern, den Anteil der erneuerbaren Energien am Primärenergieverbrauch bis 2020 auf einen Anteil von 20% zu steigern und den Energieverbrauch der EU bis 2020 um 20% zu reduzieren, wesentliche strategische Elemente zur Bewältigung der energieseitigen Herausforderungen formuliert.

Sind damit die Weichen für eine nachhaltige Energieversorgung in Europa richtig gestellt und welcher der verfügbaren bzw. in Entwicklung befindlichen Energietechniken bzw. Energieoptionen kommt dabei eine besondere Rolle und Bedeutung zu? Der Vortrag versucht, hierauf Antworten zu geben.

Plenarvortrag PV III Di 8:30 Audi-A

Anderson localization of matter-waves in a controlled disorder: a quantum simulator? — •Alain Aspect — Institut d'Optique, Campus Polytechnique, Palaiseau, France

In 1958, P.W. Anderson predicted the localization1 of electronic wave functions in disordered crystals, and the resulting absence of diffusion. It has been realized later that Anderson Localization is ubiquitous in wave physics2 as it originates from the interference between multiple scattering paths, and this has prompted an intense activity to observe it with light waves, microwaves, sound waves, and electron gases, but to our knowledge there was no direct observation of exponential spatial localization of matter-waves (electrons or others). We have observed directly [3] exponential localization of the wave function of ultracold atoms released into a one-dimensional waveguide in the presence of a controlled disorder created by laser speckle. We will present this work, and the prospects of extending that type of study to quantum gases in higher dimensions (2D and 3D) and with controlled interactions. We will also discuss its significance in the rapidly growing domain of quantum simulators to study difficult problems of Condensed Matter.

[1] Anderson, P.W. Absence of diffusion in certain random lattices. Phys. Rev. 109, 1492-1505 (1958).

[2] Van Tiggelen, B. Anderson localization of waves. In Wave diffusion in complex media 1998, edited by J.P. Fouque, Les Houches Lectures (Kluwer, Dordrecht, 1999).

[3] J. Billy, V. Josse, Z. Zuo, A. Bernard, B. Hambrecht, P. Lugan, D. Clément, L. Sanchez-Palencia, P. Bouyer & A. Aspect. Direct observation of Anderson localization of matter-waves in a controlled disorder, Nature, 453, 891 (2008); published back to back with a related work in the Inguscio's group at Florence: G. Roati et al., Anderson localization of a non interacting Bose-Einstein Condensate, Nature, 453, 895 (2008).

Plenarvortrag PV IV Di 9:15 Audi-A

"Making the Molecular Movie": Quest for the Structure-Function Correlation of Biology — •R. J. Dwayne Miller — Departments of Chemistry and Physics, Institute for Optical Sciences, University of Toronto, Toronto, Ontario, Canada

Femtosecond Electron Diffraction harbours great potential for providing atomic resolution to structural changes as they occur, essentially watching atoms move in real time – directly observe transition states. This experiment has been referred to as "making the molecular movie" and has been previously discussed in the context of a classic gedanken experiment, outside the realm of direct observation. With the recent development of femtosecond electron pulses with sufficient number density to execute nearly single shot structure determinations, this experiment has been finally realized. A new concept in electron pulse generation was developed based on a solution to the N-body electron propagation problem involving up to 10,000 interacting electrons that has led to a new generation of extremely "bright" electron pulsed sources that minimizes space charge broadening effects. Previously thought intractable problems of determining t=0 and fully characterizing electron pulses on the femtosecond time scale have now been solved through the use of the laser pondermotive potential to provide a time dependent scattering source. Synchronization of electron probe and laser excitation pulses is now possible with an accuracy of 10 femtoseconds to follow even the fastest nuclear motions. The camera for the "molecular movie" is now in hand with electron based sources. Atomic level views of the simplest possible structural transition have been obtained under strongly driven conditions (up to warm dense matter conditions) as well as electronically driven atomic motions as a direct probe of the many body electron correlation effects on the forces related to bonding. The overall objective is to extend this approach to biological systems to directly observe the structure-function correlation – the fundamental underpinnings of biology.

Plenarvortrag PV V Mi 8:30 Audi-A

On the Shape of the Photon — •Yaron Silberberg — Weizmann Institute of Science, Rehovot, Israel

In many ultrafast optics laboratories we routinely synthesized shaped femtosecond pulses with high precision to serve as the driving fields for coherent control experiments. Can we shape single photons? How short is a photon? I shall discuss how ideas borrowed from quantum control with classical pulses can be extended to nonclassical light sources, and in particular show how one can use pulse shaping tools on single photons.

Plenarvortrag PV VI Mi 9:15 Audi-A

Novel interactions in quantum gases — •Tilman Pfau — 5. Physikalisches Institut, Universität Stuttgart, Germany

Interactions among atoms in quantum gases make them a model system for many branches of physics including condensed matter, and nonlinear dynamics. So far all the impressive phenomena (like superfluidity, soliton and vortex formation, BEC-BCS crossover etc.) in atomic Bose and Fermi gases are caused by an isotropic contact interaction, originating from s-wave scattering off the van der Waals potential.

Here we report on the first realization of a purely dipolar quantum gas, where the long-range and anisotropic interaction between magnetic chromium atoms is determining the physical properties. To generate a dipolar quantum gas we tune the remaining contact interaction to zero via a Feshbach resonance. Dipolar gases exhibit characteristic instabilities due to the attractive part of the interaction, which we studied systematically. The dipolar collapse of a BEC shows the characteristic d-wave symmetry of the dipolar interaction.

We also briefly report on our experiments on interacting ultracold Rydberg atoms excited from a Rb BEC. Universal scaling behaviour due to an underlying quantum phase transition is observed. Here the long-range strong repulsive van der Waals interaction is responsible for novel many-body physics.

Abendvortrag PV VII Mi 20:00 Audi-A

Expedition in den Nanokosmos – Reise in die Zukunft — •Helmut Dosch — DESY, Hamburg, Germany

Die derzeit drängendsten Fragen in der Physik können nur durch die mutige Erforschung des Nanokosmos gelöst werden. Die wissenschaftliche Schatzsuche soll Antworten auf bohrende Fragen wie „Wie sah das Universum kurz nach dem Urknall aus?", „Was ist die Natur der Dunklen Materie und der Dunklen Energie?", „Welche neuen Eigenschaften und Funktionen haben komplexe Systeme?", „Können wir die Konzepte der Physik und Biologie erfolgreich verbinden?" oder „Können wir Quantenzustände kontrollieren?" liefern. Auch die dringend notwendigen Fortschritte in den Schlüsseltechnologien sind auf neue Konzepte im Design neuartiger Materialien auf der Nanoskala angewiesen. Für die erfolgreiche Expedition in den Nanokosmos benötigen die Wissenschaftler neuartige leistungsfähige Großgeräte: „Mikroskope" mit höchster räumlicher und zeitlicher Auflösung für die Nanowelt.

In diesem allgemeinverständlichen Vortrag erläutert Professor Dosch die großen wissenschaftlichen Herausforderungen von morgen und wie man sie mit Hilfe der neuen Großforschungsanlagen meistern will.

Plenarvortrag PV VIII Do 8:30 Audi-A

Ultra-fast Dynamic Imaging with Intense Lasers — •Jonathan Marangos — Imperial College London

Recent progress towards imaging the structure and dynamics of small molecules using the high order harmonics emitted when a molecule experiences an intense laser field is reported. We illustrate that the essence of high harmonic emission is contained in the recombination amplitude between the continuum portion of the electronic wavefunction, that is formed through field ionization and which is accelerated and driven back to recollide in the laser field, and the bound electronic state. We briefly review some recent experimental and theoretical work dealing with high harmonic generation (HHG) in molecules and related techniques. Particular attention is paid to two types of experiment recently performed in our group. The first of these types of experiment is the measurement of signatures of molecular electronic structure using HHG from molecules with a fixed orientation in space. The second is the use of HHG to track extremely fast proton rearrangement following ionization in light molecules, using the intrinsic temporal variation of the recolliding electron energy to extract these dynamics from measurements of the high harmonics.

Plenarvortrag PV IX Do 9:15 Audi-A

Deutschlands erste Glasfaserverbindung für hochgenaue Frequenzvergleiche optischer Uhren. — •Harald Schnatz — Physikalisch-Technische Bundesanstalt, Braunschweig

Im Vergleich zu Uhren im Mikrowellenbereich zeichnen sich optische Uhren durch eine wesentlich bessere Kurzzeitstabilität und höhere erreichbare Genauigkeit aus. Da diese Uhren nicht transportabel sind und Frequenzvergleiche über Satelliten nicht die erforderliche Stabilität und Genauigkeit erreichen, muss eine Methode entwickelt werden, die es erlaubt optische Uhren ohne Genauigkeitsverlust über große Entfernungen miteinander zu vergleichen. Glasfasernetze können eine optische Trägerfrequenz über weite Strecken nahezu verlustfrei übertragen. Gelingt es Fluktuationen des optischen Übertragungsweges zu unterdrücken, so lässt sich ein Frequenzvergleich zwischen optische Uhren hochgenau durchführen, indem man auf der Sende- und Empfangsseite das Frequenzverhältnis zwischen der lokalen Uhr und der übertragene Trägerfrequenz gleichzeitig misst. In Zusammenarbeit mit dem Deutschen Forschungsnetz, DFN, wurde eine Glasfaserstrecke von Braunschweig zum Institut für Quantenoptik (IQO) in Hannover und zu den Max Planck Instituten in Erlangen (IOIP) und Garching (MPQ) realisiert. Es werden das Übertragungskonzept und die bis heute erzielten wesentlichen Ergebnisse für einzelne Teilstrecken vorgestellt. Anhand dieser Ergebnisse wird die zu erwartende Stabilität und Genauigkeit für die etwa 900 km lange Faserverbindung zwischen Braunschweig und München diskutiert und ein Ausblick auf ein zukünftiges europäisches optisches Netzwerk für optische Uhren gegeben.

Plenarvortrag PV X Do 19:00 VMP 8 HS

Max-von-Laue Lecture: Bohr, Oppenheimer, and Sakharov: Physicists and Politics in the Cold War and the Responsibility of Scientists Today — •David Holloway — Stanford University

After Hiroshima and Nagasaki, physicists realized that their science, which before World War II had seemed to be remote from practical use, had laid the basis for the most terrible weapons. They felt a special responsibility for dealing with its military and political consequences. In this lecture I will look in particular at the efforts of Niels Bohr, Robert Oppenheimer, and Andrei Sakharov to confront the challenge of nuclear weapons and to prevent the catastrophe of nuclear war. I will examine how they understood that challenge, how they tried to meet it, and how their activities brought them into conflict with political authorities. I will explore the differing conceptions the three men had of the relationship between science and politics and, on that basis, discuss the responsibility of scientists today.

Plenarvortrag PV XI Fr 8:30 Audi-A

Quantum manipulation of spins and photons in diamond — •Mikhail Lukin — Physics Department, Harvard University, Cambridge, MA, USA

We will review the current efforts that make use of Nitrogen-Vacancy impurities in diamond as artificial atoms for quantum optics and quantum information science. These research efforts are at the interface between AMO and condensed matter physics, material science, photonics and quantum information science. Recent ideas and experiments involving quantum control of individual spins and photons will be described, and progress towards new applications of these techniques will be discussed.

Plenarvortrag PV XII Fr 9:15 Audi-A

Femtosecond broadband spectroscopy: From ultrafast photophysics, via femtochemistry to bimolecular reactions in a single picosecond — •Eberhard Riedle — Lehrstuhl für BioMolekulare Optik, Fakultät für Physik, LMU München

The celebrated experiments of A. H. Zewail and coworkers have paved the way to the exciting new field of ultrafast spectroscopy of molecules and molecular reactions. A major part of the investigations has, however, relied on the accidental coincidence of given laser lines with molecular absorptions, both in the spectrum of the educt and the transient spectrum of the intermediates or products. A fair amount of "chemical intuition" was then added to resolve any ambiguities.

The last years have now witnessed the upgrowth of low noise and sufficient intensity excitation sources freely tunable from the deep UV into the MIR with pulse durations in the 10 fs regime. These allow the selected molecular excitation with a speed that matches the nuclear motion within the molecules. Associated probe pulses and foremost femtosecond continua spanning from below 300 nm well into the NIR routinely warrant true transient spectroscopy with a temporal resolution of 50 femtoseconds or better.

In parallel to these methodical advancements, the systems under investigation became more complex and relevant to interdisciplinary research. Help in the understanding and interpretation comes from the evolving quantum chemistry and dynamics that add unprecedented insight. In the talk I will discuss this evolution by means of examples starting from the nonradiative relaxation, progressing through intramolecular electron and proton transfer to the dissociation of complex molecules, to finally demonstrate the first observation of a bimolecular reaction that proceeds in as little as 1 ps.