Plenar-, Abend- und Sonntagsvorträge

Plenarvortrag

PV I Fr 08:30 HU Audimax

From Einstein's dream to reality – experimenting with the coldest objects of the universe — •Immanuel Bloch — Institut für Physik, Johannes-Gutenberg-Universität, 55099 Mainz

Seventy years after Einstein's prediction, the seminal achievement of Bose-Einstein condensation in dilute atomic gases in 1995 has provided us with a new form of laser-like quantum matter. Today, research with bosonic and fermionic quantum gases has developed into an exciting and challenging research field with applications ranging from atomic- and molecular physics, over quantum optics and quantum information processing to the investigation of strongly correlated many body quantum phenomena. An introduction on how these novel states of matter are created in the laboratories at temperatures of only a few Microkelvin – one million times colder than anywhere in the universe – will be given, as well as a review of a recent series of fundamental studies, highlighting the huge impact this research field has also had on other areas of physics. In an outlook the perspectives and challenges of this young and vibrating research field will be discussed.

Plenarvortrag

PV II Fr 08:30 TU H105

Spin Qubits with Quantum Dots — •Leo Kouwenhoven — Kavli Institute of NanoScience, Delft University of Technology, POB 5046, 2600GA Delft, The Netherlands

Quantum dots are nano-scale field-effect transistor devices, which only contain a small number of electrons. This number can be changed with a gate voltage such that one can create a box containing exactly one, two, three, etc. electrons. This artificial, human-fabricated system has many similarities with atoms: the electron energy spectrum is discrete with a shell structure, which is filled with electrons according to Hund's rules. We exploit the ability to tune in-situ the quantum dot properties for a controlled study of quantum mechanical interactions for a specific number of electrons. These interactions lead to phenomena such as two-electron singlet and triplet states and the Kondo effect. We will further discuss various quantum dot systems (semiconductor, nanocrystals and carbon nanotubes) including some of the fabrication procedures. Although these studies are presently pure scientific we will speculate on electronic applications.

One such speculation concerns the possible development of quantum computers. We will outline the basic principles of a quantum computer as well as the foreseen advantages. The realization of a quantum computer contains many difficulties. We discuss these hurdles using qu-bits based on quantum dots as an example. We particularly focus on the quantum information contained in the spin degree of freedom of individual electrons. Our experimental efforts focus on realizing spin-qubit circuits. These little circuits have to include a double quantum dot with controllable tunnel coupling between the dots; electron-spin resonance loop for performing single spin rotations; and a non-invasive read-out system. Our read-out is performed by a quantum point contact detector. Parts of this little qubit circuit are now being tested, some parts are already working.

[1] See for a review on quantum dots: Few-electron quantum dots, L.P. Kouwenhoven, D.G. Austing and S. Tarucha, Rep. Prog. Phys. 64, 701-736 (2001). This review and other papers can be found at http://qt.tn.tudelft.nl/
[2] Double transport through double quantum dots. W. G. van der Wiel, S. De Franceschi, J. M. Elzerman, T. Fujisawa, S. Tarucha and L. P. Kouwenhoven, Reviews of Modern Physics 75, No.1, 1-22 (2003)
[3] Single shot read-out of an individual electron spin in a quantum dot J.M. Elzerman, R. Hanson, L.H. Willems van Beveren, B. Witkamp, L.M.K. Vandersypen and L.P. Kouwenhoven, Nature 430, 4310435 (2004).

Abendvortrag

AV I Fr 20:00 TU H105
Di 19:30 URANIA

Molekulare Maschinen und Brown'sche Motoren — •Hermann E. Gaub — Angewandte Physik und Center of Nanoscience, Ludwig-Maximilians Universität München

Seit ihrer Entdeckung als Transporter von Organellen und aktive Bestandteile der Muskeln haben molekulare Motoren Wissenschaftler der verschiedensten Disziplinen in ihren Bann gezogen. Ihre Aufklärung ist ein lebendiges Beispiel trans-disziplinärer Forschung. Während heute die Molekularbiologie der Motoren zum großen Teil verstanden ist, bleibt bei den physikalischen Grundlagen noch viel Raum für Diskussion. Ob die chemische Energie zur Gleichrichtung Brown'scher Bewegung oder direkt zur Verrichtung mechanischer Arbeit durch Konformationsänderungen umgesetzt wird, ist noch heftig umstritten. An synthetischen molekularen Maschinen, die typischerweise wesentlich einfacher aufgebaut sind, können die fundamentalen Prozesse kontrollierter untersucht werden.

Plenarvortrag

PV III Sa 17:00 TU H105

A golden age for astronomy — •Catherine Cesarsky — European Southern Observatory, Karl-Schwarzschild-Strasse 2, D-85748 Garching bei München

For some decades, astrophysics has undergone a technological and conceptual revolution. Thanks to new and powerful observational facilities, on the ground and in space, every stage of evolution of the Universe and its components is now within reach. A new era has started, ten years ago, with the discovery of planets around stars other than the sun, officially launching the quest for other worlds. The presence of a black hole in the center of our galaxy is now established, from its gravitational effect on stars orbiting around it; we can study details of the way black holes accrete matter, and use them to test General Relativity. A wealth of diverse observations find the best interpretation within the Big Bang cosmology, with a Universe totally dominated by dark energy, a form of Einstein's cosmological constant, and by dark matter of unknown nature.

Plenarvortrag

PV IV Sa 17:00 TU P270

Ciphers, quanta and computers — •Artur Ekert — DAMTP, University of Cambridge

In early 1935, Albert Einstein, together with Boris Podolsky and Nathan Rosen, published a classic paper which questioned the completeness of quantum mechanical description of reality and, in a tacit way, introduced quantum entanglement. After playing a significant role in the development of the foundations of quantum mechanics, entanglement has been recently rediscovered as a new physical resource with potential commercial applications. In particular it can be used to construct new methods of secure communication and new methods of breaking ciphers. I will outline the evolution of the concept from its origin till today and describe some of its current applications in quantum cryptography and quantum computation.

Sonntagsvortrag

SV I So 15:30 HU Audimax

Space, Einstein & Technology: The NASA-Stanford Gravity Probe B mission — •C.W. Francis Everitt — W.W. Hansen Experimental Physics Laboratory

Gravity Probe B (GP-B) was launched from Vandenberg Air Force Base on 20 April and entered its science phase 27 August 2004. It will perform two highly accurate tests of two effects in General Relativity, Einstein's theory of gravitation, by means of orbiting gyroscopes: 1) the 6.6 arc-s/year geodetic effect due to the motion of the gyroscope through the curved space-time around the Earth; 2) the 0.042 arc-s/year frame-dragging effect due to the 'dragging around' of space and time by the rotating Earth. In addition to describing GP-B science and the many new technologies developed for the experiment, a few comments will be offered on the management challenges of developing a space mission and the real-life experience of running a physics experiment on-orbit.

Sonntagsvortrag

SV II So 16:30 HU Audimax

Einsteins heritage: The social responsibility of physicists and global nuclear disarmament — •Jack Steinberger — European Organization for Nuclear Research, CERN, CH-1211 Genève 23, Switzerland

2005 is the 50th birthday of the Russell-Einstein-Manifesto which triggered workshops by scientists, such as Pugwash, to study the problem of nuclear weapons and nuclear disarmament. Following some general remarks on my understanding of the social responsibility of scientists, I would like to discuss the problem of nuclear weapons. These pose a

continuing threat to humanity, but the problem has the virtue, that, in contrast with other major problems facing our society, it could be solved easily. The chief responsibility for this is with the United Sates, to lead the disarmament of the nuclearweapons states, but Germany and other non nuclear weapons states could help with a not insignificant contribution.

Sonntagsvortrag

SV III So 17:30 HU Audimax

Unsere Verantwortung für das Klima – Was können wir wissen? — •Brigitte Falkenburg — Fakultät 14, Institut für Philosophie, D-44221 Dortmund

Unsere Verantwortung für das Klima liegt im Spannungsfeld von Technik und Wissenschaft, Ökonomie und Moral. Unser Energieverbrauch ist kollektives technisch-ökonomisches Handeln unter Bedingungen extremer Unsicherheit. Wenn wir von unserer Verantwortung für das Klima sprechen, so beziehen wir uns aber mit einem moralischen Begriff auf individuelles Handeln. Was heißt dabei „Verantwortung"? Wie kann und soll man Verantwortung für das Klima übernehmen? Offenbar, indem man sich Wissen über den Zusammenhang von Energieverbrauch und Klimaentwicklung verschafft und entsprechend handelt. Dieser Zusammenhang läßt sich aber längst nicht so exakt und eindeutig modellieren, wie Politik und Öffentlichkeit es gerne hätten. Außerdem beruht unser individueller Energieverbrauch eher auf ökonomischen Bedingungen als auf moralischen Prinzipien. Was können wir über unsere Handlungsoptionen und deren Konsequenzen wissen, angesichts des gegenwärtigen Stands der Klimaforschung und unter den Bedingungen des globalisierten Kapitalismus?

Plenarvortrag

PV V Mo 08:30 HU Audimax

Light and Life — •Ahmed H. Zewail — California Insitute of Technology, Arthur Amos Noyes Laboratory of Chemical Physics, Mail Code 127-72, Pasadena, California 91125, USA

Ever since the beginning of history, humankind has been the benefactor of light's miracles. The interconnection between life and light is so strong that man has been searching for an answer to the question - what is light? Over the last century, developments and many breakthroughs in this journey have been made. Albert Einstein was one of the prominent scientists who addressed the fundamental nature of light. In this lecture, we will address aspects of this journey and highlight some of the cornerstone developments for science and technology developments, from the early days of the 20th century until the present time.

Plenarvortrag

PV VI Mo 08:30 TU H105

Semiconductor Heterostructures — •Herbert Kroemer — ECE Department and Materials Department, University of California, Santa Barbara, CA 93111, USA

In a compositionally heterogeneous semiconductor structure with a position-dependent energy gap, the conduction and valence band edges no longer have the same slope. Hence the forces on conduction electrons and holes are no longer equal in magnitude and opposite in direction; they may in fact be in the same direction. The utilization of these quasi-electric forces is the unifying principle underlying all semiconductor heterostructure devices, both for physics research and for practical applications. Essentially all modern compound semiconductor structures draw on this principle, which is also invading silicon-based device technology, In the limit of near-atomically abrupt transitions, the quasi-electric fields turn into true potential steps, with pronounced quantum effects in the space between closely spaced interfaces, as in quantum wells, tunneling barriers, and superlattices. The presentation will give several examples of this principle and its central role in fundamental research and practical devices.

Plenarvortrag

PV VII Mo 08:30 TU P270

Einstein's Methods — •John D. Norton — Department of History and Philosophy of Science, University of Pittsburgh

Einstein's early discoveries were made by thinking physically and reflecting on special cases of clear physical meaning, as in his famous use of thought experiments. He contrasted this method with one based on formal or mathematical naturalness. In a remarkable notebook of private calculations, written during his discovery of general relativity, we can observe Einstein as he tested both approaches and failed to get them to agree. In his later years Einstein turned to formal-mathematical methods exclusively, proclaiming that "our experience hitherto justifies us in believing that nature is the realization of the simplest conceivable mathematical ideas."

Abendvortrag

AV II Mo 19:30 URANIA

Einsteins Nobelpreis: Der Quantensprung von der Mikro- in die Nanoelektronik — •Klaus von Klitzing — Max-Planck-Institut für Festkörperforschung, Heisenbergstr.1, D-70569 Stuttgart, Germany

Einsteins Nobelpreis aus dem Jahre 1921 beruht auf einer revolutionären Arbeit aus seinem Wunderjahr 1905. Das Licht wird nicht als Welle sondern in dem Bild der Lichtquanten diskutiert. In dieser Arbeit wird der von Max Planck in einem Akt der Verzweiflung eingeführten Quantenhypothese zum Durchbruch verholfen, auch wenn Einstein noch 50 Jahre später behauptet, dass er keine Antwort auf die Frage hat: Was sind Lichtquanten? Insbesondere der Welle-Teilchen Dualismus sowie diskontinuierliche Eigenschaften im Mikrokosmos widersprechen der Alltagserfahrung. Gerade diese neuartigen Eigenschaften spielen in der Nanoelektronik eine wachsende Rolle, so dass dieser Forschungsbereich nicht als kontinuierliche Weiterführung der etablierten Mikroelektronik angesehen werden kann, sondern ein Quantensprung darstellt mit dem Potenzial neuartiger Anwendungen.

Abendvortrag

AV III Mo 20:00 HU Audimax
Fr 19:30 URANIA

Einsteins Holodeck: Visualisierung relativistischer Effekte — •Hanns Ruder — Theoretische Astrophysik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen

Da wir nicht täglich mit 90 % der Lichtgeschwindigkeit durch ein Wurmloch zu unserem Arbeitsplatz in der Nähe eines Schwarzen Lochs fliegen, sondern in einem durch die Newtonschen Gesetze sehr gut beschriebenen Zwickel des Universums leben, konnten wir leider keinen intuitiven Zugang für die spezielle und allgemeinrelativistische Raumzeit entwickeln. Dank schneller Rechner und moderner Computergraphik können wir aber heute die relativistischen Effekte simulieren und visualisieren. Man „versteht" sie dadurch zwar auch nicht, aber man sieht sie wenigstens.

Abendvortrag

AV IV Mo 20:00 TU H105

Mit dem Röntgenlaser in unsichtbare Welten — •Helmut Dosch — Max Planck Institute for Metals Research, Heisenbergstr. 3, 70569 Stuttgart

Auf der Suche nach dem unentbehrlichen Rohstoff Wissen und dessen Nutzbarmachung für neue Technologien haben Physiker, Chemiker und Biologen ein revolutionäres neues Mikroskop zur Erforschung von Nanostrukturen ersonnen, das aus einem Science Fiktion Roman zu entstammen scheint und einen Menschheitstraum wahr werden läßt: Es ist gewissermaßen eine Höchstgeschwindigkeits-Filmkamera, die mit Röntgenlaserlicht arbeitet und holographische Blitzlicht-Aufnahmen vom Tanz der Atome und Moleküle in Materie erlaubt. Damit wird es erstmals möglich werden, direkt zu beobachten, wie chemische Bindungen entstehen und brechen, wie Medikamente wirken und Nanostrukturen funktionieren. Dieses atemberaubende Zukunftsprojekt zur Erforschung des Nanokosmos soll in den nächsten Jahren in Deutschland errichtet werden:

Das Europäische Röntgenlaser-Labor.

Der Vortrag entführt Sie in einer allgemein-verständlichen Sprache und anhand von verblüffenden Experimenten in eine bislang verborgene, unsichtbare Dimension des Nanokosmos, die mit dem Röntgenlaser erstmals zugänglich werden soll.

Plenarvortrag

PV VIII Di 08:30 HU Audimax

A Vision for Laser Induced Particle Acceleration and Applications — •Ken Ledingham — Department of Physics, University of Strathclyde, Glasgow, Scotland & AWE plc, Aldermaston, Reading, UK

Large particle accelerators like CERN and GSI have for more than half a century been at the vanguard of nuclear and particle physics revealing the fundamental building blocks and forces of nature.

However the size and cost of these are fuelling serious efforts to develop new and more compact accelerator technologies. Recently it has been shown that ultra-intense lasers, via plasma conditions, can generate high intensity beams of electrons, photons, protons, neutrons and heavy ions. This talk will describe some of the experiments which have been carried out as proof of principle of this new field. The experiments which will be described were mostly carried out on large single pulse lasers which equally are large accelerators.

However it will be argued that the future of the field especially for medical applications lies in compact lasers of a similar intensity to the

large single shot lasers. This may yield the vision of particle acceleration on a "table top".

Plenarvortrag

PV IX Di 08:30 TU H105

Production and Study of Matter and Anti-Matter in Modern Nuclear Physics — •Peter Braun-Munzinger — GSI, Planckstr. 1, 64291 Darmstadt

In collisions between nucleons or nuclei at high energy particles and their anti-particles, or matter and anti-matter, are copiously produced. We will discuss in this talk how the properties of the produced matter can be studied to shed light on the state of the universe a few microseconds after the big bang. Modern nuclear physics experiments have thus provided evidence for a phase transition in the early universe. We further demonstrate how the produced antimatter can be isolated and transformed into highly collimated particle beams. With such anti-matter beams new experiments can be performed. They include the production of anti-hydrogen, on which a series of fundamental measurements are underway.

Abendvortrag

AV V Di 20:00 HU Audimax

Quantum Phenomena in Nanoelectronics: A Modern Research Field — •Klaus von Klitzing — Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart, Germany

The scaling laws for the miniaturization of microelectronic devices break down if the wave nature and the discrete charge of electrons dominate the electronic properties. These quantum phenomena do not mark the end in the miniaturization of devices but open the possibility to create new devices with new functions where for example ballistic transport, the energy quantization of electrons in confined structures, the electron spin, tunnel phenomena through barriers, and single electron charging of small islands play an important role.

The talk gives an overview about the physics, technology and application of semiconductor quantum structures and discusses some recent basic research activities in the fascinating field of quantum information technology.

Abendvortrag

AV VI Di 20:00 TU H105
Mi 19:30 URANIA

Ultrakurze Lichtpulse: Wie und wofür — •Ursula Keller — Swiss Federal Institute of Technology (ETH), Physics Department, Institute of Quantum Electronics, ETH Hönggerberg, HPT, CH-8093 Zürich

Schnellste Prozesse in Natur und Technik messen, verstehen und kontrollieren zu können, ist die grundlegende Motivation für die Erzeugung von ultrakurzen Lichtpulsen. Dank der Laser können wir in fast unvorstellbar kurze Zeiteinheiten von nur einer Femtosekunde ($= 10^{-15}$ s = 0.000 000 000 000 001 s) und neuerdings auch in den Attosekundenbereich (nochmals 1 000 Mal kürzer als eine Femtosekunde!) vorstossen. Eine grundlegende Voraussetzung für den Laser wurde von Einstein 1917 mit der stimulierten Emission geschaffen – der erste Laser wurde schliesslich 1960 demonstriert. Ultraschnelle Prozessse finden wir in allen Bereichen unseres Lebens. Zum Beispiel laufen biologische und chemische Reaktionen sowie grundlegende Prozesse in elektronischen Schaltelementen auf diesen Zeitskalen ab. Aber nicht nur die Zeitauflösung ist von Bedeutung. Für sehr kurze Zeiteinheiten kann die Leistung in einem Laserpuls die Leistung sämtlicher Kraftwerke der Welt übertreffen. Zusätzlich kann Laserlicht extrem stark gebündelt werden, wodurch enorm hohe Intensitäten erzeugt werden, die ohne Probleme Metallteile schneiden können. Aufgrund der kurzen Pulszeiten ist die Materialbearbeitung mit dem Laser viel präziser, was heute zum Beispiel auch bei Augenoperationen Anwendung findet. Weiterhin haben ultrakurze Lichtpulse immer auch ein sehr breites Spektrum. Dieses Spektrum kann dazu benutzt werden, neuartige und ausserordentlich präzise Uhren zu konstruieren. Eine derartig genaue Uhr erlaubt uns vielleicht in Zukunft sogar die Allgemeingültigkeit von physikalischen Konstanten zu überprüfen.

Plenarvortrag

PV X Mi 08:30 HU Audimax

Particles and Strings - Probing the Structure of Matter and Space-Time — •Jan Louis — II. Institut für Theoretische Physik der Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

String Theory is introduced as a possible unifying concept of Particle Physics and General Relativity.

Plenarvortrag

PV XI Mi 08:30 TU H105

Quantum Tunneling of the Magnetization in Molecular Nanomagnets — •Myriam Sarachik — Dept. of Phys., CCNY-CUNY, Convent Ave & 138 St, New York, NY 10031, USA

Molecular nanomagnets, sometimes referred to as single molecule magnets, have attracted a great deal of recent attention for interesting behavior that is borderline between the classical and quantum mechanical regimes, and because of their potential usefulness for high-density data storage and quantum computation. Quantum mechanical processes are observed in these materials on a macroscopic scale in the form of steps in the magnetization curves. Two particularly simple prototypes, Mn12-acetate and Fe8, have been studied in great detail. Typical behavior of the class will be examined by considering Mn12-acetate: the structure of the molecule, the tetragonal (four-fold symmetric) crystal, the Hamiltonian that models the behavior, and the tunneling process that gives rise to the magnetization steps.