Plenary Talk PV I Mon 8:30 H1

Understanding Nanostructures: Nanotubes, Nanowires, and Graphene Nanoribbons — •Steven G. Louie — Department of Physics, University of California at Berkeley — Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

The restricted geometry and symmetry of nanostructures often give rise to novel properties that are also potentially useful in applications. In this presentation, I discuss some recent progress on using theory and computation to understand and predict some of their electronic, transport, optical, and mechanical properties. Examples of systems of interest include carbon and BN nanotubes, Si nanowires, and graphene nanoribbons. These nanostructures exhibit a number of unexpected behaviors – novel conductance characteristics, extraordinarily large excitonic effects, strange friction forces, and a field-induced half-metallic state for the zigzag graphene nanoribbons, among others. The physical mechanisms behind these unusual behaviors are examined.

Special Session "h-index" PV II Mon 13:00 H1

The h-index: how useful is it as a measure of scientific achievement? — •Jorge E. Hirsch — Department of Physics, University of California, San Diego

The h-index was proposed in 2005 as a succinct way to quantify an individual's scientific research output. It has generated considerable interest not only in physics but also in other scientific disciplines, and has recently been implemented in the ISI Web of Science. Several extensions of the original concept have also been proposed. I will discuss various properties of the h-index, what I view as its advantages over other indicators and potential disadvantages, and whether it is a good predictor of future achievement.

Special Session "h-index" PV III Mon 13:30 H1

Is it any good? Measuring scientific merit — •Philip Ball — Nature, 4-6 Crinan St, London N1 9XW, UK

How do we know if a paper is any good? How do you evaluate someone's scientific output? Which is more praiseworthy: a solid piece of work in an established field, or a stimulating new hypothesis which may or may not be right? Who are the 'best' scientists? The more deeply we probe into the question of quality in scientific research, the more contentious it becomes. That's why it is useful to have objective measures of quality, so that assessment – an important aspect of any human enterprise – does not become a lottery of personal opinion. The measures commonly in use are generally based on citation analysis. But it is widely acknowledged that merely counting up the number of papers in *Nature*, *Science* and *Physical Review Letters* is not the best way of quantifying quality. What alternatives exist, and how good are they? Can there ever be a one-size-fits-all metric of the merit of one's scientific output? In this talk I shall look at some of those that have been proposed, discuss what they tell us about the state of science (and of physics in particular), and ask where citation analysis – and the role of scientific publishing in general – seems to be heading.

Plenary Talk PV IV Mon 18:00 H1

Venus Express — •Martin Pätzold — Universität zu Köln, Institut für Geophysik und Meteorologie, Zülpicher Str. 49a, 50923 Köln

The European spacecraft Venus Express is in a 24-hours orbit about Venus since April 2006. The scientific objectives of the mission focus on the study of the structure, composition, dynamics of the atmosphere, the interaction of the upper atmosphere and ionosphere with the solar wind and the atmospheric mass loss. Seven instruments are on board; two instruments (Venus Monitoring Camera VMC and Venus Express Radio Science VeRa) are led by principal investigators from Germany. The prime mission is running over 500 orbits (=500 Earth days). The first outstanding results after one (Earth) year in orbit will be presented.

Plenary Talk PV V Mon 19:00 H1

Gender Equitable Teaching and Learning in Physics Education — •Monika Bessenrodt-Weberpals — HAW Hamburg, Fakultät DMI, Department Technik

Reflective coeducation in physics is an attempt to abolish gender stereotypes and to replace them with a positive view on female and male identity, respectively. In this approach teaching combines authentic experiences with activating cooperative learning. Topics in modern physics and in everyday life, e.g. environmental or biological examples, inspire female and male students alike to use fundamental physical concepts competently, to devise scientific experiments and models, and to apply their knowledge to everyday situations as well as to technical problems. This context-based learning experience is well adapted to physics students as well as to the needs of a knowledge-based society. Furthermore, investigations prove that a temporary segregation of female and male students can have a positive effect on the women.

Plenary Talk PV VI Tue 8:30 H1

Climate Change 2007: The Physical Science Basis — •Peter Lemke — Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, D-27515 Bremerhaven

Climate variations are a result of complex interactions between the atmosphere, the ocean, the cryosphere and the land surface including the marine and terrestrial biosphere. Until 250 years ago, the interference of man was negligible, and climate variations were a product of natural processes and interactions alone. Since the beginning of industrialisation the composition of the atmosphere, especially the concentrations of greenhouse gases like carbon dioxide and methane, have significantly increased. In addition, the character of the land surface has been largely modified through land-use and land-cover change through human activities. Part of the observed global warming during the past 100 years is attributed to these anthropogenic impacts.

In 1988 when the problem of potential anthropogenic effects on the climate system was recognised, the Intergovernmental Panel of Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The Fourth IPCC Assessment Report is currently in preparation by three working groups and will be published in 2007. Working Group I deals with "The Physical Science Basis", Working Group II discusses "Impacts, Adaptation and Vulnerability", and Working Group III addresses "Mitigation of Climate Change".

This presentation will summarize the results of Working Group I emphasizing what observations tell us about climate variability and change in the past, what progress has been made in understanding the climate system, and will give a brief outlook on the projections for the remaining part of this century.

Prize Talk PV VII Tue 13:00 H1

From Microscopic Dynamics to Macroscopic Behavior — •Joel L. Lebowitz — Department of Mathematics and Physics, Rutgers State University of New Jersey, Piscataway, New Jersey, US — Träger der Max-Planck-Medaille

Statistical mechanics aims to relate the behavior of macroscopic objects to the dynamics of their constituent microscopic entities. Examples include the approach to equilibrium in isolated systems, properties of non-equilibrium stationary states of open systems, and the nature of phase transitions in equilibrium systems. Surprisingly many aspects of these phenomena can be captured in greatly simplied models of the microscopic world, such as lattice gases evolving via simple local stochastic rules. These aspects emerge as collective properties of large aggregates which are independent of many details of the microscopic dynamics. This is fortunate, since out ability to deal rigorously with realistic quantum many body systems is still very limited. In my talk I will try to connect rigorous results on model systems of varying degrees of idealization with more heuristic arguments about the behavior of real macroscopic systems.

Plenary Talk PV VIII Tue 17:00 H1

Islam and Science — •Pervez Hoodbhoy — Quaid-e-Azam University, Islamabad/Pakistan — von Laue Lecture

In this talk I shall first assess - within the limits of available data - the current state of the hard sciences (such as physics and mathematics) in Muslim countries. Although there is considerable variation across 48 Muslim countries, one concludes that the situation is unsatisfactory. Possible causes will be explored, including the priorities and funding practices of national governments. Prevalent Muslim attitudes towards science, technology, and modernity will be discussed. Muslim successes in science in earlier centuries are well known, and a comprehensive picture requires putting these into relation with the current cultural and political resistance to change. Bottlenecks to scientific growth will be identified. I shall then turn towards thoughtful contemporary voices among Muslims that recognize the depth of the current crisis, who offer plausible remedies for bringing science back into Islam, and who have captured at least some public attention. The possible role of the EU in helping science grow in Muslim countries will be explored.

Special Talk PV IX Tue 18:00 H1

Invisible Hands, Invaluable Assets — •John Krige — Kranzberg Professor, School of History Technology, and Society at Georgia Institute of Technology, Atlanta GA 30332-0345

The reward system of science, and our culture's enthusiastic valorization of individual achievement, mean that a high premium is placed on the dicoveries of great men and women. The history of science, mimicking the prevailing norms of the social system, and often depending on leading scientists for their intellectual cooperation and institutional support, tends to reinforce this view of how knowledge is produced. And understandably so, for the sciences, and physics in particular, have attracted some of the greatest minds of all time whose outstanding contributions to our understanding of nature deserve to be recorded.

Neveretheless, at least in the experimental domain, and with increasing importance after World War II, these individual achievements would not have been possible without the assistance of skilled and highly competent technicians, whose practical knowledge of the material world and how to manipulate it provided an essential platform on which cutting-edge research was made. These technicians and virtuoisi in the mechanical arts are the silent and formally unrecognized participants in laboratory life whose contributions, even if appreciated, are seldom celebrated, nor usually traced in the historical record. To give them their voice is not only to recognize their contributions to science but also to reconfigure our undertstanding of the conditions of the possibility of scientific innovation and successful scientific achievement. Drawing on a number of case studies in physics and related fields this paper will throw light on the contributions of the otherwise invisible hands whose activites have been overshadowed by the brilliance of the men and women who have made major contributions to the advance of scientific knowledge.

Plenary Talk PV X Wed 8:30 H1

Quantum dot spin manipulation — •Atac Imamoglu — Institute of Quantum Electronics, Quantum Photonics Group, ETH Hönggerberg, HPT G10, CH-8093 Zürich

Spin dynamics in quantum dots are enriched by their solid-state environment. I will describe recent experiments demonstrating efficient all-optical pumping and measurement of a quantum dot spin. Single-spin pumping is achieved using spontaneous spin-flip Raman transition, enabled by the hyperfine-interaction induced mixing of the single electron spin states. Measurement of the time-averaged spin-state on the other hand, is realized by observing the Faraday rotation of an off-resonant laser field.

Plenary Talk PV XI Wed 9:15 H1

Magnetic Nanostructures in the Lateral and Perpendicular Direction — •Hartmut Zabel — Institute for Condensed Matter Physics, Ruhr-Universität Bochum, D-44780 Bochum, Germany

Artificial magnetic nanostructures in the lateral and in the perpendicular direction are being intensively studied because of their intriguing magnetic properties and their use in spintronic devices. Perpendicularly stacked magnetic heterostructures allow the investigation of collinear and non-collinear interlayer exchange coupling, the exchange bias phenomena between ferro- and antiferromagnetic layers, as well as confinement and scaling effects of spin density wave magnetism. In the lateral direction a multitude of different shapes for ferromagnetic nanostructures can be realized such as stripes, dots, rings, squares, etc. The main interest in these nanostructures is the understanding of the domain structure in the ground state, the magnetization reversal in space and time, and the dipole interactions between the elements. In this talk an overview will be presented on investigations of magnetic superlattices and lateral magnetic nanostructures using mainly three experimental tools: vector and Bragg-MOKE, polarized neutron reflectivity, and resonant soft x-ray magnetic scattering.

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Evening Talk PV XII Wed 20:00 H1

Adhäsion an Mikro- und Nanostrukturen: Von Geckos, Minipilzen und smarten Oberflächen — •Eduard Arzt — Max-Planck-Institut für Metallforschung — Universität Stuttgart

Haftkräfte zwischen zwei Oberflächen: wie kann man sie gezielt verändern, erhöhen oder gar an- und ausschalten? Diese Thematik birgt viele interdisziplinäre Grundlagenfragen und ist gleichzeitig von großem Interesse in Mikrofertigung, Medizintechnik, Bauwesen, Sport u.v.a.m. In den letzten Jahren bezieht die Materialforschung wesentliche Inspiration aus biologischen Systemen: die phantastischen Haftmechanismen von Fliegen, Spinnen und Geckos – erkundet mit nanomechanischen Methoden – sind das Resultat von van-der-Waals- und Kapillarkräften. Wesentlich ist jedoch eine Miniaturisierung der Kontaktelemente, die beim Gecko bis in den Bereich 100 nm reicht. Der Vortrag zeigt Ergebnisse aus unserer disziplinübergreifenden Forschung: wie biologische Haftorgane aussehen und wie sie (wahrscheinlich) funktionieren, welche Messmethoden für die Charakterisierung der Adhäsion verwendet werden und zu welchen theoretischen Entwicklungen auf dem Gebiet der Kontaktmechanik die Bioinspiration geführt hat. Schließlich werden die neuesten künstlich hergestellten Polymeroberflächen vorgestellt; durch gezielte Mikrostrukturierung reichen sie bereits an ihre biologischen Vorbilder heran und werden sie als „smarte“ Oberflächen vielleicht bald übertreffen.

Prize Talk PV XIII Thu 8:30 H1

Optically probing charge and spin interactions in semiconductor quantum dots and molecules — •Jonathan J. Finley — Walter Schottky Institut, Technical University of Munich, 85748 Garching, Germany — Träger des Walter-Schottky-Preises

I will review investigations of optically pumped spin-memory devices that enable the reversible transfer between photon polarisation and the spin orientation of isolated electrons (e) or holes (h) in self-assembled GaAs-GaInAs quantum dot (QD) nanostructures.[1] Following resonant optical excitation using circularly polarized light, individual spin orientated e-h pairs (excitons) are selectively generated in the QDs with a total spin that reflects the helicity of the optical field used to create them. After generation we inhibit spontaneous recombination by selectively removing *one* charge from the dots by tunnelling whilst the other remains stored. Preparing spins in the upper Zeeman level allows us to study spin relaxation dynamics by electrically neutralizing the dots after a defined storage time and recording the optical polarization of the resulting luminescence signal. These experiments reveal that both e and h spin relaxation is very slow in QD-nanostructures, with spin relaxation times in the millisecond regime having been measured for electrons and similar timescales for holes. Our findings firmly establish that spin-flip scattering in QD-nanostructures is strongly suppressed when compared to higher dimensional systems and is mediated predominantly by spin-orbit (SO) interaction when subject to a magnetic field in excess of 1 Tesla.

I will then continue to discuss optical investigations of individual, electrically tuneable double dot systems (QD-molecules) formed from a pair of vertically aligned GaInAs QDs separated by a thin GaAs tunnel barrier. As the electric field is tuned, we observe a clear anticrossing between spatially *direct* (e,h in the same dot) and *indirect* (e,h in different dots) excitons with coupling energies in the range of a few millielectronvolts.[2] Our findings are in very good accord with realistic calculations, confirming that the inter-dot coupling is mediated by tunnel hybridization of the electron component of the exciton wavefunction over the two dots. Our structures also enable the introduction of additional electrons into the QD-molecule allowing us to probe negatively charged excitons. In this case, the results obtained are shown to be much richer due to the delicate interplay of *intra*- and *inter*-dot Coulomb interactions between localised charges in the QD-molecule.[3] The tunnel coupling energies are shown to be most sensitive to the *electron* population in the QD-molecule, confirming that the coupling mechanism is due to electron tunnelling. Moreover, the coupling is found to be spin-dependent providing much potential for the future electro-optical control and manipulation of few spin systems in coupled QD-nanostructures.

[1] M. Kroutvar, *et al.* Nature **432**, (2004)
[2] H. J. Krenner *et al.* Phys. Rev. Lett. **94**, 057402 (2005)
[3] H.J. Krenner *et al.* Phys. Rev. Lett. **97**, 076403, (2006)

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Prize Talk PV XIV Thu 13:00 H1

Spin Transfer Phenomena in Layered Magnetic Structures — •Peter Grünberg — Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — Träger der Stern-Gerlach-Medaille

After Stern- Gerlach's discovery of directional quantization it was Mott who formulated the “two current model” which considers the total current in a ferromagnet as formed by two currents, one of electrons with

spin up and one with spin down. Spin flip processes are assumed to be rare. During the last decades a range of experiments has become known which are also based on spin dependent transfer of electrons from one ferromagnetic film to another across a nonferromagnetic interlayer. For the ferromagnetic films generally only metals are considered, whereas the interlayer material can be metallic, semiconducting or insulating. Various processes like elastic or inelastic electron scattering, reflection and/or tunnelling can occur during the transition, which depend on the orientation of the electron spin with respect to the local magnetization. Due to this, oscillatory interlayer exchange coupling (IEC), Giant Magnetoresistance (GMR), current induced magnetic switching (CIMS) and spin injection is observed when the interlayer is metallic. For insulating and semiconducting interlayers nonoscillatory IEC, tunnel magnetoresistance (TMR) and recently also CIMS has been observed. Applications are mainly in the area of information technology and sensors for position and motion.

Plenary Talk PV XV Fri 8:30 H1

Active gels: toward a generic approach of cell mechanics — •Jean-François Joanny — Physicochimie Curie (CNRS-UMR168), Institut Curie Section Recherche, 26 rue d'Ulm, 75248 Paris Cedex 05, France

Active systems are systems where energy is constantly injected by a chemical reaction or by an external drive. Examples of active systems are vibrated sand piles, bird flocks or fish colonies. The cell cytoskeleton is also active : the energy is provided by the hydrolysis of ATP molecules which both promotes the polymerization and the depolymerization of the cytoskeletal filaments but also is used as a fuel by the molecular motors that walk along the filaments and create internal stresses. The dynamical properties of the cytoskeleton seem to be dominated by the gel formed by actin filaments interacting with myosin motors. A further property of the cytoskeletal filament is their polarity which imposes a local orientation in the gel.

We have built a general hydrodynamic theory to describe the rheology of polar active gels in the spirit of the hydrodynamic theory of liquid crystals. The theory takes into account the viscoelasticity of the gel, the polymerization and depolymerization, the local polarization, and the active stresses induced in the gel. We briefly present this theory and show some very unusual hydrodynamic behavior of active gels that can flow spontaneously even in the absence of any pressure gradient. We then give some examples of application of active gel hydrodynamics to study the properties of cells: lamellipodium motion, cell instabilities driven by cortical actin.

This work has been done in collaboration with F. Jülicher, K. Kruse, J. Prost and K. Sekimoto.

Plenary Talk PV XVI Fri 9:15 H1

Catalysis from first principles — •Jens K. Nørskov — Center for Atomic-scale Materials Design, Department of Physics, Technical University of Denmark

Electronic structure methods based on density functional theory have reached a level of sophistication where they can be used to describe complete catalytic reactions on transition metal surfaces. This gives an unprecedented insight into these processes and it allows us to extract knowledge about the catalyst properties determining its activity. The ammonia synthesis is used to exemplify the approach. It will be shown that we can now predict relative catalytic activities of different materials and discussed how we can use this to develop concepts helping the design of new alloy catalysts. The generality of the approach is illustrated by including a number of other catalytic reactions into a universal property-activity scheme, which identifies the surface properties that determine the catalytic activity for a whole class of reactions.