Plenary Talk PV I Mon 8:30 H 0105

Force and Function: Single Molecule Biophysics of Molecular Interactions — •Hermann E. Gaub — Ludwig-Maximilians-Universität, München, Germany

Molecular interactions are the basis of life and forces play a crucial role in both the assembly and the structural integrity as well as the dynamics of all living systems. The regulation of bio-molecular complexes, the maintenance of cellular structures, and even cell signaling are controlled by forces. At the molecular level the relation between these forces and their biological functions have become accessible by the different single molecule force spectroscopy techniques, which evolved in recent years. A deeper understanding of the physics of this relation has emerged from the very fruitful combination of the high resolution and precision of such experiments with the insight in structural rearrangements from all-atom Molecular Dynamics Calculations. In this talk a general overview on this field will be given, followed by a report on recent discoveries: The activation mechanisms of two prominent intracellular force sensors, Myosin Light Chain Kinase and Titin Kinase were elucidated. The clamp-mechanism of catch bonds between Cohesin and Dockerins in the Cellulosome complexes could be resolved. Novel strategies for parallelization of force-measuring assays will be discussed and a new chip based strategy will be introduced starting out from genes providing direct access to the mechanics of the encoded proteins in a one step process. At last, the use of molecular force balances for the analysis of DNA-protein interactions will be presented.

Prize Talk PV II Mon 13:00 H 0105

Atomic and Molecular Reactions in Slow-Motion — •Robert Moshammer — Max-Planck-Institut für Kernphysik, Heidelberg — Laureate of the Robert-Wichard-Pohl-Prize

Many-particle spectrometers (COLTRIMS / Reaction-Microscopes) combined with modern short-pulse IR and XUV radiation sources offer new prospects for studies of ultra-fast processes in atoms and molecules. At present, due to the enormous advances in laser technology, light pulses with durations of only a few femtoseconds (5 fs) down to the attosecond regime are available at intensities of 10^{14} W/cm^2 or more, revealing insight into the coupling of light with matter. How does an atom absorb two or more photons from an intense laser pulse, and how is the energy released after the interaction? This and other fundamental processes are subject of ongoing research. Pump-probe experiments with molecules allow the observation of rotational, vibrational and electronic excitations with unprecedented resolution and in real time, and time-resolved experiments with molecules using intense fs XUV Laser pulses are very first steps towards the visualization of fundamental molecular reactions. The general physical and technical concepts will be discussed and recent results will be presented.

Prize Talk PV III Mon 13:15 H 0104

Nanophononics: investigation and manipulation of lattice dynamics and phonon transport at nanoscale level — •Ilaria Zardo[1], Simone Assali[1], Sara Yazji[2], Stefan Funk[2], Milo Y. Swinkels[1], Rob W. van der Heijden[1], Erik P. A. M. Bakkers[1], and Gerhard Abstreiter[2,3] — [1]Department of Applied Physics, Eindhoven University of Technology, Eindhoven, The Netherlands — [2]Walter Schottky Institut, Technische Universität München, Garching, Germany — [3]Institute of Advanced Study, Technische Universität München, Garching, Germany — Laureate of the Hertha-Sponer-Prize

The interest in low dimensional systems has been steadily growing over the last decades. A particularly interesting system is provided by nanowires (NWs). The functional properties of NWs can be manipulated by tuning the crystal structure, and by the fabrication of 3-D complex novel architectures. These unique features can be exploited to investigate and manipulate lattice dynamics and phonon transport at nanoscale level. Apart from the fundamental interest, these studies can provide new pathways and systems to boost thermoelectricity.

The talk will focus on showing the understanding of the modifications of the lattice dynamic and optoelectronic properties of semiconductor NWs with respect to the bulk counterpart due to the different crystal phases [1-3]. Furthermore, we report on our investigations of the thermoelectric properties of semiconductor nanowires.

[1] S. Assali et al., Nano Lett., 13, 1559, (2013). [2] S. Funk et al., ACS Nano, 7, 1400, (2013). [3] I. Zardo et al., Nano Lett., 13, 3011, (2013)

Special Talk PV IV Mon 13:15 HE 101

Inside PRL — •Reinhardt Schuhmann — Physical Review Letter, Ridge, New York, U.S.A.

Physical Review Letters receives ~12000 submissions per year, and publishes about 1/4 of them. Editors decide what to publish with extensive input from peer review, with roughly 70% of manuscripts reviewed. My talk will provide an outline of how PRL manages peer review for such large numbers of manuscripts, while maintaining its presence as the premier physics journal - it is the most cited physics journal, with a Letter cited roughly every 90 seconds.

PRL faces many challenges, however, as the publishing trends in some areas of physics shift, for example to smaller, less comprehensive, or more interdisciplinary venues. This is particularly the case for the areas of physics covered at this DPG meeting. I will discuss some of these challenges, and what PRL is doing, and plans to do, to maintain a competitive journal that covers the full arc of physics. I would greatly appreciate your feedback and questions during and after the talk.

Prize Talk PV V Mon 13:25 H 0105

The Power of Coincidence — •Reinhard Doerner — Goethe University Frankfurt am Main — Laureate of the Robert-Wichard-Pohl-Prize

The COLTRIMS Reaction Microscope provides unprecedented images of the square of the many-body wave function of electrons and ions from the fragmentation of atom and molecules. The talk will discuss experiments showing entanglement and interference of fragments, showing images of molecular structures and present the discovery of the Efimov state of He3 with this technique.

Plenary Talk PV VI Mon 14:00 H 0104

Complex functional nanooptics and plasmonics — •Harald Giessen — 4. Physikalisches Institut und Forschungszentrum SCoPE, Universität Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart

Nanooptics has experienced tremendous growth over the last few years. The possibility to tailor materials and their dielectric and optical properties from the bottom up on the subwavelength level has opened the door to ultimate control of light-matter interaction. This holds true for the linear optical properties, as well as for optical nonlinearities. Particularly, plasmonics which involves resonant electron oscillations in metallic nanostructures, allowed for large electric field confinement and enhancement on the sub-100 nm length scale. Specifically, the combination of a variety of geometrical shapes and structures has enabled optical resonance tailoring, for example by utilizing narrow Fano resonances. Novel functionalities such as plasmonic chirality, leading to giant optical activity, can be attained through geometrical arrangment of simpler plasmonic building blocks. Hybrid plasmonic structures, which involve additional elements such as active phase-change, nonlinear, or magneto-optical materials, give control over the dynamical behavior of nanoscopic light-matter interaction. In this plenary talk, I am going to review some of the key fundamentals for building more complex plasmonic and nano-optical systems, and first applications for sensing as well as dynamic changes of their functionality will be presented.

Plenary Talk PV VII Mon 14:00 H 0105

The Genesis and Renaissance of General Relativity — •Jürgen Renn — Boltzmannstraße 22, 14195 Berlin

General Relativity was developed by Albert Einstein at the beginning of the 20th century as an answer to fundamental problems of contemporary physics. The talk will trace the genesis of General Relativity in its contexts in physics, mathematics and philosophy, taking into consideration not only Einstein's research but that of many other scientists who contributed to the development of relativity. The theory nevertheless remained a marginal phenomenon of physics at first, especially in comparison to quantum theory. It was not until the second half of the 20th century that General Relativity developed into a key instrument of astrophysics. The rise of relativistic astrophysics was prepared and accompanied by a renaissance of General Relativity. The talk will explore the prehistory and conditions of this renaissance and show how General Relativity eventually became not only a highly active field of research but also one of the principal challenges to the conceptual unification of physics.

Plenary Talk PV VIII Tue 8:30 H 0105

Magnetic Materials for Green Technologies — •Oliver Gutfleisch — TU Darmstadt, Material Science, 64287 Darmstadt — Fraunhofer Project Group for Materials Recycling and Resource Strat-

egy IWKS Hanau

Due to their ubiquity, magnetic materials play an important role in improving the efficiency and performance of devices in electric power generation, conversion and transportation (1). Permanent magnets are essential components in motors and generators of hybrid and electric cars, wind turbines, etc. Magnetocaloric materials could be the basis for a new solid state energy efficient cooling technique alternative to compressor based refrigeration (2). Any improvements in magnetic materials will have a significant impact in these areas, on par with many other energy materials (e.g. hydrogen storage, batteries, thermoelectrics, etc.).

The talk focuses on rare earth and rare earth free permanent magnet and magnetocaloric materials with an emphasis on their optimization for energy and resource efficiency in terms of the usage of critical elements. The concept of criticality of strategic metals will be explained by looking at demand, sustainability and the reality of alternatives of rare earths. Synthesis, characterization, and property evaluation of the materials will be examined considering their micromagnetic length scales and phase transition characteristics.

(1) Magnetic Materials and Devices for the 21st Century: Stronger, Lighter, and More Energy Efficient, Adv. Mat. 23 (2011) 821.

(2) Giant magnetocaloric effect driven by structural transition, Nature Mat. 11 (2012) 620.

Plenary Talk PV IX Tue 13:00 H 0105

Nanoscopy with focused light — •Stefan Hell — Max-Planck-Institut für biophysikalische Chemie, Göttingen, Deutschland

For more than a century, it has been widely accepted that diffraction of light precludes any lens-based optical microscope from discerning details smaller than about half of the wavelength of light (~200 nm). However, in the 1990*s it was discovered that basic state transitions in a fluorophore can be exploited to eliminate the resolution-limiting role of diffraction. Since then, fluorescence microscopes have been developed that are now able to resolve on the nanometer scale. We discuss the basic principles of these nanoscopy (superresolution) concepts with particular emphasis on the first viable far-field *nanoscopy* method, STED microscopy. We show their scope of applications in the life sciences and beyond.

Prize Talk PV X Tue 14:00 H 0104

Classification of topological quantum matter with symmetries — •Andreas Schnyder — Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany — Laureate of the Walter-Schottky-Prize

Topological materials have in recent years become a subject of intense research due to fundamental considerations as well as potential use for technical applications in device fabrication and quantum information. One of the hallmarks of topological materials is the existence of protected exotic zero-energy surface states, which arise as a consequence of a nontrivial topology of the bulk wave functions. In this talk, starting from the ten-fold classification of topological insulators and superconductors, I will survey recent developments, with a particular emphasis on the topological classifications of fully gapped and gapless materials in terms of crystal reflection symmetries. As concrete examples, I discuss the Dirac materials Ca_3PbO and Sr_3PbO and show that these antiperovskites are reflection-symmetry-protected topological insulators. The Dirac surface states of these materials are protected by a non-zero mirror Chern number, which can take on only even values. If time permits, I will also present some results about the topological properties of the Dirac material Na_3Bi and of some noncentrosymmetric superconductors. In particular, I will explain how reflection symmetry gives rise to protected arc surface states in these topological materials. I will discuss experimental signatures of these topological surface states in charge and thermal transport measurements, as well as in Fourier-transform scanning tunneling spectra.

Prize Talk PV XI Tue 14:30 H 0104

Symmetry Protected Topological Phases in One-Dimensional Systems — •Frank Pollmann — Max Planck Institute for the Physics of Complex Systems — Laureate of the Walter-Schottky-Prize

Classifying and understanding different phases of matter is an important task of condensed matter physics. The class of "conventional" symmetry broken phases is well understood in terms of Landau's theory. In contrast, topological phases, i.e., phases of matter that cannot be characterized in terms of symmetry breaking, are less understood and no complete classification is known so far. In my talk, I will introduce the class of Symmetry Protected Topological (SPT) Phases and describe a mathematical framework to classify them. These SPT phases are topological phases of matter that are distinct from a trivially disordered phase only as long as certain symmetries are preserved. A well known example of such a phase is the Haldane phase in spin-1 chains.

Special Talk PV XII Tue 15:15 H 0104

The German Research Foundation – a short overview — •Cosima Schuster and Michael Mössle — Deutsche Forschungsgemeinschaft, Bonn

The German Research Foundation (DFG) is the central funding organization for basic research in Germany. As a self-governing organization for science and research it offers a broad spectrum of funding opportunities from individual grants to larger coordinated programmes. Thereby, DFG funding shall enable interdisciplinary and international cooperation between researchers. One of the DFG's key objectives is the promotion of young scientists and researchers. DFG offers appropriate support at every phase of their qualification. The talk will give an overview about DFG funding possibilities, the decision processes, the financial framework/budget distribution between programmes and scientific fields, and the funding rates. In particular, funding programmes for early career scientists and international programmes will be discussed in detail, e.g. the postdoctoral research fellowship for a stay abroad and the Emmy-Noether-programme.

Plenary Talk PV XIII Tue 17:50 H 0105

From laser light to brain dynamics — •Hermann Haken — University Stuttgart

The year 2015 has been declared to be "year of the light". One of the most spectacular forms of light is surely laser light with its numerous, often astounding applications. I will show what makes laser light so different from light from thermal sources. Laser light is an excellent example of selforganization of systems far from thermal equilibrium, of a nonequilibrium phase transition and of the emergence of new properties at the macroscopic scale. An appropriate treatment of selforganization requires new concepts such as circular causality and the slaving principle forming a bridge between the "microscopic" and the "macroscopic". After a brief outline of Synergetics, a field of research treating these phenomena systematically, I will present examples from brain dynamics at the macro-level (ambigous figures and hysteresis in perception) and at the micro/macro-level (pattern recognition, hybrid images, neuronal spike synchronization). An outlook at information adaptation (Shannon/semantic Information) will be given.

Plenary Talk PV XIV Wed 8:30 H 0105

Beyond electronics: abandoning perfection for quantum technologies — •David D. Awschalom — Institute for Molecular Engineering, University of Chicago, USA

Our technological preference for perfection can only lead us so far: as traditional transistor-based electronics rapidly approach the atomic scale, small amounts of disorder begin to have outsized negative effects. Surprisingly, one of the most promising pathways out of this conundrum may emerge from recent efforts to embrace defects and construct 'quantum machines' to enable new information technologies based on the quantum nature of the electron. Recently, individual defects in diamond and other materials have attracted interest as they possess an electronic spin state that can be employed as a solid state quantum bit at and above room temperature. Research at the frontiers of this field includes creating and manipulating these unusual states in a new generation of nanometer-scale structures. These developments have launched technological efforts aimed at developing applications ranging from secure data encryption to radical improvements in computation speed and complexity. We will describe recent advances towards these goals, including the surprising ability to control atomic-scale spins for communication and computation within materials surrounding us for generations.

Special Talk PV XV Wed 13:15 H 0104

Apples vs. Oranges: Comparison of Student Performance in a Massive Open Online Course (MOOC) vs. a Brick-and-Mortar Course — •Michael Dubson[1], Ed Johnsen[1], David Lieberman[2], Jack Olsen[1], and Noah Finkelstein[1] — [1]University of Colorado at Boulder, Boulder, CO USA — [2]CUNY/Queensborough Community College, Bayside, NY, USA

In the fall of 2013, we taught the calculus-based introductory physics

course at the University of Colorado at Boulder and, at the same time we taught a MOOC version of the same course, through Coursera. Students in both courses received identical lectures, homework assignments, and timed exams. We present data on participation rates and exam performance for the two groups. We find that the MOOC is like a drug targeted at a very specific population. When it works, it works well, but it works for very few. This MOOC worked well for older, well-educated students, who already have a good understanding of Newtonian mechanics.

Prize Talk PV XVI Wed 13:15 H 0105

Light control of functional materials — •Andrea Cavalleri — Max Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany — Department of Physics, University of Oxford, Oxford, UK — Laureate of the Max-Born-Prize

In this talk I will discuss how light is emerging as a new tool to imprint new properties and functionalities in solids. Work of ever increasing experimental sophistication is being fuelled by a revolution in optical technology and laser science, which is making it possible to drive and interrogate matter on the shortest time- and length-scales. Both by driving charge excitations across electronic bands, or by controlling other excitations with nonlinear THz-frequency optical techniques, coherent control has been amply shown to turn insulators into metals, switch the magnetic state of solids and even induce superconducting coherence. Behind the ever-increasing body of work in this area, is a desire to understand non-equilibrium many-body physics and to invent new technologies for data manipulation and storage at ultrahigh speeds.

Plenary Talk PV XVII Wed 14:00 H 0104

Computationally Aided Materials Discovery and Design — •Mark Asta — Department of Materials Science and Engineering, University of California, Berkeley, CA 94720, USA

The discovery and design of new materials has often been a critical enabler in the development of new technologies. Whether considering semiconductor compounds for microelectronics, new electrode materials high-voltage batteries, or high-temperature alloys for energy conversion, the design and development of new materials continues to be central to enabling technological innovation. This talk will provide an overview of efforts aimed at using the modern framework of density-functional-theory (DFT) first-principles calculations to guide materials discovery and accelerate materials design. An overview will be given of the use of DFT-based calculations, performed in a high-throughput mode, to develop databases for use in screening materials and for training data-analysis algorithms to guide discovery of new materials with targeted applications. In addition, the use of DFT-based methods as the foundation for hierarchical multiscale modeling in the arena of materials design and development will be discussed. To highlight the main concepts, examples will be described in the context of materials for energy conversion and for advanced structural applications.

Plenary Talk PV XVIII Wed 14:00 H 0105

Cosmological Inflation - A Confrontation with Data — •Dominik Schwarz — Bielefeld University

The idea of cosmological inflation refers to an epoch of accelerated expansion of the very early Universe. Besides solving some of the problems of the old hot big bang model, it provides a mechanism to seed cosmic structures (e.g. galaxies) and predicts the statistical properties of the large scale structure of the Universe.

Highest quality observations of the cosmic microwave background radiation (both in intensity and polarization), most recently by the Planck collaboration, allow us to test the predictions of cosmological inflation. Controversial claims have been put forward by the BICEP collaboration and some anomalous features have been identifies at the largest observable scales. Nevertheless, almost perfect agreement between theory and observation has been found, leaving us with a standard model of cosmology that poses several new, fundamental questions.

Evening Talk PV XIX Wed 18:00 H 0105

Max-von-Laue-Lecture: Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation — •Frank N. von Hippel — Princeton University, Princeton, New Jersey, USA

The number of operational nuclear weapons in the world has dropped from about 65,000 at the end of the Cold war to about 10,000 and can be driven much lower. But we have a huge amount of highly enriched uranium and separated plutonium from these dismantled Cold War nuclear weapons and from failed civilian plutonium breeder reactor commercialization programs. To make nuclear disarmament irreversible and prevent nuclear terrorism, all this material must be secured and disposed of. We also must abandon the idea of using a nuclear-weapon-usable material as a fuel * that is plutonium in power reactors and highly enriched uranium in naval-propulsion and research reactors. Fortunately, using plutonium as a fuel is uneconomic and research and naval reactors can be designed to use low-enriched uranium. Finally, we must move away from ambiguous national enrichment programs like Iran*s to multinational enrichment programs such as Urenco.

Evening Talk PV XX Wed 20:00 Urania

Musikalische Rhythmen und Algorithmen: Physiker auf anderen Wegen — •Theo Geisel — MPI für Dynamik und Selbstorganisation — Bernstein Center for Computational Neuroscience Göttingen

Auch die besten Musiker spielen Rhythmen nicht mit perfekter Präzision; kleine Abweichungen vom exakten Rhythmus sind charakteristisch für von Menschen erzeugte Musik. Mit Methoden der statistischen Physik und der sogenannten Chaos-Theorie wird in diesem Vortrag nach Gesetzmäßigkeiten in rhythmischen Fluktuationen gesucht und deren Rolle in der musikalischen Wahrnehmung erhellt. Akustische Demonstrationen und musikalische Beispiele von Johann Sebastian Bachs Kunst der Fuge bis zu stochastischer Musik verdeutlichen die Wichtigkeit von langreichweitigen Korrelationen in der Musik und ihre Beziehung zur Informationsverarbeitung im Gehirn. Eine Anwendung dieser Forschungsergebnisse ist ein "Humanisierungs-Algorithmus", der es ermöglicht, computergenerierter Musik eine menschlichere Note zu geben.

Plenary Talk PV XXI Thu 8:30 H 0105

Transversal transport coefficients and topological properties — •Ingrid Mertig — Martin Luther University Halle-Wittenberg, 06099 Halle, Germany — Max Planck Institute of Microstructure Physics Halle, 06120 Halle, Germany

Spintronics is an emerging field in which both charge and spin degrees of freedom of electrons are utilized for transport. Most of the spintronic effects—like giant and tunnel magnetoresistance—are based on spin-polarized currents which show up in magnetic materials; these are already widely used in information technology and in data storage devices.

The next generation of spintronic effects is based on spin currents which occur in metals as well as in insulators, in particular in topologically nontrivial materials. Spin currents are a response to an external stimulus—for example electric field or temperature gradient—and they are always related to the spin-orbit interaction. They offer the possibility for future low energy consumption electronics.

The talk will present a unified picture, based on topological properties, of a whole zoo of transversal transport coefficients: the trio of Hall, Nernst, and quantum Hall effects, all in their conventional, anomalous, and spin flavor. The formation of transversal charge and spin currents as response to longitudinal gradients is discussed. Microscopic insight into all phenomena is presented by means of a quantum mechanical analysis based on density functional theory in combination with a semi-classical description which can be very elegantly studied within the concept of Berry curvature.

Special Talk PV XXII Thu 13:15 H 0104

Optics in Medicine — •Michael Totzeck — Carl Zeiss AG, Oberkochen, Germany

Optics and photonics are key technologies in modern medical healthcare, and light - often in the form of laser light - is used as a multipurpose tool in medicine. It helps to understand the biological causes of diseases, it is used for diagnosis and it is used for treatment. For diagnosis, optical coherence tomography reveals the three dimensional structure of tissue within the eye, flowmetry images and measures the blood flow, and fluorescence is used for intraoperative detection of tumor-margins. The surgical microscope enables delicate surgical procedures. But light can be used as well for micro-manipulation, e.g. if laser light cuts and coagulates tissue or treats retinal detachment.

This talk presents an overview of status, trends and new developments in the usage of light for medical applications. Some emphasis is given to ophthalmology and microsurgery innovations, e.g. new developments in optical coherence tomography and refractive surgery with fs-lasers.

Prize Talk PV XXIII Thu 13:15 H 0105
Quantum Universe — •Viatcheslav Mukhanov — LMU, München — Laureate of the Max-Planck-Medal

What caused galaxies, stars and planets to form? I will explain why quantum physics is crucial for explaining this and will discuss the experimental evidence that assures us that everything in our universe originated from quantum fluctuations.

Prize Talk PV XXIV Thu 13:15 EW 201
Theoretische Beschreibung des Trocknungsverhaltens dicker Photoresistschichten — •Maik Schönfeld, Jens Saupe, Steffen Schubert und Jürgen Grimm — Westsächsische Hochschule Zwickau, Dr.-Friedrichs-Ring 2a, D-08056 Zwickau, AG MEMS — Laureate of the Georg-Simon-Ohm-Prize

Epoxidharz-basierte Photoresistsysteme finden neben dem Einsatz als eigentlicher Resist im Fertigungsprozeß auch als Werkstoff zur Herstellung mikromechanischer Bauelemente Anwendung. Bei der Verwendung der Strukturen als mechanische Bauelemente spielt unter Anderem die Reproduzierbarkeit der mechanischen Eigenschaften und des Fertigungsprozesses eine übergeordnete Rolle. Variationen in der Prozessierung führen hier zu erheblichen Änderungen in den mechanischen Parametern der Strukturen. Mittels einer zu Beginn der Arbeiten vorliegenden, gravimetrisch kontrollierten IR-Trocknungsmethode wurden Trocknungsverläufe für dicke Epoxidharz-basierte Photoresistschichten innerhalb des Prozessschrittes des Softbakes aufgezeichnet. Ziel der präsentierten Arbeiten war, mit Hilfe grundlegender Diffusionsmodelle anhand der angefertigten Messreihen aufzuzeigen, dass der Trocknungsprozess dicker Resistschichten überwiegend diffusionsgesteuert abläuft. Dabei soll gezielt auf einen vereinfachten, niedrigparametrigen Ansatz zur Beschreibung der Trocknungskinematik von Photoresistschichten hingearbeitet werden. Mittels einer quantitativen Beschreibung dieses Diffusionsprozesses sind grundsätzliche Aussagen über die Trocknungskinematik unterschiedlich dicker Resistschichten möglich.

Plenary Talk PV XXV Thu 14:00 H 0104
Collective Motion, Collective Decision-making, and Collective Action: From Microbes to Societies — •Simon Levin — Princeton University, Princeton, NJ 08544, USA

Ecological and economic systems are alike in that individual agents compete for limited resources, evolve their behaviors in response to interactions with others, and form exploitative as well as cooperative interactions as a result. In these complex adaptive systems, macroscopic properties like the flow patterns of resources such as nutrients and capital emerge from large numbers of microscopic interactions, and feed back to affect individual behaviors. Contagion can lead to critical transitions from one basin of attraction to another, as for example with eutrophication, desertification, pest outbreaks, and market collapses. In both sorts of systems, evolution of one type or another leads to the differentiation of roles and the emergence of system organization, but with no guarantee of robustness. It is crucial to understand how evolutionary forces have shaped individual behaviors in the face of uncertainty. In this talk, I will explore the common features of these systems, especially as they involve the evolution of intragenerational and intergenerational resource allocation and the evolution of cooperation in dealing with public goods, common-pool resources and collective movement. I will describe examples from bacteria and slime molds to vertebrate groups to insurance arrangements and social norms in human societies.

Plenary Talk PV XXVI Thu 14:00 H 0105
Two-dimensional materials beyond graphene: atomically thin semiconductors — •Tony F. Heinz — Stanford University and SLAC National Accelerator Laboratory, Stanford, CA 94305, USA

Graphene has attracted great attention because of its exceptional potential for novel science and technology. Recently, this interest has expanded to the much wider class of 2D materials that arise as layers of van-der-Waals crystals that exhibit weak interlayer coupling, but strong in-plane bonding. While preserving graphene's flexibility and tunability by external perturbations, this broader set of materials provides access to more varied electronic and optical properties. In particular, the semi-metallic system of graphene is now complemented by stable 2D layers that are insulators and semiconductors.

Here we review the properties of atomically thin layers of semiconductors in the family of transition metal dichalcogenides, MX2, where M = Mo, W and X = S, Se, Te. In the limit of atomically thin layers, these materials exhibit a transition from optically dark indirect-gap materials to bright direct-gap materials. The 2D layers display remarkably strong many-body interactions, with exciton binding energies of 100's of meV and stable charged excitons at room temperature. The materials also provide new possibilities for control of the valley character of charge carriers. In particular, the helicity of light allows the selection of one of the two energetically degenerate, but distinct K/K' valleys in the Brillouin zone. We will discuss these emergent properties, as well as new possibilities afforded by forming tailored heterostructures of these 2D semiconducting layers.

Evening Talk PV XXVII Thu 18:00 H 0105
Lise-Meitner-Lecture: Material in neuem Licht - wie maßgeschneidertes Licht Materie strukturieren und anordnen kann — •Cornelia Denz — Institut für Angewandte Physik, Westfälische Wilhelms-Universität Münster

Licht ist Lebenselixier und Technikmotor gleichermaßen. Unter dem Begriff Photonik haben seit der Erfindung des Lasers zahlreiche Technologien nicht nur die Produktion und Informationstechnik revolutioniert, sondern Licht auch als Werkzeug etabliert. Für die Herstellung neuartiger funktionaler Materialien muss Licht jedoch in all seinen Eigenschaften maßgeschneidert werden. Holographische Techniken spielen dabei eine wichtige Rolle.

In Kombination mit nichtlinearen Effekten kann Licht Material auf der Nanoskala strukturieren. Photonisches Graphen, photonische Sonnenblumen oder Lichttornados sind dafür faszinierende Beispiele. In diesen lichtinduzierten Strukturen kann Licht wiederum in beeindruckender Weise in seinen fundamentalen Eigenschafen kontrolliert werden: Licht steuert Licht!

Licht bietet zudem als optische Pinzette enormes Potential, in Westentaschenlaboren Nanopartikel anzuordnen, wirksam mikroskopische Tropfen zu lenken, Zelleigenschaften zu analysieren oder Bakterien als selbst getriebene Nanoroboter nutzbar zu machen. Im holographischen Lichtgriff werden Materialpartikel zu Legobausteinen!

Im Vortrag werden nach einem Überblick über Methoden zur Erzeugung maßgeschneiderten Lichts darauf basierende Verfahren der künstlichen Materialherstellung für die Nano- und Biophotonik diskutiert.

Plenary Talk PV XXVIII Fri 8:30 H 0105
Nanocrystalline Junctions and Mesoscopic Solar Cells — •Michael Graetzel — Laboratory of Photonics and Interfaces, Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne Switzerland

Mesoscopic solar cells have emerged as credible contenders to conventional p-n junction photovoltaics [1,2]. Separating light absorption from charge carrier transport, dye sensitized solar cells (DSCs) were the first to use three-dimensional nanocrystalline junctions for solar electricity production, reaching currently a power conversion efficiency (PCE) of 13% in standard air mass 1.5 sunlight. Large-scale production and commercial sales have been launched. Recently we witnessed the meteoric rise of metal halide perovskites such as CH3NH3PbI3 as powerful light harvesters [3,4]. Carrier diffusion lengths in the micron range have been measured for solution-processed perovskites which now attain a certified PCE of 20.1%. Perovskite-based mesoscopic photosystem that mimic natural photosynthesis in generating fuels from sunlight [6] will also be presented.

1.M. Grätzel, Nature 414, 338 (2001). 2.A.Yella, H.-W. Lee, H. N. Tsao, C. Yi, A.Kumar Chandiran, Md.K. Nazeeruddin, EW-G .Diau„C.-Y Yeh, S. M. Zakeeruddin and M. Grätzel, Science 629, 334 (2011). 3. M. Grätzel, Nature Materals 13, 838 (2014) 4. J. Burschka, N. Pellet, S.-J. Moon, R.Humphry-Baker, P. Gao1, M K. Nazeeruddin and M. Grätzel, Nature 499, 316 (2013). 5. J. Luo, J.-H. Im, M.T. Mayer, M. Schreier, Md.K. Nazeeruddin, N.-G. Park, S.D.Tilley, H.J. Fan, M. Grätzel, Science 345, 1593 (2014).