Plenary Talk PV I Mon 8:30 H 0105

Survival in the face of the unknown: some lessons from bacteria — •Stanislas Leibler — Laboratory of Living Matter, The Rockefeller University, New York, NY, USA — Institute for Advanced Study, Princeton, NJ, USA

Growing bacteria are subject to different types of environmental changes. Some changes are regular: for example, daily variations of light intensity. Others are stochastic, such as the random appearance of predators or toxins. Bacteria have developed an astonishing panoply of strategies to survive in fluctuating environments and the mechanisms underlying adaptive microbial behaviors and their consequences are only beginning to be understood. In my talk I will describe recent experimental and theoretical studies of some of these complex phenomena. Connections to other fields such statistical mechanics and information theory will be emphasized.

Keynote Talk PV II Mon 14:00 H 0105

The Fragility of Interdependency: Coupled Networks & Switching Phenomena — •H. Eugene Stanley — Departments of Physics, Chemistry, & Biomedical Engineering, Boston University, Boston, MA 02215 USA

Recent disasters ranging from financial "shocks" to large-scale power outages and terrorist attacks dramatically demonstrate what dangerous vulnerability hides in the many interdependencies which exist among different networks. In the past year, we have quantified failures in interconnected networks, and demonstrated the need to consider mutually dependent network properties in designing resilient systems. Specifically, we have uncovered new laws governing the nature of switching phenomena in coupled networks, and found that phenomena that are smooth in isolated networks become abrupt in interdependent networks [S. V. Buldyrev, R. Parshani, G. Paul, H. E. Stanley, & S. Havlin, *Nature* **464**, 1025 (2010); J. Gao, S. V. Buldyrev, H. E. Stanley, & S. Havlin, *Nature Physics* **8** (1 Jan. 2012)]. We conclude by discussing the possibility that financial crashes are not unlike the catastrophic failures occurring in coupled networks. Specifically, we find that "trend switching phenomena" in complex financial systems are remarkably independent of the scale over which they are analyzed. For example, we find that the same laws governing the formation and bursting of the largest financial bubbles govern the tiniest bubbles too, over a factor of 10^9 in time scale [T. Preis, J. Schneider, & H. E. Stanley, *Proc. Natl. Acad. Sci. USA* **108**, 7674 (2011); T. Preis & H. E. Stanley, *Physics World* **24**, No. 5, 29 (May 2011)].

Keynote Talk PV III Mon 14:00 ER 270

Soft Matter and Life Sciences: Research with Neutrons — •Dieter Richter — Jülich Centre for Neutron Science; Forschungszentrum Jülich; 52425 Jülich;Germany

Research in soft matter deals with the integration of disciplines and subjects such as colloids, polymers or amphiphilic molecules including living and synthetic matter. In this field a joint approach of disciplines like physics, chemistry, biology and simulation science is essential, in order to arrive at novel insights. Challenges are e.g. the understanding (i) of selfassembly as the basic structuring mechanism in soft materials, (ii) of slow and often hierarchical dynamics in complex environments, (iii) of out of equilibrium systems and (iv) the establishment of a bridge to biology. A molecular understanding of the associated phenomena requires knowledge on the molecular structure and dynamics, that is revealed uniquely by scattering techniques in particular by the space time resolving neutron probe.

In my lecture I will go through results addressing key challenges in the field. I will discuss the efficiency boosting effect by amphiphilic blockcopolymers in selfassembling microemulsions, I will present kinetic results on the structure formation in the selfassembly of polymer micelles. The dynamics of polymers in nanocomposites will serve as an example for the slow dynamics in complex environments including the issue of confinement and finally I discuss direct measurements on the space and time evolution of the interdomain motions in proteins that are important in promoting biochemical function.

Prize Talk PV IV Mon 14:00 HE 101

Elementary excitations in single molecules on surfaces — •Katharina J. Franke — Fachbereich Physik, Freie Universität Berlin, Germany — Laureate of the Hertha-Sponer-Prize

The ultimate goal of molecular electronics is to use single molecules as electronic devices and magnetic storage units. Chemical synthesis offers a wide variety of molecular functionalities. However, the electronic coupling of a molecule to electrodes drastically modifies its properties from the gas phase. Design strategies for electronic circuits thus need to consider the molecule along with the contacts as a complex coupled system rather than individual objects.

Using scanning tunnelling spectroscopy, we probe vibrational, electronic, and magnetic excitations in single molecules. We use these fingerprints to show how the molecular properties in contact with metallic and superconducting electrodes are affected. Variations in the atomic scale environment modify the electronic and magnetic coupling strength to the substrate. This allows us to explore different magnetic and superconducting ground states in the molecule-substrate junction.

Evening Talk PV V Mon 17:00 A 151

Max-von-Laue-Lecture: The Scientific Consensus on Climate Change: Where Do We Go From Here? — •Naomi Oreskes — University of California, San Diego

In 2004, I published an article documenting the widespread agreement among scientific researchers that anthropogenic climate change was underway. This agreement was made evident by statements of leading scientific societies and national and Royal Academies, and by the content of papers published in peer-reviewed journals. Yet, despite broad expert agreement, action on slowing, much less preventing further, climate change has been sluggish. Does this mean that our science has failed us? In this talk I discuss the implications of our collective inaction on anthropogenic climate change in the light of our current scientific knowledge.

Plenary Talk PV VI Tue 8:30 H 0105

Dynamical condensation of exciton-polaritons — •Yoshihisa Yamamoto — E. L. Ginzton Laboratory, Stanford University, Stanford, CA 94305, U.S.A. — National Institute of Informatics, 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan

An exciton-polariton is an elementary excitation in semiconductors, consisting of quantum well excitons and microcavity photons. Because of its extremely small effective mass and short lifetime, the exciton-polaritons feature unique many-body effects, which are distinct from non-equilibrium photon lasers and equilibrium atomic BEC. In this talk, we will review the recent experimental studies on the dynamical condensation of exciton-polaritons. The specific topics to be discussed include the quantized vortex-antivortex pair and Berezinskii-Kosterlitz-Thouless (BKT) phase transition, the electron-hole BCS crossover, the Bogoliubov excitation spectrum and the higher orbital orders in various 2D lattice structures.

Keynote Talk PV VII Tue 13:15 H 0105

The quantum way of doing computations — •Rainer Blatt — Institut für Experimentalphysik, Universität Innsbruck, Innsbruck, Österreich — Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Österreich

Since the mid nineties of the 20th century it became apparent that one of the century's most important technological inventions, computers in general, and many of their applications could possibly be further enormously enhanced by using operations based on quantum physics.

Computations, whether they happen in our heads or with any computational device, always rely on real physical processes, which are data input, data representation in a memory, data manipulation using algorithms and finally, the data output. Building a quantum computer then requires the implementation of quantum bits (qubits) as storage sites for quantum information, quantum registers and quantum gates for data handling and processing and the development of quantum algorithms.

In this talk, the basic functional principle of a quantum information processor will be reviewed and the ion trap technology for its implementation will be highlighted. In particular, quantum information processing will be illustrated by showing how entanglement is generated and used for computational processes. Aside from their use as quantum computers, such quantum information processors open wide perspectives for applications in many research areas. Examples will be presented for quantum enhanced metrology and quantum simulations.

Prize Talk PV VIII Tue 14:00 H 0105

Of symmetries, symmetry classes, and symmetric spaces: from disorder and quantum chaos to topological insulators — •Martin Zirnbauer — Universität zu Köln — Laureate of the Max-Planck-Medal

Quantum mechanical systems with some degree of complexity due to multiple scattering behave as if their Hamiltonians were random matrices. Such behavior, while originally surmised for the interacting many-body system of highly excited atomic nuclei, was later discovered in a variety of situations including single-particle systems with chaos and/or disorder. A fascinating theme in this context is the emergence of universal laws for the fluctuations of energy spectra and transport observables. After an introduction to the basic phenomenology, the talk highlights the role of symmetries for universality, in particular the correspondence between symmetry classes and symmetric spaces that led to a classification scheme dubbed the "10-fold way". Perhaps surprisingly, the same scheme has turned out to organize also the world of topological insulators.

Keynote Talk PV IX Tue 14:00 HE 101

STM of Defects, Adsorbates, and Nanostructures at Oxide Surfaces — •Ulrike Diebold — Institute of Applied Physics, TU Vienna, Austria

Surface science studies of metal oxides have experienced a rapid growth. The reasons for this increasing interest are quite clear: after all, most metals are oxidized under ambient conditions, so in many instances it is the oxidized surface that deserves our attention. In addition, bulk metal oxides exhibit an extremely wide variability in their physical and chemical properties. These are exploited in established and emerging technologies such as catalysis, gas sensing, and energy conversion schemes, where surfaces and interfaces play a central role in device functioning. Hence a more complete understanding of metal oxide surfaces is desirable from both a fundamental and applied point of view. By using STM measurements, in combination with DFT calculations and area-averaging spectroscopic techniques, great strides have been made in understanding the atomic-scale properties of the surfaces of several oxides. In the talk I will give recent examples drawn from studies of bulk single crystals including TiO_2, Fe_3O_4, In_2O_3, and $SrTiO_3$.

Keynote Talk PV X Tue 14:00 H 0104

Terahertz Science and Technology: Key Innovations and Driving Applications — •Karsten Buse — Fraunhofer Institute of Physical Measurement Techniques, Freiburg, Germany — Department of Microsystems Engineering, University of Freiburg, Germany

Photoconductive antennas as well as nonlinear-optical materials are able to deliver terahertz radiation, if they are pumped by laser light. For pulsed excitation "white" terahertz radiation is generated, and optical parametrical oscillators can deliver tunable terahertz radiation with line widths as small as some MHz, easily. Although the underlying ideas go back to the 60s or even to Heinrich Hertz, more than 100 years ago, it was quite recent that the systems became such reliable, efficient and powerful that they can be of use. In this talk a review about the fascinating underlying physics for generation and detection of terahertz radiation will be given, and the key innovations that were making such devices possible will be introduced. Anyhow, what is triggering the interest in these waves? Terahertz radiation passes through non-conductive matter. Phase contrast information as well as spectral fingerprints of molecular resonances can be achieved for such materials providing a wealth of information useful for non-destructive material testing. Various examples will be shown, e.g., the unambiguous identification of hidden drugs and explosives as well as measurements of layer thicknesses and structural material defects. – To work on terahertz light sources is not only fun, it is also useful for the industrial world.

Plenary Talk PV XI Tue 17:20 H 0105

Metamaterials and Transformation Optics — •Martin Wegener — Karlsruhe Institute of Technology, Institute of Applied Physics, 76131 Karlsruhe

Metamaterials are tailored man-made materials that can exhibit properties not accessible in natural substances [1]. Transformation optics goes one step further and treats intentionally spatially inhomogeneous metamaterial structures, aiming at achieving certain functionalities like, e.g., invisibility cloaking [1]. These concepts are, however, not restricted to electromagnetic waves, but can also be applied to other types of waves, e.g., to quantum mechanical matter waves, water waves, and elastic waves in mechanics. The talk gives an introduction and presents the current experimental state-of-the-art.

[1] M. Wegener and S. Linden, Shaping Optical Space with Metamaterials, Physics Today 63, 32 (2010)

Plenary Talk PV XII Wed 8:30 H 0105

Concepts in Quantum Computation — •David DiVincenzo — FZ Juelich and RWTH Aachen

While the basic concepts for the composition and uses of a quantum computer are now nearly twenty years old, detailed concepts for the achievement of working, scalable qubit structures and architectures are undergoing great development in the present time. I will show this development in the case of superconducting qubits; we see that while the basic metrics for the improvement of these qubits have shown a four-order of magnitude improvement over a decade of work, the essential further metrics for scaling and efficient operation have just begun to receive attention. Still, sufficient progress has been made that we can show a concrete conceptual framework for a workable architecture.

Prize Talk PV XIII Wed 13:15 H 0105

Optical approach to spin qubits — •Alex Greilich — Experimentelle Physik 2, Technische Universität Dortmund, 44227 Dortmund, Deutschland — Laureate of the Walter-Schottky-Prize

Spins of carriers confined in semiconductor quantum dots (QDs) are represented as a prototype quantum bit (qubit) for quantum information. Its solid state implementation has the potential for scalability and the possibility being incorporated both into electronic and photonic circuits with existing semiconductor technology.

Giant optical dipole moment and direct optical band gap of a semiconductor QD suggests exploiting the elementary optical excitations as an auxiliary state for ultrafast conversion between optical coherence and spin coherence. It allows the quantum operations to be performed at a terahertz rate or faster. This time is usually compared with spin coherence time. Due to confinement the spin is largely protected from relaxation mechanisms, leading to coherence times in the μs-range. The opportunity to combine long coherence and fast optical control has stimulated considerable progress for spin qubit realization with QDs.

This work demonstrates the development of the key components for such a qubit. It includes: 1. Definition of qubit based on electron and hole spin, 2. Optical spin initialization, 3. Measurement of spin coherence, 4. Ultra-fast coherent spin manipulations, and 5. Control of two-spin entanglement.

Keynote Talk PV XIV Wed 14:00 H 0105

A Comprehensive Study of Exchange Bias: Towards a universal explanation. — •Ivan Schuller — Physics Department and Center For Advanced Nanoscience, UCSD, La Jolla, Ca. 92093, USA

Magnetic nanostructures produce interesting new phenomena and novel applications when the physical size becomes comparable to relevant magnetic length scales.

In the *Exchange Biased* configuration in which a ferromagnetic nanostructure is in contact with an antiferromagnet a variety of unusual phenomena arise; the reversal mode of the ferromagnet changes in a substantial fashion, the superparamagnetic transition temperature is strongly affected and there is a noticeable change in the microscopic spin configuration. I will describe a comprehensive study, in which we studied these phenomena in nanostructured ferromagnets prepared by MBE and sputtering combined with lithography and self-assembly. These experiments include magnetotransport, magnetization, Magneto-Optic Kerr effect, neutron and synchrotron scattering, and ultrafast pump-probe measurements. I will present a general explanation of the origin of exchange bias which emerges from many experiments taken together.

Work done in collaboration with R. Morales, M. Velez, O. Petracic, I. V. Roshchin, X. Batlle, J. M. Alameda, M. Kovylina, M. Erekhinsky, J. E. Villegas, A. Labarta, A. Porat, and S. Bar-Ad. Work supported by the US Department of Energy and US Air Force Office of Scientific Research.

Keynote Talk PV XV Wed 14:00 H 0104

Nanostructuring of 1 Million tons: Designing ultrastrong and ductile steels — •Dierk Raabe, Dirk Ponge, Pyuck Choi, Julio Millán, Steffanie Sandlöbes, Tilmann Hickel, and Jörg Neugebauer — MPI für Eisenforschung, 40237 Düsseldorf, Germany

We present novel approaches to the atomic-scale understanding and design of advanced steels. Our interest follows three directions: First, steels are complex alloys where minor chemical or structural changes can dramatically alter the thermodynamic, kinetic, and mechanical behavior. Second, steels can undergo multiple phase transformation phenomena that entail a huge variety in the possible kinetic and structural pathways that lead to specific nanostructure and property profiles. Third, we increasingly observe * by using atomic-scale analytical methods (e.g. atom probe, TEM tomography) in conjunction with quantum mechanical simulation methods * that steels can be bottom-up designed by exploiting and designing partitioning, equilibrium defect segregation, and displacive transformation phenomena at an atomic scale. Smart use of these effects allows us to better understand and tailor mankind*s most important mass produced material via self organization, lattice defect-, phase-, and interface-design from an atomic perspective. We give exemplary examples from the fields of maraging TRIP steels, TWIP steels, pearlite, and soft magnetic steels.

Keynote Talk PV XVI Wed 14:00 HE 101

The global carbon cycle in the climate system: To which extent is it manageable? — •Martin Heimann — Max-Planck-Institute for Biogeochemistry, Jena, Germany

Only about ~50% of the anthropogenic emissions of the greenhouse gas carbon dioxide (CO2) from the burning of fossil fuels and cement production currently accumulates in the atmosphere. The remainder is taken up by carbon sinks in the ocean and on land. Hence the dynamics of these sinks are crucial for the future evolution of the atmospheric CO2 content and its climate impact. The global ocean CO2 sink is relatively well understood and can be quantified by several independent methods. The global land sink is caused by the difference between photosynthesis of the vegetation and respiration from plants and soils. It can be quantified as a remainder of the atmospheric budget, however, the underlying complex dynamics of the land vegetation and soils are still quite uncertain on a global scale. This limits our predictions of how these natural sinks will continue to operate in the future. Under high CO2 concentrations modest saturation effects in the ocean and on land are expected, which will be further exacerbated by detrimental effects from a warming climate (a.o. ocean outgassing, enhanced soil respiration). The fate of the land sink in the 21st century, however, will be dominated by direct and indirect anthropogenic impacts from changes in land use and management caused by an increasing world population with food demands and associated land reclamation. This leaves little room for land management activities specifically directed to sequester excess carbon e.g. large-scale afforestation, biomass burial, biochar formation or changes in soil tillage. Also, other proposed "geoengineering" options to foster carbon sinks (e.g. ocean fertilization), have a very limited potential for carbon sequestration in comparison to the expected emissions from fossil fuels during this century.

Evening Talk PV XVII Wed 20:00 Urania

Windenergie - eine turbulente Sache — •Joachim Peinke — ForWind, Institut für Physik , Universität Oldenburg und Fraunhofer IWES

Windenergie wird aktuell als eine vielversprechende erneuerbare Energie angesehen. Dies hat dazu geführt, dass eine neue Industriebranche an Bedeutung gewinnt. Außerdem prägen Windenergieanlagen immer mehr unser Landschaftsbild. Hieraus kann man leider nicht ableiten, dass die Windenergieanlagen schon eine voll ausgereifte Technik besitzen. Ausfälle und Wartungen tragen wesentlich zu den Energieerzeugungskosten bei und gelten als eine große Herausforderung speziell für den Offshore- Einsatz. Neben den technischen Aspekten ist weniger bekannt, dass die Windenergienutzung auch mit dem großen ungelösten physikalischen Problem der Turbulenz eng verbunden ist. In meinem Vortrag soll auf die aktuellen Entwicklungen und Herausforderungen im Bereich der Windenergie eingegangen werden. Es wird dargestellt in welcher Hinsicht grundlegende offene Fragen der Turbulenzforschung wichtig für die Arbeitsbedingungen von Windenergieanlagen sind. Die aktuellen Fragen der Einbindung der Windenergie in das Versorgungsnetz ist ein weiteres Thema. Ziel ist es zu zeigen, wie Forschungsergebnisse aus der physikalischen Grundlagenforschung neue Erkenntnisse für die Anwendungen der Windenergienutzung liefern.

Plenary Talk PV XVIII Thu 8:30 H 0105

The Complex Physics of Climate Change: Nonlinearity and Stochasticity — •Michael Ghil — Ecole Normale Supérieure, Paris, France — UCLA, Los Angeles, USA

Recent estimates of climate evolution over the coming century still differ by several degrees. This uncertainty motivates in part the work presented herein.

The complex physics of climate change arises from the large number of components of the climate system, as well as from the wealth of processes occurring in each of the components and across them. This complexity has given rise to countless attempts to model each component and process, as well as to two overarching approaches to apprehend the complexity as a whole: deterministically nonlinear and stochastically linear. Call them the Ed Lorenz and the Klaus Hasselmann approach, respectively, for short.

We propose a "grand unification" of these two approaches that relies on the theory of random dynamical systems. In particular, we apply this theory to the problem of climate sensitivity, and study the random attractors of nonlinear, stochastically perturbed systems, as well as the time-dependent invariant measures supported by these attractors.

Results are presented for several simple climate models, from the classical Lorenz convection model to El Nino-Southern Oscillation models. Their attractors support random Sinai-Ruelle-Bowen measures with nice physical properties. Applications to climate sensitivity and predictability are discussed.

This talk presents joint work with M. D. Chekroun, D. Kondrashov, J. C. McWilliams, J. D. Neelin, E. Simonnet, S. Wang, and I. Zaliapin.

Prize Talk PV XIX Thu 13:15 H 0105

Mechanics and Growth of Tissues — •Jean-Francois Joanny — Institut Curie centre de recherche 26 rue d'Ulm 75248 Paris cedex 05 — Laureate of the Gentner-Kastler-Prize

We present a mechanical model to describe the growth of healthy and cancerous tissues.

We first show that because of the coupling between cell division and the local stress, a tissue can be considered as a visco-elastic liquid with a relaxation time smaller than the cell division time. We propose a two fluid-model taking into account the interstitial fluid between the cells. We then discuss various instabilities of epithelial tissues that can be of physiological relevance : -villis are the protrusions of the surface of the intestine or the colon. We describe the formation of villis as a buckling instability of a polar cell monolayer. The polarity of the layer does not seem to play a role in the intestine where the villis are arranged in a square array but it is important in the colon where they are organized in a hexagonal array. -tubular tissue structures such as arteries or the renal excretory canals show various instabilities also related to buckling -thick epithelia have a fingering instability of their basement membrane

Keynote Talk PV XX Thu 14:00 H 0105

How superficial is adhesion? Common fundamentals of gecko, bacteria, protein and thin film adhesion — •Karin Jacobs — Saarland University, Experimental Physics, D-66041 Saarbrücken

Controlling the adhesion of biological objects to inorganic surfaces is an important issue for multiple different disciplines, from surgery and the biomedical sciences to material engineering. For an effective control, however, a thorough understanding of the fundamentals of adhesion is necessary. If e.g. an antibacterial coating of some nanometer thickness is prepared on different substrates, will it always act antibacterial? In other words, is only the surface of two adhering bodies responsible for the adhesive strength? Our studies show that also the subsurface compositions of the interacting materials play an important role. Common examples are the adhesion of gecko paws, the sticking of bacteria, the unspecific adsorption of proteins or the stability of thin films. The reason for this is that adhesion is an interplay of short- and of long-range forces. To separate the one from the other and to allow for a controlled variation, we performed the experiments with tailored Si wafers (variable Si dioxide layer thickness, variable surface coating) as substrates. Adhesion measurements were e.g. conducted by scanning probe microscopy in force spectroscopy mode and protein adsorption was monitored by ellipsometry, X-ray and neutron reflectometry. In the various set-ups and the different systems, the same trend is recorded: Adhesion is not only superficial, the long-range van der Waals forces which make up for the subsurface force contribution, have to be taken into account.

Keynote Talk PV XXI Thu 14:00 H 0104

Diamond quantum spintronics — •Jörg Wrachtrup — 3rd Institute of Physics and Research Center SCoPE, University of Stuttgart, Germany

Condensed matter physicists strive for engineering quantum states with a precision formally only reached in atom or quantum optics. However, usually the many degrees of freedom in solids hamper any fine control. Since a few years a number of attempts have been successful to fabricate solid state systems which allow high precision control of quantum states as well as the engineering of complex quantum states. Among those systems are defects in diamond. By implantation of atomic impurities single defect centers can be created with high spatial accuracy. Those defects show quasi atomic electron paramagnetic states which are effectively shielded by the diamond lattice from environmental disturbances. Precise implantation allows mutual coupling of defects and the generation of two or multiple particle state. Quantum non-demolition and feedback algorithms give full access to enhanced quantum state preparation and measurement methodology. Since diamond defects can be operated in the quantum regime at ambient conditions all those methods can be applied to sensing applications. As an example diamond defects are very sensitive detectors for external magnetic fields. Eventually this is of use for e.g. measuring small magnetic fields of single electron or even proton spins in complex environments like biological media.

Prize Talk PV XXII Thu 14:00 EW 201

3D imaging of lung tissue during total liquid ventilation — •Christian Schnabel[1,2], Sven Meissner[1], Maria Gaertner[1], and Edmund Koch[1] — [1]Faculty of Medicine Carl Gustav Carus, University of Technology, Dresden, Germany — [2]Laureate of the Georg-Simon-Ohm-Prize

Abstract: The knowledge of lung mechanics on an alveolar level is crucial for the investigation and development of new and more protective artificial ventilation methods. To acquire data describing the lung behavior of alveolar structures, a high-resolution imaging modality is necessary. A suitable, non-invasive, contactless and three-dimensional imaging modality to visualize subpleural alveoli in animal models with a high microscale resolution is optical coherence tomography (OCT). The main limitation of OCT is the scattering loss of the backscattered near-infrared light in higher depth due to the refractive index changes at each air-tissue interface. For in vivo measurements the refractive index inside the alveoli can be matched to the one of the surrounding tissue by using suitable breathing liquids and a custom-made liquid ventilator. We use this approach to improve information content of 3D OCT images to investigate lung behavior during different conditions of artificial ventilation. The setup of the developed ventilator and first results showing the feasibility of liquid ventilation to improve OCT imaging of alveolar structures and enhance the information content obtained from those data will be presented.

Evening Talk PV XXIII Thu 18:00 H 0105

Lise-Meitner-Lecture: More than meets the eye: Probing the Planckian structure of spacetime — •Renate Loll — Institute for Theoretical Physics, Utrecht University, The Netherlands

Time and Space are at once ubiquitous and mysterious. We are immersed in space and experience the flow of time, but what is their essence and origin? Our view of space and time has undergone radical changes since Newton's days. In Relativity, they form inseparable parts of a four-dimensional "spacetime", which moreover can bend and move, encoding the gravitational interactions of matter and energy.

Beyond the validity of Einstein's classical theory, we expect further insights into the nature of spacetime from quantum gravity, the eagerly searched-for unification of relativity and quantum theory: what governs the quantum dynamics of spacetime on ultrashort, Planckian scales? How can it explain the observed macroscopic structure of spacetime? Are space, time, causality and dimensionality still meaningful notions at the Planck scale, or merely emergent properties of a dynamical ensemble of more fundamental microscopic 'building blocks'?

I will report on recent, unprecedented progress in a new formulation of quantum gravity, a concrete (and computable!) realization in terms of "Causal Dynamical Triangulations" of a Feynman path integral. Intriguingly, it has been possible to extract physical properties of this quantum superposition of spacetimes with the help of numerical "experiments". They confirm the nonclassical and counter-intuitive nature of spacetime at the Planck scale - including a bizarre behaviour of "dimensions" - and the emergence of classicality on large scales.

Plenary Talk PV XXIV Fri 8:30 H 0105

Role of van der Waals Interactions in Physics, Chemistry, and Biology — •Matthias Scheffler — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany

Van der Waals (vdW) interactions are crucial for the formation, stability, and function of many molecules and materials. They typically dominate in regions where the overlap of electron densities is small. Interestingly, the commonly applied implementations of density-functional theory (LDA, GGAs, hybrids) are completely lacking the vdW tail.

In this talk, I will review recent advances in electronic-structure theory; in particular, I will highlight the "exact exchange (EX) plus random-phase approximation to correlation (cRPA)" approach and recent corrections to cRPA. Furthermore, I will discuss approximations that are computationally more efficient and enable the treatment of large systems or long time-scale molecular dynamics. The main part of the talk will deal with representative applications, e.g.,

* The noticeable role of vdW interactions in the cohesion of noble metals and semiconductors and in the intermolecular interactions in water and ice.

* Particular focus will be put on the adsorption of organic molecules at metals and semiconductors, and on tuning the workfunction of the inorganic substrate by molecular acceptors.

* Regarding biophysics, I will show how vdW interactions change the conformational landscape, stabilize the helical hydrogen bond network compared to plain DFT-GGA calculations, and thus enhance the thermal stability of helical structures by several hundred K.