Plenary Session

Tuesday, 01.09.2015, Room EI 7

Time	ID	PLENARY SESSION I *Chair: Gottfried Strasser, TU Wien*
09:20		OFFICIAL CONFERENCE OPENING
09:40	1	**Optoelectronics in two-dimensional atomic crystals** *Thomas Müller, TU Wien, Gusshausstr. 27-29, AT-1040 Wien* Two-dimensional (2D) atomic crystals are currently receiving a lot of attention for applications in electronics and opto-electronics. In this talk I will review our research activities on electrically driven light emission, photovoltaic energy conversion and photodetection in 2D transition metal dichalcogenides (TMDs) and graphene. In particular, I will present studies of 2D p-n junctions, formed by electrostatic doping using a pair of split gate electrodes, atomically-thin van der Waals p-n heterojunctions and photoconductivity studies of TMD-based field-effect transistors. In the second part of my talk, I will discuss optoelectronic properties of graphene and possible applications in integrated photonics.
10:20		*Coffee Break*
10:50	2	**Beyond density functional theory: efficient many body techniques for condensed matter** *Georg Kresse, Faculty of Physics, Univ. Vienna, Sensengasse 8, AT-1090 Vienna* The properties of all materials arise from the quantum mechanics of their constituent electrons under the influence of the field of the nuclei. The solution of the underlying many-electron Schrödinger equation is a non-polynomial hard problem, owing to the complex interplay between electron-electron repulsion and the Pauli exclusion principle. The dominant computational method for describing such systems has been density functional theory, although the accuracy of this method can not be rigourously established. Quantum-chemical methods based on an explicit ansatz for the many-electron wavefunction are potentially more accurate, but they have not been fully explored in the solid state. The talk will give an introduction to quantum chemistry methods and modern many body perturbation theory and discuss recent advances in the application of these methods to materials. Results for an exact technique, configuration interaction quantum Monte Carlo are report providing reference results. These are used to benchmark the hierarchy of quantum-chemical techniques up to the gold standard coupled-cluster ansatz. In practice, these methods are found to be too expensive to be applied to problems in materials science. Simpler methods that recover the important ingredients of the many-electron solution, such as the random phase approximation, are discussed alongside illustrative examples.
11:30		*Award Ceremony*
12:30		*Lunch*
13:30		*Topical Sessions*
18:00		*Postersession and Aperitif*
		PUBLIC LECTURE *Chair: Stéphane Goyette, Uni Genève*
19:45	21	**The future of Earth's climate - is it really in our hands?** *Jens Hesselbjerg Christensen, Danish Meteorological Institute Kopenhagen* A central element in subsequent reports from Working Group 1 of Intergovernmental Panel on Climate Change has been to point out that the level of atmospheric greenhouse gases has been increasing since the beginning of the industrial revolution due to man's ever increasing need for easily accessible and cheap energy in the form of combustion of fossil fuels (coal, oil and natural gases). This increase is causing global warming and the warming over the last several decades is very likely mostly, if not entirely due to the accelerated combustion taking place worldwide. In its most recent assessment report (the fifth in the row), AR5, the panel states that "Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Most aspects of climate change

		will persist for many centuries even if emissions of CO_2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2". But seeing climate change portrayed through global mean surface warming is clearly a very narrow way to describe and understand climate change. In this talk, I will review some of the essential material presented in the contribution from WG1 to the AR5 that have led to the central statement mentioned above and address issues related to how the changing climate manifests itself where we experience it, at a regional to local scale. Here many more issues related to how the physical climate system interacts become very important and natural variations, which are well described, but often less well understood in terms of how they function are at play. How climate change unfolds itself regionally is what we experience and what most people therefore perceive as climate change. The question is therefore to what extend controlling global warming through mitigation also can be perceived as controlling the climate. Climate models offers a tool for studying this. But how can we best interpret the spread in the projected future represented by todays multi-model ensemble of climate simulations? In this talk, I will therefore also address these issues.
21:00		

Wednesday, 02.09.2015, Room EI 7

Time	ID	**Plenary Session II** *Chair: Minh Quang Tran, EPFL*
09:00	**3**	**SwissFEL:** **science opportunities at the newest facility of the Paul Scherrer Institute** *Joël Mesot, Paul Scherrer Institut, CH-5232 Villigen PSI* While 2 hard X-ray free electron laser facilities are currently in operation, several others are in the final stage of their construction. Such facilities aim at producing femtosecond pulses of coherent x-rays for a wide range of wavelengths, with extremely high peak brightness. The brightness, the coherence and the short pulses provide unique opportunities to perform new types of experiments in the fields of chemistry, solid state physics, biochemistry and materials science. The presentation will focus on one side on the characteristics of the SwissFEL facility currently under construction at the Paul Scherrer Institute, and on the other side on the proposed experimental stations and first experiments to be realized. Challenges in instrumentation, characterization and experimental techniques will be addressed [2]. [1] B. D. Patterson et al., New Journal of Physics, 12, 035012 (2010). [2] B. D. Patterson et. al, Chimia Int. J. Chem. 68, 1 (2014)
		Chair: Georg Pabst, Uni Graz
09:40	**4**	**Acoustic Force Spectroscopy** *Gijs Wuite, VU University Amsterdam, Faculty of Sciences, Boelelaan 1081, NL-1081 HV Amsterdam* Single-molecule force spectroscopy has become an indispensable tool to unravel the structural and mechano-chemical properties of biomolecules. In most force-spectroscopy instruments only a limited number of biomolecules can be studied simultaneously, which reduces experimental throughput and limits statistics. At the same time, many independent measurements are required to distinguish the intrinsic stochasticity of the process of interest from heterogeneity. With Acoustic Force Spectroscopy (AFS) we extend the force-spectroscopy toolbox with an acoustic manipulation device that allows exerting acoustic forces on tethered molecules. AFS is a Lab-on-a-chip device consisting of a flow cell of two glass plates with a fluid chamber in between and a piezo element glued on top. While applying an alternating voltage to the piezo element, forces from sub-pN to hundreds of pNs are exerted to thousands of biomolecules in parallel, with sub-millisecond response time and inherent stability. As a proof of concept we performed force-extension measurements on DNA and RecA-coated DNA. These experiments demonstrate that AFS can be used to apply highly controlled forces up to at least 120 pN, with a force ramp speed between 10^{-4} – 10^{2} pN/s and showing inherent stability over tens of hours over an observation area of at least 1 mm^2. AFS experiments are highly parallel, allowing the simultaneous measurement of thousands of biomolecules simultaneously, in a single field of view. Wedemonstrate the use of this by mapping the energy landscape of the DIG/anti-DIG antibody-antigen bond over 6 orders of magnitude of force loading rates within several hours of experimentation.

		AFS distinguishes itself by its relative simplicity, low cost and compactness, which allow straightforward implementation in lab-on-a-chip devices. These aspects will help to spread single-molecule methods from the realm of fundamental research in specialized laboratories towards more widespread applications in for example molecular biology and medical diagnostics.
10:20		***Coffee Break***
		Chair: Eberhard Widmann, SMI Wien
10:50	**31**	**The kinetic mixing portal in cosmology, astrophysics, and experiment.** *Josef Pradler, ÖAW, Institut für Hochenergiephysik, Nikolsdorfer Gasse 18, AT-1050 Wien* More often than not, astrophysical probes are superior to direct laboratory tests when it comes to light, very weekly interacting particles, and it takes clever strategies and/or ultra-pure experimental setups for direct tests to be competitive. I will highlight this competition on the example of a simple extension of the Standard Model, a kinetically mixed massive vector particle, or “Dark Photon”. This scenario has received significant attention in the past, in particular because of its connection to the Dark Matter problem and I will report on recent progress in the eV-MeV mass window with minute couplings. I will also show how cosmology offers unique, complementary sensitivity when laboratory probes become out of reach.
		Chair: Frank Kassubek, ABB Baden
11:20	**32**	**Experimental realisation of the topological Haldane model with ultracold fermions** *Gregor Jotzu, ETH Zürich* The Haldane model is a paradigmatic example of a Hamiltonian featuring topologically distinct phases of matter. It describes a mechanism through which a quantum Hall effect appears as an intrinsic property of a material, even in the absence of an external magnetic field. We employ “Floquet engineering” to implement this Hamiltonian using fast circular driving in an optical honeycomb lattice. By probing the resulting band-structure with ultracold fermionic atoms we map out a topological transition, which occurs when both time-reversal and inversion symmetry are broken. Furthermore, we characterize the Berry-curvature by measuring a perpendicular drift when accelerating the atomic cloud.
11:50		***General Assemblies (ÖPG: Room EI 7, SPS: Room EI 8)***
12:40		***Lunch***
13:30		***Topical Sessions***
19:15		***Transfer to Dinner***
20:00		***Conference Dinner***

Time	ID	**PLENARY SESSION III** *Chair: Hans Peter Beck, Uni Bern*
09:00	**5**	**Precision particle physics at low energies** *Klaus Kirch, ETH Zürich & PSI Villigen* The landscape of particle physics experiments is very multifaceted. At low energies, experiments aiming at highest precision complement others aiming at highest sensitivity. All these activities need high intensities to achieve their precision and sensitivity goals. Some experiments determine fundamental constants and input parameters of the extremely successful Standard Model of particle physics. Others search for signals of new physics often probing mass scales or weak couplings inaccessible for direct searches at high energy colliders. The facilities around the High Intensity Proton Accelerator at PSI provide highest intensities at low momenta of the lightest unstable particles: neutrons, pions and muons. The presentation pictures parts of the low energy landscape with glimpses of some recent and ongoing efforts of international collaborations at PSI.
09:40		***SPS Honorary Member Ceremony***
		Chair: Christophe Rossel, IBM Rüschlikon
09:50	**6**	**Scanning probe microscopy of single atoms/molecules on insulating films: Orbital imaging, molecular geometry and intramolecular charge distribution** *Gerhard Meyer, IBM Research - Zurich, CH-8803 Rüschlikon* Ultrathin insulating films on metal substrates are unique systems to use Scanning Tunneling Microscopy(STM) and Atomic Force Microscopy (AFM) to study the electronic and structural properties of single atoms and molecules, which are electronically only weakly coupled to the metallic substrate. STM permits the direct imaging of molecular frontier orbitals and in combination with atomic/molecular manipulation allows the study of elementary processes related to charge state control, molecular switching and electrical contact formation [1]. Additional structural information can be obtained by AFM which leads to the direct imaging of the molecular geometry [2] and the determination of the adsorption geometry [3]. Using Kelvin Probe Force Microscopy (KPFM) the local contact potential difference can be mapped with submolecular resolution reflecting the intramolecular charge distribution of molecules [4]. [1] J. Repp, G. Meyer, S. Paavilainen, F. E. Olsson, M. Persson, Science 2006, 312, 1196 [2] L. Gross, F. Mohn, N. Moll, P. Liljeroth, G. Meyer, Science 2009, 325, 1110 [3] B. Schuler et al. Phys. Rev. Lett. 2013, 111, 106103 [4] F. Mohn, L. Gross, N. Moll, G. Meyer, Nature Nanotechnology 2012, 7, 227
10:30		***Coffee Break***
		Chair: Karl Unterrainer, TU Wien
11:00	**7**	**Nanoscopy with focused light** *Stefan W. Hell, MPI für biophysikalische Chemie Göttingen* 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.

11:40	**8**	**Chiral interaction of light and matter in confined geometries** *Arno Rauschenbeutel, TU Wien* A strong transversal intensity gradient can cause a light field to exhibit significant local polarization components which point along the direction of propagation. Remarkably, the resulting spin of the light can even be perpendicular to the direction of propagation. This transverse spin changes sign when the direction of propagation is reversed and gives the light field a chiral character. New and surprising effects can be observed in the resulting chiral interaction of light and matter. For example, when dipole emitters, like gold nanoparticles or atoms, are coupled to the evanescent field surrounding a nanophotonic waveguide, the intrinsic mirror symmetry of their emission is broken. This allowed us to realize chiral nanophotonic interfaces in which the emission direction of light into the waveguide is controlled by the polarization of the emitted light. Moreover, we employed chiral interaction to demonstrate non-reciprocal transmission of light through a nanophotonic waveguide.
12:20		***Postersession (continued) and Lunch Buffet***
14:00		***Topical Sessions***
		Lise-Meitner Lecture (Public Lecture) *Chair: Monika Ritsch-Marte, Uni Innsbruck*
19:45	**22**	**Licht hinter Gittern:** **Wie holographische Verfahren Materie strukturieren und anordnen können** *Cornelia Denz, Uni Münster* Die Photonik beschäftigt sich mit der Nutzung von Licht als Werkzeug. Für die Herstellung neuartiger funktionaler Materialien auf der Mikro- und Nanoskala muss Licht dazu in all seinen Eigenschaften maßgeschneidert werden. Holographische Techniken spielen dabei eine wichtige Rolle, denn sie sind in der Lage, eines der wichtigsten Größen zur Materialstrukturierung im Material zu ändern: den Brechungsindex. Photonisches Graphen, photonische Sonnenblumen oder Lichttornados sind faszinierende Beispiele für solche Brechungsindexstrukturen. In diesen 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.
21:00		

Time	ID	PLENARY SESSION IV *Chair: Helmut Dannerbauer, Uni Wien*
09:00	**9**	**Cosmology with the Planck satellite** *François Bouchet, Inst. d'Astrophysique de Paris* Sketched out in 1992, selected by ESA in 1996, launched in 2009, Planck delivered a first set of results in March 21st 2013, in particular a "definitive" map of the anisotropies of the Cosmic Microwave Background (CMB). The later displays minuscule variations as a function of the observing direction of the temperature of the fossil radiation around its mean temperature of 2.725K. These CMB anisotropies, of rms ~100 μK, reveal the imprint of the primordial fluctuations which initiate the growth of the large scale structures of the Universe, as transformed by their evolution, in particular during the first 370000 years. Since 2013, we analysed twice more data and in particular the polarisation information we gathered over the full course of the mission. I will describe the new results we just obtained, and in particular confront what temperature and polarisation anisotropies teach us, both in terms of content of the universe and of characteristics of the primordial fluctuations.
		Chair: Minh Quang Tran, EPFL
09:40	**10**	**Physics challenges for burning plasmas** *Ambrogio Fasoli, EPFL, Centre de Recherches en Physique des Plasmas* The understanding and control of burning plasmas constitute the next scientific frontier of fusion energy. In burning plasmas the self-heating due to the by-products of the nuclear fusion reactions provide the dominant contribution to the overall heating of the plasma. In DT plasmas, this corresponds to a fusion gain of $Q > 5$, and the by-products are alpha particles at 3.5 MeV, which transfer their energy to the background plasma by colliding with electrons and ions. As this process occurs over macroscopic time scales, a good confinement of the alphas is essential to obtain a high fusion power gain. Alpha particles couple several aspects of the plasma dynamics, including on macroscopic stability, wave-particle interactions and transport. For the success of ITER and DEMO, it is necessary to identify adequate plasma scenarios to enter the burning regime and to sustain it in the presence of such couplings for the discharge duration for which the machines are designed. The stability of alpha driven modes, the impact of alpha heating on the burn dynamics, and the compatibility with edge stability and efficient exhaust configurations are issues to be addressed. In DEMO, the challenge is extended to the requirements of being compatible with economic exploitation, implying a high degree of reliability and plant availability. Following the aim of reaching fusion energy production by the middle of the century, it is urgent to identify the burning plasma issues that can be addressed in the presently available weakly self-heated plasmas, and to prepare the extrapolation from the first results in ITER burning plasmas to the DEMO regimes.
10:20		***Coffee Break***
		Chair: Helmut Dannerbauer, Uni Wien
10:50	**11**	**The ESO science capabilities** *Bruno Leibundgut, ESO München* ESO facilities provide wide ranging capabilities for many astronomical applications. I will present the opportunities offered by ESO telescopes today giving a few selected results highlighting recent use of the instruments. The planning for the next instruments and expansions of the ESO capabilities will be presented together with a look into the next decade.
11:30		***Best Poster Awards***
11:45		***Topical Sessions***
14:00		***END OF CONFERENCE***