Sessions

Plenary Session

Tuesday, 27.08.2019, Room G 30

Time	ID	PLENARY SESSION I
10:00		OFFICIAL CONFERENCE OPENING
		Chair: Alberta Bonanni, JKU Linz
10:10	1	**Artificial intelligence in materials science - hype or revolution?** *Claudia Draxl, Physics Department and IRIS Adlershof, Humboldt-Universität zu Berlin and Fritz Haber Institute of the Max Planck Society, Berlin* The growth of data from simulations and experiments is expanding beyond a level that is addressable by established scientific methods. The so-called “4 V challenge” of Big Data – *Volume* (the amount of data), *Variety* (the heterogeneity of form and meaning of data), *Velocity* (the rate at which data may change or new data arrive), and *Veracity* (uncertainty of quality) – is clearly becoming eminent also in the sciences. Controlling our data, in turn, sets the stage for explorations and discoveries. Novel approaches and tools of Artificial Intelligence can find patterns and correlations in data that cannot be obtained from individual calculations or experiments and not even from high-throughput studies. In fact, data-driven research is adding a new research paradigm to the scientific landscape. I will discuss the concepts and recent progress of data-driven materials science, also addressing the importance of *FAIR* and *Open Data*.
		Chair: Philippe Jetzer, Uni Zürich
10:50	2	**Understanding Giant Planets** *Ravit Helled, Institute for Computational Science, Center for Theoretical Astrophysics & Cosmology, University of Zürich, Winterthurerstr. 190, CH-8057 Zürich* Planets are common astrophysical objects. Giant planets, which are massive planets made of mostly hydrogen and helium, are the first planets to form in planetary systems, and due to their large masses they affect the dynamical evolution of the system. In addition, giant planets reveal critical information on the planetary birth environment and the formation process. Gas giants are thought to have cores in their deep interiors, and the division into a heavy-element core and hydrogen-helium envelope is applied in both formation and interior models. I will briefly summarize giant planet formation models, and will show that the primordial internal structure of giant planets depends on their growth history and evolution. I will present current-state internal structure models of Jupiter, and their connection to high-pressure physics. Finally, I will discuss the importance of the recent theoretical results for interpreting the measurements of the Juno mission and for characterizing giant exoplanets.
11:30		***General Assemblies of SPS and ÖPG ****
12:30		***Lunch***
14:00		***Topical Sessions***

** in Room G 91*

Time	ID	**PUBLIC LECTURE** *Chair: Thilo Stöferle, IBM Rüschlikon*
19:30	**3**	**The Quantum Way of Doing Computations** *Rainer Blatt, Institute for Experimental Physics, University of Innsbruck, Technikerstrasse 25, AT-6020 Innsbruck and Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences, Otto-Hittmair-Platz 1, AT-6020 Innsbruck* Since the mid-nineties of the 20th century, it became apparent that one of the centuries' most important technological inventions, computers in general and many of their applications could possibly be further 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 devices and processes. Data input, data representation in a memory, data manipulation using algorithms and finally, data output require physical realizations with devices and practical procedures. 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 as well as the development of quantum algorithms. In this talk, the basic functional principle of a quantum computer will be reviewed. It will be shown how strings of trapped ions can be used to build a quantum information processor and how basic computations can be performed using quantum techniques. The quantum way of doing computations will be illustrated with analog and digital quantum simulations. Ways towards scaling the ion-trap quantum processor will be discussed.
20:45		***END***

Wednesday, 28.08.2019, Room G 30

Time	ID	**PLENARY SESSION II** *Chair: Peter Korczak*
09:00	**4**	**The Future of Computing** *Heike Riel, IBM Research, Rüschlikon* For decades miniaturization has been the driving force behind semiconductor technology and the enabler of today's information technology. The development of smaller devices resulting in faster chips and consequently cheaper microprocessors drove this first-of-a-kind revolution in IT. Today, the fundamental question raised is: what is next? What will the next revolution be? With the explosion of available data, the internet-of-things and the increasing demand for machine learning, deep learning and artificial intelligence, the computational workloads are significantly changing. Therefore, there is a growing need for specialized hardware that can handle large computational workloads that take too long to run on conventional machines. In that regard completely new computing paradigms are being developed, such as quantum computing and non-von Neumann computing. I will give an overview of our research activities in the field of these new paradigms of cognitive hardware technologies and quantum computing.

Time	ID	*Chair: Emmerich Kneringer, Uni Innsbruck*
09:40	**5**	**Galactic High-Energy Particle Accelerators** *Olaf Reimer, Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität Innsbruck, Technikerstraße 25/8, AT-6020 Innsbruck* Continuous progress in observation and theory allows to study sources of Cosmic Rays in our Galaxy in ever increasing numbers, variety and phenomenological complexity. We are presently witnessing a broadening of the research field from individual source studies to investigations of population aspects, as well as seeing Galactic source physics reaching out into the extragalactic domain. Some source classes do not permit straight generalization owing to their uniqueness (Galactic Center), or their evidently complex class composition (gamma-ray binaries). I will review properties and phenomenology of Galactic sources in the interplay between observations and assumptions regarding their primary and secondary particles, with the focus of key results from recent Cosmic Ray charged particle and nuclei measurement and source taxonomy at the energetic gamma-ray sky.
10:20		***Coffee Break***
10:50		***Award Ceremony***
		Chair: Hans Peter Beck, Uni Bern
11:50	**6**	**The Einstein-Podolsky-Rosen paradox in a many-body system** *Matteo Fadel, Tilman Zibold, Boris Décamps, Philipp Treutlein* *Departement Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel* Quantum mechanics gives a bound on how precisely two non-commuting observables can be predicted, as expressed by the Heisenberg uncertainty principle. Nevertheless, Einstein, Podolsky and Rosen (EPR) realised that there are situations in which measurements on one system allow to predict measurement results on an other system with certainty, seemingly violating the uncertainty relation. By performing experiments with ultracold atomic ensembles, we have been able to observe for the first time this EPR "paradox" between two many-body systems. Apart from their fundamental interest, our investigations could find application in quantum metrology, for example to sense gradients. During this presentation, our studies on entanglement and Bell correlations will also be mentioned.
		Chair: Gottfried Strasser, TU Wien
12:20	**7**	**Many-body localization, thermalization, and entanglement** *Maksym Serbyn, IST Austria, AT-3400 Klosterneuburg* The route of a physical system toward equilibrium and thermalization has been the subject of discussion since the time of Boltzmann. In this talk I review the recent progress in understanding many-body localization (MBL), a phase of matter in which quantum mechanics and disorder conspire to prohibit thermalization altogether. I discuss the current understanding of the novel quantum-to-classical transition between MBL and ergodic phases, for which the analytically solvable renormalization group suggests a Kosterlitz-Thouless universality class. I conclude by discussing experimental challenges and open questions related to the thermalization breakdown in quantum systems.
12:50		***Lunch***
14:00	***Topical Sessions***	
19:00		***Postersession with Apéro***
20:30		***END***

<table>
<tr><th>Time</th><th>ID</th><th>Plenary Session III
Chair: Philipp Treutlein, Uni Basel</th></tr>
<tr><td>09:00</td><td>8</td><td>Probing nanoscale magnetism using single spin magnetometry

Patrick Maletinsky
Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel

Electronic spins yield excellent sensors which enable quantitative, nanoscale imaging even down to the level of single spins. I will describe the basic working principles and technological achievements of such quantum sensors and highlight some of their recent scientific applications to open questions in condensed matter physics.
Specifically, I will discuss how we employ single electronic spins in diamond for nanoscale probing of antiferromagnetic systems and high-resolution imaging of atomically thin “van der Waals” magnets. For both, the combination of sensitivity, spatial resolution and quantitative imaging enables unprecedented insights such as quantitative, in-situ determination of magnetic moment densities or the imaging of nanoscale domains.
I will conclude with an outlook of future developments of single spin magnetometers for extreme conditions, such as high magnetic fields, millikelvin temperatures or for high-frequency sensors to probe the dynamics of nanomagnetic systems.</td></tr>
<tr><td></td><td></td><td>Chair: Giovanni Dietler, EPFL</td></tr>
<tr><td>09:40</td><td>9</td><td>Synthetic holography with spatial light modulators
for biophotonics applications

Monika Ritsch-Marte
Medizinische Universität Innsbruck, Müllerstrasse 44, AT-6020 Innsbruck

Optical wavefront shaping with spatial light modulators (SLMs), such as deformable mirrors, digital micro-mirror devices or liquid crystal (LC) panels, has become a powerful tool in Biophotonics. “Holographic optical tweezers” are well-known and widespread, but an SLM can also be integrated into optical imaging systems, making the microscope programmable and adaptable with respect to the needs of specific samples. A particular strength of the approach with programmable phase masks is the possibility to multiplex, which means that one can ‘pack’ several tasks into one computer-generated hologram. Wavefront shaping with SLMs also enables targeting structures for optogenetical stimulation of neurons in 3D, or imaging into deeper depth in scattering media.</td></tr>
<tr><td>10:20</td><td></td><td>Coffee Break</td></tr>
<tr><td></td><td></td><td>Chair: Andreas Schopper, CERN</td></tr>
<tr><td>10:50</td><td>10</td><td>First electron acceleration in AWAKE,
the proton driven plasma wakefield acceleration experiment

Edda Gschwendtner, CERN, for the AWAKE collaboration

The Advanced Wakefield Experiment, AWAKE, is an accelerator R&D experiment at CERN using for the first time ever a high-energy proton bunch to drive plasma wakefields in plasma and accelerating electrons to the GeV energy scale and, in the future, takes advantage of the large energy store in the proton bunch to reach very high energy gain in a single plasma.
The principle of the AWAKE experiment is described. We show the experimental results of the seeded self-modulation process of the long 400 GeV/c SPS proton bunch transforming the bunch into a train of bunchlets and driving resonantly the wakefields in the 10 m long Rb plasma. We also show the acceleration results to several GeVs of electrons that have been externally injected into these wakefields.
In addition the next steps of the AWAKE experimental program as well as first possible applications of this acceleration scheme will be described.</td></tr>
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Time	ID	*Chair: Minh Quang Tran, EPFL*
11:30	**11**	**A brief history of polariton quantum fluids** *Benoît Deveaud, Ecole Polytechnique, Palaiseau, France* Polaritons are half-light half matter quasiparticles resulting from the strong coupling of photons confined in a microcavity with excitons confined in a semiconductor quantum well. Polariton condensates may be created both spontaneously through a "standard" phase transition towards a Bose-Einstein condensate, or be resonantly driven with a well-defined initial phase, speed and spatial distribution. Thanks to the photonic component of polaritons, the properties of the quantum fluid may be accessed very directly, with in particular the possibility of detailed interferometric studies. This allows for example to probe the long-range coherence properties of a quantum fluid with unprecedented ease. This also allows testing superfluid properties with great precision in space and time. In this talk, I will review the main achievements in the field of polariton physics, and try to give some perspective for future research tracks. I will show that polaritons are benefiting, through their photonic component, from a very small mass, and at the same time, through their matter component, they are able to interact. The consequences of this double nature are manyfold.
~~**12:00**~~	~~**12**~~	*cancelled*
12:00		***Postersession with Lunchbuffet***
14:00		***Topical Sessions***
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

Time	ID	**Plenary Session IV** *Chair: Laura Heyderman, PSI & ETH Zürich*
09:00	**13**	**Compound semiconductor nanowires for next generation solar cells and quantum technologies** *Anna Fontcuberta i Morral, EPFL, 1015 Lausanne* Nanowires are filamentary crystals with a tailored diameter in the range of few tens of nanometers. Their particular morphology and size renders them particularly attractive for a manifold of applications and fundamental experiments. We present recent results in the area of compound semiconductor nanowires. We review the fundamental properties that render them attractive for solar cells and quantum technologies. We will show their enhanced light absorption results in materials savings up to a factor 1000 thanks to photonic properties and enhanced carrier collection.Finally, we propose a novel setting for the growth of nanowire networks in a scalable manner. So far, these structures have been considered for topological schemes of quantum computing (using Majorana Fermions that are topologically protected).
		Chair: Bernhard Braunecker
09:40	**14**	**Economic Materials Design for Clean Energy** *Greta R. Patzke* *University of Zürich, Department of Chemistry, Winterthurerstrasse 190, CH-8057 Zürich* Artificial photosynthesis is a direct and promising option to store solar light as sustainable hydrogen fuel. However, the water oxidation half reaction remains a serious bottleneck for applications and a major challenge for catalyst design. To this end, we pursue a three-pillar approach. (1) *Bio-inspired strategies*: Our recent progress includes tailored cobalt cubane cut-outs of oxide catalyst surfaces or unraveling new soft-templating strategies in a high-performance electrocatalyst.[1] (2) *Targeted nanomaterials design*: We established facile pathways to environmentally friendly InP/ZnS quantum dots for hydrogen production or to transition metal electrocatalyst-carbon nanotube architectures.[2, 3] (3) *Monitoring the synthetic and operational pathways of water oxidation catalysts*: We obtained new insight into the operando properties of unconventional non-oxide electrocatalysts and into unexpected formation pathways of cobalt oxide nanocatalysts.[4] Furthermore, we pursue overarching concepts to bridge molecules and solids in artificial photosynthesis, e.g. through hybrid photoanodes and single atom catalysts on graphene supports. These strategies will finally be contrasted with our work on oxide materials for solar-driven thermochemical CO_2 splitting.[5] [1] F. Song, K. Al-Ameed, M. Schilling, T. Fox, S. Luber, G. R. Patzke, J. Am. Chem. Soc. 2019, DOI: 10.1021/jacs.9b01356. [2] S. Yu, X.-B. Fan, X. Wang, J. Li, Q. Zhang, A. Xia, S. Wei, L.-Z. Wu, Y. Zhou, G. R. Patzke, Nat. Comm. 2018, 9, 4009. [3] W. Wan, S. Wei, J. Li, C. A. Triana, Y. Zhou, G. R. Patzke, J. Mater. Chem. A 2019, in print. [4] R. J. Müller, J. Lan, K. Lienau, R. Moré, C. A. Triana, M. Iannuzzi, G. R. Patzke, Dalton Trans. 2018, 47, 10759. [5] R. Jacot, J. M. Naik, R. Moré, R. Michalsky, A. Steinfeld, G. R. Patzke, J. Mater. Chem. A 2018, 6, 5807.
10:20		***Poster Award Session***
10:40		***Coffee Break***
11:15		***Topical Sessions***
13:45		***CONFERENCE END***