

Sessions

Plenary Session & Special: Physics funding in Switzerland

Monday, 27.06.2022, Room JD 002

Time	ID	OFFICIAL CONFERENCE OPENING
10:50		<p>Welcome note</p> <p>Opening speech</p> <p><i>Martina Hirayama, State Secretariat for Education, Research and Innovation (SERI)</i></p>
11:00		General Assembly SPS
12:00		Lunch
		<p>PLENARY SESSION I</p> <p><i>Chair: Ullrich Steiner, Université de Fribourg</i></p>
13:00	1	<p>Frontiers in Nanophotonics: Enabling Technology for Optical Biosensing and Bioimaging</p> <p><i>Hatice Altug, Laboratory of BioNanoPhotonic Systems, EPFL</i></p> <p>Nanophotonics, which excels at controlling light in sub-wavelength volumes and providing enhanced light-matter interactions, is opening up unprecedented opportunities in many fields including biology. Our laboratory has world-leading expertise in experimental nanophotonics and its application to biosensing, spectroscopy and bioimaging by combining novelties of nano-scale optics with microfluidics, nanofabrication, biochemistry and data science. We introduce powerful bioanalytical technologies enabling label-free, real-time, and high-throughput analysis of biomolecules, pathogens and living cells for life science research, disease diagnostics and point-of-care testing. In this talk, I will present some of our recent work and provide their prospects in biomedical and clinical applications.</p>
		<i>Chair: Andreas Schopper, CERN</i>
13:45	2	<p>The Cherenkov Telescope Array Observatory</p> <p><i>Teresa Montaruli, Université de Genève</i></p> <p>The Cherenkov Telescope Array Observatory construction has started and the first large size telescope is taking data since years at La Palma, Canary Islands, while three more are being built. CTAO will have a leading role in multi-messenger astrophysics, offering a view on the most powerful accelerators of the Universe. A full picture requires the combination of information from different messengers. We are witnessing in these years the many discoveries with gamma-rays from space by Fermi, the evidences of the IceCube neutrino sources and of the small-scale anisotropies by Pierre Auger with ultra-high energy cosmic rays. The future is bright for CTAO and its current status will be illustrated.</p>
		<p>PHYSICS FUNDING IN SWITZERLAND</p> <p><i>Chair: Johan Chang, Universität Zürich</i></p>
14:30	21	<p>Trends and developments in funding by the Swiss National Science Foundation</p> <p><i>Bernd Gotsmann, IBM Research Zürich</i></p>

14:45	22	Funding Swiss researchers in international large scale scientific projects <i>Michele Weber, Universität Bern</i>
15:00	23	Funding fundamental physics research, a researcher's perspective <i>Thierry Giamarchi, DQMP, Université de Genève</i>
15:15		<i>Discussion</i>
16:00		Coffee Break
16:30		Topical Sessions
		PUBLIC LECTURE <i>Chair: Hans Peter Beck, Universität Bern</i>
19:30	3	Climate models: Early warning system of the climate crisis <i>Thomas Stocker, Climate and Environmental Physics and Oeschger Centre of Climate Research, University of Bern</i> "Climate change is physics"; this was highlighted by the 2021 Nobel Prize in Physics. Physically based models of the atmosphere and ocean, which have been developed since the mid 1960s, have predicted fingerprints of climate change that we now observe worldwide. Warming in the troposphere and cooling in the stratosphere, warming of the ocean, and the accelerating melting of glaciers and polar ice sheets leading to sea level rise are testimony to these changes that are unprecedented in human experience. In this lecture we recall some of the seminal research of two of the three laureates of the Nobel Prize in Physics 2021, and put them into the broader context of climate research carried out in physics. Taken together, the physical science basis has been essential, not only for the UN Framework Convention on Climate Change but also for the Paris Agreement.
20:45		END

Tuesday, 28.06.2022, Room JD 002

Time	ID	PLENARY SESSION II <i>Chair: Christof Aegerter, Universität Zürich</i>
09:00	4	The physics of knots: from shoelaces to surgical sutures <i>Pedro M. Reis, Flexible Structures Laboratory, Institute of Mechanical Engineering, EPFL</i> Even though most of us tie our shoelaces 'wrongly,' knots in ropes and filaments have been used as functional, structural mechanisms for millennia in sailing, climbing, and surgery. Still, knowledge on physical knots is mostly empirical, and there is a need for physics-based predictive models. For tight knots, highly nonlinear and coupled behavior arises from the intricate 3D geometry, large deformations, (self)contact, and friction. Furthermore, tight knots do not exhibit separation of the relevant length scales, precluding the usage of centerline-based rod models. Our precision experiments using X-ray computed tomography and mechanical testing have yielded unprecedented data, which we contrast to Finite Element simulations and analysis of ideal (geometric) strings. Building on this understanding, we have been collaborating with a surgeon to characterize, analyze, and rationalize the physics of surgical knots. These findings could have potential applications in the training of surgeons and control of robotic-assisted surgical devices.

Time	ID	<i>Chair: Antoine Pochelon</i>
09:45	5	<p>Towards predicting plasma confinement in fusion devices</p> <p><i>Frank Jenko, Max Planck Institut für Plasmaphysik, DE-85748 Garching b. München</i></p> <p>It is a key goal of fusion research to build devices that allow us to create a plasma at sufficiently high pressure and energy confinement time, so that the conditions for a burning plasma can be met. For a long time, progress along these lines was largely based on a "trial-and-error" approach. With the preparation of ITER operation and attempts to design first versions of future fusion power plants, it became clear that a more targeted "predict-first" approach is needed to accelerate the further development of fusion energy. Modern supercomputers open up new possibilities to solve the complex underlying equations, allowing us to move from an interpretative to a truly predictive approach. So how and when will we be able to predict plasma confinement in fusion devices?</p>
10:30		Coffee Break
11:00		Award Ceremony
		<i>Chair: NN</i>
11:45	6	<p>Light-mediated strong coupling between a mechanical oscillator and atomic spins 1 meter apart</p> <p><i>Thomas Karg, IBM Research Zurich, CH-8803 Rüschlikon</i></p> <p>Engineering strong interactions between quantum systems is essential for many phenomena of quantum physics and technology. Typically, strong coupling relies on short-range forces or on placing the systems in high-quality electromagnetic resonators, which restricts its range to microscopic distances. We used a free-space laser beam to strongly couple an atomic ensemble and a micromechanical membrane over 1 meter distance in a room-temperature environment. The coupling is highly tunable and allows the observation of normal-mode splitting, coherent energy exchange oscillations, two-mode thermal noise squeezing, and dissipative coupling. Our approach to engineering coherent long-distance interactions with light enables modular interfaces for quantum networks and control.</p>
		<i>Chair: Marc Janoschek, PSI Villigen</i>
12:15	7	<p>Quantum Criticality and Dimensionality in Quasi-2D Spin-Dimer Systems</p> <p><i>Stephan Allenspach, ETH Zürich & PSI Villigen</i></p> <p>Spin-dimer systems are an ideal testbed to study criticality because a quantum phase transition from a disordered to a magnetically ordered phase can be induced by a magnetic field. To determine the spin Hamiltonians of the spin-dimer compounds $\text{BaCuSi}_2\text{O}_6$ and $\text{Ba}_{0.9}\text{Sr}_{0.1}\text{CuSi}_2\text{O}_6$ inelastic neutron scattering experiments are performed at zero field and the magnetic order in $\text{BaCuSi}_2\text{O}_6$ is investigated using neutron diffraction up to 25.9 T. The phase boundary of $\text{Ba}_{0.9}\text{Sr}_{0.1}\text{CuSi}_2\text{O}_6$ is obtained by NMR and the critical exponent is determined using Bayesian inference. Quantum Monte Carlo simulations of the phase boundaries agree excellently with the form of both measured phase boundaries.</p>
12:45		Lunch
14:00		Topical Sessions
19:00		Postersession with Apéro
20:30		END

Wednesday, 29.06.2022, Room JD 002

Time	ID	PLENARY SESSION III <i>Chair: Andreas Müller, Université de Genève</i>
09:00	8	Physics & Education – Perspectives from Condensed Matter and Biophysics <i>Christof Aegerter; Physik Institut, Universität Zürich</i> Physics education has in the past often been centred either on technological applications or the very large or small scales of the universe. As a middle ground, everyday phenomena, biological or soft matter systems are however also very useful to particularly stimulate students without an innate interest in Physics. In this presentation I will show how simple experiments on everyday phenomena can excite children for the subject of Physics. In addition, I will show how a standard Physics curriculum can be adjusted to cover the same topics with an emphasis on living matter and biological phenomena. This is not only useful for introductory lectures for life science students, but can also be used in high schools in order to increase the level of interest of the students by connecting the subject to their world.
		<i>Chair: Leonid Rivkin, PSI Villigen</i>
09:45	9	Large Research Infrastructures in Switzerland; History, Results and Opportunities <i>Hans Rudolf Ott, Laboratorium für Festkörperphysik, ETH Zürich, 8093 Zürich</i> Considering its geographical size, Switzerland hosts a relatively big number of large-size scientific research infrastructures. With respect to size and esteem, the number one on the list is, of course, CERN, the internationally funded institution situated in Geneva with France as the other host country. Its impact on the prestige of the scientific landscape of Switzerland is enormous. This contribution is intended to show how a relatively large number of national large-scale research infrastructures in Switzerland was established and examples of achievements will be presented. Apart from offering first-rate research opportunities for Swiss-based scientists, some of them play an important role at the international level as user institutions with open access to researchers also from abroad. Often the construction of these infrastructures and their upgrading is based on implementing innovative ideas with the help of demanding engineering work and craftsmanship, also with benefits to Swiss-based industries.
10:30		Coffee Break
		<i>Chair: Thilo Stöferle, IBM Rüschiikon</i>
11:00	10	Are Language Models better than Physics based models for Chemical and Materials Industries ? <i>Teodoro Laino, Alain Vaucher, Matteo Manica, Alessandra Toniato, Philippe Schwaller, Yves Gaetan Nana Teukam, Aleksandros Sobczyk, Oliver Schilter, Federico Zipoli, Dimitrios Christofidellis</i> <i>IBM Research Europe, Säumerstrasse 4, CH-8803 Rüschiikon</i> Natural language processing models in organic chemistry have emerged as one of the most effective, scalable approaches for capturing human knowledge and modelling chemical processes. Its use in machine learning tasks demonstrated high quality and ease of use in problems such as predicting chemical reactions [1-2], retrosynthetic routes [3], digitizing chemical literature [4], predicting detailed experimental procedures [5], designing new fingerprints [6] and yield predictions [7]. In this talk, I'll talk about the impact of language models in chemistry by highlighting the critical role of NLP architectures in implementing the first cloud-based AI-driven autonomous laboratory [8]. Finally, I will discuss recent applications of language models to the characterization of unknown enzymes, the recovery of 3D features from 1D sequences, the development of human-in-the-loop schemes for retrosynthetic strategies, and the promotion of sustainability and green chemistry strategies using ad-hoc AI models.

Time	ID	Chair: Sven Friedel, COMSOL
11:45	11	<p align="center">Solving quantum chemistry problems with first generation digital quantum computers</p> <p align="center"><i>Pauline Ollitrault, IBM Research Zurich</i></p> <p>In recent years the simulation of molecular systems with digital quantum computers has amassed a great deal of attention as the community realized quantum chemistry represents one of the most promising and impactful applications of quantum computing. This work has focused on the design of quantum algorithms for the resolution of electronic and vibrational structure problems as well as the simulation of molecular quantum dynamics.</p>
		Chair: Teresa Montaruli, Université de Genève
12:15	12	<p align="center">Looking into the heart of darkness - two-phase xenon time projection chambers for direct dark matter detection</p> <p align="center"><i>Laura Baudis, Physik Institut, Universität Zürich</i></p> <p>The fundamental nature of dark or invisible matter remains one of the great mysteries of our time. A leading hypothesis is that dark matter is made of new elementary particles, with proposed masses and interaction cross sections spanning an enormous range. Amongst the technologies developed to search for dark matter particles, two-phase (liquid and gas) xenon time projection chambers are currently leading the field, providing unprecedented sensitivities and a large discovery potential. I will present the development of these detectors from their earliest stages, with focus on the XENON programme. I will show results from XENON1T, the status of XENONnT which is currently taking data deep underground, and discuss the ongoing the R&D towards the next-generation DARWIN experiment.</p>
12:45		Postersession with Lunchbuffet
14:30		Topical Sessions
19:00		Transfer to Dinner
19:30		Conference Dinner

Thursday, 30.06.2022, Room JD 002

Time	ID	PLENARY SESSION IV Chair: Dirk Hegemann, EMPA
09:00	13	<p align="center">Monitoring and tracking carbon dioxide emissions from satellites</p> <p align="center"><i>Dominik Brunner, Laboratory for Air Pollution/Environmental Technology, Empa, 8600 Dübendorf</i></p> <p>Achieving the goals of the Paris Agreement to limit global warming to no more than 2°C above pre-industrial levels requires drastic cuts to CO₂ emissions from fossil fuel use. The Enhanced Transparency Framework of the Paris Agreement requires all countries to provide transparent information on the implementation and achievement of their national objectives. The atmospheric science community supports this process by providing independent emission estimates based on atmospheric concentration measurements from ground-based networks and from space. Current and future satellites such as the European CO₂ Monitoring mission CO₂M provide a wealth of observations to estimate emissions from large point sources such as power plants and from cities and countries. In this presentation, I will provide an overview of existing and new satellites, explain how they retrieve trace gas concentrations from measurements in the SWIR range of the solar spectrum, and show examples of their capabilities and limitations to quantify emissions.</p>

Time	ID	<i>Chair: Jean-Philippe Brantut, EPFL</i>
09:45	14	<p style="text-align: center;">Optical spectroscopy of strongly correlated electrons in two-dimensional materials</p> <p style="text-align: center;"><i>Ataç Imamoglu, Institute for Quantum Electronics, ETH Zürich, CH-8093 Zürich</i></p> <p>In this talk, I will describe recent experiments in atomically-thin transition metal dichalcogenides (TMDs) where Coulomb interactions between electrons dominate over their kinetic energy. Our measurements provide a direct evidence that the electrons at densities $< 3 \cdot 10^{11} \text{ cm}^{-2}$ in a MoSe_2 monolayer form a Wigner crystal even at $B = 0$ [1]. This is revealed by our low-temperature ($T = 80 \text{ mK}$) magneto-optical spectroscopy experiments that utilize a newly developed technique allowing to unequivocally detect charge order [2]. This method relies on the modification of excitonic band structure arising due to the periodic potential experienced by the excitons interacting with an electronic lattice. Under such conditions, optically-inactive exciton states with finite momentum matching the reciprocal Wigner lattice vector $k = k_w$ get Bragg scattered back to the light cone, where they hybridize with the zero-momentum bright exciton states. This leads to emergence of a new, umklapp peak in the optical spectrum heralding the presence of periodically-ordered electronic charge distribution.</p> <p>Twisted bilayers of TMDs in turn offer a wealth of new phenomena, ranging from dipolar excitons to correlated insulator states. Another striking example of qualitatively new phenomena in this system is our recent observation of an electrically tunable two-dimensional Feshbach resonance in exciton-hole scattering [3], which allows us to control the strength of interactions between excitons and holes located in different layers. Our findings enable hitherto unexplored possibilities for optical investigation of many-body physics, as well as realization of degenerate Bose-Fermi mixtures with tunable interactions.</p>
10:30		Poster Award Session
10:45		Coffee Break
11:15		IUPAP 100
13:15		Lunch
14:15		Topical Sessions
18:45		CONFERENCE END