Plenary Session

Monday, 21.06.2010, Aula

Time	ID	**Plenary Session** *Chair: C. Rossel, IBM Rüschlikon*
09:00	**1**	**50 Jahre Laser: "Genauer – Schneller – Kleiner – Heller"** *Gerd Leuchs, MPI Erlangen* Etwa hundert Jahre nach der Postulierung der stimulierten Emission und 50 Jahre nach seiner ersten experimentellen Realisierung hat der Laser eine große Breitenwirkung erzielt. „Genauer, schneller, kleiner und heller“ definieren die Rekorde, für die der Laser auch heute noch und immer wieder aufs Neue steht. Kleiner und dadurch kostengünstig spielt für den Massenmarkt eine große Rolle. Genauer und schneller markieren die entscheidenden Vorteile, die der Laser in der Kunst der Präzisionsmesstechnik bietet und zwar sowohl für den Grundlagenforscher als auch für den Anwender in der Industrie. Der Maschinenbau profitiert von dem Vorsprung durch hohe Strahlleistung, also „heller“. Im Wettstreit um immer kürzere Pulse schließlich überschlagen sich seit einigen Jahren die Rekorde und die Beobachtung eines Elektrons auf seiner Bahn im Atom scheint nur noch eine Frage der Zeit zu sein. Der Vortrag gibt einen Überblick über die faszinierende Entwicklung in einem spannenden Gebiet.
09:40	**2**	**The Large Hadron Collider at CERN: Entering a new era in unraveling the mystery of matter, space and time** *Felicitas Pauss, ETH Zürich & CERN* The research goals of particle physics are to study the structure of the Universe at its most fundamental level by exploring the basic physics laws that govern the fundamental building blocks of matter and to explore the structure of space-time. The important next step for the advancement of fundamental science is the Large Hadron Collider (LHC) at CERN, the European Particle Physics Laboratory in Geneva (Switzerland). Proton-proton collisions at an unprecedented energy will in the coming years illuminate a new landscape of physics, possibly answering some of the most fundamental questions in modern physics, such as the origin of mass, the unification of fundamental forces and new forms of matter. A summary of the first LHC operation will be presented together with future perspectives of the LHC scientific program.
10:20		***Coffee Break***
10:50	**3**	**Dirac Fermions in HgTe Quantum Wells** *Laurens W. Molenkamp* *Physikalisches Institut (EP3), Universität Würzburg, DE-97074 Würzburg* Narrow gap HgTe quantum wells exhibit a band structure with linear dispersion at low energies and thus are very suitable to study the physics of the Dirac Hamiltonian in a solid state system. In comparison with graphene, they boast higher mobilities, and moreover, by changing the well width one can adjust the effect Dirac mass from positive, through zero, to negative.

		Negative mass HgTe quantum wells are so-called topological insulators, and exhibit the quantum spin Hall effect, where a pair of spin polarized helical edge channels develops when the bulk of the material is insulating, leading to a quantized conductance. In this talk, I will give an overview of our recent work on the quantum spin Hall effect that occurs when the HgTe quantum wells are gated into the gap, as well as the Dirac fermions physics we observe when the quantum wells are metallic.
11:30	**4**	**Nanofabrication with Organometallic Polymers** *Julius Vancso* *University of Twente, MESA+ Research Institute for Nanotechnology* *Faculty of Science and Technology, P.O. Box 217, NL-7500 AE Enschede* Organometallic homo- and block copolymer resists have been used with success in top-down and bottom-up nanofabrication to provide patterned surfaces, which can serve as templates (or masks). Poly(ferrocenylsilanes) (PFS) featuring ferrocene and silane units in their main chain have been a prime candidate as alternative resists due to the presence of iron and silicon in the backbone, which provide high resistance to reactive ion etching (RIE). Pattern transfer to substrates across the length scales has been achieved by RIE to provide functional patterned platforms. In this presentation fabrication strategies encompassing PFS in lithographies alternative to optical projection approaches will be reviewed. As examples, the preparation and properties of magnetic nanostructures, and nanoporous membranes will be discussed.
12:10		***Lunch***
13:30		***Topical Sessions***

Tuesday, 22.06.2010, Aula

Time	ID	PLENARY SESSION *Chair: T. Gyalog, Uni Basel*
09:00	**5**	**Magnetic resonance imaging with nanomechanics** *Martino Poggio, Department of Physics, Uni Basel* Can we use the same forces that cause two magnets to attract or repel each other to measure the dynamics of single spins? This is the basic question driving research in mechanically detected magnetic resonance. In conventional magnetic resonance, the dynamics of a spin ensemble alter magnetic fields inside a pick-up coil inducing currents in that coil. While this works beautifully for macroscopic samples, as samples approach the nanoscale, the scheme breaks down. Moving to a mechanically-detected technique is one solution to this problem. In such methods, the oscillating force between spins and a small magnet drive a compliant cantilever. The cantilever's mechanical oscillations are then measured using an optical interferometer. I will describe how mechanically detected techniques have been used to do nanoscale magnetic resonance imaging, achieving a billion-fold improvement in the volume sensitivity over inductively-detected methods. Could a “molecular structure microscope," whereby one could image the atomic structure of macromolecules, be around the corner?
09:40		***Award Ceremony, Honorary Members, General Assembly***

10:50		*Coffee Break*
11:20	6	**Polaritons: Bose-Einstein condensation and quantum correlations in semiconductors** *Vincenzo Savona, Institut de Théorie des Phénomènes Physiques, EPFL* The excited electronic states of most semiconductors with a direct gap are polaritons - hybrid states of light and matter. Thanks to their hybrid nature, these particles are characterized by a high degree of quantum coherence over long range - like photons - while having a finite mass and undergoing many-body interactions like atoms. Hence, polaritons hold great promise for investigating quantum coherence and quantum correlations in solid-state devices. I will present an overview of the physics of polaritons, focusing on their quantum many-body properties. In particular, I will illustrate recent results in two main areas: polariton Bose-Einstein condensation, and the controlled generation of quantum correlated polariton states. In particular, I will discuss the physics of polaritons as a two-component interacting Bose gas and will illustrate the theoretical approach to the polariton condensate, predicting the phase diagram and the collective excitation spectrum. Polaritons are an ideal system for addressing open problems in the physics of the quantum degenerate Bose gas, such as low dimensionality, and disorder that naturally arises in semiconductor artificial structures. I will illustrate the recent advances of the research in this area. I will then discuss the mechanisms governing polariton nonlinearity and the possibility to generate quantum correlated polariton pairs in a controlled way - that recently stimulated the first observation of polariton-pair entanglement. This fact, joined to the recent success in the fabrication of quantum-confined polariton devices, opens the way to a new promising device paradigm for nonclassical light emission and - within a longer term perspective - for the control of quantum correlations over a long spatial range in a scalable solid-state context.
12:00		*Postersession (continued), Lunchbuffet*
13:15		*Topical Sessions*

ID	Model Booth (available during the whole conference)
51	**The SwissFEL project** *Rafael Abela, Paul Scherrer Institut, 5232 Villigen PSI* The Paul Scherrer Institute is planning the construction of a hard-x-ray free-electron laser, the SwissFEL, by 2016, which will produce intense, ultrashort pulses of transversely coherent radiation in the wavelength range 0.1–7 nm, with future extensions to cover the range 0.08–30 nm. Special design considerations include (a) a compact construction, compatible with the status of a national facility, (b) a uniform 100 Hz repetition rate, well suited to sample manipulations and detector readout, (c) flexible wavelength tuning by the electron beam energy and undulator gaps, (d) soft x-rays at approximately 1 nm wavelength, with circular polarization and Fourier-transform-limited pulses, (e) hard x-rays of pulse duration 5–20 fs and (f) an independent source of high-energy, half-cycle terahertz pump pulses. The science case for the Swiss FEL project, which emphasizes the dynamics of condensed matter systems and the damage-free imaging of nanostructures, includes novel considerations that make optimal use of these features.