4 Theoretical Physics

Wednesday, 26.03.2008, Room 2140 (2nd floor)

Time	ID	Theoretical Physics 1: Particle Theory *Chair: R. Rattazzi, EPFL*
12:00		***Postersession, Lunch***
12:45		***SPS GENERAL ASSEMBLY***
13:00	**400**	**Welcome and Introduction** *Thomas Gehrmann, Inst. für theoretische Physik, Universität Zürich*
13:15	**401**	**Theory heartbeats for LHC data-bytes** *Charalampos Anastasiou, ETHZ* The particle physics community will be soon able to study, hands on, varied data from the LHC experiments. The activities have intensified in a few directions: (i) new ideas find their way into model building yielding consistent extensions of the Standard Model, (ii) new computational and field theoretical methods shorten the distance from a gauge theory Lagrangian to precise predictions for cross-sections, (iii) drills to reconstruct underlying theories from generated "LHC data-sets" are reaching a high level of sophistication. I will describe some of the recent developments in preparation of the LHC, and I will try to paint a picture of the great expectations, hard work, and seriousness of the particle theory community in view of the forthcoming challenges of historical magnitude.
13:45	**402**	**W-boson production at the Tevatron and the LHC: higher-order electroweak and supersymmetric corrections** *Alexander Mück [1], Silja Brensing [2], Michael Krämer [2], Stefan Dittmaier [3]* *[1] Paul Scherrer Institut, 5232 Villigen PSI* *[2] RWTH Aachen, Institut für Theoretische Physik E, RWTH Aachen, DE-52056 Aachen* *[3] MPI München, Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), DE-80805 München* The high accuracy envisaged for future measurements of W-boson production at hadron colliders has to be matched by precise theoretical predictions. We study the impact of electroweak radiative corrections on W-boson production cross sections and differential distributions at the Tevatron and at the LHC. In particular, we include photon-induced processes and leading higher-order corrections in the high-energy Sudakov regime and from multi-photon final-state radiation. We furthermore present the calculation of the complete supersymmetric next-to-leading-order electroweak and QCD corrections to W-boson hadroproduction within the MSSM.

14:00	**403**	**Two-loop electroweak NLL corrections with massless and massive fermions** *Bernd Jantzen [1], Ansgar Denner [1], Stefano Pozzorini [2]* *[1] Paul Scherrer Institut, 5232 Villigen PSI* *[2] Max-Planck-Institut für Physik, Föhringer Ring 6, DE-80805 München* At high scattering energies E electroweak radiative corrections are enhanced by logarithmic mass singularities $\ln(E^2/M^2_W)$, such that even two-loop corrections yield significant contributions to LHC or ILC cross sections. Within the spontaneously broken electroweak theory the virtual one- and two-loop corrections to arbitrary processes with external fermions have been derived to next-to-leading logarithmic (NLL) accuracy, which incorporates in each order α^n of perturbation theory the two highest powers of logarithms $\ln^{2n-j}(E^2/M^2_W)$ with j=0,1. The NLL results are expressed as universal correction factors which depend only on the quantum numbers of the external particles and can be applied to any fermionic process. This talk explains the calculation of the mass singularities and presents in particular the extension of the previously published results from massless to massive fermions.
14:15	**404**	**The complete two-loop QCD amplitude gg -> h, H in the MSSM** *Stefan Beerli, Charalampos Anastasiou, Alejandro Daleo* *ETHZ, Theoretische Physik, 8093 Zürich* I present the complete two-loop QCD amplitude for the interaction of two gluons and a CP-even Higgs boson in the Minimal Supersymmetric Standard Model. I apply a novel numerical method for the evaluation of Feynman diagrams with infrared, ultraviolet and threshold singularities.
14:30	**405**	**The Di-Photon Signal in Higgs production at the LHC within the MSSM** *Stefan Bucherer, Zoltan Kunszt* *ITP, ETH Zürich, Schafmattstrasse 32, 8093 Zürich* I present the cross section for a Higgs boson decaying into two photons at the LHC. The cross section at next-to-leading order accuracy in the strong coupling is already known within the Standard Model. Here, I consider the complete corrections at this order for supersymmetric extensions of the Standard Model. I will first describe the salient features of the calculation. Then I will present new results for kinematic distributions of the photons and the cross section for the di-photon signal which may be measured experimentally.

14:45	**406**	**Matching of fixed order and resummed calculations for event shapes.** *Gionata Luisoni, Institut für Theoretische Physik, Universität Zürich, Winterthurerstrasse 190, 8057 Zürich* Event-Shape observables permit to study and to test Quantum Chromodynamics looking at the topology of events produced for example in e^+e^- annihilation. The usual way to make theoretical predictions is to compute the cross section for a given observable as an expansion in powers of the strong coupling constant α_S. The perturbative expansion converges, giving reliable results, if α_S is small end higher order corrections becomes smaller and smaller. At kinematical boundaries the logarithms appearing in the fixed order prediction become large, spoiling the convergence of the series and requiring to resum them to all orders. In order to have a reliable prediction which holds over the whole kinematical range, one has to match fixed order and resummed predictions. Up to now next-to-leading fixed order (NLO) and resummed calculations at next-to-leading logarithmic approximation (NLLA) were matched. I will discuss the matching of the very recently appeared NNLO fixed order results with NLLA computations.
15:00	**407**	**Non-Standard Model Displaced Vertices in LHCb** *Neal Gueissaz, EPFL-SB-IPEP-LPHE1, 1015 Lausanne* Some theoretical models - Minimal Supersymmetric Standard Models with R-Parity (baryonic number) violation, Hidden Valleys, Gauge-mediated SUSY, etc. - feature heavy long-live particles. Their decay length could be long enough to result in displaced vertices that could be detected at the LHCb (CERN) experiment, using its excellent spatial resolution. I will adress the potential to trigger and reconstruct such events based on the high multiplicity of charged tracks at the decay vertices. This could bring to an early discovery of physics beyond the Standard Model.
15:15	**408**	**Minimal Flavour Violation and RGE in the MSSM** *Emanuel Nikolidakis, Gilberto Colangelo, Christopher Smith ITP, Universität Bern, Sidlerstrasse 5, 3012 Bern* We study the MSSM with Minimal Flavour Violation (MFV) at different energy scales. We show that formal invariance under the flavour symmetry group leads to a general reparametrization of the soft SUSY breaking terms in the MSSM. MFV is then defined as a natural small restriction of the general parameter space and its behaviour under the renormalization group is studied after imposing phenomenological constraints at the electroweak scale. The smaller parameter space promises faster integration of the RGE while the precision in the relevant regions of the full parameter space is not decreased significantly.
15:30		***Coffee Break***

Time	ID	Theoretical Physics 2: Gravitation and Astrophysics *Chair: M. Shaposhnikov, EPFL*
16:00	**411**	**Present challenges in cosmology** *Ruth Durrer, Université de Genève* I shall talk on the following topics: The cosmic microwave background: Why is it so important for cosmology? What have we learned from it? What are the open problems and what can future experiments tell us? Cosmological magnetic fields: Where do they come from? how can we constrain their evolution? Dark energy: What are the options to address this problem? Can dark energy be related to back-reaction from non-linear clustering?
16:30	**412**	**Gravitational waves from 3D MHD core collapse simulations** *Simon Scheidegger, Matthias Liebendörfer, Tobias Fischer, Stuart C. Whitehouse* *Departement für Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel* We present the gravitational wave analysis from 3D MHD core collapse supernova simulations at bounce and the first couple of ten milliseconds afterwards. The simulations are launched from realistic progenitor stars and include the most important general relativistic effects. The input physics uses the Lattimer-Swesty equation of state for hot, dense matter and a neutrino parametrisation scheme that is accurate until the first few ms after bounce. The 3D simulations allow us to study features already known from 2D simulations as well as non-axisymmetric effects. Signals caused by the core bounce, convective instabilities in the protoneutron star and low T/|W|-instabilities are present in the simulations. Our core collapse simulations indicate that corresponding events in our Galaxy would be detectable by the LIGO detector.
16:45	**413**	**The neutrino signal from core-collapse supernovae** *Matthias Liebendörfer [1], Tobias Fischer [1], Anthony Mezzacappa [2], Friedrich-Karl Thielemann [1]* *[1] Departement für Physik, Universität Basel, Klingelbergstr. 82, 4056 Basel* *[2] Physics Division, Oak Ridge National Laboratory, Oak Ridge National Laboratory, Building 6010, MS 6354, Tennessee, 37831 Oak Ridge, United States* Core collapse and the launch of a supernova explosion form only a very short episode of several seconds in the evolution of a massive star. But an enormous gravitational energy of several times 10^{53} erg is emitted in the form of neutrinos of different flavours. The time variation of the neutrino signal, its energy spectrum and its flavour composition are tightly linked to the dynamics of matter at close to nuclear density and high temperature. We discuss the detectable coupling between matter and neutrinos in supernova explosions and black hole formation based on spherically symmetric general relativistic Boltzmann neutrino transport.

17:00	**414**	**Three-dimensional supernova models with neutrino diffusion** *Stuart Whitehouse, Matthias Liebendörfer* *Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel* We present recent results from some of the first three-dimensional magnetohydrodynamics simulations of core-collapse supernovae which include spectral neutrino diffusion. The code is a three-dimensional parallel MHD code which uses a second order total variation diminishing method. It includes a sophisticated nuclear equation of state and a general relativistic effective gravitational potential. The simulation is performed in a 3D computational domain with a resolution of up to 600^3 zones, embedded in a spherically symmetric environment. The simulation starts from a 15 solar mass progenitor model based on the results of stellar evolution calculations. We discuss different fluid instabilities in the hot accreted matter on the rotating protoneutron star and find a strong winding of the initially poloidal magnetic field.
17:15	**415**	**The effect of structure formation on the expansion rate of the universe** *Syksy Rasanen, Université de Genève, Departement de Physique Theorique, 24 quai Ernest-Ansermet, CH-1211 Genève 4* Cosmological observations require dark energy or modified gravity when interpreted in the context of homogeneous and isotropic models. However, when the effect of non-linear structures on the expansion is taken into account, it is possible to obtain acceleration with dust and standard gravity. I will discuss recent work on evaluating the expansion rate in a statistically homogeneous and isotropic universe with evolving non-linear structures.
17:30	**416**	**Maximal Amount of Gravitational Waves in the Curvaton Scenario** *Antti Vaihkonen, Department of Theoretical Physics, Université de Genève, 24, Quai E. Ansermet, 1211 Genève* The curvaton scenario for the generation of the cosmological curvature perturbation on large scales represents an alternative to the standard slow-roll scenario of inflation in which the observed density perturbations are due to fluctuations of the inflaton field itself. Its basic assumption is that the initial curvature perturbation due to the inflaton field is negligible. This is attained by lowering the energy scale of inflation, thereby highly suppressing the amount of gravitational waves produced during inflation. We compute the power-spectrum of the gravitational waves generated at second order in perturbation theory by the curvaton (isocurvature) perturbations between the end of inflation and the curvaton decay. An interesting property of this contribution to the tensor perturbations is that it is directly proportional to the amount of non-Gaussianity predicted within the curvaton scenario. We show that the spectrum of gravitational waves may be in the range of future gravitational wave detectors.

17:45	**417**	**Cosmic magnetic fields** *Elisa Fenu, Université de Genève, 24, quai E. Ansermet, 1211 Genève* I, under the supervision of Prof. Durrer, study how gravitational waves and magnetic fields could interact and amplify each other. In particular, we use the differential forms formalism to develop the gravito-magnetic interaction which is described by a set of non-linear magnetohydrodynamics equations of motion. We will also give a small overlook on the experimental data.
18:00	**418**	**Decaying Dark Matter** *Oleg Ruchayskiy [1], Alexey Boyarsky [2], [1] EPFL, ITP FSB EPFL, 1015 Lausanne [2] ETHZ & CERN, PH-TH, 1211 Genève 23* There is a number of experimental observations, which point out that the Standard Model of the particle physics cannot be a complete theory of nature. Among these problems, the most striking ones are: neutrino oscillations, existence of the dark matter, phenomena in the early Universe (baryogenesis, inflation). As it turns out, the addition to the SM of right-handed neutrinos with masses below electroweak scale can provide solutions for all these problems. In particular, the lightest sterile neutrino provides the DM candidate. In this talk I will describe this model (called nuMSM) and discuss its consequences for astrophysics, in particular, the strategy of the search of the sterile neutrino DM.
18:15		***END / Conference Dinner***

Thursday, 27.03.2008, Room 2140 (2nd floor)

Time	ID	Plenary Session and SPS Award Ceremony
08:30		***Plenary Session***
10:00		***Coffee Break***
10:30		***Plenary Session continued***
11:15		***SPS AWARD CEREMONY***
11:45		***Plenary Session continued***
12:30		***Postersession, Lunchbuffet***

Time	ID	Theoretical Physics 3: Gravitation and Mathematical Physics *Chair: R. Durrer, Uni Genève*
14:00	**421**	**Fractal Threshold Behavior in Vacuum Gravitational Collapse** *Sebastian Szybka [1], Tadeusz Chmaj [2]* *[1] OA, Jagellonian University, ul. Orla 171, 30244 Krakow, Poland, (visitor at University of Geneva)* *[2] H. Niewodniczanski Institute of Nuclear Physics, Polish Academy of Science, Cracow University of Technology, ul. Radzikowskiego 152, 31342 Krakow, Poland* We present the numerical evidence for fractal threshold behavior in the five dimensional vacuum Einstein equations satisfying the cohomogeneity-two triaxial Bianchi type-IX ansatz. In other words, we show that a flip of the wings of a butterfly may influence the process of the black hole formation.
14:15	**422** **(&)**	**Renormalization of the stress-energy tensor in scalar gravity theories** *Umberto Cannella, Riccardo Sturani, Departement de Physique Theorique, Université de Genève, Quai E. Ansermet, 24, 1211 Genève 4* We make use of a recent implementation of the Effective-Field-Theory approach to General Relativity; extending it to alternative theories of gravity, we compute the Energy-Momentum tensor renormalization up to first Post-Newtonian order: this enables us to show the Next-to-Leading-Order correction to the gravitational potential generated by point-like and string-like sources.
14:30	**423**	**Closed signal curves in k-essence dark energy.** *Camille Bonvin, Département de physique théorique Université de Genève, Quai Ernest Ansermet 24, 1211 Genève 4* I will speak about k-essence dark energy: a scalar field with non-canonical kinetic terms, able to explain the current acceleration of the Universe. First, I will show that if k-essence can solve the coincidence problem and play the role of dark energy in the Universe, the fluctuations of the field have to propagate superluminally at some stage. Then I will discuss the consequences of superluminal motion and the link with violation of causality.
14:45	**424**	**The Standard Model Higgs boson as the inflaton** *Fedor Bezrukov, Mikhail Shaposhnikov* *ITP EPFL, BSP - Dorigny, 1015 Lausanne* We argue that the Higgs boson of the Standard Model can lead to inflation and produce cosmological perturbations in accordance with observations. An essential requirement is the non-minimal coupling of the Higgs scalar field to gravity; no new particle besides already present in the electroweak theory is required.

15:00	**425**	**Multi-scale methods in atomic physics** *A. Pizzo, ETHZ* The purpose of this lecture is to report on recent progress in the rigorous analysis of atomic physics when the electrons are coupled to the quantized radiation field. First, it will be shown that a groundstate persists, then I will present a simple argument, based on a multi-scale virial theorem, showing that excited bound states of an atom turn into resonances. An infrared-finite algorithm to calculate the radiative corrections to the scattering amplitudes of Rayleigh scattering will also be presented. The algorithm provides the expansion of the S-matrix elements up to any order in the coupling constant, with a rigorous control of the remainder term, by recombining the infrared singularities that appear in plain perturbation theory.
15:15		
15:30		***Coffee Break***
		Theoretical Physics 4: Solid State and Multiparticle Theory *Chair: W. Amrein, Uni Genève*
16:00	**432** **(&)**	**Proof of Fermi liquid behavior in the 2D Hubbard model** *Vieri Mastropietro [1], Giuseppe Benfatto [1], Alessandro Giuliani [2]* *[1] Dipartimento di Matematica, Universita' di Roma "Tor Vergata", Viale della Ricerca Scientifica, 00133, Roma, Italy* *[2] Dipartimento di Matematica, Universita' di Roma Tre, 00146, Roma, Italy* We give a complete mathematical proof that the weak coupling 2D Hubbard model away from half filling is a Landau Fermi liquid upto exponentially small temperatures. In particular we show that the wave function renormalization is an order 1 constant and essentially temperature independent in the considered range of temperatures and that the interacting Fermi surface is a regular convex curve. This result is obtained by deriving a convergent expansion (which is not a power series) for the two point Schwinger function by Renormalization Group methods and proving at all orders suitable power counting improvements due to the convexity of the interacting Fermi surface. Convergence follows from determinant bounds for the fermionic expectations.
16:30	**431** **(&)**	**Integrated density of states for the periodic Schrödinger operator in dimension two** *Alexander V. Sobolev* *Department of Mathematics, University College London, UK* The Integrated Density of States (IDS) for periodic (or almost periodic) problems is one of the central objects in spectral analysis of differential operators. The question is to find a ”sharp” asymptotic formula for IDS as the spectral parameter λ tends to infinity. A two-term asymptotic formula was known with a remainder estimate which was still far from the predicted next term. In this paper we obtain the three-term asymptotic formula for IDS of the periodic Schrödinger operator in dimension $d = 2$. The crucial point is the thorough study of the so-called ”unstable” eigenvalues which usually present the main difficulty in the

		perturbation theory for periodic problems. Some intermediate results are proved for arbitrary $d \geq 2$, but the extension of the three-term formula to $d > 2$ will require a further insight into the structure of the unstable eigenvalues.
17:00	**433**	**Many-particle localisation** *Bruno Gut, Dionys Baeriswyl* *Departement of Physics, Chemin du musee 3, 1700 Fribourg* Strong correlation, for instance in the Hubbard model, lead to a Mott metal insulator transition at half filling. This can be interpreted as a transition from a delocalised state to localised state. We have studied a crossover between many-body localised and delocalised states away from half filling. We will basically consider the well known Hubbard model, as well as the model of spinless fermions with nearest neighbour interaction, both in one and in two dimensions. We present different ideas of how to describe such a crossover. For instance the Drude weight can be used to distinguish the two types of states depending on whether it is proportional to the filling parameter or to the doping relative to half filling. In one dimension the Drude weight can be calculated exactly. Another way to define such a crossover could be to compare the Gutzwiller trial wave function with its "dual" counterpart. The "dual" wave function leads to detailed investigations of the t-0 model. We discuss cage geometries, to our knowledge the only two-dimensional lattice where the t-0 ground state is exactly known.
17:15	**434**	**Controlling precipitation patterns:** **reaction diffusion processes in a time-dependent electric field** *Kirsten Martens [1], Michel Droz [1], Ioana Bena [1], Zoltán Rácz [2], István Lagzi [3], András Volford [4]* *[1] Département de Physique Théorique, Université de Genève, 24, Quai Ernest-Ansermet, 1211 Genève 4* *[2] Institute for Theoretical Physics, Eötvös University, Pázmány Péter sétány 1/a , 1117 Budapest, Hungary* *[3] Institute of Geography and Earth Sciences, Department of Meteorology, Eötvös University (ELTE), P.O.Box 32, 1518 Budapest, Hungary* *[4] Department of Physics, Group of Chemical Physics, Budapest University of Technology and Economics, Budafoki út 8, 1111 Budapest, Hungary* The search for methods of pattern control is an important challenge in the field of material design. Here, we propose a tool to create structured material by direct regulation. The immediate control of precipitation in an $A^- + B^+ \rightarrow C$ type reaction-diffusion process is realized through a time-dependent electric field. Our model based on the spinodal decomposition scenario shows how the spacing and widths of a band-like precipitation pattern can be tuned by an appropriately designed field. Experiments confirm the results obtained by the model. By choosing other geometries of the setup one can expect similar control over other type of patterns.

17:30	**435**	**Formation and growth of microcracks. A happy marriage of thermodynamics with a thoughtful characterization of the microstructure** *Markus Hütter, Theo A. Tervoort, Department of Materials, ETH Hönggerberg, Wolfgang-Pauli-Str. 10, 8093 Zürich* We formulate a macroscopic description of the mechanics of damaged materials. The microstructure in terms of the microcracks is captured by way of the Minkowski functionals, or so-called quermass integrals, introduced in integral geometry. Using nonequilibrium thermodynamic techniques, the driving force for the growth of the microcracks is naturally identified. In particular, Griffith's law is generalized to assemblies of polydisperse crack sizes. Due to the detailed characterization of the microstructure, we are also able to account for the plastic zones at the rims of the cracks, that are known to hamper the crack growth.
17:45	**436**	**Universal Features in Quasispecies Punctuated Evolution** *Ioana Bena [1], Satya Majumdar [2]* *[1] Université de Genève, Theoretical Physics Department, Quai Ernest Ansermet 24, 1211 Genève* *[2] Laboratoire de Physique Theorique et Modeles Statistiques, Université Paris Sud, Batiment 100, F-91405 Paris Orsay* We show that the random Eigen model of quasispecies punctuated evolution can be mapped exacly on a freely-expanding Jepsen gas. This offers us the extremely rare privilege of a complete analytical treatment of the time-dependent problem of the leader-genotype statistical properties. The central result is the emergence of universal scaling behavior of the leader-genotype probability distribution function. The associated scaling functions correspond to extreme-value statistics of dynamically correlated random variables, and they are therefore completely different from the usual extreme-value distributions of independent random variables. The statistics of the number of leader-genotype changes (punctuation events) is also shown to exhibit universal behaviors, both in the temporal evolution, and with respect to the finite size of the genotype pool. These results offer a firm theoretical basis to long-standing and puzzling experimental biological observations and numerical evidence of certain universal features of the random Eigen model.
18:00		***END***