Tuesday, 01.07.2014, Room E 130

Time	ID	**Theoretical Physics I** *Chair: Gian Michele Graf, ETH Zürich*
14:30	**401**	**Thermodynamic limit for the reduced BCS Hamiltonian: Not just mean-field** *Dionys Baeriswyl, Department of Physics, University of Fribourg* The reduced BCS Hamiltonian, the cornerstone of the miscroscopic theory of superconductivity, is usually treated in mean-field approximation. This appears to be appropriate for large system sizes because it is widely accepted that for this model mean-field theory becomes exact in the thermodynamic limit. While this assertion has been proven for some specific quantities such as the ground state energy and the free energy, it is not clear whether it is true in general. We have now addressed this issue in detail by studying Richardson's exact solution for large system sizes. We could confirm that some quantities, for instance the ground state energy and the order parameter, are accurately predicted by mean-field theory. However, discrepancies between mean-field and exact ground states persist for some correlation functions and for the fidelity susceptibility, even for large system sizes where these quantities have visibly converged to well-defined limits. Our results indicate that there exist non-perturbative corrections to the mean-field predictions in the thermodynamic limit. As a by-product of our studies we have discovered that the order parameter used for a definitive number of particles is equal to the largest eigenvalue of Yang's reduced density matrix. This result reconciles the order parameter concept with the notion of off-diagonal long-range order.
15:00	**402**	**Precision physics with hard scattering observables** *Aude Gehrmann-De Ridder, Department of Physics, ETH Zürich* Hard scattering observables are among the most sensitive probes of particle dynamics at high energy colliders, where they are used to determine particle masses, coupling constants and other fundamental parameters of the Standard Model of particle physics. The interpretation of precision data from collider experiments requires equally accurate theoretical predictions, including higher order corrections in quantum field theory. We report on the conceptual developments that enable calculations of corrections to hadron collider observables and discuss recent applications to precision physics in quantum chromodynamics.
15:30	**403**	**Berry phase investigation of spin-S ladders** *Natalia Chepiga, Frédéric Mila, Frédéric Michaud, EPFL, Rte de la Sorge, 1015 Lausanne* We investigate the properties of antiferromagnetic spin-S ladders with the help of local Berry phases. In a fully frustrated ladder where the total spin on a rung changes abruptly upon increasing the rung coupling, we show that two Berry phases are relevant to detect such phase transitions. In non-frustrated ladders, we have followed the fate of both Berry phases when interpolating between standard ladders and dimerized spin chains. Change of twist Berry phase is associated to a quantum phase transition, while 2S changes of rung Berry phase we have interpreted as a crossovers between domains in which the rungs are in different states of total spin.
15:45	**404**	**Electron Waiting Times in Mesoscopic Transport** *Christian Flindt, Department of Theoretical Physics, University of Geneva* Investigations of electrical fluctuations in mesoscopic conductors have traditionally concerned the full counting statistics of transferred charge. Recently, the distribution of waiting times between consecutive electrons has been proposed as a complementary view on quantum transport. Here, I describe our efforts to evaluate the waiting time distributions (WTDs) for mesoscopic conductors. For a quantum point contact, the WTD exhibits a crossover from Wigner-Dyson statistics at full transmission to Poisson statistics close to pinch-off. Our theory is extended to periodically driven conductors and used to analyze a train of single-particle excitations. I conclude by identifying possible avenues for further developments.

16:15	**405**	**Flavour-Violation in the Minimal Supersymmetric Standard Model** **and its decoupling limit** *Andreas Crivellin, CERN, Route de Meyrin 385, 1217 Meyrin* The two-Higgs doublet model (2HDM) with generic flavour structure is the decoupling limit of the Minimal Supersymmetric Standard Model (MSSM). After reviewing flavour violation in the MSSM I discuss the matching of the Yukawa sector of the MSSM on the 2HDM including 2-loop corrections. I then discuss the flavour-phenomenology of 2HDMs with special emphesis on the recently observed deviations for the Standardmodel expectations in tauonic B decays.
16:30		***Coffee Break***
17:00	**406**	**Reflection Positivity for Para-fermions and some Applications** *Fabio Pedrocchi, Department of Physics, University of Basel* Physical systems hosting parafermions have recently attracted a lot of interest, in particular in the context of topological quantum computation. In fact, braiding parafermions would in principle allow one to realize some quantum gates in a topologically protected fashion. In this talk, I will consider a class of Hamiltonians that describe the interaction of parafermions on a lattice. I will focus on a fundamental property of such (reflection-symmetric) Hamiltonians, namely reflection positivity. After introducing the basic concepts, I will present a sketch of the proof showing that reflection positivity indeed holds for parafermions. Such result is extremely useful in the analysis of ground-state properties of a variety of many-body Hamiltonians. As an example, I will show how the synergy between reflection positivity and topological order can be applied to examine the expectation value (in the ground states) of certain local operators. Finally, I will use reflection positivity to study vortex configurations of certain spin ladders, which are relevant to topological quantum computation.
17:30	**407**	**Cosmological perturbations and structure formation** **in nonlocal infrared modifications of general relativity** *Yves Dirian [1], Michele Maggiore [1], Stefano Foffa [1], Martin Kunz [1], Nima Khosravi [2]* *[1] Dép. de Physique Théorique, Université de Genève, 24 quai Ernest-Ansermet, 1211 Genève* *[2] School of Astronomy, Inst. for Research in Fundamental Sciences (IPM), 19395, IR-5531 Teheran* We study the cosmological consequences of a recently proposed nonlocal modification of general relativity, obtained adding a term $m^2 R \Box^{-2} R$ to the Einstein-Hilbert action. The model has the same number of parameters as ΛCDM and is very predictive. At the background level we get a pure prediction for the equation of state of dark energy $w_{DE}(z)$, with $w_{DE}(0)$ in the range [-1.165,-1.135] for Ω_M in [0.20,0.36]. We find that the cosmological perturbations are well-behaved. The nonlocal model fits well SN data and predicts deviations from GR in structure formation and in weak lensing at the level of 3-4 %, therefore consistent with existing data but readily detectable by future surveys.
17:45	**408**	**Atomic Quantum Simulation of Abelian and Non-Abelian Gauge Theories** *Uwe-Jens Wiese, Fachbereich Physik, University of Bern* Gauge theories, which realize symmetries locally in space and time, play an important role in many areas of physics. In elementary particle physics, an Abelian U(1) gauge symmetry governs the electromagnetic interaction between electrons mediated by photons, while a non-Abelian SU(3) gauge symmetry controls the strong interaction between quarks mediated by gluons. In condensed matter physics, gauge symmetries arise, for example, in the description of spin liquids, and in quantum information theory, Kitaev's toric code is an Abelian Z(2) gauge theory. The solution of gauge theories is often very complicated, in particular, in the presence of strong interactions, as between quarks and gluons in a dense neutron star or between electrons in a spin liquid. Numerical simulations of such systems on classical computers suffer from very severe sign problems. Quantum simulators are accurately controllable quantum systems that can mimic other quantum systems. They do not suffer from sign problems, because their hardware is intrinsically quantum mechanical. Recently, using ultracold atoms in optical lattices, quantum simulators have been designed for Abelian and non-Abelian gauge theories. Their experimental realization is a challenge for the foreseeable future, which holds the promise to access physical phenomena, as, for example, the evolution of strongly coupled quantum systems in real time, whose understanding has remained beyond reach of the traditional tools of theoretical physics.
18:15		

19:45		***Conference Dinner***

Wednesday, 02.07.2014, Room E 130

Time	ID	**THEORETICAL PHYSICS II** *Chair: Gian Michele Graf, ETH Zürich*
15:00	**411**	**Massive black hole binaries in the cosmic landscape as probes of the gravitational wave Universe** *Lucio Mayer, Institute for Computational Science, University of Zürich* Black holes with masses between a million and 10 billion solar masses are ubiquitous in the nuclei of galaxies. Mergers between such massive black holes result in bursts of gravitational waves. They are the primary target of future gravitational wave experiments, such as the space-born laser interferometer eLISA recently approved by the European Space Agency. Detecting such black hole mergers will promote a new window on the growth of cosmological structures since black hole mergers are driven by the merging and growth of their host galaxies. However, the theoretical understanding of how, how fast and how often such massive black hole mergers occur as their host galaxies merge is still very incomplete. In this talk I will briefly summarize the current status of the field and the open issues. I will highlight the recent results of numerical simulations and analytical models showing how the clumpiness of the interstellar medium introduces a stochastic regime in the orbital evolution of massive black hole pairs well before they reach separations small enough for gravitational wave emission to trigger their ultimate spiral-in and coalescence.
15:30	**412**	**The colors of graphene: Hofstadter butterfly for the honeycomb lattice** *Andrea Agazzi, Department of Theoretical Physics, University of Geneva* The interaction of an electron with a preiodic 2-dimensional lattice having rational magnetic flux per unit cell can be described by the Hofstadter model. The spectrum of this Hamiltonian and the Chern numbers σ_H associated to each of its gaps can be calculated and gives rise to a fractal diagram called the colored Hofstadter butterfly. It was shown earlier that σ_H for the Hofstadter model on this lattice are solutions of the Diophantine equation $r = \sigma_H\, p + s\, q$ with the natural uniqueness condition $\sigma_H \in (-q/2, q/2)$. In this work we compute the Chern numbers σ_H for the Hofstadter model on the honeycomb lattice with a method based on bulk-edge correspondence. This analysis indicates that the solution for σ_H conforms with the same Diophantine equation as in the rectangular case. However, the natural window condition turns out not to be met, and we conjecture a relaxed window condition $\sigma_H \in (-q, q)$. This work has been carried out with G. M. Graf and J.-P. Eckmann.
16:00	**413**	**Statistics of charge transport and modified time ordering** *Vincent Beaud, Department of Physics, ETH Zürich* In the last 25 years a discrepancy arose in the statistics of charge transport across a tunnel junction for independent fermionic carriers. Our result removes the ambiguity in a model of energy-dependent scattering with quadratic dispersion relation. Independently, we treat the special case of a large detector and complete similar results of Bachmann, Graf and Lesovik (2010) on a model with linear dispersion relation. In all cases binomial statistics is confirmed. In this talk, after briefly reviewing some results and expectations, a generating function of counting statistics will be introduced and reformulated in terms of time-ordered current correlators. The ordering prescription will be shown to differ from the usual ones (Dyson and Keldysh) by the Matthews modification, inducing additional terms at coinciding times. Eventually, we shall present the model with quadratic dispersion relation and illustrate the method in a simple instance. This is joint work with G. M. Graf, G. B. Lesovik and A. V. Lebedev.
16:30		***Coffee Break; END***