Conference SEWM 2014: Abstract list

Speaker: Gert Aarts - Swansea University

Title: Complex actions, complex Langevin and Lefschetz thimbles

Abstract: I discuss the recent progress in exploring the complexified field space in order to tackle the numerical sign problem for problems with a complex action, e.g. due to the presence of a nonzero chemical potential.

Speaker: Oscar Akerlund – ETH, Zurich

Title: Electro-weak stability in the presence of higher dimension operators in the Higgs sector

Abstract: We apply Extended Mean Field Theory to a chirally invariant Higgs-Yukawa model, as a gaugeless approximation of the Standard Model, to study the effect of higher dimension operators, induced by BSM physics at a scale of a few to a few hundred TeV, on the stability of the model. We show that the simplest extension, a \phi^6 operator, is enough to significantly lower the stability bound on the Higgs mass. We also study the finite temperature transition to the Higgs phase and conclude that in the absence of gauge fields the transition remains second order.

Speaker: Jens Oluf Andersen - NTNU, Trondheim

Title: Three loop HTL perturbation theory at finite temperature and baryon chemical potential

Abstract: We present results of a three-loop hard-thermal-loop perturbation theory (HTLpt) calculation of the thermodynamic potential of a quark-gluon plasma at finite temperature and chemical potential. The resulting pressure, energy density, and diagonal/off-diagonal quark susceptibilities are compared with lattice data. We show that there there is good agreement between the three-loop HTLpt analytic result and available lattice data.

Speaker: Federico Antinori - INFN Padova

Title: Results from the LHC heavy ion programme - overview

Speaker: Peter Arnold - University of Virginia

Title: Relating Classical Strings and Gravitons in AdS/CFT jet quenching

Abstract: Here's a fun question in gravity: What happens when a high-momentum graviton falls into a large (AdS-)black hole? Answer: Tidal forces outside the black hole can stretch the graviton from a quantum string into a large, classical string. I will discuss how this problem bears on theory related to jet quenching in strongly coupled plasmas. It provides a link between two very different methodologies (one involving classical strings and the other not) that have been used to set up "jet stopping" problems in such plasmas and which have given parametrically different results.

Presenter: Loredana Bellantuono - Università di Bari

Title: Hybrid exotic mesons in Soft-Wall AdS/QCD

Abstract: QCD describes strong interactions among quarks as processes with colored self-interacting gluons exchanged. This picture brings to the prediction of hybrid bound states with gluons appearing as

constituents. Hybrid mesons are configurations composed by a quark-antiquark pair, plus an excited gluon which accounts for either ordinary or exotic J^{PC} quantum numbers. Hybrid mesons with ordinary quantum numbers yield an overpopulation of the experimental spectrum respect to standard model predictions. Conversely, mesons with exotic quantum numbers cannot be described as simple quark-antiquark pairs, and their detection would demonstrate the role of gluons as constituents.

Speaker: Jean-Paul Blaizot - CEA Saclay, France

Title: Jets in medium

Presenter: Igor Bogolubsky - JINR, Dubna

Title: On gluon propagator and Gribov noise suppression in Landau gauge gluodynamics

Abstract: Simulations of gluon and ghost propagators in lattice gauge-fixed QCD, especially on very large lattices, encounter severe problems related with Gribov ambiguities. Herewith I will propose a way of a Gribov noise suppression and show the results for the gluon propagator which have been obtained by this technique in the SU(2) Landau gauge quenched QCD when using small number of Monte-Carlo lattice configurations.

Speaker: Claudio Bonati – INFN, Pisa

Title: Properties of strong interactions in strong magnetic fields

Abstract: We discuss our results on the physics of strongly interacting matter in the presence of an external magnetic field B. We focus, in particular, on the anisotropy of the quark-antiquark potential at finite B and on the magnetic susceptibility of the strongly interacting medium as a function of the temperature.

Speaker: Szabolcs Borsanyi - Bergische Universität Wuppertal

Title: Lattice QCD: from the Hadron Gas to Hard Thermal Loops

Abstract: We present the thermodynamics results of the Wuppertal-Budapest collaboration. We study the range of validity of the Hadron Resonance Gas model in detail, including the dependence on the quark flavor. We show how our lattice data can be used to find the freeze-out temperature and chemcial potential in heavy ion collisions. At higher temperature we give an update to our equation of state results and establish conctact to the HTL perturbation theory

Presenter: Yannis Burnier - EPFL, Lausanne

Title: A new method for numerical analytic continuation

Abstract: Lattice calculations are performed in Euclidean time and the measurement of real-time observables, for instance the heavy quark potential or transport coefficients require an analytic continuation. One possible path is to extract spectral functions from Euclidean data, which constitute a bridge between the real and imaginary time domain. Even if the problem at first seems ill-defined, as the Euclidean correlators are only measured at a discrete number of points and the real time spectral function is a complicated object, using Bayesian inference allows us to give a meaningful and unique answer. I.e. high precision data complemented with physical assumptions on the behaviour of the spectral function enables a reliable reconstruction. We elaborate on the ingredients of the new method, compare to the often deployed maximum entropy method and finally benchmark its performances to the other methods on both test and physical cases.

Presenter: Frederic Brünner - Vienna University of Technology

Title: Holographic Glueball Decay

We report new results on glueball decay rates in the Sakai-Sugimoto model, a realization of holographic QCD from first principles that has only one coupling constant and an overall mass scale as free parameters. We extend a previous investigation by Hashimoto, Tan and Terashima who have considered the lowest scalar glueball which arises from a somewhat exotic polarization of supergravity modes and whose mass is uncomfortably small in comparison with lattice results. On the other hand, the scalar glueball dual to the dilaton turns out to have a mass of about twice the mass of the rho meson (1487 MeV), very close to the scalar meson $f_0(1500)$ that is frequently interpreted as predominantly glue. Calculating the decay rate into two pions we find a a surprisingly good agreement with experimental data for the $f_0(1500)$. We have also obtained decay widths for tensor and excited scalar glueballs, indicating universal narrowness.

Speaker: Margaret Carrington - Brandon University

Title: Renormalization group approach to calculations in n-particle irreducible field theories

Abstract: We use the functional renormalization group to formulate the renormalization of the nPI effective action. The resulting set of coupled integro-differential equations can be solved using a numerical lattice method. The major numerical obstacle is the size of the phase space, which can be reduced by efficiently exploiting the symmetries of the n-point functions. The renormalization group method does not require counter-terms and can be used beyond the level of the 2PI effective action to obtain next-to-leading order contributions to physical observables like viscosity. We present some numerical results for the non-perturbative 2-point and 4-point functions from the 2PI and 4PI effective actions.

Speaker: Alina Czajka - Jan Kochanowski University, Kielce

Title: Ghosts out of equilibrium

Abstract: We discuss how to introduce Faddeev-Popov ghosts to the Keldysh-Schwinger formalism describing equilibrium and non-equilibrium statistical systems of quantum elds such as the quark-gluon plasma which is considered. The plasma is assumed to be homogeneous in a coordinate space but the momentum distribution of plasma constituents is arbitrary. Using the technique of generating functional, we derive the Slavnov-Taylor identities and one of them expresses the ghost Green's function, which we look for, through the gluon one. As an application, the Green's function of ghosts is used to compute the gluon polarization tensor in the hard loop approximation which appears to be automatically transverse, as required by the gauge invariance.

Speaker: Sacha Davidson - CNRS / University of Lyon, France

Title: Leptogenesis

Speaker: Katarzyna Deja - National Centre for Nuclear Research (NCBJ), Warsaw

Title: Plasmons in Anisotropic Quark-Gluon Plasma

Abstract: Plasmons of quark-gluon plasma - gluon collective modes - are systematically studied. The plasma is, in general, non-equilibrium but homogeneous. The momentum distribution of plasma constituents is obtained from the isotropic one by stretching it or squeezing in one direction, which leads to a prolate or oblate distribution, respectively. We consider all possible degrees of one dimensional deformation from the extremely prolate case, when the momentum distribution is infinitely elongated in one direction, to the extremely oblate distribution, which is infinitely squeezed in the same direction. In between these extremes we discuss arbitrarily prolate, weakly prolate, isotropic, weakly oblate and arbitrarily oblate distributions. For each case, the complete spectrum of plasmons is given analytically if possible, and numerically when not. The number of modes is found by means of a Nyquist analysis. Unstable modes are shown to exist in all

cases except that of isotropic plasma. We derive conditions on the wave vectors for the existence of these instabilities. We also discuss stable modes which are not limited to small domains of wave vectors and therefore have an important influence on the system's dynamics. The work is done in collaboration with M. Carrington and St. Mrowczynski.

Speaker: Shintaro Eijima – EPFL, Lausanne

Title: Lepton asymmetry production in the nuMSM

Abstract: The nuMSM is the Standard Model which is extended by three right-handed neutrinos with masses below the electroweak scale. The lightest of them is a dark matter candidate with mass of O(10) keV, and the rest two heavier particles with quasi-degenerate masses of O(1) GeV can explain the neutrino oscillation and the baryon asymmetry of the universe simultaneously. It is known that a lepton asymmetry which is larger than that in Baryogenesis is required for the dark matter production. In this work we discuss a lepton asymmetry production via right-handed neutrino oscillation, which is the mechanism to produce baryon asymmetry in this model.

Speaker: Kari Enqvist - University of Helsinki, Finland

Title: Decay of the Higgs and other spectators after inflation

Speaker: Miguel Angel Escobedo Espinosa - Technische Universität Muenchen

Title: Effective field theories for non-relativistic particles in a medium: Application to quarkonium and Majorana neutrinos

Abstract: It is a well known fact when very different energy scales enter in the computation of a physical phenomena unexpected suppressions and enhancements can be encountered. This is the case when a very heavy particle interacts with a medium of massless particles, as for example heavy quarkonium in heavy ion collisions or a heavy Majorana neutrino in the early universe. Effective field theories allow to reorganize the computation as a controlled expansion of the ratio of this two scales simplifying the computations and allowing to understand the needed resummations at the Lagrangian level. In this talk I will show some advantages of using effective field theories for non-relativistic fermions (Dirac or Majorana) in combination with the real-time formalism of thermal field theory or non-equilibrium field theory and this will be illustrated with examples from heavy quarkonium and heavy Majorana neutrinos.

Presenter: Gergely Fejos - RIKEN, Nishina Center

Title: Fluctuation induced first order phase transition in U(n)xU(n) models using chiral invariant expansion of FRG flows

Abstract: Phase transition in the $U(n)\times U(n)$ model is investigated for arbitrary flavor number n. We present a non-perturbative, 3+1 dimensional finite temperature treatment of obtaining the effective potential, based on a chiral invariant expansion of the functional renormalization group flows. The obtained tower of equations are similar but not identical to that of the Dyson-Schwinger hierarchy, and has to be truncated for practical purposes. We investigate the finite temperature behavior of the system in the whole parameter space for $n=2,3,4$, and in restricted regions for arbitrary flavor numbers. Our results recover the β-functions of the coupling constants obtained from the ϵ-expansion, and furthermore, it shows a direct evidence that the system always undergo a fluctuation induced first order phase transition.

Speaker: Jose Ramon Espinosa - Universitat Autònoma de Barcelona, Spain

Title: Stability of the Electroweak Vacuum in Light of LHC Data

Presenter: Sadataka Furui - Teikyo University

Title: Triality selection rules of Octonions in QCD and Astrophysics

Abstract: Leptons and Quarks are described by four-component spinors, but they can have different triality symmetries of E. Cartan, which introduce different selection rules in pseudo scalar meson decays into two photons and in dark matter generations in Astrophysics. Some details of the work accepted in the Few Body System will be presented.

Speaker: Florian Gautier - Technische Universität München, München

Title: An exact solution of the Schwinger-Dyson equation in de Sitter space

Abstract: We study the issue of infrared logarithmic divergences of radiative corrections in de Sitter space. We obtain an exact analytical solution of the Schwinger-Dyson equation, at two loop order, for super horizon momenta of the twopoint function of a scalar field with quartic self-coupling. The infinite series of self-energy insertions generates a rich, but infrared-regular, structure of the propagator.

Presenter: Ioan Ghisoiu - Institute for Theoretical Physics, University of Bern

Title: Three-loop Debye mass and effective coupling in thermal QCD

Abstract: QCD at finite temperature is afflicted with infrared divergences that can be cured, in part, in the framework of a dimensionally reduced effective theory, Electrostatic QCD. Within this theory we compute the screening mass of the chromo-electric fields and the effective coupling to three-loop order. The technical challenge of organizing the perturbative expansion and the evaluation of three-loop scalar and tensor sum-integrals will be discussed.

Speaker: Angel Gomez Nicola - Universidad Complutense Madrid

Title: Chiral Symmetry Restoration: partners and patterns

Abstract: We will discuss partner degeneration in the scalar-pseudoscalar sector at chiral symmetry restoration, from the analysis of scalar and pseudoscalar susceptibilities (χ_S, χ_P) in the QCD meson gas at finite temperature and in lattice data. Our study allows to understand, in a consistent framework built from model-independent assumptions, chiral partner degeneration within the $O(4)\rightarrow O(3)$ restoration pattern, without having to introduce explicitly the σ-state dynamics in the lagrangian. Thus, within Chiral Perturbation Theory we obtain a direct relation between χ_P and the quark condensate at finite temperature, which is consistent with lattice data on meson screening masses and with (χ_S, χ_P) matching at the transition point from the degeneration of the corresponding correlators. The same degeneration pattern is extracted directly from lattice data. A unitarized extension of χ_S saturated by the thermal $f_0(500)/\sigma$ dynamically generated pole fits well to lattice points and is also consistent with scalar-pseudoscalar degeneration. On the other hand, the separation of connected and disconnected parts for χ_S in $SU(3)$ in a isospin-breaking scenario allows to describe in a model-independent ChPT framework their mass and temperature dependence, which is also important for lattice studies of scaling behaviour. We will pay special attention to the role of the $\sigma/f_0(500)$ state in the thermodynamics of the meson gas. Finally, our recent results on electromagnetic effects on the pion dispersion relation at finite temperature will also be discussed, in connection with chiral degeneration in the vector-axial vector sector and with possible phenomenological consequences.

Speaker: Tomoya Hayata - University of Tokyo, Tokyo

Title: Temporal Chiral Spiral in Strong Magnetic Fields

Abstract: We study the QCD vacuum in the presence of strong magnetic and finite electric fields. We show that a uniform electric field, which is instantaneously applied in the parallel direction to a strong magnetic field induces a temporal oscillation of scalar and pseudoscalar condensates in a spiral form. This is a temporal analog to the chiral spiral and thus we call it temporal chiral spiral. The temporal chiral spiral originates with the propagation of the chiral magnetic wave, which is protected by the axial anomaly and thus non dissipative.

Speaker: Mark Hindmarsh - Sussex University, United Kingdom

Title: Gravitational waves from phase transitions in the early universe

Presenter: Mauricio Hippert Teixeira - Universidade Federal do Rio de Janeiro

Title: Pions Near the Chiral Critical Point

Abstract: The neighborhood of the QCD chiral critical point is characterized by the arising of intense fluctuations of the chiral field which could, in principle, generate pronounced experimental signatures of its presence. However, experimental uncertainties which are inherent to heavy ion collisions, as well as the modest size and duration of the formed plasma in these collisions, might severely attenuate these signatures, demanding a careful search for robust and reliable signals of the critical point neighborhood. In this work, using Monte Carlo techniques, we study the viability of correlations of the pions as signatures of the chiral critical point in a realistic scenario, similar to the ones which are found in RHIC.

Presenter: Andreas Hohenegger - University in Stavanger

Title: TBA

Speaker: Mei Huang – IHEP, CAS, Beijing

Title: Spontaneous generation of local CP violation and inverse magnetic catalysis

Abstract: In the chiral symmetric phase, the polarized instanton--anti-instanton molecule pairing induces a nontrivial repulsive quark interaction in the iso-scalar axial-vector channel. One unusual property is observed that in the chiral restoration phase, there is a first order phase transition for the spontaneous generation of local CP violation and chiral imbalance. Furthermore, it is found that external magnetic fields will lower the critical temperature for the local CP-odd phase transition and catalyze the chiral imbalance, which destroys the chiral condensate with pairing between different chiralities. A reasonable strength of the repulsive interaction in the iso-scalar axial-vector channel can naturally explain the inverse magnetic catalysis around critical temperature under external magnetic fields.

Speaker: Edmond Iancu – Ipht Saclay, Gif-sur-Yvette

Title: The non-linear evolution of jet quenching

Abstract: Within perturbative QCD, we consider the high-energy evolution of phenomena like the transverse momentum broadening and the radiative energy loss, which accompany the propagation of an energetic parton through a dense QCD medium, and which are globally known as "jet quenching". When the medium size L is sufficiently large, say $L \gg 1/T$ for a slice of quark-gluon plasma with temperature T, we find large one-loop corrections, which are enhanced by single or even double powers of the logarithm $\ln(LT)$. Such corrections, which are associated with soft gluon emissions (bremsstrahlung) by the energetic projectile, represent only the first step in a quantum evolution, which is generally non-linear, due to multiple scattering in the medium.
We construct the equations describing this non-linear evolution to leading logarithmic accuracy in pQCD. These equations may be viewed as a generalization, going beyond the eikonal approximation, of the BK-JIMWLK equations for the evolution of the gluon distribution in a large nucleus. An important prediction of

these equations is a rapid growth of the jet quenching parameter with increasing the medium size L. We expect this evolution to have a strong impact on the phenomenology of hard probes in heavy ion collisions at the LHC.

Speaker: Antal Jakovac - Eotvos University, Budapest

Title: Excitations of finite temperature QCD: hadrons, partons and continuum

Abstract: The QCD phase transition will be discussed in terms of spectral functions of the elementary excitations. We demonstrate that with the appropriate change of the spectral functions can describe hadron melting, correlation, and can be adjusted to describe the crossover observed around T_c = 156 MeV. We find that in the temperature regime [T_c,3T_c] the multiparticle continuum of the spectra plays an important role, and so the elementary excitations are not fully particle-like.

Speaker: Peter Jenni - Albert-Ludwigs-University of Freiburg and CERN

Title: The long journey to the Higgs boson and beyond at the LHC

Abstract: Since a few years the experiments at the Large Hadron Collider (LHC) investigate particle physics at the highest collision energies ever achieved in a laboratory. Following a rich harvest of results for Standard Model (SM) physics, came in 2012 the first spectacular discovery, by the ATLAS and CMS experiments observing a new, heavy particle which is most likely the long-awaited Higgs boson. The latest results with the full data sets accumulated over the first three-year running period of the LHC will be presented. Other, far-reaching results can be reported for exploratory new physics searches like Supersymmetry (SUSY), Extra Dimensions, and the production of new heavy particles. However, with this recent discovery of a heavy scalar boson the exciting journey into unexplored physics territory, within and beyond the SM, has only just begun at the LHC. Besides the first results and the future prospects, the talk will also touch on the history and the challenges of the whole LHC project.

Speaker: Olaf Kaczmarek - University of Bielefeld

Title: Continuum results of the heavy quark momentum diffusion coefficient from Lattice QCD

Abstract: Among quantities playing a central role in the theoretical interpretation of heavy ion collision experiments at RHIC and LHC are so-called transport coefficients. Out of those heavy quark diffusion coefficents play an important role e.g. for the analysis of the quenching of jets containing c or b quarks (D or B mesons) as observed at RHIC and LHC.
We report on a lattice investigation of heavy quark momentum diffusion within pure SU(3) plasma above the deconfinement transition, with the quarks treated to leading order in the heavy mass expansion. We measure the relevant colour-electric Euclidean correlator and based on several lattice spacings perform the continuum extrapolation. This extends our previous study progressing towards a removal of lattice artifacts and a physical interpretation of the results.
We find that the correlation function clearly exceeds its perturbative counterpart which suggests that at temperatures just above the critical one, non-perturbative interactions felt by the heavy quarks are stronger than within the weak-coupling expansion. Our results will be compared to heavy quark diffusion coefficients obtained from charmonium vector correlation functions.

Speaker: Kohei Kamada - EPFL, Lausanne

Title: Imprints of cosmic strings in late-time scaling scenario

Abstract: Cosmic strings are line-like topological defects associated with symmetry breaking. For example, if we add to the U(1)_{B-L} symmetry to the standard model gauge group, its breaking necessarily results in B-L cosmic string formation. Though it is often assumed that they are formed after inflation and enters so-called scaling regime at very early Universe, it is possible to let them enter scaling regime at a later time if phase transition takes place during inflation. Here we study its effect on the cosmological observables, in particular cosmic microwave background radiation, and show how it changes the predictions of the usual scenario.

Speaker: Alexander Kartavtsev - Max-Planck-Institute for Physics

Title: Leptogenesis in runaway and crossing regimes

Abstract: We study runaway and crossing regimes of resonant leptogenesis using non-equilibrium quantum field theory. In the runaway regime the mass difference monotonously grows with temperature, whereas in the crossing regime the mass difference initially decreases, such that the effective masses become equal at some temperature. We analytically demonstrate that vanishing of the difference of the effective masses by no means implies vanishing or suppression of C-violation. In the vicinity of the crossing point the asymmetry calculated in the Boltzmann approximation develops a spurious peak, which signals the breakdown of the quasiparticle approximation. In the exact result the spurious enhancement is exactly compensated by coherent transitions between the two mass shells. Despite the breakdown of the quasiparticle approximation the purely off-shell contributions remain small even at the crossing point. The results of this work provide a reference point for various approximations schemes including the density matrix equations.

Speaker: Seyong Kim - Sejong University

Title: Bottomonium in thermal medium from NRQCD on $N_f = 2+1$ light flavors lattices

Abstract: We study in-medium modification of bottomonium states using lattice formulation of Non-Relativistic QCD (NRQCD) on non-zero temperature lattices with $N_f = 2+1$ light quark flavor. Using spectral functions of S-wave and P-wave bottomonium channel extracted via new improved Bayesian method and Maximum Entropy Method (MEM), we investigate how temperature affects non-relativistic bound states in QCD. It is found that in-medium behavior of S-wave (Υ) channel is distinctly different from that of P-wave ($\chi_b{1}$) channel around the deconfinement temperature. Also, these spectral functions are compared with those computed with free lattice gauge field to understand lattice artefacts.

Presenter: Chris Korthals Altes - NIKHEF, Amsterdam; CPT, Marseille

Title: Calorons and the Stefan-Boltzmann gas

Abstract: We compute the effect of the one loop fluctuations around the caloron on the effective potential, in particular its stability.

Presenter: Daniel Kroff Fogaça - Universidade Federal do Rio de Janeiro

Title: Chirally symmetric droplets in the presence of a magnetic background

Abstract: The phase structure of strong interactions is much richer in the presence of an external magnetic field, as this enters as a new control parameter in the thermodynamical description. This has to be taken into consideration if one wishes to investigate the possibility of phase conversion in the interior of magnetars. We use an effective chiral description of the strong interactions, the linear-sigma model, to study the formation of chirally symmetric droplets in this scenario. We use the one-loop effective potential in the cold and dense regime and extract the nucleation parameters.

Speaker: Krzysztof Kutak - IFJ, Krakow

Title: Non-linear evolution of unintegrated gluon density at large values of coupling constant

Abstract: An evolution equation for unintegrated gluon densities that is valid for large values of the QCD coupling constant \bar{\alpha} _s is proposed. The approach is based on the linear resummation model introduced by Sta\'{s}to. We generalize the model including a non-linear term in the diffusive regime. The validity of the diffusive evolution at strong coupling is supported by the AdS/CFT consideration, as well as perturbative arguments. The evolution equation is solved numerically and the saturation scale is extracted and compared with the weak coupling counterpart.

Speaker: Aleksi Kurkela - CERN, Genève

Title: Bottom-up thermalization in heavy-ion collisions

Abstract: It is a commonly held belief that weak coupling dynamics are in contradiction with the apparently fast thermalization observed in heavy-ion collisions at RHIC and at the LHC. This belief is based on parametric estimates and naturalness arguments in the Bottom-up picture of thermalization of Baier, Mueller, Schiff, and Son. In my talk, I will discuss elevating this parametric picture into a numerical one through simulations in an effective kinetic theory. I discuss how the numerical factors play an important role and show that the Bottom-Up scenario results in rapid thermalization at realistic couplings.

Speaker: Julien Lesgourgues – EPFL, Lausanne

Title: Planck and Particle Physics

Speaker: Cristina Manuel - IEEC-CSIC, Barcelona

Title: Chiral transport equation from the quantum Dirac Hamiltonian and the on-shell effective field theory

Abstract: We derive the relativistic chiral transport equation for massless fermions and antifermions by performing a semiclassical Foldy-Wouthuysen diagonalization of the quantum Dirac Hamiltonian. The Berry connection naturally emerges in the diagonalization process to modify the classical equations of motion of a fermion in an electromagnetic field. We also see that the fermion and antifermion dispersion relations are corrected at first order in the Planck's constant by the Berry curvature, as previously derived by Son and Yamamoto for the particular case of vanishing temperature. Our approach does not require knowledge of the state of the system, and thus it can also be applied at high temperature. We provide support to our result by an alternative computation using an effective field theory for fermions and antifermions: the on-shell effective field theory. In this formalism, the off-shell fermionic modes are integrated out to generate an effective Lagrangian for the quasi-on-shell fermions/antifermions. The dispersion relation at leading order exactly matches the result from the semiclassical diagonalization. From the transport equation, we explicitly show how the axial and gauge anomalies are not modified at finite temperature an333d density despite the incorporation of the new dispersion relation into the distribution function. We also check that this transport approach allows to describe the anomalous gauge polarization tensor that appears in the Hard Thermal (and/or Dense) effective field theory. We also construct an energy density associated to the gauge collective modes of the chiral relativistic plasma, valid in the case of small couplings or weak fields, which can be the basis for the study of their dynamical evolution.

Presenter: Gergely Marko - Ecole Polytechnique, CPHT, France

Title: Light meson phenomenology and Bose-Einstein condensation in the 2-loop 2PI framework

Abstract: We present high precision FFT based numerical investigations done in Euclidean space using the 2-loop level truncation of the 2PI effective potential. We parametrize the the O(4) model at vanishing isospin chemical potential using the pion and sigma curvature masses and the pion decay constant and study the thermodynamics of the chiral phase transition and the bounds triviality poses on the predictive power of the model. We also investigate the relation between spontaneous symmetry breaking and the forming of a Bose-Einstein condensate within the charged scalar model at finite chemical potential, where we discuss the silver blaze phenomenon.

Presenter: Peter Mati - BME, Budapest

Title: Validating the 2PI resummation: the Bloch-Nordsieck example

Abstract: In this work we provide a numerical method to obtain the Bloch-Nordsieck spectral function at finite temperature in the framework of the 2PI approximation. We find that the 2PI results nicely agree with the exact one, provided we perform a coupling constant matching. In the paper we present the resulting finite temperature running of the 2PI coupling constant. This result may apply for the finite temperature behavior of the coupling constant in QED, too.

Speaker: Akihiko Monnai - Riken BNL Reasearch Center, Upton

Title: Thermal photons from chemically non-equilibrated QCD medium

Abstract: The hot QCD medium created in a heavy-ion collision is characterized with near-perfect fluidity, which is quantified by hadronic elliptic flow v2. On the other hand, elliptic flow of thermal photons has been found much larger than hydrodynamic expectations, which is recognized as "photon v2 puzzle".
In this work, I show that late quark chemical equilibration in a QCD medium can be a key to understand the phenomenon. The medium would be initially gluon-rich as indicated by color glass theory. Thermal photons are then emitted after sizable anisotropy flow has developed in the medium along with quark production, leading to the enhancement of the photon elliptic flow. Numerical analyses with a (2+1)-dimensional hydrodynamic model coupled to the rate equations for parton number evolution indicate that the quantity is visibly enhanced.

Speaker: Stanislaw Mrowczynski - NCBJ, Warsaw

Title: Wigner Functional of Fermionic Fields

Abstract: The Wigner function, which provides a phase-space description of quantum systems, has various applications in quantum mechanics, quantum kinetic theory, quantum optics, radiation transport and others. The concept of the Wigner function has been extended to quantum fields, scalar and electromagnetic. Then, one deals with the Wigner functional which gives a distribution of field and its conjugate momentum. We introduce here the Wigner functional of fermionic fields of the values in a Grassmann algebra. Properties of the functional are discussed and its equation of motion, which is of the Liouville form, is derived.

Speaker: Kyohei Mukaida - University of Tokyo

Title: Dynamics of Peccei-Quinn Scalar Revisited

Abstract: Before the saxion (radial component of PQ scalar) relaxes into the global minimum of the potential, the decay of the saxion coherent oscillation would produce too much axion dark radiation which contradicts with the current observations. We show that, by taking account of the finite-temperature dissipation effect on the saxion, the overproduction of axion dark radiation can be avoided because the PQ scalar can participate in the thermal plasma even after the PQ phase transition.

Speaker: Joyce Myers - Niels Bohr Institute

Title: Calculating the chiral condensate diagrammatically at strong coupling

Abstract: We develop a diagrammatic approach for calculating the chiral condensate on the lattice at strong coupling for QCD and related theories with fermions in the symmetric, antisymmetric, and adjoint representations. The approach is inspired by recent work of Tomboulis and earlier work in which the chiral condensate is obtained diagrammatically in the limit of infinite coupling. We calculate the chiral condensate in this limit as a function of the number of colours and fermion flavours and discuss convergence of the approach and sources of error.

Speaker: Francesco Negro - INFN - Sezione di Pisa

Title: The QCD critical line at finite chemical potentials

Abstract: We present results regarding the curvature of the critical line for N_f = 2+1 QCD with physical quark masses. We adopt analytic continuation from imaginary chemical potentials and a discretization of the theory with stout improved staggered fermions.

Speaker: William Naylor - NTNU, Trondheim

Title: The Polyakov loop extended quark meson model at finite mu and B

Abstract: We investigate the chiral and deconfinement transitions of QCD using the Polyakov loop extended quark meson model at finite chemical potential, mu, and magnetic field, B. Results are calculated using the functional renormalization group. We focus on the role of the Polyakov loop and what this can achieve within the model. We compare different potentials for the Polyakov loop (gluonic sector) and allow these to be dependent upon both mu and B. We find that one has the desired freedom to change the behaviour of the deconfinement transition, but not the chiral transition. Specifically, although the addition of the Polyakov loop weakens the magnetic catalysis found in the quark meson model, one cannot reproduce the inverse magnetic catalysis found on the lattice with physical meson masses.

Presenter: Mathias Neuman - Frankfurt University

Title: Finite density QCD and thermodynamics with heavy quarks

Abstract: We investigate QCD with heavy Wilson quarks, employing a 3d effective theory derived by a combined strong coupling and hopping parameter expansions. The effective theory is simulated using the method of complex Langevin, furthermore, on sufficiently small volumes, the sign problem is small enough to permit Monte Carlo simulations. The derived effective theory describes the onset to cold dense nuclear matter including the binding energy between nucleons causing the liquid gas transition. At vanishing and imaginary chemical potential it also reproduces the chiral restoration seen in full QCD simulations.

Presenter: András Patkós - Eötvös University, Budapest

Title: Fixed point search without auxiliary fields in fermionic theories

Abstract: The functional equation governing the renormalisation flow of fermionic field theories is investigated without introducing auxiliary fields on the example of the three-dimensional Gross-Neveu and of the Nambu--Jona-Lasinio model. Its UV safe fixed point and the corresponding full set of local eigen-operators is found in the local potential approximation. The results are in complete agreement with the results obtained in higher approximations to the Wetterich equation with the auxiliary field formulation of the model and do not receive any correction in the next-to-leading order approximation of the gradient expansion of the effective action. (Coauthor: A. Jakovác)

Presenter: Chrisanthi Praki - Swansea University

Title: The Silver Blaze Problem in the Presence of an External Magnetic Field

Abstract: The phase structure for a charged self-interacting complex scalar field in the presence of a chemical potential and an external magnetic field is studied. The inclusion of a non-zero chemical potential results in a complex action. Numerical approaches using importance sampling cannot be used to solve problems with a complex action, so complex Langevin dynamics is applied to the theory in order to circumvent this problem and allow a numerical study of the system

Speaker: Florian Preis - Vienna University of Technology, Vienna

Title: Nuclear matter in strong magnetic fields

Abstract: We study the influence of strong magnetic fields on the first order phase transition to nuclear matter in the Walecka model. Magnetic fields that are sufficiently strong might be realized in the core of magnetars as well as in neutron star mergers. We show that the naive renormalization prescription commonly utilized in the mean field approximation of the Walecka model ignores important effects that lead to a qualitative as well as quantitative behavior of the phase transition, which is in stark contrast to what has been observed in the literature so far. Formally, this is closely related to the socalled magnetic catalysis known in the context of spontaneous chiral symmetry breaking.

Speaker: Krishna Rajagopal - MIT, Cambridge (USA)

Title: A Hybrid Strong/Weak Coupling Approach to Jet Quenching in Strongly Coupled Plasma

Abstract: I will describe a new hybrid approach to jet quenching in strongly coupled plasma in which the QCD evolution of the jet from production as a single hard parton through its fragmentation is treated perturbatively, as in PYTHIA, while the interactions between the partons in the shower and the hydrodynamic medium in which they find themselves that lead to energy loss are modeled using insights from holographic calculations of the energy loss of light quarks and gluons in strongly coupled plasma. These insights come from a calculation in which an energetic light quark is shot through a slab of strongly coupled N=4 SYM plasma, focussing on what comes out the other side. Even when the "jets" that emerge from the slab of plasma have lost a substantial fraction of their energy, they look in almost all respects like jets in vacuum with the same reduced energy. Along the way we obtain a fully geometric characterization of energy loss. We take the parametric form of dE/dx obtained in this calculation and apply it parton-by-parton to every parton in a PYTHIA shower embedded in a hydrodynamic solution describing a heavy ion collision. We compute the jet R_AA, the dijet asymmetry and the jet fragmentation function ratio, all as functions of centrality, and find that we obtain a good fit to all these sets of data after fixing our one free parameter to a value corresponding to choosing a stopping length for jets in QCD that is about three to four times longer than in N=4 SYM theory. We close with suggestions of observables that could provide more incisive evidence for, or against, the importance of strongly coupled physics in jet quenching.

Presenter: Anton Rebhan - Vienna University of Technology

Title: Holograpic Glueball Decay

Abstract: We report new results on glueball decay rates in the Sakai-Sugimoto model, a realization of holographic QCD from first principles that has only one coupling constant and an overall mass scale as free parameters. We extend a previous investigation by Hashimoto, Tan, and Terashima who have considered the lowest scalar glueball which arises from a rather exotic polarization of supergravity modes and whose mass is uncomfortably small in comparison with lattice results. On the other hand, the scalar glueball dual to the dilaton turns out to have a mass of about twice the mass of the rho meson (1487 MeV), very close to the scalar meson $f_0(1500)$ that is frequently interpreted as predominantly glue. Calculating the decay rate to two pions we find a surprisingly good agreement with experimental data for the $f_0(1500)$. We have also obtained decay widths for tensor and excited scalar glueballs, indicating universal narrowness.

Speaker: Urko Reinosa - CNRS, Palaiseau

Title: Polyakov loop potential and center symmetry breaking in a massive extension of the background field gauge

Abstract: We discuss the breaking of center symmetry by thermal fluctuations in pure SU(2) and SU(3) Yang-Mills theories. We explore this question perturbatively within a massive (phenomenological) extension of the background field gauge which is supposed to cope with the problem of Gribov copies. At one-loop order, this simple perturbative calculation yields a second order phase transition in the SU(2) case and a first

order one in the SU(3) case, in agreement with lattice results and with previous findings from functional renormalization group techniques. I also comment on the effect of higher loop corrections.

Speaker: Alexander Rothkopf - Heidelberg University

Title: The heavy quark potential at finite temperature from quenched and dynamical lattice QCD

Abstract: We present the latest results of two projects focused on determining the temperature dependence of the heavy quark potential from lattice QCD. The real and imaginary part of this real-time potential is obtained from the position and width of the lowest lying peak in the Coulomb gauge Wilson line correlator spectral function. Spectral information is extracted from Euclidean time data using a novel Bayesian approach different from the Maximum Entropy Method, which has been shown to be capable of reproducing the relevant spectral features in mock data tests.
Since the determination of the imaginary part is related to the extraction of a spectral width, a large N_\tau is required for a reliable result. Hence the first project deploys anisotropic quenched lattices 32^3xN_\tau (b=7.0 x=3.5) with N_\tau=24,32,40,48,56,64,72,80,96, corresponding to 838.8MeV \geq T\geq 209.7MeV. We find that fits to the Debye mass are in good agreement with prediction from HTL perturbation theory even at rather low temperatures T\gtrsim T_C.
The second project provides for the first time a Bayesian spectral function based determination of the heavy quark potential in dynamical lattice QCD. We use the isotropic Nf=2+1 48^3x12 ASQTAD lattices of the HotQCD collaboration and find a clean transition from a confining to a Debye screened Re[V], while the small Nt precludes us from making a quantitative statement about Im[V]. Close agreement between the real part of the potential and the color singlet free energies at high temperatures or small distances is observed.

Presenter: Javier Rubio - EPFL, Lausanne

Title: Higgs-Dilaton Cosmology: Universality vs. Criticality

Abstract: The Higgs-Dilaton model is able to produce an early inflationary expansion followed by a dark energy dominated era responsible for the late time acceleration of the Universe. At tree-level, the model predicts a small tensor-to-scalar ratio ($0.0021\leq r \leq 0.0034$), a tiny negative running of the spectral tilt ($-0.00057 \leq dn_s/d\ln k \leq -0.00034$) and a non-trivial consistency relation between the spectral tilt of scalar perturbations and the dark energy equation of state, which turns out to be close to a cosmological constant ($0 \leq 1+w_{DE} \leq 0.014$). We reconsider the validity of these predictions in the vicinity of the critical value of the Higgs self-coupling giving rise to an inflection point in the inflationary potential. The value of the inflationary observables in this case strongly depends on the parameters of the model. The tensor-to-scalar ratio can be large ($r\sim {\cal O}(0.1)$) and notably exceed its tree-level value. If that happens, the running of the scalar tilt becomes positive and rather big ($dn_s/d\ln k \sim {\cal O}(0.01)$) and the equation-of-state parameter of dark energy can significantly differ from a cosmological constant ($1+w_{DE}\sim {\cal O}(0.1)$).

Speaker: Oleg Ruchayskiy - EPFL, Lausanne

Title: Quest for new physics driven by experiment and simplicity

Speaker: Kari Rummukainen - University of Helsinki

Title: Jet quenching with EQCD

Abstract: The jet quenching coefficient "qhat" characterizes the momentum transfer between a hard parton (p>>T) and the quark-gluon plasma. In perturbation theory it is known to order g^4. We calculate the soft g^6 contribution to qhat using lattice simulations of electrostatic QCD, EQCD, which is an effective theory of QCD at high temperatures.

Speaker: Daisuke Satow - Riken Nishina Center, Saitama

Title: Photon and Dilepton Production in Semi-QGP and its effect on elliptic flow

Abstract: Lattice simulation of quantum chromodynamics showed that, even above the transition temperature, the value of the Polyakov loop, which is approximate order parameter of confinement, is different from the perturbative value. This result suggested the importance of considering the effect of nontrivial value of the Polyakov loop effect, in analyzing the properties of quark-gluon plasma. We calculate the photon and the dilepton production rates in a model in which the effect of the nontrivial Polyakov loop is taken into account as a gluon condensate. As a result, we find that the photon production is suppressed compared with the calculation in which the Polyakov loop effect is neglected, while the dilepton production is slightly enhanced. We discuss a physical interpretation of these results. Furthermore, we briefly discuss how these modifications of the production rates change the v2, by using a simulation with hydrodynamics.

Speaker: Andreas Schmitt - Vienna University of Technology

Title: Sound modes and two-stream instability in a relativistic superfluid

Abstract: Relativistic superfluids are most likely present in the interior of compact stars, in nuclear matter and/or quark matter. I will discuss a field-theoretical approach to superfluidity and some of its applications, most notably first and second sound for all temperatures and the two-stream instability that is known from plasma physics and that may be relevant for compact star phenomenology.

Speaker: Thomas Schäfer - NCSU Raleigh, USA

Title: Lessons from the unitary Fermi gas for strongly coupled fluids

Speaker: Sören Schlichting - Brookhaven National Laboratory, USA

Title: Thermalization process in weakly coupled field theories far-from equilibrium

Speaker: York Schroeder - Universidad del Bio-Bio, Chillan

Title: QCD thermodynamics at three loops

Abstract: In analogy to the screening of electric fields within an electromagnetic plasma, chromo-electric fields within a quark-gluon plasma exhibit a characterictic screening length as well. Its inverse, the Debye screening mass, can be mapped onto a matching coefficient within dimensionally reduced effective theories. We report on an evaluation of this coefficient to 3-loop order, and point out how it contributes to the thermodynamic pressure of hot QCD.

Speaker: Kai Schwenzer - Washington University in Saint Louis

Title: Seeing into a compact star using precise radio pulsar data

Abstract: Astrophysical observations of compact stars provide an important source of information on matter under extreme conditions. The largest and most precise data set about neutron stars is the timing data of radio pulsars. We show how this unique data can be used to learn about the ultra-dense matter in the compact star interior. The method relies on astro-seismology based on special global oscillation modes (r-modes) that emit gravitational waves. They would prevent pulsars from spinning with their observed high frequencies, unless the damping of these modes, determined by the microscopic properties of matter, can prevent this. We show that for each form of matter there is a distinct region in a frequency/spindown-rate diagram where r-modes can be present. We find that stars containing quark matter are consistent with both the observed radio and x-ray data, whereas for standard neutron stars so far unestablished, enhanced

damping mechanisms would be required. Moreover, we show that the poorly known neutron star crust does not affect this conclusion, so that astro-seismology indeed probes the ultra-dense core.

Speaker: Gordon W. Semenoff - British Columbia University, Vancouver

Title: Lessons from graphene for relativistic field theory

Speaker: Julien Serreau - Université Paris Diderot, Paris

Title: Infrared dynamics of quantum scalar fields in de Sitter space

Abstract: The dynamics of quantum fields in de Sitter space is radically different from the flat space case. For light scalar fields, perturbation theory is plagued by infrared divergences which require resummation. Existing resummation techniques, developed for flat space quantum field theory (QFT) are difficult to implement in curved spaces mainly because of the phenomenon of gravitational redshift. I present recent work on this topics concerning a new formulation of QFT in de Sitter space which exploits as much as possible de Sitter symmetries and the power of a momentum representation. This p-representation solves the gravitational redshift problem and allows one to formulate standard resummation techniques of QFT (e.g. renormalization group, two-particle-irreducible methods, etc.) in an efficient way. I discuss recent applications concerning the calculation of field correlators and the issue of spontaneous symmetry breaking in de Sitter space.

Speaker: Denes Sexty - Heidelberg University

Title: Progress in finite density lattice QCD (tentative)

Speaker: Edward Shuryak - Stony Brook University

Title: The sounds of the Little Bang and the smallest drops of QGP

Abstract: The talk covers two new developments in the field of heavy ion collisions, due to recent discoveries at LHC and RHIC. The first is study of small perturbations of the hydro evolution, created by fluctuations of the initial conditions. Those create fluctuating angular harmonics of particle distribution, seen in certain correlation functions. The physics is similar to fluctuations in the Big Bang, observed in CMB experiments. The number of harmonics observed is not yet large, so far six, but those display interesting correlations and indication to nonlinear effects and non-Gaussian ensemble. The second is due to discovered collective explosion in high multiplicity pA and even pp collisions. Those in some respects even more violent than cases observed before, and these observations created a number of challenges for the theory.

Speaker: Kiyoumars Sohrabi Universität Bern, Bern

Title: Chiral Vortical Effect in Relativistic Hydrodynamics

Abstract: There is a possibility of observing fluctuations in charge asymmetry in heavy ion collisions. Among possible scenarios, two of them are particularly interesting; Chiral Magnetic Effect (CME) and Chiral Vortical Effect (CVE). A lot has been done in the literature to understand CME in recent years, but the same treatment is lacking in the context of CVE. In fact there are many contradictions about the existence of CVE and its physical picture. We show using simple arguments that CVE is comprehensible in the context of quantum field theory.

Speaker: Dam T. Son - University of Chicago

Title: Spacetime symmetries in quantum Hall physics

Speaker: Mikhail Stephanov - University of Illinois at Chicago

Title: Chiral Kinetic Theory

Abstract: A chiral (parity violating) medium can generate a current in response to magnetic field or rotation. The physics of such non-dissipative currents has attracted much theoretical and experimental interest recently. To shed light on the microscopic origin of these effects and their relation to chiral anomaly we derive the non-equilibrium classical kinetic equation for massless chiral particles. We show that Berry monopole appearing at the origin of the momentum space due to level crossing is responsible for chiral magnetic and vortical effects. We also find that Lorentz invariance is realized nontrivially in the classical motion of chiral particles and explore implications for the chiral kinetic theory.

Speaker: Stefan Stricker - Vienna University of Technology

Title: Holographic thermalization at indermediate coupling

Abstract: The thermalization pattern of a heavy ion collision, with which the various plasma constituents of different energies approach their final thermal distribution, is still not well understood. In this talk I will report on the thermalization patterns using N=4 super Yang Mills theory at strong but finite coupling. Special attention will be paid to the determination of out-of-equilibrium Greens functions and the pattern with which they approach their thermal limits as the coupling constant decreases from the infinite coupling limit. I will argue that all results point towards a weakening of the usual top/down thermalization pattern.

Speaker: Masahiro Takimoto - University of Tokyo

Title: Correspondence of I- and Q-balls as Non-relativistic Condensates

Abstract: In the non-relativistic limit, a real scalar field approximately conserves its number and obeys an equation that governs a complex scalar field theory with a conserved global U(1) symmetry in the non-relativistic limit. From this fact, it is shown that the I-ball (oscillon) can be naturally understood as a projection (e.g., real part) of the non-relativistic Q-ball solution. In particular, we clarify that the stability of the I-ball is guaranteed by the U(1) symmetry in the corresponding complex scalar field theory as long as the non-relativistic condition holds. We also discuss the longevity of I-ball from the perspective of the complex scalar field in terms of U(1) charge violating processes. This talk is based on arxiv:1405.3233.

Speaker: Anders Tranberg - University of Stavanger

Title: Quantum corrections to scalar field dynamics during inflation

Abstract: We compute the quantum corrections to the scalar field equation of motion to leading order in slow-roll, in semi-classical gravity. We show that by resummation, we recover an IR enhancement in terms of the slow-roll parameters, in addition to the self-consistent mass described earlier in the literature. We comment on possible applications and issues of this result and method.

Presenter: Andréas Tresmontant - Université Pierre et Marie Curie - Paris Diderot

Title: Covariant gauges without Gribov ambiguities in Yang-Mills theories

Abstract: We propose a one parameter family of nonlinear covariant gauges that can be implemented on the lattice. At high energies, where the Gribov ambiguities can be ignored, this reduces to the class of Curci-Ferrari-Delbourgo-Jarvis gauges. We further propose a formulation in terms of a local action which is free of

Gribov ambiguities and avoids the Neuberger zero problem of the standard Faddeev-Popov construction. We show that the gauge-fixed action is perturbatively renormalizable in four dimensions and that the theory admits renormalization group trajectories with no Landau pole, for which the perturbative expansion remains under control down to the regime of deep infrared momenta. We compute the corresponding gluon and ghost propagators explicitly at one-loop order.

Speaker: Dionysios Triantafyllopoulos - ECT* and FBK, Trento

Title: Running coupling effects in the evolution of jet quenching

Abstract: We study running coupling effects in the evolution of the jet quenching parameter qhat in the double logarithmic approximation. We deduce the dominant asymptotic behavior of the renormalized qhat in the limit of large $Y=\ln(L/\lambda)$, with L the size of the medium and λ the typical wavelength its constituents. We show that the asymptotic expansion is universal with respect to the choice of the initial condition at $Y = 0$ and that it is remarkably similar to the corresponding expansion for the saturation momentum of a large nucleus. As expected, the running of the coupling significantly slows down the increase of qhat with Y in the asymptotic regime at $Y \gg 1$. For $Y = 3$, we find an enhancement factor close to 3, independently of the initial condition and for both fixed and running coupling

Presenter: Helvio Vairinhos - University of Porto

Title: Worldline models for lattice gauge theories beyond the strong coupling limit

Abstract: We integrate out all the link variables in the partition function of SU(N) or U(N) lattice gauge theory with the Wilson plaquette action, for arbitrary values of the lattice coupling. The partition function is recast as a Gaussian integral over auxiliary fields, after using suitable Hubbard-Stratonovich transformations. We extend our formalism to lattice gauge theories with staggered fermions at finite temperature and density, and show how to construct the corresponding monomer-dimer-polymer models for arbitrary values of the lattice coupling.

Speaker: Aleksi Vuorinen - University of Helsinki

Title: Constraining neutron star properties with QCD

Abstract: The structure and composition of neutron stars is determined through a competition between gravity and the pressure of cold and dense strongly interacting matter, making these objects the best available laboratory for high-density QCD. I will describe, how first principles calculations at low and high densities can be used to predict the properties of neutron star matter with controllable uncertainties. Similarly, I will argue that accurate measurements on star masses and radii reveal important insights about the properties of QCD matter at extreme densities.

Speaker: Andreas Windisch - University of Graz, Graz

Title: No admittance under 4: Four-fermion condensation in strongly interacting dense matter

Abstract: We present the idea of four-fermion condensation in a strongly coupled system of fermionic species with differing chemical potentials. Such imbalanced systems are likely to occur in many contexts in nature, including quark matter and ultracold atoms. With largely imbalanced populations, two-fermion condensation is suppressed due to kinematic constraints, while (at strong coupling as realized in matter at accessible densities) a homogeneous and isotropic condensate made out of four fermions can overcome this restriction. We discuss the mechanism of four-fermion condensation in the framework of functional renormalization group equations by studying the four-fermion condensate in the local potential approximation.

Speaker: David Weir - Helsinki Institute of Physics

Title: Gravitational waves from bubble collisions: simulations and approximations

Abstract: We present the results of large-scale 3D simulations of first order phase transitions in the early Universe. The cosmic fluid is included for the first time. We obtain the gravitational wave spectrum resulting from bubble collisions for scenarios relevant to electroweak physics. Based on these results, we see that the principal source of gravitational waves is typically acoustic waves set up by the collisions. We support our large-scale numerical investigations with a straightforward approximation for the resulting source, the Acoustic Approximation, that can easily be scaled to realistic bubble separations.

Speaker: Laurence G. Yaffe - University of Washington and Regensburg

Title: Numerical holography and far-from-equilibrium dynamics

Speaker: Yan Zhu Universidade de Santiago de Compostela, Santiago

Title: On the perturbative computation of energy-momentum tensor correlators in hot Yang-Mills theory

Abstract: The hydrodynamic description of an expanding quark-gluon plasma, including a small but nonzero shear viscosity, has been seen to be in a good agreement with experimental results from high energy heavy ion collisions. This highlights the need for an accurate first principles determination of various transport coefficients, in particular the bulk and shear viscosities, of hot QCD. Unfortunately, it is very difficult to obtain direct non-perturbative lattice results for these quantities, at least without perturbative input. In this talk, I will present recent next-to-leading order (NLO) perturbative calculations of the bulk and shear correlators of SU(N) Yang-Mills theory, including determinations of the corresponding spectral functions. The results are subsequently compared to lattice and gauge/gravity predictions, as well as used to verify known sum rules. Finally, I will comment on the application of HTL resummation on the spectral functions and on the prospects of using the results to aid an eventual lattice determination of the viscosities.