Strong and Electroweak Matter Conference (SEWM 2018)

Report of Contributions

https://indico.ice.csic.es/e/6

Contribution ID : **3** Type : **not specified**

Charmonium mass in antiproton-nucleus reactions, how the in-medium gluon condensate can be measured

Monday, 25 June 2018 18:00 (30)

The masses of the low lying charmonium states, namely, the J/Ψ, $\Psi(3686)$, and $\Psi(3770)$ are shifted downwards due to the second order Stark effect. In $\bar{p} + \mathrm{Au}$ collisions at $6 - 10$~GeV we study their in-medium propagation. The time evolution of the spectral functions of these charmonium states is studied with a Boltzmann-Uehling-Uhlenbeck (BUU) type transport model. We show that their in-medium mass shift can be observed in the dilepton spectrum. Therefore, by observing the dileptonic decay channel of these low lying charmonium states, especially for $\Psi(3686)$, we can gain information about the magnitude of the gluon condensate in nuclear matter. This measurement could be performed at the upcoming PANDA experiment at FAIR.

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Presenter(s) : Dr WOLF, György (MTA Wigner RCP)

Session Classification : Parallel

Contribution ID : **5** Type : **not specified**

Holographic Picture for Heavy Vector Meson Dissociation in a Plasma

Friday, 29 June 2018 15:30 (30)

It is important to understand the properties of heavy vector mesons inside a thermal medium. One of the reasons is that the fraction of such particles detected after a heavy ion collision can provide information about the formation of a plasma state.
An interesting framework for estimating the degree of dissociation of heavy mesons in a plasma is the holgraphic approach.
We will discuss some recent results showing that a consistent picture for the thermal behavior of charmonium and bottomonium states in a thermal medium emerges from holographic bottom up models.
A crucial ingredient in this approach is the appropriate description of decay constants, since they are related to the heigths of the quasiparticle peaks of the finite temperature spectral function.
Considering a medium with finite temperature and density, the thermal spectra of $c\bar{c}$ and $b\bar{b}$ S wave states are obtained. A very recent result for a medium with magnetic eB field is also considered.

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Presenter(s) : Prof. BRAGA, Nelson (Universidade Federal do Rio de Janeiro)

Session Classification : Parallel

Contribution ID : **7** Type : **not specified**

On nonequilibrium quarkonium evolution in the QGP fireball

Friday, 29 June 2018 15:00 (30)

A Lindblad equation for the evolution of heavy quarkonia in QGP has recently been derived from potential non-relativistic QCD (pNRQCD) and open quantum system framework. We derive the classical limit of the evolution equations for
color-singlet and color-octet quarkonia states. Within the classical approximations, we are able to write the evolution equations respectively as a Langevin equation and Boltzmann equations in two different regimes. This allows us to identify the difference between quantum and classical evolution, and examine the effect of classical approximations. Applications to the study of the quarkonium evolution in QGP are presented.

Primary author(s) : Prof. VAIRO, Antonio (TUM); Prof. BRAMBILLA, Nora (TUM); ZHU, Yan (TUM)

Presenter(s) : ZHU, Yan (TUM)

Session Classification : Parallel

Contribution ID : **8** Type : **not specified**

Color superconductivity and charge neutrality in Yukawa theory

Monday, 25 June 2018 17:00 (30)

It is generally believed that systems with two fermion species that form Cooper pairs form a neutral state, where the number densities of the two fermion species are equal. This belief is based on mean field calculations with a zero-range contact interaction. We investigate whether this claim still holds if a Yukawa model is employed, where the interaction range is finite. Our results indicate that the conclusions drawn from the zero-range interaction case may not be as general as initially believed. Our findings also support the results of an earlier Dyson-Schwinger based study that found the color-flavor locked phase to be non-neutral.

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Session Classification : Parallel

Contribution ID : **9** Type : **not specified**

Towards improved overclosure bounds for WIMP-like dark matter models

Tuesday, 26 June 2018 15:00 (30)

Tight constraints from the LHC and from direct and indirect detection experiments have put many simple dark matter models under tension in
recent years. Besides putting forward new ideas in model building, it can be useful to develop more accurate computations on which a given dark matter
scenario is based. In particular, we focus on the calculation of the dark matter relic density via thermal freeze-out and investigate the impact of the thermal medium: modified Sommerfeld effect, Salpeter correction decohering scatterings, formation and dissociation of bound states. We apply this formalism to the Inert Doublet Model and to a Majorana fermion dark matter co-annihilating with a strongly interacting scalar.

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Presenter(s) : Dr BIONDINI, Simone (Albert Einstein Center, Institute for Theoretical Physics)

Session Classification : Parallel

Contribution ID : **12** Type : **not specified**

Spectral function for over-occupied gluodynamics from real-time lattice simulations

Thursday, 28 June 2018 17:00 (30)

We study the spectral properties of a highly occupied non-Abelian system, which is expected to be created in the weak-coupling picture during the initial stages after a heavy-ion collision. The spectral function of this far-from-equilibrium plasma is measured by employing linear response theory in classical-statistical lattice simulations. We establish the existence of transversely and longitudinally polarized quasi-particles and obtain their dispersion relations, effective mass, plasmon frequency, damping rate and further structures in the spectral and statistical functions. Our results are consistent with hard thermal loop (HTL) effective theory but also indicate effects surpassing its leading order. The method can be employed beyond the range of validity of HTL.

Primary author(s) : KURKELA, Aleksi (CERN, Switzerland; University of Stavanger, Norway); PEURON, Jarkko (University of Jyväskylä, Finland); BOGUSLAVSKI, Kirill (University of Jyväskylä, Finland); LAPPI, Tuomas (University of Jyväskylä, Finland; University of Helsinki, Finland)

Presenter(s) : BOGUSLAVSKI, Kirill (University of Jyväskylä, Finland)

Session Classification : Parallel

Contribution ID : **13** Type : **not specified**

Simulations of Cold Electroweak Baryogenesis

Friday, 29 June 2018 14:30 (30)

We perform numerical simulations of Cold Electroweak Baryogenesis, including for the first time in the Bosonic sector the full electroweak gauge group SU(2)×U(1) and CP-violation.
We investigate the dependence of the asymmetry on the speed at which electroweak symmetry breaking takes place.
Curiously, we find that the overall sign of the asymmetry depends on the quench time and the maximum asymmetry does not occur for arbitrarily fast quenches.
In addition, we compute the magnitude of the helical magnetic fields, and find that it is proportional to the strength of CP-violation and dependent on quench time, but is not proportional to the magnitude of the baryon asymmetry as proposed in the literature.
Astrophysical signatures of primordial magnetic helicity can therefore not in general be used as evidence that electroweak baryogenesis has taken place.
We also compute the baryon asymmetry generated from Cold Electroweak Baryogenesis, when a dynamical Beyond-the-Standard-Model scalar singlet field triggers the spinodal transition.
Using a simple potential for this additional field, we match the speed of the quench to earlier simulations with a "by-hand" mass flip.
We find that for the parameter subspace most similar to a by-hand transition, the final baryon asymmetry shows a similar dependence on quench time and is of the same magnitude.
For more general parameter choices the Higgs-singlet dynamics can be very complicated, resulting in an enhancement of the final baryon asymmetry.

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Presenter(s) : Dr MOU, Zong-Gang (University of Stavanger)

Session Classification : Parallel

Contribution ID : **14** Type : **not specified**

An effective approach to electroweak baryogenesis

Friday, 29 June 2018 15:00 (30)

Effective field theory is an attractive framework to study Electroweak Baryogenesis in a model-independent way. We add a dimension-six operator to the Higgs potential in order to have a strongly first order phase transition, which is necessary for successful baryogenesis. Another necessary ingredient is CP-violation, which can be provided by dimension-six interactions between the Higgs and, for example, the top quark. We study two of these operators that are related by the equations of motion. In our study we test the applicability of the effective field theory framework to electroweak baryogenesis. We also make a comparison between the asymmetries obtained from CP-violating interactions involving the top-quark, the bottom-quark and the tau-lepton.

Primary author(s) : Ms VAN DE VIS, Jorinde (Nikhef)

Presenter(s) : Ms VAN DE VIS, Jorinde (Nikhef)

Session Classification : Parallel

Contribution ID : **15** Type : **not specified**

Heavy Quarks in Turbulent QCD Plasmas

Monday, 25 June 2018 17:00 (30)

The quark-gluon plasma, which is produced at an early stage of ultrarelativistic heavy-ion collisions, is expected to be initially strongly populated with chromodynamic fields. We address the question how heavy quarks interact with such a turbulent plasma in comparison with an equilibrated one of the same energy density. For this purpose we derive a Fokker-Planck transport equation of heavy quarks embedded in a plasma of light quarks and gluons. We first discuss the equilibrium plasma and then the turbulent one applying the same approach, where the heavy quarks interact not with the plasma constituents but rather with the long wavelength classical fields. We first consider the three schematic models of isotropic trubulent plasma and then the simplified model of glasma with the chromodynamic fields only along the beam direction. The momentum broadening and collisional energy loss of a test heavy quark are computed and compared to those of equilibrium plasma of the same energy density.

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Presenter(s) : MROWCZYNSKI, Stanislaw (National Centre for Nuclear Research)

Session Classification : Parallel

Contribution ID : **16** Type : **not specified**

How does relativistic kinetic theory remember about initial conditions?

Tuesday, 26 June 2018 15:00 (30)

Understanding hydrodynamization in microscopic models of heavy-ion collisions has been an important topic in current research. Many lessons obtained within the strongly-coupled (holographic) models originate from the properties of transient excitations of equilibrium encapsulated by short-lived quasinormal modes of black holes. The aim of this talk is to develop similar intuition for expanding plasma systems described by, perhaps, the simplest model from the weakly-coupled domain, i.e. the Boltzmann equation in the relaxation time approximation. I will show that in this kinetic theory setup there are infinitely many transient modes carrying at late times the vast majority of information about the initial distribution function. They all have the same exponential damping set by the relaxation time but are distinguished by different power-law suppressions and different frequencies of very slow, logarithmic in proper time, oscillations. Finally, I will analyze the resurgent interplay between the hydrodynamics and transients. In particular, I will show that there are choices of relaxation time dependence on temperature for which the asymptotics of the divergent hydrodynamic series is dominated not be the least damped transient, but rather by an unphysical exponential correction having to do with non-analyticities of the equation of motion in complexified time variable.

Primary author(s) : Dr HELLER, Michal (MPI for Gravitational Physics (Albert Einstein Institute) / National Centre for Nuclear Research)

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Session Classification : Parallell

Contribution ID : **17** Type : **not specified**

Low-scale resonant leptogenesis at complete leading order

Thursday, 28 June 2018 12:30 (30)

There has been recent interest in leptogenesis induced by "light" right-handed neutrinos, with masses in the 1 - 100 GeV range. We review the form of rate equations applying to this system, as well as the computation of rate coefficients to leading order in Standard Model couplings. The resulting non-linear system is solved numerically, taking into account that right-handed neutrinos are neither in kinetic, nor in chemical, nor in helicity-flip equilibrium. The possibility of producing the observed baryon asymmetry is confirmed. A remaining challenge is to scan the full parameter space of right-handed neutrino masses and Yukawa couplings, searching for islands that can be confronted with experiment.

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Presenter(s) : LAINE, Mikko (AEC, ITP, U. Bern)

Session Classification : Plenary

Contribution ID : **18** Type : **not specified**

Nonequilibrium Dynamics of Inhomogeneous Quantum Fields

Tuesday, 26 June 2018 15:30 (30)

The dynamics of inhomogeneous quantum fields out of equilibrium are especially relevant for the study of first-order phase transitions. It is our aim to calculate how bubble configurations of the new phase, that form in such a process, propagate and locally approach thermal equilibrium. The Electroweak phase transition in the early universe is of particular interest, since Baryogenesis can potentially explain the matter-antimatter asymmetry in the Universe for fitting dynamical properties of the phase transition and the bubble collisions result in gravitational waves that could be observed by the new generation of detectors.
To calculate the dynamics of quantum bubbles we have developed a program that solves the non-equilibrium equations of motion, the so called *Kadanoff-Baym Equations*. As a starting point we investigate the dynamics of bubbles in toy models.

Primary author(s) : Mr GARRATT, Thomas (University of Wuerzburg)

Presenter(s) : Mr GARRATT, Thomas (University of Wuerzburg)

Session Classification : Parallel

Contribution ID : **19** Type : **not specified**

Hydro+ : Hydrodynamics for the QCD critical point

Monday, 25 June 2018 12:30 (30)

The search for the QCD critical point in heavy-ion collision experiments requires dynamical modeling of the bulk evolution of the QCD matter as well as of the fluctuations near the critical point. Critical slowing down means that fluctuations are significantly deviating from equilibrium near the critical point. We generalize hydrodynamics to quasi-equilibrium conditions where the state of the system is characterized by the off-equilibrium magnitude of fluctuations in addition to the usual hydrodynamic variables – conserved densities. We find that the key ingredient of the formalism -– the extended entropy taking into account the off-equilibrium fluctuations – is remarkably similar to the 2PI action in quantum field theory. We use the new formalism to demonstrate the major effects of critical fluctuations on the bulk evolution: the strong frequency dependence of the anomalously large bulk viscosity as well as the stiffening of the equation of state with increasing frequency or wave-number.

Primary author(s) : Prof. STEPHANOV, Mikhail (UIC); Dr YIN, Yi (MIT)

Presenter(s) : Prof. STEPHANOV, Mikhail (UIC)

Session Classification : Plenary

Contribution ID : **20** Type : **not specified**

Plasmon mass scale in classical nonequilibrium gauge theory in two and three dimensions

Thursday, 28 June 2018 17:30 (30)

The initial stage of a relativistic heavy ion collision is dominated by an overoccupied, strong gluon field, which can be understood in a classical approximation. The physics of equilibration and isotropization of this field is dominated by the plasmon mass scale, which is poorly understood in this very nonequilibrium system. We address this by measuring the plasmon mass scale in two and three dimensional classical Yang-Mills systems numerically. We use three different methods: a Hard Thermal Loop (HTL) expression involving the quasiparticle spectrum constructed from Coulomb gauge field correlators, an effective dispersion relation (DR) and the measurement of oscillations between electric and magnetic energies after introducing a spatially uniform perturbation to the electric field (UE). We find that the HTL and the UE methods are in rough agreement. The DR method agrees with other methods within a factor of two. We also study the dependence on time and occupation number. We observe that a power law dependence sets in in both cases after an occupation number dependent transient time. We find that in both cases our results are insensitive to the infrared cutoff. In three dimensions we find that the UE and HTL measurements can be brought into agreement when we take the ultraviolet cutoff to zero. However, in two dimensions the results obtained using all three methods seem to increase when we take the ultraviolet cutoff to zero. At late times in three spatial dimensions, the square of the plasmon mass seems to scale as $t^{\frac{-2}{7}}$, which is also predicted by kinetic theory analysis and previous research. In two dimensions the square of the plasmon mass seems to decrease as $t^{\frac{-1}{3}}$ according to HTL method measurement.

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Presenter(s) : PEURON, Jarkko (University of Jyväskylä)

Session Classification : Parallel

Contribution ID : **21** Type : **not specified**

Perturbative dynamics of massive gluons and chiral symmetry breaking

Friday, 29 June 2018 15:30 (30)

Lattice simulations of Yang-Mills theories and QCD in the Landau gauge demonstrate that the gluon propagator saturates at vanishing momentum. This can be modelled by a massive deformation of the corresponding Faddeev-Popov Lagrangian known as the Curci-Ferrari model. The latter does not modify the known ultraviolet regime of the theory and provides a successful perturbative description of essential aspects of the non-Abelian dynamics in the infrared regime, where, in particular, the coupling remains finite, as also seen in lattice simulations. This opens the possibility of a controlled (semi)perturbative description of various aspects of the infrared QCD dynamics, including correlation functions and the deconfinement phase transition at finite temperature and density. I present recent progress concerning the description of chiral symmetry breaking in this context.

Primary author(s) : Dr SERREAU, Julien (Université Paris Diderot)

Presenter(s) : Dr SERREAU, Julien (Université Paris Diderot)

Session Classification : Parallel

Contribution ID : **22** Type : **not specified**

Quantum corrections to the Classical Statistical Approximation for the longitudinally expanding scalar field

Thursday, 28 June 2018 16:00 (30)

Quantum corrections to the Classical Statistical Approximation (CSA) are calculated within the Keldysh-Schwinger technique for the longitudinally expanding homogeneous scalar field. Influence of these corrections to the evolution of the trace of the energy-momentum tensor is considered in details. It is shown that quantum corrections modify the equation of state in the intermediate quasistationary regime formed during expansion of the matter. This effect can contribute to the problem of hydrodynamic simulations applicability for the description of the initial stages of ultrarelativistic heavy-ion collisions.

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Session Classification : Parallel

Contribution ID : **23** Type : **not specified**

(CANCELLED)Gravitational-wave constraints on the neutron-star-matter equation of state

Tuesday, 26 June 2018 12:30 (30)

The LIGO/Virgo detection of gravitational waves originating from a neutron-star (NS) merger, GW170817, has recently provided new stringent limits on the tidal deformabilities of the stars involved in the collision. In this talk, I will discuss recent analysis of the implications of this measurement for the NS-matter equation of state (EoS). In our analysis, we combinine this measurement with the existence of two-solar-mass stars and generate a generic family of NS-matter EoSs that interpolate between state-of-the-art theoretical results at low and high baryon density. Comparing the results to ones obtained without the tidal-deformability constraint, we witness a dramatic reduction in the family of allowed EoSs. Moreover, our construction also allows us to place strict, robust bounds on, e.g., the maximal masses and radii for a typical 1.4-solar-mass star.

Primary author(s) : KURKELA, Aleksi (CERN, University of Stavanger); VUORINEN, Aleksi (University of Helsinki); ANNALA, Eemeli (University of Helsinki); GORDA, Tyler (University of Helsinki)

Presenter(s) : GORDA, Tyler (University of Helsinki)

Session Classification : Plenary

Contribution ID : **24** Type : **not specified**

Fluctuatioans and long time tails in fluid dynamics

Tuesday, 26 June 2018 15:30 (30)

We revisit the calculation of long time tails in non-relativistic fluid dynamics. We show how to compute long time tails and bounds on transport coefficients in the shear, bulk, and thermal diffusivity channel. We study the constraints from scale invariance, and we show how the calculations can be extended to account for critical behavior.

Primary author(s) : Prof. SCHAEFER, Thomas (North Carolina State University)

Presenter(s) : Prof. SCHAEFER, Thomas (North Carolina State University)

Session Classification : Parallell

Contribution ID : **25** Type : **not specified**

Fun with thermal dimension-six operators

Thursday, 28 June 2018 18:00 (30)

We consider effects induced by dimension-six operators in the dimensionally reduced effective theory for thermal QCD ("EQCD"). In particular we demonstrate, through 1-loop and 2-loop computations including dimension-six vertices, that their effects are in general of the same order or larger than 3-loop effects from non-zero Matsubara modes that have recently been determined by Ghisoiu and Schröder.

Primary author(s) : SCHICHO, Philipp (AEC, ITP, U. Bern)

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Presenter(s) : SCHICHO, Philipp (AEC, ITP, U. Bern)

Session Classification : Parallel

Contribution ID : **26** Type : **not specified**

Backreaction of the infrared modes of scalar fields on de Sitter geometry

Tuesday, 26 June 2018 18:00 (30)

We study the back-reaction of the infrared modes of an O(N) theory in a classical de Sitter background. We use the nonperturbative renormalization group methods to extract the flow of the Hubble constant as we integrate the gravitationally enhanced long wavelength modes. The scalar theory flows towards an effective zero dimensional theory for the super-horizon modes, which allows to perform analytical computations. For a massless theory, the interactions tend to renormalize negatively the Hubble constant, thus drawing energy from the classical gravitational field. This phenomenon saturates however, due to the generation of a mass. Also, in the case of a broken symmetry, we show that the goldstone modes don't contribute to the flow.

Primary author(s) : Mr MOREAU, Gabriel (Université Paris Diderot); Dr SERREAU, Julien (Université Paris Diderot)

Presenter(s) : Mr MOREAU, Gabriel (Université Paris Diderot)

Session Classification : Parallel

Contribution ID : **28** Type : **not specified**

Jet energy loss in a flowing plasma

Monday, 25 June 2018 16:00 (30)

We present new results on the energy loss of light partons traversing a highly dynamical strongly coupled quark-gluon plasma. As QGP has large gradients in both temperature and the fluid velocity, it is crucial to study energy loss without assuming a homogeneous plasma, especially as it is known that energy loss depends on the plasma evolution in a non-local way. In a holographic description, we consider several subsequent improvements of the hydrodynamic background by keeping increasing orders in the gradient expansion. Already for varying temperature and velocity profiles and ideal hydrodynamics, the energy loss is considerably modified. However, this description is limited to very small gradients and it is hence necessary to include viscous corrections. We present a numerical analysis of jet energy loss in a boost-invariant and transversely-expanding droplet of QGP. We find that depending on the direction of the fluid flow, the velocity gradients can change the distance a parton can travel by a factor of two, which would correspond to changing the coupling constant by a factor of more than fifty.

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Presenter(s) : Dr VAN DER SCHEE, Wilke (Utrecht University/MIT)

Session Classification : Parallel

Contribution ID : **29** Type : **not specified**

Equation of State for neutron stars with modified gravity

Tuesday, 26 June 2018 18:00 (30)

I discuss the EoS of neutron stars in the context of modified theories of gravity so that astrophysical constraints cannot be taken for granted (e.g. a two-solar mass neutron star might be achieved because of weaker gravity instead of a stiffer EoS).

Primary author(s) : Prof. LLANES-ESTRADA, Felipe J. (Universidad Complutense de Madrid)

Presenter(s) : Prof. LLANES-ESTRADA, Felipe J. (Universidad Complutense de Madrid)

Session Classification : Parallel

Contribution ID : **31** Type : **not specified**

Scale invariant hard thermal loop resummation

Thursday, 28 June 2018 17:30 (30)

We will illustrate how our recently developed renormalization group optimized perturbation theory (RGOPT) resums perturbative expansions in thermal field theories. The convergence and scale dependence of RGOPT thermodynamical quantities are drastically improved as compared to standard perturbative expansions, and it cures the odd drastic scale dependence observed in other related methods such as the screened perturbation or (resummed) hard-thermal-loop (HTL) perturbation. I will present some recent results in scalar models and first applications to HTL resummation for QCD thermodynamical quantities, also explaining the additionnal calculations needed in gauge theories with respect to standard HTLpt within our framework.

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Session Classification : Parallel

Contribution ID : **32** Type : **not specified**

Baryons, chiral symmetry and in-medium effects: results from lattice QCD

Thursday, 28 June 2018 18:00 (30)

The behaviour of strange baryons in the hadronic gas and the quark-gluon plasma gives essential insight into chiral symmetry restoration and parity doubling, and has direct consequences for phenomenology, e.g. via the hadron resonance gas. We present results obtained using nonperturbative lattice simulations, employing the FASTSUM anisotropic Nf=2+1 ensembles.

Primary author(s) : Prof. AARTS, Gert (Swansea University)

Presenter(s) : Prof. AARTS, Gert (Swansea University)

Session Classification : Parallel

Contribution ID : **33** Type : **not specified**

Power corrections to the HTL effective Lagrangian of QED

Thursday, 28 June 2018 17:00 (30)

We present compact expressions for the power corrections to the hard thermal loop (HTL) Lagrangian of QED in d space dimensions. These are corrections of order (L/T)^2, valid for momenta L « T, where T is the temperature. In the limit d ⟶ 3 we achieve a consistent regularization of both infrared and ultraviolet divergences, which respects the gauge symmetry of the theory. We also discuss how to generalise our results in the presence of a chemical potential, so as to obtain the power corrections to the hard dense loop (HDL) Lagrangian.

Primary author(s) : Dr CARIGNANO, Stefano (ICE)

Presenter(s) : Dr CARIGNANO, Stefano (ICE)

Session Classification : Parallel

Contribution ID : **34** Type : **not specified**

Gaussian rapidity profile from collisions in Glasma simulations

Thursday, 28 June 2018 15:00 (30)

I present our work on simulating the emergence of the Glasma in the early stages of heavy ion collisions in full 3+1 dimensions. In the color glass condensate framework incoming nuclei are usually assumed to be infinitely thin Lorentz-contracted pancakes which leads to boost-invariant rapidity profiles of the resulting energy density after the collision. We break boost invariance by allowing for a finite thickness of the incoming nuclei along the beam direction and obtain Gaussian-like rapidity profiles already at tree level. The profiles resemble strong coupling results and allow for comparison with experimental data of pion multiplicities as obtained at RHIC.

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Presenter(s) : Dr IPP, Andreas (TU Wien)

Session Classification : Parallel

Contribution ID : **35** Type : **not specified**

Excitation and saturation of the spinodal instability

Tuesday, 26 June 2018 18:00 (30)

Ever since the discovery of the quark-Gluon plasma (QGP) the location of the critical point in the QCD phase diagram - the end point of the first-order transition between hadron matter and QGP - has been a main research goal for heavy-ion collisions experiments. We use the gauge/gravity duality to study as first a four-dimensional, strongly-coupled gauge theory with a first-order thermal phase transition. In the dual gauge theory the Gregory-Laflamme instability corresponds to the spinodal instability. We uncover the favored final phase separated state across phase mergers. This final inhomogeneous system is independent of the early unstable mode excitations.

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Presenter(s) : Dr ATTEMS, maximilian (Universidad de Santiago de Compostela)

Session Classification : Parallell

Contribution ID : **38** Type : **not specified**

New ideas for the proton radius puzzle

Friday, 29 June 2018 16:00 (30)

The radius of the proton has been studied using several techniques. Methods using electron scattering and the atomic spectrum of electronic hydrogen have both produced values compatible with r_E = 0.8751(51)fm. Note that the spectroscopy method relies on being able to measure the transition energies accurately enough that the influence of the finite size of the proton can be discerned. More recent results have used spectroscopic measurements of muonic hydrogen. Due to the muon's larger mass, its wave function is more spatially concentrated meaning that it is a better probe of the proton than electronic hydrogen and hence can provide more accurate proton radius determinations. Using this method, Pohl et al found that the radius from muonic hydrogen is around 4% smaller than the electronic hydrogen case. Since this represents 7 standard deviations, it is an unresolved puzzle. This paper introduces new ideas which may affect these proton radii measurements.

Primary author(s) : Prof. ALLTON, Chris (Swansea University)

Presenter(s) : Prof. ALLTON, Chris (Swansea University)

Session Classification : Parallel

Contribution ID : **39** Type : **not specified**

Signals from strange stars

Monday, 25 June 2018 15:30 (30)

Strange stars are exotic stellar objects, almost entirely consisting of deconfined quark matter. We analyze the possible emission of electromagnetic signals and of gravitational wave echoes from strange stars. In both cases we expect that the typical frequency of the emitted signals are on the order of tens of kHz.

Primary author(s) : Dr MANNARELLI, Massimo (INFN)

Presenter(s) : Dr MANNARELLI, Massimo (INFN)

Session Classification : Parallel

Contribution ID : **40** Type : **not specified**

Holography and the problem of parton energy loss in a quark-gluon plasma

Monday, 25 June 2018 15:30 (30)

The nearly perfect fluidity of the quark-gluon plasma (QGP) and its apparent strongly coupled nature has opened a rich window of phenomenology for holographic techniques. These studies offer key benchmarks against which to interpret the data in the context of the long term quest towards the determination of the nature of the QGP degrees of freedom at collider relevant temperatures. In particular, the phenomenon of jet quenching, or parton energy loss, can be modelled through hybrid frameworks that exploit the wide separation of scales present in the system, combining perturbative QCD methods and holographic insights at their corresponding regime of applicability. In this talk, I will present the basis and phenomenology of such models, which are already capable of giving not only qualitative but also a quantitative description of many experimental data produced at the LHC and RHIC. Indeed, by exploring the geometric intuitions provided by holography, we are able to address genuine non-perturbative aspects of many body QCD that will hopefully lead us to a better understanding of the emerging collective behaviour observed in experiments (also in small systems), a crucial task in which the phenomenology of the jet/plasma interplay plays a central role due to its potential to unravel the precise way in which energy and momentum hydrodynamize in such short time scales.

Primary author(s) : PABLOS, Daniel (McGill); MILHANO, Guilherme (CERN); CASALDERREY--SOLANA, Jorge (UB); RAJAGOPAL, Krishna (MIT); HULCHER, Zachary (Cambridge)

Presenter(s) : PABLOS, Daniel (McGill)

Session Classification : Parallel

Contribution ID : **41** Type : **not specified**

Transport Phenomena in Neutron Star Cores

Tuesday, 26 June 2018 17:00 (30)

Multi-messenger observations of neutron stars are likely to usher in a golden age of nuclear astrophysics and promote neutron stars to one of the most interesting "laboratories" in the universe. Transport in the outer core of neutron stars determines a number of observable phenomena, including the damping of hydrodynamic modes, r-modes and the spin evolution of neutron stars. In the core of a neutron star we expect to find a dense plasma comprised of electrons, muons, protons and neutrons interacting via electromagnetic and strong forces. The complicated interplay of these interactions lead to screening and damping effects which have a profound impact on the spectra of photons within the plasma. The photon spectrum in turn strongly modifies the scattering rate of fermions in the plasma and therefore the transport.
I will provide a detailed study of the photon spectrum and scattering rates based on the relativistic Random Phase Approximation (RPA), placing a particular focus on dynamical screening effects and collective modes. Potential repercussions on the interpretation of future observations of neutron stars will be discussed.

Primary author(s) : Mr STETINA, Stephan (TU Vienna)

Presenter(s) : Mr STETINA, Stephan (TU Vienna)

Session Classification : Parallel

Contribution ID : **42** Type : **not specified**

Evolution of Chemical Potentials in the Early Universe

The QCD phase diagram is commonly drawn in the baryon chemical potential versus temperature plane ($\mu_B - T$). As until a few microseconds after the big bang the Universe was filled with strong-interaction matter, often also a sketch of the trajectory of the early Universe is displayed in the QCD phase diagram.
However, below the electroweak phase transition and above neutrino oscillations, the cosmic trajectory lies in a (5+1)-dimensional space of chemical potentials for baryon number B, electric charge Q, three lepton flavours L_α and temperature T.
We are going to present some new results on the evolution of these chemical potentials throughout a large temperature range in the early Universe.

Primary author(s) : WYGAS, Mandy M. (Bielefeld University)

Co-author(s) : BOEDEKER, Dietrich (Bielefeld University); SCHWARZ, Dominik J. (Bielefeld University); OLDENGOTT, Isabel M. (Bielefeld University)

Presenter(s) : WYGAS, Mandy M. (Bielefeld University)

Contribution ID : **43** Type : **not specified**

Vacuum-like jet fragmentation in a dense QCD medium

Monday, 25 June 2018 15:00 (30)

It is well known that the multiple interactions of a hard probe with the dense quark-gluon plasma results in the "medium-induced" radiation of soft gluon, responsible e.g. for jet energy loss. Such an emission is computed using the BDMPS-Z formalism which has since been generalised to include multiple medium-induced emissions. To get a complete picture of the evolution of a jet in a dense medium, the main missing ingredient is the inclusion of both medium-induced emissions and "vacuum-like" emissions responsible for the parton shower from large virtualities (of the order of the hard scale) down to the hadronisation scale.

In this talk, we adopt a new approach and show that in a (leading) double-logarithmic approximation, the time scales in the evolution of a jet factorise. The vacuum-like parton cascades develop at early times and exhibit angular ordering due to color coherence, like the standard parton showers in the vacuum. The effect of the medium can be simply formulated as a kinematic constraint which limits the phase-space for vacuum-like radiation and thus reduces the parton multiplicities. The gluons produced by these cascades lose their mutual coherence via multiple scattering and thus act as independent sources of energy loss via medium-induced radiation.

To the best of our knowledge, this is the first complete picture of jet evolution in the medium derived from perturbative QCD. It has the additional advantage of being well-suited for a Monte-Carlo implementation. In the talk, we show how this simple evolution arise and investigate its main properties.

Primary author(s) : Dr IANCU, Edmond (Institut de Physique Théorique, Saclay)

Presenter(s) : Dr IANCU, Edmond (Institut de Physique Théorique, Saclay)

Session Classification : Parallel

Contribution ID : **44** Type : **not specified**

Quantum interference in showering: Progress on IR-safe calculations

Wednesday, 27 June 2018 12:30 (30)

High-energy particles passing through matter lose energy by showering via splitting processes such as hard bremsstrahlung and pair production. There has been a great deal of research in the last 5 years on what happens if two successive splittings in such a shower overlap quantum mechanically, so that their splitting probabilities cannot be treated independently. The effects of soft bremsstrahlung have been shown to be significant for QCD applications but are also absorbable into effective running of a parameter $\hat{q}$ that describes the medium. Is that enough? What about interference effects that cannot be absorbed, such as from interference between two successive hard bremsstrahlung splittings – are those small effects? And what's a clean, infrared-safe thought experiment for separating hard from soft bremsstrahlung interference effects on shower development, in order to cleanly address this question? This talk will explain these issues and discuss recent progress on explicit calculations, which require computing virtual corrections to double-splitting processes without taking the soft limit.

Primary author(s) : ARNOLD, Peter (University of Virginia)

Presenter(s) : ARNOLD, Peter (University of Virginia)

Session Classification : Plenary

Contribution ID : **45** Type : **not specified**

QCD Topology to High Temperatures via Reweighting

Thursday, 28 June 2018 15:30 (30)

Lattice QCD is the only feasible way to study topological effects of QCD above T_c. Especially at high temperatures, the topological susceptibility has important implications for the properties of axion dark matter. However, at high temperatures there arise difficulties in the lattice calculation, namely poor sampling of non-zero topological sectors. We discuss these problems and present a new technique to circumvent them, namely a combination of gradient flow and reweighting in terms of the topological charge. We also present first results of the topological susceptibility up to about $4\,T_c$ in the quenched approximation.

Primary author(s) : Mr JAHN, Peter Thomas (TU Darmstadt)

Co-author(s) : Dr ROBAINA, Daniel (TU Darmstadt); Prof. MOORE, Guy D. (TU Darmstadt)

Presenter(s) : Mr JAHN, Peter Thomas (TU Darmstadt)

Session Classification : Parallel

Contribution ID : **46** Type : **not specified**

Stability and Electromagnetic Properties of the Magnetic Dual Chiral Density Wave Phase of High Density QCD

Monday, 25 June 2018 18:00 (30)

We study the electromagnetic properties of dense QCD in the Magnetic Dual Chiral Density Wave phase and show that it exhibits anomalous Hall conductivity and magnetoelectricity. We investigate the stability of this inhomogeneous phase against low-energy fluctuations about the spatially modulated order parameter.

Primary author(s) : Prof. INCERA, Vivian (CUNY)

Co-author(s) : Prof. FERRER, Efrain (CUNY)

Presenter(s) : Prof. INCERA, Vivian (CUNY)

Session Classification : Parallel

Contribution ID : **47** Type : **not specified**

Axion Electrodynamics in High-T QCD in the Presence of a Magnetic Field

Monday, 25 June 2018 17:30 (30)

Axion electrodynamics of high-T QCD with topological charge changing transitions in the presence of a magnetic field is investigated. We find that this system exhibits two currents depending on the time derivative of the axion field θ, which have the same magnitude but opposite directions along the magnetic field. The anomalous current is produced by a time dependent medium polarization of topological origin, while the ordinary current is due to the chiral imbalance on the non-trivial background of quarks in the lowest Landau level. Only, if an electric field is present, a non-anomalous Hall current perpendicular to the plane formed by the magnetic and the electric fields can take place. Thus, the axion electrodynamics reduces to the ordinary Maxwell theory with an ordinary charge and Hall current and as a consequence, the net charge separation in the system along the magnetic field is zero, what implies that the chiral magnetic effect is absent. We discuss the analogies and discrepancies with Weyl semimetals in a magnetic field.

Primary author(s) : Prof. FERRER, Efrain (CUNY)

Co-author(s) : Prof. INCERA, Vivian (CUNY)

Presenter(s) : Prof. FERRER, Efrain (CUNY)

Session Classification : Parallel

Contribution ID : **48** Type : **not specified**

Dynamics of entanglement in expanding quantum fields

Monday, 25 June 2018 17:30 (30)

The entanglement entropy associated to finite spatial regions for Gaussian states in quantum field theory is characterized in terms of local correlation functions on space-like Cauchy hypersurfaces. The framework is applied to explore an expanding light cone geometry in the particular case of the Schwinger model for quantum electrodynamics in 1+1 space-time dimensions. We observe that the entanglement entropy becomes extensive in rapidity at early times and that the corresponding local reduced density matrix is a thermal density matrix for excitations around a coherent field with a time dependent temperature. Since the Schwinger model successfully describes many features of multiparticle production in e+e− collisions, our results provide an attractive explanation in this framework for the apparent thermal nature of multiparticle production even in the absence of significant final state scattering.

Primary author(s) : Dr FLOERCHINGER, Stefan (Heidelberg U.)

Presenter(s) : Dr FLOERCHINGER, Stefan (Heidelberg U.)

Session Classification : Parallel

Contribution ID : **50** Type : **not specified**

The dark-matter axion mass

Tuesday, 26 June 2018 15:30 (30)

The QCD axion solves the QCD theta problem and is a possible dark matter candidate. Axion production in the early Universe is complicated because the axion field develops cosmic strings. The string dynamics is sensitive to the tension, which cannot be reproduced correctly in conventional classical-field simulations. We introduce a new approach to solve this problem without an exponentially large lattice by using an effective theory. Our results for the axion mass, if it makes up all of the dark matter, is $m_a = 26.2 \pm 3.4 \mu\text{eV}$.

Primary author(s) : Prof. MOORE, Guy D. (TU-Darmstadt); Mr KLAER, Vincent (TU-Darmstadt)

Presenter(s) : Mr KLAER, Vincent (TU-Darmstadt)

Session Classification : Parallel

Contribution ID : **52** Type : **not specified**

Autocorrelations of the Glasma energy-momentum tensor

Thursday, 28 June 2018 15:30 (30)

I shall present an analytical calculation of the two-point correlator of the energy-momentum tensor associated to the early stages of the matter produced in heavy ion collisions, $\langle T^{\mu\nu}(x)T^{\mu\nu}(y)\rangle$. Our calculation is performed under the classical approximation of the Color Glass Condensate and provides additional dynamical information on the early times ($\tau = 0^+$) of the out-of equilibrium Glasma phase of these collisions. I shall discuss the large-N limit of our results as well as their possible use as initial conditions for further hydrodynamical evolution or their use for the calculation of transport coefficients. Incidentally, as part of our calculations we obtain interesting results such as the correlator of four Wilson lines in the adjoint representation, which we derive for the first time in the most general case.

Primary author(s) : Prof. ALBACETE, Javier L (Universidad de Granada)

Co-author(s) : Dr MARQUET, Cyrille (Ecole Polytechnique); Mr GUERRERO-RODRIGUEZ, PAblo (Ecole Polytechnique)

Presenter(s) : Prof. ALBACETE, Javier L (Universidad de Granada)

Session Classification : Parallel

Contribution ID : **53** Type : **not specified**

Renormalisation of non-perturbative calculations in scalar theories

Tuesday, 26 June 2018 17:00 (30)

Non-perturbative techniques are needed to study strongly coupled systems. One powerful approach is the n-particle irreducible effective action. The technique provides a systematic expansion for which the truncation occurs at the level of the action. However, renormalisation using a standard counterterm approach is not well understood. At the 2PI level one must introduce multiple counterterms, and at higher orders there is no known way to renormalise an nPI theory using counterterms. On the other hand, renormalisation is much simpler using a renormalisation group approach. We present results from a calculation using a scalar theory with quartic coupling in 4 dimensions, at the 4 loop level. The 2PI theory is renormalised using one bare coupling constant which is introduced at the level of the Lagrangian. We show that the method can be generalised to higher order calculations.

Primary author(s) : Prof. CARRINGTON, Margaret (Brandon University)

Presenter(s) : Prof. CARRINGTON, Margaret (Brandon University)

Session Classification : Parallell

Contribution ID : **54** Type : **not specified**

Pion condensate versus chiral density wave at zero temperature

Tuesday, 26 June 2018 16:00 (30)

The quark-meson model is often used as an effective low-energy model for QCD to study the chiral transition at finite temperature T, baryon chemical potential \mu and isospin chemical potential \mu_I.
We determine the model parameters to one-loop order and express them in terms of the physical meson and quark masses, as well as the pion decay constant using on-shell renormalization. We study the existence of different phases at zero temperature. In particular, we investigate the competition between an inhomogeneous chiral condensate and a pion condensate. We show that due to our parameter fixing, the onset of pion
condensation takes place exactly at \mu_I = m_\pi/2 in accordance with exact results. Furthermore the existence of an inhomogeneous phase at large \mu in a certain parameter window is shown.

Primary author(s) : KNESCHKE, Patrick (University of Stavanger)

Presenter(s) : KNESCHKE, Patrick (University of Stavanger)

Session Classification : Parallel

Contribution ID : **55** Type : **not specified**

QCD Phase Diagram in an Extended Effective Lagrangian Approach

Thursday, 28 June 2018 16:00 (30)

The phase diagram for strongly interacting matter is currently the subject of intense study from both the experimental and theoretical sides. In the low-energy regime, due to the non-perturbative nature of QCD, several alternative theoretical approaches have become popular. An extension of the NJL model to include all the spin-0 terms, without and with explicit chiral symmetry breaking, which are of the same order as the ‘t Hooft flavor determinant in a 1/Nc expansion enabled in an unprecedented success in reproducing the low lying scalar and pseudoscalar meson spectra. When used in conjunction with results coming from lattice QCD this model provides us the tools to test the basic underlying mechanisms at play and enable an easy way to explore the phase diagram [1].

Here we will present some recent results pertaning the thermodynamical properties of a strongly interacting medium under equilibrium in the presence and absence of a background magnetic field using this model and some comparisons to lattice QCD results. We will focus in particular in the phase diagram and fluctuations of conserved charges.

[1] J. Moreira, J. Morais, B. Hiller, A. A. Osipov, and A. H. Blin, Phys. Rev. D 91, 116003

Primary author(s) : MOREIRA, João (CFisUC)

Co-author(s) : BLIN, Alex H. (CFisUC); OSIPOV, Alexander A. (JINR); HILLER, Brigitte (CFisUC); MORAIS, Jorge (CFisUC)

Presenter(s) : MOREIRA, João (CFisUC)

Session Classification : Parallel

Contribution ID : **56** Type : **not specified**

Color-magnetic flux tubes in dense quark matter

Tuesday, 26 June 2018 17:30 (30)

In color-superconducting quark matter gluons and photons mix, and thus an external ordinary magnetic field may induce color-magnetic flux tubes. I will discuss the structure of these flux tubes, in particular pointing out a novel flux tube configuration in color-flavor locked quark matter that has a 2SC core, rather than a completely unpaired one. This configuration is energetically preferred under neutron star conditions, and I will discuss possible consequences for sustained "color-magnetic mountains" and resulting gravitational waves of isolated neutron stars.

Primary author(s) : SCHMITT, Andreas (University of Southampton)

Presenter(s) : SCHMITT, Andreas (University of Southampton)

Session Classification : Parallel

Contribution ID : **58** Type : **not specified**

Magnetoresponse: QCD vs. N=4 SYM

Thursday, 28 June 2018 15:00 (30)

The QCD pressure anisotropy in a uniform background magnetic field has been computed for a wide range of temperature and magnetic field. Surprisingly, it has been found to exhibit near universal behavior, depending predominately on a single dimensionless ratio, B/T^2. When appropriately compared with the corresponding quantity in maximally supersymmetric Yang-Mills (SYM) theory, remarkably good agreement is found.

Primary author(s) : Prof. YAFFE, Laurence (University of Washington)

Co-author(s) : Prof. SCHAFER, Andreas (Universitat Regensburg); Dr ENDRODI, Gergely (Universitat Frankfurt); Dr WU, Jackson (Univ. of Alabama); Prof. KAMINSKI, Matthias (Univ. of Alabama)

Presenter(s) : Prof. YAFFE, Laurence (University of Washington)

Session Classification : Parallel

Contribution ID : **59** Type : **not specified**

Gravitation waves from QCD and electroweak phase transitions

Tuesday, 26 June 2018 15:00 (30)

We investigate the gravitation waves produced from QCD and electroweak phase transitions in the early universe by using a 5-dimension holographic QCD model and a holographic technicolor model. The dynamical holographic QCD model is to describe the pure gluon system, where a first order confinement-deconfinement phase transition can happen at the critical temperature around 250 MeV. The minimal holographic technicolor model is introduced to model the strong dynamics of electroweak, it can give a first order electroweak phase transition at the critical temperature around 100-360 GeV. We find that for both GW signals produced from QCD and EW phase transitions, in the peak frequency region, the dominant contribution comes from the sound waves, while away from the peak frequency region the contribution from the bubble collision is dominant. The peak frequency of gravitation wave determined by the QCD phase transition is located around 10^{-7} Hz which is within the detectability of FAST and SKA, and the peak frequency of gravitational wave predicted by EW phase transition is located at $0.002 - 0.007$ Hz, which might be detectable by BBO, DECIGO, LISA and ELISA.

Primary author(s) : Mr CHEN, Yidian (Institute of High Energy Physics, CAS)

Co-author(s) : Prof. HUANG, Mei (Institute of High Energy Physics,CAS); Prof. YAN, Qi-Shu (School of Physics Sciences, University of Chinese Academy of Sciences)

Presenter(s) : Mr CHEN, Yidian (Institute of High Energy Physics, CAS)

Session Classification : Parallel

Contribution ID : **60** Type : **not specified**

Relativistic magneto-hydrodynamics

Tuesday, 26 June 2018 16:00 (30)

I will talk about relativistic thermodynamics and magneto-hydrodynamics, with an emphasis on the derivative expansion, the transport coefficients, and the Kubo formulas.

Primary author(s) : Prof. KOVTUN, Pavel (University of Victoria)

Presenter(s) : Prof. KOVTUN, Pavel (University of Victoria)

Session Classification : Parallell

Contribution ID : **64** Type : **not specified**

QCD phase diagram for nonzero isospin-asymmetry

Monday, 25 June 2018 15:00 (30)

The QCD phase diagram is studied in the presence of an isospin asymmetry with lattice QCD methods. In particular, we investigate the phase boundary between the normal and the pion condensation phases and the chiral/deconfinement transition. Our findings indicate that no pion condensation takes place above T≈160 MeV and also suggest that the deconfinement crossover continuously connects to the BEC-BCS crossover at high isospin asymmetries.

Primary author(s) : Mr SCHMALZBAUER, Sebastian (Institut für theoretische Physik, Goethe-Universität Frankfurt)

Co-author(s) : Dr BRANDT, Bastian (Insitut für Theoretische Physik, Goethe-Univiersität Frankfurt); Dr ENDRÖDI, Gergely (Institut für Theoretische Physik, Goethe-Universität Frankfurt)

Presenter(s) : Mr SCHMALZBAUER, Sebastian (Institut für theoretische Physik, Goethe-Universität Frankfurt)

Session Classification : Parallel

Contribution ID : **65** Type : **not specified**

Decay of the standard model Higgs into the SU(2)xU(1) gauge fields after inflation

Tuesday, 26 June 2018 17:30 (30)

I will discuss the out-of-equilibrium dynamics of the Standard Model after inflation, when the Higgs is weakly coupled to the inflationary sector. During inflation the Higgs forms a condensate, which oscillates short after inflation ends, transferring most of its energy to the SU(2)xU(1) gauge fields via parametric resonance. I have studied this process with classical lattice simulations, including explicitly the non-Abelian Higgs-gauge interactions in the lattice. I will describe and quantify the main time scales, energy ratios, and field spectra, and compare our results with an equivalent Abelian-Higgs modelling.

Primary author(s) : TORRENTI, Francisco (Instituto de Fisica Teorica UAM-CSIC)

Presenter(s) : TORRENTI, Francisco (Instituto de Fisica Teorica UAM-CSIC)

Session Classification : Parallel

Contribution ID : **66** Type : **not specified**

Semiholography for heavy ion collisions: recent developments

Tuesday, 26 June 2018 17:30 (30)

We discuss recent developments in the semiholographic model for heavy ion collisions (HICs) proposed by Iancu and Mukhopadhyay and further developed by Mukhopadhyay, FP, Rebhan, and Stricker. In this approach a GLASMA description of the early stages of HICs, i.e. a classical Yang-Mills field theory is coupled to a holographic model which plays the role of a bath of strongly coupled gluons. We will show the first results of such a setup in the fully dynamical non-equilibrium regime in particular how the classical Yang-Mills sector looses energy to the strongly coupled sector. Finally we discuss in more generality, how to consistently couple holographic descriptions of non-perturbative physics to classical and perturbative quantum field theories.

Primary author(s) : Dr PREIS, Florian (Technische Universität Wien)

Co-author(s) : SOLOVIEV, Alexander (Technische Universität Wien); Prof. REBHAN, Anton (Technische Universität Wien); Dr MUKHOPADHYAY, Ayan (IIT Madras); ECKER, Christian (Technische Universität Wien)

Presenter(s) : Dr PREIS, Florian (Technische Universität Wien)

Session Classification : Parallell

Contribution ID : **67** Type : **not specified**

Unstable r-modes and gravitational waves

Tuesday, 26 June 2018 09:00 (45)

Gravitational waves may drive the oscillations of a rotating neutron star unstable. In turn, the angular momentum carried away by the waves would spin the star down. This mechanism may determine the spin evolution of newly born neutron stars. It may also set a speed limit for neutron stars that accrete matter (and gain angular momentum) from a binary companion. In this talk I will provide an overview of the most "promising" manifestation of this scenario - the instability of the so-called r-modes. I will discuss how the supranuclear equation of state (and a range of transport properties) enter the problem, provide a status update on related gravitational-wave search and summarise indirect constraints from a range of astrophysical observations.

Primary author(s) : Prof. ANDERSSON, Nils (University of Southampton)

Presenter(s) : Prof. ANDERSSON, Nils (University of Southampton)

Session Classification : Plenary

Contribution ID : **68** Type : **not specified**

QCD phase diagram with heavy quarks: Universal aspects in one-loop models and extension to 2-loop in Curci-Ferrari

Friday, 29 June 2018 16:00 (30)

The QCD phase diagram with heavy quarks exhibits ubiquitous features among all confining one-loop models, e.g. its Nf-dependence. These will be illustrated invoking various approaches and its predictions tested against a particular extension to two-loop order within the Curci-Ferrari model.

Primary author(s) : Mr MAELGER, Jan (Ecole Polytechnique/Université Paris 7 Diderot); Dr SERREAU, Julien (Université Paris Diderot); Dr REINOSA, Urko (Ecole Polytechnique)

Presenter(s) : Mr MAELGER, Jan (Ecole Polytechnique/Université Paris 7 Diderot)

Session Classification : Parallel

Contribution ID : **69** Type : **not specified**

Inflation in higher-derivative gravity with scalar electrodynamics

Tuesday, 26 June 2018 17:00 (30)

In this talk we overview the inflation in higher-derivative quantum gravity which is shown to be consistent with Planck observational data. The account of one-loop quantum gravity corrections is done. It is demonstrated that quantized R^2 gravity with scalar electrodynamics also gives the consistent inflation.

Primary author(s) : Prof. ODINTSOV, Sergey (ICREA and ICE)

Presenter(s) : Prof. ODINTSOV, Sergey (ICREA and ICE)

Session Classification : Parallel

Contribution ID : **70** Type : **not specified**

Consequences of neutron star mergers for constraining the equation of state of nuclear matter

Tuesday, 26 June 2018 09:45 (45)

I will discuss the rapid recent progress made in modelling neutron stars in binary system and show how the inspiral and merger of these systems is more than a strong source of gravitational waves. Indeed, while the gravitational signal can provide tight constraints on the equation of state for matter at nuclear densities, the formation of a black-hole–torus system can explain much of the phenomenology of short gamma-ray bursts, while the the ejection of matter during the merger can shed light on the chemical enrichment of the universe. Finally, I will review how our understanding on the maximum mass and radii of neutron stars has improved with the detection of GW170817.

Primary author(s) : Prof. REZZOLLA, Luciano (University of Frankfurt)

Presenter(s) : Prof. REZZOLLA, Luciano (University of Frankfurt)

Session Classification : Plenary

Contribution ID : **71** Type : **not specified**

Open quantum systems approach to the study of quarkonium suppression

Thursday, 28 June 2018 11:45 (45)

Heavy quarkonium related observables are very useful to obtain information about the medium created in relativistic heavy ion collisions. In recent years the theoretical description of quarkonium in a medium has moved towards a more dynamical picture in which decay and recombination processes are very important. In this talk we will discuss the equations that describe the evolution of the heavy quarks reduced density matrix in different approximations, highlighting the color dynamics that is absent in the Abelian case. Non-relativistic effective field theories are useful tools to study this problem. Using them we will derive the master equation that describes the evolution of quarkonium inside the medium in the case $1/r \gg T$ and we will analyse a specific temperature regime in which all the information needed from the medium can be encoded in two non-perturbative parameters.
We will also discuss the relation with classical equations (Langevin and Boltzmann) and how they can help reducing the computational cost of solving the master equation.

Primary author(s) : ESCOBEDO ESPINOSA, Miguel Ángel (University of Jyväskylä)

Presenter(s) : ESCOBEDO ESPINOSA, Miguel Ángel (University of Jyväskylä)

Session Classification : Plenary

Contribution ID : **72** Type : **not specified**

From instantons to axions: a lattice perspective

Thursday, 28 June 2018 09:45 (45)

Axions are hypothetical particles that solve
the strong CP problem, and contribute to the dark matter
at the same time. A key input is the axion potential, that
depends on the topological susceptibility in quantum chromodynamics.
I discuss various lattice computations to the calculation
of this quantity and its impact on the axion search.

Primary author(s) : Dr BORSANYI, Szabolcs (University of Wuppertal)

Presenter(s) : Dr BORSANYI, Szabolcs (University of Wuppertal)

Session Classification : Plenary

Contribution ID : **73** Type : **not specified**

Lessons from QCD on a circle

Friday, 29 June 2018 11:00 (45)

I'll review some recently-appreciated lessons from thinking about QCD and related theories on compactified directions with non-thermal boundary conditions. For example, such non-traditional compactifications sometimes allow one to define new analytically tractable regimes in gauge theory, which yield insights into the appearance of mass gaps, chiral symmetry breaking, and other dynamical phenomena.

Primary author(s) : Dr CHERMAN, Aleksey (INT, University of Washington)

Presenter(s) : Dr CHERMAN, Aleksey (INT, University of Washington)

Session Classification : Plenary

Contribution ID : **82** Type : **not specified**

Institutional Opening

Monday, 25 June 2018 09:00 (45)

9:00- 9:12 Sr. **Jordi Portabella**, Director de l'Àrea de Divulgació Científica i CosmoCaixa, de la Fundació Bancària "la Caixa"

9:13-9:25 Dr. **Ignasi Ribas**, director del Institut d'Estudis Espacials de Catalunya (IEEC) i vice-director del Instituto de Ciencias del Espacio (ICE, CSIC)

9:26-9:38 Dr. **Ramon Miquel**, director del Institut de Física d'Altes Energies

9:38-9:45 Dra. **Assumpta Parreño**, Vice-directora del Institut de Ciències del Cosmos de la Universitat de Barcelona (ICC-UB)

Primary author(s) : Dr PARREÑO, Assumpta (ICC-UB); Dr RIBAS, Ignasi (ICE, IEEC-CSIC); Mr PORTABELLA, Jordi (La Caixa); Dr MIQUEL, Ramon (IFAE)

Presenter(s) : Dr PARREÑO, Assumpta (ICC-UB); Dr RIBAS, Ignasi (ICE, IEEC-CSIC); Mr PORTABELLA, Jordi (La Caixa); Dr MIQUEL, Ramon (IFAE)

Session Classification : Plenary

Contribution ID : **97** Type : **not specified**

Gravitational Waves: From Einstein to a New Science

Tuesday, 26 June 2018 19:00 (60)

Albert Einstein predicted the existence of gravitational waves 100 years ago, but the effects are so tiny that even Einstein thought they could never be detected. After 40 years of controversy, theorists finally developed a consensus that they really do exist. Then the problem became whether experimental physicists could develop instruments sensitive enough to actually detect them? The Laser Interferometer Gravitational-wave Observatory (LIGO), using exquisitely sensitive techniques, has made the dramatic observations of gravitational waves coming from the collision of two Black Holes and more recently, Binary Neutron Stars. These observations have opened a totally new window on the universe. The history, discoveries and future science will all be discussed.

Primary author(s) : Prof. BARISH, Barry (Caltech)

Presenter(s) : Prof. BARISH, Barry (Caltech)

Session Classification : Colloquium

Contribution ID : **98** Type : **not specified**

Funding opportunities from the European Research Council

Friday, 29 June 2018 12:30 (30)

Funding opportunities from the European Research Council

Primary author(s) : Prof. ALBACETE, Javier L (Universidad de Granada)

Presenter(s) : Prof. ALBACETE, Javier L (Universidad de Granada)

Session Classification : Plenary

Contribution ID : **99** Type : **not specified**

Sudakov effects in jet quenching

Wednesday, 27 June 2018 11:00 (45)

Hard processes in heavy-ion collisions, in particular those involving the production of jets in the final-state, can potentially serve as well-constrained probes of a hot and dense QCD medium.

At high-energies, radiation stimulated via interactions with the medium, that is subject to LPM interference effects, control the amount of energy radiated away from the jet constituents, providing a direct way to extract the relevant medium properties from experimental data.

However, improving the precision of such comparisons has until recently been hampered by the lack of theoretical control regarding jet fragmentation inside the medium.

Here, we report on first developments toward incorporating jet and medium scales on equal footing, focussing mostly on effects related to the iconic single-inclusive jet suppression factor. We demonstrate in particular how energy loss processes acts on multi-particle systems and discuss the logarithmic phase space for resummation. The progress in understanding these effects points toward a more complete description of in-medium jet fragmentation at leading-logarithmic order.

Primary author(s) : TYWONIUK, Konrad (CERN)

Presenter(s) : TYWONIUK, Konrad (CERN)

Session Classification : Plenary

Contribution ID : **100** Type : **not specified**

Extreme Holography

Monday, 25 June 2018 11:00 (45)

A massive experimental effort will be devoted in the coming years to the physics of QCD at high energy density and/or high baryon density. Understanding this physics, especially out of equilibrium, is an important theoretical challenge. I will discuss how holography can help us address this challenge. Topics covered will include the far-from-equilibrium dynamics near the QCD critical point and colour superconducting phases. No prior knowledge of string theory required.

Primary author(s) : Prof. MATEOS, David (ICREA & U of Barcelona)

Presenter(s) : Prof. MATEOS, David (ICREA & U of Barcelona)

Session Classification : Plenary

Contribution ID : **101** Type : **not specified**

Complex Paths around the Sign Problem

Monday, 25 June 2018 11:45 (45)

We will discuss a programme to circumvent the "sign problem" in lattice calculations in field theory. The main idea is to deform the region of integration in field space to the complex domain. The theoretical underpinnings and algorithms will be exemplified through the application of the method to low dimensional finite density models and real time calculations.

Primary author(s) : Prof. BEDAQUE, Paulo (University of Maryland College Park)

Presenter(s) : Prof. BEDAQUE, Paulo (University of Maryland College Park)

Session Classification : Plenary

Contribution ID : **102** Type : **not specified**

Recent results and surprises from collisions of ultrarelativistic heavy ions

Wednesday, 27 June 2018 09:00 (45)

I will review the latest experimental results of heavy-ion physics, focussing on results from the Large Hadron Collider (LHC) and the Relativistic Heavy-Ion Collider (RHIC).

A particular emphasis is given on the topic of collectivity in small systems, i.e. the paradigm-shifting observation that experimental signatures traditionally associated with the production of a large and deconfined plasma of quarks and gluons, are also observed in small collisions systems, like proton-nucleus and even proton-proton collisions.

Primary author(s) : Dr GROSSE-OETRINGHAUS, Jan Fiete (CERN)

Presenter(s) : Dr GROSSE-OETRINGHAUS, Jan Fiete (CERN)

Session Classification : Plenary

Contribution ID : **103** Type : **not specified**

Quantum Simulatiotions: From Lattice Gauge Theories to Machine Learning

Friday, 29 June 2018 11:45 (45)

I my lecture I will discuss the present status of one of the pillars of the Quantum Technologies Flagship: Quantum Simulations. I will comment on various platforms and approaches, focusing, however, on ultra-cold atoms, molecules and ions. I will present the recent progress in the most challenging quantum simulations of lattice gauge theories
and speculate about the future directions, such as merging of quantum simulations and machine learning, or novel methods of quantum many body verification and certification.

Primary author(s) : Prof. LEWENSTEIN, Maciej (ICFO - Institut de Ciéncies Fotóniques)

Presenter(s) : Prof. LEWENSTEIN, Maciej (ICFO - Institut de Ciéncies Fotóniques)

Session Classification : Plenary

Contribution ID : **104** Type : **not specified**

Probing the photon emission rate of quark-gluon plasma in lattice QCD

Thursday, 28 June 2018 11:00 (45)

We investigate the emission rate of photons in a perfectly thermalized quark-gluon plasma via lattice QCD correlation functions of the electromagnetic current. The thermal correlation functions can be split into a spatially longitudinal and a transverse part, and the photon rate is determined by the transverse part, since the longitudinal part vanishes at light-like kinematics. However, we focus mostly on the difference of the transverse and longitudinal parts, because this difference vanishes identically in the vacuum and is therefore directly sensitive to thermal effects. We thus probe the photon rate in the range of photon momenta between $\pi T/2$ and $2\pi T$. The relevant Euclidean correlation functions are
computed with $N_f = 2$ O(a) improved Wilson fermions in the high-temperature phase and extrapolated to the continuum. In order to estimate the photon rate, an ill-posed problem for the vector-channel spectral function must be solved. Within a class of Pade-form spectral functions describing in particular the diffusion pole, we determine the subset that is not excluded by the lattice data and obtain from it a range of possible photon emission rates. Comparisons are made with the non-interacting spectral functions and with the well-known N=4 super-Yang-Mills spectral functions at infinite coupling obtained by AdS/CFT methods.

Primary author(s) : Prof. MEYER, Harvey (Johannes Gutenberg University Mainz)

Presenter(s) : Prof. MEYER, Harvey (Johannes Gutenberg University Mainz)

Session Classification : Plenary

Contribution ID : **105** Type : **not specified**

Transport coefficients of QCD at NLO

Wednesday, 27 June 2018 11:45 (45)

I will give an overview of the determination of the transport coefficients of QCD at next-to-leading order. It is known that leading-order perturbative computations give values of the shear viscosity over entropy density (η/s) that are significantly larger than phenomenological values and AdS/CFT computations. I will thus explain the recent improvements in our understanding of thermal amplitudes at light-like separations. This in turn can be used to extend the Arnold-Moore-Yaffe effective kinetic theory of QCD to NLO. I will explain the physical picture behind the NLO corrections and then use this kinetic theory to determine the NLO transport coefficients. First-order transport coefficients such as η/s show a rather poor convergence, but do become comparable to phenomenological values when extrapolated to the QCD transition region. On the other hand, second-order relaxation (τ_π) can be shown to obey a lower bound in any kinetic theory, which is approximately twice the AdS/CFT result, and NLO corrections push the value further away from the bound. Hence, second-order relaxation provides a natural way to distinguish strongly-coupled systems from those described by kinetic theory.

Primary author(s) : Dr GHIGLIERI, Jacopo (CERN)

Presenter(s) : Dr GHIGLIERI, Jacopo (CERN)

Session Classification : Plenary

Contribution ID : **106** Type : **not specified**

Gravitational waves from first order phase transitions

Tuesday, 26 June 2018 11:45 (45)

I will discuss phase transitions at the TeV scale, in particular the electroweak one (in extensions of the standard model). I will review the current status of how gravitational waves are generated during the phase transition, and show how the resulting gravitational wave signal can be computed from key properties of the transition. Finally, I will discuss detection prospects at future interferometers, such as LISA.

Primary author(s) : HUBER, Stephan (University of Sussex)

Presenter(s) : HUBER, Stephan (University of Sussex)

Session Classification : Plenary

Contribution ID : **107** Type : **not specified**

The Electroweak Phase Transition-Flavour Cosmology Interplay

Thursday, 28 June 2018 09:00 (45)

The nature of the electroweak phase transition is still weakly constrained experimentally and many possibilities remain open, in particular when the scalar sector of the theory is extended. There has been growing interest lately in the possibility of a strong first-order electroweak phase transition, not only because of its relevance for baryogenesis but also because it is a potential source of gravitational waves detectable at LISA.
I will report on recent work attempting to link flavour cosmology with electroweak symmetry breaking
and show how the electroweak baryogenesis mechanism is a natural outcome in composite Higgs models with partial fermion compositeness.

Primary author(s) : Prof. SERVANT, Geraldine (U. Hamburg and DESY)

Presenter(s) : Prof. SERVANT, Geraldine (U. Hamburg and DESY)

Session Classification : Plenary

Contribution ID : **108** Type : **not specified**

Axions and General Relativity

Tuesday, 26 June 2018 11:00 (45)

Axions are ubiquitous in beyond the Standard Model theories, ranging from ordinary QCD to exotic string theory constructions.
In this talk, I will present and discuss – both from a theoretical and a phenomenological viewpoint – their rich interplay with General Relativity in relation with gravitational wave astrophysics and cosmology.

Primary author(s) : Dr URBANO, Alfredo (INFN, sez. di Trieste and CERN)

Presenter(s) : Dr URBANO, Alfredo (INFN, sez. di Trieste and CERN)

Session Classification : Plenary

Contribution ID : **109** Type : **not specified**

Hydrodynamics Off Equilibrium

Wednesday, 27 June 2018 09:45 (45)

Having a thermalized system is the textbook requirement for the applicability of hydrodynamics. However, there is mounting evidence that hydrodynamics offers a good quantitative description even in off-equilibrium situations. Recent applications of resurgence to relativistic fluid dynamics in the context of conformal systems is able to put the new, generalized theory of off-equilibrium fluid dynamics on solid theoretical footing, without requiring near local equilibrium or even isotropy. This potentially explains the 'unreasonable success' of hydrodynamics in describing experimental data for p+p and p+A collisions

Primary author(s) : Prof. ROMATSCHKE, Paul (University of Colorado Boulder)

Presenter(s) : Prof. ROMATSCHKE, Paul (University of Colorado Boulder)

Session Classification : Plenary

Contribution ID : **110** Type : **not specified**

Quark matter: the high density frontier

Monday, 25 June 2018 09:45 (45)

I will describe what the standard model leads us to expect for the densest phase of matter: quark matter. Quark matter is predicted to have a rich phase structure, including color superconductors, superfluids, insulators, and crystals.
Quark matter may exist in nature, formed in the ultra-compressed cores of neutron stars: I will review the search for signatures of its presence.

Primary author(s) : Prof. ALFORD, Mark (Washington University in St. Louis)

Presenter(s) : Prof. ALFORD, Mark (Washington University in St. Louis)

Session Classification : Plenary

Contribution ID : **111** Type : **not specified**

The Electroweak Phase Transition Near the Standard Model.

Friday, 29 June 2018 09:45 (45)

A strong Electroweak Phase Transition may be responsible for the observed baryon asymmetry of the Universe and may generate a detectable stochastic background of Gravitational Waves. Sadly, in the Minimal Standard Model, the transition is a weak cross-over. I will first give a short introduction to how one computes the properties of the transition perturbatively and non-perturbatively. I will then proceed to present a snapshot of ongoing efforts to pin down the transition in minimal extensions of the Standard Model, imposing LHC constraints on parameter scans.

Primary author(s) : Prof. TRANBERG, Anders (University of Stavanger)

Presenter(s) : Prof. TRANBERG, Anders (University of Stavanger)

Session Classification : Plenary

Contribution ID : **113** Type : **not specified**

Wess-Zumino-Witten term in QCD-like theories

Friday, 29 June 2018 14:30 (30)

The so-called chiral soliton lattice was recently found to describe the ground state of the dense QCD matter in strong magnetic fields. Such a state consists of a periodic array of topological solitons, spontaneously breaks the parity and the translational symmetry and is known to appear also in condensed-matter systems such as chiral magnets. Motivated by the fact that the QCD-like theories such as the two-color QCD are accessible to the lattice simulations even at finite densities, we continue this work by investigating the behavior of the two-color QCD in strong magnetic fields. The analytic approach of low-energy effective field theory is used, hence, as a first step the gauged Wess-Zumino-Witten term reproducing the chiral anomaly has to be found. The well-known shape of the WZW term relevant for the QCD symmetry breaking pattern was generalized in order to be applicable also to the QCD-like theories.

Primary author(s) : KOLESOVA, Helena (University of Stavanger)

Presenter(s) : KOLESOVA, Helena (University of Stavanger)

Session Classification : Parallel