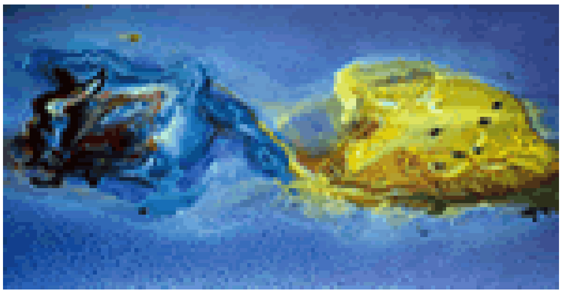
XIIIth Quark Confinement and the Hadron Spectrum



Report of Contributions

https://indico.cern.ch/e/ConfXIII

Contribution ID: **2** Type: **Talk**

A Model for Soft and Hard Interactions based on the CGC/Saturation Approach

Friday, 3 August 2018 17:00 (20 minutes)

A model based on CGC/Saturation approach and the BFKL Pomeron was originally constructed to describe soft interactions at LHC energies [reference (a)]. It has now been extended to also describe hard interactions at HERA energies [reference (b)]. The model also provides a good description of inclusive production, rapidity and angular correlations over a wide range of energies. We outline the formalism and compare the predictions with the relevant experimental data.

(a) Gotsman, Levin and Maor, Eur.Phys.J.C75, 179 (2015).

(b) Gotsman, Levin and Potashnikova, Eur.Phys.j.C77, 632 (2017).

Primary authors: Prof. GOTSMAN, Errol (Tel Aviv University); Prof. LEVIN, Evgeny (Tel Aviv University); Dr POTASHNIKOVA, Irina (Universidad Tecnica Fedrico Santa Maria)

Presenter: Prof. GOTSMAN, Errol (Tel Aviv University)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **3** Type: **Poster**

Phase Transition, Critical Point and Random Fluctuation Walk

Friday, 3 August 2018 18:06 (1 minute)

The critical phenomena of strongly interacting matter are presented in the random fluctuation walk model at finite temperature. The phase transitions are considered in systems where the Critical Point (CP) is a distinct singular one existence of which is dictated by the dynamics of conformal symmetry breaking.
The physical approach to the effective CP is predicted through the influence fluctuations of two-particle quantum correlations to which the critical mode couples. The finite size scaling effects are used to extract the vicinity of deconfinement phase transition.
We obtain the size of the particle emission source affected by the stochastic forces in thermal medium characterized by the Ginzburg-Landau parameter which is defined by the correlation length of characteristic dual gauge field. The size above mentioned blows up when the temperature approaches the critical value as correlation length becomes large enough.
The results are the subject to the physical programs at accelerators to search the hadronic matter produced at extreme conditions.

Primary author: Prof. KOZLOV, Gennady (JINR)

Presenter: Prof. KOZLOV, Gennady (JINR)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **4** Type: **Talk**

Charm Quark Mass with Calibrated Uncertainty

Thursday, 2 August 2018 16:20 (20 minutes)

We determine the charm quark mass mc(mc) from QCD sum rules of moments of the vector current correlator calculated in perturbative QCD. Only experimental data for the charm resonances below the continuum threshold are needed in our approach, while the continuum contribution is determined by requiring self-consistency between various sum rules, including the one for the zeroth moment. Existing data from the continuum region can then be used to bound the theoretical error. Our result is mc(mc)=1272±8 MeV for αs(MZ)=0.1182. Special attention is given to the question how to quantify and justify the uncertainty.

Primary author: Prof. ERLER, Jens (IF-UNAM)

Co-authors: Prof. SPIESBERGER, Hubert (Mainz University); Dr MASJUAN QUERALT, Pere (IFEA Barcelona)

Presenter: Dr MASJUAN QUERALT, Pere (IFEA Barcelona)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **5** Type: **Invited talk**

The quark/gluon structure of the proton in the high-precision LHC era

Thursday, 2 August 2018 14:00 (30 minutes)

In this talk I review recent progress in the determination of the parton distribution functions (PDFs) of the proton, with emphasis on the applications for precision phenomenology and of searches for new physics beyond the Standard Model at the Large Hadron Collider (LHC). I discuss the number of recent developements such as the use of novel observables such as top quark pair production and charm production to constrain PDFs, the relevance of accounting for higher-order QCD and electroweak corrections, the photon and heavy quark content of the proton, and recent evidence for the onset of BFKL (small-x) dynamics in HERA data. I also provide representative examples of the implications of PDF fits for high-precision LHC phenomenological applications, such as Higgs coupling measurements, the W mass determination, and searches for high-mass New Physics resonances.

Primary author: Dr ROJO, Juan (VU Amsterdam and Nikhef)

Presenter: Dr ROJO, Juan (VU Amsterdam and Nikhef)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **6** Type: **Invited talk**

Chiral effective field theory for few- and many-nucleon systems

Thursday, 2 August 2018 15:00 (30 minutes)

Chiral effective field theory has been developed into a reliable, qiantitative approach to low-energy few- and many-nucleon systems. I will review the current status of nuclear forces in this framework and discuss selected applications to light nuclei and nuclear matter. Special emphasis will be given to uncertainty quantification.

Primary author: EPELBAUM, Evgeny (Ruhr-University Bochum)

Presenter: EPELBAUM, Evgeny (Ruhr-University Bochum)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **7** Type: **Talk**

Color Confinement, Hadron Dynamics, and Hadron Spectroscopy from Light-Front Holography and Superconformal Algebra

Friday, 3 August 2018 14:30 (30 minutes)

QCD is not supersymmetrical in the traditional sense – the QCD Lagrangian is based on quark and gluonic fields, not squarks nor gluinos. However, its hadronic eigensolutions conform to a representation of superconformal algebra, reflecting the underlying conformal symmetry of chiral QCD and its Pauli matrix representation. The eigensolutions of superconformal algebra provide a unified Regge spectroscopy of meson, baryon, and tetraquarks of the same parity and twist as equal-mass members of the same 4-plet representation with a universal Regge slope. The pion $q\bar{q}$ eigenstate has zero mass for $m_q = 0$. The superconformal relations also can be extended to heavy-light quark mesons and baryons. The combined approach of light-front holography and superconformal algebra also provides insight into the origin of the QCD mass scale and color confinement. A key observation is the remarkable dAFF principle which shows how a mass scale can appear in the Hamiltonian and the equations of motion while retaining the conformal symmetry of the action. When one applies the dAFF procedure to chiral QCD, a mass scale κ appears which determines universal Regge slopes, hadron masses in the absence of the Higgs coupling, and the mass parameter underlying the Gaussian functional form of the nonperturbative QCD running coupling: $\alpha_s(Q^2) \propto \exp -Q^2/4\kappa^2$, in agreement with the effective charge determined from measurements of the Bjorken sum rule. The mass scale κ underlying hadron masses can be connected to the parameter $\Lambda_{\overline{MS}}$ in the QCD running coupling by matching its predicted nonperturbative form to the perturbative QCD regime. The result is an effective coupling $\alpha_s(Q^2)$ defined at all momenta. One also obtains empirically viable predictions for spacelike and timelike hadronic form factors, structure functions, distribution amplitudes, and transverse momentum distributions. I will also discuss properties of the QCD and electroweak light-front vacuum.

Primary author: Prof. BRODSKY, Stanley J. (SLAC National Accelerator Laboratory, Stanfird University)

Presenter: Prof. BRODSKY, Stanley J. (SLAC National Accelerator Laboratory, Stanfird University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **8** Type: **Poster**

Bethe−Salpeter-Motivated Modelling of Pseudo-Goldstone Pseudoscalar Mesons

Friday, 3 August 2018 18:21 (1 minute)

We analyze the pseudo-Goldstone-boson nature of the lightest pseudoscalar mesons within a framework residing somewhere in between the genuinely Poincaré-covariant Bethe−Salpeter approach to bound states (facing various inherent problems yet to be resolved) and the latter's extreme instantaneous limit, represented by its three-dimensional reduction due to Salpeter. A promising tool to assess the merits of such kind of "intermediate" formalism proves to be, among others, the fulfillment of a generalized Gell-Mann−Oakes−Renner-type relation by the characteristic properties of the pseudoscalar mesons under study.

Primary author: LUCHA, Wolfgang (Austrian Academy of Sciences)

Presenter: LUCHA, Wolfgang (Austrian Academy of Sciences)

Session Classification: Poster

Track Classification: B: Light quarks

Contribution ID: **11** Type: **Talk**

Out-of-equilibrium dynamics of topological an anomalous effects from chiral kinetic theory

Friday, 3 August 2018 16:50 (30 minutes)

Recent studies suggest that important contributions to the CME originate in the pre-equilibrium phase of a collision. While real-time lattice simulations can be utilized to understand the dynamics of anomalous effects in the earliest stages of a collision, quantitative predictions of experimental signatures are only feasible once the subsequent transport of the messengers of the CME through the fireball are understood. This motivates the need of a Chiral Kinetic Theory for relativistic fermions. In this talk we present a novel approach based on the world line formulation of quantum field theory that clarifies the relative role of a possible Berry phase and chiral anomaly that generates topological transitions. Our formulation is Lorentz covariant and independent of adiabatic approximations. Employing a coarse graining procedure, we derive a Chiral Boltzmann equation with collision terms. Our framework allows us to follow ab initio the fate of the Chiral Magnetic current from the earliest times (via solutions of the Dirac equation in topological sphaleron backgrounds) through its matching to Chiral Kinetic Theory and finally to Chiral MagnetoHydrodynamics. We discuss the implications of our results for quantitative extraction of the CME in heavy-ion collisions.

Primary authors: MUELLER, Niklas (Brookhaven National Laboratory); VENUGOPALAN, Raju (Brookhaven National Laboratory); Dr YIN, Yi (MIT)

Presenter: MUELLER, Niklas (Brookhaven National Laboratory)

Session Classification: Focus Subsection - Parallel

Track Classification: D: Deconfinement

Contribution ID: **13** Type: **Talk**

Near threshold exotic hadrons with two heavy quarks

Thursday, 2 August 2018 16:40 (20 minutes)

This talk considers exotic hadrons containing two heavy quarks (or a heavy quark and a heavy antiquark). It is argued on very general model-indpendent grounds that in the heavy quark limit such exotic hadrons must exist as parametrically narrow states. Moreover, it is shown that there in this limit there will be multiple exotic resonances with the same quantum numbers and that some of these must be parametrically close to the threshold for dissociation into two hadrons each of which containing a heavy quark. While, it the charm quark is too light for the analysis to apply directly in the charm-anticharm sector, the talk will end with a discussion of whether this kind of analysis might give some insight into states which have been been identified as putative charm-anticharm exotics.

Primary author: COHEN, Thomas (University of Maryland)

Presenter: COHEN, Thomas (University of Maryland)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **14** Type: **Invited talk**

Dense matter in strong magnetic fields without nucleons

Sunday, 5 August 2018 14:00 (20 minutes)

The ground state of QCD in sufficiently strong magnetic fields and at nonzero baryon chemical potential is a topological crystal made of neutral pions: the Chiral Soliton Lattice (CSL). Due to its topological nature, it carries nonzero baryon number density that can reach values relevant for the cores of neutron stars. The spectrum of excitations above the CSL ground state contains a soft, nonrelativistic mode that gives an anomalous contribution to pressure, scaling with temperature and magnetic field as $T^{5/2}B^{3/2}$. In stronger but still achievable magnetic fields, the neutral pion CSL background may catalyze Bose-Einstein condensation of charged pions.

Primary author: BRAUNER, Tomas (University of Stavanger)

Presenter: BRAUNER, Tomas (University of Stavanger)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **15** Type: **Poster**

Open-Flavour Mesons from the Angle of Bethe, Dyson, Salpeter, Schwinger, et al.

Friday, 3 August 2018 18:20 (1 minute)

In order to paint, within a common framework, a comprehensive picture of the description of mesons as quark–antiquark bound states by a Bethe–Salpeter formalism drawing on the outcomes of the Dyson–Schwinger equation for the quark propagator, we complement existing discussions of quarkonia (i.e., same-flavour quark–antiquark bound states) by a thorough investigation of open-flavour mesons composed of all conceivable combinations of quark flavour and present predictions for these mesons' masses, leptonic decay constants, and in-hadron condensates, arising from a single model characterized by a fixed set of parameter values for all states under study.

Primary author: LUCHA, Wolfgang (Austrian Academy of Sciences)

Presenter: LUCHA, Wolfgang (Austrian Academy of Sciences)

Session Classification: Poster

Track Classification: B: Light quarks

Contribution ID: **18** Type: **Talk**

Thermal ground state in Quantum Yang-Mills theory

We explain the essentials of the structure of the thermal ground state in the deconfining phase of SU(2) Quantum Yang-Mills theory. Applications here discussed involve the evolution of the coupling constant, aspects of the loop expansion of thermodynamical quantities and the polarization tensor the massless mode as well as a derivation of the 3D Ising critical exponent for the correlation length based on an exact solution for conformal temperature-redshift scaling.

Primary author: Dr HOFMANN, Ralf (ITP, Uni Heidelberg)

Presenter: Dr HOFMANN, Ralf (ITP, Uni Heidelberg)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **19** Type: **Talk**

HQET renormalization group improved Lagrangian at $\mathcal{O}(1/m^3)$ with leading logarithmic accuracy

Wednesday, 1 August 2018 14:00 (20 minutes)

In this talk we explain how to obtain the renormalization group improved expressions of the Wilson coefficients of the HQET Lagrangian with leading logarithmic approximation to $calO(1/m^3)$, which includes the heavy quark chromopolarizabilites. For the spin-independent sector, our analysis includes the effects induced by spectator quarks. We observe that the numerical impact of these logarithms is very large in most cases. The Wilson coefficients we compute are necessary ingredients to obtain the pNRQCD Lagrangian with NNNLL accuracy, which in turn is the necessary precision to obtain the complete heavy quarkonium spectrum with NNNLL accuracy, and also necessary for the computation of the production and annihilation of heavy quarkonium with NNLL precision.

Primary author: Mr MORENO, Daniel (IFAE)

Co-authors: Dr PINEDA, Antonio (IFAE); Mr LOBREGAT, Xabier (IFAE); Mr PETROSSIAN-BYRNE, Rudin (Oxford University)

Presenter: Mr MORENO, Daniel (IFAE)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **20** Type: **Talk**

Ω_c excited states with heavy-quark spin symmetry

Wednesday, 1 August 2018 16:00 (20 minutes)

We study the $C = 1$, $S = -2$, $I = 0$ sector, where five Ω_c states have been recently observed by the LHCb Collaboration [1]. In Ref. [2] a unitarized meson-baryon model was solved by adopting a one-subtraction renormalization scheme taking, as bare meson-baryon interaction, an extended Weinberg-Tomozawa interaction consistent with both chiral and heavy-quark spin symmetries. This $\mathrm{SU}(6)\times$HQSS scheme lead to a successful description of the observed lowest-lying odd parity charmed $\Lambda_c(2595)$ and $\Lambda_c(2625)$ states [2], and bottomed $\Lambda_b(5912)$ and $\Lambda_b(5920)$ resonances [3]. In the $C = 1$, $S = -2$, $I = 0$ sector, five odd-parity Ω_c states were dynamically generated, but with masses below 3 GeV, not allowing for an identification with the observed LHCb resonances [2]. Recently we have revised this model and explored two different scenarios for the renormalization scheme, that is, using a modified common energy scale to perform the subtractions or utilizing a common UV cutoff to render finite the UV divergent loop functions in all channels. In both cases, we show that some (at least three) of the dynamically generated states can be identified with the experimental Ω_c, while having odd parity and $J = 1/2$ or $J = 3/2$. Two of these states turn out to be part of the same $\mathrm{SU}(6)\times$HQSS multiplets as the charmed and bottomed Λ baryons [4].

[1] R. Aaij et al. [LHCb Collaboration], Phys. Rev. Lett. 118, 182001 (2017)

[2] O. Romanets, L. Tolos, C. Garcia-Recio, J. Nieves, L.L. Salcedo and R.G.E. Timmermans, Phys. Rev. D 85, 114032 (2012)

[3] C. Garcia-Recio, J. Nieves, O. Romanets, L.L. Salcedo and L. Tolos, Phys. Rev. D 87, 034032 (2013)

[4] J. Nieves, R. Pavao and L. Tolos, Eur. Phys. J. C 78, 114 (2018)

Primary authors: NIEVES, Juan M (IFIC (CSIC-UV)); Mr PAVAO, Rafael (IFIC (CSIC-UV)); Dr TOLOS, Laura (University of Frankfurt)

Presenter: Dr TOLOS, Laura (University of Frankfurt)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **21** Type: **Talk**

Study of the e+e- -> hadrons reactions with the CMD-3 detector at the VEPP-2000 collider

Friday, 3 August 2018 15:20 (20 minutes)

The CMD-3 detector is taking data at the VEPP-2000 e+e- collider (BINP, Novosibirsk, Russia). The CMD-3 is the general purpose particle magnetic (1.3 T) detector, equipped with the tracking system, two crystal (CSI and BGO) calorimeters, liquid Xe calorimeter, TOF and muon systems. The main goal of experiments with CMD-3 is the measurement of the cross-sections and dynamics of the exclusive modes of e+e−>hadrons reactions. In particular, these results provide important input for the calculation of the hadronic contribution to the muon anomalous magnetic moment.
First round of data taking with the CMD-3 detector at the VEPP-2000 e+e- collider was performed in 2011-2013 with about 60 1/pb integrated luminosity in the energy range from 0.32 to 2.0 GeV in c.m. Amount of collected data exceeds all previous experiments. The beam energy was continuously measured concurrently with the data taking using a Compton backscattering system.

Here we present the survey of new and published analysis results, including precise measurement of e+e−>pi+pi- reaction, as well as other hadron final states with up to six pions or states include two kaons.

At the end of 2016 the VEPP-2000 collider resumed operations after upgrade of the injection system, and a performance close to the project luminosity of 10^32 cm-2s-1 at 2 GeV has been demonstrated. First preliminary results of new 2017 run are also presented.

Primary author: Dr LUKIN, Peter (BINP & NSU)

Presenter: Dr LUKIN, Peter (BINP & NSU)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **22** Type: **Talk**

On the analytic structure of QCD propagators

Sunday, 5 August 2018 16:30 (20 minutes)

Local formulations of quantum field theory provide a powerful framework in which non-perturbative aspects of QCD can be analysed. In this talk I will outline how this approach can be used to elucidate the general analytic features of QCD propagators.

Primary author: Dr LOWDON, Peter (SLAC National Accelerator Laboratory)

Presenter: Dr LOWDON, Peter (SLAC National Accelerator Laboratory)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **23** Type: **Talk**

CANCELLED - Mass shift of charmonium states in $\bar{p}A$ collision

Sunday, 5 August 2018 16:50 (20 minutes)

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 $\bar{p}$ + 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.

Primary authors: WOLF, Gyorgy (Wigner FK); KOVACS, Peter (Wigner RCP); ZETENYI, Miklos (Wigner RCP, Budapest); LEE, Su Houng (Yonsei University); Mr BALASSA, Gabor (MTA WIgner RCP)

Presenter: WOLF, Gyorgy (Wigner FK)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **24** Type: **Talk**

BRST invariant d=2 condensates in Gribov-Zwanziger theory

Sunday, 5 August 2018 16:50 (20 minutes)

In this talk, we consider SU(N) Yang-Mills theory quantized in the linear covariant gauges, while taking into account the issue of Gribov copies. We construct the one-loop eective potential for a set of mass dimension 2 condensates, including the Gribov parameter, that rene the infrared region of the Gribov-Zwanziger theory, whilst maintaining the renormalization group invariance.
This is based on work-in-preparation with D.Dudal (KU Leuven & UGent, Belgium), L. Palhares (UERJ, Brasil) and F.Rondeau (ENS Paris-Saclay, France & KU Leuven, Belgium).

Primary authors: FELIX, Caroline; Mr RONDEAU, François (KU Leuven); DUDAL, David; PALHARES, Leticia (UERJ)

Presenter: FELIX, Caroline

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **25** Type: **Talk**

Managing Many Simultaneous Systematic Uncertainties

Thursday, 2 August 2018 14:00 (30 minutes)

Recent statistical evaluation for High-Energy Physics measurements, in particular those at the Large Hadron Collider, require careful evaluation of many sources of systematic uncertainties at the same time. While the fundamental aspects of the statistical treatment are now consolidated, both using a frequentist or a Bayesian approach, the management of many sources of uncertainties and their corresponding nuisance parameters in analyses that combine multiple control regions and decay channels, in practice, may pose challenging implementation issues, that make the analysis infrastructure complex and hard to manage, eventually resulting in simplifications in the treatment of systematics, and in limitations to the result interpretation. Typical cases will be discussed, having in mind the most popular implementation tool, RooStats, with possible ideas about improving the management of such cases in future software implementations.

Primary authors: LISTA, Luca (INFN Sezione di Napoli); IORIO, Alberto Orso Maria (Universita e sezione INFN di Napoli (IT)); DE IORIO, Agostino (Universita e sezione INFN di Napoli (IT))

Presenter: LISTA, Luca (INFN Sezione di Napoli)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **28** Type: **Talk**

Recent results of the NA61/SHINE experiment - spectra and study of the onset of deconfinement

Sunday, 5 August 2018 17:50 (20 minutes)

One of the main physics goals of the NA61/SHINE programme on strong interactions is the study of the properties of the onset of deconfinement. This goal is pursued by performing an energy (beam momentum 13A - 158A GeV/c) and system size (p+p, p+Pb, Be+Be, Ar+Sc, Xe+La) scan. This talk will review results and plans of NA61/SHINE. In particular, recently obtained inclusive spectra in inelastic p+p and centrality selected Be+Be, Ar+Sc interactions at the SPS energies will be shown. The energy dependence of quantities inspired by the Statistical Model of the Early Stage (kink, horn and step) shows interesting behavior in p+p interactions, which is not described by Monte-Carlo models. Moreover a comparison with Be+Be, Ar+Sc collisions and results from other heavy ion experiments will be performed.

Primary author: PULAWSKI, Szymon Mateusz (University of Silesia (PL))

Presenter: PULAWSKI, Szymon Mateusz (University of Silesia (PL))

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **29** Type: **Invited talk**

Spectroscopy of muonic atoms

Sunday, 5 August 2018 16:30 (30 minutes)

We have measured several 2S-2P transitions in muonic hydrogen (μp), muonic deuterium (μd) and muonic helium ions (μ^3He, μ^4He). From muonic hydrogen we extracted a proton charge radius 20 times more precise than obtained from electron-proton scattering and hydrogen high-precision laser spectroscopy but at a variance of 7σ from these values. This discrepancy is nowadays referred to as the "proton radius puzzle".

The status of the proton charge radius puzzle including the new insights obtained from spectroscopy of other muonic atoms will be discussed.

Primary author: ANTOGNINI, Aldo (Paul Scherrer Institute)

Presenter: ANTOGNINI, Aldo (Paul Scherrer Institute)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **30** Type: **Invited talk**

Correlations functions of QCD from the functional renormalization group

Thursday, 2 August 2018 14:30 (30 minutes)

We present non-perturbative first-principle results for quark-, gluon- and meson 1PI correlation functions of two-flavour Landau-gauge QCD in the vacuum [1] and Yang-Mills theory at finite temperature [2]. These correlation functions carry the full information about the theory and their connection to physical observables is discussed. We confront our results for the correlation functions with lattice simulations and compare our result for the Debye mass to hard thermal loop perturbation theory.

The presented correlation functions and derived quantities are obtained by solving their Functional Renormalisation Group equations in a systematic vertex expansion, aiming at apparent convergence within a self-consistent approximation scheme. The presented calculations represent a crucial prerequisite for the ultimate goal of quantitative first-principle studies of QCD and its phase diagram within this framework. In particular, they constitute an important step towards achieving control over quantitative uncertainties. Our results stress the outstanding importance of the consistent running of different vertices in the semi-perturbative regime for describing the phenomena and scales of confinement and spontaneous chiral symmetry breaking without phenomenological input.

Primary authors: CYROL, Anton Konrad (University of Heidelberg); MITTER, Mario (Univ. Heidelberg); PAWLOWSKI, Jan M. (University of Heidelberg); Dr STRODTHOFF, Nils (LBNL)

Presenter: MITTER, Mario (Univ. Heidelberg)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **31** Type: **Talk**

Recent experimental results from the SND detector

Wednesday, 1 August 2018 17:20 (20 minutes)

We present recent experimental results for e+e− annihilation into hadrons below 2 GeV obtained with the SND detector at the VEPP-2000 collider. The analyses are based on data collected in the detector runs from 2010 to 2017 years.

Primary author: Dr KOROL, Aleksandr (Budker Institute of Nuclear Physics (RU))

Presenter: Dr KOROL, Aleksandr (Budker Institute of Nuclear Physics (RU))

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **33** Type: **Talk**

Exotic states and their properties in large-Nc QCD

Friday, 3 August 2018 17:00 (20 minutes)

Discussing four-point Green functions of bilinear quark currents in large-Nc QCD, we formulate rigorous criteria for selecting diagrams appropriate for the analysis of potential tetraquark poles. We find that both flavor-exotic and cryptoexotic (i.e., flavor-nonexotic) tetraquarks, if such poles exist, have a width of order $O(1/Nc^2)$, so they are parametrically narrower compared to the ordinary qq mesons, which have a width of order O(1/Nc). Moreover, for flavor-exotic states, the consistency of the large-Nc behavior of "direct" and "recombination" Green functions requires two narrow flavor-exotic states, each coupling dominantly to one specific meson-meson channel.

Primary authors: LUCHA, Wolfgang (Austrian Academy of Sciences); MELIKHOV, Dmitri (HEPHY); SAZDJIAN, Hagop (University Paris-Sud)

Presenter: MELIKHOV, Dmitri (HEPHY)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **34** Type: **Talk**

Strong isospin breaking in the decay constants of heavy–light mesons from local-duality QCD sum rules

Wednesday, 1 August 2018 14:20 (20 minutes)

We discuss the leptonic decay constants of heavy–light mesons by means of Borel QCD sum rules in the local-duality (LD) limit of infinitely large Borel mass parameter. In this limit, for an appropriate choice of the invariant structures in the QCD correlation functions, all condensate contributions vanish and all nonperturbative effects are contained in only one quantity, the effective threshold. We study properties of the LD effective thresholds in the limits of large heavy-quark mass mQ and small light-quark mass mq. We show that the dependence of the meson decay constants on mq arises predominantly (at the level of 70–80%) from the calculable mq-dependence of the perturbative spectral densities. Making use of the lattice QCD results for the decay constants of nonstrange and strange pseudoscalar and vector heavy mesons, we obtain solid predictions for the decay constants of heavy–light mesons as functions of mq in the range from a few to 100 MeV and evaluate the corresponding strong isospin-breaking effects: fD+ − fD0 = (0.96 ± 0.09) MeV, fD*+ − fD*0 = (1.18 ± 0.35) MeV, fB0 − fB+ = (1.01 ± 0.10) MeV, fB*0 − fB*+ = (0.89 ± 0.30) MeV.

Primary authors: LUCHA, Wolfgang (Austrian Academy of Sciences); MELIKHOV, Dmitri (HEPHY); SIMULA, Silvano (INFN)

Presenter: MELIKHOV, Dmitri (HEPHY)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **35** Type: **Talk**

Rare FCNC radiative leptonic B⟶ γl+l- decays in the standard model

Wednesday, 1 August 2018 14:40 (20 minutes)

We revisit rare radiative leptonic decays B_(s,d) → γee and B_(s,d) → γμμ in the standardmodel and provide the updated estimates for various differential distributions (the branching ratios, the forward-backward asymmetry, and Rμ=e, the ratio of the differential distribution for muons over electrons in the final state). The new ingredients of this work compared to the existing theoretical analyses are the following: (i) we calculate all B → γ form factors induced by the vector, axial-vector, tensor and pseudotensor quark currents within the relativistic dispersion approach based on the constituent quark picture; (ii) we perform a detailed analysis of the charm-loop contributions to radiative leptonic decays: we obtain constraints imposed by electromagnetic gauge invariance and discuss the existing ambiguities in the charmonia contributions.

Primary authors: KOZACHUK, Anastasiia (M.V. Lomonosov Moscow State University (RU)); MELIKHOV, Dmitri (HEPHY); NIKITIN, Nikolai (M.V. Lomonosov Moscow State University (RU))

Presenter: KOZACHUK, Anastasiia (M.V. Lomonosov Moscow State University (RU))

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **37** Type: **Talk**

Field-Strength Descriptions for a Confined System of SU(2) Charges

Friday, 3 August 2018 16:00 (20 minutes)

The existence of a mechanism with QCD to confine quarks and gluons to the interior of hadrons has long been accepted empirically. To explore the properties required for this confinement we present a field-strength description for a simple extended system of SU(2) charges with spherical symmetry and then impose confining boundary conditions on the time-independent Yang-Mills-Maxwell equations. Nontrivial solutions to these equations necessarily describe a dual topological insulator with a shell of topological charge between the interior and exterior volumes. The dimensional reduction implicit in the characterizations of spherically symmetric SU(2) can be extended to SU(3).

Primary author: Prof. SIVERS, Dennis (Portland Physics Institute)

Presenter: Prof. SIVERS, Dennis (Portland Physics Institute)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **38** Type: **Talk**

Higher-order condensate corrections to bottomonium observables

Thursday, 2 August 2018 15:20 (20 minutes)

The perturbative accuracy for bottomonium observables has recently been extended to next-to-next-to-next-to-leading order. Assuming the hierarchy $\Lambda_{\mathrm{QCD}} \ll m_b v^2$ holds, non-perturbative corrections take the form of local condensates. I determine higher-order corrections in this approach and assess its validity by studying the convergence of the series. In particular, the non-perturbative effects on the determination of the bottom-quark mass from the bottomonium spectrum and sum rules are discussed.

Primary author: Dr RAUH, Thomas (IPPP Durham)

Presenter: Dr RAUH, Thomas (IPPP Durham)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **40** Type: **Talk**

A look at hadronization via high multiplicity

Wednesday, 1 August 2018 17:00 (20 minutes)

Multiparticle production is studied experimentally and theoretically in QCD that describes interactions in the language of quarks and gluons. In the experiment the real hadrons are registered. For transfer from quarks and gluons to observed hadrons various phenomenological models are used.
In order to describe the high multiplicity region, we have developed a gluon dominance model (GDM). It represents a convolution of two stages. First stage is described as a part of QCD. For second one (hadronisation), the phenomenological model is used. To describe hadronisation, a scheme has been proposed, consistent with experimental data in the region of its dominance. Comparison of this model with data on e+e- annihilation over a wide energy interval (up to 200 GeV) confirms the fragmentation mechanism of hadronisation, the development of the quark-gluon cascade with energy increase and domination of bremsstrahlung gluons.
The description of topological cross sections in pp collisions within of GDM testifies that in hadron collisions the mechanism of hadronisation is being replaced by the recombination one. At that point, gluons play an active role in the multiparticle production process, and valence quarks are passive. They stay in the leading particles, and only the gluon splitting is responsible for the region of high multiplicity.
GDM with inclusion of intermediate quark charged topologies describes topological cross sections in a proton-antiptoton annihilation and explains linear growth of a secondary correlative momentum in the negative area.
The scaled variance of a neutral pion number mesuared by us is rising abruptly in the region of high total multiplicity and differs from Monte Carlo predictions by seven standard deviations. The growth of fluctuations of the neutral pion number in this region may indicate the formation of a pion (Bose-Einstein) condensate. While searching for this collective phenomenon, events with a predominance of a large number of neutrals (16) among total multiplicity (32) have been found along with an indication that "centaurs" exist. Despite the growth of fluctuations on the neutral number, their average remains equal to 1/3 of the total pion number.
Our planned study of soft photon yield in the region of high multiplicity at U-70 and Nuclotron is presented.

Primary authors: Prof. KOKOULINA, Elena (JINR); Dr KUTOV, Andrei (research officer); Prof. NIKITIN, Vladimir (JINR); Dr RIADOVIKOV, Vasilii (IHEP); Prof. VOROBIEV, Alexander (IHEP)

Presenter: Prof. KOKOULINA, Elena (JINR)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **41** Type: **Talk**

Estimation of global statistical significance of a new signal within the GooFit framework on GPUs

Friday, 3 August 2018 17:00 (20 minutes)

GPUs represent one of the most sophisticated and versatile parallel computing architectures that have recently entered in the HEP field. GooFit is an open source tool interfacing ROOT/RooFit to the CUDA platform that allows to manipulate probability density functions and perform fitting tasks. The computing capabilities of GPUs with respect to traditional CPU cores have been explored with a high-statistics pseudo-experiment method implemented in GooFit with the purpose of estimating the local statistical significance of an already known signal. The striking performance obtained by using GooFit on GPUs has been discussed in the previous edition (XII) of this conference.
This method has been extended to situations when, dealing with an unexpected new signal, a global significance must be estimated.
The LEE is taken into account by means of a scanning/clustering technique in order to consider, within the same background only fluctuation and anywhere in the relevant mass spectrum, any fluctuating peaking behaviour with respect to the background model. The presented results clearly indicate that the systematic uncertainty associated to the method is negligible and that the p-value estimation is not affected by the clustering configuration. A comparison with the evaluation of the global significance provided by the method of trial factors is also provided.

Primary authors: Mr DI FLORIO, Adriano (Universita e INFN, Bari (IT)); POMPILI, Alexis (Universita e INFN, Bari (IT))

Presenter: Mr DI FLORIO, Adriano (Universita e INFN, Bari (IT))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **42** Type: **Talk**

Pseudoscalar pole contribution to the hadronic light-by-light piece of a_μ

Thursday, 2 August 2018 15:00 (20 minutes)

We studied the transition form factor involved in pseudoscalar meson (π,η,η') decays into two virtual photons by means of a chiral-invariant Lagrangian, considering the lowest-lying multiplet of vector and pseudoscalar resonances. Accounting for $U(3)$ breaking effects, we give the most general corrections of order m_P^2 to the form factor. Most parameters are fixed requiring short-distance constraints. The remaining ones are fitted to experimental measurements of the form factors in the space-like ($q^2 < 0$) region of photon momenta. We, thus, obtain the P-pole contribution to the hadronic light-by-light scattering of the muon g-2 with an improved certainty: $(8.47 \pm 0.16) \times 10^{-10}$. This is obtained neglecting BaBar data for the π^0 Transition Form Factor which, in our analysis, is in conflict with the remaining experimental inputs.

Primary authors: GUEVARA, Adolfo (Madrid University); SANZ-CILLERO, Juan José (Universidad Complutense de Madrid); ROIG GARCÉS, Pablo

Presenter: GUEVARA, Adolfo (Madrid University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **43** Type: **Talk**

Direct Learning of Systematics-Aware Summary Statistics

Friday, 3 August 2018 14:30 (30 minutes)

Complex machine learning tools, such as deep neural networks and gradient boosting algorithms, are increasingly being used to construct powerful discriminative features for High Energy Physics analyses. These methods are typically trained with simulated or auxiliary data samples by optimising some classification or regression surrogate objective. The learned feature representations are then used to build a sample-based statistical model to perform inference (e.g. interval estimation or hypothesis testing) over a set of parameters of interest. However, the effectiveness of the mentioned approach can be reduced by the presence of known uncertainties that cause differences between training and experimental data, included in the statistical model via nuisance parameters. This work presents an end-to-end algorithm, which leverages on existing deep learning technologies but directly aims to produce inference-optimal sample-summary statistics. By including the statistical model and a differentiable approximation of the effect of nuisance parameters in the computational graph, loss functions derived form the observed Fisher information are directly optimised by stochastic gradient descent. This new technique leads to summary statistics that are aware of the known uncertainties and maximise the information that can be inferred about the parameters of interest object of a experimental measurement.

Primary author: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Co-author: DORIGO, Tommaso (Universita e INFN, Padova (IT))

Presenter: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **44** Type: **Invited talk**

Baryon Matrix Elements for New Physics Searches

Sunday, 5 August 2018 17:00 (30 minutes)

The allowed window on new physics to emerge from low-energy precision measurements of hadronic properties and processes relies on theoretical input as well. I review how recent progress in the analysis and computation of baryon matrix elements impact the interpretation of current, planned, and possible experiments in neutron beta decay and searches for neutron-antineutron conversion.

Primary author: Prof. GARDNER, Susan (University of Kentucky)

Presenter: Prof. GARDNER, Susan (University of Kentucky)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **45** Type: **Invited talk**

The Primakoff Experimental Program at JLab

Thursday, 2 August 2018 17:50 (30 minutes)

The light pseudoscalar meson decays provide a unique laboratory to test fundamental QCD symmetries at low energies. A comprehensive Primakoff experimental program at Jefferson Laboratory (JLab) is aimed at gathering high precision measurements of the two-photon decay widths and the transition form factors (at low four-momentum transfer squares) of π0, η and η′ via the Primakoff effect. The results of these measurements will offer stringent tests on the chiral anomaly and provide sensitive probes for the origin and dynamics of chiral symmetry breaking. The status of these experimental activities and their physics impacts will be discussed.

Primary author: Prof. GAN, Liping (University of North Carolina Wilmington)

Presenter: Prof. GAN, Liping (University of North Carolina Wilmington)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **46** Type: **Talk**

|Vxb| determination: an updated theoretical prospective

Wednesday, 1 August 2018 15:00 (20 minutes)

We describe the recent theoretical results on |Vxb| determinations, as well as the status and prospective of the related inclusive/exclusive puzzle

or

We analyze the issue of lepton flavor non universality in b -> s l l decays in non-minimal 331 models

Primary author: RICCIARDI, Giulia (Univ. Napoli Federico II)

Presenter: RICCIARDI, Giulia (Univ. Napoli Federico II)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **47** Type: **Talk**

Confidence intervals for linear combinations of Poisson observations

Thursday, 2 August 2018 14:30 (30 minutes)

Different situations appearing in HEP involve the calculation of CI for linear combinations of observations that follow a Poisson distribution. Although apparently a simple problem, no precise methods exist unless asymptotic approximations can be assumed. We propose different alternatives beyond the error propagation of Gaussian errors and estimate their performance in some common examples.

Primary author: Prof. FRANCISCO, Matorras (Instituto de Fisica de Cantabria, Spain)

Presenter: Prof. FRANCISCO, Matorras (Instituto de Fisica de Cantabria, Spain)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **48** Type: **Talk**

New results and prospects in kaon physics from the NA62 experiment

Wednesday, 1 August 2018 14:40 (30 minutes)

New results in kaon physics from the NA62 experiment at CERN are presented, including the measurement of the K+ –> pi+ nu nu decay rate. NA62 short-term prospects and on-going analyses, including radiative kaon decay measurements and searches lepton number violation, are discussed. Finally, recent results on rare kaon decays from the NA48/2 experiment at CERN are presented.

Primary author: GOUDZOVSKI, Evgueni (University of Birmingham)

Presenter: GOUDZOVSKI, Evgueni (University of Birmingham)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **49** Type: **Invited talk**

Meson resonances in QCD

Friday, 3 August 2018 14:30 (30 minutes)

I will report on recent progress using lattice QCD to study coupled-channel meson resonances with particular focus on the light scalars and tensors. Taking advantage of the relation between scattering amplitudes and the discrete spectrum of states in a box of finite-size, the presence and properties of resonances can be determined in a rigorous manner.

Primary author: DUDEK, Jozef

Presenter: DUDEK, Jozef

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **51** Type: **Invited talk**

Light-Quark Resonances at COMPASS

Friday, 3 August 2018 14:00 (30 minutes)

COMPASS is a multi-purpose fixed-target experiment at CERN aimed at studying the structure and spectrum of hadrons. The two-stage spectrometer has a good acceptance over a wide kinematic range and is thus able to measure a wide range of reactions. Light mesons are studied with a negative hadron beam (mostly π^-) with a momentum of 190 GeV$/c$.
The light-meson spectrum is investigated in various final states produced in diffractive dissociation.
The flagship channel is the $\pi^-\pi^+\pi^-$ final state, for which COMPASS has acquired the so far world's largest dataset of 46 M exclusive events.
We report on new results of a partial-wave analysis (PWA) of this final state, where we investigate a_J and π_J mesons with various spins J. In the PWA, the decay into $\pi^-\pi^+\pi^-$ is modeled as a chain of subsequent two-body decays in order to disentangle the contributions of different partial waves.
The large size of our dataset allows us to perform this analysis in narrow bins of the squared four-momentum transfer t'. Thus, we can also extract the t' dependence of the various partial-wave components from the data.
Finally, the resonance parameters of a_J and π_J mesons are measured by disentangling resonant and non-resonant components of 14 selected partial-wave amplitudes simultaneously in a resonance-model fit.
Describing 14 partial-wave amplitudes and all their interferences simultaneously in a single resonance-model fit allows us to study also weaker signals, e.g. from excited states, by making use of their interference pattern and their different couplings to the various decay modes.

Primary author: WALLNER, Stefan (Technische Universitaet Muenchen (DE))

Presenter: WALLNER, Stefan (Technische Universitaet Muenchen (DE))

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **52** Type: **Talk**

QCD-like theories in strong magnetic fields

Sunday, 5 August 2018 15:00 (20 minutes)

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 ground state 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 term reproducing the chiral anomaly has to be found. The well-known shape of the WZ term relevant for the QCD symmetry breaking pattern was generalized in order to be applicable also to the QCD-like theories.

Primary author: KOLEŠOVÁ, Helena (University of Stavanger)

Presenter: KOLEŠOVÁ, Helena (University of Stavanger)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **53** Type: **Poster**

Temperature dependence of SU(3)-gluodynamics bulk and shear viscosities within lattice simulation

Friday, 3 August 2018 18:19 (1 minute)

The talk is aimed at the study of $SU(3)$-gluodynamics bulk and shear viscosities temperature dependence. We measured the correlation functions of the Energy-Momentum Tensor for a set of temperatures in the region T/Tc∈[0.9,1.5] and then applied various parametrical and non-parametrical approaches which give consistent results. Observed temperature dependence agrees with the recent experimental data and previously performed calculations. We notice a peak of bulk viscosity in the vicinity of phase transition, as for shear viscosity, there is a slight rise with the temperature at $T > T_c$. The analysis of our data confirms that the quark-gluon plasma behaves as a strongly-interacting system.

Primary authors: KOTOV, Andrey; ASTRAKHANTSEV, Nikita; Dr BRAGUTA, Victor (ITEP)

Presenter: ASTRAKHANTSEV, Nikita

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **54** Type: **Talk**

Exotic and Conventional Quarkonium Physics Prospects at Belle II

Thursday, 2 August 2018 14:00 (20 minutes)

The Belle II experiment, now operating at the KEK laboratory in Japan, is a substantial upgrade of both the Belle detector and the KEKB e^+e^-accelerator. It aims to collect 50 times more data than existing B-Factory samples. Belle II is uniquely capable to study the so-called "XYZ" particles: heavy exotic hadrons consisting of more than three quarks. First discovered by Belle, these now number in the dozens, and represent the emergence of a new category within quantum chromodynamics. This talk will present the capabilities of Belle II to explore both exotic and conventional quarkonium physics.

Primary author: MUSSA, Roberto (INFN Torino)

Co-author: PERUZZI, Ida (Laboratori Nazionali di Frascati dell'INFN)

Presenter: MUSSA, Roberto (INFN Torino)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **55** Type: **Talk**

Quark-gluon vertex and flavour-dependence of dynamical chiral symmetry breaking

Friday, 3 August 2018 15:20 (20 minutes)

In this work, we examine the flavour-dependence of dynamical chiral symmetry breaking (DCSB) due to the effect of different model kernels in the gap equation. For that, we have computed the quark's sigma term and its ratio to the Euclidean constituent mass, that computes the DCSB contribution.

Primary authors: SERNA, Fernando (IFT-UNEPS); Prof. EL-BENNICH, Bruno (Universidade Cruzeiro do Sul)

Presenter: SERNA, Fernando (IFT-UNEPS)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **57** Type: **Talk**

Analytical generalization of 3+1 dimensional self-similar and Gubser flows to relativistic magnetohydrodynamics

Wednesday, 1 August 2018 17:00 (20 minutes)

Due to absence of expansion transverse to the beam direction, Bjorken flow is unable to describe certain observables in heavy ion collisions such as transverse momentum spectra of final hadrons. This caveat has motivated introduction of analytical relativistic hydrodynamics(RH) solutions with transverse expansion, in particular 3+1 self-similar and Gubser flows. Inspired by recently found generalizations of Bjorken flow to the relativistic magnetohydrodynamics(RMHD), we present a procedure for generalization of RH solutions to RMHD using symmetry arguments. We find the relation between RH degrees of freedom and the magnetic field evolution in ideal limit, namely an infinitely conductive fluid. Using this procedure, we find the magnetic field evolution in aforementioned flows. In the case of self-similar flow a family of solutions are found, which are related through a certain differential equation. To find the magnetic field evolution in Gubser flow, we solve RMHD equations for a stationary fluid in the conformally flat $dS^3 \times E^1$ spacetime. The results are then Weyl transformed back to Minkowski spacetime. In this case the magnetic field temporal evolution exhibits a transmission between $1/t$ to $1/t^3$ near the center of collision. Longitudinal component of the magnetic field is found to be sensitive to transverse size of the fluid. We also find the radial evolution of magnetic field for both flows. The radial domain of validity in the case of self-similar flow is highly restricted, in contrast to Gubser flow. Comparison of the results suggest that Gubser RMHD may give a qualitative picture of magnetic field decay in the QGP.

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Co-author: SADOOGHI, Neda (Sharif University of Technology)

Presenter: Mr SHOKRI, Masoud (Sharif University of Technology)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **58** Type: **Talk**

Chiral symmetry restoration by parity doubling and the structure of neutron stars

Sunday, 5 August 2018 14:20 (20 minutes)

Recent lattice QCD studies at vanishing density exhibit the parity-doubling structure for the low-lying baryons around the chiral crossover temperature. This finding is likely an imprint of the chiral symmetry restoration in the baryonic sector of QCD, and is expected to occur also in cold dense matter, which makes it of major relevance for compact stars. By contrast, typical effective models for compact star matter embody chiral physics solely in the deconfined sector, with quarks as degrees of freedom. In this talk, we present a description of QCD matter based on the effective hybrid quark-meson-nucleon model. Its characteristic feature is that, under neutron-star conditions, the chiral symmetry is restored in a first-order phase transition deep in the hadronic phase, before the deconfinement of quarks takes place. We discuss the implications of the parity doubling of baryons on the mass-radius relation for compact stars obtained in accordance with the modern constraints on the mass from PSR J0348-0432, the compactness from GW170817, as well as the direct URCA process threshold. We show that the existence of high-mass stars might not necessarily signal the deconfinement of quarks.

Primary authors: MARCZENKO, Michał (University of Wrocław); BLASCHKE, David (University of Wroclaw); REDLICH, Krzysztof (University of Wroclaw); SASAKI, Chihiro

Presenter: MARCZENKO, Michał (University of Wrocław)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **59** Type: **Talk**

Fractal structure, power-law distribution and hadron spectrum

Wednesday, 1 August 2018 15:20 (20 minutes)

One of the most celebrated features of QCD is the asymptotic freedom that allows calculations of strong interaction with a perturbative method when the momentum transferred is sufficiently large. The non perturbative regime, however, remains veiled to {\it ab initio} calculations, and it is expected that the large amount of data made available by high energy experiments will give some insight to solve the theoretical difficulties on this issue. Meanwhile, phenomenological approaches seems to be one of the best ways to access the non perturbative QCD in those problems where even Lattice QCD struggles to find an answer. An effort is necessary, then, to understand the phenomenological approaches in therms of QCD.

Transverse momentum distribution is one of the most direct experimental observables in high energy collisions, and one of its distinguishing features is the large tail at the high momentum sector, deviating from the exponential distribution expected to be found in a thermodynamically equilibrated system. Chemical production ratios, however, clearly show that such equilibrium is reached in the collisions. One possible solution to this apparent paradox is to attribute the high p_T momentum region to non equilibrium processes, while the bulk of particle production would result from the Boltzmann distributions of a thermal system. Another possibility is to assign the non extensive statistics to the description of the thermodynamics properties of the hadronic system obtained in high energy collisions, which would describe the whole p_T distribution, among other aspects of those collisions. In the present work a system presenting fractal structure in its energy-momentum space is investigated aiming to understand which aspects of QCD could possibly give rise to the fractal structure. Such system, which will be referred to as thermofractals, has been show to follow Tsallis non extensive statistics and also present many aspects also present in hadrons.

Thermofractals were recently introduced in the context of non extensive statistics and features fractal structure in thermodynamics functions as a possible origin of non extensivity [1]. The main aspect of such system is the energy fluctuation that results to be given by
\begin{equation}
P(E)dE=A e_q(-\beta E)\,,
\end{equation}
with $e_q(x)$ being the q-exponential function, given by
\begin{equation}
{e_q(x)=\bigg[1+(1-q)x \bigg]^{\frac{1}{1-q}}}\,,
\end{equation}
and β the inverse of temperature. The presence of the q-exponential makes clear that Tsallis statistics [2] is the proper tool to describe this system thermodynamically.

Fractal features in hadronic multiparticle production were already addressed by Veneziano [3] in association to the complex interaction that arises when one considers high transferred momentum, Q^2 in high order logarithm expansion in the QCD evolution contributions according to Altarelli-Parisi approach [4]. This fractal aspects were in fact observed experimentally through the intermittency analysis, a technique proposed by Bialas and Peschanski [5,6] that allows to measure, from energy, momentum or rapidity distributions, the fractal dimension associated to the particle production process.

There are more direct observations of self-similarity in multiparticle production at high energy collisions. The so-called z-scaling shows that particle energy distributions collapses to a single distribution when described by the z variable, that takes into account fractal dimensions of the particle phase-space. Experimentally, an analysis of transverse momentum dstributions of jets and particles was shown to have the same description in terms of Tsallis distribution. Moreover, when the jet-particles are analyzed with respect to the jet momentum, the transverse momentum distribution with respect to the jet axis direction shows, surprisingly, the same distribution. These are clear manifestations of self-similarity in high energy collisions.

With the introduction of thermofractals it was possible to show that a system like those proposed for fireballs and hadrons should be described by Tsallis statistics instead of Boltzmann one. When Hagedorn's theory [7] is generalized to a non extensive self-consistent thermodynamics, the results present the power-law behavior that describes the outcome of high energy collision by means of two parameters that are likely to be universal for all particle species and all colliding energies. In addition, a new hadron mass spectrum formula is derived, resulting in
\begin{equation}
\rho(m)=A e_q(\beta_o m)\,.
\end{equation}
The hadron mass spectrum for the known hadronic states is described very well by this new mass spectrum formula up to masses as low as the pion mass, performing much better than the Hagedorn's formula for that spectrum.

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Presenter: DEPPMAN, Airton (University of São Paulo)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **60** Type: **Poster**

Charge correlations and strongly intensive fluctuations in ultrarelativistic nuclear collisions in the string model

Friday, 3 August 2018 18:01 (1 minute)

The fluctuations of the net electric charge of hadrons, produced in ultrarelativistic heavy ion collisions, were proposed as one of the indicators of the formation of a quark-gluon plasma [1,2]. They also carry important information on the collective dynamical effects in AA collisions [3,4].
Experimentally, they are studied in terms of dynamical fluctuation parameter ν_{dyn} and the balance functions. These observables showed to be robust against volume fluctuations and centrality class width, being therefore strongly intensive variables [5].
The comparison of theoretical predictions of the net charge fluctuations, initially made in statistical models [3, 6, 7], does not allow unambiguous conclusions about the formation of quark-gluon plasma in ultrarelativistic heavy ion collisions at RHIC and LHC. It was shown [8] that the experimental behavior of the net charge fluctuations, including the dependence on the width of the pseudorapidity window, is successfully described by the string model, and its dependence on centrality is related to the average string tension. For the more detailed study, the method of net charge long-range correlations in the windows separated by rapidity has been proposed for the better exclusion the short-range correlation effects [8].
In this paper we calculate the strongly intensive correlations and fluctuations of produced hadrons in a string-partonic Monte Carlo model [9, 10], taking into account fusion of quark-gluon strings [11,12], finite rapidity width of strings and explicit charge conservation. The model successfully describes the main features of forward-backward correlations between multiplicities and transverse momentum in pp and Pb-Pb collisions at LHC energy [13, 14]. We demonstrate that the centrality dependence of the width of balance function as well as dynamical net charge fluctuation can be explained by formation in central AA collisions of the strings of higher string tension. We provide the predictions for net charge correlations in Pb-Pb collisions at LHC energies and discuss the applicability of the method at SPS and NICA energies.
The research was supported by the grant of the Russian Foundation for Basic Research (project 18-32-01055 mol_a).

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Primary author: Dr KOVALENKO, Vladimir (St Petersburg State University)

Presenter: Dr KOVALENKO, Vladimir (St Petersburg State University)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **61** Type: **Invited talk**

Experimental challenges in neutrinoless double beta decay search

Sunday, 5 August 2018 18:00 (30 minutes)

The search of neutrinoless double-beta decay plays a fundamental role in the understanding of neutrino physics. Its observation would prove that neutrinos are Majorana particles and that lepton number is not conserved, with a profound impact on elementary particle physics, nuclear physics, astrophysics, and cosmology. Experiments presently running will cover the quasi-degeneracy region of the neutrino mass pattern and the experimental challenge for the next future is the construction of detectors characterized by a tonne-scale size and an incredibly low background, to approach and fully probe the inverted-hierarchy region. In this presentation, a description of the most relevant experimental techniques is given and the strongest recent results are compared in terms of achieved background contributions and limits on effective Majorana mass, with a particular focus on the preliminary performances and results from the CUORE experiment. Finally, the most relevant parameters contributing to the experimental sensitivity are discussed and a critical comparison of the future projects is proposed.

Primary author: GIACHERO, Andrea (Universita & INFN, Milano-Bicocca (IT))

Presenter: GIACHERO, Andrea (Universita & INFN, Milano-Bicocca (IT))

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **62**   Type: **Invited talk**

Confinement and asymptotic freedom with Cooper pairs

Friday, 3 August 2018 16:00 (20 minutes)

We have studied the superconductor-insulator transition (SIT) in strongly disordered superconducting films and Josephson junction arrays (JJA) as a paradigm example example in which quantum synchronization gives rise to new phases of matter in d=2 and d=3 spatial dimensions.
In fact recent experimental results have shown that at absolute zero electrons can form quantum coherent states different from a superconductor. These states are superinsulators, dual superconductors with infinite resistance even at finite temperature, a new topological state of matter that we predicted in 1996, and a metallic state often referred to as Bose metal. We propose a long-distance topological gauge theory description SIT that enabled us to identify the underlying mechanism of superinsulation as Polyakov's linear confinement of Cooper pairs via instantons, blocking their motion on large scales and in asymptotic freedom at small distances. This implies that systems of a size smaller than the string scale appear in a quantum metallic state. Accordingly, the SIT realizes the field-theoretical S-duality.
Our findings generalize the concept of a super-insulator to 3D systems and open the route to desktop experiments revealing and elucidating observable implications of confinement and topological phenomena in QED.

Primary authors: Dr DIAMANTINI, Maria Cristina (University of Perugia); Prof. VINOKOUR, Valerii (Argonne National Laboratory); Dr TRUGENBERGER, Carlo (SwissScientific)

Presenter: Dr DIAMANTINI, Maria Cristina (University of Perugia)

Session Classification: Focus Subsection - Parallel

Track Classification: Focus Subsection: Emergent Gauge Fields and Chiral Fermions

Contribution ID: **63** Type: **Talk**

On the distinction between color confinement, and confinement

Wednesday, 1 August 2018 14:30 (30 minutes)

The property of color confinement (”C-confinement”), meaning that all asymptotic particle states are color neutral, holds not only in QCD, but also in gauge-Higgs theories deep in the Higgs regime. In this talk I will describe a new and stronger confinement criterion, separation-of-charge confinement or “S-confinement,” which is an extension of the Wilson area-law criterion to gauge + matter theories. I will show that there is a transition between S and C confinement in the phase plane of gauge-Higgs theories, and I will also explain what symmetry is actually broken in the Higgs phase of a gauge-Higgs theory.

Primary authors: Prof. GREENSITE, Jeff (San Francisco State University); Dr MATSUYAMA, Kazue (San Francisco State University)

Presenter: Prof. GREENSITE, Jeff (San Francisco State University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **64** Type: **Invited talk**

CP violation in QCD

Wednesday, 1 August 2018 17:20 (20 minutes)

Among the parameters of QCD is one that results in CP violation when non-vanishing. This is closely related to possible quark mass terms. It is conventionally interpreted in terms of gauge field topology or alternatively in terms of real chiral eigenvalues of the Dirac operator. There is no experimental evidence for this parameter having a non-zero value, a puzzle for theories involving unification.

Primary author: Dr CREUTZ, Michael (Brookhaven Lab)

Presenter: Dr CREUTZ, Michael (Brookhaven Lab)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **65** Type: **Talk**

Neural networks and machine learning tools for global PDF analyses

Thursday, 2 August 2018 15:30 (30 minutes)

The precision determination of the parton distribution functions (PDFs) of the proton is a central component for the precision phenomenology program at the Large Hadron Collider (LHC). Pinning down the quark and gluon structure of the proton strengthens a number of LHC cornerstone measurements such as the characterisation of the Higgs sector and searches for high-mass bSM resonances. In this talk I present recent methodological developments in the NNPDF approach to PDF determination, basic of artificial neural networks and related machine learning tools. I discuss progress towards improved training algorithms, studies of the dependence on the network architecture, and the implementation of external theoretical constraints. I conclude by briefly discussing some possible future directions, such as the applications of Generative Adversarial Networks or the Riemann-Theta Boltzmann Machine for PDF fits.

Primary author: ROJO, Juan (VU Amsterdam and Nikhef)

Presenter: ROJO, Juan (VU Amsterdam and Nikhef)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **66** Type: **Talk**

Strong Decay Analysis of Strange Charm Mesons

Wednesday, 1 August 2018 17:00 (20 minutes)

In the last decade, charmed and bottom meson spectroscopy have seen great success in experimental sector. Experiments like LHCb, Babar etc are providing many new states which are being added to their spectroscopy. Newly predicted states like Ds(3040), Ds(2700), Ds(2860) and many more still need to be assigned their proper place in the spectroscopy. So we studied the decay constant and the coupling constants of these states using the heavy quark effective theory as our model. We analysed the two-body strong decays of the above states to their ground state mesons with light pseudo-scalar mesons (π, η, K). We also obtained the ratios among their strong decays, which can be confronted to the experimental data for the verification of their JP states. In addition to this, we also study the strong decays of their spin and strange partners, which are still experimentally not observed, and may be useful for future experiments in searching for these heavy-light mesons.

Primary authors: Ms GUPTA, Pallavi (Thapar University, Patiala); Dr UPADHYAY, alka (thapar university)

Presenters: Ms GUPTA, Pallavi (Thapar University, Patiala); Dr UPADHYAY, alka (thapar university)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **67** Type: **Talk**

Schwinger-Dyson Equation confronts lattice QCD

Wednesday, 1 August 2018 14:00 (30 minutes)

We report on a study of the Schwinger-Dyson equation (SDE) in the Euclidean formulation of local quantum gauge field theory, with Coulomb gauge condition $partial_i A_i = 0$. We compare the results of that study with a numerical simulation of lattice gauge theory and find that the infrared critical exponents and related quantities agree to within 1\% to 3\%. This raises the question, Why is the agreement is so good, despite the systematic neglect of non-instantaneous terms? We discovered the happy circumstance that all the non-instantaneous terms are in fact zero. They are forbidden by the symmetry of the local action in Coulomb gauge under time-dependent gauge transformations $g(t)$. This remnant gauge symmetry is not fixed by the Coulomb gauge condition. The numerical result of the present calculation is the same as in a previous study; the novelty is that we now demonstrate that all the non-instantaneous terms in the SDE vanish. We derive some elementary properties of propagators which are a consequence of the remnant gauge symmetry. In particular the time component of the gluon propagator is found to be purely instantaneous $D_{A_0 A_0}(t, R) = \delta(t) V(R)$, where $V(R)$ is the color-Coulomb potential. There is no non-instantaneous part. Our results support the simple physical scenario in which confinement is the result of a linearly rising color-Coulomb potential, $V(R) \sim \sigma R$ at large R.

Primary authors: Prof. ZWANZIGER, Daniel (New York University, New York, NY 10003, USA); Dr COOPER, Patrick (Duquesne University, Pittsburgh PA 15282, USA)

Presenter: Prof. ZWANZIGER, Daniel (New York University, New York, NY 10003, USA)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **68** Type: **Talk**

Knot solitons in an effective model of the SU(3) Yang-Mills theory

Sunday, 5 August 2018 14:20 (20 minutes)

It has been conjectured that glueballs can be described by knot solitons in a low energy effective model of the Yang-Mills theory. In this talk, we consider knot solitons in the F_2 Skyrme-Faddeev-Niemi model, which can be interpreted as a low energy effective model of the $SU(3)$ Yang-Mills theory. It will be shown that the Euler-Lagrange equation reduces to that of the well-known CP^1 Skyrme-Faddeev-Niemi model. We also discuss some relation between the knot solitons and classical gauge vacua.

Primary author: Mr AMARI, Yuki (Tokyo University of Science)

Co-author: Dr SAWADO, Nobuyuki (Tokyo University of Science)

Presenter: Mr AMARI, Yuki (Tokyo University of Science)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **69** Type: **Talk**

Conformal Perturbation description of Deconfinement.

Wednesday, 1 August 2018 16:00 (30 minutes)

Conformal perturbation is a powerful tool to describe the behavior of statistical mechanics models and quantum field theories in the vicinity of a critical point. It was widely used in the past to describe two dimensional models and has been recently extended, thanks to the remarkable results of the bootstrap approach, also to three dimensional models. We show here that it can be also used to describe the behavior of (3+1) lattice gauge theories in the vicinity of a critical point. We discuss as an example the behavior of Polyakov loop correlators in the vicinity of the deconfinement transition of the (3+1) SU(2) Lattice Gauge Theory. We show that the short distance behavior of the correlator (and thus of the interquark potential) is precisely described by conformal perturbation theory and that this result can be used to constrain the effective string description of the theory in the confining phase.

Primary author: CASELLE, Michele (INFN - National Institute for Nuclear Physics)

Presenter: CASELLE, Michele (INFN - National Institute for Nuclear Physics)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **70** Type: **Invited talk**

Baryon masses and σ terms in $\mathrm{SU(3)\ BChPT \times 1/N_c}$

Thursday, 2 August 2018 14:30 (30 minutes)

Chiral perturbation theory (ChPT) and the $1/N_c$ expansion provide systematic frameworks in investigating the strong interactions at low energy. A combined framework of both approaches has been developed and applied for baryons with three light-quark-flavors. The small scale expansion of the combined approach is identified as the ξ-expansion, in which the power counting of $1/N_c$ and chiral expansions are linked as
$calO(p) =$
$calO(1/N_c) =$
$calO(\xi)$. Experimentally observed baryon masses as well as the lattice QCD baryon masses are analyzed to
$calO(\xi^3)$ in the combined framework, with explicit inclution of the decuplet intermediate-baryon states. The connection between the deviation of the Gell-Mann-Okubo relation and the σ term associated with the scalar density $\bar{u}u + \bar{d}d - 2\bar{s}s$ is identified. In particular, the deviation from the mass combination $\hat{m}\frac{\partial}{\partial\hat{m}}m_N = \frac{\hat{m}}{m_s-\hat{m}}\left(m_\Sigma + m_\Xi - 2m_N\right)$ which gives rise to the so called σ-term puzzle is studied in the ξ-expansion. The application of this present framework allows one to identify the large higher order non-analytic inquark masses contributions to that mass combination. The final result on the nucleon $\sigma_{\pi N}$ obtained by combined fits to experimental and lattice QCD baryon masses, will be presented.

Primary authors: Dr FERNANDO, Ishara (Hampton University); Dr GOITY, Jose (Hampton University / Jefferson Lab)

Presenter: Dr FERNANDO, Ishara (Hampton University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **71** Type: **Talk**

Composite operator and condensate in SU(N) Yang-Mills theory with U(N-1) stability group

Thursday, 2 August 2018 16:30 (20 minutes)

To establish the widely accepted dual superconductivity picture for explaining quark confinement, a reformulated version of $SU(N)$ Yang-Mills theory, which is based on the Cho-Faddeev-Niemi decomposition, has been recently developed. However, from a novel viewpoint, this decomposition is merely considered to be a nonlinear change of variables.

Within this framework, we consider a certain dimension-2 composite operator whose condensate would give raise to mass term for the coset degrees of freedom through gluon self-interactions. This would not only indicate the analogue to the "Abelian dominance" within our reformulation, but in the past it has also been shown that such a gluon mass leads to many interesting consequences, e.g., removal of the Nielsen-Olesen instability in the Savvidy vacuum or direct implication of quark confinement at low temperatures.

Our discussion is based on the one-loop analysis of the reformulated Yang-Mills theory, which in particular includes the proof of the multiplicative renormalizability of the composite operator. With these results, the existence of the corresponding condensate is discussed within the so-called Local Composite Operator formalism. The condensate is related to the vacuum expectation value of a scalar auxiliary field via a Hubbard-Stratonovich transformation. From the one-loop effective potential for the auxiliary field it is then shown that the condensate can indeed exist.

Finally, a (preliminary) analysis based on the functional renormalization group will be presented to go beyond the loop calculations, if time permits.

Primary author: Mr WARSCHINKE, Matthias (Chiba University)

Co-authors: KONDO, Kei-Ichi (Chiba University); Mr SHOGO, Nishino (Chiba University); Mr MATSUDO, Ryutaro (Chiba University); Dr SHINOHARA, Toru (Chiba University)

Presenter: Mr WARSCHINKE, Matthias (Chiba University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **72** Type: **Talk**

Model independent searches for new physics via parametric anomaly detection

Thursday, 2 August 2018 17:00 (20 minutes)

The Standard Model is currently the most widely accepted physical theory that classifies all known elementary particles and represents three out of the four fundamental forces in the universe. Despite the confirmation of the model, there is a need for its generalization or for the development of a new theory, able to complete our knowledge of the Universe. For this purpose, High Energy Physics experiments are performed, to detect empirically any possible signal which behaves as a deviation from the background process, representing, in turn, the known physics. Such searches may be conducted in a model-dependent fashion, trying to confirm some particular physical conjecture alternative to the Standard Model. Alternatively, the searches follow a more general model independent approach by being unconstrained to any specific theory already formulated.

In this work, we are interested in finding physical anomalies that collectively deviate from our knowledge of the universe by not taking any specific assumption on the potential signal. Anomaly detection is performed parametrically by fitting mixture of Gaussian densities to model data generated by particle collisions. As the dimensionality of these data is high the standard approach is generalized in order to jointly perform regularization and proper selection of informative variables. We propose a method based on the penalized likelihood approach that puts specific constraints on components covariance matrices and performs dimensionality reduction by shrinkage of the parameters.

Primary authors: Mr KOTKOWSKI, Grzegorz (University of Padova); Dr FINOS, Livio (University of Padova); MENARDI, Giovanna (Department of Statistical Sciences, University of Padua); SCARPA, Bruno (Università di Padova)

Presenter: Mr KOTKOWSKI, Grzegorz (University of Padova)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **73** Type: **Talk**

Big Data Software in High Energy Physics

Thursday, 2 August 2018 17:50 (30 minutes)

For decades, high-energy physics (HEP) had been on the forefront of big data technology, developing techniques to explore and analyze datasets too large for memory that were revolutionary when they appeared in other fields years later. Today, that dominance is ending, and I argue that it's a good thing. The rise of web-scale datasets and high-frequency trading has interested the commercial sector in data analysis, driving the development of professional yet open-source software with a much larger userbase than HEP— software that we do not need to develop or maintain ourselves.

However, using this software in HEP analysis isn't trivial, at least not yet. Some differences in conventions have to be bridged, such as HEP's C++ toolset and the preponderance of Python, R, and Java/Scala in industry. I will show some of this "plumbing" software for Python (PyROOT and uproot) and Java/Scala (Spark-ROOT). But there are also deeper differences in emphasis between the two communities: our nested data model vs. flat data frames, our focus on histograms and basic plotting, and the industry's satisfaction with merely predictive models. After showing illustrative examples and how to use them, I will conclude that we still have work to do, developing some software on our own, but can significantly benefit by working within the conventions of the larger big data community.

Primary author: PIVARSKI, Jim (Princeton University)

Presenter: PIVARSKI, Jim (Princeton University)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **74** Type: **Talk**

Statistics in Particle Physics: Ideals vs Reality

Friday, 3 August 2018 16:30 (30 minutes)

The presentation will provide insight into the treatment of statistical problems by particle physicists, which is commonly driven by practical considerations much more than mathematical reasoning. Common pitfalls and their origin will be discussed using real life (but anonymized) examples, touching on topics such as unfolding and limit setting.

Primary author: MOZER, Matthias Ulrich (KIT - Karlsruhe Institute of Technology (DE))

Presenter: MOZER, Matthias Ulrich (KIT - Karlsruhe Institute of Technology (DE))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **75** Type: **Talk**

Nonequilibrium viscous correction to the phase space density and bulk viscosity in the relaxation time approximation

Friday, 3 August 2018 14:30 (30 minutes)

We present the correct form of the nonequilibrium viscous correction to the phase space density in the relaxation time approximation that properly takes into account the space-time dependence of the thermal mass. We also investigate the impact the correction has on the bulk viscosity. This correction automatically satisfies the Landau matching condition and energy-momentum conservation. It also makes the appearance of the Callan-Symanzyk β_λ-function natural in the bulk viscosity calculation. The bulk viscosity has the expected parametric form for the Boltzmann gas, while for the Bose-Einstein case, it is affected by the cut-off of infrared divergences. This may be an indication that the relaxation time approximation is too crude to obtain the correct form of the bulk viscosity for quantum gases.

Primary author: CZAJKA, Alina (McGill University/Jan Kochanowski University)

Co-authors: HAUKSSON, Sigtryggur (McGill University); Dr SHEN, Chun (Brookhaven National Laboratory); JEON, Sangyong (McGill University); Prof. GALE, Charles (McGill University)

Presenter: CZAJKA, Alina (McGill University/Jan Kochanowski University)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **76** Type: **Talk**

Chiral and $U(1)_A$ restoration: Ward Identities and effective theories

Friday, 3 August 2018 17:00 (20 minutes)

The nature of chiral symmetry restoration and the identification of its correct pattern in terms of $O(4)$ and $U(1)_A$ symmetries are central problems for our present understanding of the QCD phase diagram, currently explored in lattice simulations and heavy-ion collisions. We will present a theoretical analysis based on Ward Identities for the full scalar/pseudoscalar $U(3)$ meson nonets, which sheds light on these issues. Our results lead to interesting conclusions regarding the behaviour of chiral partners in the limit of exact restoration and provide useful input for lattice analysis. In addition, it allows to connect partner degeneration with physical interaction vertices and to understand the temperature dependence of lattice screening masses in terms of quark condensate combinations. We will also describe the realization of these ideas in effective theories. In particular, a $U(3)$ Chiral Perturbation Theory calculation supports the partner and pattern conclusions from the WI analysis. The role of the thermal $f_0(500)$ state to describe the scalar susceptibility will also be analyzed, as well as the information provided by the large number of Goldstone Bosons framework.

Primary authors: Prof. GOMEZ NICOLA, Angel (Universidad Complutense Madrid); Dr RUIZ DE ELVIRA, Jacobo (ITP, University of Bern); Ms VIOQUE-RODRIGUEZ, Andrea (Universidad Complutense Madrid); FERRERES-SOLÉ, Silvia (Lund University)

Presenter: Prof. GOMEZ NICOLA, Angel (Universidad Complutense Madrid)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **77** Type: **Talk**

Holographic Phase Transition in Soft Walls: Gravitational Waves and Collider Signatures

Thursday, 2 August 2018 16:20 (20 minutes)

We study the electroweak phase transition within a 5-dim warped model including a scalar potential with an exponential behavior, and strong back-reaction over the metric, in the infrared. By means of a novel treatment of the superpotential formalism, we explore parameter regions that were previously inaccessible. We find that for large values of the t'Hooft parameter the holographic phase transition occurs, and it can force the Higgs to undergo a first order electroweak phase transition, suitable for electroweak baryogenesis. The model exhibits gravitational waves and colliders signatures. It typically predicts a stochastic gravitational wave background observable both at the Laser Interferometer Space Antenna and at the Einstein Telescope. Moreover the radion tends to be heavy enough such that it evades current constraints, but may show up in future LHC runs. Some relatd references are [1,2,3,4,5]. This work is based on [6].

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[2] L.Randall, G.Servant, JHEP 05 (2007) 054.
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[5] C.Caprini et al. JCAP 1604 (2016) 001.
[6] E.Megias, G.Nardini, M.Quiros, in preparation (2018).

Primary authors: Dr MEGIAS, Eugenio (University of Granada); QUIROS CARCELEN, Mariano (ICREA - Institucio catalana de recerca estudis avancats (ES)); NARDINI, Germano (Universitaet Bern)

Presenter: Dr MEGIAS, Eugenio (University of Granada)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **78** Type: **Poster**

Anomalous transport, massive gravity theories and holographic momentum relaxation

Friday, 3 August 2018 18:10 (1 minute)

Quantum anomalies give rise to new transport phenomena. In particular a magnetic field can induce an anomalous current via the chiral magnetic effect [1] and a vortex in the relativistic fluid can also induce a current via the chiral vortical effect [2]. The related transport coefficients can be calculated via Kubo formulae [3,4,5]. These effects can be studied in holographic models with Chern-Simons couplings dual to anomalies in field theory.

We study a holographic model with translation symmetry breaking based on linear massless scalar field backgrounds. We compute the electric DC conductivity and find that it can vanish for certain values of the translation symmetry breaking couplings. Then we compute the chiral magnetic and chiral vortical conductivities. They are completely independent of the holographic disorder couplings and take the usual values in terms of chemical potential and temperature. To arrive at this result we suggest a new definition of energy-momentum tensor in presence of the gravitational Chern-Simons coupling.

Some related works are [6,7]. This work is based on [8].

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Primary authors: Dr MEGIAS, Eugenio (University of Granada); Mr COPETTI, Christian (Instituto de Fisica Teorica UAM/CSIC); Mr FERNANDEZ-PENDAS, Jorge (Instituto de Fisica Teorica UAM/CSIC); LANDSTEINER, Karl (Unknown)

Presenter: Dr MEGIAS, Eugenio (University of Granada)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **79** Type: **Invited plenary talk**

Dual QCD and Kaon Flavour Physics

Monday, 6 August 2018 09:30 (30 minutes)

After recalling the basis of the Dual QCD (DQCD) and its past successes in Kaon flavour physics within the Standard Model, I will present 2018 results that include the calculation of hadronic matrix elements of four-quark operators for $K^0 - \bar{K}^0$ mixing and $K \to \pi\pi$ decays in arbitrary extension of the Standard Model.
The results for $K^0 - \bar{K}^0$ mixing allow an insight into those from Lattice QCD and imply that the so-called meson evolution in DQCD is crucial for the understanding of lattice data. As no lattice QCD calculations of the hadronic matrix elements of 13 BSM four-quark operators contributing to $K \to \pi\pi$ are available we present the first to date calculation of these matrix elements in DQCD. Implications of these results for the ratio ϵ'/ϵ and its correlation with other Kaon observables are briefly discussed.

Primary author: Prof. BURAS, Andrzej (TUM-IAS)

Presenter: Prof. BURAS, Andrzej (TUM-IAS)

Session Classification: Plenary

Contribution ID: **80** Type: **Invited plenary talk**

SUSY and Confinement

Friday, 3 August 2018 11:00 (30 minutes)

I will review insights into confinement in supersymmetric theories, and discuss some strongly coupled beyond the standard model scenarios.

Primary author: Prof. TERNING, John (UC Davis)

Presenters: Prof. TERNING, John (UC Davis); TERNING, John (UC Davis)

Session Classification: Plenary

Track Classification: G: Strongly Coupled Theories

Contribution ID: **81** Type: **Talk**

Confinement, Instanton-dyons and Monopoles

Wednesday, 1 August 2018 15:00 (30 minutes)

Confinement in QCD vacuum has been explained in terms of monopoles, and chiral symmetry breaking in terms of instantons. At finite temperature the latter get split to instanton-dyons and their semiclassical theory was shown to describe well both
Phase transitions. And yet, their interrelation to monopoles remained unclear.
In this talk it will be explained, in terms of the so called Poisson duality.
Chiral symmetry breaking in terms of monopoles will also be explained.
Finally, a brief review of QGP as
a dual plasma containing as quasiparticles not only quarks and gluons but
also magnetic monopoles, dominating the ensemble near T_c.

Primary author: SHURYAK, Edward

Presenter: SHURYAK, Edward

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **82** Type: **Talk**

¯b ¯bud tetraquark resonances in the Born-Oppenheimer approximation using lattice QCD potentials

Friday, 3 August 2018 14:40 (20 minutes)

We study tetraquark resonances for a pair of static quarks $\bar{b}\bar{b}$ in presence of two light quarks ud based on lattice QCD potentials. The system is treated in the Born-Oppenheimer approximation and we use the emergent wave method. We focus on the isospin $I = 0$ channel but take different angular momenta l of the heavy quarks $\bar{b}\bar{b}$ into account. Further calculations have already predicted a bound state for the $l = 0$ case with quantum numbers $I(J^P) = 0(1^+)$. Performing computations for several angular momenta, we extract the phase shifts and search for T and S matrix poles in the second Riemann sheet. For angular momentum $l = 1$, we predict a tetraquark resonance with quantum numbers $I(J^P) = 0(1^-)$, resonance mass $m = 10576^{+4}_{-4}$ MeV and decay width $\Gamma = 112^{+90}_{-103}$ MeV, which decays into two B mesons.

Primary authors: PETERS, Antje; WAGNER, Marc (Goethe University Frankfurt); CARDOSO, Marco (Instituto Superior Técnico); PFLAUMER, Martin (Goethe Universität Frankfurt); BICUDO, Pedro (IST Lisboa)

Presenter: PFLAUMER, Martin (Goethe Universität Frankfurt)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **83** Type: **Invited plenary talk**

Consequences of neutron star mergers for constraining the QCD equation of state

Wednesday, 1 August 2018 11:30 (30 minutes)

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: REZZOLLA, Luciano (Goethe University Frankfurt)

Presenter: REZZOLLA, Luciano (Goethe University Frankfurt)

Session Classification: Plenary

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **84** Type: **Talk**

Direct CP violation in $K^0 \to \pi\pi$: Standard Model Status

Wednesday, 1 August 2018 14:20 (20 minutes)

In 1988 the NA31 experiment presented the first evidence of direct CP violation in the $K^0 \to \pi\pi$ decay amplitudes. A clear signal with a $7.2\,\sigma$ statistical significance was later established with the full data samples from the NA31, E731, NA48 and KTeV experiments, confirming that CP violation is associated with a $\Delta S = 1$ quark transition, as predicted by the Standard Model. However, the theoretical prediction for the measured ratio ε'/ε has been a subject of strong controversy along the years. We review the current status, discussing in detail the different ingredients that enter into the calculation of this observable and the reasons why seemingly contradictory predictions were obtained in the past by several groups. An update of the Standard Model prediction is presented and the prospects for future improvements are analysed. Taking into account all known short-distance and long-distance contributions, one obtains Re $(\varepsilon'/\varepsilon) = (15 \pm 7) \cdot 10^{-4}$, in good agreement with the experimental measurement.

Primary authors: Mr GISBERT, Hector; Prof. PICH, Antonio

Presenter: Mr GISBERT, Hector

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **85** Type: **Talk**

Soft gluon factorization for quarkonium production

Sunday, 5 August 2018 15:00 (20 minutes)

NRQCD factorization is currently the most widely used theory to describe heavy quarkonium production. Although NRQCD has got lots of successes, it also faces some notable difficulties right now. A possible reason to explain these difficulties is that, because of soft gluons radiation at the hadronization stage, convergence of velocity expansion in NRQCD is too bad. In the soft gluon factorization, we take into account the soft gluon radiation effect and thus expect to have a much better convergence. The soft gluon factorization may provide a better description for heavy quarkonium production.

Primary author: MA, Yan-Qing (PKU)

Presenter: MA, Yan-Qing (PKU)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **86** Type: **Poster**

Evolution of higher moments of multiplicity distribution

Friday, 3 August 2018 18:14 (1 minute)

The evolution of the multiplicity distribution can be described with the help of master equation. At the beginning we look at 3rd and 4th factorial moments and their equilibrium values from which central moments and other ratios can be calculated.
Firstly, we study the master equation for the fixed temperature, because we want to know how fast different moments of the multiplicity distribution
approach their equilibrium value. Then we study the situation in which the temperature of the system decrease.
We found out that in the non-equilibrium state, higher factorial moments differ more from their equilibrium values than the lower moments
and that the behaviour of the combination of the central moments depends on the combination we choose.

Primary author: SOCHOROVÁ, Radka (FNSPE, Czech Technical University Prague, Czech Republic)

Presenter: SOCHOROVÁ, Radka (FNSPE, Czech Technical University Prague, Czech Republic)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **87** Type: **Poster**

Direct Learning of Systematics-Aware Summary Statistics

Friday, 3 August 2018 18:11 (1 minute)

Complex machine learning tools, such as deep neural networks and gradient boosting algorithms, are increasingly being used to construct powerful discriminative features for High Energy Physics analyses. These methods are typically trained with simulated or auxiliary data samples by optimising some classification or regression surrogate objective. The learned feature representations are then used to build a sample-based statistical model to perform inference (e.g. interval estimation or hypothesis testing) over a set of parameters of interest. However, the effectiveness of the mentioned approach can be reduced by the presence of known uncertainties that cause differences between training and experimental data, included in the statistical model via nuisance parameters. This work presents an end-to-end algorithm, which leverages on existing deep learning technologies but directly aims to produce inference-optimal sample-summary statistics. By including the statistical model and a differentiable approximation of the effect of nuisance parameters in the computational graph, loss functions derived form the observed Fisher information are directly optimised by stochastic gradient descent. This new technique leads to summary statistics that are aware of the known uncertainties and maximise the information that can be inferred about the parameters of interest object of a experimental measurement.

Primary author: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Co-author: DORIGO, Tommaso (Universita e INFN, Padova (IT))

Presenter: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Session Classification: Poster

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **88** Type: **Invited talk**

Nuclear structure aspects of nuclear matrix elements in neutrinoless double-beta decay

Sunday, 5 August 2018 17:30 (30 minutes)

Potential detection of non-conserving lepton number processes, such as the neutrinoless double beta decay, constitutes one of the most promising signals of new physics beyond the Standard Model, apart from experiments using high energy collisions. In the neutrinoless double beta decay ($0\nu\beta\beta$) two neutrons are transformed into two protons and only two electrons are emitted in the final state. This is a very encouraging case due to its implications in fundamental physics since it can only occur if neutrinos are massive and Majorana particles (neutrinos and antineutrinos are identical particles). Additionally, the inverse of the half-life of this process is proportional to the neutrino effective mass. Therefore, an eventual detection of this decay mode would determine the absolute scale of the mass of these elementary particles. However, if the half-life of a given double-beta emitter is experimentally measured, the absolute scale of the neutrino mass can be only determined if the so-called nuclear matrix element (NME), that connects initial and final nuclear states, is accurately known. However, current $0\nu\beta\beta$ NMEs calculations differ by a factor of three approximately, depending on the nuclear model.
In this contribution I will give an overview of the current status and future perspectives for nuclear matrix elements calculations performed with one of the most promising theoretical methods to compute $0\nu\beta\beta$ NMEs, namely, the energy density functional method.

Primary author: Dr RODRÍGUEZ, Tomás R. (Universidad Autónoma de Madrid)

Presenter: Dr RODRÍGUEZ, Tomás R. (Universidad Autónoma de Madrid)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **89** Type: **Talk**

Azimuthal momentum anisotropies in proton-proton collisions and other small systems

Friday, 3 August 2018 14:00 (30 minutes)

I will review recent developments in the theoretical description and understanding of multi-particle correlations in collisions of small projectiles (p/d/3He) with heavy nuclei (Au, Pb), as well as in proton+proton collisions. A main question is, whether the physical processes responsible for the observed long range rapidity correlations and their azimuthal structure are the same in small systems as in heavy ion collisions. In the latter, they are interpreted as generated by the initial spatial geometry being transformed into momentum correlations by strong final state interactions. However, explicit calculations show that also initial state momentum correlations are present and should contribute to observables in small systems. This talk provides a pedagogical survey of the various sources of momentum anisotropies and discusses their relative contributions to observables.

Primary author: SCHENKE, Bjoern (Brookhaven National Lab)

Presenter: SCHENKE, Bjoern (Brookhaven National Lab)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **91** Type: **Invited talk**

Recent results on strangeness production at the LHC with ALICE

Sunday, 5 August 2018 16:40 (30 minutes)

The main goal of the ALICE experiment at the LHC is to study the strongly-interacting hot and-dense matter created in ultra-relativistic heavy-ion collisions. In this context, the measurement of strangeness production is one of the most powerful tools to investigate the thermal properties of the deconfined state of QCD matter known as Quark-Gluon Plasma (QGP). Smaller collision systems, such as proton-proton and proton-nucleus, provide reference samples for nucleus-nucleus interactions and allow the unveiling of features attributed to the formation of the QGP.
In this contribution, a systematic set of measurements on strangeness production in Pb-Pb (2.76 and 5.02 TeV), Xe-Xe (5.44 TeV), p-Pb (5.02 TeV) and pp (7 and 13 TeV) collisions will be presented. The relative production rates of strange and multi-strange particles to pions are observed to smoothly increase as a function of event multiplicity in pp and p-Pb, reaching values measured in heavy-ion collisions. Even more remarkably, they are also consistent for different systems and energies at any given multiplicity. In addition, results on baryon to meson ratios in different collision systems, useful to probe particle production mechanisms, will be reported.
The intriguing similarities observed across different collision systems provide a greater insight into observables associated to QGP formation. A rather complete experimental picture allows comparisons with phenomenological model calculations and predictions from QCD-inspired event generators.

Primary authors: ELIA, Domenico (INFN Bari); ALICE COLLABORATION, CERN LHC

Presenter: ELIA, Domenico (INFN Bari)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **92** Type: **Talk**

On nonequilibrium quarkonium evolution in the QGP fireball

Sunday, 5 August 2018 15:00 (20 minutes)

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.

Primary authors: VAIRO, Antonio; BRAMBILLA, Nora; VANDER GRIEND, Peter (University of Washington); ZHU, Yan (University of Jyvaskyla)

Presenter: ZHU, Yan (University of Jyvaskyla)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **93** Type: **Talk**

Structure of hybrid static potential flux tubes in Lattice Yang-Mills-theory

Thursday, 2 August 2018 17:50 (30 minutes)

We report about an ongoing lattice field theory project concerned with static hybrid mesons. In particular we study the structure of hybrid static potential flux tubes in Lattice Yang-Mills-theory by computing the square of the chromoelectric and chromomagnetic field strength components for several hybrid static potential quantum numbers. We find clear indications that the gluonic distribution is different compared to the ordinary static potential and present corresponding results.

Primary authors: MÜLLER, Lasse (ITP, Universität Frankfurt); WAGNER, Marc (Goethe University Frankfurt); PHILIPSEN, Owe (Goethe-University Frankfurt); Mr REISINGER, Christian (Goethe University Frankfurt)

Presenter: MÜLLER, Lasse (ITP, Universität Frankfurt)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **94** Type: **Invited talk**

Transport coefficients of leptons in superconducting neutron star cores

Wednesday, 1 August 2018 16:40 (20 minutes)

I consider the thermal conductivity and shear viscosity of leptons (electrons and muons) in the nucleon NS cores where protons are in the superconducting state. Charged lepton collision frequencies are mainly determined by the transverse plasmon exchange and are mediated by the character of the transverse plasma screening. In superconducting neutron star core protons give the dominant contribution to the screening. In the previous works [Shternin & Yakovlev, Phys. Rev. D **75** 103004 (2007); **78** 063006 (2008)] the superconducting proton contribution to the transverse screening was considered in the Pippard limit $\Delta \ll \hbar q v_{\mathrm{F}p}$, where Δ is the proton pairing gap, $v_{\mathrm{F}p}$ is the proton Fermi velocity, and $\hbar q$ is the typical transferred momentum in collisions. However, for large critical temperatures (large Δ) and relatively small densities (small q) the Pippard limit may become invalid. Here I revisit these calculations in the limit of not too high temperatures $T < 0.35 T_{cp}$, where T_{cp} is the critical temperature of the proton pairing and show [1] that the older calculations severely underestimated the screening in a certain range of the parameters appropriate to the NS cores. As a consequence, the values of the kinetic coefficients at $T \ll T_{cp}$ are found to be smaller than in previous calculations.

[1] P.S. Shternin, 2018, arXiv:1805.06000

Primary author: SHTERNIN, Petr

Presenter: SHTERNIN, Petr

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **95** Type: **Talk**

Application of new anomaly to QCD vacua

Friday, 3 August 2018 16:20 (20 minutes)

Recent developments of anomaly matching allows us to study the new nonperturbative aspects of various gauge theories. In this talk, I will show that there is a new 't Hooft anomaly for QCD with massless quarks containing the two-form gauge fields. This will give new constraints on the possible chiral symmetry breakings, and I will revisit the Stern phase (chiral symmetry broken phase without quark bilinear condensate) from this viewpoint.

Primary author: Dr TANIZAKI, Yuya (RIKEN BNL)

Presenter: Dr TANIZAKI, Yuya (RIKEN BNL)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **96** Type: **Talk**

4d ensembles of percolating center vortices and chains

Sunday, 5 August 2018 14:00 (20 minutes)

Ensembles of magnetic defects successfully explain many properties of confinement and are strongly believed to capture the (infrared) YM path-integral measure. In this work, we motivate and propose a measure to compute center element averages where vortices and chains (with non-Abelian d.o.f. and monopole fusion) are differentiated. When center vortices percolate and monopoles condense, using Julia-Toulouse and related ideas, we suggest that the average is captured by a saddle point and collective modes in a YMH model. In this manner, flux tubes with N-ality and Lüscher terms are accommodated in an ensemble picture.

Primary author: Prof. OXMAN, Luis E. (Fluminense Federal University)

Presenter: Prof. OXMAN, Luis E. (Fluminense Federal University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **97** Type: **Invited talk**

Merger of two compact stars within the two-families scenario

Wednesday, 1 August 2018 14:20 (20 minutes)

I will discuss how the process of merger of two compact stars is described within the two-families scenario. In that scenario hadronic stars made of nucleons, of delta resonances and of hyperons can co-exist with strange quark stars made (almost) entirely of deconfined quarks. I will discuss the event of August 2017 at the light of that scheme, concluding that it was associated with the merger of a hadronic star with a strange quark star.

1) Merger of two neutron stars: predictions from the two-families scenario.
A.Drago, G.Pagliara; Astrophys.J. 852 (2018) no.2, L32
2) The merger of two compact stars: a tool for dense matter nuclear physics. A.Drago, G.Pagliara, S.B.Popov, S.Traversi, G.Wiktorowicz; Universe 4 (2018) no.3, 50
3) Has deconfined quark matter been detected during GW170817/AT2017gfo?
G.F.Burgio, A.Drago, G.Pagliara, H.J.Schulze, J.B.Wei; arXiv: 1803.09696, accepted by Astrophys.J.

Primary author: DRAGO, Alessandro

Presenter: DRAGO, Alessandro

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **98** Type: **Talk**

Dynamical spin effects in the pseudoscalar meson octet within holographic light-front QCD

Friday, 3 August 2018 15:00 (20 minutes)

We quantify the importance of dynamical spin effects in the holographic light-front wavefunctions of the pion, kaon, η and η′. Using a universal AdS/QCD scale and constituent quark masses, we find that such effects are maximal in the pion where they lead to an excellent simultaneous description of a wide range of data: the decay constant, charge radius, spacelike EM and transition form factors, as well as, after QCD evolution, both the Parton Distribution Function (PDF) and the Parton Distribution Amplitude (PDA) data from Fermilab. These dynamical spin effects lead up to a 30% chance of finding the valence quark and antiquark with aligned spins in the pion. The situation is very different for the kaon, where a simultaneous description of the available data (decay constant, radius and spacelike EM form factor) prefer no dynamical spin effects at all. The situation is less clear for the η and η′: while their radiative decay widths data are consistent with dynamical spin effects only in η′, the data on their spacelike transition form factors clearly favour maximal dynamical spin effects in both mesons.

Primary authors: Dr SANDAPEN, Ruben (Acadia University); AHMADY, Mohammad (Mount Allison University); MONDAL, Chandan (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: Dr SANDAPEN, Ruben (Acadia University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **99** Type: **Invited talk**

Influence of quark masses and strangeness degrees of freedom on inhomogeneous chiral phases

Friday, 3 August 2018 14:20 (20 minutes)

In most studies of the QCD phase structure at nonzero temperature and density it is assumed that the chiral condensate is constant in space. Allowing for spatially modulated condensates on the other hand, it was found in various model calculations that in certain regions of the phase diagram such inhomogeneous condensates are favored over homogeneous ones. For instance it was shown that in a standard NJL model the would-be first-order phase boundary between the homogeneous chirally broken and restored phases is entirely covered by an inhomogeneous phase which ends exactly at the chiral critical point. In this talk we will discuss how this result is altered by model variations, like vector interactions, nonzero quark masses and strange quarks. In particular we will investigate whether by variation of external parameters the inhomogeneous phase can be moved closer to the temperature axis, making it potentially accessible to lattice QCD simulations.

Primary author: BUBALLA, Michael (TU Darmstadt)

Presenter: BUBALLA, Michael (TU Darmstadt)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **100** Type: **Talk**

Matching the non-equilibrium initial stage of heavy ion collisions to hydrodynamics with QCD kinetic theory

Wednesday, 1 August 2018 16:30 (30 minutes)

In the collision of nuclei at high energies the produced matter reinteracts and form a plasma which ultimately equilibrates and exhibits collective hydrodynamic flow. While a general theory of the equilibration process has been outlined previously, there were no practical frameworks to smoothly connect the early gluon production in classical field simulations with hydrodynamic simulations of the late time plasma expansion. We provide this practical tool (called KøMPøST) by constructing a set of non-equilibrium Green functions calculated in QCD kinetic theory. We demonstrate with a realistic simulation of a heavy ion collisions the smooth transition from the classical fields to hydrodynamics, and calculate the pragmatic lower bound for the time when hydrodynamics becomes applicable.

References:

1. A. Kurkela, A. Mazeliauskas, J.F. Paquet, S. Schlichting and D. Teaney, "Matching the non-equilibrium initial stage of heavy ion collisions to hydrodynamics with QCD kinetic theory," arXiv:1805.01604 [hep-ph].
2. A. Kurkela, A. Mazeliauskas, J.F. Paquet, S. Schlichting and D. Teaney, "Effective kinetic description of event-by-event pre-equilibrium dynamics in high-energy heavy-ion collisions," arXiv:1805.00961 [hep-ph]

Primary authors: MAZELIAUSKAS, Aleksas (Universität Heidelberg); TEANEY, Derek (Stony Brook University); KURKELA, Eero Aleksi (CERN); SCHLICHTING, Soeren (University of Washington); PAQUET, Jean-Francois (Duke University)

Presenter: MAZELIAUSKAS, Aleksas (Universität Heidelberg)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **101** Type: **Talk**

Transport and dissipation in neutron star mergers

Wednesday, 1 August 2018 16:20 (20 minutes)

Neutron star mergers provide a great opportunity to gather multi-messenger observational information about nuclear matter at high density and moderate temperature. Numerical simulations of mergers are an essential tool for exploiting this opportunity. However, up to now such simulations have generally not included the effects of transport or dissipation, and have focused on measuring the equation of state.
In this talk I will describe rough estimates of the likely role of transport phenomena like thermal diffusion, shear viscosity, and bulk viscosity. The conclusion is that the impact of transport is sensitive to the type of matter occurring in the merger (whether it traps neutrinos, allows direct Urca processes, etc). This opens up the possibility that observations of mergers could provide information about dense matter that goes beyond the equation of state, maybe even telling us about the presence of exotic phases.

Primary authors: ALFORD, Mark (Washington University, St Louis); BOVARD, Luke; HANAUSKE, Matthias; REZZOLLA, Luciano (Goethe University Frankfurt); SCHWENZER, Kai (Washington University)

Presenter: ALFORD, Mark (Washington University, St Louis)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **102** Type: **Talk**

The density of state approach to the sign problem

Thursday, 2 August 2018 14:00 (30 minutes)

Approaches to the sign problem based on the density of states have been recently revived by the introduction of the LLR algorithm, which allows us to compute the density of states itself with exponential error reduction. In this work, after a review of the generalities of the method, we show recent results for the Bose gas in four dimensions, focussing on the identification of possible systematic errors and on methods of controlling the bias they can introduce in the calculation.

Primary author: LUCINI, Biagio (Swansea University)

Co-authors: Mr FRANCESCONI, Olmo (Swansea University); Dr HOLZMANN, Markus; RAGO, Antonio (University of Plymouth (GB))

Presenter: LUCINI, Biagio (Swansea University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **103** Type: **Talk**

Pseudosignificances as figures of merit: a systematic study and Bayesian solutions

Wednesday, 1 August 2018 14:40 (30 minutes)

Optimization problems in HEP often involve maximizing a measure of how sensitive is a given analysis to an hypothesis with respect to another hypothesis; the latter is referred to as "null" hypothesis and in a frequentist framework is tested against the former, which is referred to as "alternative" hypothesis.

In most cases, it is desirable to fully compute the expected frequentist significance, accounting for all sources of systematic uncertainty and interpreting the result as the real sensitivity of the analysis to the effect sought.
Sometimes, however, either computational or conceptual reasons can favour the use of different or approximate figures of merit, often collectively called "pseudosignificances", which exhibit different properties depending on the relationship between the hypotheses being tested.

This work will review the most common definitions of sensitivity (pseudosignificances), and compare them with the fully frequentist significances computed in toy analyses spanning a spectrum of typical HEP use cases. A connection will be made with the concept of Bayes Factor, and evidence values from Bayesian significance tests will be studied and evaluated in the same toy cases, attempting to build an improved approximate condition-aspecific figure of merit. Finally, Bayesian solutions to the on-off problem, well known in astrophysics, will be transported to the typical HEP cases.

Primary author: Dr VISCHIA, Pietro (Universidad de Oviedo (ES))

Presenter: Dr VISCHIA, Pietro (Universidad de Oviedo (ES))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **104** Type: **Talk**

Study of deconfined quark matter at zero temperature and high density

Sunday, 5 August 2018 17:10 (20 minutes)

We present the recent results on the confinement/deconfinement transition in lattice SU(2) QCD with two flavors of quarks at finite quark density and zero temperature. In the region μ_q ~ 1000 MeV we observe the confinement/deconfinement transition which manifests itself in rising of the Polyakov loop and vanishing of the string tension σ. After the deconfinement is achieved at μ_q > 1000 MeV we observe a monotonous decrease of the spatial string tension σ_s which ends up with σ_s vanishing at μ_q > 2000 MeV. To study the properties of cold dense quark medium we measure the dependence of chiral and diquark condensates, quark density, topological susceptibility, color singlet and triplet free energies and other physical quantities on the chemical potential.

Primary authors: Mr NIKOLAEV, Aleksandr (Far Eastern Federal University); MOLOCHKOV, Alexander (Far Eastern Federal University); KOTOV, Andrey; ILGENFRITZ, Ernst-Michael (Joint Institute for Nuclear Research Dubna, Russia); ASTRAKHANTSEV, Nikita; BRAGUTA, Victor (ITEP); BORNYAKOV, Vitaly (IHEP)

Presenter: Mr NIKOLAEV, Aleksandr (Far Eastern Federal University)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **105** Type: **Talk**

On the existence of heavy-light tetraquarks

Friday, 3 August 2018 15:00 (20 minutes)

We present energy spectra of various tetraquark states with one or more heavy quarks using lattice quantum chromodynamics. These calculations are performed on $N_f = 2+1+1$ MILC ensembles at lattice spacings ~ 0.12, 0.09 and 0.06 fm. A relativistic action with overlap fermions is employed for the light and charm quarks while a non-relativistic action with non-perturbatively improved coefficients is used for bottom quarks. Our results provide a clear indication of the presence of energy levels below the relevant thresholds of different tetraquark states. While in double charm sector we find very shallow bound levels, our results suggest deeply bound energy levels with double bottom tetraquarks.

Primary author: Prof. MATHUR, Nilmani (Tata Institute of Fundamental Research)

Co-authors: Dr PADMANATH, M (University of Regensburg); Dr JUNNARKAR, Parikshit (Tata Institute of Fundamental Research)

Presenter: Prof. MATHUR, Nilmani (Tata Institute of Fundamental Research)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **106** Type: **Invited talk**

Euclidean versus Minkowski short distance

Sunday, 5 August 2018 14:30 (30 minutes)

In this talk I shall reexamine the possibility of extracting parton distribution functions from lattice simulations. I discuss the case of quasi-parton distribution functions, the more recent proposal of directly trying to compute the current-current T-product on the lattice and the possibility of making reference to the reduced Ioffe-time distribution. I show that the process of renormalization hindered by lattice momenta limitation represent an obstruction to a direct Euclidean calculation of the parton distribution function.

Primary authors: Prof. ROSSI, Giancarlo (University of Roma Tor Vergata); Prof. TESTA, Massimo (University of Roma La Sapienza)

Presenter: Prof. ROSSI, Giancarlo (University of Roma Tor Vergata)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **107** Type: **Talk**

Hadron gas with repulsive mean field

Friday, 3 August 2018 16:00 (30 minutes)

We study the thermodynamics of hadronic matter using the hadron resonance gas model where the repulsive interactions between baryons are modeled using the mean field approach.

We have shown [1] that repulsive interactions are especially important when considering the higher order fluctuations. We now extend the treatment of [1] to cover not only ground state baryons but heavier resonances too, include the resonance states predicted by lattice calculations and relativistic quark models. We evaluate both the equation of state and the higher order fluctuations and correlations of baryon number and strangeness, and compare the results with the most recent lattice results. After fixing the magnitude of nucleon-nucleon repulsion from the nucleon-nucleon scattering phase shift, we study how different repulsion between ground state baryons and resonances on one hand, and between strange and non-strange baryons on the other, affect the EoS and fluctuations.

[1] Huovinen and Petreczky, Phys.Lett. B777, 125, (2018)

Primary author: HUOVINEN, Pasi (University of Wroclaw)

Co-author: PETRECZKY, Peter (BNL)

Presenter: HUOVINEN, Pasi (University of Wroclaw)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **108** Type: **Talk**

Equation of state in 2 + 1 flavor QCD at high temperatures

Wednesday, 1 August 2018 14:30 (30 minutes)

We calculate the equation of state at high temperatures in 2+1 flavor QCD using the highly improved staggered quark (HISQ) action. We study the lattice spacing dependence of the pressure at high temperatures using lattices with temporal extent \(N_\tau= 6,\ 8,\ 10\) and \(12\) and perform continuum extrapolations.
We also give a continuum estimate for the equation of state up to temperatures \(T = 2\) GeV, which are then compared with results of the weak-coupling calculations. We find a reasonably good agreement with the weak-coupling calculations at the highest temperatures.

Primary authors: Dr WEBER, Johannes Heinrich (Michigan State University); PETRECZKY, Peter (BNL); BAZAVOV, Alexei (Michigan State University)

Presenter: Dr WEBER, Johannes Heinrich (Michigan State University)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **109** Type: **Invited plenary talk**

Exploring non-abelian gauge theory with energy-momentum tensor; stress, thermodynamics and correlations

Saturday, 4 August 2018 09:30 (30 minutes)

We perform various lattice simulations with the energy-momentum tensor in SU(3) Yang-Mills theory. The energy-momentum tensor defined on the basis of the Yang-Mills gradient flow is used in these analyses. We explore the spatial distribution of the stress tensor in quark-anti-quark system and thermodynamic quantities at nonzero temperature, as well as the correlation functions. Extensions of the analysis to other new observables and full-QCD simulation will also be discussed.

Primary authors: KITAZAWA, Masakiyo (Osaka University); Prof. ASAKAWA, Masayuki (Osaka University); HATSUDA, Tetsuo (RIKEN); IRITANI, Takumi (KEK); Dr YANAGIHARA, Ryosuke (Osaka University)

Presenter: KITAZAWA, Masakiyo (Osaka University)

Session Classification: Plenary

Contribution ID: **110** Type: **Talk**

Towards understanding the ϕ meson in nuclear matter with finite momentum

Sunday, 5 August 2018 16:30 (20 minutes)

The behavior of the ϕ meson in nuclear matter has attracted renewed interest because of (recent and future) experiments that aim to study the ϕ meson properties in nuclei [1-3]. Theoretically, many works have however been conducted for the ϕ meson at rest with respect to the nuclear medium [4-5]. In this presentation, I will review recent theoretical progress about the behavior of the ϕ meson in nuclear matter [6] and, in particular, discuss the effect of finite momentum to these results. Non-zero momentum effects will be especially relevant for future experiments, such as E16 at J-PARC, where the ϕ meson will normally not be measured at rest with respect to the surrounding nucleus.

[1] R. Muto et al., Phys. Rev. Lett. 98, 042501 (2007).
[2] A. Polyanskiy et al., Phys. Lett. B 695, 74 (2011).
[3] K. Aoki (J-PARC E16 Collaboration), arXiv:1502.00703 [nucl-ex].
[4] P. Gubler and K. Ohtani, Phys. Rev. D 90, 094002 (2014).
[5] P. Gubler and W. Weise, Phys. Lett. B 751, 396 (2015).
[6] H.J. Kim, P. Gubler and S.H. Lee, Phys. Lett. B 772, 194 (2017).

Primary author: Dr GUBLER, Philipp (JAEA)

Presenter: Dr GUBLER, Philipp (JAEA)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **111** Type: **Talk**

Dynamics and flavor symmetry realizations in chiral QCD

Wednesday, 1 August 2018 16:30 (30 minutes)

We discuss the dynamics and phases of a large class of chiral varieties of QCD. We find that the requirement of the correct realization of chiral symmetries in the infrared is sometimes so strong that it virtually determines the dynamics and phase of the system. In the models considered no gauge-invariant bi-fermion condensates exist, and yet in most cases the assumption of confinement and unbroken flavor symmetries leads to a conflict with the anomaly matching requirement. Partial color-flavor locking and dynamical Abelianization emerge as possible mechanisms governing the dynamics of these systems. Possible implications to the real-world theory of fundamental interactions are discussed.

Primary author: KONISHI, Kenichi (University of Pisa, INFN, Pisa)

Presenter: KONISHI, Kenichi (University of Pisa, INFN, Pisa)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **112** Type: **Talk**

Spontaneous Symmetry Breaking in the U(2) Planar Thirring Model?

Thursday, 2 August 2018 15:30 (30 minutes)

Whether the U(2N) symmetry of Dirac fermions in 2+1 space-time dimensions is spontaneously broken by pair condensation once interactions are present is an important problem in non-perturbative quantum field theory. Here I focus on the Thirring model, whose interaction is a current-current contact term, using numerical simulations of a lattice model formulated with domain wall fermions - it has been demonstrated that U(2N) symmetry is recovered in the limit of infinite wall separation. I present results obtained with flavor numbers N=0, 1 and 2, and will attempt to put both upper and lower bounds on N_c, the critical number of flavors above which symmetry breaking does not occur even for arbitrarily strong coupling. The resulting N_c will be shown to be very far from the value $N_c \approx 6.6$ obtained with staggered lattice fermions, which not observe U(2N) symmetry.

Primary author: Prof. HANDS, Simon (Swansea University)

Presenter: Prof. HANDS, Simon (Swansea University)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **113** Type: **Talk**

Bayesian unfolding of charged particle p_T spectra with ALICE at the LHC

Wednesday, 1 August 2018 14:20 (20 minutes)

The study of the Quark-Gluon Plasma created in ultrarelativistic heavy-ion collisions at the CERN-LHC is complemented by reference measurements in proton-lead (p–Pb) and proton-proton (pp) collisions, where the effects of multiple-parton interactions and hadronization beyond independent string fragmentation can be investigated.
In this talk, we present a Bayesian unfolding procedure to reconstruct the correlation between transverse momentum (p_T) spectra of charged particles and the corresponding charged particle multiplicities N_ch.
The unfolded spectra are presented in single multiplicity (ΔN_ch = 1) bins and are used to derive moments of the p_T distributions.
We illustrate the unfolding procedure of the p_T spectra with MC simulations for pp collisions and compare the resulting $\langle p_\mathrm{T} \rangle$ of different systems (pp, p–Pb, Pb–Pb) and collision energies.

Primary author: KRUGER, Mario (Johann-Wolfgang-Goethe Univ. (DE))

Presenter: KRUGER, Mario (Johann-Wolfgang-Goethe Univ. (DE))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **114** Type: **Invited talk**

Hadron spectroscopy with photons at CLAS and CLAS12

Wednesday, 1 August 2018 16:30 (30 minutes)

Hadron spectroscopy is a well known powerful tool to study the properties of confinement and the nature of strong interactions. Electro- and photoproduction reactions were never extensively exploited in the past due to the lack of beams of sufficient intensity and momentum resolution. However, a new generation of experiments started recently their operations at Jefferson Lab, exploiting the unprecedented features of the new 12 GeV CEBAF electron machine, and will be soon provide new precise and abundant data on the production of light mesons and baryons (which could also exhibit "exotic" quantum numbers, that can in principle be excited more easily with a spin 1 probe).
A part of the scientific program of one of the main experiments operating at JLAB, CLAS12, is indeed dedicated to meson and baryon spectroscopy studies in reactions induced by photons with very low virtualities. CLAS12 extends the hadron spectroscopy program already initiated with the previous CLAS experiment, which was based on the study of reactions induced by real photons.
In this talk a description of the CLAS12 hadron spectroscopy program will be reported, together with a review of some selected results from CLAS and a discussion of future plans.

Primary author: Dr FILIPPI, Alessandra (INFN Torino)

Presenter: Dr FILIPPI, Alessandra (INFN Torino)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **115** Type: **Invited talk**

New results on distribution amplitudes from lattice QCD

Wednesday, 1 August 2018 14:00 (30 minutes)

Light cone distribution amplitudes are needed in the theoretical description of exclusive processes. I will summarize results on their first Gegenbauer moments obtained by recent lattice simulations and comment on attempts to directly compute them in coordinate space.

Primary author: Prof. BALI, Gunnar (Universität Regensburg)

Presenter: Prof. BALI, Gunnar (Universität Regensburg)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **116** Type: **Invited talk**

Heavy Quarkonium with next-to-next-to-next-to leading logarithmic accuaracy

Thursday, 2 August 2018 15:00 (20 minutes)

I review the status of the resummation of large logarithms in the spectrum of heavy quarkonium. The seaked precision is NNNLL. Special emphasis is put in P-wave states for which complete results to this order are presented.

Primary author: PINEDA, Antonio (UAB & IFAE)

Presenter: PINEDA, Antonio (UAB & IFAE)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **117** Type: **Poster**

Energy-dependent hotspots model via vector meson photoproduction

Friday, 3 August 2018 18:09 (1 minute)

We present a model for the QCD structure of hadrons as seen in the dipole picture. The model is based on hot spots – regions of large gluonic density – populating the impact parameter space. In our model, the number of hot spots grows with energy and their positions fluctuate event-by-event.

Using this model, we calculate coherent and incoherent photoproduction of vector mesons off a proton and nuclear targets. We compare our predictions with current data from HERA, RHIC and the LHC at different energies. We also present new signatures of saturation effects that could be observed with current and future data.

Primary author: Dr KRELINA, Michal (Universidad Técnica Federico Santa María)

Co-authors: CONTRERAS NUNO, Jesus Guillermo (Czech Technical University (CZ)); CEPILA, Jan (Czech Technical University (CZ)); Prof. TAPIA TAKAKI, Daniel (University of Kansas)

Presenter: Dr KRELINA, Michal (Universidad Técnica Federico Santa María)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **118** Type: **Talk**

Hamiltonian approach to QCD in Coulomb gauge at finite temperatures

Friday, 3 August 2018 14:00 (30 minutes)

I will review recent results obtained within the Hamiltonian approach to QCD in Coulomb gauge. The focus will be on the quark sector at finite temperatures. The temperature is introduced by compactifying a spatial dimension. The quark gap equation is solved numerically at finite temperatures. I will also report on preliminary studies of the effective potential of the Polyakov loop at 2-loop level.

Primary author: REINHARDT, Hugo (Universität Tübingen)

Presenter: REINHARDT, Hugo (Universität Tübingen)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **119** Type: **Invited plenary talk**

Atmospheric charm, QCD and neutrino astronomy

Friday, 3 August 2018 09:00 (30 minutes)

We present predictions for the prompt-neutrino flux arising from the decay of charmed mesons and baryons produced by the interactions of high-energy cosmic rays in the Earth's atmosphere, making use of a QCD approach on the basis of the general-mass variable-flavor-number scheme for the description of charm hadroproduction at NLO, complemented by a consistent set of fragmentation functions. We compare the theoretical results to those already obtained by our and other groups with different theoretical approaches. We provide comparisons with the experimental results obtained by the IceCube Collaboration in two different analyses and we discuss the implications for parton distribution functions.

Primary author: Prof. KNIEHL, Bernd (II. Inst. f. Theor. Phys., Univ. Hamburg)

Presenter: Prof. KNIEHL, Bernd (II. Inst. f. Theor. Phys., Univ. Hamburg)

Session Classification: Plenary

Contribution ID: **120** Type: **Talk**

Making Sense of Divergent Series: Resummation of Logarithms in the Nonrelativistic Expansions of Light-Cone Amplitudes

Sunday, 5 August 2018 15:20 (20 minutes)

Logarithms of the hard-scattering scale that appear in light-cone amplitudes can be resummed by making use of the Efremov-Radyushkin-Brodsky-Lepage (ERBL) evolution equation for the light-cone distribution amplitude (LCDA). The standard method for carrying out the evolution is to decompose the LCDA in a series of eigenfunctions of the lowest-order evolution kernel (Gegenbauer polynomials). When the LCDA is expressed as a nonrelativistic expansion, as in applications to heavy quarkonia, the eigenfunction series can become divergent because the unevolved LCDA contains generalized functions, such as the Dirac delta-function and its derivatives. We show that the divergent eigenfunction series can be regulated in a way that is consistent with the definition of the generalized functions by making use of Abel summation and that the regularization can be made computationally efficient through the use of Pade approximants. We present results from the application of our method to the calculation of the rates for Z-boson decays to a vector quarkonium plus a photon.

Primary authors: Dr BODWIN, Geoffrey (Argonne National Laboratory); Dr CHUNG, Hee Sok (TUM); Mr EE, June-Haak (Korea Univ.); Prof. LEE, Jungil (Korea Univ.)

Presenter: Dr BODWIN, Geoffrey (Argonne National Laboratory)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **121** Type: **Invited plenary talk**

Review of quarkonium production: status and prospects

Sunday, 5 August 2018 12:00 (30 minutes)

Production cross sections of heavy quarkonia are considered as useful tools to study various aspects of QCD. Unfortunately, the mechanism of quarkonium production itself remains elusive to this day. Even analyses based on the same formalism can lead to different descriptions of the production process and give contradicting predictions of processes involving heavy quarkonia. In this talk, we review the current status of theoretical approaches and discuss possible strategies that may improve our understanding of heavy quarkonium production.

Primary authors: CHUNG, Hee Sok (Technische Universität Muenchen (DE)); BODWIN, Geoffrey (Argonne National Laboratory); LEE, Jungil (Korea University); KIM, U-Rae (Korea University)

Presenter: CHUNG, Hee Sok (Technische Universität Muenchen (DE))

Session Classification: Plenary

Track Classification: C: Heavy quarks

Contribution ID: **122** Type: **Talk**

Temperature dependence of η/s: uncertainties from the equation of state

Friday, 3 August 2018 15:00 (20 minutes)

Recent advancements in multi-parameter model-to-data comparison have provided notable constraints on the temperature dependence of the shear viscosity over entropy density ratio η/s in the matter produced in the Pb+Pb collisions at the LHC. The results of the Bayesian analysis with a flexible initial state parametrization [1,2] support a linear temperature dependence of η/s found in the earlier study using the EKRT pQCD + saturation + hydrodynamics model [3]. However, it remains unexplored how much the choice of the equation of state affects the final outcome of the global analysis.

We perform a global model-to-data comparison on Au+Au and Pb+Pb collisions at $\sqrt{s_{NN}} = 200$ GeV, 2.76 TeV and 5.02 TeV, using a hydrodynamics model with the EKRT initial state, and the same parametric form for $\eta/s(T)$ as in Ref. [3]. To quantify the amount of uncertainty incorporated in the choice of EoS, we compare analysis results based on three different equations of state: the well known s95p parametrisation [4], an updated parametrisation based on the same list of particles, but recent lattice results [5] for the partonic EoS, and an updated parametrisation based on the Particle Data Group 2016 particle list and the recent lattice results.

References:
[1] Bernhard et al., Phys. Rev. C 94, 024907 (2016), arxiv:1605.03954
[2] Bass et al., Nucl.Phys. A 967, 67 (2017), arXiv:1704.07671
[3] Niemi et al., Phys. Rev. C 93, 024907 (2016), arxiv:1505.02677
[4] Huovinen and Petreczky, Nucl. Phys. A 837, 26 (2010), arXiv:0912.2541
[5] Bazavov et al., arXiv:1710.05024 and
Bazavov et al., Phys. Rev. D 90, 094503 (2014), arXiv:1407.6387 and
Borsanyi et al., Phys. Lett. B 730, 99 (2014), arXiv:1309.5258

Primary authors: AUVINEN, Jussi (Institute of Physics Belgrade); ESKOLA, Kari J. (University of Jyvaskyla); HUOVINEN, Pasi (University of Wroclaw); NIEMI, Harri (Johann Wolfgang Goethe-Universität); Dr PAATELAINEN, Risto (University of Santiago de Compostela); PETRECZKY, Peter (BNL)

Presenter: AUVINEN, Jussi (Institute of Physics Belgrade)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **124** Type: **Talk**

Localisation, chiral symmetry and confinement in QCD and related theories

Thursday, 2 August 2018 16:50 (30 minutes)

I discuss recent results on the relation between the localisation of low-lying Dirac eigenmodes, the restoration of chiral symmetry, and deconfinement in QCD and QCD-like models, providing evidence of a close connection between the three phenomena.

Primary author: GIORDANO, Matteo (Eotvos University)

Presenter: GIORDANO, Matteo (Eotvos University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **125** Type: **Talk**

Collider phenomenology of vector resonances in WZ scattering processes

Thursday, 2 August 2018 17:00 (20 minutes)

We study the production of vector resonances at the LHC via WZ scattering processes and explore the sensitivities to these resonances for the expected future LHC luminosities. The electroweak chiral Lagrangian and the Inverse Amplitude Method (IAM) are used for analyzing a dynamically generated vector resonance, whose origin would be the (hypothetically strong) self interactions of the longitudinal gauge bosons, WL and ZL. We implement the unitarized scattering amplitudes into a single model, the IAM-MC, that as been adapted to MadGraph 5. It is written in terms of the electroweak chiral Lagrangian and an additional effective Proca Lagrangian for the vector resonances, so that it reproduces the resonant behavior of the IAM and allows us to perform a realistic study of signal versus background at the LHC. We focus on the ppWZjj channel, discussing first on the potential of the hadronic and semileptonic channels of the final WZ, and next exploring in more detail the clearest signals. These are provided by the leptonic decays of the gauge bosons, leading to a final state with l+1l-1l+2jj, l=e„ having a very distinctive signature, and showing clearly the emergence of the resonances with masses in the range of 1.5-2.5 TeV, which we have explored.

Primary authors: Dr DELGADO, Rafael (Technische Universität München); Prof. ESPRIU, Domenec (University of Barcelona (ES)); Ms GARCIA-GARCIA, Claudia (IFT-UAM/CSIC); Prof. HERRERO, Maria José (Universidad Autonoma de Madrid); Mr MARCANO, Xavier (Universidad Autonoma de Madrid); Prof. SANZ-CILLERO, Juan José (Universidad Complutense de Madrid); Prof. DOBADO, Antonio (Universidad Complutense (ES))

Presenter: Dr DELGADO, Rafael (Technische Universität München)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **127** Type: **Talk**

Discrete anomaly matching and high-T âcenter vorticesâ in QCD(adj)

Wednesday, 1 August 2018 17:00 (30 minutes)

We study the recently discovered mixed discrete-chiral/center-symmetry (0-form/1-form) 't Hooft anomalies, which give new nontrivial consistency conditions that the IR dynamics of a strongly coupled QFT should obey. We use the simplest QFT example where such anomalies are present, the massless Schwinger model with charge-q fermions, to simply elucidate how they appear. We show that the anomalies show up as a central extension of the symmetry algebra and that they are matched in the IR by breaking of both the discrete chiral and center symmetries.
Further, we show that the charge-2 Schwinger model appears on the worldvolume of the high-T domain walls (a kind of center vortices) in QCD with adjoint Weyl fermions.Thus, there is a nonzero fermion condensate and a perimeter law for the Wilson loop on the domain walls. We discuss the multiflavor generalizations, the utility of the domain wall physics, possible lattice studies, and the theoretical questions that await better understanding.

Primary author: Prof. POPPITZ, Erich (University of Toronto)

Presenter: Prof. POPPITZ, Erich (University of Toronto)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **128** Type: **Invited plenary talk**

Double beta decay, low energy hadron physics, neutron EDM: results from Lattice QCD

Monday, 6 August 2018 10:00 (30 minutes)

Lattice QCD is currently our only reliable tool for calculating low-energy nuclear physics observables directly from the Standard Model. It is thus a crucial bridge between high-energy beyond the Standard Model (BSM) matrix elements and precision nuclear experiments looking for these rare BSM signals. In this talk, I will discuss recent lattice QCD results relevant for nuclear BSM searches, including general advancements in applications of lattice QCD to nuclear physics.

Primary author: NICHOLSON, Amy (University of North Carolina, Chapel Hill)

Presenter: NICHOLSON, Amy (University of North Carolina, Chapel Hill)

Session Classification: Plenary

Track Classification: E: QCD and New Physics

Contribution ID: **129** Type: **Invited plenary talk**

Quantum information and strongly interacting theories

Saturday, 4 August 2018 12:00 (30 minutes)

Quantum information theoretic concepts such as entanglement entropy provide interesting information on QCD dynamics. I will discuss in particular the role of entanglement in the context of particle production from the Schwinger mechanism for an expanding QCD string. In the bosonized Schwinger model of QED confined to 1+1 dimensions, entanglement between rapidity regions leads actually to a thermal spectrum of excitations around the coherent field with a time-dependent temperature at early time.

Primary author: FLOERCHINGER, Stefan (Heidelberg University)

Presenter: FLOERCHINGER, Stefan (Heidelberg University)

Session Classification: Plenary

Contribution ID: **130** Type: **Talk**

The mixing of hybrids with quarkonia

Friday, 3 August 2018 14:20 (20 minutes)

We present an effective field theory calculation of the lower lying heavy hybrid spectrum, which includes mixing with heavy quarkonium states as a novel feature. Spin zero (one) hybrids turn out to mix with spin one (zero) quarkonia, which is intrumental to explain apparent spin symmetry violating decays of certain XYZ resonances that have been identified as hybrid states. We also present some model independent results for the hiperfine splittings.

Primary author: SOTO, Joan (Universitat de Barcelona)

Presenter: SOTO, Joan (Universitat de Barcelona)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **131** Type: **Talk**

Unfolding: Point Estimation, Uncertainty Quantification and Future Directions

Thursday, 2 August 2018 17:20 (30 minutes)

Differential cross section measurement in experimental particle physics are smeared by the finite resolution of particle detectors. Using the smeared observations to infer the true particle-level spectrum is an ill-posed inverse problem, which is typically referred to as unfolding or unsmearing. In this talk, I will first give an overview of the statistical techniques that are currently used for unfolding particle spectra. I will then explain how optimal point estimation and optimal uncertainty quantification are distinct and separate problems in unfolding and demonstrate that some existing unfolding methods may produce statistical uncertainties that seriously underestimate the true uncertainty. I will then describe how debiasing and shape constraints provide two complementary ways of obtaining more realistic unfolded uncertainties and discuss directions for future progress on this fundamentally challenging problem.

Primary author: Dr KUUSELA, Mikael (Statistical and Applied Mathematical Sciences Institute (US), University of North Carolina at Chapel Hill (US), Helsinki Institute of Physics (FI), Carnegie Mellon University (US))

Presenter: Dr KUUSELA, Mikael (Statistical and Applied Mathematical Sciences Institute (US), University of North Carolina at Chapel Hill (US), Helsinki Institute of Physics (FI), Carnegie Mellon University (US))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **132** Type: **Invited talk**

On the rare CP conserving $K \to \pi l^+ l^-$ decays

Thursday, 2 August 2018 16:20 (30 minutes)

The properties of the form factors describing the rare CP conserving decay modes $K \to \pi l^+ l^-$, $(K, \pi) = (K^\pm, \pi^\pm)$ or (K_S, π^0), $l = e, \mu$, are addressed. First, a full two-loop representation of the corresponding form factors in the low-energy expansion is constructed. Next, the contribution from pi-pi intermediate states is considered from a dispersive point of view. Particular attention is given to the matching with the short-distance behaviour of the form factors. Finally, phenomenological aspects of this study are discussed.

Primary authors: Dr KNECHT, Marc (CPT/CNRS); Dr GREYNAT, David; Dr D'AMBROSIO, Giancarlo (Univ. Napoli)

Presenter: Dr KNECHT, Marc (CPT/CNRS)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **133** Type: **Poster**

The proper-time evolution of the magnetic susceptibility in a magnetized quark-gluon plasma

Friday, 3 August 2018 18:05 (1 minute)

In ultrarelativistic heavy ion collisions enormous magnetic fields are generated because of fast moving charged particles. In the presence of this magnetic field, the spin of particles are aligned either in the parallel or in the antiparallel direction with respect to the direction of the magnetic field. This alignment produces a finite magnetization.
It is kown that finite magnetic susceptibility of the medium, χ_m, changes the evolution of the energy density of the Quark-Gluon Plasma, which is believed to be created in these collisions. It slows down or speeds up the decay of the energy density, depending on whether the system under consideration is a paramagnetic ($\chi_m > 0$) or diamagnetic ($\chi_m < 0$) fluid.
All these studies have been done under two assumptions : 1) A transversally homogeneous and longitudinally boost invariant expansion and 2) a uniform magnetic susceptibility. In general, one expects that the magnetic susceptibility depends on the magnetic field and temperature. These parameters evolve with the evolution of the fluid so that a nonuniform magnetic susceptibility in this system is naturally expected. In this work, we determine first χ_m by making use of the standard anisotropic kinetic theory method, where the one-particle distribution function is replaced by the corresponding anisotropic distribution function. We then study the proper-time dependence of the magnetic susceptibility in the framework of ideal magnetohydrodynamics.

Primary authors: Mr TABATABAEE, S.M.Ali (Sharif University of Technology); Prof. SADOOGHI, Neda (Sharif University of Technology)

Presenter: Mr TABATABAEE, S.M.Ali (Sharif University of Technology)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **134** Type: **Talk**

Lattice QCD2 effective action with Bogoliubov transformations

Sunday, 5 August 2018 17:50 (20 minutes)

In the Wilson's lattice formulation of QCD, a fermionic Fock space can be explicitly constructed at each time slice using canonical creation and annihilation operators. The partition function $\mathcal{Z}$ is then represented as the trace of the transfer matrix, which maps the Fock space at time t in the one at time $t+1$. The usual functional representation of $\mathcal{Z}$ as a path integral of $\exp(-S)$ can be recovered in a standard way. However, applying a Bogoliubov transformation on the canonical operators *before* passing to the functional formalism, we can isolate a vacuum contribution in the resulting action which depends only on the parameters of the transformation and fixes them via a variational principle. This term corresponds to the LO (saddle point) approximation in a large number of colours N_c expansion. Then, inserting in the trace defining $\mathcal{Z}$ an operator projecting on the colourless mesons subspace at each time slice and making the physical assumption that the true partition function is well approximate by the projected one, we can also write an effective quadratic action for colourless mesons, which is a NLO term in N_c. We tested the method in the celebrated ‘t Hooft model, namely QCD in two spacetime dimensions for large number of colours, in Coulomb gauge. The method can be extended to a model at finite temperature and chemical potential.

Primary authors: Mr PASTORE, Mauro (INFN - National Institute for Nuclear Physics); Prof. CARACCIOLO, Sergio (INFN - National Institute for Nuclear Physics)

Presenter: Mr PASTORE, Mauro (INFN - National Institute for Nuclear Physics)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **135** Type: **Talk**

A quark model description of X(4260)

Friday, 3 August 2018 16:00 (20 minutes)

It is fairly well established that X(4260) does not correspond, regarding its mass and transition properties, to a conventional c-cbar state of the type provided for example by the Cornell [1] or the Godfrey-Isgur [2] models. This has motivated the development of other descriptions involving Fock space components (tetraquarks, meson molecules, hybrids…) different from c-cbar (see for example [3] and references therein).
Alternatively one may think of keeping a c-cbar description provided that the c-cbar static potential interaction includes the effect of other Fock components. This kind of decription has been developed for J^{++} charmonium (as well as bottomonium) states through the so called Generalized Screened Potential Model (GSPM) [4]. In this model the effective potential incorporates the effects of single S-wave meson-meson thresholds in the way suggested by lattice QCD calculations. This allows for a universal treatment of states below and above open flavor meson-meson thresholds.
Dealing with 1^{--} states is more complicated due to the presence of many meson-meson component thresholds. In this work we explore the application of the GSPM to X(4260) and show that a consistent description of the mass as well as the transition properties is feasible.

[1] E. Eichten, K. Gottfried, T. Kinoshita, K. D. Lane and T. M. Yan, Phys. Rev. D 17, 3090 (1978); Phys. Rev. D 21, 203 (1980).
[2] S. Godfrey and N. Isgur, Phys. Rev. D 32, 189 (1985).
[3] H-X. Chen, W. Chen, X. Liu and S-L. Zhu, Phys. Rep. 639, 1 (2016).
[4] P. González, Phys. Rev. D 92, 014017 (2015); J.Phys. G 41, 095001 (2014).

Primary author: Prof. GONZALEZ, pedro (Universitat de Valencia (Spain))

Presenter: Prof. GONZALEZ, pedro (Universitat de Valencia (Spain))

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **136** Type: **Invited talk**

Hadronic contributions to the muon anomalous magnetic moment

Friday, 3 August 2018 14:30 (30 minutes)

The anomalous magnetic moment of the muon is one of the most accurately measured quantities in particle physics and one of the very few to exhibit a significant discrepancy with respect to its Standard Model determination. The origin of this discrepancy is unknown. Forthcoming experimental results which are expected to improve the already impressive accuracy of 0.54 parts per million reached by previous measurements, call for improved theory predictions. Stan uncertainties are dominated by non-perturbative QCD corrections, namely the hadronic vacuum polarization and the hadronic light-by-light (HLBL) contributions. After reviewing the status of theory predictions, I will present the basic features and numerical results of a novel framework which by exploiting the general principles of unitarity and analyticity, paves the way for the first data-driven determination of HLbL with controlled uncertainties.

Primary authors: PROCURA, Massimiliano (University of Vienna (AT)); HOFERICHTER, MARTIN (University of Washington); Dr STOFFER, Peter; COLANGELO, Gilberto

Presenter: PROCURA, Massimiliano (University of Vienna (AT))

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **137** Type: **Talk**

Spectrum of the open QCD flux tube and its effective string description

Thursday, 2 August 2018 17:20 (30 minutes)

We perform a high precision measurement of the static quark-antiquark potential in three-dimensional SU(N) gauge theory with N=2 to 6. The results are compared to the effective string theory for the QCD flux tube and we obtain continuum limit results for the string tension and the non-universal leading order boundary coefficient, including an extensive analysis of all types of systematic uncertainties. The magnitude of the boundary coefficient decreases with increasing N, so that it could potentially vanish in the large-N limit. We also test for the presence of possible contributions from rigidity or massive modes and compare our results for the string theory coefficients to results for the excited states.

Primary author: Dr BRANDT, Bastian (Goethe University Frankfurt)

Presenter: Dr BRANDT, Bastian (Goethe University Frankfurt)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **138** Type: **Talk**

Entanglement entropy and high energy scattering

Thursday, 2 August 2018 15:00 (30 minutes)

I discuss some features of entanglement between the fast valence modes and the soft gluons in high energy hadronic scattering. Production entropy for the ensemble of events as well as for a single event is discussed.

Primary authors: KOVNER, Alexander (University of Connecticut); LUBLINSKY, Michael (BGU); SERINO, Mirko (BGU)

Presenter: KOVNER, Alexander (University of Connecticut)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **139** Type: **Poster**

QCD at nonzero isospin asymmetry

Friday, 3 August 2018 18:18 (1 minute)

We study the phase diagram and the thermodynamic properties of QCD at nonzero isospin asymmetry at physical quark masses with staggered quarks. In particular, continuum results for the phase boundary between the normal and the pion condensation phases and the chiral/deconfinement transition are presented. 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. We also compare our results to the results from Taylor expansion and show first results for the equation of state.

Primary author: BRANDT, Bastian (Goethe University Frankfurt)

Presenter: BRANDT, Bastian (Goethe University Frankfurt)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **141** Type: **Talk**

Wigner function approach to polarization-vorticity coupling and hydrodynamics with spin

Friday, 3 August 2018 15:20 (20 minutes)

We critically compare thermodynamic and kinetic approaches, that have been recently used to study relations between the spin polarization and fluid vorticity in systems consisting of spin-1/2 particles. The thermodynamic approach refers to general properties of global thermal equilibrium with a rigid-like rotation and demonstrates that the spin-polarization and thermal-vorticity tensors are equal. On the other hand, the kinetic approach uses the concept of the Wigner function and its semi-classical expansion. In most of the works done so far, the Wigner functions satisfy kinetic equations with a vanishing collision term. We show that this assumption restricts significantly applicability of such frameworks and, in contrast to many claims found in the literature, does not allow for drawing any conclusions regarding the relation between the thermal-vorticity and spin-polarization tensors, except for the fact that the two should be constant in global equilibrium. We further show how the kinetic-theory equations including spin degrees of freedom can be used to formulate a hydrodynamic framework for spinning particles. This analysis suggests the use of the spin tensor introduced by de Groot, van Leuwen, and van Weert, which should be conserved in the leading order of the semiclassical expansion.

Primary authors: KUMAR, Avdhesh; RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN); FLORKOWSKI, Wojciech (Institute of nuclear Physics, Krakow)

Presenter: KUMAR, Avdhesh

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **142** Type: **Talk**

Relativistic fluid dynamics of spin-polarized systems of particles

Wednesday, 1 August 2018 17:20 (20 minutes)

A new framework for relativistic fluid dynamics of particles with spin 1/2 is presented. It is based on the conservation laws for baryon number, energy and momentum, and angular momentum. The conservation laws lead to hydrodynamic equations for the charge density, local temperature, and fluid velocity, as well as for the spin polarization tensor. The resulting set of differential equations extends the standard framework of perfect-fluid hydrodynamics, with a conserved entropy current, in a minimal way.

In addition, the properties of the relativistic spin density matrices for spin-1/2 particles, which have been used recently in works on the polarization of Lambda hyperons, are discussed. Their relations to the Pauli-Lubański four-vector and different forms of the spin tensor are elucidated. Some numerical results in full 3+1D space-time coordinates are presented.

The proposed framework forms a basis for hydrodynamic interpretation of polarization measurements of Lambda hyperons in heavy-ion collisions.

Based on the recent works by:
[1] W. Florkowski, B. Friman, A.Jaiswal, E. Speranza, arXiv:1705.00587, Phys.Rev. C97 (2018) no.4, 041901
[2] W. Florkowski, B. Friman, A.Jaiswal, R.Ryblewski, E. Speranza, arXiv:1712.07676, submitted to PRD,
[3] W. Florkowski, B. Friman, A.Jaiswal, R.Ryblewski, E. Speranza, forthcoming

Primary authors: FLORKOWSKI, Wojciech (Institute of nuclear Physics, Krakow); Dr RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN); SPERANZA, Enrico (Frankfurt University); FRIMAN, Bengt (GSI); JAISWAL, Amaresh (National Institute of Science Education and Research)

Presenter: Dr RYBLEWSKI, Radoslaw (Institute of Nuclear Physics PAN)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **144** Type: **Talk**

Variational and Dyson-Schwinger Equations of QCD

Sunday, 5 August 2018 17:10 (20 minutes)

Dyson–Schwinger equations are an established, powerful non-perturbative tool to investigate QCD. In the Hamiltonian formulation of a quantum field theory they allow variational calculations with non-Gaussian wave functionals: by means of DSEs the various n-point functions, needed in expectation values of observables like the Hamilton operator, can be thus expressed in terms of the variational kernels of our trial ansatz. Equations of motion for these variational kernels are derived by minimizing the energy density and solved numerically. We determine the chiral condensate from the renormalized quark propagator and investigate the quark-gluon vertex.

Primary authors: CAMPAGNARI, Davide (Universität Tübingen); REINHARDT, Hugo (Universität Tübingen)

Presenter: CAMPAGNARI, Davide (Universität Tübingen)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **145** Type: **Talk**

Infrared Behavior of SU(2) gauge theory

Sunday, 5 August 2018 14:30 (30 minutes)

I will review the recent progress in determining the infrared behavior of SU(2) gauge theory with fermions in fundamental representation of the gauge group.
Especially, we will focus on the six and eight fermion cases.

Primary author: Mr LEINO, Viljami (University of Helsinki)

Co-authors: Prof. RUMMUKAINEN, Kari (University of Helsinki); Dr TUOMINEN, Kimmo (University of Helsinki)

Presenter: Mr LEINO, Viljami (University of Helsinki)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **146** Type: **Poster**

Non-equilibrium generalizations of Large-N_c volume independence

Friday, 3 August 2018 18:16 (1 minute)

Confining gauge theories are known to exhibit large-N_c volume independence, *i.e.*, finite volume effects from compactifying any space-time dimension are suppressed by factors of $1/N_c^2$. Compactifying the temporal dimension, this implies thermal effects are also suppressed. This feature breaks down if a deconfined phase is reached beyond a critical compactification radius. We explore the large-N_c properties of confining gauge theories out of thermal equilibrium. We find analogous suppression of terms with factors of $1/N_c$ and $1/N_c^2$ within the confined phase, the first kind arising from far-from-equilibrium contributions. This suppression breaks down when deconfined states are accessed in the non-equilibrium time evolution, a feature that can be used to define non-equilibrium order parameters at large N_c. We show explicit results for a (1+1)-d integrable field theory after a quantum quench, where the non-equilibrium time evolution can be computed analytically, and $1/N_c$ suppression of terms is manifest.

Primary author: CORTÉS CUBERO, Axel

Presenter: CORTÉS CUBERO, Axel

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **147** Type: **Invited talk**

A lattice study of minimal composite dark matter

Sunday, 5 August 2018 14:00 (30 minutes)

Lattice calculations are in progress to study SU(2) gauge theory with one Dirac fermion in the fundamental representation. This model bears some resemblance to QCD but there are also essential differences, such as an enlarged global symmetry and an absence of Goldstone bosons. The model contains a dark matter candidate that remains naturally stable over cosmological timescales.

Primary authors: FRANCIS, Anthony Sebastian (CERN); HUDSPITH, Renwick J. (York University); LEWIS, Randy (York University); TULIN, Sean (York University)

Presenter: LEWIS, Randy (York University)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **148** Type: **Invited talk**

Color superconductivity and charge neutrality

Friday, 3 August 2018 14:40 (20 minutes)

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 have put this claim to the test using a Yukawa model, where the interaction range is finite. The results of this study suggest 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. As a next step, we are now moving on from employing a Yukawa model to using actual QCD degrees of freedom.

Primary authors: ALFORD, Mark (Washington University, St Louis); Dr PANGENI, Kamal; WINDISCH, Andreas (Washington University in St Louis)

Presenter: WINDISCH, Andreas (Washington University in St Louis)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **149** Type: **Invited talk**

Was GW170817 not a merger of two neutron stars?

Wednesday, 1 August 2018 14:40 (20 minutes)

We discuss the case that GW170817 may not have been the merger of a neutron star (NS) with another neutron star, but rather with a hybrid star (HS) possessing a quark matter core, or even a HS-HS merger, and the implications for the equation of state of dense matter at supersaturation densities.

References:

[1] D. Blaschke & N. Chamel, "Phases of dense matter in compact stars", Chapter 7 of the NewCompStar White Book; arxiv:1803.01836
[2] V. Paschalidis et al., "Implications from GW170817 and I-Love-Q relations for relativistic hybrid stars", PRD 97, 084038 (2018)
[3] A. Ayriyan et al., "Robustness of third family solutions for hybrid stars against mixed-phase effects", PRC 97, 045802 (2018)
[4] D. Alvarez-Castillo et al., "Third family of compact stars within a nonlocal chiral quark model equation of state", arxiv:1805.04105 (2018)

Primary author: Prof. BLASCHKE, David (University of Wroclaw & JINR Dubna)

Presenter: Prof. BLASCHKE, David (University of Wroclaw & JINR Dubna)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **150** Type: **Invited plenary talk**

Anomalous chiral matter: from QCD to condensed matter

Saturday, 4 August 2018 11:00 (30 minutes)

I will review anomalous properties of chiral forms of relativistic matter, which attracted a lot of attention recently in the context of heavy-ion physics and in studies of the Early Universe. In part, the recent interest to chiral matter is driven by the intriguing possibility of observing unusual chiral properties that stem directly from quantum anomalies. In addition, the same fundamental physics can be also relevant for a growing number of novel condensed matter materials, known as the Dirac and Weyl semimetals. The latter provide an excellent testbed for studying basic properties of chiral matter and, at the same time, hold a great potential for technological applications.

Primary author: SHOVKOVY, Igor (Arizona State University)

Presenter: SHOVKOVY, Igor (Arizona State University)

Session Classification: Plenary

Track Classification: Focus Subsection: Emergent Gauge Fields and Chiral Fermions

Contribution ID: **151** Type: **Talk**

Radiative corrections in Dalitz decays of π^0, η and η' mesons

Thursday, 2 August 2018 15:20 (20 minutes)

We briefly summarize current experimental and theoretical results on the two important processes of the low energy hadron physics involving neutral pions: the Dalitz decay of π^0 and the rare decay $\pi^0 \to e^+e^-$. As novel results we present the complete set of radiative corrections to the Dalitz decays $\eta^{(\prime)} \to \ell^+\ell^-\gamma$ beyond the soft-photon approximation, i.e. over the whole range of the Dalitz plot and with no restrictions on the energy of a radiative photon. The corrections inevitably depend on the $\eta^{(\prime)} \to \gamma^*\gamma^{(*)}$ transition form factors. For the singly virtual transition form factor appearing e.g. in the bremsstrahlung correction, recent dispersive calculations are used. For the one-photon-irreducible contribution at the one-loop level (for the doubly virtual form factor), we use a vector-meson-dominance-inspired model while taking into account the η-η' mixing.

Primary author: Dr HUSEK, Tomáš (IFIC, Universitat de València-CSIC (ES))

Co-authors: KAMPF, Karol (Charles University, Prague (CZ)); NOVOTNÝ, Jiří (Charles University, Prague (CZ)); LEUPOLD, Stefan (Uppsala University (SE))

Presenter: Dr HUSEK, Tomáš (IFIC, Universitat de València-CSIC (ES))

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **152** Type: **Talk**

Building Synthetic Skies for Future Sky Surveys

Wednesday, 1 August 2018 16:00 (20 minutes)

Upcoming sky surveys require large-volume, high-quality simulated extra-galactic catalogs for such diverse tasks as investigating various data-analysis strategies, understanding and mitigating systematic errors, developing and testing analysis pipelines, and studying observing strategies. In order to prepare adequately for the rich and complex datasets to be delivered by these surveys, the astrophysics-cosmology community needs simulated catalogs that provide a wide range of detailed galaxy properties whose distributions match those of the observational data. We describe the end-to-end simulation pipeline, starting from gravity-only N-body simulations. We present a new hybrid method of populating dark-matter halos with galaxies that combines empirical methods with semi-analytic galaxy modeling. We also discuss DESCQA, a new software framework that was developed by the LSST-DESC collaboration, and is capable of testing and validating a variety of catalogs against a diverse set of physics requirements.

Primary author: Dr KOVACS, Eve (Argonne National Laboratory)

Presenter: Dr KOVACS, Eve (Argonne National Laboratory)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **154** Type: **Talk**

Thermal effective potential for the Polyakov loop to higher loop order

Sunday, 5 August 2018 18:10 (20 minutes)

We compute the effective potential for the Polyakov loop in a pure SU(N) gauge theory beyond two-loop order. We introduce a new approach using the Poisson resummation formula, which is well suited to compute thermal sums/integrals with non-trivial holonomy. We discuss the implications for phenomenology with three colors, and theoretical questions at large N.

Primary author: NISHIMURA, Hiromichi (RIKEN BNL)

Presenter: NISHIMURA, Hiromichi (RIKEN BNL)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **155** Type: **Talk**

Analysis of the b_1 meson decay in local tensor bilinear representation

Friday, 3 August 2018 17:20 (20 minutes)

We explore the validity of vector meson dominance in the radiative decay of the $b_1(1235)$ meson. In order to explain the violation of the vector meson dominance hypothesis in this decay process, we investigate a model where the b_1 meson strongly couples with the local current in tensor bilinear representation. The tensor representation is investigated in the framework of the operator product expansion (OPE) and we found a low energy decay process that does not follow the usual vector meson dominance hypothesis. In the OPE of the tensor current, four-quark operators are leading quark contribution and their value can be inferred from the QCD vacuum structure. The ω-like intermediate meson state of quantum numbers $I^G(J^{PC}) = 0^-(1^{--})$ is found to have a nontrivial role in the decay process of the b_1 meson. The spectral structure of the ω-like state is found to be close to a π-ρ hybrid state, which provides a mechanism that evades the usual vector meson dominance hypothesis. Precise measurements of various decay channels of the b_1 meson are, therefore, required to unravel the internal structure of
axial vector mesons.

Primary authors: Dr JEONG, Kie Sang (Asia Pacific Center for Theoretical Physics); LEE, Su Houng (Yonsei University); Prof. OH, Yongseok (Kyungpook National University)

Presenter: Dr JEONG, Kie Sang (Asia Pacific Center for Theoretical Physics)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **156** Type: **Talk**

On the origin of Y(4260) and the J^{PC}=1^{–} exotic mesons

Friday, 3 August 2018 17:00 (20 minutes)

The $q\bar{q}s\bar{s}$ and $q\bar{q}c\bar{c}$ $J^{PC} = 1^{--}$ 4-body systems are investigated by a simplified quark cluster model, where the 14 relevant channels are coupled. In each of the systems, one or more poles have been found. For the $q\bar{q}c\bar{c}$, a pole appears close to the thresholds and its width is found to be small. The poles found in the $q\bar{q}s\bar{s}$ have rather larger width. We argue that they can be seeds of the observed exotic mesons like the $Y(4260)$.

Primary authors: Dr TAKEUCHI, Sachiko (Japan College of Social Work); Dr TAKIZAWA, Makoto (Showa Pharmaceutical University)

Presenter: Dr TAKEUCHI, Sachiko (Japan College of Social Work)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **157** Type: **Invited talk**

Constraints from the GW170817 merger event on the nuclear matter EoS

Wednesday, 1 August 2018 14:00 (20 minutes)

The equation of state (EoS) of nuclear matter is one of the key issues in understanding the physical properties of neutron stars (NS). Currently, the strongest constraint comes from the fact that the maximum mass for NSs must be larger than about 2Mo, whereas the determination of the radius is still suffering of observational uncertainties and models dependence.

Gravitational wave (GW) observations of coalescing binary NSs is a promising avenue to constrain the dense matter EoS. The detection of the merger event, GW170817, along with its electromagnetic counterpart, has allowed to place lower and upper bounds on some parameters describing the binary's tidal interactions, thus ruling out very stiff and very soft EoS. This translates into an allowed window for the radius of the 1.4Mo stellar configuration between ~12 and 13 km. Using various microscopic and phenomenological equations of state for nuclear and hybrid stars' configurations, we find radii compatible with the observational limits, thus identifying suitable EoS. Correlations between various observables, e.g. moment of inertia and tidal deformability, will also be discussed.

Primary author: Dr BURGIO, Fiorella (INFN Sezione di Catania)

Co-authors: Mr WEI, Jinbiao (Universita' di Catania); Dr SCHULZE, Hans-Josef (INFN Sezione di Catania)

Presenter: Dr BURGIO, Fiorella (INFN Sezione di Catania)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **158** Type: **Talk**

Z3 gauge theory with matter at finite densities

Thursday, 2 August 2018 15:00 (30 minutes)

Z3 gauge theory mimics certain properties of QCD and might even have a quantitative link when the Z3 physical degrees of freedom are identified with the core of the so-called centre vortices of QCD. In particular, the Z3 theory confines static triality charges. In this talk, I will consider Z3 gauge theory with Z3 dynamical matter. A finite chemical potential is introduced to study this theory at finite densities. Objective will be to study the deconfinement transition in the cold but dense matter region. By integrating out the gauge and matter fields, the theory can be formulated in terms of gauge invariant non-local degrees of freedom free of a sign-problem. Observables of the original theory appear as ratio of partition functions, which are evaluated by the snake algorithm. First numerical results are presented.

Primary author: Prof. LANGFELD, Kurt (University of Liverpool)

Presenter: Prof. LANGFELD, Kurt (University of Liverpool)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **160** Type: **Talk**

Baryonic and quarkyonic matter

Thursday, 2 August 2018 14:30 (30 minutes)

During the last years it has become possible to address the nuclear liquid gas transition in QCD directly for
sufficiently heavy quarks, where combined strong coupling and hopping expansions are convergent. In this
contribution we study the Nc-dependence of the liquid gas transition and the equation of state of baryonic
matter. We find the transition to become more strongly first order with growing Nc, suggesting that in the large
Nc limit its critical endpoint moves to high temperatures.
This suggests that baryonic and quarkyonic matter might be the same at large Nc.

Primary authors: Prof. PHILIPSEN, Owe (Goethe University Frankfurt); Dr SCHEUNERT, Jonas

Presenter: Prof. PHILIPSEN, Owe (Goethe University Frankfurt)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **162** Type: **Talk**

Ghost Sector in Minimal Linear Covariant Gauge

Friday, 3 August 2018 15:00 (20 minutes)

We discuss possible definitions of the Faddeev-Popov matrix for the minimal linear covariant gauge on the lattice and present preliminary results for the ghost propagator.

Primary authors: CUCCHIERI, Attilio (University of São Paulo); DUDAL, David; MENDES, Tereza; Dr OLIVEIRA, Orlando (University of Coimbra); ROELFS, Martin; SILVA, Paulo (Center for Physics, University of Coimbra)

Presenter: CUCCHIERI, Attilio (University of São Paulo)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **163** Type: **Poster**

How to find the glueball among the f0s with the QCD counting rules

Friday, 3 August 2018 18:04 (1 minute)

We propose a model-independent method to ascertain the leading valence composition of a hadron: to measure the energy dependence of its production cross section at a fixed angle interval. This E-dependence, by the QCD Brodsky-Farrar counting rules, falls at high energy with a steepness that depends on the leading quark and gluon composition.
We exemplify with a reaction that could help classify the f0 mesons, exclusive e-e+ -> phi + f0 with an easily reconstructible final state. Some of the f0 may have a glueball gg component in their wavefunction decomposition; this will dominate at high energy over higher twist quark-antiquark components (because they necessarily have a p-wave) or hybrid/tetraquark components (because of the higher number of particles in the final state). We discuss the prospects to carry out this or similar analysis in Belle II.

Primary authors: LLANES-ESTRADA, Felipe J. (Univ. Complutense de Madrid); BRODSKY, Stanley J. (Stanford Linear Accelerator Center); PELAEZ, Jose R. (Univ. Complutense de Madrid)

Presenter: LLANES-ESTRADA, Felipe J. (Univ. Complutense de Madrid)

Session Classification: Poster

Track Classification: B: Light quarks

Contribution ID: **164** Type: **Talk**

Gluon saturation from transverse-momentum dependent distributions at small x in the Color Glass Condensate

Thursday, 2 August 2018 14:00 (30 minutes)

We first review transverse-momentum dependent (TMD) gluon distributions at small x and their relation to unintegrated gluon distributions in the Color Glass Condensate (CGC) theory. We then explore several applications of this connection relevant for studying gluon saturation at small x. For instance, based on the equivalence between the TMD factorization approach and the CGC cross section for dijet production in proton-nucleus collisions we show onset of saturation effects in the kinematic region of almost back-to-back jets, and a similar result for the case with an extra soft photon in the final state. We also review the property of non-universality of TMD gluon distributions at small x from a CGC point of view. Using the JIMWLK evolution, we observe different behavior of the distributions at small transverse momenta and a restoration of the universality at high transverse momenta. Finally, we show that a similar connection can be made between generalized transverse-momentum dependent (GTMD) distributions at small x and impact-parameter dependent unintegrated gluon distributions in the CGC theory and we study consequences of having such a relation.

Primary author: PETRESKA, Elena (Nikhef/VU Amsterdam)

Presenter: PETRESKA, Elena (Nikhef/VU Amsterdam)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **165** Type: **Invited talk**

Using gravitational-wave data for neutron star binaries to constrain supra nuclear physics

Wednesday, 1 August 2018 15:00 (20 minutes)

The spectacular first detection of gravitational waves from the inspiral and merger of a neutron star binary heralded a new era for relativistic astrophysics. This first event - GW170817 - provided interesting constraints on the neutron star radius (through the inferred tidal deformability) and the supranuclear equation of state. In this talk I will present an overview of these results. I will also look to the future and consider how we may do better, and perhaps (eventually) put constraints on the star's internal composition, as well.

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

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

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **166** Type: **Talk**

Pentaquark and hybrid states

Friday, 3 August 2018 16:40 (20 minutes)

A review and comparison of different models for the LHC_b pentaquarks and different predictions will be given. Predictions also for hidden bottom pentaquark states will be given. New predictions for the most intresting channels where to look for new pentaquark states will be discussed, as it can be intresting also for the experimentalists. The second part of the talk will be devoted to hybrid states (q antiq gluon) and some theoretical models presented and discussed.
(1) E. Santopinto, A. Giachino, Phys.Rev. D96 (2017) no.1, 014014
(2)Y. Yamaguchi, E. Santopinto, Phys.Rev. D96 (2017) no.1, 014018
(3) Y. Yamaguchi, A. Giachino, A. Hosaka, E. Santopinto, S. Tacheuchi, M. Takizawa, Phys.Rev. D96 (2017) no.11, 114031
(4)P. Guo, Adam P. Szczepaniak, G. Galata, A. Vassallo, E. Santopinto, Phys.Rev. D78 (2008) 056003

Primary author: SANTOPINTO, Elena (INFN)

Presenter: SANTOPINTO, Elena (INFN)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **167** Type: **Talk**

Charmonium resonances from 2+1 flavor CLS lattices

Thursday, 2 August 2018 17:00 (20 minutes)

Properties of resonances and excited states near decay thresholds are encoded in hadronic scattering amplitudes, which can be extracted from the finite volume spectrum using (extensions of) Lueschers method. We discuss how to reliably extract the finite volume spectrum above strong-interaction decay thresholds from lattice QCD simulations. Preliminary results for such spectra in various frames and lattice irreducible representations on some of the coarser CLS gauge field ensembles with a pion mass of roughly 280 MeV are presented. The current results focus on two particular sets of charmonium quantum numbers J^{PC}:
For $J^{PC}=1^{--}$ the $\Psi(3770)$ resonance is considered as a benchmark for our methods, while we attempt to predict the more interesting resonance spectrum with $J^{PC}=0^{++}$. For $J^{PC}=0^{++}$ Belle sees a candidate for the χ'_{c0} and the $X(3915)$ seen in the $J/psi\omega$ channel has previously been argued to have these quantum numbers. The future aim of our investigation is to further extend the scope of these calculations with the long-term goal of understanding the properties of the X(Y,Z) states that do not fit into the conventional models of quark-antiquark mesons.

Primary authors: MOHLER, Daniel (Helmholtz-Institut Mainz); PRELOVSEK, Sasa; COLLINS, Sara (University of Regensburg); MADANAGOPALAN, Padmanath (Universitaet Regensburg); PIEMONTE, Stefano (Universitaet Regensburg); BALI, Gunnar (Universität Regensburg); WEISHAEUPL, Simon (Universitaet Regensburg)

Presenter: MOHLER, Daniel (Helmholtz-Institut Mainz)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **168**   Type: **Talk**

Understanding the dynamics of field theories far from equilibrium

Thursday, 2 August 2018 15:30 (30 minutes)

In recent years, there have been important advances in understanding the far-from-equilibrium dynamics in gauge and scalar field theories. For non-Abelian gauge systems, the combination of different methods led to the development of a consistent weak-coupling thermalization picture in ultrarelativistic heavy-ion collisions, from the initial Glasma state to the onset of hydrodynamics, and the quantitative details of the evolution are currently being studied. In this talk, I will review recent progress in the understanding of the early-time evolution of non-Abelian plasmas, and also its connection with scalar field theories.

Primary author: BOGUSLAVSKI, Kirill (University of Jyvaskyla (FI))

Presenter: BOGUSLAVSKI, Kirill (University of Jyvaskyla (FI))

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **170** Type: **Talk**

J/ψ production in pp and nucleus-nucleus collisions measured with ALICE

Sunday, 5 August 2018 15:20 (20 minutes)

Charmonium production is a crucial observable in pp and A-A collisions.
Studies on charmonium production in pp collisions can help to understand both fundamental perturbative QCD processes $i.e.$ the initial charm-quark pair production, as well as hadronization mechanisms $i.e.$ the subsequent binding into a charmonium state. J/ψ measurements as a function of multiplicity can help to explore the interplay between the hard and soft relevant mechanisms.

In the study of charmonium in A-A collisions, several QGP effects have been observed, such as the suppression of charmonium states due to color screening. In addition, an enhancement due to (re)combination of uncorrelated charm and anti-charm quarks is also present at LHC energies. This enhancement is more pronounced at low transverse momentum ($p_{\mathrm{T}} < 4.0$ GeV/c).

ALICE measures J/ψ production in the mid-rapidity ($|y| < 0.9$) and forward-rapidity ($2.5 < y < 4.0$) regions down to p_{T} = 0. In this talk, ALICE measurements in pp collisions at $\sqrt{s}$ = 13 TeV as a function of charged-particle multiplicity will be shown. The inclusive J/ψ nuclear modification factor (R_{AA}) in Pb-Pb and Xe-Xe collisions as a function of centrality and p_{T} will be discussed as well and compared to model predictions.

Primary author: Mr JIMENEZ BUSTAMANTE, Raul Tonatiuh (GSI, Heidelberg University)

Presenter: Mr JIMENEZ BUSTAMANTE, Raul Tonatiuh (GSI, Heidelberg University)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **171** Type: **Invited plenary talk**

Recent QCD and electroweak results from LHC

Sunday, 5 August 2018 09:30 (30 minutes)

Recent measurements from the ATLAS, CMS and LHCb collaborations are testing QCD with unprecedented precision and in a new energy regime.
This talk covers recent measurements by the LHC experiments on the production of jets, isolated photons, electroweak bosons and top quarks.

Primary author: MUELLER, Katharina (Universitaet Zuerich (CH))

Presenter: MUELLER, Katharina (Universitaet Zuerich (CH))

Session Classification: Plenary

Track Classification: E: QCD and New Physics

Contribution ID: **172** Type: **Talk**

Low-mass dielectron measurements in pp, p-Pb and Pb-Pb collisions with ALICE at the LHC

Sunday, 5 August 2018 15:40 (20 minutes)

Measurements on dielectrons (electron-positron pairs) produced in ultra-relativistic heavy-ion collisions (HIC) allow the study of the electromagnetic radiation that is emitted through the whole evolution of the system and that is not affected by final state interactions. Through the study of dielectrons at midrapidity one can investigate different phenomena by taking advantage of the degree of freedom given by the dielectron invariant mass. Low-mass dielectrons deliver information on the temperature of the system at its different stages, the in-medium modification of the spectral function of the rho meson, the modifications on the production of open heavy-flavour pairs, and the production of direct photons at low transverse momentum (pT) accessing the virtual quasi-real photon production.
In proton-proton collisions, dielectrons are used to establish a vacuum baseline for the study of HIC and to obtain heavy-flavour cross sections of open charm and beauty production in a method sensitive to the correlation of the initial quark pairs, and to measure the direct photon production at low pT that can be compared with perturbative QCD calculations.
Proton-nucleus collisions are investigated in order to disentangle hot from cold-nuclear matter effects.

In this talk we report the results of the ALICE measurements in three collision systems: Pb-Pb collisions at sqrt(s_NN) = 2.76 and 5.02 TeV, pp collisions at sqrt(s) = 7 TeV and 13 TeV, and p-Pb collisions at sqrt(s_NN) = 5.02 TeV. Results from high-multiplicity pp collisions at sqrt(s) = 13 TeV are reported as well.
The effects on the obtained dielectron spectra of a reduced magnetic field configuration and multivariate analyses with machine learning are also shown.

Primary author: VAZQUEZ DOCE, Oton (Technische Universitaet Muenchen (DE))

Presenter: VAZQUEZ DOCE, Oton (Technische Universitaet Muenchen (DE))

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **173** Type: **Invited talk**

Generalized spin-independent WIMP-nucleus scattering from chiral effective field theory

Thursday, 2 August 2018 16:50 (30 minutes)

We present a formalism based on chiral effective field theory that incorporates all coherent responses relevant for the analysis of direct-detection dark-matter searches. The nuclear response functions are derived, including contributions from one- and two-body nuclear currents as well as interference terms between the different channels. The corresponding structure factors for the isotopes currently used in direct-detection
experiments are evaluated using state-of-the-art nuclear structure calculations. We present first results for extended analyses of direct-detection experiments based on a minimal set of coherently enhanced responses beyond the standard spin-independent analysis.

Primary authors: KLOS, Philipp (Technische Universität Darmstadt); HOFERICHTER, MARTIN (University of Washington); MENENDEZ, Javier; Prof. SCHWENK, Achim (TU Darmstadt)

Presenter: KLOS, Philipp (Technische Universität Darmstadt)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **175** Type: **Talk**

Sphaleron diffusion rate in lattice gluodynamics

Sunday, 5 August 2018 17:30 (20 minutes)

QCD vacuum can be treated as a series of energetically equivalent, but topologically distinct sectors. The rate of transitions between various topological sectors is determined by the sphaleron diffusion rate Γ_{CS}. This quantity is given by the limits of zero frequency and zero momentum of the correlator of topological charge density. Sphaleron diffusion rate is very similar to such transport coefficients as viscosity or conductivity. Sphaleron diffusion rate also describes time relaxation of the chiral charge. In this report we discuss the measurement of sphaleron diffusion rate in lattice gluodynamics in the deconfinement phase. We use Gradient Flow to measure the topological charge density correlator, and we also take continuum limit. We provide an estimation of the sphaleron diffusion rate in lattice gluodynamics and compare it with results obtained by other methods.

Primary author: KOTOV, Andrey

Presenter: KOTOV, Andrey

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **176** Type: **Talk**

Low-energy kaons experiment at DAFNE Collider : SIDDHARTA experiment

Sunday, 5 August 2018 16:50 (20 minutes)

The study of the antikaon nucleon system at very low energies plays a key role in the study of the strong interaction with strangeness, with important impact in particle and nuclear physics and astrophysics. Exotic atoms measurements, in particular kaonic hydrogen and deuterium, allow to determine the s-wave antikaon-nucleon isospospin dependent scattering lengths. Taking advantage of the excellent quality kaon beam delivered by the DAFNE collider in Frascati (Italy) combined with new experimental techniques, as fast and very precise X ray detectors, like the Silicon Drift Detectors, we have performed unprecedented measurements in the low-energy strangeness sector in the framework of SIDDHARTA . The most precise kaonic hydrogen measurement, together with an exploratory measurement of kaonic deuterium, were performed by SIDDHARTA. Presently, a major upgrade of the setup, SIDDHARTA-2 is being realized to perform a precise measurement of kaonic deuterium and of other exotic atoms. The experiment at the DAFNE collider represents an opportunity which is unique in the world in the strangeness sector.

Primary author: Dr SIRGHI, Diana (INFN-LNF)

Presenter: Dr SIRGHI, Diana (INFN-LNF)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **177** Type: **Talk**

Novel approach to holographic composite Higgs models

Thursday, 2 August 2018 16:40 (20 minutes)

We revisit the construction of the composite Higgs models in a context of the bottom-up holographic approach. The soft wall framework is under consideration imposing the translation of the $4D$ global symmetry breaking characteristic to the new strongly interacting sector to the $5D$ bulk. The focus stays on the minimal $SO(5) \to SO(4)$ breaking pattern.
The $5D$ model has a specific form and is inspired by the effective models of QCD, representing a generalized sigma model coupled both to the composite resonances and to the SM gauge bosons. The last are treated as external $4D$ sources and conceptually develop no propagation into the bulk. The holographic description allows for the consideration of spin one and spin zero resonances. The resulting spectrum leads in a natural way to a variety of new composite resonances, four of which represent the massless Goldstone bosons. Existing experimental constraints implemented, the model is able to accommodate vector and scalar resonances with masses in the range of 1–2 TeV without encountering phenomenological difficulties.
Moreover, for the SM gauge fields holography provides relevant vacuum polarization amplitudes and mixing with composite resonances. Further considering higher order correlation functions we may formulate semi-quantitative predictions for the effective couplings and cross-sections.

Primary author: KATANAEVA, Alisa (University of Barcelona)

Co-author: ESPRIU CLIMENT, Domenec (University of Barcelona (ES))

Presenter: KATANAEVA, Alisa (University of Barcelona)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **178** Type: **Invited talk**

Neutron Star Mergers Chirp About Vacuum Energy

Wednesday, 1 August 2018 15:20 (20 minutes)

Observations of gravitational waves from neutron star mergers open up novel directions for exploring fundamental physics: they offer the first direct access to the structure of objects with a non-negligible contribution from vacuum energy to their total mass. The presence of such vacuum energy in the inner cores of neutron stars is a natural consequence of possible new QCD phases at large densities. This in turn leads to a change in tidal deformabilities which are measurable in the chirp signals of merging neutron stars, and for large chirp masses the effect of vacuum energy can be sizable. Measurements of this sort have the potential to provide a first test of the gravitational properties of vacuum energy independent of those obtained from the acceleration of the Universe, and also determine the size of the QCD contribution to vacuum energy in the Universe.

Primary authors: TERNING, John (UC Davis); CSAKI, Csaba (Cornell University); HUBISZ, Jay (Syracuse University); ERÖNCEL, Cem (Syracuse University); RIGO, Gabriele (Syracuse University)

Presenter: TERNING, John (UC Davis)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **179** Type: **Talk**

Symmetry breaking patterns in dense QCD

Friday, 3 August 2018 15:00 (20 minutes)

We discuss the fixed-point structure and symmetry breaking patterns of hot and dense QCD. Our study particularly addresses the phase structure at low temperature and large quark chemical potential, a region where the application of fully first-principles approaches is currently difficult at best. To this end, we employ a Fierz-complete set of four-quark interactions which are dynamically generated by the gauge degrees of freedom in the renormalization group (RG) approach underlying our study. We observe that the dense regime is dominated by diquark degrees of freedom in contrast to the dominance of pions at small quark chemical potential. This change in the dominance of the associated interaction channels is driven by a corresponding change in the fixed-point structure when the chemical potential is varied. In particular at large quark chemical potential we find that the use of a Fierz-complete set of four-quark interactions is indeed of great importance. Phenomenological implications of these findings for the critical temperature and the equation of state at large chemical potential are discussed.

Primary author: LEONHARDT, Marc (Technische Universität Darmstadt)

Co-authors: Prof. BRAUN, Jens (Technische Universität Darmstadt); Mr POSPIECH, Martin (Technische Universität Darmstadt)

Presenter: LEONHARDT, Marc (Technische Universität Darmstadt)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **180** Type: **Talk**

Deconfinement to Confinement as PT phase transition

We consider $SU(N)$ QCD in a new quadratic gauge which highlights certain characteristic of the theory in the non-perturbative sector. By considering natural hermiticity property of the ghost fields we cast this model as non-Hermtian but symmetric under combined Parity (P) and Time reversal (T) transformations. We explicitly study the PT phase transition in this model. This is very first such study in the non-Hermitian gauge theory. The ghost fields condensate as a direct consequence of spontaneous breaking of PT symmetry. This leads to realize the transition from deconfined phase to confined phase as a PT phase transition in this system. The hidden C-symmetry in this system is identified as inner automorphism in this theory. Explicit representation is constructed for the C-symmetry.

Primary author: Dr RAVAL, Haresh (Indian Institute of Technology Delhi)

Presenter: Dr RAVAL, Haresh (Indian Institute of Technology Delhi)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **181** Type: **Talk**

S-matrix approach to hadron gas

Friday, 3 August 2018 16:30 (30 minutes)

In this talk I shall discuss how the S-matrix formalism can be applied to study the thermal properties of interacting hadrons.

The approach allows a consistent treatment of broad resonances and purely repulsive channels, while correctly implementing the constraints from the chiral perturbation theory. This provides a useful framework for identifying the limitations of the Hadron Resonance Gas model and for incorporating additional effects from hadron physics to reliably describing the thermal medium.

As an application I study the pion-nucleon system and demonstrate how the natural implementation of the repulsive forces can help to better understand the lattice QCD result on the baryon electric charge correlation.

Lastly, I discuss some recent progress in extending the analysis to a coupled-channel system of hyperons.

Primary authors: Dr LO, Pok Man (University of Wroclaw); FRIMAN, Bengt (GSI); REDLICH, Krzysztof (University of Wroclaw)

Presenter: Dr LO, Pok Man (University of Wroclaw)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **183** Type: **Talk**

The NNNLO spectrum: Bc, bottomonium and charmonium

Thursday, 2 August 2018 14:40 (20 minutes)

In this talk I will explain how to obtain the perturbative NNNLO heavy quarkonium spectrum for equal and different masses. This computation allows to determine the charm and bottom quark masses from the bottomonium, charmonium and B_c systems. The use of the renormalon subtracted scheme, provides control over the divergence of the perturbative series due to the pole mass renormalon. On top of this, we also study an alternative computational scheme that treats the static potential exactly.
Finally, I will present a determination of $\alpha_s(M_z)$ based on a renormalon free combination of the heavy quarkonium systems.

Primary author: PESET MARTIN, Clara (Technical University of Munich (TUM))

Presenter: PESET MARTIN, Clara (Technical University of Munich (TUM))

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **185** Type: **Talk**

Solving numericaly the JIMWLK equation

Sunday, 5 August 2018 17:30 (20 minutes)

The JIMWLK equation, which describes the evolution of color fields, together with a choice of the initial conditions, for instance according to the Venugopalan-McLerran model, provide a framework in which correlation functions of Wilson lines and their derivatives can be estimated, hence providing necessary information to describe hadron Transverse Momentum Dependent structure functions. After discretizing the transverse plane and reformulating the original equation using a Langevin equation the JIMWLK equation can be solved numerically. In the talk I will present a highly parallel implementation of such a numerical framework and discuss several systematic effects introduced by the discretization of the transverse plane. I will also describe necessary steps needed towards the comparison of the numerical results with experiment.

Primary author: Dr KORCYL, Piotr (Jagiellonian University)

Presenter: Dr KORCYL, Piotr (Jagiellonian University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **186** Type: **Talk**

Radially excited ψ mesons and the Y enhancements

Thursday, 2 August 2018 17:20 (20 minutes)

While many properties of the vector charmonium first excitations are yet to be determined, enhancements at unexpected energies are intriguing, alias the Y states. In order to understand the naturally unquenched mesonic line-shapes, the influence of the most relevant hadronic decay channels must be taken into account. Within an unitary effective approach we present results where mesonic loops are included in an equivalent manner to coupled-channels.

Primary authors: Dr COITO, Susana (Jan Kochanowski University); Prof. GIACOSA, Francesco (Jan Kochanowski University)

Presenter: Dr COITO, Susana (Jan Kochanowski University)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **187** Type: **Talk**

Thermodynamics and non-Gaussian Measures in the Covariant Variational Approach to Yang-Mills Theory

Sunday, 5 August 2018 17:30 (20 minutes)

The covariant variational approach to Yang-Mills theory is further developed. After reviewing the extension to finite temperature, we briefly recall the effective action for the Polyakov loop and the critical properties of the deconfinement phase transition within this approach. The thermodynamics of pure Yang-Mills theory are studied in detail and the resulting equation of state is compared to lattice data and other functional methods. In the confined phase, a small but non-zero pressure is predicted in contrast to physical expectations; we propose possible improvements to address this issue. Finally, we discuss the combination of the variational approach with Dyson-Schwinger techniques in order to extend the method beyond the Gaussian ansatz. It is shown how to apply this technique to low order Green's functions in pure Yang-Mills theory at zero temperature, and the inclusion of fermions by the same method is briefly layed out.

Primary author: QUANDT, Markus (Universität Tübingen)

Co-authors: REINHARDT, Hugo (Universität Tübingen); CAMPAGNARI, Davide (Universität Tübingen)

Presenter: QUANDT, Markus (Universität Tübingen)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **189** Type: **Invited talk**

Strange Quarks in Compact Stars

Wednesday, 1 August 2018 17:20 (20 minutes)

The appearance of strangeness in compact stars is uncertain in both, the nuclear and quark matter sector. While hyperons are sensitive to coupling constants, the threshold for the appearance of strange quark matter depends on both, coupling constants in the entire light quark sector and the way one models the deconfinement phase transition.
I will present how this can lead to ambiguities which may result in difficulties to interpret compact star data in favor of a particular scenario concerning the underlying inner structure.

Primary author: Prof. KLAEHN, Thomas (California State University, Long Beach)

Co-authors: JAIKUMAR, Prashanth; Prof. WEI, Wei

Presenter: Prof. KLAEHN, Thomas (California State University, Long Beach)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **190** Type: **Talk**

Pion structure from lattice QCD

Wednesday, 1 August 2018 15:00 (20 minutes)

I will present recent lattice QCD calculations for the pion form factors and quasi parton distributions using partially quenched calculations with HYP smeared Wilson quarks in the valance sector and highly improved staggered quarks in the sea. The calculations are performed at two lattice spacings a=0.06fm and a=0.04fm.

Primary author: PETRECZKY, Peter (BNL)

Presenter: PETRECZKY, Peter (BNL)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **191** Type: **Poster**

Hadronic Paschen-Back effect: P-wave charmonia under strong magnetic fields

Friday, 3 August 2018 18:15 (1 minute)

QCD dynamics under a strong magnetic field is of great interest to the field of relativistic heavy-ion collisions and magnetars.
In this talk, I will discuss a new effect we recently found in Ref.[1], 'Hadronic Paschen-Back effect (HPBE)', which is analogous to the Paschen-Back effect observed in atomic physics.
This effect is induced by the interplay between a strong magnetic field and finite orbital angular momenta in hadronic systems.
It allows the wave functions to drastically deform and leads to anisotropic decays.
Such a decay gives a possibility to measure the strength of the magnetic field in heavy-ion collision at LHC, RHIC and SPS, which has not experimentally been measured.
As an example of HPBE, I will report our results [1] of the mass spectra, wave functions, and mixing rates of P-wave charmonia in a wide range of magnetic fields by using the potential model and a numerical few-body technique.
Furthermore, I will talk about a systematic study for the radiative decays of P-wave quarkonia by HPBE based on potential non-relativistic QCD in Ref.[2].
[1] arXiv:1802.04971 [2] arXiv:1805.09787

Primary authors: IWASAKI, Sachio; Prof. OKA, Makoto; SUZUKI, Kei (Tokyo Institute of Technology); Dr YOSHIDA, Tetsuya

Presenter: IWASAKI, Sachio

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **192** Type: **Talk**

Towards a precise determination of the EoS of QCD to high-temperature

Wednesday, 1 August 2018 15:00 (20 minutes)

In this talk I will present our strategy for a fully non-perturbative determination of the equation of state (EoS) of QCD from low (T~100 MeV), up to very high temperature (T~100 GeV). The key ingredient for such determination is the lattice formulation of QCD in a moving reference frame. I shall discuss in particular how the set-up allows for a neat determination of the entropy density from simple correlation functions of the energy momentum tensor.

Primary authors: Dr DALLA BRIDA, Mattia (Universita' & INFN, Milano-Bicocca (IT)); Prof. GIUSTI, Leonardo (Universita & INFN, Milano-Bicocca (IT)); Dr PEPE, Michele (INFN - Milano-Bicocca)

Presenter: Dr DALLA BRIDA, Mattia (Universita' & INFN, Milano-Bicocca (IT))

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **193** Type: **Talk**

Confinement/deconfinement phase transition in SU(3) Yang-Mills theory and non-Abelian dual Meissner effect.

Sunday, 5 August 2018 15:20 (20 minutes)

The dual superconductivity is a promising mechanism of quark confinement. In the preceding works, we have given a non-Abelian dual superconductivity picture for quark confinement, and demonstrated the numerical evidences on the lattice.
In this talk, we focus on the the confinement and deconfinement phase transition at finite temperature in view of the dual superconductivity. By using our new formulation of lattice Yang-Mills theory and numerical simulations on the lattice, we extract the dominant mode for confinement by decomposing the Yang-Mills field, and we investigate the Polyakov loop average, static quark potential, chromoelectric flux, and induced monopole current for both Yang-Mills field and decomposed restricted field in both confinement and deconfinement phase at finite temperature.
We further discuss the role of the chromomagnetic monopole in the confinement/deconfinement phase transition.

Primary authors: KONDO, Kei-Ichi (Chiba University); KATO, Seikou (Oyama College)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **194** Type: **Talk**

Charmed baryon spectrum in Lattice QCD — a work in progress

Wednesday, 1 August 2018 16:20 (20 minutes)

We calculate the spectrum of charmed baryons on $32^3 \times 64$, $2 + 1$-flavor lattice QCD ensembles generated by the PACS-CS Collaboration. Calculations are done with almost physical light quarks, m_π ~ 156 MeV, and physical strange and charm quarks. A relativistic heavy-quark action is used for valance charm quarks to suppress the systematic errors. A two-fold variational analysis is employed in order to access the excited states by varying the interpolating operators and smearing parameters independently. In this talk, we report on the details and status of the current calculations and present some preliminary results for positive and negative parity, spin-$1/2$ and spin-$3/2$ states.

Primary author: Dr CAN, K. Utku (RIKEN)

Co-authors: Dr ERKOL, Guray (Ozyegin University); Dr BAHTIYAR, Huseyin (Istanbul Technical University (TR)); Prof. OKA, Makoto; GUBLER, Philipp (Yonsei University); Dr TAKAHASHI, Toru T. (Gunma College of Technology)

Presenter: Dr CAN, K. Utku (RIKEN)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **195** Type: **Invited talk**

Nucleon matrix elements from lattice QCD

Sunday, 5 August 2018 14:00 (30 minutes)

Significant progress has been achieved recently in the determination of properties of nucleons by lattice methods. This includes studies of the response of the nucleon to electromagnetic, weak or beyond the Standard Model probes and the internal dynamics in terms of the contributions from quarks and gluons. In particular, the systematics due to simulating in a finite box with a finite lattice spacing and typically unphysical quark masses have been explored leading to improved evaluation of both benchmark quantities and less well known, more challenging, observables. I present selected highlights of recent calculations, including the nucleon charges, form factors and nucleon sigma terms.

Primary author: COLLINS, Sara (University of Regensburg)

Presenter: COLLINS, Sara (University of Regensburg)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **196** Type: **Talk**

Correct way to extract the dominant part of the Wilson loop in higher representations

Sunday, 5 August 2018 15:00 (20 minutes)

The Abelian dominance of the string tension for the fundamental sources in MA gauge was shown in the lattice simulations. However, it is known that, for higher representations, the naive "Abelian" Wilson loop, which is defined by using the diagonal part of the gauge field, does not reproduce the correct behavior. To solve this problem, for an arbitrary representation of an arbitrary gauge group, we redefine the "Abelian" Wilson loop through the non-Abelian Stokes theorem. By using this redefined operator, we check the "Abelian" dominance for sources in the adjoint representation and the six-dimensional representation of SU(3) gauge group in lattice simulations.

Primary authors: Mr MATSUDO, Ryutaro (Chiba University); SHIBATA, Akihiro (KEK); KATO, Seikou (Oyama College); KONDO, Kei-Ichi (Chiba University)

Presenter: Mr MATSUDO, Ryutaro (Chiba University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **198** Type: **Invited talk**

Recent COMPASS results on the transverse extension of partons inside the proton and plans for a new measurement of the proton radius with muons

Wednesday, 1 August 2018 16:00 (30 minutes)

In the recent years COMPASS at CERN has started to investigate the proton structure using exclusive reactions like Deeply Virtual Compton Scattering (DVCS), where high energy muons are scattered off a hydrogen target. This reaction allows to access Generalised Parton Distributions and thus the 3-dimensional structure of the proton. From a pilot measurement in 2012 first results were obtained for the dependence of the DVCS cross section on the momentum transfer. The exponential slope of this cross section is related to the transverse extension of the parton distributions in the nucleon.
Further investigations of the proton structure are proposed for the time after the LS2 shutdown of the CERN accelerator complex. To obtain new input in the current puzzle of the proton radius we plan a measurement of elastic muon-proton scattering using the CERN high energy muon beam. As will be discussed such a measurement is complementary and can reach the same precision as the planned experiments at Mainz and PSI using elastic scattering of low energy electrons and muons, respectively, but with different sources of systematic uncertainties.

Primary author: KABUSS, Eva-Maria (Johannes Gutenberg-Universitat)

Presenter: KABUSS, Eva-Maria (Johannes Gutenberg-Universitat)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **199** Type: **Talk**

Competing Order in the Hexagonal Hubbard Model

Friday, 3 August 2018 17:20 (30 minutes)

I will report on our studies of strongly correlated fermions on the hexagonal lattice with Hybrid Monte-Carlo simulations. In particular, we have determined the phase diagram in on-site U and nearest-neighbor repulsion V of the extended Hubbard model in the region $V < U/3$ where it can be simulated without a fermion sign problem. Several important algorithmic improvements, such as the analogue of a chiral fermion action with an exact sublattice symmetry or a complexified Hubbard field to avoid domain walls, were necessary for this unbiased study of the competition between spin-density wave and charge-density wave formation in the ground state. For $V > U/3$ or away from half filling the model is also well suited to diagnose and test approaches to circumvent the sign problem.

Primary author: Prof. VON SMEKAL, Lorenz (Justus-Liebig University Giessen)

Co-authors: Dr SMITH, Dominik (Justus-Liebig University Giessen); Dr ULYBYSHEV, Maksim (Uni Wuerzburg); Dr BUIVIDOVICH, Pavel (Regensburg University)

Presenter: Prof. VON SMEKAL, Lorenz (Justus-Liebig University Giessen)

Session Classification: Focus Subsection - Parallel

Track Classification: Focus Subsection: Emergent Gauge Fields and Chiral Fermions

Contribution ID: **200** Type: **Poster**

The role of the thermal f0(500) or sigma in chiral symmetry restoration

Friday, 3 August 2018 18:23 (1 minute)

We analyze the $f_0(500)$ state generated as a pole of $\pi\pi$ scattering within unitarized low-energy effective theories at finite temperature. The relation of that thermal pole with the scalar susceptibility is studied within a scalar saturation approach, which yields results complying with lattice data. The robustness and predictability of this method are studied in terms of the low-energy constants involved and the unitarization method. A detailed fit to lattice data is provided, which is compared to a Hadron Resonance Gas description. Our analysis highlights the importance of this thermal state to describe the main qualitative features of the scalar susceptibility around the chiral transition.

Primary authors: Ms VIOQUE-RODRÍGUEZ, Andrea (Universidad Complutense Madrid); Prof. GÓMEZ NICOLA, Angel (Universidad Complutense Madrid); Ms FERRERES-SOLÉ, Silvia (Lund University)

Presenter: Ms VIOQUE-RODRÍGUEZ, Andrea (Universidad Complutense Madrid)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **201** Type: **Talk**

In-medium heavy quarkonium from lattice NRQCD

Sunday, 5 August 2018 14:00 (30 minutes)

We present the final results from a multi-year [1,2] study of the in-medium spectral properties of heavy quarkonium bound states on the lattice. In this work we combine high statistics N_f=2+1 ensembles from the HotQCD collaboration with the effective theory NRQCD and improved Bayesian spectral reconstruction methods. We corroborate earlier findings on the sequential suppression of quarkonium states with respect to their binding energy and provide updated values on the melting temperatures. In particular we are able to overcome previous disagreements between different Bayesian methods.
The main result is our first robust determination of the in-medium mass shifts of quarkonium ground states, which we find are negative, consistent with the behavior observed in potential based computations.

[1] S. Kim, P. Petreczky, A.R., PRD91 (2015) 054511
[2] S. Kim, P. Petreczky, A.R., Nucl.Phys. A967 (2017) 724 and in preparation

Primary authors: PETRECZKY, Peter (BNL); KIM, Seyong (Sejong University); Prof. ROTHKOPF, Alexander (University of Stavanger)

Presenter: Prof. ROTHKOPF, Alexander (University of Stavanger)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **202** Type: **Talk**

Quark-photon vertex from lattice QCD in Landau gauge

Sunday, 5 August 2018 16:50 (20 minutes)

We study the nonperturbative structure of the quark-photon vertex in Landau gauge. To this end we utilize Green's functions from two-flavor lattice QCD simulations and extract all longitudinal and transversal form factors. Interestingly, our lattice results fit rather well with solutions of the inhomogenous Bethe-Salpether equation of the vertex in the rainbow-ladder approximation. Though, differences are seen, too.

Primary authors: Ms LEUTNANT, Milena (Friedrich-Schiller-University Jena); Dr STERNBECK, Andre (Friedrich-Schiller-University Jena)

Presenter: Dr STERNBECK, Andre (Friedrich-Schiller-University Jena)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **203** Type: **Talk**

Non-abelian Higgs theory in a strong magnetic field and confinement

Thursday, 2 August 2018 15:30 (30 minutes)

We investigate non-abelian Higgs theory in a constant strong magnetic field, where the lowest-Landau-level approximation can be used. At a critical magnetic value $eB = m^2$, the off-diagonal charged vector fields behave as one-dimensional massless fields and give a strong correlation along the magnetic direction, which may lead a new type of confinement caused by off-diagonal vector fields.

Primary author: SUGANUMA, Hideo (Kyoto University)

Presenter: SUGANUMA, Hideo (Kyoto University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **204** Type: **Invited plenary talk**

Bayesian techniques and applications to QCD

Wednesday, 1 August 2018 11:00 (30 minutes)

Connecting experimental measurements, numerical simulations and microscopic theory to form a genuine understanding of nuclear matter in extreme conditions requires robust statistical tools. In this talk I will discuss Bayesian techniques, which allow the practitioner to make explicit her prior knowledge, as well as uncertainty, in a well controlled manner. As examples for application of Bayesian techniques in the realm of the strong interactions I will discuss the extraction of spectral functions from lattice QCD [1,2] and the recent estimates of transport properties from hydrodynamic modeling [3].

[1] M. Jarrell, J.E. Gubernatis Phys. Rep. 269 (1996) 133
[2] Y. Burnier, A.R., PRL 111 (2013) 182003
[3] J.E. Bernhard et.al. PRC94 (2016) 024907

Primary author: Prof. ROTHKOPF, Alexander (University of Stavanger)

Presenter: Prof. ROTHKOPF, Alexander (University of Stavanger)

Session Classification: Plenary

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **205** Type: **Poster**

On the order of the thermal transition in QCD as function of the number of quark flavours and their masses

Friday, 3 August 2018 18:02 (1 minute)

The extraction of the order of the thermal transition of QCD at zero chemical potential, with two dynamical flavours of massless quarks, has proven to be a formidably difficult task. A first order region is found in the chiral limit only on coarse lattices and employing unimproved fermion discretisations, but whether it survives in the continuum limit is yet far from being known.
This situation motivates attempts to better constrain the first-order region by studying its extension in additional parameter directions, which might allow for controlled extrapolations to the chiral limit.
The idea is based on the fact that a first-order transition in the chiral limit on a finite system represents a 3-state coexistence. Hence, if a continuous parameter is varied such as to weaken the transition, like increasing the strange quark mass or considering nonzero imaginary chemical potential, the 3-state coexistence may terminate in a tricritical point, which governs, by known critical exponents, the functional behavior of the second-order boundary lines emanating from it. Thus, if such a boundary line can be followed into the tricritical scaling regime, an extrapolation becomes possible.
We investigated to which extent one can exploit the dependence of the chiral transition on the number of light degenerate flavours N_f, re-interpreted as continuous parameter in the path integral formulation, as a means to perform controlled chiral extrapolations in the (m, N_f)-plane.

Primary authors: CUTERI, Francesca (J. W. Goethe Universität); PHILIPSEN, Owe (Goethe-University Frankfurt); Dr SCIARRA, Alessandro (J. W. Goethe Universität)

Presenter: CUTERI, Francesca (J. W. Goethe Universität)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **206** Type: **Talk**

One-loop lattice study of composite bilinear operators in Supersymmetric QCD

Friday, 3 August 2018 17:20 (20 minutes)

We study 4-dimensional SQCD with gauge group $SU(N_c)$ and N_f flavors of chiral super-multiplets on the lattice. We perform extensive calculations of matrix elements and renormalization factors of composite operators in Perturbation Theory. In particular, we compute the renormalization factors of quark and squark bilinears, as well as their mixing at the quantum level with gluino and gluon bilinear operators. From these results we construct correctly renormalized composite operators, which are free of mixing effects and may be employed in non-perturbative studies of Supersymmetry. All our calculations have been performed with massive matter fields, in order to regulate the infrared singularities which are inherent in renormalizing squark bilinears. Furthermore, the quark and squark propagators are computed in momentum space with nonzero masses.

This work is a feasibility study for the perturbative computations relevant to a number of observables, such as spectra and distribution functions of hadrons, but in the context of supersymmetric QCD, as a forerunner to lattice investigations of SUSY extensions of the Standard Model.

Primary author: Dr COSTA, Marios (University of Cyprus)

Co-author: Prof. PANAGOPOULOS, Haralambos (University of Cyprus)

Presenter: Dr COSTA, Marios (University of Cyprus)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **207** Type: **Talk**

Pion condensation and the QCD phase diagram at finite isospin density

Friday, 3 August 2018 15:20 (20 minutes)

In this talk I will discuss various aspects of pion condensation at finite temperature and density. At T=0, the phase diagram will be mapped out in the mu_I-mu_B plane, and we will discuss the competition between an inhomogeneous chiral condensate and a pion condensate. At finite T, we map out the phase diagram in the mu_I-T plane focusing on the deconfinement and chiral transitions as well as the onset of pion condensation. Comparison with recent lattice data will be made.

Primary authors: Prof. ANDERSEN, Jens Oluf (NYNU); Mr KNESCHKE, Patrick (UiS); Dr ADHIKARI, Prabal (St. Olaf College)

Presenter: Prof. ANDERSEN, Jens Oluf (NYNU)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **208** Type: **Invited talk**

Toward a unified description of jet and medium scales in heavy-ion collisions

Thursday, 2 August 2018 16:50 (30 minutes)

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: TYWONIUK, Konrad (CERN)

Presenter: TYWONIUK, Konrad (CERN)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **209** Type: **Talk**

Lattice Landau gauge quark propagator at finite temperature

Sunday, 5 August 2018 17:50 (20 minutes)

We study the Landau gauge quark propagator, at finite temperature, using quenched lattice simulations. Special focus is given to the behaviour of the momentum space form factors across the confinement-deconfinement phase transition.

Primary authors: OLIVEIRA, Orlando (University of Coimbra); SILVA, Paulo (Center for Physics, University of Coimbra)

Presenter: SILVA, Paulo (Center for Physics, University of Coimbra)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **210** Type: **Poster**

High Precision Statistical Landau Gauge Lattice Gluon Propagator Computation

Friday, 3 August 2018 18:03 (1 minute)

We report on results for the Landau gauge gluon propagator computed from large statistical ensembles and look at the compatibility of the results with the Gribov-Zwanziger tree level prediction for its refined and very refined versions. Our results show that the data is well described by the tree level estimate only up to momenta p ⊠1 GeV, while clearly favoring the so-called Refined Gribov-Zwanziger scenario. We also provide a global fit of the lattice data which interpolates between the above scenario at low momenta and the usual continuum one-loop renormalization improved perturbation theory after introducing an infrared log-regularizing term.

Primary authors: DUDAL, David; OLIVEIRA, Orlando (University of Coimbra); SILVA, Paulo (Center for Physics, University of Coimbra)

Presenter: SILVA, Paulo (Center for Physics, University of Coimbra)

Session Classification: Poster

Track Classification: A: Vacuum structure and confinement

Contribution ID: **211** Type: **Talk**

Mass-deformed Yang-Mills theory in the covariant gauge and its gauge-invariant extension through the gauge-independent BEH mechanism

Sunday, 5 August 2018 15:40 (20 minutes)

We consider the mass-deformed Yang-Mills theory in the Landau gauge which is obtained by just adding a gluon mass term to the Yang-Mills theory in the Landau gauge. We show that the decoupling solution is well reproduced by taking into account loop corrections from the mass-deformed Yang-Mills theory. Then we derive gluon confinement/deconfinement from the reflection-positivity violation/restoration to give a phase structure in the phase diagram of the gauge-scalar model, which includes confinement phase in the pure Yang-Mills theory as a subregion. This result is not restricted to the Landau gauge, rather it is a gauge-invariant result. In fact, we show that the mass-deformed Yang-Mills theory is reproduced as a gauge-fixed version of the gauge-invariantly extended theory which is identified with the gauge-scalar model with a fixed-modulus scalar field in the fundamental representation of the gauge group, as a consequence of the gauge-independent Brout-Englert-Higgs mechanism proposed recently by the author. This result is suggested from the Fradkin-Shenker continuity as an elucidation of the Osterwalder-Seiler theorem for the Confinement-Higgs complementarity on the lattice.

Primary author: KONDO, Kei-Ichi (Chiba University)

Presenter: KONDO, Kei-Ichi (Chiba University)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **212** Type: **Invited talk**

Parton-pseudo distribution functions from Lattice QCD

Wednesday, 1 August 2018 14:30 (30 minutes)

The light-cone definition of Parton Distribution Functions (PDFs) does not allow for a direct ab initio determination employing methods of Lattice QCD simulations that naturally take place in Euclidean spacetime. In this presentation we focus on pseudo-PDFs where the starting point is the equal time hadronic matrix element with the quark and anti-quark fields separated by a finite distance. We focus on Ioffe-time distributions, which are functions of the Ioffe-time ν, and can be understood as the Fourier transforms of parton distribution functions with respect to the momentum fraction variable x. We present lattice results for the case of the nucleon and we also perform a comparison with the pertinent phenomenological determinations.

Primary authors: ZAFEIROPOULOS, Savvas; ORGINOS, Kostas (William and Mary - Jlab); Prof. RADYUSHKIN, Anatoly (ODU and JLAB); Mr KARPIE, Joseph (College of William & Mary); ROTHKOPF, Alexander (Heidelberg University)

Presenter: ZAFEIROPOULOS, Savvas

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **213** Type: **Talk**

Meson spectroscopy and scattering from lattice QCD

Sunday, 5 August 2018 16:30 (20 minutes)

I will discuss some recent progress in studying excited and exotic mesons using first-principles lattice QCD calculations. In particular, I will present some new work on meson-meson scattering involving mesons with non-zero spin, an area which is important for understanding many of the various puzzling structures that have been observed in experiment but where so far lattice QCD calculations have been very limited. Highlights include a calculation of $\rho\pi$ isospin-2 scattering, where the mixing between the dynamically-coupled S and D-wave channels was determined, and some work on heavy exotic-flavour tetraquarks.

Primary author: THOMAS, Christopher (University of Cambridge)

Presenter: THOMAS, Christopher (University of Cambridge)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **214** Type: **Invited plenary talk**

Experimental Aspects of Heavy Quark Exotica

Thursday, 2 August 2018 09:00 (30 minutes)

Striking new phenomena in the charmonium and bottomonium regions have been uncovered in the past few years that likely point to the existence of configurations of quarks and gluons beyond the traditional quark-antiquark picture of mesons and the three-quark picture of baryons. I will review recent progress, highlight outstanding puzzles, and give some indication for how future progress might be made.

Primary author: MITCHELL, Ryan

Presenter: MITCHELL, Ryan

Session Classification: Plenary

Track Classification: C: Heavy quarks

Contribution ID: **216** Type: **Talk**

Fisher information metrics for binary classifier evaluation and training

Friday, 3 August 2018 15:00 (30 minutes)

Different evaluation metrics for binary classifiers are appropriate to different scientific domains and even to different problems within the same domain. This presentation discusses the evaluation of binary classifiers in experimental high-energy physics, and in particular those used for the discrimination of signal and background events. In the introductory part of the talk, the general properties of binary classifiers for HEP are analysed, and the similarities and differences to other domains are pointed out. The rest of the presentation then focuses on the optimisation of event selection to minimise statistical errors in HEP parameter estimation, a problem that is best analysed in terms of the maximisation of Fisher information about the measured parameters. After describing a general formalism to derive evaluation metrics based on Fisher information, three more specific metrics are introduced for the measurements of signal cross sections in counting experiments (FIP1) or distribution fits (FIP2) and for the measurements of other parameters from distribution fits (FIP3). The FIP2 metric is particularly interesting because it can be derived from any ROC curve, provided that prevalence is also known. In addition to their relation to measurement errors when used as evaluation criteria (which makes them more interesting that the ROC AUC), a further advantage of Fisher information metrics is that they can also be directly used for training decision trees (instead of the Shannon entropy or Gini coefficient). Preliminary results based on the Python sklearn framework are presented.

Primary author: VALASSI, Andrea (CERN)

Presenter: VALASSI, Andrea (CERN)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **217** Type: **Talk**

The emergent light BSM scalar as 0++ sigma-particle or dilaton

Thursday, 2 August 2018 14:00 (30 minutes)

The effective field theory of the light 0^{++} scalar is discussed in an important near-conformal strongly coupled BSM gauge theory and its lattice simulations. Relevant for the composite Higgs, two distinct scenarios are analyzed for the emergent light scalar as composite σ-particle of chiral symmetry breaking or the dilaton of conformal symmetry breaking.

Primary author: Prof. KUTI, Julius (University of California, San Diego)

Presenter: Prof. KUTI, Julius (University of California, San Diego)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **218** Type: **Invited plenary talk**

Determinations of alpha_s from lattice and EFT

Thursday, 2 August 2018 11:15 (15 minutes)

I will discuss determination of α_s from the comparison of the lattice results on the static quark anti-quark static energy at short distances to EFT based weak coupling calculations. I addition I will present results on α_s from the moment of quarkonium correlators.

Primary author: PETRECZKY, Peter (BNL)

Presenter: PETRECZKY, Peter (BNL)

Session Classification: Plenary

Track Classification: C: Heavy quarks

Contribution ID: **220** Type: **Talk**

Determination of the quark-gluon string parameters from the data on pp, pA and AA collisions at wide energy range using Bayesian Gaussian Process Optimization

Wednesday, 1 August 2018 17:00 (20 minutes)

Bayesian Gaussian Process Optimization [1,2,3] can be considered as a method of the determination of the model parameters, based on the experimental data. In the range of soft QCD physics, the processes of hadron and nuclear interactions require using phenomenological models containing many parameters. In order to minimize the computation time, the model predictions can be parameterized using Gaussian Process regression, and then provide the input to the Bayesian Optimization.

In this paper the Bayesian Gaussian Process Optimization has been applied to the Monte Carlo model with string fusion [4,5,6]. The parameters of the model are determined using experimental data on multiplicity and cross section of pp, pA and AA collisions at wide energy range (from SPS to LHC). Principal Component Analysis has been applied to the data and model predictions. The results provide important constrains on the transverse radius of the quark-gluon string (r_{str}) and the mean multiplicity per rapidity from one string (μ_0).

The research was supported by Russian Science Foundation under grant 17-72-20045.

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Primary author: Dr KOVALENKO, Vladimir (St Petersburg State University)

Presenter: Dr KOVALENKO, Vladimir (St Petersburg State University)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **221** Type: **Talk**

Using Machine Learning methods for improving data quality in the ALICE experiment

Thursday, 2 August 2018 16:20 (20 minutes)

Data Quality plays an important role in many high-energy physics experiments, e.g. the ALICE experiment at the Large Hadron Collider (LHC), CERN. Currently used methods for quality assurance problems such as quality label assignment or particle identification, rely heavily on human expert judgments and complex computations. Those tasks, however, can be easily addressed by modern machine learning methods. In this talk, we present an overview of machine learning approaches to several tasks. The first task we address is automatic assignment of data quality label. Our results for the Time Projection Chamber (TPC) show that using the best performing algorithm, i.e. Random Forest, we can correctly classify over 75% of all data without any human interaction with over 95% precision. We also show how to use a Random Forest to improve the current approach for Particle identification task. Instead of manual 'cut-offs', we propose to select desired type of particles with more complex classification algorithms. Our tests indicate that with our solution we can distinguish up to 16.4% more of desired particles, while increasing the purity of resulting subsample by 9.33%. Finally, as a first step toward a semi-real-time anomaly detection tool, we present a proof-of-concept solution for generating the possible responses of detector clusters to particle collisions, using the real-life example of the TPC. Its essential component is a fast generative model that allows to simulate synthetic data points that bear high similarity to the real data, so they can be compared with the real detector output. Leveraging recent advancements in machine learning, we propose to use state-of-the-art generative models, namely Variational Autoencoders (VAE) and Generative Adversarial Networks (GAN), which are up to 103 faster than currently used GEANT3 simulation tool.

Primary author: GRACZYKOWSKI, Lukasz Kamil (Warsaw University of Technology (PL))

Presenter: GRACZYKOWSKI, Lukasz Kamil (Warsaw University of Technology (PL))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **222** Type: **Invited plenary talk**

Nonperturbative Casimir Effects

Saturday, 4 August 2018 11:30 (30 minutes)

The Casimir effect is a quantum phenomenon rooted in the fact that vacuum fluctuations of quantum fields are affected by the presence of physical objects and boundaries. As the energy spectrum of vacuum fluctuations depends on distances between (and geometries of) physical bodies, the quantum vacuum exerts a small but experimentally detectable force on neutral objects. Usually, the associated Casimir energy is calculated for free or weakly coupled quantum fields. In our talk, we review recent studies of the Casimir effect in non-perturbative regimes: we discuss chiral and deconfining transitions in finite geometries, describe the influence of phase transitions on the Casimir energy and characterize the role of topological defects on Casimir phenomenon and vice versa.

Primary author: Dr CHERNODUB, Maxim (Institute Dennis Poisson, University of Tours, France)

Presenter: Dr CHERNODUB, Maxim (Institute Dennis Poisson, University of Tours, France)

Session Classification: Plenary

Track Classification: Focus Subsection: Emergent Gauge Fields and Chiral Fermions

Contribution ID: **223** Type: **Talk**

Confinement, infrared screening of the QCD vacuum density and small cosmological constant

Friday, 3 August 2018 15:20 (20 minutes)

The dynamical cancellation of the vacuum energy of the QCD sector in the infrared regime is a relevant problem for both particle physics and cosmology. We find an argument related to the existence of a Z_2-symmetry for the renormalization group flow derived from the bare Yang-Mills Lagrangian, and show that the cancellation of the vacuum energy may arise motivated both from the renormalization group flow solutions and the effective Yang-Mills action. At the cosmological level, we explore the stability of the electric and magnetic attractor solutions, both within and beyond the perturbation theory, and find that thanks these latter the cancellation between the electric and the magnetic vacua components is achieved at macroscopic space and time separations. This implies the disappearance of the conformal anomaly in the classical limit of an effective Yang-Mills theory and the emergence of novel space-time instanton-like objects with possibly important implications for real-time dynamics of QCD confinement.

Primary authors: PASECHNIK, Roman (Lund university); Dr MARCIANO, Antonino (Fudan U.); Dr ADDAZI, Andrea (Fudan U.)

Presenter: PASECHNIK, Roman (Lund university)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **224** Type: **Talk**

The Born-Oppenheimer approximation in an effective field theory framework

Friday, 3 August 2018 15:20 (20 minutes)

The Born–Oppenheimer approximation is the standard tool for the studying systems in atomic molecular systems. It is founded on the observation that the energy scale of the electron dynamics in a molecule is larger than that of the nuclei. A very similar physical picture can be used to describe QCD states containing heavy quarks as well as light quarks and gluonic excitations. In this talk I will report on a recent work [PRD 97, 016016 (2018)] in which we derived the Born–Oppenheimer approximation for atomic and hadronic molecular systems in an effective field theory framework by sequentially integrating out degrees of freedom living at energies above the typical energy scale where the dynamics of the heavy degrees of freedom occurs.

Primary author: KREIN, Gastao (UNESP)

Presenter: KREIN, Gastao (UNESP)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **225** Type: **Invited talk**

Perturbative investigation of ”Wilson-line”-type operators in Parton Physics

Sunday, 5 August 2018 15:30 (30 minutes)

We consider a class of gauge-invariant nonlocal quark bilinear operators, including a finite-length Wilson-line (called Wilson-line operators). The matrix elements of these operators are involved in the recent "quasi-distribution" approach for computing parton distributions nonperturbatively.

In this work, we study the renormalization of two types of classes of Wilson-line operators: straight-line and "staple" operators, which are related to the parton distribution functions (PDFs) and transverse momentum-dependent distributions (TMDs) respectively. In particular, we calculate in Dimensional Regularization (DR), the 1-loop conversion factors of straight-line operators between RI' (appropriate for nonperturbative renormalization on the lattice) and MS-bar (typically used in phenomenology) schemes for massive quarks, as well as the 1-loop conversion factors of staple operators for massless quarks. We also compute the RI' renormalization factors of staple operators on the lattice, up to 1-loop level, using Wilson/clover fermions and Symanzik improved gluons.

A nontrivial aspect in the renormalization of such operators is the observed operator mixing, which is disentangled by introducing mixing matrices. The combination of the calculated conversion factors with the nonperturbative RI'-renormalized lattice calculation of a quasi distribution, as well as the matching formula between the quasi distribution and the corresponding physical distribution, computed in MS-bar, leads to a nonperturbative lattice estimate of a parton distribution.

Primary authors: Mr SPANOUDES, Gregoris (University of Cyprus); PANAGOPOULOS, Haris

Presenter: Mr SPANOUDES, Gregoris (University of Cyprus)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **226** Type: **Talk**

Thermal hadron production rate in confining gauge theories

We use the AdS/CFT correspondence to derive a formula which can be used, in confining gauage theories, to compute the production rate of hadrons from a quark-gluon plasma at freez-out temperature T_f. The formula is given in terms of the retarded Green's function of the corresponding hadronic current operator evaluated at freez-out temperature T_f, and reduces to the Cooper-Frye formula in the low-energy (low-p_T) or hydrodynamic limit. The formula is applicable both at weak and strong coupling regimes as long as one can compute the retarded Green's function of the corresponding hadronic current operator in those regimes. In addition to the low-energy (low-p_T) hadrons, it can also be used to compute the production rate of high-p_T hadrons or high-energy jets by computing the retarded Green's function of the corresponding hadronic current operator.

Primary author: Dr MAMO, Kiminad (Stony Brook University)

Presenter: Dr MAMO, Kiminad (Stony Brook University)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **227** Type: **Talk**

Quark-hadron duality at finite temperature : Local Correlators in the hadron resonance gas

Wednesday, 1 August 2018 15:20 (20 minutes)

We analyze the role of high spin hadronic states in the correlation functions of conserved charges such as baryon and electric charge and strangeness at finite temperature. The corresponding integrated quantities correspond to (global) thermal fluctuations and their related susceptibilities are well known from lattice QCD. At the local level we conjecture an interesting duality between the correlators at zero temperature, and the fluctuations of integrated quantities at low temperatures.

Primary authors: Prof. RUIZ ARRIOLA, Enrique (Universidad de Granada); Dr MEGIAS, Eugenio (Universidad de Granada); Prof. SALCEDO, Lorenzo Luis (Universidad de Granada)

Presenter: Prof. RUIZ ARRIOLA, Enrique (Universidad de Granada)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **228** Type: **Talk**

Colored resonances in strongly-coupled electroweak scenarios

Taking into account the negative results of searches for new fields, the existence of a gap between SM and New Physics states justifies the use of electroweak effective theories. We consider a non-linear realization of the electroweak symmetry breaking and a set of new heavy states, incorporating colored bosonic and fermionic resonances. By integrating out these heavy resonances, we analyze the implications of these new scales: the pattern of low-energy constants among the SM fields is studied. Some phenomenological consequences are also shown.

Primary author: ROSELL, Ignasi (Universidad CEU Cardenal Herrera)

Co-authors: KRAUSE, Claudius (Fermilab); PICH, Antonio (University of Valencia); SANTOS, Joaquin; SANZ-CILLERO, Juan José (Universidad Complutense de Madrid)

Presenter: ROSELL, Ignasi (Universidad CEU Cardenal Herrera)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **229** Type: **Talk**

Nonperturbative quark-gluon thermodynamics at finite density.

Sunday, 5 August 2018 18:10 (20 minutes)

Thermodynamics of the quark-gluon plasma at finite density is studied in the framework of the Field Correlator Method, where thermodynamical effects of Polyakov loops and the colormagnetic confinement force (CMC) is defined by the spatial Wilson loop projection are taken into account. It was shown that the CMC potential plays an important role in QGP thermodynamics providing the magnetic Debye mass for quarks and gluons. Having found good agreement with numerical lattice data for zero density, an analytical expression for the pressure $P(T, \mu)$ was calculated for $0 < \mu < 400$ MeV and $150 < T < 1000$ MeV. The analytical structure of the expression for the QGP equation of state was studied in the complex μ plane. The resulting multiple complex branch points are found at the Roberge-Weiss values of Im μ, with Re μ defined by the values of Polyakov lines and colormagnetic confinement.

Primary authors: ANDREICHIKOV, Maxim (Institute for Theoretical and Experimental Physcis, Moscow); Prof. SIMONOV, Yuri (Institute for Theoretical and Experimental Physics, Moscow)

Presenter: ANDREICHIKOV, Maxim (Institute for Theoretical and Experimental Physcis, Moscow)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **230** Type: **Talk**

Heavy K* mesons with hidden charm

We report a robust prediction of heavy K^* mesons, which can be viewed as excited kaon states with hidden charm, through a study of the three body system $KD\bar{D}^*$ using the fixed center approximation to the Feddeev equations. The two-body interactions are stringently constrained by the experimental as well as theoretical investigations and leave little space for uncertainties. Concrete coupled channel three-body calculations yield the two heavy K^* mesons: $4337.0 - i3.3$ MeV and $4277.6 - i14.0$ MeV with
$I(J^P) = 1/2(1^-)$.

Similar to the recent discovery of the pentaquark states pentaquark states with hidden charm content, our findings could inspire the experimental community to study the so far unexplored heavy strange physics, help improve our understanding of nonperturbative strong interactions.

Primary author: Dr REN, Xiu-Lei

Co-authors: Prof. GENG, Lisheng (Beihang University); Prof. KHEMCHANDANI, Kanchan (Universidade Federal de Sao Paulo); Prof. TORRES, Alberto Martinez (Universidade de Sao Paulo)

Presenter: Dr REN, Xiu-Lei

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **231** Type: **Invited plenary talk**

The mass of the QCD axion

Friday, 3 August 2018 11:30 (30 minutes)

The strong CP problem of QCD can be solved via the Peccei-Quinn mechanism, which results in not-yet observed particles, called axions. They are natural dark matter candidates. Assuming that all dark matter is axionic, the theory can predict the mass of the axion providing useful hint for experimental searches. I review hier recent theory developments aiming to put such predictions on a solid footing.

Primary author: SZABO, Kalman (Forschungszentrum Jülich GmbH)

Presenter: SZABO, Kalman (Forschungszentrum Jülich GmbH)

Session Classification: Plenary

Track Classification: E: QCD and New Physics

Contribution ID: **232** Type: **Invited talk**

Convolutional Neural Network for Track Seed Filtering at the CMS HLT

Starting from 2020, future development projects for the Large Hadron Collider will constantly bring nominal luminosity increase, with the ultimate goal of reaching a peak luminosity of $5 \cdot 10^{34} cm^{-2} s^{-1}$ for ATLAS and CMS experiments planned for the High Luminosity LHC (HL-LHC) upgrade. This rise in luminosity will directly result in an increased number of simultaneous proton collisions (pileup), up to 200, that will pose new challenges for the CMS detector and, specifically, for track reconstruction in the Silicon Pixel Tracker.

One of the first steps of the track finding workflow is the creation of track seeds, i.e. compatible pairs of hits from different detector layers, that are subsequently fed to to higher level pattern recognition steps. However the set of compatible hit pairs is highly affected by combinatorial background resulting in the next steps of the tracking algorithm to process a significant fraction of fake doublets.

A possible way of reducing this effect is taking into account the shape of the hit pixel cluster to check the compatibility between two hits. To each doublet is attached a collection of two images built with the ADC levels of the pixels forming the hit cluster. Thus the task of fake rejection can be seen as an image classification problem for which Convolutional Neural Networks (CNNs) have been widely proven to provide reliable results.

In this work we present our studies on CNNs applications to the filtering of track pixel seeds. We will show the results obtained for simulated event reconstructed in CMS detector, focussing on the estimation of efficiency and fake rejection performances of our CNN classifier.

Primary author: Mr DI FLORIO, Adriano (Universita e INFN, Bari (IT))

Presenter: Mr DI FLORIO, Adriano (Universita e INFN, Bari (IT))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **233** Type: **Invited talk**

Transition temperature and universal scaling in QCD at zero and non-zero baryon densities

Wednesday, 1 August 2018 14:00 (30 minutes)

We will update our continuum extrapolated result on the chiral crossover temperature in QCD with (2+1)-flavor and physical quark masses. Results are based on calculations with Highly improved Staggered Quarks (HISQ) on three different lattices sizes (Nτ=6,8,12). We systematically study all chiral second-order susceptibilities that diverge in the ciral limit. From a Taylor expansion of these susceptiblities up to forth-order we obtain the dependence of the transition temperature on baryon, electric charge, and strangeness chemical potentials. We also analyse fluctuations along the crossover line. Finally we discuss universal scaling of the susceptibilities with quark mass. From calculations with 5 values of the light quark masses, that are up to a factor 6 smaller than physical, we estimate the transition temperature in the chiral limit. Our results are consistent with O(N) scaling and support the existence of a true-second order phase transition in the chrial limit.

Primary author: SCHMIDT, Christian (University of Bielefeld)

Presenter: SCHMIDT, Christian (University of Bielefeld)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **234** Type: **Poster**

Color screening in 2+1 flavor QCD

Friday, 3 August 2018 18:22 (1 minute)

Following the work in Ref. http://inspirehep.net/record/1670613, we are investigating the Polyakov loop correlator, singlet and octet quark-antiquark correlators, diquark correlators, and screening masses in 2+1 flavor QCD. We are using the highly improved staggered quark (HISQ) action and several lattice spacings at a wide variety of temperatures.
We include more levels of HYP smearing as well as more data for the analysis from which we hope to get better statistics in the long rT range.
The contribution will be a report on the work in progress in the form of a poster.

Primary authors: Mr STEINBEIßER, Sebastian (Technische Universität München); PETRECZKY, Peter (BNL); WEBER, Johannes Heinrich (Michigan State University)

Presenter: Mr STEINBEIßER, Sebastian (Technische Universität München)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **235** Type: **Invited talk**

New view of melting nuclear matter into quark matter

Friday, 3 August 2018 14:00 (20 minutes)

We propose a new view of crossover between nuclear and quark matter. There are already some theoretical discussions on a percolation picture to describe how quark degrees of freedom would appear. In such a picture of classical percolation, however, it was overlooked that nuclear interactions also contribute to quark mobility, and the physical mechanism to make quark wave-functions localized was unclear. We point out that a more realistic situations should be closer to quantum percolation, in which the Anderson localization should be the physical mechanism to make the system be an insulator, that is interpreted in the QCD context as a color confined state. We present a simple model and give a rough estimate of crossover point beyond which quark matter is realized.

Primary authors: FUKUSHIMA, Kenji (The University of Tokyo); Prof. KOJO, Toru (Central China Normal University)

Presenter: FUKUSHIMA, Kenji (The University of Tokyo)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **236** Type: **Invited talk**

Machine learning for hypothesis testing in HEP

Thursday, 2 August 2018 15:00 (30 minutes)

First I will review significant performance gains that were reached for ongoing experiments by applying deep learning techniques classification tasks in jet physics. I will also review how to extend such methods to for cases where we do not have unique labels, but where the labels in simulation themselves are already a production of a random process of simulation. Finally, if times allow I will present methods, that allow using real data and simulation in the training simultaneously to mitigate differences between them.

Primary author: STOYE, Markus (Imperial College (GB))

Presenter: STOYE, Markus (Imperial College (GB))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **237** Type: **Invited talk**

Patterns in pion-exchange

Friday, 3 August 2018 16:20 (20 minutes)

The potential between heavy hadrons due to pion-exchange can be obtained in the quark model (as a straightforward generalisation of the NN potential), or from heavy quark and chiral symmetries. The two approaches are shown to be fundamentally equivalent, and general results applicable to both are discussed. Expressions are derived for the pion-exchange potential between any constituents, combined in arbitrary spin and flavour channels. Although the existence or otherwise of molecular bound states depends on a poorly-constrained parameter, the pattern of which channels are most susceptible to binding is robust and generic, and can be readily understood in terms of the strength and sign of the long-range potential. In this sense the predictions of the molecular model are more tightly constrained by experimental data than the compact multiquark model, which generally predicts a large number of states in all possible spin and flavour channels.

Primary author: BURNS, Timothy

Presenter: BURNS, Timothy

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **238** Type: **Invited talk**

Analysis of LHC quarkonium production data

Sunday, 5 August 2018 14:30 (30 minutes)

A global analysis of ATLAS and CMS measurements reveals a startling observation: the directly-produced mid-rapidity J/ψ, ψ(2S), χc1, χc2 and Υ(nS) have differential cross sections of seemingly identical shapes, when presented as a function of the mass-rescaled transverse momentum, pT/M. This universal momentum scaling pattern, together with the absence of strong polarizations of S-wave mesons (directly or indirectly produced), strongly suggests that the QQbar production mechanisms do not depend on the quantum numbers and mass of the final quarkonium state.
The remarkable similarity of kinematic behaviours among S- and P-wave quarkonia is not a natural expectation of non-relativistic QCD (NRQCD), where each quarkonium state is expected to reflect a specific family of elementary production processes, of significantly different pT-differential cross sections. Remarkably, accurate kinematic cancellations among the variegated (singlet and octet) NRQCD terms can lead to a surprisingly good description of the data.
This peculiar tuning of the NRQCD mixtures leads to a clear prediction regarding the χc1 and χc2 polarizations, the only observables not yet measured: they should be almost maximally different from one another, and from the J/ψ polarization, a striking exception in the global panorama of quarkonium production. Measurements of the difference between the χc1, χc2 and J/ψ polarizations, complementing the observed identity of momentum dependences, represent a decisive probe of NRQCD.
Moreover, the application of dimensional analysis to LHC data (Drell–Yan and quarkonium cross sections) provides strong experimental evidence supporting the validity of the factorization ansatz, a cornerstone of NRQCD. Furthermore, data-driven patterns emerge for the factorizable long-distance bound-state formation effects, including a remarkable correlation between the S-wave quarkonium cross sections and their binding energies.

Primary authors: FACCIOLI, Pietro (LIP and IST, Lisbon); LOURENCO, Carlos (CERN); ARAUJO, Mariana (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part); SEIXAS, Joao (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Presenter: LOURENCO, Carlos (CERN)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **239** Type: **Invited talk**

Progress on the nucleon EDM in lattice QCD

Wednesday, 1 August 2018 16:30 (30 minutes)

EDM of the nucleon, whether observed or further constrained, can be traced back to various CP-violating quark and gluon effective interactions. In order to constrain these effective interactions and, subsequently, the extensions of the Standard Model, nonperturbative calculations of nucleon structure are necessary. Low-energy theories and nucleon models provide ballpark estimates for the nEDM sensitivity to CP violation at the quark/gluon level, while precise and model-independent relations between nEDM and various sources of CP violation are expected from QCD calculations on a lattice. Lattice QCD has reached a respectable level of statistical and systematic precision for hadron spectrum and simple nucleon structure observables with physical quark masses, and on the verge of producing reliable results for nucleon EDM induced by lowest-order quark-gluon operators. In this talk, I will briefly overview the current status of these calculations as well as show some recent preliminary results.

Primary author: Prof. SYRITSYN, Sergey (Stony Brook University)

Presenter: Prof. SYRITSYN, Sergey (Stony Brook University)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **240** Type: **Invited talk**

EFT determination of the hybrid spin potential

Sunday, 5 August 2018 15:40 (20 minutes)

We study the spin-splitting in the spectrum of heavy quarkonium hybrids using non-relativistic effective theory. After sequentially integrating out modes at the scales m_Q, m_Q v and Lambda_QCD, we obtain the spin-dependent potential to order 1/m_Q^2, in which non-perturbative contributions are given by gluonic correlators. With the hybrid potentials obtained from the lattice, we solve the relevant Schrodinger equation in the EFT, and obtain the spin-splitting by applying perturbation theory. Values of non-perturbative contributions are obtained by fitting to lattice data of the charmonium hybrid spectrum. With these non-perturbative parameters obtained, we predict the bottomonium hybrid spectrum.

Primary author: LAI, Wai Kin (TUM)

Presenter: LAI, Wai Kin (TUM)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **241** Type: **Invited talk**

The static quark potential in Maximal Abelian gauge with perturbation theory

Sunday, 5 August 2018 14:40 (20 minutes)

A popular idea, originally proposed by ‘t Hooft, explains confinement in analogy to superconductivity in electromagnetism. Instead of the condensation of electrons, in QCD magnetic monopoles would condense leading to the confinement of the chromoelectric force. Since there are no elementary particles that could act as magnetic monopoles, the gluons themselves take on this role, which can be made explicit in certain gauges. An essential feature of these gauges is the discrimination between diagonal gluons, belonging to the center of the gauge group, and off-diagonal gluons. The most actively studied gauge is called the Maximal Abelian gauge, which minimizes the off-diagonal gluons globally. There is abundant lattice data showing both the existance of magnetic monopoles in this gauge and how they seem to be solely responsible for the linear part of the static quark potential. An interesting feature of these results is that the linear behavior of the monopole contribution seems to extend even to short distances, where the potential becomes perturbative. In order to investigate this, we have calculated the potential and its Abelian projection in Maximal Abelian gauge up to two-loop order in perturbation theory.

Primary author: BERWEIN, Matthias (RIKEN)

Co-author: SUMINO, Yukinari (Tohoku University)

Presenter: BERWEIN, Matthias (RIKEN)

Session Classification: Vacuum structure and confinement

Track Classification: A: Vacuum structure and confinement

Contribution ID: **242** Type: **Invited talk**

Searching for beauty-fully bound tetraquarks using lattice Non-relativistic QCD

Thursday, 2 August 2018 14:20 (20 minutes)

Recently, an unapproved CMS study indicates that there appears to be a QCD bound state approximately 300MeV below the $2\eta_b$ threshold. An obvious candidate for this would be a stable (in QCD) four quark bound-state composed of two bottom-quarks and two anti-bottom quarks: $bb\bar{b}\bar{b}$. This system has generated significant attention in the literature from model-dependent calculations. This talk will discuss the exciting search for this tetraquark state using the first-principles lattice QCD methodology and give a conclusive statement about the existence of such a tetraquark.

Primary authors: HUGHES, Ciaran; Dr EICHTEN, Estia (Fermilab); Dr DAVIES, Christine (University of Glasgow)

Presenter: HUGHES, Ciaran

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **243** Type: **Invited talk**

Statistics and data analysis for neutrino experiments

Wednesday, 1 August 2018 16:00 (30 minutes)

Experiments on neutrinos are very challenging due to the usual collection of very low number of events, the huge and sometime unknown systematics, and the sparse experimental techniques with the corresponding critical assembling of the measurements. All these characteristics point to the necessity of robust, controlled and well established data analyses. Unfortunately, the neutrino community is far from promoting a common framework (like e.g. in LHC) for data analysis and statistics, even if the feeling about that item is more and more rising up. The author will report about specific examples about these difficulties, providing some personal suggestions and perspectives.

Primary author: STANCO, Luca (Universita e INFN, Padova (IT))

Presenter: STANCO, Luca (Universita e INFN, Padova (IT))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **244** Type: **Invited talk**

Do we produce quark-gluon plasma in all hadronic colliding systems?

Wednesday, 1 August 2018 16:00 (30 minutes)

The formation of a QGP in heavy ion collisions and the collective/hydrodynamic expansion of the created medium are well established and reasonably well understood. In particular, looking at anisotropy of the final-state distribution of particles produced in A-A collisions, it is now established that the QGP behaves like a nearly perfect fluid with a shear viscosity close to the KSS bound. This state of nuclear matter was not expected to be produced in reactions involving smaller colliding systems, such as the proton-nucleus (p-A) and proton-proton (p-p) collisions. Nevertheless, a wealth of experimental evidence in recent years has suggested the presence of collective phenomena and a possible QGP medium being formed also in high-multiplicity p-A and p-p collisions. A detailed investigation is needed to establish the cause of the observed collective behavior and to determine if, indeed, a QGP medium is being created or if another mechanism is at play. Over the past year, LHC and RHIC experiments have recorded a large amount of A-A, p-A, d-A and p-p collisions, opening new opportunities in the understanding of collective phenomena in high-multiplicity hadronic final state. Upon reviewing the experimental data and confronting them with theoretical models, a unified paradigm in describing the observed collectivity accross all hadronic collision system is emerging. Potential future paths toward addressing key open questions, especially on collectivity in small colliding systems (p-A and p-p) and new opportunities to study emergent Quantum Chromodynamics phenomena under extreme conditions, will be discussed

Primary author: Dr GUILBAUD, Maxime (CERN)

Presenter: Dr GUILBAUD, Maxime (CERN)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **245** Type: **Invited talk**

Quarkonium cross sections, polarizations and spectroscopy in pp collisions with CMS

Sunday, 5 August 2018 14:00 (30 minutes)

Studies of the production of heavy quarkonium states are very important to improve our understanding of QCD and hadron formation, given that the heavy quark masses allow the application of theoretical tools less sensitive to nonperturbative effects. Thanks to a dedicated dimuon trigger strategy, combined with the record-level energy and luminosity provided by the LHC, the CMS experiment has collected large data samples of quarkonia produced in pp collisions at 7, 8 and 13 TeV. Thanks to its high-granularity silicon tracker, CMS can also reconstruct low-energy photons through their conversions to e+e- pairs, thereby accessing the radiative decays of the P-wave quarkonium states, with a very good mass resolution, so that the J=1 and J=2 states can be resolved.

This allowed the CMS collaboration to perform a series of systematic measurements in quarkonium production physics, including double-differential cross sections and cross-section ratios, polarizations, and feed-down decay fractions involving the chi states, in both the charmonium and bottomonium families. Some of these measurements extend to transverse momentum around or exceeding 100 GeV, probing kinematic regions where the theory calculations are the most reliable.

Such measurements also provide crucial inputs to a better understanding of quarkonium production as a signal of new physics in Pb-Pb collisions.

This talk presents the most recent CMS quarkonium production results, obtained with the 13 TeV pp data, including some first measurements of P-wave production.

Primary author: ARAUJO, Mariana (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Presenter: ARAUJO, Mariana (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **246** Type: **Invited talk**

Color-magnetic flux tubes in dense quark matter

Sunday, 5 August 2018 14:40 (20 minutes)

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: SCHMITT, Andreas (University of Southampton)

Presenter: SCHMITT, Andreas (University of Southampton)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **249** Type: **Invited talk**

The Bayesian Interpretation of Deep Neural Networks: What Is It Good For?

Wednesday, 1 August 2018 15:10 (30 minutes)

Much effort has been expended in deconstructing deep neural networks, that is, in trying to understand their internal representations of data. For example, understanding what convolutional neural networks are doing layer by layer has been the focus of much research. I argue that this effort is largely misplaced. Of far greater importance, in my view, is understanding what these functions approximate and how well they do so. In this talk, I briefly review the so-called Bayesian interpretation of these highly non-linear functions and follow with an exploration of how that interpretation might be exploited.

Primary author: Prof. PROSPER, Harrison (Florida State University)

Presenter: Prof. PROSPER, Harrison (Florida State University)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **250** Type: **Invited talk**

Linear Sigma EFT for Nearly Conformal Gauge Theories

Thursday, 2 August 2018 15:00 (30 minutes)

I discuss using a generalized linear sigma model as an effective field theory (EFT) to describe nearly conformal gauge theories at low energies.
The work is motivated by recent lattice studies of gauge theories near the conformal window, which have shown that the lightest flavor-singlet scalar state in the spectrum (σ) can be much lighter than the vector state (ρ) and nearly degenerate with the PNGBs (pions) over a large range of quark masses.
The studies have also revealed that the flavored scalar states (a_0) may be lighter than the ρ. The EFT naturally incorporates these features. I highlight the crucial role played by the terms in the potential that explicitly break chiral symmetry. The explicit breaking can be large enough so that a limited set of additional terms in the potential can no longer be neglected, with the EFT remaining weakly coupled and usable in this new range. The additional terms contribute importantly to the scalar and pion masses. In particular, they relax the inequality $M_\sigma^2 \geq 3M_\pi^2$, which is incompatible with current lattice data.

Primary authors: INGOLDBY, James (Yale University); LATTICE STRONG DYNAMICS (LSD) COLLABORATION

Presenter: INGOLDBY, James (Yale University)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **251** Type: **Invited talk**

Recent developments in deep-leaning applied to open physics data

Thursday, 2 August 2018 16:40 (20 minutes)

A lot of work done in advancing the performance of deep-learning approaches often takes place in the realms of image recognition - many papers use famous benchmark datasets, such as Cifar or Imagenet, to quantify the advantages their idea offers. However it is not always obvious, when reading such papers, whether the concepts presented can also be applied to problems in other domains and still offer improvements.

One such example of another domain is the task of event classification in high-energy particle-collisions, such as those which occur at the LHC. In this presentation, a classifier trained on publicly available physics data (from the HiggsML Kaggle challenge) is used to test the domain transferability of several recent Machine-Learning concepts.

A system utilising relatively recent concepts, such as cyclical learning-rate schedules and data-augmentation, is found to slightly outperform the winning solution of the HiggsML challenge, whilst requiring less than 10% of the training time, no feature engineering, and less specialised hardware. Other recent ideas, such as superconvergence and stochastic weight-averaging are also tested.

Primary author: STRONG, Giles Chatham (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Presenter: STRONG, Giles Chatham (LIP Laboratorio de Instrumentacao e Fisica Experimental de Part)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **252** Type: **Invited talk**

Cornell Model calibration with NRQCD at N3LO

Thursday, 2 August 2018 15:40 (20 minutes)

The typical energy scale of heavy hadron spectroscopy makes the system accessible to perturbative calculations in terms of non-relativistic QCD. Within NRQCD the predictions of heavy quarkonium energy levels rely on the accurate description of the static QCD potential $V_{\mathrm{QCD}}(r)$. Most recent calculations computed the energy levels of the lower-lying bottomonium states up to $\mathcal{O}(\alpha_s^5 m)$ and $\mathcal{O}(\alpha_s^5 m \log \alpha_s)$ utilizing pNRQCD 1. A closed expression for arbitrary quantum numbers can be found in Ref [2].

Historically, the heavy quarkonium spectroscopy was study using phenomenological approaches such as the Cornell model $V_{\mathrm{Cornell}} = -\kappa/r + \sigma r$, which assumes a short-distance dominant Coulomb potential plus a liner rising potential that emerges at long distances. Such model works satisfactorily in describing the charmonium and bottomonium spectroscopy. However, even when there are physically-motivated arguments for the construction of the Cornell model, there is no connection a priori between the model and QCD parameters.

Based on a previous work on heavy meson spectroscopy [3], we calibrate the Cornell model with NRQCD predictions for the lowest lying bottomonium states at N^{3}LO, in which the bottom mass is varied within a wide range. We show that the Cornell model mass parameter can be identified with the low-scale short-distance MSR mass at the scale $R = 1$ GeV. This identification holds for any value of α_s or the bottom mass. Furthermore we show that a) the "string tension" parameter is completely independent of the bottom mass, and b) the Coulomb strength κ of the Cornell model can be related to the QCD strong coupling constant α_s at a certain scale. Finally we show that for moderate values of r, the NRQCD and Cornell static potentials are in head-on agreement when switching the pole mass to the MSR scheme, which allows to simultaneously cancel the renormalon and sum up large logarithms.

1 N. Brambilla, A. Pineda, J. Soto and A. Vairo, Nucl. Phys. B 566, 275 (2000).

[2] Y. Kiyo and Y. Sumino, Nucl. Phys. B 889, 156 (2014).

[3] V. Mateu and P. G.~Ortega, JHEP 1801 (2018) 122.

Primary authors: Dr GARCIA ORTEGA, Pablo (University of Salamanca); Dr MATEU BARREDA, Vicent (University of Salamanca); RODRIGUEZ ENTEM, David (University of Salamanca); FERNANDEZ, Francisco (Universidad de Salamanca)

Presenter: Dr GARCIA ORTEGA, Pablo (University of Salamanca)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **254** Type: **Invited talk**

Towards a new measurement of the neutron electric dipole moment at the Paul Scherrer Institute

Wednesday, 1 August 2018 17:00 (20 minutes)

The quest for a non-zero electric dipole moment (EDM) in a non-degenerate system such as the neutron is a powerful way to search for physics beyond the standard model in the CP violation framework, complementary to LHC based experiments. So far, no evidence for such an intrinsic property was observed, neither for the neutron nor for any other system. After a long and successful data taking at the ILL, where the best upper limit on the neutron EDM was established in 2006, the RAL/Sussex/ILL apparatus was moved to PSI in 2009. It was upgraded and used by a collaboration of 15 institutions until late 2017. The collected data set represents the most sensitive one and has been also used to search for axion-like particles. I will discuss some of the most recent developments and their impact on both the sensitivity and the control of the systematic effects.

Primary author: Dr ROCCIA, Stephanie (CSNSM - Universite Paris Sud)

Presenter: Dr ROCCIA, Stephanie (CSNSM - Universite Paris Sud)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **255** Type: **Invited talk**

Vacuumlike Jet Fragmentation in a Dense QCD Medium

Thursday, 2 August 2018 17:20 (30 minutes)

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 authors: Mr CAUCAL, Paul (IPhT); Prof. IANCU, Edmond (IPhT); Prof. MUELLER, Alfred (Columbia University); Prof. SOYEZ, Gregory (IPhT)

Presenter: Mr CAUCAL, Paul (IPhT)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **256** Type: **Invited talk**

Forward particle production in proton-nucleus collisions at next-to-leading order

Thursday, 2 August 2018 14:30 (30 minutes)

Reaching next-to-leading order accuracy in perturbative calculations of particle production in QCD at high energy is essential for reliable phenomenological applications. In recent years, the Color Glass Condensate effective theory (the natural framework for such calculations) has indeed been promoted to NLO accuracy. However, the first NLO calculation of single-inclusive hadron production met with an unexpected difficulty: the cross-section suddenly turns negative at transverse momenta of the order of a few GeV, in a range where perturbation theory is expected to be reliable. We summarize recent efforts to understand and solve this issue, as well as to develop a running coupling scheme that can be used to consistently describe various processes in this formalism.

Primary author: DUCLOUE, Bertrand (IPhT Saclay)

Presenter: DUCLOUE, Bertrand (IPhT Saclay)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **257** Type: **Invited talk**

Spectral and transport properties from Lattice QCD

Thursday, 2 August 2018 17:50 (30 minutes)

We will report on recent progress in the determination of spectral and transport properties of heavy quarks. Combining continuum extrapolated correlation functions in a pure SU(3) plasma and spectral reconstructions constrained by phenomenological and perturbative input, we study thermal modifications of quarkonium spectra and improve the determination of heavy quark diffusion coefficients.

Primary author: Dr KACZMAREK, Olaf (University of Bielefeld)

Presenter: Dr KACZMAREK, Olaf (University of Bielefeld)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **258** Type: **Poster**

Monopole Dominance of Confinement in SU(3) Lattice QCD

Friday, 3 August 2018 18:26 (1 minute)

We accurately investigate monopole dominance of quark confinement for both quark-antiquark and three-quark systems in SU(3) quenched lattice QCD in the maximally Abelian gauge at beta=5.8 on 16^3*32 with 2000 gauge configurations. We find monopole dominance of the string tension for quark-antiquark and three-quark systems.

Primary authors: Dr SAKUMICHI, Naomichi (Ochanomizu University); SUGANUMA, Hideo (Kyoto University)

Presenter: SUGANUMA, Hideo (Kyoto University)

Session Classification: Poster

Track Classification: A: Vacuum structure and confinement

Contribution ID: **259** Type: **Invited talk**

Interacting Topological Insulators with Synthetic Dimensions

Friday, 3 August 2018 16:20 (30 minutes)

Recent developments of experimental techniques have given us unprecedented opportunities of studying topological insulators and emergent Dirac and chiral fermions in high dimensions, while some of the dimensions are "synthetic", in the sense that the effective lattice momenta along these synthetic dimensions are controllable periodic tuning parameters. We study interaction effects on topological insulators with synthetic dimensions. We show that although the free fermion band structure of high dimensional topological insulators can be precisely simulated with the "synthetic techniques", the generic interactions in these effective synthetic topological insulators are qualitatively different from the local interactions in ordinary condensed matter systems. And we show that these special but generic interactions have unexpected effects on topological insulators, namely they would change (or reduce) the classification of topological insulators differently from the previously extensively studied local interactions.

Primary author: Dr XU, Cenke (UCSB)

Presenter: Dr XU, Cenke (UCSB)

Session Classification: Focus Subsection - Parallel

Track Classification: Focus Subsection: Emergent Gauge Fields and Chiral Fermions

Contribution ID: **260** Type: **Invited talk**

Recent results from CRESST-III and brief summary of other dark matter direct detection experiments

Thursday, 2 August 2018 16:20 (30 minutes)

A possible explanation of dark matter is the existence of an unobserved massive particle. The mass range and the interaction rate with ordinary matter extend over several orders of magnitude. Different detector technologies will be required in order to reach the necessary sensitivity. The CRESST III experiment (Cryogenic Rare Event Search with Superconducting Thermometers) is best suited to explore the sub-GeV mass region. At CRESST III Dark matter is detected by elastic scatters off a atomic nuclei, which currently provides the best limit in the mass region below 1.8 GeV/c^2. Besides CRESST III a brief summary of dark matter search results using different approaches, like liquid nobel gas detectors, is presented.

Primary author: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Presenter: SCHIECK, Jochen (Austrian Academy of Sciences (AT))

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **261** Type: **Invited talk**

Networked data-science for research, academic communities and beyond

Friday, 3 August 2018 14:00 (30 minutes)

In this talk, I will focus on an exceptional way of doing data-driven research employing networked community. Many examples of collaboration with the data-science community within competitions organised on Kaggle or Coda Lab platforms usually get limited by restrictions on those platforms. Common metrics do not necessarily correspond to the goal of the original research. Constraints imposed by the problem statement typically look artificial for ML-community. Preparing a perfect competition takes a considerable amount of efforts. On the contrary, research process requires a lot of flexibility and ability to look at the problem from different angles. I will describe the alternative research collaboration process can bridge the gap between domain-specific research and data science community. Particularly, it can involve academic researchers, younger practitioners and all enthusiasts who are willing to contribute. Such research process can be supported by an open computational platform that is will be described along with meaningful examples and discussed amongst the audience of the track.

Primary author: USTYUZHANIN, Andrey (Yandex School of Data Analysis (RU))

Presenter: USTYUZHANIN, Andrey (Yandex School of Data Analysis (RU))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **262** Type: **Talk**

First determination of D^*-meson fragmentation functions and their uncertainties at next-to-next-to-leading order

Wednesday, 1 August 2018 16:40 (20 minutes)

In this talk, I will present the first set of next-to-next-to-leading order (NNLO) fragmentation functions (FFs) describing the production of charmed-meson D^* from partons [Phys.Rev. D97 (2018) no.7, 074014]. Exploiting the universality and scaling violations of FFs, we extract the NLO and NNLO FFs through a global fit to all relevant data sets from single-inclusive e^+e^- annihilation. The uncertainties for the resulting FFs as well as the corresponding observables are estimated using the Hessian approach.
We evaluate the quality of the {\tt SKM18} FFs determined in this analysis by comparing with the recent results in literature and show how they describe the available data for single-inclusive $D^{*\pm}$-meson production in electron-positron annihilation.
As a practical application, we apply the extracted FFs to make our theoretical predictions for the scaled-energy distributions of $D^{*\pm}$-mesons
inclusively produced in top quark decays. We explore the implications of {\tt SKM18} for LHC phenomenology and show that our findings of this study can be introduced as a channel to indirect search for top-quark properties.

Primary authors: Dr KHANPOUR, Hamzeh (University of Science and Technology of Mazandaran & Institute for Research in Fundamental Sciences (IPM), IRAN); Dr SOLEYMANINIA, Maryam (School of Particles and Accelerators, Institute for Research in); Dr MOOSAVI NEJAD, Seyed Mohammad (Yazd univ. IRAN)

Presenter: Dr KHANPOUR, Hamzeh (University of Science and Technology of Mazandaran & Institute for Research in Fundamental Sciences (IPM), IRAN)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **263** Type: **Talk**

Disconnected contributions to the hadronic part of the muon anomalous magnetic moment

Sunday, 5 August 2018 17:10 (20 minutes)

The goal of calculating the one loop hadronic contribution to the muon anomalous magnetic moment using lattice QCD, with an error under 1%, requires the calculation of the disconnected contributions. We discuss some of the numerical challenges of computing disconnected vector correlators, in lattice QCD calculations using the highly improved staggered quark (HISQ) action. We report preliminary results and compare them to the results from other lattice QCD calculations.

Primary authors: DAVIES, Christine (University of Glasgow); DETAR, Carleton; EL-KHADRA, Aida (UIUC); Dr MCNEILE, Craig (Plymouth University); VAN DE WATER, Ruth (Fermilab); Dr VAQUERO, Alejandro (University of Utah); Mr YAMAMOTO, Shuhei (University of Utah)

Presenter: Dr MCNEILE, Craig (Plymouth University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **264** Type: **Invited talk**

Charmonium(like) and open charm production at Belle

Sunday, 5 August 2018 16:30 (20 minutes)

A number of new states have been observed from the Belle experiment
ever since the discovery of the X(3872) in 2003
and related studies are still ongoing by using full Belle data set.
Here we report some of recent results on the charmonium and
charmoniumlike states, and also open charm production based on a large data sample recorded at the
Belle detector at the KEKB asymmetric-energy e+e- collider.
Those include the measurement of the absolute branching fraction CCbar
K in B decays, the observation of chi_c0(2P) candidate in e+e- -> J/psi
DDbar, the first search for Zc pair production in U(1S) and U(2S) decays and
in e+e- annihilation at Sqrt(s)=10.52, 10.58, and 10.867 GeV,Â
and the measurement of gamma gamma to eta_c(1S), etac_c(2S) in eta'
pi+pi-.

Primary author: CHOI, Sookyung (Gyeongsang N University)

Presenter: CHOI, Sookyung (Gyeongsang N University)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **265** Type: **Invited talk**

Reviewing hadronic uncertainties in rare semileptonic b decays

Wednesday, 1 August 2018 15:10 (30 minutes)

I will review recent development in the theoretical descriptions of exclusive rare B-meson decays. These developments have the potential to remove one source of theoretical systematic uncertainties, which are presently the biggest roadblock to our understanding of the present $b \longrightarrow s\ell\ell$ anomalies.

Primary author: Dr VAN DYK, Danny (TU Munich)

Presenter: Dr VAN DYK, Danny (TU Munich)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **266** Type: **Invited talk**

Lattice calculation of QED corrections to hadronic decay rates

Thursday, 2 August 2018 16:50 (30 minutes)

Recent developments in the calculation of radiative QED corrections to hadronic weak decays are described and results of numerical simulations presented. A critical discussion of possible future developments will also be given.

Primary author: Prof. GUIDO, Martinelli (Physics Department and INFN Sezione di Roma La Sapienza)

Presenter: Prof. GUIDO, Martinelli (Physics Department and INFN Sezione di Roma La Sapienza)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **267** Type: **Invited talk**

New Machine Learning Tools in ROOT/TMVA

Wednesday, 1 August 2018 16:30 (30 minutes)

In this talk, we will describe the latest additions to the Toolkit for Multivariate Analysis (TMVA), the machine learning package integrated into the ROOT framework. In particular, we will focus on the new deep learning module that contains robust fully-connected, convolutional and recurrent deep neural networks implemented on CPU and GPU architectures. We will present performance of these new libraries on benchmark datasets from high-energy physics. Additionally, we will discuss new developments in parallelization, cross-validation, regression and unsupervised learning and new interfaces to external machine learning frameworks, such as Tensorflow and scikit-learn.

Primary author: Dr MONETA, Lorenzo (CERN)

Presenter: Dr MONETA, Lorenzo (CERN)

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **268** Type: **Invited talk**

Chiral Perturbation Theory with an Isosinglet Scalar

Thursday, 2 August 2018 14:30 (30 minutes)

We discuss an extension of chiral perturbation theory where we include an isosinglet scalar in the Lagrangian. The dynamical effects from the scalar state is of phenomenological relevance in theories where the mass of the isosinglet scalar is comparable to the mass of the pseudo-Goldstone bosons. This near-degeneracy of states is for example observed in certain near-conformal BSM models. From the Lagrangian we calculate the one-loop radiative corrections to the pion mass and decay constant, for different patterns of chiral symmetry breaking of immediate relevance for phenomenology and lattice investigations. We then discuss the results and how our generic approach encompass different interesting limits, such as the dilation limit.

Primary authors: HANSEN, Martin (CP3-Origins, University of Southern Denmark); Mr LANGÆBLE, Kasper (CP3-Origins, University of Southern Denmark); Prof. SANNINO, Francesco (CP3-Origins, University of Southern Denmark)

Presenter: HANSEN, Martin (CP3-Origins, University of Southern Denmark)

Session Classification: Strongly Coupled Theories

Track Classification: G: Strongly Coupled Theories

Contribution ID: **269** Type: **Invited talk**

Structure of pion and kaon from lattice QCD

Sunday, 5 August 2018 15:00 (30 minutes)

Direct lattice computation of the key measures of hadron structure such as the form factors, parton distribution functions, quark distribution amplitudes have always been challenging. With current enormous experimental efforts at JLab (with its 12 GeV upgrade), COMPASS in CERN, RHIC-spin and at a future EIC, it is now crucial to test and exploit the newly proposed lattice QCD ideas in hadron structure which requires increasingly high momenta. Here I will discuss the progress of our ongoing calculation of high-momentum electromagnetic form factors and parton distribution functions from lattice QCD.

Primary author: Dr CHAKRABORTY, Bipasha (Jefferson Lab)

Presenter: Dr CHAKRABORTY, Bipasha (Jefferson Lab)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **270** Type: **Poster**

Black Hole Thermodynamics from D0 Brane Quantum Mechanics

Friday, 3 August 2018 18:13 (1 minute)

D0-brane QM is a 0+1D large-N supersymmetric gauged matrix quantum mechanics which is known to reduce to 10+1D supergravity in the low-temperature limit, and which has been proposed as a nonperturbative definition of M-theory. My poster will discuss the direct tests of gauge/gravity duality that can be made by studying the black hole internal energy with lattice calculations.

Primary authors: BERKOWITZ, Evan; RINALDI, Enrico (Lawrence Livermore National Laboratory); HANADA, Masanori (Kyoto University); Dr VRANAS, Pavlos (LLNL); Dr ISHIKI, Goro (University of Tsukuba); Dr SHIMASAKI, Shinji (KEK)

Presenter: BERKOWITZ, Evan

Session Classification: Poster

Track Classification: G: Strongly Coupled Theories

Contribution ID: **271** Type: **Invited talk**

Progress in Two-Nucleon Spectroscopy

Sunday, 5 August 2018 17:10 (20 minutes)

Anchoring the nuclear interaction in QCD is a long-outstanding problem in nuclear physics. While the lattice community has made enormous progress in mesonic physics and single nucleon physics, continuum-limit physical-point multi-nucleon physics has remained out of reach. I will review CalLat's strategy for multi-nucleon spectroscopy and our latest results.

Primary authors: BERKOWITZ, Evan; RINALDI, Enrico (Lawrence Livermore National Laboratory); KURTH, Thorsten (Bergische Universität Wuppertal); KURTH, Thorsten (Unknown); CLARK, Kate (NVIDIA); WALKER-LOUD, Andre (LBNL); Dr VRANAS, Pavlos (LLNL); NICHOLSON, Amy; NICHOLSON, Amy (New York University); Dr GAMBHIR, Arjun (LLNL); Dr JOO, Balint (JLab); Mr MONGE-CAMACHO, Henry (College of William and Mary, LBNL); Mr BRANTLEY, David (LBNL); Dr MCELVAIN, Kenneth (LBNL); Dr CHANG, Chia Cheng (iTHEMS RIKEN)

Presenter: BERKOWITZ, Evan

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **272** Type: **Invited talk**

Tests of NRQCD with quarkonium production in jets at the LHC

Sunday, 5 August 2018 17:10 (20 minutes)

This talk will describe new tests of quarkonium production using quarkonia that are produced within jets. We study the distribution in the fraction z of a jet's longitudinal momentum carried by the quarkonium. The z distribution is sensitive to the underlying NRQCD production mechanism. Analytic calculations of the z distributions in SCET that incorporate Next-to-Leading-Log (NLL) resummation disagree with default PYTHIA predictions. We describe a modified simulation method which agrees well with NLL analytic calculations. This method is then successfully applied to recent LHCb measurements of J/ψ within jets. We discuss the implications of this measurement for extractions of NRQCD long-distance matrix elements. Finally, we discuss other observables involving quarkonium within jets which may be useful for discriminating between NRQCD production mechanisms.

Primary author: Dr MEHEN, Thomas (Duke University)

Co-author: MAKRIS, Yiannis (LANL)

Presenter: Dr MEHEN, Thomas (Duke University)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **273** Type: **Invited talk**

Towards the NNNLO pressure of cold and dense QCD

Friday, 3 August 2018 17:20 (30 minutes)

I will discuss the current state of perturbation theory of the cold and dense QCD thermodynamics. Alongside, I explain a method of handling the infrared degrees of freedom of the theory using Hard Thermal Loop approximations, suitable for the computation of the non-analytic terms of the pressure. By making use of this framework, I will present the computation of a new term, the leading, "doubly logarithmic", contribution to the NNNLO T=0 pressure.

Primary author: SÄPPI, Matias (University of Helsinki)

Co-authors: KURKELA, Aleksi (University of Stavanger; CERN); VUORINEN, Aleksi (University of Helsinki); ROMATSCHKE, Paul (University of Colorado); GORDA, Tyler (University of Helsinki)

Presenter: SÄPPI, Matias (University of Helsinki)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **274** Type: **Invited plenary talk**

Large N_c QCD and tetraquarks

Thursday, 2 August 2018 09:30 (30 minutes)

Tetraquark properties will be examined in the limit of large N_c of color in QCD. The qualitative differences between molecular and compact teraquarks will be outlined. Consequences of the possible existence of compact tetraquarks will be analyzed and shown to lead to upper bounds in the N_c-behavior of their decay widths. Open questions on theoretical grounds, related to the dynamics of systems composed of two quarks and two antiquarks, will be addressed.

Primary author: Prof. SAZDJIAN, Hagop (IPN, University Paris-Sud, Orsay)

Presenter: Prof. SAZDJIAN, Hagop (IPN, University Paris-Sud, Orsay)

Session Classification: Plenary

Track Classification: B: Light quarks

Contribution ID: **275** Type: **Invited talk**

EFT calculations of P- and T-violating forces in light nuclei

Sunday, 5 August 2018 17:30 (20 minutes)

A nonzero electric dipole moment (EDM) of the neutron, proton, deuteron or helion, in fact, of any finite system necessarily involves the breaking of a symmetry, either by the presence of external fields (i.e., electric fields leading to the case of induced EDMs) or explicitly by the breaking of the discrete parity and time-reflection symmetries in the case of permanent EDMs. Recent results for the relevant matrix elements of nuclear EDM operators based on calculations in chiral effective field theory (chiralEFT) are presented. Furthermore, strategies are discussed for disentangling the underlying sources of CP breaking beyond what is generated by the Kobayashi-Maskawa quark-mixing mechanism in the Standard Model.

Primary author: Dr WIRZBA, Andreas (Forschungszentrum Jülich GmbH)

Presenter: Dr WIRZBA, Andreas (Forschungszentrum Jülich GmbH)

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **276** Type: **Poster**

Type of dual superconductivity for SU(2) and SU(3) Yang-Mills theories

Friday, 3 August 2018 18:12 (1 minute)

We investigate the type of dual superconductivity responsible for quark confinement. For this purpose, we first obtain the static vortex solution of U(N) gauge-scalar models, which reduces to the Abrikosov-Nielsen-Olesen vortex in the U(1) case, by numerically solving the field equations of the gauge-scalar models in the whole range of space without restricting to the long-distance region. Then we use the resulting magnetic field of the vortex to fit the gauge-invariant chromoelectric field connecting a pair of quark and antiquark which was obtained by our numerical simulations for SU(2) and SU(3) Yang-Mills theories on a lattice. This result improves the accuracy of the fitted value for the Ginzburg-Landau parameter to reconfirm the type I dual superconductivity for quark confinement. Moreover, we calculate the Maxwell stress tensor to obtain the distribution of the force around the flux tube. This suggests the attractive force acting perpendicular to the chromoelectric flux tube, in agreement with the type I dual superconductivity.

Primary authors: SHIBATA, Akihiro (KEK); KONDO, Kei-Ichi (Chiba University); KATO, Seikou (Oyama College); NISHINO, Shogo (Chiba Univ.); SASAGO, Takaaki (Chiba Univ.)

Presenter: SHIBATA, Akihiro (KEK)

Session Classification: Poster

Track Classification: A: Vacuum structure and confinement

Contribution ID: **277** Type: **Invited talk**

Lattice QCD inputs for neutrino-nucleon and neutrino-nucleus interactions

Thursday, 2 August 2018 15:30 (30 minutes)

I will discuss recent lattice QCD calculations that constrain aspects of neutrino-nucleon and neutrino-nucleus interactions. In particular, I will show results for axial charges and form factors of the nucleon and of nuclei, constraints of tritium beta decay, and input for neutrinoful and neutrinoless double beta decay.

Primary author: SHANAHAN, Phiala (Massachusetts Institute of Technology)

Presenter: SHANAHAN, Phiala (Massachusetts Institute of Technology)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **278** Type: **Invited talk**

Parity-Violating and Parity-Conserving Asymmetries in ep and eN Scattering in the Qweak Experiment

Thursday, 2 August 2018 17:20 (30 minutes)

The Standard Model provides the current best description of fundamental particles and forces, but among other limitations it fails to account for dark matter which could manifest itself as more massive particles. Precision measurements of well predicted observables in the Standard Model allow for highly targeted tests for physics beyond the Standard Model. The Qweak experiment at Jefferson Lab has made the first precise determination of the weak charge of the proton in elastic scattering of longitudinally polarized electrons from unpolarized protons. To achieve the required precision to measure the small parity-violating asymmetry of -226.5 ± 9.3 parts per billion, we directed a high current polarized electron beam on a liquid hydrogen target and integrated scattered events in eight azimuthally symmetric fused silica Cerenkov detectors. We find a value for the weak charge of proton of 0.0719 ± 0.0045, in agreement with predictions of the Standard Model. This result rules out leptoquark masses below 2.3 TeV and excludes generic new semi-leptonic parity-violation physics beyond the Standard Model below 3.5 TeV. To correct for the contributions from background processes, we conducted several additional parity-violating and parity-conserving asymmetry measurements with different kinematics (elastic and through the production of a Delta resonance), polarization (longitudinal and transverse), and targets (protons, electrons, aluminum, and carbon). I will discuss the results of the main experiment and highlight several ancillary results of interest to experiments at future facilities.

Primary author: DECONINCK, Wouter

Presenter: DECONINCK, Wouter

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **279** Type: **Invited talk**

First Observation of the Parity-Violating Asymmetry in Polarized Cold Neutron Capture on Hydrogen

Thursday, 2 August 2018 17:50 (30 minutes)

We report the first observation of the parity-violating 2.2 MeV gamma-ray asymmetry A_γ^{np}, in neutron-proton capture using polarized cold neutrons incident on a liquid parahydrogen target, at the Spallation Neutron Source at Oak Ridge National Laboratory. The asymmetry isolates the long-range component of the hadronic weak interaction, corresponding to the $\Delta I = 1$, ${}^3S_1 \rightarrow {}^3P_1$ component of the weak nucleon-nucleon interaction. Weak NN interaction observables in few nucleon systems are currently calculated, using modern effective field theory, the $1/N_c$ expansion formalism of QCD, and lattice gauge theory. We measured $A_\gamma^{np} = (-3.0 \pm 1.4\,(\text{stat.}) \pm 0.2\,(\text{sys.}))\times 10^{-8}$, which implies a DDH weak πNN coupling of $h_\pi^1 = (3.1 \pm 1.5) \times 10^{-7}$ and a pion-less EFT constant of $C^{{}^3S_1 \rightarrow {}^3P_1}/C_0 = (-5.2 \pm 2.4) \times 10^{-7}\ \text{MeV}^{-1}$. We describe the experiment, data analysis, systematic uncertainties, and the implications of the result.

Primary author: GERICKE, Michael (University of Manitoba)

Presenter: GERICKE, Michael (University of Manitoba)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **280** Type: **Invited talk**

B decays anomalies at LHCb

Wednesday, 1 August 2018 16:00 (30 minutes)

The LHCb collaboration has measured several observables in the B sector which show consistent deviations from the Standard Model predictions. B decay anomalies are mainly related to lepton flavour universality and angular observables in flavour-changing-neutral-current transitions. In this talk I will present recent results which are key to enlighten new physics scenarios

Primary author: OYANGUREN CAMPOS, Arantza (IFIC - Valencia)

Presenter: OYANGUREN CAMPOS, Arantza (IFIC - Valencia)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **281** Type: **Invited talk**

The Lund Jet Plane

Friday, 3 August 2018 16:00 (30 minutes)

Lund diagrams, a representation of the phase space within jets, have long been used in discussing parton showers and resummations. I will point out that they can also serve as a powerful tool for experimentally characterising the radiation pattern within jets. I will briefly comment on some of their analytical properties and highlight their scope for constraining Monte Carlo simulations. I will examine the use of the Lund plane for boosted electroweak boson tagging, which when used as an input to deep-learning methods yields high performance. Furthermore, much of that performance can be reproduced by using the Lund plane as an input to simpler log-likelihood type discriminators. This suggests a potential for unique insight and experimental validation of the features being used by machine-learning approaches. In the context of this discussion, I will also highlight the importance of accounting for detector effects when considering the performance of machine-learning approaches.

Primary author: DREYER, Frederic Alexandre (MIT)

Presenter: DREYER, Frederic Alexandre (MIT)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **282** Type: **Invited talk**

Precision spectroscopy of charmonium-like (exotic) XYZ states at PANDA/FAIR

Sunday, 5 August 2018 17:30 (20 minutes)

The PANDA experiment represents the central part of the hadron physics programme at the new Facility for Antiproton and Ion Research (FAIR) under construction at GSI/Darmstadt (Germany). The multi-purpose PANDA detector in combination with an intense and high-quality antiproton beam allows for coverage of a broad range of different aspects of QCD, and it is best suited for charmonium spectroscopy.
We present a comprehensive PANDA Monte Carlo simulation study for precision resonance energy scan measurements, using the example of the charmonium-like $X(3872)$ state discussed to be exotic. Apart from the proof of principle for natural decay width and line shape measurements of very narrow resonances, the achievable sensitivities are quantified for the concrete example of the $X(3872)$.
The discussed measurement is uniquely possible witha $\bar{p}p$ annihilation experiment such as PANDA at FAIR.

Primary author: NERLING, Frank (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Presenter: NERLING, Frank (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **283** Type: **Invited talk**

The g-2 Experiment at Fermilab.

Friday, 3 August 2018 14:00 (30 minutes)

The talk will describe the g-2 experiment based at Fermilab. As the experiment enters an exciting period of data taking and analysis, the current status and future prospects will be highlighted.

Primary author: Dr KING, Barry (University of Liverpool)

Presenter: Dr KING, Barry (University of Liverpool)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **285** Type: **Invited talk**

Studying the structure of few-hadron states

Friday, 3 August 2018 16:30 (30 minutes)

Recent years have seen significantly increased interest in hadron spectroscopy, triggered primarily by the experimental discovery of unconventional states. However, experimental data alone is not always sufficient to discern the nature and structure of a given state. In this talk, I discuss a class of observables that are experimentally inaccessible but can be accessed
via lattice QCD. I will explain how this will shed light into the nature of low-lying QCD resonances.

Presenter: BRICENO, Raul (Thomas Jefferson National Accelerator Facillity)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **286** Type: **Invited talk**

Quark masses from lattice QCD

Thursday, 2 August 2018 17:20 (30 minutes)

Quark masses are fundamental parameters of the standard
model that are key for our understanding of the natural laws. Light quark masses give valuable information on the flavor structure of natural laws and on the nature of spontaneous chiral symmetry breaking. The masses of the heavy charm and bottom quark play a key role in the theoretical predictions of the Higgs boson decay rates. Due to confinement, free quarks are never observed in experiments, making a direct experimental determination of these parameters impossible. Lattice QCD offers a unique tool to relate the value of quark masses with well measured experimental quantities like meson masses. In this talk I will give an overview of the efforts of the lattice community in determining precise and accurate values for the quark masses.

Presenter: RAMOS MARTINEZ, Alberto (Trinity College Dublin (IE))

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **287** Type: **Invited talk**

Hyperons: Production systematics, form factors, and diquark correlations

Friday, 3 August 2018 16:00 (30 minutes)

The first measurements of the production of lambda, sigma, cascade, and omega hyperons at large timelike momentum transfers of 13.6, 14.2, and 17.4 GeV^2 have been made using e+e- annihilation data taken at the CESER electron-positron collider at Cornell using the CLEOc detector. The measurements reveal interesting features of hyperon production systematics and timelike form factors, and provide evidence for diquark correlations in hyperon structure.

Presenter: SETH, Kamal (Northwestern University)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **288** Type: **Invited talk**

Standard Model Effective Field Theory and Lepton Flavour Violation

Friday, 3 August 2018 15:00 (20 minutes)

This talk reviews recent theoretical developments in the study of charged lepton flavour violation. It describes the recent progress in the effective field theory interpretation of charged lepton-flavour violating observables in connection with different energy scales by exploiting the SMEFT framework. A systematic approach is briefly presented and applications on muonic and tauonic observables are reported.

Primary author: PRUNA, Giovanni Marco

Presenter: PRUNA, Giovanni Marco

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **292** Type: **Invited talk**

Long distance effects to rare kaon decays

Wednesday, 1 August 2018 14:00 (20 minutes)

Rare kaon decays belong to the class of flavour changing neutral current decays and are forbidden at leading order in the Standard Model. For this reason, these decays constitute attractive channels to look for new physics. The NA62 experiment (CERN) is starting this year to measure rare kaon decay amplitudes and it is important to have precise predictions of these quantities in the Standard Model. Some of these amplitudes are dominated by long-distance hadronic effects that can only be obtained through a non-perturbative calculation. I will present in this talk a proposal and a proof-of-concept calculation on how this can be achieved through lattice simulations.

Primary author: Dr PORTELLI, Antonin (The University of Edinburgh)

Presenter: Dr PORTELLI, Antonin (The University of Edinburgh)

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **293** Type: **Invited talk**

Review of phenomenological analyses of \eta \pi resonances measured at the COMPASS experiment activities and recent results

Friday, 3 August 2018 17:40 (20 minutes)

In this talk I will review the recent analyses and other activities carried out by the JPAC collaboration. In particular, the phenomenological analysis of the COMPASS data on $\eta\pi$ and $\eta'\pi$ partial waves, with the goal of determining in a robust way the pole position of the hybrid meson $\pi_1(1400)$, as well as the ordinary mesons $a_2(1320)$ and the $a_2'(1700)$

Primary author: RODAS BILBAO, Arkaitz (Universidad Complutense de Madrid)

Presenter: RODAS BILBAO, Arkaitz (Universidad Complutense de Madrid)

Session Classification: Light quarks

Track Classification: B: Light quarks

Contribution ID: **294** Type: **Talk**

Stiff Equation of State of Neutron Matter from Thick Isovector Aura

Sunday, 5 August 2018 17:50 (20 minutes)

On account of symmetry energy dropping with density, nuclear isovector density extends farther out than the isoscalar density, leading to an isovector aura surrounding a nucleus. The faster the drop of the symmetry energy and energy of neutron matter with density, the thicker the aura. The width and sharpness of the aura can be assessed by simultaneously analyzing elastic scattering and quasielastic charge-exchange data off the same target, with the two, respectively, testing primarily isoscalar and isovector densities. In the past (P. Danielewicz et al., Nucl. Phys. 958, 147 (2017)) we analyzed unpolarized nucleon elastic and quasielastic cross sections on ^{48}Ca, ^{90}Zr, ^{120}Ca and ^{208}Pb. We now augment the analyzed set with two more targets, ^{92}Zr and ^{94}Zr, and expand the data to include vector analyzing powers. The results consistently point to large widths, ~1fm, of the isovector aura, now for 6 nuclei. Such an aura implies stiff symmetry energy, with a slope parameter L>70MeV, and stiff energy of neutron matter. The neutron skins may be viewed as nucleus-dependent reflections of the aura.

Primary author: DANIELEWICZ, Pawel

Co-author: Mr CIANYI, Yannick (African Institute for Mathematical Sciences)

Presenter: DANIELEWICZ, Pawel

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **295** Type: **Invited talk**

Loop functions in thermal QCD

Sunday, 5 August 2018 14:30 (30 minutes)

We present recent computations of loop functions in thermal QCD
like the Polyakov loop, correlators of Polyakov loops and Wilson lines,
and the cyclic Wilson loop.
We discuss divergences and how to renormalize them.
Finally we compare with lattice data.

Primary author: VAIRO, Antonio

Presenter: VAIRO, Antonio

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **296** Type: **Invited talk**

Isospin violations at BESIII

Friday, 3 August 2018 17:20 (20 minutes)

At present large data samples were accumulated at the BESIII detector, operated in the upgraded electron positron collider in Beijing (BEPC-II), in the energy region of 2.0-4.6 GeV, which provides a super opportunity in the study of light hadron spectra and charmonium(-like) decays. We summarize the isospin violations in recent BESIII analyses, which are divided into three categories: isospin violating charmonium(-like) transitions with a π^0 production, isospin violating processes with a $f_0(980)^0$ production, and isospin violations in baryon final states.

Primary author: Dr QI, Hongrong (Beihang University)

Presenter: Dr QI, Hongrong (Beihang University)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **297** Type: **Invited plenary talk**

The shape of new physics in B-meson decays

Sunday, 5 August 2018 10:00 (30 minutes)

High-precision measurements of flavor-transitions are sensitive to the virtual effects of particles at energies beyond the reach of current colliders. In fact, there are measurements of semileptonic B-meson decays which are in tension with the SM predictions and suggest the existence of new lepton non-universal interactions. I will discuss the phenomenological and theoretical implications of these anomalies, including the extent up to which the SM are understood, the new-physics required or the type of high pT signatures and simplified mediators one should be looking for at the LHC.

Primary author: MARTIN CAMALICH, Jorge (CERN)

Presenter: MARTIN CAMALICH, Jorge (CERN)

Session Classification: Plenary

Track Classification: C: Heavy quarks

Contribution ID: **298** Type: **Invited talk**

XYZ States at BESIII

Friday, 3 August 2018 14:00 (20 minutes)

In recent years, a new class of exotic charmonium-like states, also referred to as XYZ states, have been discovered. Being incompatible with the simple quark-antiquark model, they are candidates for non-standard hadrons such as tetraquarks, meson molecules, and hybrids. The BESIII experiment operating at the electron-positron collider BEPCII at IHEP (Beijing) has accumulated a large amount of data in the tau-charm mass region and offers unique access to the study of XYZ states. In this contribution, the latest results on XYZ states at BESIII are presented.

Primary author: KOCH, Leonard (Justus-Liebig-Universität Gießen)

Presenter: KOCH, Leonard (Justus-Liebig-Universität Gießen)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **299** Type: **Invited talk**

Transport in Dense Nuclear Matter

Wednesday, 1 August 2018 17:00 (20 minutes)

Refined calculations of transport phenomena are likely to be in demand in the emerging era of multi-messenger neutron star observations. The outer core of neutron stars presumably consists of a dense plasma comprised of degenerate electrons, muons, protons, and neutrons. Transport phenomena in this region are of particular phenomenological relevance as they impact the damping of hydrodynamic modes and r-modes, the thermal relaxation, and the spin evolution of neutron stars. In this talk, the microscopic physics that determine transport such as screening and damping effects are briefly reviewed. A particular focus is placed on the impact of electron-neutron scattering induced by medium effects.

Primary author: STETINA, Stephan

Co-authors: Prof. SANJAY, Reddy (INT Seattle); Dr RRAPAJ, Ermal (University of Guelph)

Presenter: STETINA, Stephan

Session Classification: Nuclear and Astroparticle Physics

Track Classification: F: Nuclear and Astroparticle Physics

Contribution ID: **300** Type: **Invited talk**

Charm Decay at BESIII

Wednesday, 1 August 2018 15:20 (20 minutes)

The BESIII experiment at BEPCII accumulated the world's largest e+e- collision samples at 3.773 and 4.178 GeV. In (semi-)leptonic decay aspect, we have studied the purely leptonic decays D+ -> tau+v and D_S+->mu+v, and the semi-leptonic decays of D0 to K(pi)- mu+v, D+ -> pi0 mu+v, D+(_S) -> eta(') ev and D_S+->K(*)0 e+v. We will report the improved measurements of the branching fractions of these decays and the CKM matrix elements |Vcs(d)|, the D(s)+ decay constants, the form factors of D(s) semi-leptonic decays. In hadronic decay aspect, we will report the measurements of the branching fractions of D0(+) -> PP (P=Peudecalor) decays, the observations of baryonic decay Ds+ -> pn-bar, the pure W-annhilation decay Ds+ -> omega pi+ and scs decay Ds+ -> omega K+. In rare decay aspect, we will report the upper limit of branching fractions of radiative decay D+ -> gamma e+v, c quark unchanged decay D+ -> D0e+v and FCNC process D -> h(h')e+e-
We also collected data at 567pb-1 data at 4.6GeV, which can be use to learn the Lambdac property. We have studied the 12 absolute hadronic branching fractions for Lambdac and we also studied semileptonic decays of Lambdac->Lambda e nu and Lambda mu nu.

Primary author: WANG, Binlong (UCAS)

Presenter: WANG, Binlong (UCAS)

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **301** Type: **not specified**

Opening

Wednesday, 1 August 2018 09:00 (30 minutes)

Presenter: Prof. MULKEEN, Aidan (Maynooth University)

Session Classification: Plenary

Contribution ID: **302** Type: **Invited plenary talk**

Review of experimental results from heavy-ion collisions

Wednesday, 1 August 2018 09:30 (30 minutes)

Presenter: FOKA, Yiota (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Session Classification: Plenary

Contribution ID: **303** Type: **Invited plenary talk**

Status of QCD at nonzero temperature

Wednesday, 1 August 2018 10:00 (30 minutes)

Presenter: BAZAVOV, Alexei (Michigan State)

Session Classification: Plenary

Contribution ID: **307** Type: **Invited plenary talk**

Advances in machine learning and applications to QCD

Thursday, 2 August 2018 10:00 (30 minutes)

Presenter: ASQUITH, Lily (University of Sussex (UK))

Session Classification: Plenary

Contribution ID: **308** Type: **Invited plenary talk**

Lattice calculations of αs

Thursday, 2 August 2018 11:00 (15 minutes)

Presenter: RAMOS MARTINEZ, Alberto (Trinity College Dublin (IE))

Session Classification: Plenary

Contribution ID: **309** Type: **not specified**

αs from high-energy collider data

Thursday, 2 August 2018 11:30 (15 minutes)

Presenter: MOCH, Sven-Olaf (Hamburg)

Session Classification: Plenary

Contribution ID: **310** Type: **Invited plenary talk**

Determinations of αs from SCET

Thursday, 2 August 2018 11:45 (15 minutes)

Presenter: HOANG, Andre (University of Vienna)

Session Classification: Plenary

Contribution ID: **312** Type: **Invited plenary talk**

Applications of the functional renormalisation group: From strongly correlated QCD to asymptotically safe quantum gravity

Saturday, 4 August 2018 09:00 (30 minutes)

In this talk I review some applications of the functional renormalisation group to infrared QCD and asymptotically safe quantum gravity (QG). It is shown that the universal nature of the FRG allows for a surprisingly similar formulation of these two physically very different theories. This allows us to discuss their physics in a rather similar fashion.

In QCD current applications concern the quantitative access to correlation functions at vanishing and finite density and temperature, while current applications in QG concentrate on the establishment of the asymptotically safe theory without and with matter content, as well as on phenomenological consequences of an asymptotically safe Standard Model.

The talk closes with a short discussion of the respective perspectives.

Primary author: PAWLOWSKI, Jan M. (University of Heidelberg)

Presenter: PAWLOWSKI, Jan M. (University of Heidelberg)

Session Classification: Plenary

Contribution ID: **313** Type: **Invited plenary talk**

Complex paths beyond Lefschetz thimbles: real time dynamics and the sign problem

Saturday, 4 August 2018 10:00 (30 minutes)

Presenter: ALEXANDRU, Andrei (The George Washington University)

Session Classification: Plenary

Contribution ID: **315** Type: **Invited plenary talk**

GPDs and nucleon tomography

Friday, 3 August 2018 10:00 (30 minutes)

Presenter: SABATIÉ, Franck (CEA Saclay)

Session Classification: Plenary

Contribution ID: **316** Type: **Invited plenary talk**

Parton and quasi-parton distribution functions: EFT description and lattice

Friday, 3 August 2018 09:30 (30 minutes)

Presenter: JI, Xiangdong (Shanghai)

Session Classification: Plenary

Contribution ID: **319** Type: **Invited plenary talk**

Mass definition in QCD and mass extraction

Sunday, 5 August 2018 11:30 (30 minutes)

Primary author: KOMIJANI, Javad (Glasgow)

Presenter: HELLER, Urs M. (American Phycsical Society)

Session Classification: Plenary

Contribution ID: **320** Type: **Invited plenary talk**

Mike Pennington - an appreciation

Sunday, 5 August 2018 12:30 (20 minutes)

Presenter: KIZILERSÜ , Ayşe (Adelaide)

Session Classification: Plenary

Contribution ID: **322** Type: **Invited plenary talk**

SCET and jets in QCD

Monday, 6 August 2018 10:30 (30 minutes)

Presenter: STEWART, Iain (MIT)

Session Classification: Plenary

Contribution ID: **323** Type: **Invited plenary talk**

Dark matter from strongly coupled dark sectors

Monday, 6 August 2018 11:55 (30 minutes)

Presenter: DIENES, Keith (University of Arizona)

Session Classification: Plenary

Contribution ID: **324** Type: **Invited talk**

Searching for new physics with jet substructure

Friday, 3 August 2018 16:30 (30 minutes)

The high energy scale of the LHC and the large associated Lorentz boost of hadronically decaying massive particles has resulted in the creation of a new approach to jet identification. Jet substructure, or the use of angular and energy distributions within jets, has proven to be a powerful means of differentiating between hadronic decays of massive particles and QCD multijets production. This rapidly evolving field is now a key part of the ATLAS and CMS physics programs, and is frequently used to identify W/Z bosons, H bosons, top quarks, and more. In particular, jet substructure techniques have become a critical tool in the search for new physics, both extending past results into new regimes and opening up new possibilities and new analysis strategies. I will present an overview of the many uses of jet substructure as applied to the search for new physics by both the ATLAS and CMS collaborations, as well as a brief outlook into how jet substructure techniques are being refined for the next set of search results.

Primary author: SCHRAMM, Steven (Universite de Geneve (CH))

Presenter: SCHRAMM, Steven (Universite de Geneve (CH))

Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics

Contribution ID: **325** Type: **Invited talk**

Continuous signal modelling in a multidimensional space of coupling parameters

Wednesday, 1 August 2018 17:20 (20 minutes)

The plans for the second Run of the LHC changes the focus in the Higgs sector from searches to precision measurements. Effective Lagrangians can be used for parameterisation. A signal morphing method is developed to take all parameters into account simultaneously and model interference effects. It provides a continues description of arbitrary physical signal observables such as cross sections or differential distributions in a multidimensional space of coupling parameters. This method is capable of morphing signal distributions and rates based on a minimal orthogonal set of independent base samples and therefore allows to directly fit the coupling parameters that describe the SM and possible non-SM interactions for, for example, the Higgs boson.

Primary author: BRENNER, Lydia (Deutsches Elektronen-Synchrotron (DE))

Presenter: BRENNER, Lydia (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **326** Type: **Invited plenary talk**

Multi-hadron observables from lattice QCD

Sunday, 5 August 2018 11:00 (30 minutes)

Nearly half a century after its formulation, calculating the resonance spectrum of QCD in a reliable way continues to be challenging. These observables are of great interest, in particular because the abundance of exotic or otherwise poorly-understood states, together with new theoretical methods, could provide a real opportunity to unlock a deeper understanding of the strong force. Here numerical lattice QCD promises to be a powerful tool, systematically relating the quark- and gluon-field lagrangian to a tower of low-lying hadronic excitations. In this talk I will review the status of resonance lattice calculations in which the unstable nature of the excitations is rigorously treated by calculating multi-hadron scattering and transition amplitudes. I will outline both numerical and formal challenges and summarize recent progress on both fronts, focusing on coupled-channel scattering and three-particle states.

Primary author: HANSEN, Maxwell (CERN)

Presenter: HANSEN, Maxwell (CERN)

Session Classification: Plenary

Track Classification: B: Light quarks

Contribution ID: **327** Type: **Talk**

Introduction and Goals of The Session

Wednesday, 1 August 2018 14:00 (20 minutes)

Statistics plays a crucial role in the extraction of information from physics measurements, and its scope has been steadily increasing in the XXI century, pushed in particular by development of machine learning tools. In this talk will be given an introduction of the status of statistics practice, relying on the driving example of HEP, and a look at the goals for the three days of talks, bringing to focus a few specific topics of special relevance covered by the session.

Presenter: DORIGO, Tommaso (Universita e INFN, Padova (IT))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **328** Type: **Talk**

Summary and closing of section H

Friday, 3 August 2018 17:20 (20 minutes)

Summary Section H

Presenter: Dr GLEYZER, Sergei (University of Florida (US))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **329** Type: **Poster**

The electromagnetic respond of quark gluon plasma in asymmetry heavy ion collisions

Friday, 3 August 2018 18:07 (1 minute)

In this work we investigate the response of the QGP with the constant electrical conductivity to the electromagnetic
fields in asymmetry collisions such as Cu- Au collisions . We study the response of resistive fluid with finite electrical conductivity σ to the presence of coupled transverse electric and magnetic fields analytically.
Here, we consider the combination of relativistic hydrodynamic equations with Maxwell equations and
solve in (1+1) dimensions a set of coupled MHD equations.

Primary author: Dr FARZANEH KORD, Ahmad (Hakim Sabzevari University)

Presenter: Dr FARZANEH KORD, Ahmad (Hakim Sabzevari University)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **330** Type: **Invited talk**

Recent highlights of the LHC program on jets in heavy ion collisions

Thursday, 2 August 2018 16:20 (30 minutes)

Hard scattered quarks and gluons have been used extensively as multi-scale probes of the strongly interacting medium produced in relativistic heavy ion collisions. The high statistics data recorded in the Large Hadron Collider and large transverse momentum reach due to the high nucleon-nucleon center-of-mass energy have opened a new era for the understanding of the mechanism of parton-medium interaction and for the extraction of medium properties. In this talk, recent highlights of the LHC program on the jets, coming from particles produced by high pT partons, are reviewed and discussed. Future performance of the LHC experiments on heavy ion jet physics at the HL-LHC will also be briefly discussed.

Primary author: Prof. LEE, Yen-Jie (Massachusetts Institute of Technology)

Presenter: Prof. LEE, Yen-Jie (Massachusetts Institute of Technology)

Session Classification: Deconfinement

Track Classification: D: Deconfinement

Contribution ID: **331** Type: **not specified**

Closing Remarks

Monday, 6 August 2018 12:45 (10 minutes)

Presenter: SKULLERUD, Jon-Ivar (National University of Ireland Maynooth)

Session Classification: Plenary

Contribution ID: **332** Type: **Poster**

On the quark-gluon vertex at nonvanishing temperature

Friday, 3 August 2018 18:00 (1 minute)

The phase structure of QCD can be explored with functional methods. The challenge is to devise and solve an appropriate truncation of the corresponding equations. Here the application to theories similar to QCD but without the sign problem of lattice methods (QCD-like theories) becomes useful, as truncations can be tested by comparison to corresponding lattice results also at nonvanishing density. The universality of a certain class of truncations is shown for three dierent theories including QCD. Going one step further, results for the quark-gluon vertex, the main model input of most contemporary studies, will be shown.

Primary author: CONTANT, Romain (University of Graz)

Presenter: CONTANT, Romain (University of Graz)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **333** Type: **not specified**

Summary

Monday, 6 August 2018 12:25 (20 minutes)

Presenter: BRAMBILLA, Nora

Session Classification: Plenary

Contribution ID: **334** Type: **Poster**

Spectral properties of light and charm mesons from Nf=2+1 anisotropic lattice QCD

Friday, 3 August 2018 18:27 (1 minute)

We compute temporal correlators and spectral functions for light, open charm and charmonium mesons in the pseudoscalar and vector channel for a range of temperatures below and above the deconfinement transition. The study is carried out using anisotropic lattice QCD with 2+1 dynamical flavours, a_s=0.123fm and a_s/a_t=3.5. The high-temperature results are benchmarked by comparing them to reconstructed correlators obtained by direct summation of the zero temperature correlator. We use two Bayesian methods to reconstruct the spectral functions: the maximum entropy method and the more recent BR metod.

Primary authors: QUINN, Ryan (Maynooth University); SKULLERUD, Jon-Ivar (National University of Ireland Maynooth); ROTHKOPF, Alexander (Heidelberg University); GLESAAEN, Jonas Rylund

Presenter: QUINN, Ryan (Maynooth University)

Session Classification: Poster

Track Classification: D: Deconfinement

Contribution ID: **335** Type: **Invited talk**

Quarkonium and doubled charmed baryon production at LHCb

Sunday, 5 August 2018 17:50 (20 minutes)

Charmed mesons and baryons provide an ideal laboratory to probe non-perturbative strong interaction dynamics. The LHCb experiment, with its excellent vertexing, tracking and particle identification capabilities, is very suitable for the study of charmed mesons and baryons, and interesting results in this area have been obtained from several recent analyses of LHCb data. Following the discovery of the doubly charmed baryon Ξ_{cc}^{++} via its decay to $\Lambda_c^+ K^- \pi^+ \pi^+$, this state has now also been confirmed through its decay to the final state $\Xi_c^+ \pi^+$. In addition, the Ξ_{cc}^{++} lifetime has been measured for the first time and found to be $\tau(\Xi_{cc}^{++}) = 256^{+24}_{-22}$ (stat) ± 14 (syst) fs, which firmly establishes that the Ξ_{cc}^{++} baryon decays weakly. In a third analysis, the $\Omega_c 0$ lifetime is measured to be 268 ± 24 fs, which is approximately four times larger than, and inconsistent with, the current world average, 69 ± 12 fs. Quarkonia production in various collision systems (pp, proton-ion, ion-ion and fixed target mode) will also be presented, including central exclusive production where the colliding particles remain intact.

Primary author: MCNULTY, Ronan (University College Dublin (IE))

Presenter: MCNULTY, Ronan (University College Dublin (IE))

Session Classification: Heavy quarks

Track Classification: C: Heavy quarks

Contribution ID: **336** Type: **not specified**

Empty

Thursday, 2 August 2018 17:20 (40 minutes)

Session Classification: Strongly Coupled Theories

Contribution ID: **337** Type: **not specified**

Empty

Session Classification: Heavy quarks

Contribution ID: **338** Type: **not specified**

Empty

Friday, 3 August 2018 16:40 (1 hour)

Session Classification: Vacuum structure and confinement

Contribution ID: **339** Type: **Talk**

empty

Wednesday, 1 August 2018 17:20 (20 minutes)

Session Classification: Heavy quarks

Contribution ID: **340** Type: **Invited plenary talk**

What can neutron star and heavy ion physics learn from each other?

Wednesday, 1 August 2018 12:00 (1 hour)

Primary authors: VUORINEN, Aleksi (University of Helsinki); TEWS, Ingo; ALFORD, Mark (Washington University, St Louis); DANIELEWICZ, Pawel; KLAEHN, Thomas (University of Wroclaw)

Presenters: VUORINEN, Aleksi (University of Helsinki); BLASCHKE, David (University of Wroclaw); TEWS, Ingo; ALFORD, Mark (Washington University, St Louis); DANIELEWICZ, Pawel; KLAEHN, Thomas (University of Wroclaw)

Session Classification: Round table

Contribution ID: **341** Type: **Invited plenary talk**

Determining the strong coupling: status and challenges

Thursday, 2 August 2018 12:00 (1 hour)

Primary authors: VAIRO, Antonio; ROJO, Juan (VU Amsterdam and Nikhef); SOMMER, Rainer Paul (DESY)

Presenters: PICH, Antonio (Unknown); VAIRO, Antonio; ROJO, Juan (VU Amsterdam and Nikhef); SOMMER, Rainer Paul (DESY)

Session Classification: Round table

Contribution ID: **342** Type: **not specified**

Axion physics: status, prospects and challenges

Friday, 3 August 2018 12:00 (1 hour)

Primary authors: LINDNER, Axel (DESY); MARTINELLI, Guido (Sapienza Universita e INFN, Roma I (IT)); LATTANZI, Massimiliano (INFN - National Institute for Nuclear Physics); GIANOTTI, Maurizio

Presenters: LINDNER, Axel (DESY); MARTINELLI, Guido (Sapienza Universita e INFN, Roma I (IT)); LATTANZI, Massimiliano (INFN - National Institute for Nuclear Physics); GIANOTTI, Maurizio; DI VECCHIA, Paolo (Nordita, Stockholm +N. Bohr Inst. Copenhagen)

Session Classification: Round table

Contribution ID: **343** Type: **Invited talk**

20+ years of CLs

I recall the basic properties and history of CLs, a method or procedure to derive robust upper limits in searches for new phenomena that was developed in preparation for Higgs boson searches at LEP200 in the 1990's.

Primary author: READ, Alexander Lincoln (University of Oslo (NO))

Presenter: READ, Alexander Lincoln (University of Oslo (NO))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **344** Type: **Talk**

20+ Years of CL_s

Friday, 3 August 2018 16:00 (30 minutes)

Presenter: READ, Alexander Lincoln (University of Oslo (NO))

Session Classification: Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **345**		Type: **Poster**

Spatial distribution of colour fields in the $SU(3)$ flux tube

Friday, 3 August 2018 18:28 (1 minute)

We present results for our measurements of the chromoelectric and chromomagnetic fields produced by a static quark-antiquark pair in $SU(3)$ Yang-Mills theory at zero temperature. We propose a method for the extraction of the nonperturbative confining part of the longitudinal chromoelectric field and discuss properties of its spatial structure.

Primary authors: Prof. BAKER, Marshall (University of Washington); Prof. CEA, Paolo (INFN - Sezione di Bari); Dr CHELNOKOV, Volodymyr (INFN - Gruppo Collegato di Cosenza); Dr COSMAI, Leonardo (INFN - Sezione di Bari); CUTERI, Francesca (J. W. Goethe Universität); Prof. PAPA, Alessandro (INFN - Gruppo Collegato di Cosenza)

Presenter: CUTERI, Francesca (J. W. Goethe Universität)

Session Classification: Poster

Track Classification: A: Vacuum structure and confinement

Contribution ID: **346** Type: **Invited plenary talk**

Direct Learning of Systematics-Aware Summary Statistics

Monday, 6 August 2018 11:42 (6 minutes)

Complex machine learning tools, such as deep neural networks and gradient boosting algorithms, are increasingly being used to construct powerful discriminative features for High Energy Physics analyses. These methods are typically trained with simulated or auxiliary data samples by optimising some classification or regression surrogate objective. The learned feature representations are then used to build a sample-based statistical model to perform inference (e.g. interval estimation or hypothesis testing) over a set of parameters of interest. However, the effectiveness of the mentioned approach can be reduced by the presence of known uncertainties that cause differences between training and experimental data, included in the statistical model via nuisance parameters. This work presents an end-to-end algorithm, which leverages on existing deep learning technologies but directly aims to produce inference-optimal sample-summary statistics. By including the statistical model and a differentiable approximation of the effect of nuisance parameters in the computational graph, loss functions derived form the observed Fisher information are directly optimised by stochastic gradient descent. This new technique leads to summary statistics that are aware of the known uncertainties and maximise the information that can be inferred about the parameters of interest object of a experimental measurement.

Primary author: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Co-author: DORIGO, Tommaso (Universita e INFN, Padova (IT))

Presenter: DE CASTRO MANZANO, Pablo (Universita e INFN, Padova (IT))

Session Classification: Plenary

Track Classification: H. Statistical Methods for Physics Analysis in the XXI Century

Contribution ID: **347** Type: **Invited plenary talk**

How to find the glueball among the f0s with the QCD counting rules

Monday, 6 August 2018 11:36 (6 minutes)

We propose a model-independent method to ascertain the leading valence composition of a hadron: to measure the energy dependence of its production cross section at a fixed angle interval. This E-dependence, by the QCD Brodsky-Farrar counting rules, falls at high energy with a steepness that depends on the leading quark and gluon composition.
We exemplify with a reaction that could help classify the f0 mesons, exclusive e-e+ -> phi + f0 with an easily reconstructible final state. Some of the f0 may have a glueball gg component in their wavefunction decomposition; this will dominate at high energy over higher twist quark-antiquark components (because they necessarily have a p-wave) or hybrid/tetraquark components (because of the higher number of particles in the final state). We discuss the prospects to carry out this or similar analysis in Belle II.

Primary authors: LLANES-ESTRADA, Felipe J. (Univ. Complutense de Madrid); BRODSKY, Stanley J. (Stanford Linear Accelerator Center); PELAEZ, Jose R. (Univ. Complutense de Madrid)

Presenter: LLANES-ESTRADA, Felipe J. (Univ. Complutense de Madrid)

Session Classification: Plenary

Track Classification: B: Light quarks

Contribution ID: **348** Type: **Invited plenary talk**

On the order of the thermal transition in QCD as function of the number of quark flavours and their masses

Monday, 6 August 2018 11:30 (6 minutes)

The extraction of the order of the thermal transition of QCD at zero chemical potential, with two dynamical flavours of massless quarks, has proven to be a formidably difficult task. A first order region is found in the chiral limit only on coarse lattices and employing unimproved fermion discretisations, but whether it survives in the continuum limit is yet far from being known.
This situation motivates attempts to better constrain the first-order region by studying its extension in additional parameter directions, which might allow for controlled extrapolations to the chiral limit.
The idea is based on the fact that a first-order transition in the chiral limit on a finite system represents a 3-state coexistence. Hence, if a continuous parameter is varied such as to weaken the transition, like increasing the strange quark mass or considering nonzero imaginary chemical potential, the 3-state coexistence may terminate in a tricritical point, which governs, by known critical exponents, the functional behavior of the second-order boundary lines emanating from it. Thus, if such a boundary line can be followed into the tricritical scaling regime, an extrapolation becomes possible.
We investigated to which extent one can exploit the dependence of the chiral transition on the number of light degenerate flavours N_f, re-interpreted as continuous parameter in the path integral formulation, as a means to perform controlled chiral extrapolations in the (m, N_f)-plane.

Primary authors: CUTERI, Francesca (J. W. Goethe Universität); PHILIPSEN, Owe (Goethe-University Frankfurt); Dr SCIARRA, Alessandro (J. W. Goethe Universität)

Presenter: CUTERI, Francesca (J. W. Goethe Universität)

Session Classification: Plenary

Track Classification: D: Deconfinement

Contribution ID: **349** Type: **Invited plenary talk**

Particle Physics Masterclasses

Monday, 6 August 2018 11:48 (7 minutes)

Primary authors: SKULLERUD, Jon-Ivar (National University of Ireland Maynooth); FOKA, Yiota (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Presenter: SKULLERUD, Jon-Ivar (National University of Ireland Maynooth)

Session Classification: Plenary

Contribution ID: **350** Type: **not specified**

Close of conference

Monday, 6 August 2018 12:55 (5 minutes)

Presenter: Mr LAWLESS TD, James

Session Classification: Plenary