Excited QCD 2022

Monday, 24 October 2022 - Saturday, 29 October 2022

Sicily, italy

Book of Abstracts

Contents

2

Relativistic spin-magnetohydrodynamics

Authors: Amaresh Jaiswal[1]; SAMAPAN BHADURY[None]

[1] *NISER Bhubaneswar, Jatnoi, India*

Corresponding Authors: samapan.bhadury@niser.ac.in, amaresh.tifr@gmail.com

Recent relativistic heavy-ion collision experiments have found evidence for the generation of strong magnetic field and global angular momentum. The numerical simulation of evolution of the QCD medium is based on either magnetohydrodynamics or spin-hydrodynamics for calculation of observables pertaining to magnetic field or global angular momentum, respectively. However, these two effects are not entirely separable due to the possible spin alignment of medium constituents in the presence of magnetic fields, similar to the Einstein-de Haas effect. Therefore a unified framework of "spin-magnetohydrodynamics"needs to be developed for precise calculation of experimental observables. Here we present the first formulation of this unified framework in a relativistic context.

Starting from the classical description of spin, a kinetic theory of massive spin-1/2 particles in the presence of a magnetic field is obtained in the small polarization limit. We use a relaxation time approximation for the collision kernel in the relativistic Boltzmann equation and obtain the correction to phase-space distribution function. Building on the kinetic description, we then formulate a non-resistive, relativistic dissipative spin-magnetohydrodynamics for a fluid, whose constituent particles are considered to be spin-polarizable but non-magnetizable. We find multiple novel transport coefficients and show that all dissipative currents i.e. particle diffusion, shear stress tensor, bulk viscous pressure and non-equilibrium spin-tensor contain coupling terms between spin and magnetic field.

4

Perspective studies of charmonium, exotics and baryons with charm and strangeness

Author: Mikhail Barabanov[1]

Co-author: Alexander Vodopyanov [1]

[1] *JINR/IUPAP*

Corresponding Authors: vodo@mail.ru, barabanov@jinr.ru

The spectroscopy of charmonium-like states together with the spectroscopy of charmed and strange baryons is discussed. It is a good testing tool for the theories of strong interactions, including: QCD in both the perturbative and non-perturbative regimes, LQCD, potential models and phenomenological models [1, 2, 3]. An understanding of the baryon spectrum is one of the primary goals of non-perturbative QCD. In the nucleon sector, where most of the experimental information is available, the agreement with quark model predictions is astonishingly small, and the situation is even worse in the strange and charmed baryon sector. The experiments with antiproton-proton annihilation and proton-proton (proton-nuclei) collisions are well suited for a comprehensive spectroscopy program, in particular, the spectroscopy of charmonuim-like states and flavour baryons. Charmed and strange baryons can be produced abundantly in both processes, and their properties can be studied in detail [1, 2, 3].
For this purpose an elaborated analysis of charmonium and exotics spectrum together with spectrum of charmed and strange baryons is given. The recent experimental data from different collaborations (BaBar, Belle, BES, LHCb,$\cdots$) are analyzed. A special attention was given to the recently discovered XYZ-particles. The attempts of their possible interpretation are considered [4 - 7]. The results of physics simulation are obtained. Some of these states can be interpreted as higher lying charmonium and tetraquarks with a hidden charm [5, 6, 7] and strangeness [8, 9]. It has been shown that charge/neutral tetraquarks must have their neutral/charged partners with mass values which differ

by few MeV. This hypothesis coincides with that proposed by Maiani and Polosa [10] and need confirmation nowdays. Many heavy baryons with charm and strangeness are expected to exist. But much more data on different decay modes are needed before firmer conclusions can be made. These data can be derived directly from the experiments using a high quality antiproton beam with √Spp\bar up to 5.5 GeV planned at FAIR and proton-proton (proton-nuclei) collisions with √SpN up to 26 GeV planned at NICA.

References
[1] W. Erni et al., arXiv:0903.3905v1 [hep-ex] (2009) 63.
[2] N. Brambilla et al., European Physical Journal C 71:1534, (2011) 1.
[3] J. Beringer et al., Review of Particle Physic, Physical. Review, D 86, (2012).
[4] M.Yu. Barabanov, A.S. Vodopyanov, Physics of Particles and Nuclei Letters, V.8, N.10, (2011) 1069.
[5] M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen, Physics of Atomic Nuclei, V.77, N.1, (2014) 126.
[6] M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen , Physica Scripta, T 166 (2015) 014019.
[7] M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen, A.I. Zinchenko, Physics of Atomic Nuclei, V.79, N 1 (2016) 126.
[8] R. Aaij et al., Phys. Rev. 95, (2017) 012002
[9] R. Aaij et al., Phys. Rev 118 (2017) 022003
[10] L. Maiani, F. Piccinini, A.D. Polosa, V. Riquer, Phys. Rev. Lett. 99 (2007) 182003.

5

Estimation of the spatial diffusion coefficient of Heavy Quarks in light of Gribov-Zwanziger action

Author: Najmul Haque[1]

[1] *NISER, India*

Corresponding Author: nhaque@niser.ac.in

The heavy quark momentum diffusion coefficient κ is one of the most important ingredients for the Langevin description of the heavy quark dynamics. In the temperature regime relevant for the heavy ion collision phenomenology, a substantial difference exists between the lattice estimations of κ and the corresponding leading order (LO) result from the hard thermal loop (HTL) perturbation theory. Moreover, the indication of poor convergence in the next-to-leading order (NLO) perturbative analysis has motivated the development of several approaches to incorporate the non-perturbative effects in the heavy quark phenomenology. In this talk, I will discuss the results for the non-perturbative estimation of the temperature dependence of the heavy quark diffusion coefficient in a gluonic plasma based on the Gribov-Zwanziger prescription. The gluon propagator, in this framework, depends on the Gribov mass parameter, whose temperature dependence has been obtained by solving the one loop gap equation originating from the horizon condition. Incorporating this modified gluon propagator in the leading order analysis, we find a reasonable agreement with the existing lattice estimates of κ within the model uncertainties, which, in our case, essentially arises from the non-perturbative running coupling adopted from lattice simulation.

6

Recent quarkonium results at Belle II

Author: Dmytro Meleshko[None]

Co-author: James Libby [1]

[1] *Indian Institute of Technology Madras (IN)*

Corresponding Authors: dmytro.meleshko@exp2.physik.uni-giessen.de, james.libby@cern.ch

Belle II offers unique possibilities for the discovery and interpretation of exotic multiquark combinations to probe the fundamentals of QCD.
This talk present recent searches for the hidden bottom transition between Υ(10750) and χbJ, as well as other results from an energy scan around 10.75 GeV.

7

Dispersive analysis of the γγ→DD data and the confirmation of the DD bound state

Author: Igor Danilkin[None]

Corresponding Author: danilkin@uni-mainz.de

In my talk, I will present our recent data-driven analysis of the γγ→D+D− and γγ→D0D0 reactions from threshold up to 4.0 GeV in the DD invariant mass. For the S-wave contribution, we adopt a partial-wave dispersive representation, which is solved using the N/D ansatz. The left-hand cuts are accounted for using the model-independent conformal expansion. The D-wave χc2(3930) state is described as a Breit-Wigner resonance. The resulting fits are consistent with the data on the invariant mass distribution of the e+e−→J/ψDD process. Performing an analytic continuation to the complex s-plane, we find no evidence of a pole corresponding to the broad resonance X(3860) reported by the Belle Collaboration. Instead, we find a clear bound state below the DD threshold at 3695(4) MeV, confirming the previous phenomenological and lattice predictions.

8

Four-quark states from functional methods

Author: Joshua Hoffer[None]

Co-author: Christian S. Fischer [1]

[1] *Justus-Liebig-Universität Gießen*

Corresponding Authors: christian.fischer@theo.physik.uni-giessen.de, joshua.hoffer@theo.physik.uni-giessen.de

Since the discovery of tetraquarks, there has been a lot of excitement around this topic from the theoretical as well as the experimental side. To study the poperties of these four-quark states we use a functional framework which combines (truncated) Dyson-Schwinger and Bethe-Salpeter equations in Landau gauge. This approach allows us to extract qualitative results for mass spectra, decay widths and wavefunctions of tetraquark candidates. Furthermore, we can investigate the possible internal structure of such states. We report on recent developments and results using this functional framework and give an overview about the current status as well as future developments.

9

Critical Endpoint of QCD in a Finite Volume and Mesonic Contributions to the Columbia Plot

Author: Julian Bernhardt[1]

Co-authors: Bernd-Jochen Schaefer ; Christian Fischer [2]; Philipp Isserstedt [3]

[1] *Institute for Theoretical Physics, Justus Liebig University Giessen*

[2] *University of Giessen, Germany*

[3] *University of Giessen*

Corresponding Authors: bernd-jochen.schaefer@theo.physik.uni-giessen.de, philipp.isserstedt@physik.uni-giessen.de, julian.bernhardt@physik.uni-giessen.de, christian.fischer@theo.physik.uni-giessen.de

We summarize recent results on the volume dependence of the location of the critical endpoint in the QCD phase diagram. To this end, we employ a sophisticated combination of Lattice Yang–Mills theory and a (truncated) version of Dyson–Schwinger equations in Landau gauge for $2 + 1$ quark flavours. We study this system at small and intermediate volumes and determine the dependence of the location of the critical endpoint on the boundary conditions and the volume of a three-dimensional cube with edge length L. We also discuss quark number fluctuations in this setup. Additionally, we report on the chiral limit of the light quarks for different strange quark masses at vanishing chemical potential.

10

Inhomogeneous phases in the QCD phase diagram

Author: Theo Motta[1]

[1] *Justus Leibig University Gießen*

Corresponding Author: theo.motta@protonmail.com

For more than two decades now, models of QCD such as the NJL model and quark-meson models have been showing that a specially inhomogeneous phase is favoured over the homogeneous one at high chemical potentials. Few studies, however, have attempted to show this within QCD itself. This is in part due to the fact that the usual stability analysis formalism had not yet been developed for QCD. In this talk, I will summarise a newly developed framework for performing such a QCD-based stability analysis and discuss some preliminary results.

11

Machine Learning for Hadron Spectroscopy

Author: Cesar Fernandez-Ramirez[1]

[1] *UNED*

Corresponding Author: cefera@gmail.com

Recently, JPAC collaboration has developed and benchmarked a systematic approach to use Deep Neural Networks as a model-independent tool to analyze and interpret experimental data and to determine the nature of an exotic hadron. Specifically, we studied the line shape of the Pc(4312) signal reported by the LHCb collaboration. This novel method presents great potential and can be applied to other near-threshold resonance candidates.

12

Heavy-lighty excited hadrons - old laces and new pieces

Authors: Maciej Michal Nowak[1]; Maciej Nowak[None]

[1] *Wroclaw University of Science and Technology (PL)*

Corresponding Authors: maciej.michal.nowak@cern.ch, maciejandrzejnowak@gmail.com

I will review the traditional approach to heavy-light hadrons based on effective models of QCD and I will confront those old predictions for heavy-light hadrons (with the emphasis on exotica) with the recent developments based on string theory. The presentation exploits recent series of papers coauthored by me (Phys. Rev. D100 (2019)126023;
Phys.Rev. D104 (2021)114021; Phys. Rev. D104 (2021) 114022; Phys. Rev. D104 (2021) 114023; Phys. Rev D105 (2022)054021 and Phys. Rev. D105 (2022)114021).

13

Latest results from Kaon experiments at CERN

Author: Nicolas Lurkin[1]

Co-author: Patrizia Cenci [2]

[1] *Universite Catholique de Louvain (UCL) (BE)*

[2] *INFN Perugia (IT)*

Corresponding Authors: nicolas.lurkin@cern.ch, patrizia.cenci@cern.ch

The NA62 experiment at CERN collected the world's largest dataset of charged kaon decays in 2016-2018, leading to the first measurement of the branching ratio of the ultra-rare K+ –> pi+ nu nu decay, based on 20 candidates.
The radiative kaon decay K+ ⟶ pi0e+vg (Ke3g) was studied with a data sample of O(100k) Ke3g candidates with sub-percent background contaminations recorded in 2017-2018. The most precise measurements of the branching ratio and of T-asymmetry are achieved.
An analysis of the flavour-changing neutral current K+ -> pi+ mu+ mu- decay, based on about 27k signal events with negligible background contamination collected in 2017 and 2018 with a dedicated pre-scaled di-muon trigger, leads to the most precise determination of the branching ratio and of the form factor.
New preliminary results are obtained from an analysis of the K+ -> pi+ gamma gamma decay using data collected in 2016—2018 with a minimum-bias trigger. The sample, about 15 times larger than the previous largest one, leads to an unprecedented sensitivity. This analysis can be naturally extended to search for the K+ -> pi+ a, a -> gamma gamma process, where a is a short-lived axion-like particle.
Dedicated trigger lines were employed to collect dilepton final states, which allowed establishing new stringent upper limits on the rates lepton flavor and lepton number violating kaon decays.
NA62 can also be run as a beam-dump experiment, by removing the Kaon production target and moving the upstream collimators into a "closed" position. Analyses of the data taken in beam-dump mode were performed to search for visible decays of exotic mediators, with a particular emphasis on Dark Photon Models.
An overview of the latest NA62 results and the future prospect of the experiment are presented.
The first observation of the decay K± ⟶ π0 π0 μ± ν (K00μ4) by the NA48/2 experiment at the CERN and the preliminary measurement of the branching ratio are also presented. The result is converted into a first measurement of the R form factor in Kl4 decays and compared with the prediction from 1-loop Chiral Perturbation Theory.

16

Singularities and Resummation between the Jet and Color Glass Condensate Evolution Equations.

Author: Jibran Bohra[1]

Co-author: Heribert Weigert [2]

[1] *University of Cape Town*

[2] *University of Oulu*

Corresponding Authors: jabohra17@gmail.com, heribert.weigert@oulu.fi

My MSc thesis involves the study of a map that links jet evolution to CGC (color glass condensate) evolution. In recent years, there has been a concerted effort to formalize the many similarities between jet evolution, which models high energy particle production experiments - and CGC evolution, which models high energy scattering experiments. To this end, a conformal map which establishes the link between jet and CGC evolutions has been identified. My goal is to investigate the various properties of the aforementioned conformal map to lay the foundation to identify phenomenological shortcomings of CGC evolution. More specifically, there exist collinear singularities in the JIMWLK equation (an example of a CGC evolution equation) at the NLO level which do not exist in the standard jet evolution equation at the NLO level. The aim is to use the conformal map to reverse engineer the required mechanisms in the JIMWLK equation for greater phenomenological success.

17

Bottomonium suppression in the QGP –From EFTs to non-unitary quantum evolution

Authors: Ajaharul Islam[1]; Antonio Vairo[None]; Anurag Tiwari[2]; Michael Strickland[1]; Miguel´Ángel Escobedo Espinosa[None]; Nora brambilla[None]; Peter Vander Griend[None]

[1] *Kent State University*

[2] *Tata Institute of Fundamental Research*

Corresponding Authors: nora.brambilla@ph.tum.de, anurag.tiwari128@gmail.com, mstrick6@kent.edu, antonio.vairo@mytum.de, aislam2@kent.edu, scbt1984@gmail.com, vandergriend@tum.de

The strong suppression of bottomonia in ultrarelativistic heavy-ion collisions is a smoking gun for the production of a deconfined quark-gluon plasma (QGP). In this talk, I will discuss recent work that aims to provide a more comprehensive and systematic understanding of bottomonium dynamics in the QGP. The new paradigm is based on an open quantum system approach applied in the framework of the potential non-relativistic QCD EFT (pNRQCD), which has recently been extended to next-to-leading order in the binding energy over temperature. I demonstrate that the computation of bottomonium suppression can be reduced to solving a Lindblad-type equation for the evolution of the b-bbar reduced density matrix including both singlet and octet states and transitions between them. To solve the resulting Lindblad equation, we make use of a quantum trajectories algorithm which can be deployed in a massively parallel manner. Our computation depends on two fundamental transport coefficients that have been evaluated independently using lattice QCD. Comparisons with experimental data for bottomonium suppression and elliptic flow show very good agreement between theory and experiment.

Reference: JHEP 2022, 303 (2022)

19

Jet and heavy flavour measurements in heavy Ion collisions with ATLAS

Authors: Alexandre Lebedev[None]; Alexandre Lebedev[1]

Co-author: Erich Ward Varnes [2]

[1] *Iowa State University (US)*

[2] *University of Arizona (US)*

Corresponding Authors: lebedev@iastate.edu, alexandre.lebedev@cern.ch, erich.varnes@cern.ch

Measurements of hard processes in heavy-ion collisions provide powerful and broad information on the dynamics of the hot, dense plasma formed in relativistic nucleus-nucleus collisions. This talk gives an overview of the latest jet measurements with the ATLAS detector at the LHC, utilizing the high statistics 5.02 TeV Pb+Pb data collected in 2015 and 2018. This talk presents multiple measurements of jet and dijet production in heavy ion collisions and studies of jet structure using novel analysis techniques. New results sensitive to the role of color-charge on jet quenching using EW boson-tagged jets will also be shown. The talk will also present the latest measurements of heavy flavor in heavy ion collisions. A particular focus of the measurements is the systematic comparison of fully unfolded data to state-of-the-art theoretical models.

21

The Tcs(2900) in the hidden gauge approach and its spin partners

Authors: Dai L. R.[None]; Oset Eulogio[1]; Raquel Molina Peralta[None]; Tanja Branz[None]

[1] *IFIC-UV*

Corresponding Author: raquel.molina@ific.uv.es

Recently, the LHCb has reported the first flavor exotic state, the $X_0(2866)$ or $T_{cs}(2900)$. We recall the predictions made within the hidden gauge formalism of a bound state of $D^*\bar{K}^*$ with $I = 0, J^P = 0^+$, which is manifestly exotic, and we associate it to the state reported in the recent LHCb experiment. Fine tuning the parameters to reproduce exactly the mass and width of the state, we report two more states stemming from the same interaction, one with 1^+ and the other with 2^+. For reasons of parity, the 1^+ state cannot be observed in $D\bar{K}$ decay, and we suggest to observe it in the $D^*\bar{K}$ spectrum. On the other hand, the 2^+ state can be observed in $D\bar{K}$ decay but the present experiment has too small statistics in the region of its mass to make any claim. We note that measurements of the $D^*\bar{K}$ spectrum and of the $D\bar{K}$ with more statistics should bring important information concerning the nature of the $X_0(2866)$ and related ones that could be observed. We propose different reactions where the spin partners of the observed states could be observed.

22

Higgs boson decay into gluons: IR cancellation in the decay rate at NLO using Implicit Regularization

Author: Ana Isabel Costa Pereira[1]

Co-authors: Adriano Cherchiglia [2]; Brigitte Hiller [1]; Marcos Sampaio [3]

[1] *CFisUC, Department of Physics, University of Coimbra, 3004-516 Coimbra, Portugal*

[2] *Instituto de Física Gleb Wataghin –Universidade Estadual de Campinas, Campinas-SP, Brasil*

[3] *Universidade Federal do ABC, 09210-580 , Santo André, Brasil*

Corresponding Author: ana.pereira98@icloud.com

Abstract: Implicit Regularization (IReg) is a regularization scheme that works in the physical dimension of the theory and allows for the separation of the ultraviolet (UV) and infrared (IR) divergences of an amplitude. We compute the Higgs decay into gluons using an effective Higgs–Yang-Mills interaction in the limit of infinite top quark mass by using a dimension five operator. The decay

rate for H → gg(g) is calculated in this strictly 4-dimensional set-up to α_sˆ3 order in the strong coupling. We use spinor-helicity formalism to include the processes that contribute at the same perturbative order in the real emission channels consisting of 3 gluons and a gluon and quark-antiquark final states with light (zero mass) quarks. Unambiguous identification and separation of UV from IR divergences is achieved putting at work the renormalization group scale relation inherent to the method. UV singularities are removed by renormalization and the IR divergences are cancelled due to the method's compliance with the Kinoshita-Lee-Nauenberg (KLN) theorem. The remaining finite integral contributions are evaluated using Package-X. We verify that no evanescent fields such as ε-scalars need be introduced as required by some mixed regularizations that operate partially in the physical dimension.

23

Enhanced charm CP asymmetries from final state interactions

Authors: Patricia Magalhaes[1]; Patricia Magalhaes[2]

Co-authors: Ignacio De Bediaga Hickman [1]; Tobias Frederico

[1] *CBPF - Brazilian Center for Physics Research (BR)*

[2] *Complutense University of Madri*

Corresponding Authors: patricia.camargo.magalhaes@cern.ch, tobias@ita.br, ignacio.de.bediaga.e.hickman@cern.ch, pcamargos@cern.ch

I developed a mechanism where the final state interaction (FSI) within a CPT invariant two-channel framework can enhance the charge-parity (CP) violation difference between $D^0 \to \pi^-\pi^+$ and $D^0 \to K^-K^+$ decays up to the current experimental value.
%
This result relies upon:
(i) the dominant tree-level diagram,
(ii) the well-known experimental values for the $D^0 \to \pi^-\pi^+$ and $D^0 \to K^-K^+$ branching ratios, and
(iii) the $\pi\pi \to \pi\pi$ and $\pi\pi \to KK$ scattering data to extract the strong phase difference and inelasticity. Based on well-grounded theoretical properties, we found the sign and bulk value of the ΔA_{CP} and $A_{CP}(D^0 \to \pi^-\pi^+)$ recently observed by the LHCb collaboration.

24

CMS ZDC data monitoring for RUN 3

Authors: Aivaras Silale[1]; Cole Douglas Le Mahieu[2]; Mantas Stankevicius[3]; Sorina Popescu[4]; Valdas Rapsevicius[1]

[1] *Vilnius University (LT)*

[2] *University of Kansas*

[3] *CERN*

[4] *The University of Kansas (US)*

Corresponding Authors: valdas.rapsevicius@cern.ch, cole.le.mahieu@cern.ch, mantas.stankevicius@cern.ch, aivaras.silale@cern.ch, sorina.popescu@cern.ch

The CMS Zero Degree Calorimeters (ZDCs) are used to measure very forward and backward neutrons and photons from heavy-ion (and possibly pp) collisions at the LHC. Their purpose is to characterise the geometry of heavy ion, photon nucleus and photon-photon collisions. The ZDCs are built from layers of tungsten and quartz fiber and detect Cerenkov light produced by the showers of particles generated from incoming neutrons and photons. They will serve as basic minimum bias trigger for 2022 PbPb run. To operate the ZDCs efficiently it is vital to have a comprehensive monitoring system. This paper will present design considerations and results of prototype testing of the new ZDC monitoring system. This system operates within the framework of the CMS Online Monitoring System (OMS). A dedicated workspace for the ZDC allows the organizing of monitored metrics in folders and pages. The most important metrics are energy distributions, the shower shape profile and the single neutron peak. At a lower level charge and time distributions for individual channels are available. CMS OMS supports correlation of multiple data sources which allows monitoring of rate per layer of ZDC average flux versus luminosity. Different pages give access to the current status of the detector as well as access to historical data.

25

Regge Theory for the Pion Form Factor

Authors: Adam Szczepaniak[1]; Kevin Quirion[None]

[1] *Indiana University*

Corresponding Authors: aszczepa@iu.edu, kquirion@iu.edu

We propose a model for the electromagnetic form factor of the pion based on Regge theory in which the interaction vertex is represented by a $q\bar{q} \to \pi\pi$ u-channel Regge amplitude, and study the asymptotic limits of various modifications of this model. With this we hope to accurately reproduce the high energy behavior exhibited in $\gamma \to \pi + \pi$ reactions.

26

Studying light flavour resonances in pi+pi- photoproduction

Author: Nadine Hammoud[None]

Corresponding Author: nadine.hammoud.28@gmail.com

The double pion photoproduction is known as an ideal tool for the investigation of nucleon resonances, especially the exotic meson states. To study the interference of meson resonance production and meson-baryon rescattering effects, we focus on the reaction $\gamma p \to \pi^+\pi^- p$. We used Deck model to describe the essential features of the diffractive $\pi^+\pi^-$ photoproduction, assuming that it is dominated by virtual pion exchange.
Aiming at the description of the latest data collected at CLAS12 and GlueX experiments, we computed the moments of the π^+ π^- angular distribution for different beam energies in the helicity frame i.e the rest frame of the $\pi\pi$ with the direction opposite to the recoil nucleon defining the z axis. We also computed the prediction for the P -wave projected differential cross section and compared it by the ones performed by the CLAS collaboration in order to validate our theoretical model.

27

Lifetime and confinement of a quasi-gluon

Author: Fabio Siringo[1]

Co-author: Giorgio Comitini [1]

[1] *Università di Catania e INFN sezione di CT*

Corresponding Author: fabio.siringo@ct.infn.it

The problem of confinement and the nature of the gluon are discussed in the framework of the screened massive expansion, a perturbative analytical approach to non-perturbative QCD.

After a brief review of the method, the main finding are outlined with some emphasis on the anlytic properties of the gluon propagator and on the nature of the complex conjugated poles.

Some conjectures are analysed on the physical role of the complex poles and their (observable?) effects on string tension, condensates, lifetime, mass spectrum and glueball excitations.

The nature of gluon confinement is re-examined at the light of the emerging scenario.

28

News from the strong interactions program of NA61/SHINE

Author: Angelika Magdalena Tefelska[1]

[1] *Warsaw University of Technology (PL)*

Corresponding Author: angelika.tefelska@cern.ch

The NA61/SHINE experimental physics program focuses on searching for the critical point and studying the properties of the onset of deconfinement in the strongly interacting matter. A two-dimensional scan is performed by varying the beam momentum (from 13\textit{A} to 150/158\textit{A} GeV/\textit{c}) and the system size (from p+p to Pb+Pb) of the collided nuclei. This contribution will present the most recent results from the strong interactions (SI) NA61/SHINE program and will include future data taking and analysis plans.

The presented new results will include: hadron spectra, K/π multiplicity ratios as a function of energy, and multiplicity and net-charge fluctuations measured by higher-order moments in p+p, Be+Be, and Ar+Sc collisions. The singly and multi-strange hadron production in p+p reactions will be also discussed. This contribution will also include proton and charged hadron intermittency in Ar+Sc and Pb+Pb reactions, HBT measurements, and collective electromagnetic effects in Ar+Sc collisions. The NA61/SHINE results will be compared with worldwide experiments and predictions of various theoretical models, like EPOS, PHSD, UrQMD, etc. Finally, the motivation for future research and NA61/SHINE upgrade status will be discussed.

29

The QCD phase diagram and the critical end point at large N_c

Authors: Francesco Giacosa[1]; Győző Kovács[2]; Péter Kovács[2]

[1] *Kielce University*

[2] *Wigner RCP*

Corresponding Authors: fgiacosa@ujk.edu.pl, kovacs.peter@wigner.hu, kovacs.gyozo@wigner.hu

We investigated the QCD phase diagram at large N_c in a Polyakov loop extended quark-meson model with particular attention to the critical point(s). An exciting behavior was seen, as the well-known $N_c = 3$ CEP disappears rapidly and leaves a crossover transition in the whole phase boundary. Furthermore, for large enough N_c, a distinct CEP emerges along the temperature axis. Moreover, besides the confined chirally broken and the deconfined chirally symmetric phase, the quarkyonic-type phase was found, which shows confinement and chiral restoration. For these regions of the phase diagram, the pressure also had the expected N_c^0, N_c^2, and N_c^1 scaling, respectively.

30

Bottomonium vector resonances and threshold effects

Authors: Eef van Beveren[1]; George Rupp[2]

[1] *University of Coimbra, Portugal*

[2] *CeFEMA/IST, University of Lisbon*

Corresponding Authors: george@ist.utl.pt, george@tecnico.ulisboa.pt, eef@uc.pt

The bottomonium spectrum is a perfect testing ground for the QCD confining potential and unitarisation effects. First of all, the bottom quark is about three times heavier than the charm quark, so that $b\bar{b}$ systems probe much more the short-range region of that potential. Secondly, the much smaller colour-hyperfine interaction in the B meson makes the $B\bar{B}$ threshold lie significantly higher relative to the $\Upsilon(1S)$ state than the $D\bar{D}$ threshold with respect to the J/ψ.

Another complicating circumstance is that none of the experimentally observed vector $b\bar{b}$ mesons have been positively identified as $^3D_1$ states, contrary to the situation in charmonium. This makes definite conclusions about level splittings very problematic. Finally, there are compelling indications that the $\Upsilon(10580)$ is not the $\Upsilon(4S)$ state, as is generally assumed.

In this talk I shall review an empirical modelling of vector $b\bar{b}$ resonances above the open-bottom threshold, including the $\Upsilon(10580)$, based on the Resonance-Spectrum-Expansion production formalism. Furthermore, an analysis of other experimental bottomonium data will be presented, showing strong indications of the two lowest and so far unlisted $^3D_1$ states below the $B\bar{B}$ threshold.

31

Gravitational form factor and D-term for hydrogen-like atom

Author: Yizhuang Liu[1]

[1] *Jagiellonian University*

Corresponding Author: namgunzitsau@gmail.com

Recently, gravitational form factors (EMT-form factor) for nucleons has drawn attention in relation to internal structure of nucleons. It has been proposed that the EMT form factor can be interpreted as pressure or shear force distribution and its value at zero momentum transfer (the D-term) are required to be negative as a result of stability. In this talk, we show that for the most famous bound-state in quantum field theory, the hydrogen-like atom bounded by QED forces, the EMT form factor and in particular, the D-term can be explicitly calculated to NLO in the frame work of NRQED. The value is positive.

33

QCD at high temperatures and finite densities: heavy-ion collisions

Author: Federica Fabiano[1]

[1] *INFN Cagliari*

Corresponding Author: federica.fabiano@cern.ch

The LHCb collaboration pursues a full physics program studying dense QCD with both beam-beam and fixed-target collisions. The forward design of the LHCb spectrometer allows probing the low-x region of the nucleus, while high vertexing precision and full particle ID guarantee the reconstruction of a wide range of hadrons down to very low transverse momentum. In this talk we present the recent LHCb results including quarkonia production in peripheral and ultra-peripheral heavy-ion collisions, and antiproton and charm production in fixed-target collisions.

34

Hadron Physics results at KLOE-2

Author: Giuseppe Mandaglio[1]

[1] *University of Messina & INFN-Catania*

Corresponding Author: giuseppe.mandaglio@cern.ch

KLOE and KLOE-2 data are the largest dataset ever collected at an electron-positron collider operating at the ϕ resonance peak (almost 8 fb^{-1}).
The data corresponds to the production of about 24 billion of ϕ mesons, namely 8 billion pairs of neutral K mesons and 300 million η mesons.
A wide hadron physics program, investigating rare meson decays, $\gamma\gamma$ interaction, and dark forces is being carried out by the KLOE-2 Collaboration.

The η decay into $\pi^0\gamma\gamma$ is a test bench for various models and effective theories, like VMD (Vector Meson Dominance) or ChPT (Chiral Perturbation Theory, which predict branching ratio (BR) far from the experimental value. KLOE-2, with its highly pure η sample produced
in $\phi \to \eta\gamma$ process performed a new precise measurement of this BR.

KLOE-2 is currently probing a complementary model to the U boson or "dark photon", where the dark force mediator is a hypothetical leptophobic B boson that could show up in the $\phi \to \eta B \to \eta\pi^0\gamma\,, \eta \to \gamma\gamma$ channel. The preliminary upper limit on the dark α_{B} coupling constant will be shown.

The High Energy Tagger detectors of KLOE-2 open the possibility to investigate π^0 production from $\gamma\gamma$ scattering by
tagging final-state leptons from $e^+e^- \to \gamma^*\gamma^*e^+e^- \to \pi^0e^+e^-$ in coincidence with the π^0 in the barrel calorimeter. The preliminary measurement of the $\gamma^*\gamma^* \to \pi^0$ counting obtained by using single tagged events will be reported.

Moreover, the search for the double suppressed $\phi \to \eta\,\pi^+\pi^-$ and the conversion $\phi \to \eta\,\mu^+\mu^-$ decays are being performed at KLOE-2 with both $\eta \to \gamma\gamma$ and $\eta \to 3\pi^0$. Clear signals are seen for the first time.

Finally, preliminary and promising results on the ω cross section measurement in the $e^+e^- \to \pi^+\pi^-\pi^0\gamma_{\mathrm{ISR}}$ channel using the Initial State Radiation (ISR) method will be also presented.

35

Analytical dispersive parameterization for elastic scattering of spinless particles

Authors: Igor Danilkin[None]; Marc Vanderhaeghen[None]; Volodymyr Biloshytskyi[None]; Xiu-Lei Ren[None]

Corresponding Author: vbiloshy@uni-mainz.de

We present an improved parameterization of the elastic scattering of spin-0 particles, which is based on a dispersive

representation for the inverse scattering amplitude. Besides being based on well known general principles, the requirement that the
inverse amplitude should satisfy the dispersion relation significantly constrains its possible forms and have not been incorporated
in the existing parameterizations so far. While the right-hand cut of the inverse scattering amplitude is controlled by unitarity, the
contribution from the left-hand cut, which comes from the crossing symmetry, is commonly ignored or incorporated improperly.
The latter is parameterized using the expansion in a suitably constructed conformal variable, which accounts for its analytic struc-
ture. The correct implementations of the Adler zero and threshold factors for angular momentum J > 0 are discussed in detail as
well. The amplitudes are written in a compact analytic form and provide a useful tool to analyze current and future lattice data in
the elastic region improving upon the commonly used Breit-Wigner or K-matrix approaches.

36

Estimate of the energy density of the formed medium in small collision systems at LHC energies

Author: Jesus Ricardo Alvarado Garcia[1]

Co-author: Irais Bautista Guzman [1]

[1] *Autonomous University of Puebla (MX)*

Corresponding Authors: jesus.alvaradoga@alumno.buap.mx, irais.bautista.guzman@cern.ch

Results on small collision systems are still under study to characterize whether a strongly interacting perfect fluid is formed or not. In this work we present an estimate of the initial state energy density on small collision systems. Results consider effects of initial state fluctuations on geometry and finite volume in a clusterization of color sources framework. The results are compared with Lattice QCD calculations. This work presents a perspective of how high energy densities can be reached in such small collision systems at the LHC energies. The results give a collective description of the system.

37

Modelling the source for coalescence in small systems

Author: Maximilian Horst[1]

[1] *Technische Universitaet Muenchen (DE)*

Corresponding Author: maximilian.horst@frm2.tum.de

In accelerator experiments, the production of light (anti)nuclei such as (anti)deuterons and (anti)Helium can be studied in a wide range of collision systems from small (pp) to large (A–A) emission source sizes. However, the microscopic mechanism by which they are produced and how they survive such hot and turbulent conditions is still unknown. The most commonly used models to describe this process are the statistical hadronization model and the coalescence approach. In this talk, a state-of-the-art coalescence model based on the Wigner function formalism to describe (anti)nuclear production on an event-by-event basis is presented. Additionally, this model is parameter-free and tuned on experimental measurements of nucleon production spectra and of the emitting source size. Such a model would find application in astroparticle physics to predict

(anti)nuclear fluxes in cosmic rays, which are a crucial ingredient for indirect Dark Matter searches.

38

Fully Coherent Energy Loss: from collider to cosmic ray energies

Author: Stéphane Peigné[1]

[1] *CNRS*

Corresponding Author: peigne@subatech.in2p3.fr

In high-energy proton-nucleus (pA) collisions, an incoming energetic parton crosses the target nucleus and suffers medium-induced, fully coherent gluon radiation. I will briefly review the theoretical status of this effect, and present the phenomenological consequences of the corresponding fully coherent energy loss (FCEL) on hadron production in pA collisions at the LHC, and on the atmospheric neutrino fluxes induced by semileptonic decays of hadrons produced in the collisions of cosmic rays with light nuclei of the atmosphere.

39

Glueball and meson spectroscopy within the holographic graviton soft-wall model

Author: Matteo Rinaldi[1]

Co-author: Vicente Vento Torres [2]

[1] *Dipartimento di Fisica e Geologia. Università degli studi di Perugia.Istituto Nazionale di Fisica Nucleare, sezione Perugia*

[2] *Univ. of Valencia and CSIC (ES)*

Corresponding Authors: matteo.rinaldi@pg.infn.it, vicente.vento@uv.es

In this contribution we present the main results of the calculations of spectra of meson and glueballs. To this aim the so called graviton soft-wall (GSW) has been used. This holographic semi-classic approximation to non perturbative QCD has been developed for the first time in Ref. [1] to calculate the scalar and tensor component spectra of glueballs. In particular we proposed to consider as dual field of the glueball operator in QCD a graviton propagating in a modified space with respect to the usual AdS5, i.e. the space
involved in the known AdS/QCD approaches. The resulting spectra were described by linear trajectories has expected from lattice QCD. In particular, the quoted ground state mass is comparable with that addressed same years later in Ref. [2]. Moreover, with this model, also the light scalar meson spectrum has been calculated, see Refs. [3, 4], together with the mixing condition, between scalar and glueball states. The main result is that above masses of 2 GeV pure glueball state are expected. In addition in Ref. [5] the GSW model has been applied to heavy scalar, vector, a1 and pseudo-scalar meson spectra. The results obtained with only two and not flexible parameters are comparable with present data. Finally, in Ref. [6] a strategy based on the longitudinal light-front dynamics, see e.g. Ref. [7, 8], has been adopted to implement chiral symmetry breaking into the GSW model to describe the pion. This approach has been used to calculate (with only two additional parameters coming from the longitudinal contribution) the pion: spectrum, form factor, effective form factor [9], distribution amplitude, transitional form factor and

parton distribution function. Also in this case results are in fair agreement with data and thus highlighting the predicting power of the GSW model.

References
[1] M. Rinaldi and V. Vento, Eur. Phys. J. A 54, 151 (2018)
[2] E. Klempt, K. V. Nikonov, A. V. Sarantsev and I. Denisenko, Phys. Lett. B 830, 137171 (2022)
[3] M. Rinaldi and V. Vento, J. Phys. G 47, no.5, 055104 (2020)
[4] M. Rinaldi and V. Vento, J. Phys. G 47, no.12, 125003 (2020)
[5] M. Rinaldi and V. Vento, Phys. Rev. D 104, no.3, 034016 (2021)
[6] M. Rinaldi, F. A. Ceccopieri and V. Vento, Eur. Phys. J. C 82, no.7, 626 (2022)
[7] G. 't Hooft, Nucl. Phys. B 75, 461-470 (1974)
[8] G. F. de Teramond and S. J. Brodsky, Phys. Rev. D 104, no.11, 116009 (2021)
[9] M. Rinaldi, Eur. Phys. J. C 80, no.7, 678 (2020)

40

Emergence of hydrodynamics in expanding ultra-relativistic plasmas

Author: Jean-Paul Blaizot[1]

[1] *IPhT Paris-Saclay University*

Corresponding Author: jean-paul.blaizot@cea.fr

TBA

41

Static quark operators based on Laplacian Eigenmodes

Author: Roman Höllwieser[1]

Co-authors: Francesco Giacomo Knechtli [2]; Mike Peardon

[1] *University of Wuppertal*

[2] *Bergische Universitaet Wuppertal (DE)*

Corresponding Authors: mjp@maths.tcd.ie, hoellwieser@uni-wuppertal.de, knechtli@physik.uni-wuppertal.de

We investigate a representation of static quark operators based on trial states formed by eigenvector components of the covariant lattice Laplace operator. We test the method for computing the static quark-antiquark potential and compare the results to standard Wilson loop measurements. The runtime of the new method is significantly smaller when computing the static potential not only for on-axis, but also for many off-axis quark-antiquark separations, i.e., when a fine spatial resolution is required, e.g., for string breaking calculations. We further improve the signal by using multiple eigenvector pairs, weighted with Gaussian profile functions of the eigenvalues, providing a basis for a generalized eigenvalue problem (GEVP), as it was recently introduced to improve distillation in meson spectroscopy. The method presented here can be applied to extract other potential functions for all possible excitations of a gluonic string with fixed ends, hybrid or tetra-quark potentials, as well as static-light systems.

42

CMS Heavy-Ion Physics Results

Authors: Jaebeom Park[1]; Prabhat Pujahari[2]; Prabhat Ranjan Pujahari[3]

[1] *Korea University (KR)*

[2] *IIT Bombay*

[3] *Indian Institute of Technology Madras (IN)*

Corresponding Authors: jaebeom.park@cern.ch, p.pujahari@gmail.com, p.pujahari@cern.ch

TBA

43

Diffractive and photon-induced processes at CMS

Author: David d'Enterria[1]

[1] *CERN*

Corresponding Author: david.d'enterria@cern.ch

TBA

44

Heavy baryons in the Chiral QuarkSoliton Model

Author: Michal Praszalowicz[1]

[1] *Jagiellonian University, Krakow*

Corresponding Author: michal@if.uj.edu.pl

In this talk we shall summarise present status of the heavy baryon description within the Chiral Quark Soliton model, including exotica. We shall show that ground state parity + and excited parity - states are well described by the model. We shall argue that within the model some excitations are parametrically suppressed, so that the predicted spectrum is less abundant that in other approaches. We shall also argue that new exotic states are in most cases "invisible".

45

Diquark properties from lattice QCD

Corresponding Author: afrancis.heplat@gmail.com

The idea of diquarks as effective degrees of freedom in QCD has been a successful concept in explaining certain low lying QCD states. Recently they have also played an important role in studying doubly heavy tetraquarks in phenomenology and on the lattice. The first member of this family of hadrons is the T_{CC}, newly discovered at LHCb. However, diquarks are colored objects and this has hampered ab initio, lattice calculations in the past. Here we present a study that resolves this issue and report on the properties of diquarks in a gauge-invariant formalism with quark masses down to almost physical pion masses in full QCD. We broadly confirm the diquark-diquark as well as diquark-quark mass splittings estimated phenomenologically. Going further we find attractive quark-quark

spatial correlations only in the "good" scalar channel with $\bar{3}_F$, $\bar{3}_c$, $J^P = 0^+$ quantum numbers and we observe that the good diquark shape is spherical. From the spatial correlations in the good diquark channel we extract a diquark size of ~ 0.6 fm. Our results provide quantitative support for modelling certain QCD states using good light diquark effective degrees of freedom.

46

Using heavy quarks and jets to probe the quark-gluon plasma: highlights from ALICE

Author: Jaime Norman[1]

[1] *University of Liverpool (GB)*

Corresponding Author: jaime.norman@cern.ch

Due to the extremely large temperatures generated in ultra-relativistic heavy-ion collisions at the LHC, a state of matter known as the Quark-Gluon Plasma (QGP), where quarks and gluons are no longer confined within hadrons but exist in a deconfined state, is created. This phase transition occurs at around 170 MeV, and studies of the QGP aim to address fundamental questions related to the bulk properties and dynamics of hot QCD matter and confinement. One of the most important methods of probing the QGP is the measurement of the production and modification of 'hard'partons produced at the start of the collision, which experience the full lifetime of the system and thus can be used to study the structure and dynamics of the QGP. This talk will outline the motivation for these measurements and will show some highlights of recent results from ALICE. The focus of this contribution will be on two such probes - i) heavy quarks and ii) jets, measurements of which have brought important new insights into the properties of the QGP in recent years.

47

Recent LHCb results on multiquark states

Corresponding Authors: rosa.fini@cern.ch, fini@cern.ch, rosanna.fini@ba.infn.it

The excellent performance of the LHCb experiment has opened the road to precise hadron spectroscopy studies. A rich variety of new resonances has already been discovered since last years. The very recent LHCb results on pentaquark and tetraquarks are presented here.

49

Exotic tetraquarks with some heavy quarks in lattice QCD

Corresponding Author: bicudo@tecnico.ulisboa.pt

We review all the different direct and indirect approaches that lattice QCD has been employing to study multiquarks, focusing in the tetraquarks with heavy quarks. We also briefly review the experimental progress in observing tetraquarks, and the most representative models of tetraquarks, comparing them with the results of lattice QCD.

Since the discovery of quarks and the development of the QCD theory, there has been a large interest in exotic hadrons, initiated by the tetraquark models developed by Jaffe in 1974. In the new millennium, this interest exploded with several experimental discoveries of tetraquark resonances with heavy quarks, starting with the Z_c and Z_b.

Moreover there is a second class of tetraquarks such as the T_{bb}, boundstates in the sense of having no strong decays. Very recently, the narrow T_{cc} tetraquark first predicted with quark models in 1982 by Richard et al, was observed experimentally.

Lattice QCD, being a first principle approach to solve non-perturbative QCD, has been crucial not only to compute precise results, but also to motivate and inspire research in hadronic physics, with particular interest in exotic hadrons. So far, lattice QCD has not yet been able to comprehend the Z class of tetraquarks, while it predicted the T class of tetraquarks. New methods are being developed to determine the masses, decay widths and decay processes of tetraquarks.

50

Understanding hadronization through measurements of light-flavor hadron production with ALICE

Author: Chiara Pinto[1]

[1] *Technische Universitaet Muenchen (DE)*

Corresponding Author: chiara.pinto@cern.ch

Light-flavor hadrons constitute the bulk of particle production in ultrarelativistic hadron-hadron collisions at the LHC. The measurements of the production of such particles are relevant to investigate the microscopic production mechanism of hadrons and to study collective effects in small collision systems. Among the light-flavor particles stemming from the hadronic collisions occurring at the LHC, light (anti)(hyper)nuclei are also produced. Recent results on the production of (anti)nuclei conducted within the ALICE Collaboration, up to A=4, are shown in this contribution. Production measurements in small collision systems are combined with femtoscopic measurements of the emitting source size, and discussed in this contribution in the context of nucleosynthesis models.
Further insights into the hadronization process can be obtained by investigating the production of exotic bound states, such as hypernuclei (multi-baryon states with hyperons). In particular, the study of the production and properties of the hypertriton provides insights into the strong hyperon-nucleon interaction, which has important implications for astrophysics. Indeed, detailed knowledge of the strong interaction between hyperons and nucleons is fundamental to constraining the equation of state of high-density baryonic matter, which will allow a better understanding of the internal structure of neutron stars.

52

Multiquark States

Author: Elena Santopinto[1]

[1] *INFN e Universita Genova (IT)*

Corresponding Author: elena.santopinto@cern.ch

The last exotic spectroscopy discoveries and observations will be first shortly reviewed and then some of the main theoretical interpretations presented and discussed.
Finally, some results of which I am also one of the authors will be presented and discussed.

53

Latest results on hadronic resonance production with ALICE at the LHC

Corresponding Author: angela.badala@ct.infn.it

Hadronic resonances, due to their short lifetimes, are good probes to investigate the late-stage evolution of ultra-relativistic heavy ion collisions. Since they have lifetimes comparable to that of the fireball, the measured yields may be affected by rescattering and regeneration processes in the hadronic phase, which also modifies the particle's momentum distributions after hadronization. Measurements of the production of resonances characterized by different lifetimes, masses, quark content, and quantum numbers can be used to explore the different mechanisms that influence the shape of particle momentum spectra, the dynamical evolution and lifetime of the hadronic phase, strangeness production, and collective effects. Moreover, recent multiplicity-dependent studies of particle production in pp and pPb collisions have shown similar features as in heavy-ion collisions. Measurements using resonances could help to understand the possible onset of collective-like phenomena and a non-zero lifetime of the hadronic phase in a small collision system.
With its excellent tracking and particle-identification capabilities, the ALICE experiment at the LHC has measured a comprehensive set of both meson and baryon resonances. Recent results on resonance production in pp, pPb, XeXe and PbPb collisions at various center-of-mass energies, highlighting new results on $K^*(892)^{\pm}$, $\Sigma(1385)$ and $\Lambda(1520)$, will be presented.

55

Amplitude analysis for hadron Spectroscopy

Author: Adam Szczepaniak[1]

[1] *Indiana University*

Corresponding Author: aszczepa@iu.edu

56

On the Zcs(3985) and X(3960) states: towards HQSS and SU(3) multiplet descriptions

Author: Miguel Albaladejo[1]

[1] *IFIC (CSIC & Valencia U.)*

Corresponding Author: miguelalbaladejo@gmail.com

In this talk we will discuss our recent works (2201.08253 and 2207.08563) in which we make analyses of several X and Z states. In the first part of the talk, we present a combined study of the BESIII spectra in which the Zc(3900) and Zcs(3985) states are seen, assuming that both are SU(3) partners. In the second part, a step further is taken and we analyze the full heavy quark spin and light flavor multiplets arising by considering as inputs the X(3872), Zc(3900), and the X(3960) recently claimed by LHCb in the D+s D-s spectrum.

57

Cornell potential from Soft Wall holographic approach to QCD

Author: Sergey Afonin[None]

Corresponding Author: afonin@hep.phys.spbu.ru

We discuss the confinement potential of the Cornell type arising within the framework of generalized Soft Wall holographic model to QCD. The generalized model includes a parameter controlling the intercept of the linear Regge spectrum. Our analysis shows that the Cornell potential obtained in the scalar channel leads to a quantitative consistency with the phenomenology and lattice simulations while the agreement in the vector channel is only qualitative. The first excitation in the scalar sector responsible for the formation of confinement potential lies in our fits near 1.5 GeV that is consistent with f0(1500).

58

Electromagnetic form factors of hadrons from spectral Dyson-Schwinger equations

Corresponding Author: sauli@ujf.cas.cz

Within the use of framework of spectral Dyson-Schwinger equations three important QCD correlators will be presented: vacuum hadron polarization, pion transition form factor and the pion electromagnetic form factor. Future directions
will be discussed in my talk.

59

Registration

60

Welcome

61

Transport at Strong Coupling – a Field Theory Approach

Corresponding Authors: romatschke@fias.uni-frankfurt.de, paul.romatschke@colorado.edu

Transport properties are hard to calculate from first principles for any value of the coupling. At strong coupling, it's generally considered impossible except for field theories with known gravity duals. In this talk I will review large N approaches to simple scalar and fermion field theories and show that they allow for the determination of exact transport coefficients at strong coupling, directly from the field theory. As an example, I calculate the (large N exact) infinite coupling value of eta/s in the 3d O(N) model.

62

Confinement and Coulomb gauge Lattice QCD

Corresponding Author: smithwya@iu.edu

In Coulomb gauge QCD, there exists an instantaneous chromo-electric interaction between static quark-antiquark pairs. Studying this interaction is an effective way to probe aspects of quark confinement, as the confining behavior of this 'Coulomb potential'is related to the confining behavior of the Wilson potential in non-gauge fixed QCD. A clearer picture of the mechanism of confinement would then allow us to better explain aspects of the meson spectrum. We present our attempts to understand this interaction via SU(2) and SU(3) Coulomb Gauge Lattice QCD simulations on anisotropic lattices.