Quark Confinement and the Hadron Spectrum XI

Sunday 07 September 2014 - Friday 12 September 2014

St. Petersburg

Book of Abstracts

Contents

Parallel III: C2 Heavy Quarks / 0

Recent results on charmonium-like spectroscopy and transitions at Belle

Author: Chengping Shen[1]

[1] *Beihang University, Beijing*

Corresponding Author: shencp@ihep.ac.cn

Using a 980 fb-1 data sample collected with the Belle detector on or near Y(nS), n=1, 2, ..., 5, the production cross sections of e+e- →K+K-J/Ψ, KsKs J/Ψ, ɣ χcJ, π+π-Ψ(2S) are measured. The properties of the Y(4360) and Y(4660) in π+π-Ψ(2S) mode are updated, and no significant signal is observed in ɣ χcJ, mode, except those from the Ψ(2S) decays. The possible charged charmoniumlike structures are also searched for in the K±J/Ψ and π±Ψ(2S)intermediate states.

Parallel II: B8 Light Quarks / 1

Hadronic effects within dispersive approach to QCD: tau lepton decay and vacuum polarization function

Author: Alexander Nesterenko[1]

[1] *Joint Institute for Nuclear Research*

Corresponding Author: nesterav@gmail.com

The dispersive approach to QCD, which extends the applicability range of perturbation theory towards the infrared domain, is developed. This approach properly accounts for the intrinsically nonperturbative constraints, which originate in the low-energy kinematic restrictions on pertinent strong interaction processes. The dispersive approach proves to be capable of describing recently updated ALEPH and OPAL experimental data on inclusive tau lepton hadronic decay in vector and axial-vector channels in a self-consistent way. The vacuum polarization function obtained within developed approach appears to be in a good agreement with relevant low-energy lattice simulation data.

[1] A.V.Nesterenko,
“Dispersive approach to QCD and inclusive tau lepton hadronic decay”.
Phys. Rev. D88, 056009 (2013); arXiv:1306.4970[hep-ph].

[2] M.Baldicchi, A.V.Nesterenko, G.M.Prosperi, and C.Simolo,
“QCD coupling below 1 GeV from quarkonium spectrum”.
Phys. Rev. D77, 034013 (2008); arXiv:0705.1695[hep-ph].

[3] A.V.Nesterenko,
“Inclusive tau lepton decay: the effects due to hadronization”.
PoS ConfinementX, 350 (2013); arXiv:1302.0518[hep-ph].

[4] A.V.Nesterenko,
“Hadronic effects in low-energy QCD: inclusive tau lepton decay”.
Nucl. Phys. B (Proc. Suppl.) 234, 199 (2013); arXiv:1209.0164[hep-ph].

Parallel VI: F3 Nuclear and Astroparticle Physics / 2

Effective Field Theories for thermal calculations in Cosmology

Authors: Antonio Vairo[1]; Miguel Escobedo[1]; Nora Brambilla[1]; Simone Biondini[1]

[1] *TUM*

Corresponding Author: simone.biondini@tum.de

Cosmology and particle physics come across a tight connection in the attempt to reproduce quantitatively the results of experimental findings. Indeed, the dark matter relic abundance and the amount of baryon asymmetry in the universe are accurately determined by the recent analysis of the cosmic microwave background.
Majorana fermions enter in many scenarios of physics beyond the Standard Model. In the simplest leptogenesis framework Majorana neutrinos are at the origin of the baryon asymmetry and most of the dark matter candidates are described by Majorana fermion fields. The non-relativistic regime comes up to be relevant during the lepton asymmetry generation and the dark matter dynamics at the freeze-out as well. Moreover all the interactions occur in a thermal medium that is the universe in its early stage.
We discuss the development of an effective field theory for non-relativistic Majorana which is analogous to the HQEFT. Then, we apply it to the case of a heavy Majorana neutrino decaying in a hot and dense plasma of Standard Model particles, whose temperature is much smaller than the mass of the Majorana neutrino but still much larger than the electroweak scale. Thermal corrections to the neutrino width are addressed.
Finally we show an effective field theory derivation of the Boltzmann equation for weakly interacting dark matter particles. The presented techniques have broad applications also to the treatment of hard probes in a hot QCD medium, for instance quarkonia suppression and jet quenching. The development and application of resummation techniques in hot QCD or cosmology can benefit both fields.

Parallel V: D9 Deconfinement / 3

Jet broadening at NNLL in perturbation theory

Author: Michael Benzke[1]

[1] *TUM*

Corresponding Author: michael.benzke@tum.de

The effect of jet broadening and the related jet quenching parameter \hat{q} are important in the description of energy loss of a jet moving through a medium. This effect has been calculated perturbatively up to NLO. In this talk I will show that in order to compute the NNLO result one needs to consider contributions from transverse momenta of order πT , gT and gˆ2T and that in the region gT a resummation of large logarithms is needed. Using results from the calculation of the static potential in 3 dimensions, this resummation can be performed in the context of jet broadening at NNLL accuracy and its effect on \hat{q} calculated.

Parallel IV: D6 Deconfinement / 4

Heavy quarkonium suppression in a fireball

Author: Miguel Angel Escobedo Espinosa[1]

[1] *Technische Universitaet Muenchen*

Corresponding Author: miguel.escobedo@ph.tum.de

The dissociation of heavy quarkonium seen in heavy-ion collisions is a phenomena that allows to extract information of the produced thermal medium. This was believed to be due to the screening of the static potential, but recently perturbative computations and some lattice studies have pointed out to the possibility of having an imaginary part of the potential that would also contribute to dissociation. In recent years a program to study heavy quarkonium with the use of non-relativistic effective field theories (EFTs) has been started, this allows to make the computations in a more systematic way by defining a more suitable power counting and making it more difficult to miss necessary resummations. However until now these studies have been done assuming thermal equilibrium. In this talk I will discuss what happens in the EFT formalism when heavy quarkonium is in a medium that is not in thermal equilibrium and what is the expected suppression when a medium with a time dependent effective temperature that follows Bjorken evolution is considered. This will be done adapting previous results from different temperature regimes.

Parallel V: E2 QCD and New Physics / **7**

Instanton mediated baryon number violation in gauge extended models.

Authors: Javier Fuentes[1]; Jorge Portoles[1]; Pedro Ruiz-Femenia[2]

[1] *Instituto de Fisica Corpuscular*

[2] *Instituto de Física Corpuscular*

Corresponding Author: fuentes@ific.uv.es

Instanton solutions of non-abelian Yang-Mills theories generate an effective action that may induce lepton and baryon number violation, namely $\Delta B = \Delta L = N_f$, being N_f the number of families coupled to the gauge group. It is well known that within the Standard Model the size of the violation is negligible, however this might not be longer true in non-universal gauge extended models. I will analyze instanton mediated $\Delta B = \Delta L = 1$ interactions within a $SU(2)_\ell \otimes SU(2)_h \otimes U(1)$ extension of the Standard Model that breaks the universality of couplings of the third family. I will apply these interactions to the study of proton decay and to the analysis of non-leptonic and radiative decays of the tau lepton.

Parallel VI: G1 Strongly Coupled Theories / **9**

Current status of Higgs physics

Author: Michael Rauch[1]

[1] *Univ. Karlsruhe, KIT*

Corresponding Author: michael.rauch@kit.edu

In 2012 a resonance at around 126 GeV was discovered at the LHC in the Higgs search channels. Since then, work has continued to verify that it is indeed the Standard Model (SM) Higgs boson which has been found, or to find deviations from the SM predictions, which would point to new physics.

In this talk I will summarize the current experimental results on the Higgs boson and discuss the state-of-the-art of its phenomenological

aspects. This will then be compared with predictions from theories beyond the SM, in particular also composite scenarios. I will show how well these are already constrained by today's data and give an outlook of what to expect in the future.

Parallel III: B6 Light Quarks / **10**

Recent results from CMD-3 detector at VEPP-2000 collider

Author: Peter Lukin[1]

Co-author: Collaboration CMD-3 [1]

[1] *Budker Institute of Nuclear Physics*

Corresponding Author: p.a.lukin@inp.nsk.su

Regular data taking with the CMD-3 detector at the VEPP-2000 electron-positron collider in Novosibirsk is underway since 2010. The luminosity up to 10**31 cm-2s-1 has been reached at the energy 2E=2 GeV, and another order of magnitude will be achieved after construction of the new positron source.

The already collected physical data sample corresponds to about 60 inversed picobarns of integrated luminosity in the energy range from phi-meson up to 2 GeV and currently the first scan from 2 pion threshold up to 1 GeV with about 6 pb-1 has been performed to get a new precision measurement of the e+e- -> pi+pi- cross section. Preliminary results on cross sections of a number of multi-hadron final states from the CMD3 detector is reported. The obtained results are in good agreement with previous experiments and have a comparable or better statistical precision.

Parallel II: B3 Light Quarks / **11**

Chiral-symmetry breaking and confinement in Minkowski space

Author: Elmar P. Biernat[1]

Co-authors: Alfred Stadler [2]; Franz Gross [3]; Jose Emilio F.T. Ribeiro [4]; Maria Teresa Peña [1]

[1] *Centro de Fisica Teorica de Particulas (CFTP), Instituto Superior Tecnico, Universidade de Lisboa*

[2] *Departamento de Fisica da Universidade de Evora and Centro de Fisica Teorica de Particulas (CFTP), Instituto Superior Tecnico, Universidade de Lisboa*

[3] *Thomas Jefferson National Accelerator Facility (JLab), Newport News, VA, USA*

[4] *Departamento de Fisica and Centro de Fisica das Interacçoes Fundamentais, Instituto Superior Tecnico, Universidade de Lisboa*

Corresponding Author: elmar.biernat@tecnico.ulisboa.pt

We propose a model for the quark-antiquark interaction in the framework of the Covariant Spectator Theory (CST). Our interaction kernel in momentum space is the sum of a delta-function potential and a covariant generalization of the linear confining interaction. With a pure vector Lorentz structure for the delta-function and a mixed scalar-pseudoscalar structure for the confining part, the axial-vector Ward-Takahashi identity is preserved. The confining part decouples from the pion CST equation in the chiral limit of vanishing current quark masses, a necessary condition for chiral symmetry to hold. These properties also ensure that the Adler zero in pi-pi scattering is reproduced. Within this model, the dressed quark mass function is calculated and compared to the existing lattice QCD data at negative Minkowski-space momenta-squared. Furthermore, it is used, together with a dressed off-shell quark current that satisfies the vector Ward-Takahashi identity, in the calculation

of the pion electromagnetic form factor in the relativistic impulse approximation. Our form factor results are in agreement with experimental data, they exhibit the typical monopole behaviour at high-momentum transfer squared, and they satisfy some remarkable scaling relations.

Parallel I: A4 Vacuum structure and confinement / 12

Renormalons in the lattice: the pole mass and the gluon condensate

Authors: Gunnar S. Bali[1]; Pineda Antonio[2]

[1] *University of Regensburg*

[2] *Universitat Autonoma de Barcelona*

Corresponding Author: pineda@ifae.es

We obtain the asymptotic behavior of the perturbative expansion of the pole mass and the plaquette by computing the self-energy of an static quark and
the plaquette to order alphaˆ{20} and alphaˆ{35} respectively. The results fully confirm renormalon expectations. Confronting these results with nonperturbative lattice data we confirm the OPE beyond perturbation theory (no dimension two condensate is found) and determine the gluon condensate and the binding energy of the B-meson.

Parallel IV: D4 Deconfinement / 13

On transport properties of charged drop in external electric field

Author: Sergey Bondarenko[1]

[1] *Ariel University*

Corresponding Author: sergeyb@ariel.ac.il

In our work we consider calculations of distribution function of the charged droplet in the electric field of
another, relativistically moving charged drop. Namely, we consider rotating charged droplet in transverse plane
which was created during the very first stage of interaction of two neutral objects in high-energy scattering. Due the small droplet's size, the thermalization of this drop was very quick and, therefore, the distribution function of the droplet and it's electric field is determined by Vlasov's equation. External field of other charge fluctuations
leads to the perturbation of initial static configuration of the droplet and makes the problem time-dependent.

In present calculations we consider simple two-dimensional radially symmetrical problem, with only external electric field included.
Solving time-dependent Vlasov's equation, which describe collective motion of particles in the drop under influence of external field, we obtain a non-equilibrium distribution function $f(\vec{r}, \vec{v}, \tau)$ of the drop in the transverse plane. The τ variable in this distribution function we define as a characteristic time of drop's particles collective motion or as a time of drop's expansion/compression. This time is limited by the transition from mean-field (collisionless) description of the drop's to the usual Boltzman equation and approximately
it is in the order of nucleon radius. Using obtained distribution function we calculate transport properties of the drop, namely we calculate the shear viscosity of the drop's expansion/compression in the transverse plane. Finally, we discuss obtained results in application to the high-energy scattering.

Parallel II: B1 Light Quarks / **14**

The hadronic corrections to muonic hydrogen Lamb shift from ChPT and the proton radius

Authors: Antonio Pineda[1]; Clara Peset[1]

[1] *Universitat Autonoma de Barcelona /IFAE*

Corresponding Author: peset@ifae.es

We obtain a model independent expression for the muonic hydrogen Lamb shift. The leading hadronic effects are controlled by the chiral theory, which allows for their model independent determination. We give their complete expression including the pion and Delta particles. Out of this analysis and the experimental measurement of the muonic hydrogen Lamb shift we determine the electromagnetic proton radius: r_p = 0.8412(15) fm. This number is at 6.8\sigma variance with respect to the CODATA value. The parametric control of the uncertainties allows us to obtain a model independent determination of the error, which is dominated by hadronic effects.

Parallel VI: G5 Strongly Coupled Theories / **15**

Chiral transition of fundamental and adjoint quarks

Author: Adriano Natale[1]

[1] *UFABC/IFT-Unesp*

Corresponding Author: natale@ift.unesp.br

Chiral transition of fundamental and adjoint quarks, published in Phys.Lett.B728, 626 (2014)

The chiral symmetry breaking transition of quarks in the fundamental and adjoint representation is studied in a model where the gap equation contains two contributions, one containing a confining propagator and another corresponding to the exchange of one-dressed dynamically massive gluons. When quarks are in the fundamental representation the confinement effect dominates the chiral symmetry breaking while the gluon exchange is suppressed due to the dynamical gluon mass effect in the propagator and in the coupling constant. In this case the chiral and deconfinement transition temperatures are approximately the same. For quarks in the adjoint representation, due to the larger Casimir eigenvalue, the gluon exchange is operative and the chiral transition happens at a larger temperature than the deconfinement one

Summary:

The chiral symmetry breaking transition of quarks in the fundamental and adjoint representation is studied in a model where the gap equation contains two contributions, one containing a confining propagator and another corresponding to the exchange of one-dressed dynamically massive gluons. When quarks are in the fundamental representation the confinement effect dominates the chiral symmetry breaking while the gluon exchange is suppressed due to the dynamical gluon mass effect in the propagator and in the coupling constant. In this case the chiral and deconfinement transition temperatures are approximately the same. For quarks in the adjoint representation, due to the larger Casimir eigenvalue, the gluon exchange is operative and the chiral transition happens at a larger temperature than the deconfinement one

Parallel I: A8 Vacuum structure and confinement / **16**

A model of random center vortex lines in continuous 2+1 dimensional space-time

Author: Roman Höllwieser[1]

Co-authors: Derar Altarnaweh [2]; Michael Engelhardt [2]

[1] *NMSU/VUT*

[2] *NMSU*

Corresponding Author: hroman@kph.tuwien.ac.at

A promising picture of confinement in QCD is based on a condensate of thick vortices with fluxes in the center of the gauge group (center vortices). A number of studies of this picture have been made and specific models have been formulated to obtain a concrete realization of the vortex picture. In our model,
vortices are represented by closed random lines in 2+1- dimensional space-time. These random lines are modeled as being piece-wise linear and an ensemble is generated by Monte Carlo methods. The physical space in which the vortex lines are defined is a cube with periodic boundary conditions. Besides moving, growing
and shrinking of the vortex configuration also reconnections are allowed. Our ensemble therefore contains not a fixed, but a variable number of closed vortex lines. This is expected to be important for realizing the deconfining phase transition. Using the model, we study both vortex percolation and the potential V(R) between quark and anti-quark as a function of distance R at different vortex densities, vortex segment lengths, reconnection conditions and at different temperatures. We have found three deconfinement phase transitions, as a function of density, as a function of vortex segment length, and as a function of temperature.

Parallel III: C1 Heavy Quarks / **17**

Heavy Hybrids in pNRQCD

Author: Jaume Tarrus Castella[1]

Co-authors: Antonio Vairo [2]; Matthias Berwein [1]; Nora Brambilla [3]

[1] *Technische Universität München*

[2] *Institut fuer Theoretische Physik-Ruprecht-Karls-Universitaet H*

[3] *Institut fuer Theoretische Physik*

Corresponding Author: jaume.tarrus@ph.tum.de

During the past years experimental observations have revealed the existence of a large number of states above open flavor thresholds that can not be identified as standard heavy quarkonium states. In this talk we discuss the possibility that some of these states are heavy quarkonium hybrids. Heavy quarkonium hybrids are states formed by a heavy quark-antiquark pair in a color octet configuration bounded together by excited gluons. Heavy quarkonium hybrids can be treated with an analog of the Born-Oppenheimer approximation for molecules.

In a first step the heavy quarks are considered static, the energy levels of the gluonic degrees of freedom are the static energies. The gluonic static energies are non-perturbative and are computed on the lattice. In the short distance range the static energies can be described using potential non-relativisitc QCD. In a second step the hybrid energy levels are obtained by solving the Schrödinger equation for the heavy quarks with the gluonic potentials defined by the static energies.

Parallel V: F2 Nuclear and Astroparticle Physics / **18**

Strangeness in the nuclear medium: experimental studies with the KLOE Drift Chamber.

Author: Oton Vazquez Doce[1]

[1] *Excellence Cluster Universe, TU-Munich.*

Corresponding Author: oton.vazquez.doce@cern.ch

The hyperon-pion and hyperon-nucleon(s) correlations following K- nuclear absorption in Helium and Carbon were investigated with the KLOE drift chamber and the results will be presented. To this end, KLOE 1 data (from 2004-2005) was analyzed using the detector itself as an active target. Also results from a more recent run (end of 2012) with a dedicated solid Carbon target will be presented. The information extracted about the antikaon-nucleon potential is of great importance in the framework of the non-perturbative QCD in the strangeness sector, and the understanding of these processes has consequences that go from hadron and nuclear physics to astrophysics.

In particular, the debated resonance Lambda(1405) is investigated in the Sigma0 pi0 (a privileged, free of contamination from Sigma(1385), but still poorly explored channel [2]) and the Sigma+ pi- channels, generated by K- absorptions (at rest and with 120 MeV/c) on bound protons in 4He and 12C.

The Lambda(1405) is generally accepted to be a spin 1/2, I=0, S=-1 negative parity baryon resonance assigned to the lowest L=1 supermultiplet of the three-quark system, and decays only to Sigma-pi (I=0) through the strong interaction. Its nature still remains unsettled, in the meson-baryon picture it is viewed as a antikaon-nucleon quasi-bound I=0 [3], and in the context of chiral unitary models [4][5] two poles emerge in the scattering amplitude in the neighborhood of the Lambda(1405) mass, both contributing to the final experimental invariant mass.

The antikaon-nucleon potential is also investigated searching for signals from bound kaonic clusters (systems where a kaon is attached inside a nucleus [6]). The existence of such objects is very debated, and it would open the possibility for the formation of very dense baryonic matter and it would imply a deep attractive value for the potential. Results for the Lambda-proton, Lambda-deuteron and Lambda-triton correlations analyses will be presented.

1 M. Adinolfi et al., Nucl. Instr. Meth. A 488, 51-73 (2002).
[2] K. Moriya, R. Schumacher, and CLAS Collaboration, AIP Conf. Proc. 1441, 296 (2012).
[3] R. H. Dalitz, T. C. Wong, G. Rajasekaran, Phys. Rev. 153, 1617 (1967).
[4] E. Oset, A. Ramos, Nuclear Phys. A 635,99 (1998).
[5] Y. Ikeda, T. Hyodo, W. Weise, Nucl. Phys. A 881, 98 (2012).
[6] Y. Akaishi and T. Yamazaki, Phys. Rev. C 65, 044005 (2002).

Parallel II: B7 Light Quarks / 19

”The reaction pi- p -> pi- pi- pi+ p at COMPASS: developement of the analysis methods and selected results.”

Author: Dmitry Ryabchikov[1]

[1] *Institute for High Energy Physics*

Corresponding Author: ryabchik@cern.ch

The COMPASS experiment, at CERN SPS, has collected the worlds largest statistics
of the reaction pi- p -> pi- pi- pi+ p - more than 5*10ˆ7 events.
The amount and also the quality of this data sample allows for detailed
studies of 3pi partial-wave amplitudes behaviour in 2 dimentions: invariant mass m(3pi) and four momentum transfer t'.
The method of traditional mass-independent PWA with 3 body isobar model is performed in multiple m(3pi) and t' bins which is followed by mass-dependent analysis performed simultaneously in

all t' slices. This makes it possible for
efficient separation between resonant and background components. The new PWA method of simultaneous optimization of 3pi isobaric amplitudes and several pi+pi- amplitudes - different for each JˆPC 3pi mother state (so called "de-isobared fit") is developed and applied to the current data.

Poster Session / **20**

Contribution of plasminos to the shear viscosity of a hot and dense Yukawa-Fermi gas

Author: Farid Taghinavaz[1]

Co-author: Neda Sadooghi [1]

[1] *Department of Physics, Sharif University of Technology*

Corresponding Author: taghinavaz@physics.sharif.edu

The shear viscosity of a hot and dense Yukawa-Fermi
gas will be determined, using the standard Green-Kubo relation, according to which the
shear viscosity is given by the retarded correlator of the traceless
part of viscous energy-momentum tensor. We approximate this retarded
correlator using a one-loop skeleton expansion, and express the
bosonic and fermionic shear viscosities, η_b and η_f,
in terms of bosonic and fermionic spectral widths, Γ_b and
$\Gamma_\pm$. Here, the subscripts $\pm$ correspond to normal and
collective (plasmino) excitations of fermions. We study, in
particular, the effect of these excitations on thermal properties of
$\eta_f[\Gamma_\pm]$. To do this, we determine first the
dependence of Γ_b and $\Gamma_\pm$ on momentum p,
temperature T, chemical potential μ and $\xi_0 \equiv m_b^0/m_f^0$, in a one-loop perturbative expansion in the
orders of the Yukawa coupling. Here, m_b^0 and m_f^0 are
T and μ independent bosonic and fermionic masses,
respectively. We then numerically determine $\eta_b[\Gamma_b]$
and $\eta_f[\Gamma_\pm]$, and study their thermal properties. It
turns out that whereas Γ_b and Γ_+ decrease with
increasing T or μ, Γ_- increases with increasing T
or μ. This behavior qualitatively changes by adding thermal
corrections to m_b^0 and m_f^0, while the difference
between Γ_+ and Γ_- keeps increasing with
increasing T or μ. Moreover, η_b (η_f) increases
(decreases) with increasing T or μ. We show that the effect of
plasminos on η_f becomes negligible with increasing
(decreasing) T (μ).

Reference

N. Sadooghi and F. Taghinavaz, *Contribution of plasminos to the shear viscosity of a hot and dense Yukawa-Fermi gas*, arXiv: 1404.1552, Accepted for publication in Phys. Rev. **D** (2014).

Summary:

The contribution of plasmino modes to the shear viscosity of a Yukawa-Fermi gas will be investigated at finite temperature and chemical potential.

Parallel III: C1 Heavy Quarks / **21**

Charged charmonium-like and bottomonium-like structures and the initial single chiral particle emission mechanism

Author: Takayuki Matsuki[1]

Co-authors: Dian-Yong Chen [2]; Xiang Liu [3]

[1] *Tokyo Kasei University*

[2] *Institute of Modern Physics, CAS*

[3] *Lanzhou University*

Corresponding Author: matsuki@tokyo-kasei.ac.jp

In the past decade, many of charmoniumlike and bottomoniumlike states have been reported in experiments, which have led us to extensive discussions on the underlying structure of these states. We would like to address the possibility to explain these structures by hadronic one-loop diagrams, which may correspond to recapitulate threshold effects. Starting from charged XYZ states, we also apply our mechanism to the recent Zc(3900) as well as Zb(4430).

Summary:

Including the hadronic one-loop diagrams, many of charged as well as neutral charmoniumlike and bottomoniumlike states can be successfully explained. That is to say, many of these states as evidence of existence of multi-quark states can be explained in the ordinary quark picture by our findings. A real multi-quark state may exist when our fitting can not be applied, e.g., a couple of states among three Zb states observed by Belle and LHCb.

Parallel V: E3 QCD and New Physics / **22**

The Q-weak Experiment: An Overview and Preliminary Analysis

Author: Joshua Magee[1]

[1] *College of William and Mary*

Corresponding Author: magee@jlab.org

The Q-weak experiment completed data taking at Jefferson Laboratory in 2012, with the aim of making the first experimental determination of the proton's weak charge, Q_W^p, which is the neutral-weak analogue of the proton's electric charge. The experiment measured the small parity-violating asymmetry in elastic electron-proton scattering at forward angles and low momentum-transfer ($Q^2 = 0.026$ GeV^2), allowing direct extraction of Q_W^p. Once extracted, the current results directly probe potential new parity-violating semi-leptonic physics beyond the Standard Model at the TeV scale. This talk will focus on the implications of the current Q-weak experimental results, including the extraction of the proton and neutron weak charges, Q_W^p and Q_W^n, the individual quark weak-vector couplings, C_{1u} and C_{1d}, and also highlight the mass-limit reach of Standard Model extensions probed. An experimental overview will be provided, along with preliminary results from the first period of data-taking, which comprises 4% of the total data set. Projections to the final Q-weak dataset will also be discussed.

Parallel III: C3 Heavy Quarks / **23**

"The coupled channel system D*D*-DD* and decays of doubly charm mesons molecules"

Author: Raquel Molina[1]

Co-authors: Atsushi Hosaka [2]; Hideko Nagahiro [2]

[1] *The George Washington University*

[2] *RCNP*

Corresponding Author: ramope71@email.gwu.edu

Several observed states close to the D\bar{D}ˆ*and Dˆ{(s)}\bar{D}ˆ{(s)} thresholds, as the X(3872) and some XYZ particles can be described in terms of a two-meson molecule. Furthermore, doubly charmed states are also predicted, named as R*{cc}(3970) and S_{cc}(4100). These new states are near the DDˆ, *Dˆ*Dˆ *and Dˆ*Dˆ_*s thresholds. We compute decays into DD\pi and radiative decays of doubly charmed meson molecules into DD*{(s)}\gamma. Essentially, the decay modes are three body DD_{(s)}\pi and DD_{(s)}\gamma decays, with the D\pi and D_{(s)}\gamma emitted by one of the Dˆ_*{(s)} meson which forms the molecule. In addition, we consider the possible coupled channel system DD*ˆ-D*ˆD*ˆ. These new states could be observed in experimental facilities as the LHCb.

Parallel V: F2 Nuclear and Astroparticle Physics / 24

Relating the strangeness content of the nucleon with the mass shift of the phi meson in nuclear matter

Author: Philipp Gubler[1]

Co-author: Keisuke Ohtani [2]

[1] *RIKEN*

[2] *Tokyo Institute of Technology*

Corresponding Author: pgubler@riken.jp

The behavior of the ϕ meson at finite density is studied, making use of a QCD sum rule approach in combination with the maximum entropy method. It is demonstrated that a
possible mass shift of the ϕ in nuclear matter is strongly correlated to the strangeness content of the nucleon, which is proportional to the strange sigma term, σ_{sN}. In contrast to earlier studies, our results show that, depending on the value of σ_{sN}, the ϕ meson could receive both a positive or negative mass shift at nuclear matter density. We find that these results depend only weakly on potential modifications of the width of the σ_{sN} meson peak and on assumptions
made on the behavior of four-quark condensates at finite density.

Parallel III: C1 Heavy Quarks / 29

Charged charmonium Zc+ from lattice QCD

Author: Sasa Prelovsek[1]

Co-authors: Christian B. Lang [2]; Daniel Mohler [3]; Luka Leskovec [4]

[1] *University of Ljubljana*

[2] *University of Graz*

[3] *Fermilab*

[4] *Jozef Stefan Institute*

Corresponding Author: sasa.prelovsek@ijs.si

I will present the first evidence for the existence of the charged charmonium-like Zc+ from lattice QCD. The results on the other charmonium and charmonium-like states will also be reviewed.

Parallel II: B5 Light Quarks / **31**

Light quark spectroscopy at BESIII

Authors: Alexey Zhemchugov[1]; Liu Beijiang[2]

[1] *Joint Institute for Nuclear Research*

[2] *Institute of High Energy Physics, CAS*

Corresponding Author: zhemchugov@jinr.ru

Based on the world's largest samples of J/psi, psi(3686) decays collected at the BESIII detector, the progresses on the hadron spectroscopy are presented, including the PWA of J/psi radiative decays, eta and eta' physics.

Parallel VI: F4 Nuclear and Astroparticle Physics / **33**

"Buddha's light" of cumulative particles

Author: Vladimir Kopeliovich[1]

Co-authors: Galina Matushko [1]; Irina Potashnikova [2]

[1] *Institute for Nuclear Research of RAS*

[2] *UTFSM*

Corresponding Author: kopelio@inr.ru

We show analytically that in the cumulative particles production off
nuclei multiple interactions lead to a glory-like backward focusing effect. Employing
the small phase space method we arrived at a characteristic angular dependence of the production cross section $d\sigma \sim 1/\sqrt{\pi - \theta}$ near the strictly backward direction. This effect takes place for any number $n \geq 3$ of interactions of rescattered particle, either elastic or inelastic (with resonance excitations in
intermediate states), when the final particle is produced near corresponding kinematical boundary. In the final angles interval including the value $\theta = \pi$ the angular dependence of the cumulative production cross section can have the crater-like (or funnel-like) form.
Such a behaviour of the cross section near the backward direction is in qualitative agreement with some of available data.

Parallel VI: F3 Nuclear and Astroparticle Physics / **34**

Transport coefficients in superfluid neutron matter

Author: Laura Tolos[1]

Co-authors: Cristina Manuel [1]; Jaume Tarrus [2]; Sreemoyee Sarkar [3]

[1] *ICE*

[2] *TUM*

[3] *Saha Institute*

Corresponding Author: tolos@ice.csic.es

We study the shear and bulk viscosity coefficients as well as the thermal conductivity as arising from the collisions among phonons in superfluid neutron stars. We use effective field theory techniques to extract the allowed phonon collisional processes, written as a function of the equation of state and the gap of the system.

We analyze the shear viscosity taking into account the contribution of superfluid phonons to the viscosity, both in their hydrodynamical and ballistic regime. We compare to recent calculations of the shear viscosity from electron collisions and comment on the possible consequences for r-mode damping in superfluid neutron stars. Moreover, we find that phonon collisions give the leading contribution to the bulk viscosities in the core of the neutron stars, except for densities $n \sim 2\ n_0$ with n_0 the nuclear saturation density, when the opening of the URCA processes takes place. We finally obtain the thermal conductivity from phonon collisions and compare it with the electron thermal conductivity in superfluid neutron stars.

Parallel IV: D7 Deconfinement / **35**

Holographic thermalization at intermediate coupling

Author: Aleksi Vuorinen[1]

[1] *University of Bielefeld*

Corresponding Author: aleksi.vuorinen@gmail.com

I will describe recent efforts to take holographic studies of the thermalization process of heavy ion collisions away from the limits of infinite ‘t Hooft coupling and the Vaidya spacetime, corresponding to lightlike gravitational collapse. In particular, I will demonstrate, how classic results such as quasinormal mode spectra, the top-down pattern of thermalization and the rate of entropy growth during the equilibration process change when these typical assumptions are relaxed.

Parallel IV: D5 Deconfinement / **36**

High energy evolution at NLO

Author: Michael Lublinsky[1]

[1] *Ben-Gurion University of the Negev*

Corresponding Author: lublinsky@phys.uconn.edu

We present a construction of an effective high energy QCD Hamiltonian at NLO accuracy.
This Hamiltonian is an NLO extension of the JIMWLK LO Hamiltonian, known to incorporate BFKL dynamics with gluon saturation phenomena. We are to demonstrate how the conformal symmetry is realized within the NLO JIMWLK.

Parallel V: F2 Nuclear and Astroparticle Physics / **38**

Baryonic forces in SU(3) chiral effective field theory

Author: Stefan Petschauer[1]

Co-authors: Andreas Nogga [2]; Johann Haidenbauer [2]; Norbert Kaiser [1]; Ulf-G. Meißner [3]; Wolfram Weise [4]

[1] *TU München*

[2] *Forschungszentrum Jülich*

[3] *Universität Bonn / Forschungszentrum Jülich*

[4] *ECT* Trento / TU München*

Corresponding Author: stefan.petschauer@ph.tum.de

We use SU(3) chiral effective field theory to describe the two- and three-baryon forces. Results for the hyperon-nucleon interaction at next-to-leading order are reported. These potentials include one- and two-meson exchange diagrams as well as contact terms with SU(3) symmetric low-energy constants. Furthermore we present potentials for the leading order three-baryon interactions, which involve contact terms and irreducible one- and two-meson exchange diagrams. A minimal set of terms in the chiral Lagrangian responsible for these contributions is presented in the non-relativistic limit. The low-energy constants of the Lagrangian are estimated by including decuplet baryons as explicit degrees of freedom. This leaves one with only two unknown low-energy constants. These potentials could shed some light on the question how three-baryon forces, especially between lambda-nucleon-nucleon, affect hypernuclei or neutron star matter.
Work supported in part by DFG and NSFC (CRC110).

Parallel IV: D1 Deconfinement / 39

Jet quenching in pp and pA collisions

Author: Bronislav Zakharov[1]

[1] *Landau Institute*

Corresponding Author: bgz@itp.ac.ru

We study jet quenching in pp and pA collisions in the scenario with formation of a mini quark-gluon plasma.
We find a significant suppression effect. For light hadrons at $p_T \sim 10$ GeV we obtained the reduction of the spectra by $\sim [20-30, 25-35, 30-40]\%$ in pp collisions at $\sqrt{s} = [0.2, 2.76, 7]$ TeV.
We also give predictions for modification of the photon-tagged and inclusive jet fragmentation functions in high multiplicity pp events. We show that for underlying pp events with $dN_{ch}/d\eta \sim 20-60$ the medium effects lead to a considerable modification of the jet fragmentation functions.

Parallel III: C6 Heavy Quarks / 40

The quark masses and meson spectrum: A holographic approach

Author: Ilya Pusenkov[1]

[1] *SPbSU*

Corresponding Author: ilyapusenkov@gmail.com

The spectrum of radially excited unflavored vector mesons is relatively well measured, especially in the heavy-quark sector. This provides a unique opportunity to observe the behavior of the hadron spectrum at fixed quantum numbers as a function of the quark mass. The experimental data suggests the approximately Regge form for the radial spectrum, $M_n^2 = An + B$, where A and B are growing functions of the quark mass. We use the bottom-up holographic approach to find the functions A and B. The obtained result shows a good agreement with the phenomenology and consistency with some predictions of the Veneziano-like dual amplitudes.

Parallel V: F5 Nuclear and Astroparticle Physics / **41**

Models of Quark-Hadron Matter and Compact Stars

Author: Stefan Schramm[1]

[1] *Goethe University*

Corresponding Author: schramm@fias.uni-frankfurt.de

Phenomenological approaches to Quantum Chromodynamics covering the region from low to high temperature and/or density have to address the problem that the effective degrees of freedom change drastically from hadrons to quarks and gluons.

We study this situation with a unified description of hadronic and quark matter allowing for cross-over as well as first or second-order phase transitions. As further benefit of such an approach a quantitatively satisfactory description of nuclear ground state matter as well as nuclear and hyper-nuclear properties can be achieved.

We apply the model to neutron stars and consider potential constraints on star properties arising from heavy-ion physics and lattice gauge results in relation with the observation of 2 solar mass stars.

Parallel V: F5 Nuclear and Astroparticle Physics / **42**

Delta-resonance production in compact stars

Author: Alessandro Drago[1]

Co-authors: Andrea Lavagno [2]; Daniele Pigato [2]; Giuseppe Pagliara [3]

[1] *University of Ferrara*

[2] *Turin Politecnico*

[3] *Univ. Ferrara*

Corresponding Author: drago@fe.infn.it

I will show that Delta resonances are easily produced in compact stars when the asymmetry energy is taken into account by using the correct value of its density derivative at saturation (the parameter called L). The Delta production has crucial implications on the maximum mass of the compact stars and on their radius.

Parallel III: C4 Heavy Quarks / **43**

Relativistic description of the weak decays of B_s mesons

Authors: Rudolf Faustov[1]; Vladimir Galkin[None]

[1] *RAS*

Corresponding Author: igourevi@ccas.ru

The branching fractions of the semileptonic and rare B_s decays are calculated in the framework of the QCD-motivated relativistic quark model. The form factors of the weak B_s transitions are expressed through the overlap integrals of the initial and final meson wave functions in the whole accessible kinematical range. The momentum
transfer dependence of the form factors is explicitly determined without additional model assumptions and extrapolations. The obtained results agree well with available experimental data.

Parallel I: A4 Vacuum structure and confinement / 44

Lessons from SUSY: ”Instead-of-Confinement” Mechanism

Author: Alexei Yung[1]

[1] *Petersburg Nuclear Physics Institute*

Corresponding Author: yung@thd.pnpi.spb.ru

Abstract

I discuss physical scenarios in different vacua of N=2 supersymmetric QCD deformed by the mass term μ
for the adjoint matter. This deformation breaks supersymmetry down to N=1 and at large μ the theory flows to N=1 QCD.
I focus on dynamical scenarios which can serve as a prototypes of what we observe in the real world QCD.
In particular, I discuss the ‘’instead-of-confinement” phase where quarks and gauge bosons screened at weak coupling evolve at strong coupling into monopole-antimonopole pairs confined by non-Abelian strings.
I also discuss the relation of this picture to the Seiberg’s duality.

Parallel III: C5 Heavy Quarks / 45

Probing heavy quarkonium production mechanism: chi_c polarization

Authors: Huasheng Shao[1]; Kuang-Ta Chao[2]

Co-author: Yan-Qing Ma [3]

[1] *Peking University (CN)*

[2] *Peking University*

[3] *BNL*

Corresponding Author: huasheng.shao@cern.ch

The necessecity of the color-octet mechanism in describing heavy quarkonium production is a long-standing puzzle. Compared to the yields of heavy quarkonium, its polarizations should be more sensitive to the color-octet contributions. In this talk, I will focus on the chi_c polarization in hadroproduction processes, which may provide a unique test for the color-octet mechanism in nonrelativistic QCD.

Parallel I: A6 Vacuum structure and confinement / **46**

Perfect Abelian dominance of confinement in SU(3) fine lattice QCD

Author: Hideo Suganuma[1]

Co-author: Naoyuki Sakumichi [2]

[1] *Kyoto University*

[2] *RIKEN*

Corresponding Author: suganuma@scphys.kyoto-u.ac.jp

We investigate the inter-quark potential in the maximally Abelian (MA) gauge in SU(3) quenched QCD on a fine lattice at beta=6.4 (a=0.058 fm). Remarkably, we find almost perfect Abelian dominance of the string tension or the quark confining force on the fine lattice 1. Thus, the confinement phenomenon in QCD can be well described only with Abelian variables in the MA gauge.

1 N. Sakumichi and H. Suganuma, arXiv:1406.2215 [hep-lat], "Perfect Abelian dominance of quark confinement in SU(3) QCD on a fine lattice".

Summary:

We find almost perfect Abelian dominance of confinement in the MA gauge in fine lattice QCD.

Parallel V: F2 Nuclear and Astroparticle Physics / **47**

Chiral effective field theory for light nuclei

Author: Evgeny Epelbaum[1]

[1] *University of Bochum*

Corresponding Author: evgeny.epelbaum@rub.de

I review recent progress in the application of chiral effective field theory to nuclear forces and low-energy nuclear observables. Both the continuum and the lattice formulations will be addressed.

Poster Session / **49**

Existence of Mass-Gap & Pure Yang – Mills Theory

Author: Rajan Dogra[1]

[1] *Government Industrial Training Institute for Women, Sector 11, Chandigarh, India*

Corresponding Author: rajandogra_2000@yahoo.com

Due to the non-linearity involved in quantum chromodynamics (QCD), the required uncertainty in position of a transverse hard gluon, emitted in 3-jet event, is accommodated by allowing for the possibility that Gribov copies are created as virtual entities by quantum fluctuations of the transverse gluon energy over the brief intervals of time during which the special relativity theory and the quantum theory are merged together consistently in QCD. These Gribov copies can be ignored in perturbative sector due to asymptotic freedom of pure QCD empty space but their common characterstic i.e., zero value of Faddeev-popov operator, serves as a mathematical proof of mass-gap and color confinement properties on the boundary of the Gribov region, so-called the Gribov horizon in the non-perturbative sector of pure QCD.

Parallel I: A1 Vacuum structure and confinement / 50

Spontaneous symmetry breaking and anomalous transport in Weyl semimetals

Author: Pavel Buividovich[1]

[1] *Regensburg University*

Corresponding Author: pavel.buividovich@physik.uni-regensburg.de

We study interacting Dirac fermions with chirality imbalance in the mean-field approximation and find that the chiral imbalance is strongly enhanced due to spontaneous chiral symmetry breaking. This result is valid both for the breaking of the exact chiral symmetry and for the pion condensation phase in the case of Wilson-Dirac fermions. We then consider the Chiral Magnetic Effect (CME) in the linear response approximation and find that in a phase with broken chiral symmetry the CME current is saturated by vector mesons with different polarizations, which are mixed in chirally imbalanced matter. It turns out that the CME is strongly enhanced in a phase with broken symmetry. We also argue that Weyl semimetals with chiral imbalance are free of the sign problem by virtue of time-reversal symmetry and can be efficiently simulated using the Rational Hybrid Monte-Carlo algorithm.

Parallel V: F1 Nuclear and Astroparticle Physics / 51

Influence of pion condensate on neutron stars spectrum

Author: Sergey kolevatov[1]

Co-author: Alexander Andrianov [2]

[1] *SPbSU*

[2] *Saint Petersburg State University*

Corresponding Author: s.s.kolevatov@gmail.com

There is no precise theory describing the structure of neutron stars. However, inside such objects the baryon density is very high and a pion condensation may occur. This condensate, if it exist, might give a significant effect on a spectrum of neutron stars. We investigate this influence with a help of simplified model to give qualitative picture of the effect.

Parallel I: A3 Vacuum structure and confinement / **52**

Research on Event Search

Author: Andrey Ustyuzhanin[1]

[1] *ITEP Institute for Theoretical and Experimental Physics (RU)*

Corresponding Author: andrey.ustyuzhanin@cern.ch

In this talk we focus on a meta-problem of physics i.e. on problems that arise in collaborative computational research. HEP research is a meaningful and important example. Problems come from different aspects of complexity of research and usually are more generic than research in physics and probably apparent in all computational science domains. A possible solution for such problems is outlined and direction that could lead to interdisciplinary and fruitful results is provided. This approach is by no means intended to specify an ultimate solution for those problems, but rather it can serve as starting point for further discussion. Conclusions mentioned in this paper are not specific to physics or industry, they might be applicable to different fields of computational science and hopefully may serve as a foundation for boosting the overall quality of research and eventually help next generation of scientists to reach for stars or even dark matter.

Poster Session / **53**

Center vortices as composites of monopole fluxes

Author: Sedigheh Deldar[1]

Co-author: Seyed Mohsen Hosseini Nejad [1]

[1] *University of Tehran*

Corresponding Author: sdeldar@ut.ac.ir

We study the relation between the flux of a center vortex obtained from the vortex model and the flux formed between monopoles obtained from the Abelian gauge fixing method.
Motivated by the Monte Carlo simulations which have
shown that almost all monopoles are sitting on the top of vortices, we combine differnet fluxes of monopoles and obtain the flux of center vortices for SU(2)
and SU(3) gauge groups and compare the results with the Monte Carlo data.

Parallel IV: D10 Deconfinement / **54**

Hadronic resonance production measured by the ALICE experiment at LHC

Author: Mikhail Malaev[1]

[1] *B.P. Konstantinov Petersburg Nuclear Physics Institute - PNPI (*

Corresponding Author: mikhail.malaev@cern.ch

Hadronic resonances are among the most interesting probes of the hot and dense matter created in Pb–Pb collisions. Due to their short lifetime, they are sensitive to the anticipated chiral symmetry restoration as well as to suppression and regeneration due to hadronic interactions in the final state. At intermediate and high transverse momenta (p_{T}) resonances which cover the range of masses between the light pions and heavier protons contribute in systematic study of the baryon puzzle

and parton energy loss in the dense medium. Measurements in pp collisions are used as a reference for heavier collision systems and contribute to precision tests of the pQCD and of the currently available parameterizations of fragmentation functions. Studies in p–Pb collisions are important for the interpretation of heavy ion results as they allow to decouple and understand the cold nuclear matter effects from final state effects.

The ALICE collaboration has performed systematic study of the K(892)^0 and ϕ(1020) mesons production at mid-rapidity in pp, p–Pb and Pb–Pb collisions at LHC energies. In this presentation recent results of these studies including $p_{\rm T}$ spectra, particle ratios, nuclear modification factors in p–Pb and Pb–Pb collisions are presented and compared to available model predictions.

Parallel III: C4 Heavy Quarks / **55**

Lattice QCD results for mesons containing b-quarks from the HPQCD Collaboration

Author: Ronald Horgan[1]

Co-authors: Chris Monahan [2]; Christine Davies [3]; Georg von Hippel [4]; Junko Shigemitsu [5]; Peter Lepage [6]; Rachel Dowdall [1]

[1] *DAMTP, University of Cambridge*

[2] *College of William and Mary*

[3] *Physics Dept., University of Glasgow*

[4] *Physics Dept., University of Mainz*

[5] *Physics Dept., Ohio State University*

[6] *Physics Dept., Cornell University*

Corresponding Author: rrh@damtp.cam.ac.uk

I report on progress by the HPQCD Collaboration using radiatively-improved lattice NonRelativistic QCD on ensembles of gluon field configurations that now include u, d, s and c quarks in the sea with the u/d quark mass going down to its physical value. I describe the background field approach for determining the one-loop radiative improvement to coefficients in the NRQCD action, and I present the most accurate results yet for a range of quantities, including f_B/f_B_s,m_B_s/m_B, the B_Bbar mixing calculation, the determination of m_b and the Upsilon-eta_b hyperfine splitting.

Parallel III: C6 Heavy Quarks / **56**

Heavy quarkonia description from a generalized screened potential model

Author: Pedro Gonzalez[1]

[1] *Universitat de Valencia*

Corresponding Author: pedro.gonzalez@uv.es

From lattice results a new non relativistic quark model to calculate the spectrum of heavy quark mesons has been developed. Te model interaction is generated from the identification of E(r), the energy of two static color sources, Q and antiQ, in terms of the Q-antiQ distance, calculated in the lattice, with the sum of the masses of the Quark (m_{Q}) and the antiQuark (m_{antiQ}) plus the static Q-antiQ potential V(r). Thus one gets V(r)=E(r)-m_{Q}-m_{antiQ}. By using this potential in the Schródinger equation the heavy quarkonia spectra is calculated and compared to data.

In the so called quenched approximation (only the bare valence Q_0-antiQ_0 configuration) lattice results for E(r) give rise to a Cornell potential form (see for example <cite>Bal01</cite>) which has been widely used in the literature to evaluate heavy quarkonia spectra (see for example <cite>Eic08</cite> and references therein).
When the coupling to meson (Q-anti$_0$q) - meson (antiQ_0-q) configurations is implemented the form of E(r) is altered by screening effects <cite>Bal05</cite>. By interpreting E(r) as the energy of a dressed quark (Q)- dressed antiquark state the corresponding Q-antiQ interaction incorporates the effect of meson (Q_0-antiq) - meson (antiQ_0-q) configurations. The resulting potential, called Generalized Screened Potential (GSP), preserves the Cornell form but modulated by meson-meson thresholds <cite>Gon14</cite>. A richer spectrum (bigger number of bound states) than the one resulting from the non-screened Cornell potential is obtained. In charmonium some of these extra states may be assigned to new charmonium states, in particular a quite resonable description of the masses of X type resonances is obtained.

Bal01 : G. S. Bali, Phys. Rep. 343, 1 (2001).
Eic08 : E. Eichten, S. Godfrey, H. Malke and J. L. Rosner, Rev. Mod. Phys. 80, 1161 (2008).
Bal05 : G. S. Bali et al. (SESAM Collaboration), Phys. Rev. D 71, 114513 (2005).
Gon14 : P. González, J. Phys. G. in print; arXiv:1406.5025 [hep-ph].

Parallel IV: D10 Deconfinement / **57**

Modeling the influence of string collective phenomena on the long range rapidity correlations between the transverse momentum and the multiplicities

Author: Evgeny Andronov[1]

Co-author: Vladimir Vechernin [1]

[1] *St. Petersburg State University (RU)*

Corresponding Author: evgeny.andronov@cern.ch

The long-range rapidity correlations between the multiplicities (n-n) and the transverse momentum and the multiplicity (pT-n) of charge particles are analyzed in the framework of the simple string inspired model with two types of sources. The sources of the first type correspond to the initial strings formed in a hadronic collision. The sources of the second type imitate the appearance of the emitters of a new kind resulting from interaction (fusion) of the initial strings. The model enabled to describe effectively the influence of the string fusion effects on the strength both the n-n and the pT-n correlations.

It was found that in the region, where the process of string fusion comes into play, the calculation results predict the non-monotonic behavior of the n-n and pT-n correlation coefficients with the growth of the mean number of initial strings, i.e. with the increase of the collision centrality. It was shown also that the increase of the event-by-event fluctuation in the number of primary strings leads to the change of the pT-n correlation sign from negative to positive. One can try to search these signatures of string collective phenomena in interactions of various nuclei at different energies varying the class of collision centrality and its width.

E.V. Andronov acknowledges Saint-Petersburg State University for the research grant 11.38.193.2014 and V.V. Vechernin for the grant 11.38.197.2014.

Parallel III: C4 Heavy Quarks / **58**

Decay constants of heavy mesons from QCD sum rules

Author: Dmitri Melikhov[1]

Co-authors: Silvano Simula [2]; Wolfgang LUCHA

[1] *SINP, M.V.Lomonosov Moscow State University*

[2] *INFN*

Corresponding Author: dmitri_melikhov@gmx.de

We present the analysis of the decay constants of charmed and beauty heavy mesons using QCD sum rules. We show that the perturbative expansion in terms of the pole mass of the heavy quark exhibits no sign of convergence whereas reorganizing this expansion in terms of the running mass leads to a distinct hierarchy. Making use of the OPE in terms of the running mass, we determine the decay constants of the D, Ds, B, Bs and the corresponding vector mesons with the emphasis on the uncertainties in these quantities related both to the input QCD parameters and to the limited accuracy of the method of sum rules.

Parallel I: A6 Vacuum structure and confinement / 59

Lattice QCD analysis for relation between quark confinement and chiral symmtery breaking

Author: Takahiro Doi[1]

Co-authors: Hideo Suganuma [1]; Takumi Iritani [2]

[1] *Kyoto University*

[2] *K*

Corresponding Author: doi@ruby.scphys.kyoto-u.ac.jp

In the lattice QCD formalism, we analytically derive a relation between the Polyakov loop and Dirac modes on the lattice where the temporal size is odd and link-variables are temporally periodic. The Polyakov loop is an order parameter for quark confinement and low-lying Dirac modes are essential for chiral symmetry breaking. Remarkably, from the relation, we find that low-lying Dirac modes have little contribution to the Polyakov loop [1,2], which indicates no direct one-to-one correspondence between confinement and chiral symmetry breaking in QCD. In the confinement phase, we also numerically find a new "positive/negative symmetry" of the Dirac-mode matrix element of the link-variable operator, and this symmetry leads to the zero value of the Polyakov loop [2]. Moreover, we derive a similar relation between the Wilson loop and Dirac modes 1.

References:
1 H. Suganuma, T.M. Doi and T. Iritani, arXiv:1404.6494 [hep-lat]; Proc. Sci. (QCD-TNT-III) 042 (2014); EPJ Web of Conf. 71 (2014).
[2] T.M. Doi, H. Suganuma and T. Iritani, arXiv:1405.1289 [hep-lat]; Proc. Sci. (Lattice 2013) 375 (2013); Proc. Sci. (Hadron 2013) 122 (2014).

Summary:

In the lattice QCD formalism, we analytically derive a relation between the Polyakov loop and Dirac modes, and find that low-lying Dirac modes have little contribution to the Polyakov loop analytically and numerically.

Parallel IV: D1 Deconfinement / 60

Constraints on the Jet-Energy Loss from Jet Measurements at RHIC and LHC

Author: Barbara Betz[1]

Co-author: Miklos Gyulassy [2]

[1] *Frankfurt University*

[2] *Columbia University*

Corresponding Author: betz@th.physik.uni-frankfurt.de

Results based on a generic dE/dx-model that interpolates between running coupling pQCD based models such as CUJET2.0 and AdS/CFT-inspired holographic prescriptions are compared to recent data on the high-pT pion nuclear modification factors and the high-pT elliptic flow in nuclear collisions at RHIC and LHC. The jet-energy loss models are coupled to state-of-the-art viscous hydrodynamic fields. The impact of energy-loss fluctuations, event-by-event fluctuations, viscosity, and different colliding systems is discussed. While RHIC data are found to be surprisingly consistent with most dE/dx+Hydro models, extrapolations to
LHC energies favor running coupling QCD-based energy-loss models, while conformal holography models are shown to be inconsistent with the data.

Parallel II: B1 Light Quarks / 61

Leading chiral logarithms for the nucleon mass

Author: Alexey Vladimirov[1]

[1] *Lund University*

Corresponding Author: vladimirov.aleksey@gmail.com

We present the method of calculation of leading logarithms for the nucleon sector of chiral perturbation theory in heavy baryon formulation and in the relativistic invariant formulation. We have studied the leading logarithm behavior of the nucleon mass up and present the expression for it up to four-loop order exactly. We also present some results up to six-loop order as well as all-order conjecture. The same methods allow to calculate the main logarithm multiplying the terms with fractional powers of quark mass.

Poster Session / 62

Holographic Estimates of the Deconfinement Temperature

Author: Alisa Katanaeva[1]

Co-author: Sergey Afonin [1]

[1] *SPbSU*

Corresponding Author: alice.katanaeva@gmail.com

The problem of self-consistent estimates of the deconfinement temperature T_c in the framework of the bottom-up holographic approach to QCD is observed. It is shown that the standard soft wall model gives T_c around 260 MeV for planar gluodynamics in a good agreement with the lattice data. The extensions of soft wall model adjusted for descriptions of realistic meson spectra result

in a broad range of predictions. This variability is related to
a poor experimental information on the radially excited mesons.

Parallel II: B2 Light Quarks / **63**

Electroweak probes in the presence of resonances on the lattice

Author: Andria Agadjanov[1]

[1] *University of Bonn*

Corresponding Author: aagadjanov@hiskp.uni-bonn.de

Lattice quantum chromodynamics (LQCD) provides an ab initio way to study the non-perturbative aspects of strong interaction. In recent years, it plays a more significant role in experimental physics.

The studies of the different electromagnetic and weak processes on the lattice are of particular interest. Some of the important processes proceed through the resonances. However, the resonances are treated as stable particles in current lattice simulations, due to the large pion mass values. The LQCD data on the corresponding transition form factors are thus obtained under this assumption. The situation changes drastically at lower values of quark masses, since the resonances decay. Consequently, a proper theoretical framework for the lattice extraction of these form factors is needed.

We rely on the previous work 1, in which the so called non-relativistic effective field theory framework for resonance matrix elements was developed. We modify and apply it to the following physically interesting processes:

The pion photoproduction $\gamma N \to \pi N$ near the $\Delta(1232)$ resonance region. The $\Delta N \gamma$ transition is experimentally most accessible one to reveal a possible hadron deformation. We show in the recent paper [2], how to extract the $\Delta N \gamma$ transition multipoles from lattice data. We also give a prescription to calculate the $\Delta N \gamma$ form factor at the resonance pole. We argue that the second approach is less model-independent.

The rare B-meson decays with $K(892) \to K\pi$ in the final state. These processes are forbidden at tree level and thus sensitive to physics beyond the Standard Model. However, the main obstacle here is a lack of good theoretical control over the hadronic uncertanities. LQCD can potentially provide such a control. The work is in progress and proceeds along the lines of ref. [2].

1 V. Bernard, D. Hoja, U.-G. Meissner, A. Rusetsky, JHEP **1209** (2012) 023.

[2] A. Agadjanov, V. Bernard, U.-G. Meissner, A. Rusetsky, arXiv:1405.3476 [hep-lat].

Parallel VI: F3 Nuclear and Astroparticle Physics / **64**

Functional renormalization group study of nuclear and neutron matter

Authors: Matthias Drews[1]; Wolfram Weise[2]

[1] *Technische Universitaet Muenchen*

[2] *Technische Universität München*

Corresponding Author: matthias.drews@ph.tum.de

A chiral model based on nucleons interacting via boson exchange is investigated. Fluctuation effects are then included consistently beyond the mean-field approximation in the framework of the functional renormalization group. The liquid-gas phase transition of symmetric nuclear matter is studied in detail. No sign of a chiral restoration is found up to 100 MeV temperature and about three times saturation density. Moreover, the model is extended to asymmetric nuclear matter. The constraints from neutron star observations are discussed.

Parallel III: C6 Heavy Quarks / **65**

Magnetic transitions in heavy quarkonium

Author: Antonio Pineda[1]

[1] *Universitat Autonoma de Barcelona*

Corresponding Author: pineda@ifae.es

We compute the magnetic dipole transitions between low lying Heavy Quarkonium states in a model independent way. We use the weak-coupling version of the effective field theory named potential NRQCD with the static potential exactly incorporated in the leading order Hamiltonian. The convergence for the b-\bar b ground state is quite good, and also quite reasonable for the c-\bar c ground state and the b-\bar b 1P state. For all of them we give solid predictions. For the 2S decays the situation is less conclusive, yet our results are perfectly consistent with existing data, as the previous disagreement with experiment for the Υ(2S)⟶η_b(1S)γ decay fades away. We also profit to compute some expectation values like the electromagnetic radius, rˆ2, or pˆ2. We find rˆ2 to be nicely convergent in all cases, whereas the convergence of pˆ2 is typically worse.

Parallel V: F1 Nuclear and Astroparticle Physics / **66**

QCD constraints on the equation of state for compact stars

Authors: Aleksi Vuorinen[1]; Eduardo Fraga[2]; Eero Aleksi Kurkela[3]; Juergen Schaffner-Bielich[4]

[1] *u*

[2] *Universidade Federal do Rio de Janeiro*

[3] *CERN*

[4] *Frankfurt University*

Corresponding Author: edfraga@mac.com

In recent years, there have been several successful attempts to constrain the equation of state of neutron star matter using input from low-energy nuclear physics and observational data. We demonstrate that significant further restrictions can be placed by additionally requiring the pressure to approach that of deconfined quark matter at high densities. Remarkably, the new constraints turn out to be highly insensitive to the amount - or even presence - of quark matter inside the stars.

In this framework, we also present a simple effective equation of state for cold quark matter that consistently incorporates the effects of interactions and furthermore includes a built-in estimate of the inherent systematic uncertainties. This goes beyond the MIT bag model description in a crucial way, yet leads to an equation of state that is equally straightforward to use.

Parallel IV: D8 Deconfinement / **67**

Search for critical point indications in long-range correlations by energy and system size scanning in string fusion approach

Author: Vladimir Kovalenko[1]

Co-author: Vladimir Vechernin [1]

[1] *St. Petersburg State University (RU)*

Corresponding Author: vladimir.kovalenko@cern.ch

Studies of the collisions of various hadrons and nuclei at different centrality and energy enable to explore the QCD phase diagram over a wide range of temperature and baryon density in search of the critical point. In the framework of the string fusion approach 1 the critical behavior takes place when the processes of string fusion and percolation come into play, what can be considered as a possible way of Quark Gluon Plasma formation [2]. Around percolation threshold, strong fluctuations in colors of strings appear what lead to large fluctuations in some observables, which one can find by the event by event analysis.

In the present study, a Monte Carlo model [3] of proton-proton, proton-nucleus, and nucleus-nucleus collisions has been developed and applied to heavy and light ion collisions at the cms energy range from a few up to several hundred GeV per nucleon, where the critical effects are expected. The model takes into account both the string fusion and the finite rapidity length of strings, implementing the hadronic scattering through the interaction of color dipoles. It well describes the proton-nucleus and nucleus-nucleus collisions at the partonic level without using Glauber model of nuclear collisions. All parameters are fixed using experimental data on inelastic cross section and multiplicity. In the framework of the model, we performed a beam energy and system size scan and studied the behaviour of correlation and fluctuation observables. The detailed modeling of the event by event charged particles production allowed to provide predictions in the conditions close to the experimental ones and to make a direct comparison to the existing data.

The authors acknowledge Saint-Petersburg State University for the research grants 11.38.66.2012 and 11.38.197.2014. V. N. Kovalenko also acknowledges the support of Special SPbSU Rectors Scholarship and Dynasty Foundation Scholarship.

1 N. S. Amelin, M. A. Braun and C. Pajares, Phys. Lett. B306, 312 (1993); Z. Phys. C63,507 (1994).
[2] M. A. Braun, C. Pajares, J. Ranft. Int. J. Mod. Phys. A 14 2689 (1999).
[3] V. N. Kovalenko. Phys. Atom. Nucl. 76, 1189 (2013), arXiv:1211.6209 [hep-ph]; V. Kovalenko, V. Vechernin. PoS (Baldin ISHEPP XXI) 077, arXiv:1212.2590 [nucl-th], 2012.

Parallel IV: D6 Deconfinement / **68**

Heavy-flavour dynamics in proton-proton and nucleus-nucleus collisions at LHC

Author: Marzia Nardi[1]

Co-authors: Andrea Beraudo [2]; Arturo De Pace [2]; Francesco Prino [3]; Marco Monteno [3]

[1] *INFN*

[2] *INFN Torino*

[3] *Universita e INFN (IT)*

Corresponding Author: marziacc.nardi@gmail.com

I will present recent results on heavy-quark quenching, elliptic flow and azimuthal correlations in proton-proton and nucleus-nucleus collisions at LHC energies.

We simulate the c-cbar and b-bbar pair initial creation with a perturbative QCD approach (POWHEG+PYTHIA). Successively we study the propagation of the heavy quarks in the plasma with the relativistic Langevin equation, by using transport coefficients computed with perturbative-QCD and HTL approximation. Successively, the heavy quarks hadronize in the medium.
We compute the nuclear modification ratio R_{AA} and v_2 of the final D mesons, as well as D-h correlations and compare our results to experimental data of ALICE and CMS Collaborations.

Parallel IV: D8 Deconfinement / **69**

Dynamical locking of the chiral and the deconfinement phase transition in QCD at finite chemical and isospin chemical potential

Authors: Jens Braun[1]; Marc Leonhardt[1]; Paul Springer[2]

[1] *Technische Universität Darmstadt*

[2] *Technische Universität München*

Corresponding Author: paul.springer@mytum.de

Studies of the QCD phase diagram at finite temperature and quark chemical potential are currently one of the most discussed topics in theoretical physics and are of great importance to better our understanding of heavy-ion collision experiments. However, the relation of confining and chiral dynamics is not yet completely understood. At vanishing chemical potential, results from lattice QCD indicate that the chiral and the deconfinement phase transition lie close to each other. In this talk, we analyze the fixed-point structure of four-fermion interactions in two-flavor QCD and show that there indeed appears to be a mechanism which dynamically locks the chiral phase transition to the deconfinement phase transition, both at vanishing and at finite quark chemical potential. As a direct consequence, this observation suggests that the chiral phase transition to the deconfinement phase transition temperatures lie close to each other, at least for small quark chemical potentials.

Parallel II: B4 Light Quarks / **70**

Isospin breaking in Ke4 decays

Author: Marc KNECHT[1]

[1] *CNRS - CPT Marseille*

Corresponding Author: knecht@cpt.univ-mrs.fr

Isospin breaking in the $K_{\ell 4}$ form factors induced by the difference between charged and neutral pion masses is discussed within a framework built on suitably subtracted dispersion representations. The $K_{\ell 4}$ form factors are constructed in an iterative way up to two loops in the low-energy expansion by implementing analyticity, crossing, and unitarity due to two-meson intermediate states. Analytical expressions for the phases of the two-loop form factors of the $K^\pm \to \pi^+\pi^- e^\pm \nu_e$ channel are presented, allowing one to connect the difference of form-factor phase shifts measured experimentally (out of the isospin limit) and the difference of S- and P-wave $\pi\pi$ phase shifts studied theoretically (in the isospin limit). The dependence with respect to the two S-wave scattering lengths a_0^0 and a_0^2 in the isospin limit is worked out in a general way, in contrast to previous analyses based on one-loop chiral perturbation theory. The results on the phases of the $K^\pm \to \pi^+\pi^- e^\pm \nu_e$ form factors obtained by the NA48/2 collaboration at the CERN SPS are reanalysed including isospin-breaking correction to extract values for the scattering lengths a_0^0 and a_0^2.

Parallel II: B3 Light Quarks / **71**

Quark scalar, axial and tensor charges in the Schwinger-Dyson formalism

Author: Nodoka Yamanaka[1]

[1] *iTHES Research Group, RIKEN*

Corresponding Author: nodoka.yamanaka@riken.jp

We evaluate the quark scalar, axial and tensor charges of the nucleon in the Schwinger-Dyson formalism.
For the scalar charge, it is found that it is enhanced by the gluon dressing effect, and that it is a sensitive observable to the quark confinement.
For the axial and tensor charges, it is found that the gluon dressing effect suppresses them.
This result can be understood as the superposition of the spin flipped states of spin 1/2 quark due to the emission/absorption of the gluon which carries spin 1.

Parallel VI: F4 Nuclear and Astroparticle Physics / **72**

Van der Waals forces in pNRQED and pNRQCD

Authors: Antonio Vairo[1]; Jaume Tarrús Castellà[1]; Nora Brambilla[1]; Vladyslav Shtabovenko[1]

[1] *TUM*

Corresponding Author: v.shtaboveno@tum.de

The properties of quarkonia in a nuclear medium are still poorly known, yet they are very important for the description of photo- and hadro-production of quarkonium on nuclear targets (e.g. in experiments at the FAIR facility at GSI) as well as for the diagnostic of hadronic final states in heavy ion collisions at the LHC at CERN.

Interactions of heavy quarkonia with hadrons or nucleons
are expected to have significant contributions from the multiple gluon exchange processes. This type of interactions, known as the gluonic van der Waals force, can also be responsible for bound states between quarkonia and nucleons.

Our approach is to study the gluonic van der Waals forces in the effective field theory (EFT) framework using potential non-relativistic QCD, an EFT of QCD that describes bound states of heavy quarkonia.

In this talk we will present an application of this approach to the electromagnetic van der Waals forces between two hydrogen atoms using
potential non-relativistic QED (pNRQED) and compare the results we obtained in this framework to the literature. Furthermore, we will discuss
perspectives for QCD, in particular concerning interactions between two heavy quarkonia or a heavy quarkonium and a nucleon.

Parallel IV: D8 Deconfinement / **73**

The critical end point through observables

Author: Gennady Kozlov[1]

[1] *JINR*

Corresponding Author: kozlov@jinr.ru

The critical phenomena of strongly interacting matter are presented in the frame of an effective theory at finite temperatures. The phase transitions are considered in systems where the critical end point (CEP) is a distinct singular feature existence of which is dictated by the chiral dynamics. The physical approach to the effective CEP is studied via the influence fluctuations of Bose-Einstein correlations for observed particles to which the critical end mode couples. The results may be the subject of the physical program at NICA and other heavy-ion machines to search the hadronic matter produced at extreme conditions.

Summary:

The critical phenomena of strongly interacting matter are presented in the frame of an effective theory at finite temperatures. The phase transitions are considered in systems where the critical end point (CEP) is a distinct singular feature existence of which is dictated by the chiral dynamics. The physical approach to the effective CEP is studied via the influence fluctuations of Bose-Einstein correlations for observed particles to which the critical end mode couples. The results may be the subject of the physical program at NICA and other heavy-ion machines to search the hadronic matter produced at extreme conditions.

Poster Session / **74**

One-loop computations from the Electroweak Chiral Lagrangian with a light Higgs

Authors: Antonio Dobado[1]; Felipe J. Llanes Estrada[2]; Rafael Delgado[2]

[1] *Universidad Complutense (ES)*

[2] *Universidad Complutense de Madrid (UCM)*

Corresponding Author: rdelgadol@ucm.es

Recently, a new boson has been discovered at LHC which, so far, fits the properties of the SM Higgs boson. This would make the SM unitary. However, the SM is not the more general low-energy dynamics for the minimal electroweak symmetry breaking sector (EWSBS) with three Goldstone bosons and one light scalar.

By using a more general low energy effective Lagrangian for these four particles and their scattering amplitudes, we study different processes at one-loop precision, and identify the counterterms needed to cancel the divergences.

Our aim is using unitarization methods over a partial wave decomposition of these amplitudes, in order to make phenomenological prediction which can be tested at LHC run II and to discuss the limitations of our computations. We specially look for sets of parameters which lead to a strongly interacting regime for the EWSBS.

The studied processes are the elastic scattering amplitude for both the longitudinal components of the gauge bosons $V = W,\ Z$ and the ligh scalar φ, as well as the inelastic channels $VV \to \varphi\varphi$.

Summary:

Based on:
http://link.springer.com/article/10.1007%2FJHEP02%282014%29121
http://iopscience.iop.org/0954-3899/41/2/025002/

Plenary 9 / **75**

Bottom-up holographic approach to QCD

Author: Sergey Afonin[1]

[1] *Saint Petersburg State University*

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

The phenomenological five-dimensional holographic models represent a interesting and unexpectedly fruitful theoretical laboratory for studying the strongly coupled QCD.
We present a short review of these models and of various results concerning the hadron spectrum, chiral symmetry breaking and the deconfinement temperature.

Poster Session / **76**

Two potential quark models for double heavy baryons

Author: Andrei Puchkov[1]

Co-author: Alexei Kozhedub [1]

[1] *Saint Petersburg State University*

Corresponding Author: putchkov@mail.ru

Baryons containing two heavy quarks are treated in the Born-Oppenheimer approximation. Two non-relativistic potential models are proposed, in which the Schrödinger equation admits a separation of variables in prolate and oblate spheroidal coordinates, respectively. In the first model, the potential is equal to the sum of Coulomb potentials of the two heavy quarks, separated from each other by a distance - R and linear potential of confinement. In the second model the center distance parameter R is assumed to be purely imaginary. In this case, the potential is defined by the two-sheeted mapping with singularities being concentrated on a circle rather than at separate points. Thus, in the first model diquark appears as a segment, and in the second - as a circle. In this paper we calculate the mass spectrum of double heavy baryons in both models, and compare it with previous results.

The author (A.P.) acknowledges Saint-Petersburg State University for research grants 11.38.197.2014 and 11.38.66.2012.

Parallel III: C3 Heavy Quarks / **77**

Exotic few-body systems with a heavy meson

Author: Yasuhiro Yamaguchi[1]

[1] *R*

Corresponding Author: yasuhiro.yamaguchi@riken.jp

Hadron as an impurity bound in nuclei causes interesting phenomena which
do not emerge in normal nuclei.
These effects would give us the information not only on the internal
structure of the nuclei, but also on the changing properties of the
impurity in the nuclear medium.

The hadron-nucleus systems have been studied in the light flavor sector, especially.
However, a strong attraction between a heavy meson ($\bar{D}$ and B) and a nucleon, provided by the one pion exchange potential (OPEP), was suggested recently.
The OPEP is enhanced by the heavy quark spin symmetry which induces the mass degeneracy between the heavy pseudoscalar and vector mesons.
The attraction motivates us to investigate the $\bar{D}$ (B) nuclei having the exotic flavor structure.
Hence, these bound states are stable against the strong decay.

We discuss the possible existence of exotic few-body states realized as $\bar{D}NN$ and BNN.
The OPEP between the $\bar{D}$ (B) meson and the nucleon N is considered.
By solving coupled channel equations for PNN and P^*NN channels (P (P^*) is the heavy pseudoscalar (vector) meson), we obtain bound states and resonances.
In these states, the tensor force of the OPEP plays an important role to yield the attraction.

Parallel IV: D7 Deconfinement / **78**

Strange tensor mesons decay constants at finte temperature

Author: kazem azizi[1]

Co-authors: arzu türkan [2]; elsen veli [2]; hayriye sundu [3]

[1] *Dogus Unıversıty*

[2] *kocaeli universty*

[3] *kcaeli university*

Corresponding Author: elsen@kocaeli.edu.tr

tensor mesons, thermal qcd sum rules

Summary:

Investigation of the thermal properties of the higher spin mesons is one of the important problems of the hadron physics. Theoretical calculations on the physical parameters of the tensor mesons and their comparison with experimental data could give essential information about their nature and it can also be useful for understanding of nonperturbative QCD dynamics. At finite temperature, the Lorentz invariance is broken by the choice of a preferred frame of reference and some new operators appear in the Wilson expansion. Taking into account these additional operators coming up at finite temperature, we calculate the thermal two-point correlation function for $D_2^*(2460)$ and $D_{s2}^*(2573)$ tensor mesons and obtain the QCD sum rules. In order to perform the numerical analysis, we use the fermionic part of the energy density obtained both from lattice QCD and Chiral perturbation theory. We also used the temperature dependent continuum threshold and we observed that the values of the decay constants decrease considerably near to the critical temperature comparing to their values in the vacuum. Our results at zero temperature are in good consistency with the existing experimental data as well as predictions of the other nonperturbative models.

Parallel VI: G3 Strongly Coupled Theories / **79**

Strongly Interacting Electroweak Symmetry Breaking Sector with a Higgs-like light scalar

Authors: Antonio Dobado[1]; Felipe J. Llanes-Estrada[2]; Juan Jose Sanz-Cillero[3]; Rafael Delgado[4]; maria herrero[3]

[1] *Universidad Complutense (ES)*

[2] *Univ. Complutense de Madrid*

[3] *Universidad Autonoma de Madrid*

[4] *Universidad Complutense de Madrid (UCM)*

Corresponding Author: rdelgadol@ucm.es

The apparent finding of a 125-GeV light Higgs boson closes unitarity of the minimal Standard Model (SM), that is weakly interacting. This is an exceptional feature not generally true if new physics exists beyond the mass gap found at the LHC up to 700 GeV.

Such new physics induces departures of the low-energy dynamics for the minimal electroweak symmetry-breaking sector (EWSBS), with three Goldstone bosons (related to longitudinal W bosons) and one light scalar, from the SM couplings.

For most of parameter space, the scattering is strongly interacting (with the SM a remarkable exception). We therefore explore various unitarization methods, that can already be applied to the tree-level $W_L W_L$ amplitude; we find and study a natural second sigma-like scalar pole there.

Based on arXiv:1402.0666 [hep-ph],arXiv:1404.2866 [hep-ph] and arXiv:1408.1193 [hep-ph]

Parallel III: C3 Heavy Quarks / 81

Hadronic Molecules in the Heavy Baryon Spectrum

Author: David R. Entem[1]

Co-authors: Francisco Fernandez [1]; Pablo G. Ortega [2]

[1] *University of Salamanca*

[2] *CERN*

Corresponding Author: entem@usal.es

We study possible baryon molecules in the non-strange heavy baryon spectrum. We include configurations with a heavy-meson and a light baryon. We find several structures, in particular we can understand the $\Lambda_c(2940)$ as a D^*N molecule with $J^P = 3/2^-$ quantum numbers. We also find $D^{(*)}\Delta$ candidates for the recently discovered $X_c(3250)$ and $X_c(3212)$ resonances.

Summary:

The hadron spectrum has enriched significantly during the last years thanks to the experimental activity of facilities such as BaBar, CLEO, Belle, CDF and LHCb. In the open charm and open bottom baryon spectrum most of the low lying states agrees quite well with quark model expectations. However there are excited states that are not clearly assigned in the quark model.

In 2003 the best candidate for a state beyond the naive quark model was found, the $X(3872)$ 1, which is the most accepted candidate for a meson-meson

molecule. This state has challenged the naive quark model and a lot of theoretical work to go beyond has been done during the last decade.

We have studied in a Chiral Constituent quark model possible hadron-hadron molecules and found the $X(3872)$ as a DD^* molecule coupled to $c\bar{c}$ configurations [2]. In this work we apply the same ideas to study the heavy baryon spectrum in the open charm and open bottom sectors. We have studied possible $D^{(*)}N$ ($\bar{B}^{(*)}N$) and $D^{(*)}\Delta$ ($\bar{B}^{(*)}\Delta$) configurations and found several bound states. The partial widths to the most important decay channels has been computed within the same model.

For the $\Lambda_c(2940)$ [3] we find a D^*N molecule very close in mass [4]. For this state the main decay channel is DN in agreement with the observed experimental width. This explains why it was discovered by BaBar in the D^0p invariant mass distribution, however we also find a sizable decay into $\Sigma_c\pi$ where Belle confirmed the state.

We also find more exotic configurations like $D^{(*)}\Delta$ states. In particular we find a $D^*\Delta$ with $I = 2$ [5] with a mass close to the mass of the $X_c(3250)$ [6]. This state has also been proposed to be a $D_0^*(2400)N$ molecule however the width of the state under this hypothesis is too big, been our result in better agreement with the experimental data. The main decay channel under our hypothesis would be $D^*N\pi$ while in the second would be $DN\pi$. The experimental study of these two decay channels could give a very important information to understand the structure of the state.

Analogs in the bottom sector has also been found. As the position of the states is close to the hadron-hadron threshold the discovery of these states would confirmed the molecule character of both, open-charm and open-bottom, states.

1 S.K. Choi *et al.* (Belle Collaboration), Phys. Rev. Lett. **91**, 262001 (2003).

[2] P.G. Ortega, J. Segovia, D.R. Entem, and F. Fernández, Phys. Rev. D **81**, 054023 (2010).

[3] B. Aubert *et al.* (BaBar Collaboration), Phys. Rev. Lett. **98**, 012001 (2007).

[4] P.G. Ortega, D.R. Entem, and F. Fernández, Phys. Lett. B **718**, 1381 (2013).

[5] P.G. Ortega, D.R. Entem, and F. Fernández, Phys. Lett. B **729**, 24 (2014).

[6] J.P. Lees *et al.* (BaBar Collaboration), Phys. Rev. D **86**, 091102 (2012).

Parallel IV: D10 Deconfinement / **82**

Transverse momentum dependence of spectra of cumulative particles produced from droplets of dense nuclear matter

Author: Vladimir Vechernin[1]

[1] *St. Petersburg State University (RU)*

Corresponding Author: v-vechernin@ya.ru

The approach relies on a microscopic treatment of cumulative phenomena based on perturbative QCD calculations of the corresponding quark diagrams near the thresholds 1. This enables to find the asymptotic behavior of the structure functions of nuclear fluctons – the dense drops of nuclear matter in nuclei composed of a few nucleons. As a result, in the framework of the approach the nuclear structure function of the DIS process from nuclei and the yield of charged particles in the cumulative

region were calculated [2]. It was shown [3] that the approach enables to describe the increase of the mean transverse momentum of the produced pions with the growth of their cumulativity x. It was also found [4] that in the case of cumulative proton production the mechanism of quark coalescence (coherent quark fusion) dominates over the production by fragmentation of one fast cumulative parton. Later it was confirmed in STAR and PHENIX experimental studies of azimuthal flows at RHIC [5-7] that the production of hadrons with transverse momenta upto a few GeV/c are well described by the mechanism of the coalescence (recombination) of the valence quarks.

In present study we focus on the calculations of the transverse momentum dependence of cumulative pions and protons spectra in the framework of the Quark Coherent Coalescence (QCC) model [4]. The results are shown in Fig.1. We see that the model enables to describe the transverse momentum dependence of the yields of cumulative pions and protons at different values of their cumulativity x with the only parameter – the constituent quark mass, taken to be equal 300 MeV.

The author thanks Saint-Petersburg State University for the research grant 11.38.197.2014 and the RFFI for the grant 12-02-00356-a.

References

1. M.A. Braun, V.V. Vechernin, Nucl. Phys. B 427, 614 (1994).
2. M.A. Braun, V.V. Vechernin, Physics of Atomic Nuclei 60, 432 (1997).
3. M.A. Braun, V.V. Vechernin, Physics of Atomic Nuclei 63, 1831 (2000).
4. M.A. Braun, V.V. Vechernin, Theoretical and Mathematical Physics 139, 766 (2004); M.A. Braun, V.V. Vechernin, Nucl. Phys. B (Proc. Suppl.) 92, 156 (2001); arXiv: hep-ph/9710269 (1997).
5. J. Adams et al. (STAR Collaboration), Phys. Rev. Lett. 92, 052302 (2004).
6. J. Adams et al. (STAR Collaboration), Phys. Rev. Lett. 95, 122301 (2005).
7. A. Adare et al. (PHENIX Collaboration), Phys. Rev. Lett. 98, 162301 (2007).
8. S.V. Boyarinov et al., Physics of Atomic Nuclei 57, 1379 (1994).
9. S.V. Boyarinov et al., Sov. J. Nucl. Phys. 55, 917 (1992).
10. S.V. Boyarinov et al., Sov. J. Nucl. Phys. 46, 871 (1987).

Indico rendering error

```
Could not include image: Problem downloading image (http://vecherni.nm.ru/pt3\_x.jpg)
```

Relative dependence (normalized to the value at kt=0) of the yields of cumulative pions (left) and protons (right) on the transverse momentum at different values of their cumulativity x. The experimental points are taken from [8-10]. The curves – results of the present calculations in the framework of the QCC model [4] with the only parameter – the constituent quark mass m = 300 MeV.

Parallel III: C4 Heavy Quarks / 83

Puzzles in Quarkonium hadronic transitions with two pion emission

Author: Francisco Fernandez[1]

Co-authors: David R. Entem [1]; Jorge Segovia [1]; Pablo G. Ortega [2]

[1] *Universidad de Salamanca*

[2] *CERN*

Corresponding Author: fdz@usal.es

The hadronic transitions of heavy quarkonia such as $\psi(nS)$ or $\Upsilon(nS)$ to lower states with emission of two pions are important tools for
understanding both, the heavy quarkonium dynamics and the formation of light hadrons.
The typical momentum involve in the transition is too low for perturbative QCD and then perturbative method does not apply.

The recent experimental data shows a puzzling behavior. In charmonium each $Y(4260)$, $Y(4360)$ and $Y(4660)$ decay to only one particular channel, $J/\psi\pi^+\pi^-$ or $\psi(2S)\pi^+\pi^-$, showing the $Y(4360)$ and $Y(4660)$ a particularly large width. Moreover, such decays have not been observed for the $\psi(4415)$. In bottomoiun, the $\Upsilon(10860)$ also shows an anomalous large width 1.

These behaviors can be due to several mechanism: contribution of hadronic loops, four quarks molecular components of the quarkonium wave function or the existence of hybrids mesons with a mass near the mass of the decaying resonance.
In this work we address these problems in the framework of a constituent quark model which has been successful in describing the hadronic phenomenology [2].

Hadronic decays can be described, at least for the lower lying states, using the QCD multipole expansion approach (QCDME) where the heavy quarkonium system serves as a compact color source and emits soft gluons which are hadronized into pions. After the emission of the first gluon and before de emission of the second there exist an intermediate state where the $q\bar{q}$ together with the gluon constitute an hybrid state. The width of the transition depends critically on the position of this state, therefore it is important to describe the $q\bar{q}$ states and the hybrid consistently using as few parameters as possible.
Moreover, when the excited states lies above the open flavor threshold, the QCDME scenario may change because the possible contribution of molecular components [3] can enhanced the decay width.

Using the constituent quark model quoted above, we calculate the $J/\psi\pi\pi$ and $\psi(2S)\pi\pi$ decays of the $J^P = 1^{--}$ charmonium and bottomonium states. Hybrid states are consistently generated in the original quark model using the quark confining string (QCS) scheme [4]. Above threshold we incorporate the effects of molecular components.
We are able to explain the anomalous large decay width of the $X(4360)$ and $Y(4660)$ due to the presence of hybrid states close by in energies. However this mechanism does not work in the case of the $\Upsilon(10860)$ being in this case the large width due to the contributions of significant molecular components. Our model also predicts a large value for the decay $X(4360) \to J/\psi\pi\pi$ which has been not seen in the experiments. Therefore the puzzling situation of the hadronic transition in quarkonium still deserves more experimental and theoretical efforts.

\vspace

1 N. Bambrilla {\it et al.},
Eur. Phys. J. C {\bf 71}, 1334 (2011).
J. P Lees{\it et al} Phys Rev D {\bf 86} 051102 (2012).
J. P Lees{\it et al} arXiv:1211.6271v2.

[2] J. Vijande, F. Fern\'andez, and A. Valcarce,
J. Phys. G {\bf 31}, 481 (2005).
J. Segovia, A. M. Yasser, D. R Entem and F. Fern\'andez,
Phys. Rev. D {\bf 78} 114033 (2008).

[3]P. G. Ortega, D. R. Entem and F. Fern\'andez,
J. Phys. G {\bf 40} 065107 (2013).

[4]R. C. Giles ans S.-H. H. Tye Phys. Rev. D {\bf 16} 1079 (1977).

Summary:

We study the anomalously large rates of some hadronic transition from quarkonium in a constituent quark model which has been successful in describing the hadronic phenomenology. Some of the anomalies are explained due to the presence of hybrid states in the QCD multipole expansion approach whereas others are due to the presence of molecular components in the state wave function

Parallel VI: G5 Strongly Coupled Theories / 84

Symmetry on honeycomb lattice formulation

Author: Eigo Shintani[1]

Co-authors: Masaki Hirotsu [2]; Testuya Onogi [2]

[1] *Mainz*

[2] *Osaka*

Corresponding Author: shintani@kph.uni-mainz.de

We present our investigation of a symmetry on honeycomb lattice. Using the formulation developed recenetly by analogy of staggered fermion formulation, we show the explicit formulation of "hidden" chiral symmetry on honeycomb lattice. We also discuss the possible extension of this formulation to interacting system as an application to Graphene.

Parallel VI: G2 Strongly Coupled Theories / 85

Holographic description of QGP production in heavy ion collisions.

Author: Irina Aref'eva[1]

[1] *Steklov Mathematical Institute, Moscow*

Corresponding Author: arefeva@mi.ras.ru

Dual holographic approach provides a powerful tool to study the static
properties of QGP as well as its thermalization.
There are models that reproduce perfectly the static properties of QGP,
meanwhile others models are used to reproduce non-static characteristics,
for example the charged multiplicity dependence on the energy.
We propose a holographic background that reproduces at large and small distances
the Cornell potential and in which collision of shock domains recovers
the experimental energy dependence of multiplicities obtained recently at LHC.

Parallel V: F2 Nuclear and Astroparticle Physics / 86

Hadron interactions and exotic hadrons on the lattice

Author: Yoichi Ikeda[1]

[1] *RIKEN*

Corresponding Author: yikeda@riken.jp

One of the interesting subjects in hadron physics is to look for the multiquark configurations. One of candidates is the H-dibaryon (udsuds), and the possibility of the bound H-dibaryon has been recently studied from lattice QCD.

We also extend the HAL QCD method to define potential on the lattice between baryons to meson-meson systems including charm quarks to search for the bound tetraquark Tcc (ud ¥bar{c} ¥bar{c}) and Tcs (ud ¥bar{c} ¥bar{c}).
In the presentation, after reviewing the HAL QCD method, we report the results on the H-dibaryon, the tetraquark Tcc (ud ¥bar{c} ¥bar{c}) and Tcs (ud ¥bar{c} ¥bar{c}), where we have employed the relativistic heavy quark action to treat the charm quark dynamics with pion masses, m_{¥pi}=410, 570, 700 MeV.

Parallel IV: D4 Deconfinement / **87**

Manifestations of local parity breaking in heavy ion collisions

Author: Domènec Espriu[1]

[1] *ICCUB - Universitat de Barcelona*

Corresponding Author: espriu@icc.ub.edu

We investigate how local parity breaking due to fluctuations of the topological charge may affect hadron physics in heavy ion collisions. A distorted dispersion relation is derived for the lightest vector mesons ρ and ω and compared to the experimental results. The main characteristic of LPB is an invariant mass splitting that depends on the polarization. We present a detailed analysis of the invariant mass and angular distribution associated to the lepton pairs created from these mesons looking for possible LPB effects. Two angular variables are found to carry the main information related to the parity breaking effect. Possible signatures for experimental detection of LPB are discussed. We also discuss how LPB may affect other hadronic processes such as Dalitz decays.

Parallel II: B8 Light Quarks / **88**

Amplitude Analysis in Lights Hadron Spectroscopy

Author: Vincent Mathieu[1]

[1] *Indiana university*

Corresponding Author: vincent.mathieu@umons.ac.be

I give an overview of the Jefferson Lab Physics Analysis Center (JPAC) activities.
JPAC is a join center between Indiana University and the Jefferson Laboratory.
We provide theoretical tools for data analysis in hadron spectroscopy.
In this talk, I will present the following topics:

- Dalitz plot analysis of eta-> 3pi and omega-> 3pi
- omega -> pi gamma transition form factor
- Application of Dual models to charmonium -> 3pi and extension to gamma p -> K+ K- p
- pion-nucleon amplitudes from threshold to Regge energies: application of finite energy sum rules to constrain baryon resonances

Parallel II: B9 Light Quarks / **89**

Corrections Beyond the Leading Order in Processes $\pi^0 \to e^+e^-$ and $\pi^0 \to e^+e^-\gamma$

Authors: Jiri Novotny[1]; Karol Kampf[1]; Tomas Husek[1]

[1] *Charles University (CZ)*

Corresponding Author: tomas.husek@cern.ch

In this talk we will discuss two important processes of the low energy hadron physics: the Dalitz decay of π^0 and $\pi^0 \to e^+e^-$.

We briefly summarize experimental and theoretical results on the rare decay $\pi^0 \to e^+e^-$. The analytical two-loop QED corrections together with the bremsstrahlung contribution beyond the soft-photon approximation are reviewed. Using the leading logarithm approximation, the possible contribution of QCD corrections is estimated. The complete result is then used to fit the value of the contact interaction coupling to the recent KTeV experiment.

This, together with a study of the Dalitz decay $\pi^0 \to e^+e^-\gamma$, can be used in the theoretical calculation of the hadronic light-by-light scattering contribution in the $g-2$ type experiments.

Parallel V: E2 QCD and New Physics / 90

A new look on signals of collective effects in AA and pA at LHC based on Modified Glauber Model.

Authors: Andrey Seryakov[1]; Grigori Feofilov[1]

[1] *St. Petersburg State University (RU)*

Corresponding Author: andrey.seryakov@cern.ch

G.Feofilov, A.Seryakov

We present current status of Modified Glauber Model (MGM) 1, which standard version is widely used for determination of centrality classes, for comparison AA and pA collision with pp data and for search collective effects. In MGM we take into account energy losses which are needed for particle production in each nucleon-nucleon collision. This proposal allowed us to predict total multiplicity in all centrality classes, which were obtained at ALICE experiment [2]. The analysis, which based on this model, of nuclear modification factor in AA, multiplicity density and scaling of hard and soft processes in pA, shows dramatic transformation of our view on processes in heavy ion collisions at LHC.

The work was supported by the St.Petersburg State University grants 11.38.66.2012 and 11.38.193.2014

1 G.Feofilov, A.Ivanov, Number of nucleon-nucleon collisions vs energy in modified Glauber calculations // Journal of Physics G CS, 5, (2005) 230-237

[2] T.Drozhzhova, G.Feofilov, V.Kovalenko, A.Seryakov, Geometric properties and charged particles yields behind Glauber model in high energy pA and AA collisions, PoS(QFTHEP 2013)053, 2013.

Parallel I: A8 Vacuum structure and confinement / 91

How center vortices break chiral symmetry

Author: Manfried Faber[1]

Co-author: Roman Höllwieser [2]

[1] *VUT*

[2] *NMSU & VUT*

Corresponding Author: faber@kph.tuwien.ac.at

We analyze the creation of near-zero modes from would-be zero modes of various topological charge contributions from classical center vortices in SU(2) lattice gauge theory. We show that colorful spherical vortex and instanton configurations have very similar Dirac eigenmodes and also vortex intersections are able to give rise to a finite density of near-zero modes, leading to chiral symmetry breaking via the Banks-Casher formula. We discuss the influence of the magnetic vortex fluxes on quarks and how center vortices may break chiral symmetry.

Parallel III: B6 Light Quarks / 92

Gluon- and Quark-Jet Multiplicities

Author: Anatoly Kotikov[1]

[1] *JINR*

Corresponding Author: kotikov@theor.jinr.ru

We present a new approach to consider and include both the perturbative and the non-perturbative contributions to the multiplicities of gluon and quark jets. Thanks to this new method, we have included for the first time new contributions to these quantities obtaining next-to-next-to-leading-logarithmic resummed formulas. Our analytic expressions depend on two non-perturbative parameters with a clear and simple physical interpretation. A global fit of these two quantities shows how our results solve a longstanding discrepancy in the theoretical description of the data.

Parallel II: B5 Light Quarks / 94

Electromagnetic Strangeness Production at Jefferson Lab Energies

Author: Reinhard Schumacher[1]

[1] *Carnegie Mellon University*

Corresponding Author: schumacher@cmu.edu

An overview of a decade of elementary strangeness production results from CLAS at Jefferson Lab will be presented. Photoproduction off the proton of the ground state Λ and Σ^0 states and kaons has been instrumental in identifying the N^* resonance structure of the nucleon around 2 GeV. Spin observables, aiming at "complete" determination of the photoproduction amplitudes, promise to further constrain the excitation spectrum of nucleons. Electroproduction measurements have extended to non-zero 4-momentum transfer Q^2 the structure function information about strangeness production. Photoproduction of the excited hyperons, the $\Sigma^0(1385)$, $\Lambda(1405)$, and $\Lambda(1520)$ in the reactions $\gamma + p \to K^+ + Y^* \to K^+ + \Sigma + \pi$, can be compared to the hyperon ground state reactions for the first time. The cross sections have been compared to current theoretical models based on the effective

Lagrangian approach, with varying success. The cross sections for the $\Lambda(1405)$ region are strikingly different for the $\Sigma^+\pi^-$, $\Sigma^0\pi^0$, and $\Sigma^-\pi^+$ decay channels, indicating the effect of isospin interference, especially at W values close to the threshold. We show how this behavior is reflected in the differing mass distributions for the $\Lambda(1405)$ in the different decay channels. Chiral unitary models of the $\Lambda(1405)$ and related non-strange baryonic states suggest how the $\Lambda(1405)$ is a structure of several interfering poles. We highlight also the first measurement of the spin and parity of the $\Lambda(1405)$. Finally, we outline the next experimental steps to be taken in strangeness electromagnetic production in the Jefferson Lab 12 GeV era.

Parallel I: A5 Vacuum structure and confinement / 95

Hamiltonian Approach to QCD in Coulomb gauge-from the vacuum to finite temperatures

Author: Hugo Reinhardt[1]

Co-authors: Davide Campagnari [2]; Jan Heffner [1]

[1] *Universität Tübingen*

[2] *Unversität Tübingen*

Corresponding Author: h.reinhardt@uni-tuebingen.de

I will review recent results obtained within the Hamiltonian approach to QCD. I will focus on the description of the deconfinement phase transition by compactifying one spatial dimension.

Parallel VI: G2 Strongly Coupled Theories / 96

All order linearized hydrodynamics from fluid/gravity correspondence

Author: Michael Lublinsky[1]

[1] *Ben-Gurion University of the Negev*

Corresponding Author: lublinsky@phys.uconn.edu

Using fluid/gravity correspondence, we determined the (linearized) stress energy tensor of N = 4 super-Yang-Mills theory at strong coupling with all orders of the boundary derivative included. We found that the dissipative effect is totally encoded in the shear term and a newly appeared one starting from third order. In the hydrodynamic regime, we analytically obtained the stress tensor up to third order in derivative expansion. To our primary goal of including all orders of derivatives, we numerically determined the (generalized) momenta-dependent transport coefficients to a rather large regime of momenta. As a partial check of our results, we also derived the linearized relativistic Navier-Stokes equations from the Einstein equations in the dual gravity.

Parallel VI: F3 Nuclear and Astroparticle Physics / 97

Nonuniform phases in the ’t Hooft extended Nambu–Jona-Lasinio Model

Author: Joao Moreira[1]

Co-authors: Alexander Andreevich Osipov [2]; Blin Alex [2]; Brigitte Hiller [3]; Wojciech Broniowski [4]

[1] *Centro de Fisica Computacional, Departamento de Fisica da Universidade de Coimbra*

[2] *Center for Computional Physics, Physics Department of the University of Coimbra*

[3] *Center for Computational Physics, Physics Department of the University of Coimbra*

[4] *IFJ PAN*

Corresponding Author: jmoreira@teor.fis.uc.pt

The possible existence of nonuniform phases in cold dense quark matter in the light quark sector (u, d and s) is adressed using the Nambu–Jona-Lasinio Model extended to include flavor-mixing ‘t Hooft determinant. The effect of changes in the coupling strengths of the model as well as that of the value of the current mass of the strange quark is discussed.
It is seen that the inclusion of the strange sector actually catalyses the appearance of these nonuniform phases extending the domain for their appeaarance.

Summary:

The Nambu–Jona-Lasinio model 1 is a simple, yet powerful, tool in the study of strongly interacting matter in the low energy nonperturbative regime. The inclusion of flavor mixing through the ‘t Hooft determinant [2] breaks the unwanted axial symmetry.

The possibility of nonuniform phases characterized by a spatially periodic chiral condensate has been the subject of intense investigation (for a recent review see for instance [3]).

The results pertaining the inclusion of the strange quark in these nonuniform phases, which is of great importance for a realistic description of dense quark matter, was done for the first time by the authors in [4]. There it was shown that flavor mixing of the strange and light quarks allows for existence of a much larger baryonic chemical potential window for the formation of a stable dual chiral-wave state as compared to the two-flavor case. In addition, strangeness catalyzes the occurrence of a new branch of nonhomogeneous solutions at moderate densities. The modulation of the chiral condensates in the light quark sector is taken to be one dimensional, while strangeness is embedded as a homogeneous condensate in the spontaneously broken phase of chiral symmetry. A finite current quark mass for the strange quark is incorporated, while the up and down current masses are set to zero. In that case the modulation considered provides an exact analytic solution for the
system. Despite the simplicity of the ansatz, the emerging phase diagram displays a very
rich structure.

1 Y. Nambu and G. Jona-Lasinio, Phys. Rev. 122, 345 (1961); Y. Nambu and G. Jona-Lasinio, Phys. Rev. 124, 246 (1961); V. G. Vaks and A. I. Larkin., Zh. Éksp. Teor. Fiz. 40, 282
(1961).[Sov. Phys. JETP 13, 192 (1961)].

[2] G. ’ t Hooft, Phys. Rev. D 14, 3432 (1976); V. Bernard, R. L. Jaffe, and U. G. Meissner, Phys. Lett. B198, 92 (1987); V. Bernard, R. L. Jaffe, and U. G. Meissner, Nucl. Phys. B308, 753 (1988); H. Reinhardt and R. Alkofer, Phys. Lett. B 207, 482 (1988).

[3] Michael Buballa and Stefano Carignano, arXiv:1406.1367 [hep-ph]

[4] J. Moreira, B. Hiller, W. Broniowski, A.A. Osipov, A.H. Blin, Phys.Rev. D89 (2014) 036009 arXiv:1312.4942 [hep-ph]

Parallel IV: D1 Deconfinement / 98

From Jet Quenching to Wave Turbulence

Author: Edmond Iancu[1]

[1] *Institut de Physique Théorique de Saclay*

Corresponding Author: edmond.iancu@cea.fr

We discuss average properties of the gluon cascade generated by an energetic parton propagating through a dense QCD medium. The cascade is mostly made with relatively soft gluons, whose production is not suppressed by the LPM effect. Unlike for usual QCD cascades in the vacuum, where the typical splittings are very asymmetric (soft and collinear), the medium-induced branchings are quasi-democratic and lead to wave turbulence. This results in a very efficient mechanism for the transport of energy at large angles with respect to the jet axis, which might explain the di-jet asymmetry observed in Pb-Pb collisions at the LHC. We furthermore present the equations describing the non-linear evolution of the jet quenching parameter with increasing the medium size, to leading logarithmic accuracy in perturbative QCD. These equations may be viewed as a generalization, going beyond the
eikonal approximation, of the BK-JIMWLK equations for the gluon
distribution in a large nucleus. An important prediction of these equations is a rapid growth
of the jet quenching parameter with increasing the medium size L.

Parallel VI: F4 Nuclear and Astroparticle Physics / 100

(Multi-)Strange hadron and light (anti-) nuclei production with ALICE at the LHC

Author: Ramona Lea[1]

[1] *University and INFN Trieste*

Corresponding Author: ramona.lea@cern.ch

Thanks to its excellent tracking performance and Particle Identification
capabilities, the ALICE detector allows for the identification of light
(anti-) (hyper-) nuclei and for the measurement of (multi-) strange particles
over a wide range of transverse momentum.
Deuterons, tritons, ^{3}He and ^{4}He and their corresponding
antinuclei are identified via their specific energy loss in the
Time Projection Chamber and the velocity measurement provided
by the Time-Of-Flight detector.
Strange and multi-strange baryons and mesons as well as (anti-) hypertritons are
reconstructed via their topological decays.
Detailed measurements of (multi-) strange hadron production in pp, p-Pb and Pb-Pb
collision and of light (anti-) nuclei and (anti-) hypertritons in Pb-Pb collisions
with ALICE at the LHC will be presented.
The experimental results will be compared with the predictions of both
statistical hadronization and coalescence models.

Parallel IV: D8 Deconfinement / 101

Deconfinement transition in a massive extension of the background field gauge

Author: Matthieu Tissier[1]

[1] *Univ. P. and M. Curie*

Corresponding Author: tissier@lptmc.jussieu.fr

We discuss the breaking of center symmetry in pure SU(2) and SU(3) Yang-Mills theories at finite temperature. We explore this question using a perturbative approach within a massive extension of the background field gauge which is seen as a phenomenological way of taking into account the effect of the Gribov copies. At one-loop order, this simple perturbative calculation yields a second order phase transition for SU(2) and a first order one for SU(3), in agreement with lattice results and with previous findings from functional renormalization group techniques. I also discuss the average of the Polyakov loop, computed at the same order, and comment on the effect of higher loop corrections.

Poster Session / **102**

Thermodynamics from lattice QCD with Nf=2+1+1 dynamical twisted fermions

Author: Michael Mueller-Preussker[1]

Co-authors: Ernst-Michael Ilgenfritz [2]; Florian Burger [1]; Maria Paola Lombardo [3]

[1] *Humboldt-Universitaet zu Berlin*

[2] *JINR Dubna, VBLHEP and BLTP*

[3] *INFN, Lab. Nazionali di Frascati*

Corresponding Author: mmp@physik.hu-berlin.de

We present the results achieved for a project dealing with lattice QCD thermodynamics in the presence of two dynamical quark generations employing the twisted mass discretization for Wilson-type quarks and an improved gauge action in order to ensure (automatic) O(a) improvement of lattice artifacts. We fix the (charged) pseudo-scalar meson mass values at 400 MeV and around 250 MeV. The temperatures range from 150 to 650 MeV. A fixed-lattice scale approach is used at three different lattice spacings in order to control the approach to the continuum limit. The effect due to the inclusion of the second quark generation is studied by comparing with previously obtained two-flavour results at the higher pseudo-scalar mass value.

Parallel II: B8 Light Quarks / **103**

The lightest scalar-isoscalar meson, its history, new parameters and role in QCD

Author: Robert Kaminski[1]

[1] *Institute of Nuclear Physics PAN, Krakow, Poland*

Corresponding Author: robert.kaminski@ifj.edu.pl

Recently reparameterized $f_0(500)$ (former σ) meson became subject of a number of innovative works in QCD physics.
Difficult to find and to determine experimentally after many years of failures has been finally precisely described be means of theoretical dispersion relations with imposed crossing symmetry condition [1,2].

Its fundamental importance for low energy QCD opened up the possibility of constructive examination of its internal structure but also allowed for study
of delicate phenomena like CP violation via final strong pion-pion state interactions.
History of this meson, of its almost re-discovery two years ago, and its importance for QCD will be discussed.
Also presented will be evidence of the uniqueness of the dispersion method used to obtain its parameters.
Example of a successful application of dispersive method in modification of coupled channel $\pi\pi$, $K\bar{K}$ and $\eta\eta$ amplitudes fitted in past only to experimental data and not fulfilling crossing symmetry condition will be presented.
Several questions concerning the possibility of extending the dispersion method for study of the low energy QCD will be selected.

1 "The Pion-pion scattering amplitude. IV: Improved analysis with once subtracted Roy-like equations up to 1100˜MeV", R. Garcia-Martin, R. Kaminski, J. R. Pelaez, J. Ruiz de Elvira and F.J. Yndurain, Phys. Rev. D83, 074004 (2011); "Precise determination of the $f_0(600)$ and $f_0(980)$ pole parameters from a dispersive data analysis", R. Garcia-Martin, R. Kaminski, J. R. Pelaez and J. Ruiz de Elvira, Phys. Rev. Lett. 107 (2011) 072001,

[2] "Mass and width of the lowest resonance in QCD",
I. Caprini, G. Colangelo and H. Leutwyler, Phys. Rev. Lett. 96, 132001 (2006)

Summary:

The described method, its uniqueness and precision of the results should facilitate modification of often used incorrect $\pi\pi$ amplitudes. This should significantly increase the reliability of obtained results (e.g. in decays of heavy mesons) and accelerate research on other light mesons - candidates for being the lightest non quark-antiquark states.

Parallel V: D9 Deconfinement / **104**

Exponentiation and Renormalization of Wilson line operators

Author: Matthias Berwein[1]

Co-authors: Antonio Vairo [1]; Nora Brambilla [1]

[1] *TU Munich*

Corresponding Author: matthias.berwein@mytum.de

I will discuss how Wilson line operators can be exponentiated, and how this exponentiation helps in studying their renormalization properties. Explicit examples will include rectangular Wilson loops, the cyclic Wilson loop and the Polyakov loop correlator. Relations to the Polyakov loop correlator's spectral decomposition will also be discussed.

Based on arXiv:1312.6651 [hep-th]

Poster Session / **105**

Logarithmic violation of scaling in strongly anisotropic turbulent transfer of a passive vector field

Author: Nikolay Antonov[1]

[1] *Saint-Petersburg State University*

Corresponding Author: n.antonov@spbu.ru

Inertial-range asymptotic behavior of a vector (e.g., magnetic) field, passively advected by a strongly anisotropic turbulent flow, is studied by means of the field theoretic renormalization group and the operator product expansion. The advecting velocity field is Gaussian, not correlated in time, with the pair correlation function of the form $\propto \delta(t-t')/k_\perp^{d-1+\xi}$, where $k_\perp = |\mathbf{k}|$ and $\mathbf{k}$ is the component of the wave vector, perpendicular to the distinguished direction ("direction of the flow") - the d-dimensional generalization of the ensemble introduced by Avellaneda and Majda [*Commun. Math. Phys.* **131**: 381 (1990)]. The stochastic advection-diffusion equation for the transverse (divergence-free) vector field includes, as special cases, the kinematic dynamo model for magnetohydrodynamic turbulence and the linearized Navier-Stokes equation. In contrast to the well known isotropic Kraichnan's model, where various correlation functions exhibit anomalous scaling behavior with infinite sets of anomalous exponents, here the dependence on the integral turbulence scale L has a logarithmic behavior: instead of power-like corrections to ordinary scaling, determined by naive (canonical) dimensions, the anomalies manifest themselves as polynomials of logarithms of L. The key point is that the matrices of scaling dimensions of the relevant families
of composite operators appear nilpotent and cannot be diagonalized. The detailed proof of this fact is given for correlation functions of arbitrary order.

Poster Session / **106**

Bose-Einstein effects in multiplicity and net-charge correlations in pp collisions using PYTHIA8 simulations

Author: Dmitry Neverov[1]

[1] *Saint Petersburg State University*

Corresponding Author: d.i.neverov@gmail.com

Correlations between various observables, e.g. multiplicities of particles produced in pp collisions at the LHC energies within intervals separated in pseudorapidity and azimuth angle, could be a sensitive tool to analyze hadron collisions dynamics and test hadron production models.

In this report we present results of studies of multiplicity correlation coefficient topology for like- and unlike-sign pairs of charged particles using PYTHIA8 event generator 1. Correlation coefficients were extracted using long-range forward-backward correlation method [2].

Peculiar behavior of correlation coefficient topology of net-charge is obtained in short-range region. Analysis shows that effects of Bose-Einstein statistics [3] have strong influence in this region of such correlations.

The results indicate the necessity of experimental studies of net-charge correlation topology that could bring new constraints to PYTHIA8 tunes.

References:
1 http://home.thep.lu.se/~torbjorn/Pythia.html
[2] ALICE collaboration, ALICE Physics Performance Report, vol. 2, part 2 (6.5.15, Long-range correlations, pp. 452-455), CERN/LHCC 2005-030, 5 December 2005
[3] L. Lönnblad, T. Sjöstrand, Eur.Phys.J.C2:165-180, (1998) //arXiv:hep-ph/9711460

Parallel II: B9 Light Quarks / **107**

Potential of a combined analysis of the $\tau^- \to (K\pi)^-\nu_\tau$ and $\tau^- \to K^-\eta\nu_\tau$ decays

Author: Sergi Gonzàlez-Solís[1]

Co-authors: Matthias Jamin [2]; Pablo Roig [3]; Rafel Escribano [1]

[1] *IFAE-U.A.Barcelona*

[2] *IFAE*

[3] *UNAM-Mexico*

Corresponding Author: sgonzalez@ifae.cat

We illustrate how the $K^\star(1410)$ resonance parameters can be extracted with improved precision by exploiting the synergy of a combined study of the
$\tau^- \to (K\pi)^-\nu_\tau$ and $\tau^- \to K^-\eta\nu_\tau$ decays for the first time. On the one hand we take advantage of the much larger statistics
accumulated for the former decay in the $K_S\pi^-$ channel, while on the other we also benefit from the larger sensitivity of the latter decay to the properties of
this resonance.
Our study is done in the frame of Chiral Perturbation Theory including resonances as explicit degrees of freedom. Different resummations of final state interactions are
considered, allowing for a better control of the theoretical uncertainties.

Poster Session / 108

Renormalized Light Front Hamiltonian in the Pauli-Villars Regularization

Author: Mikhail Malyshev[1]

Co-authors: Evgeni Prokhvatilov [2]; Roman Zubov [2]; Sergey Paston [2]

[1] *Saint-Petersburg State University*

[2] *Saint Petersburg State University*

Corresponding Author: mimalysh@yandex.ru

We address the problem of nonperturbative calculations on the light front in quantum field theory regularized by Pauli-Villars method. As a preliminary step we construct light front Hamiltonians in (2+1)-dimensional $\lambda\varphi^4$ model, for the cases without and with spontaneous symmetry breaking. The renormalization of these Hamiltonians in Pauli-Villars regularization is carried out via comparison of all-order perturbation theory, generated by these Hamiltonians, and the corresponding covariant perturbation theory in Lorentz coordinates.

Summary:

In the present paper we have constructed the renormalized LF Hamiltonian for the $\lambda\varphi^4$ model in (2+1)-dimensional space-time.
We have found the explicit expression for the counterterm, necessary for the renormalization, using the PV regularization. To do this we compare the diagrams of the covariant perturbation theory in Lorentz coordinates with the analogous diagrams of the perturbation
theory generated by the LF Hamiltonian which has also the cutoff in the momentum p_- ($|p_-| \geq \delta > 0$). We show that both perturbation theories can be described by
the same set of diagrams, with the values of the compared diagrams coinciding in the limit $\delta \to 0$. Then we renormalize the LF Hamiltonian by the counterterm found in
the calculation of the divergent part of the corresponding diagram in the covariant perturbation theory in Lorentz coordinates.

Furthermore we have taken into account the possibility of the spontaneous symmetry breaking in this model and obtained the LF Hamiltonians corresponding to two different vacua. We arrive at these LF Hamiltonians by considering the limit transition from the theories quantized on the spacelike planes approaching the LF. It is

possible to describe the vacuum on these planes using the Gaussian approximation. The Hamiltonians obtained with this approximation still require UV renormalization. And the above-mentioned comparison of perturbative theories, generated by these LF Hamiltonians, and the covariant perturbation theory in Lorentz coordinates allows to renormalize both of these Hamiltonians in the PV regularization.

Parallel I: A6 Vacuum structure and confinement / 109

Dynamical QCD string and its symmetries

Author: Leonid Glozman[1]

[1] *University of Graz*

Corresponding Author: leonid.glozman@uni-graz.at

Mesons constructed from the quark propagators without the lowest-lying eigenmodes of the Dirac operator reveal not only restored chiral and U(1)_A symmetries, but actually a higher symmetry. All possible
chiral and U(1)_A multiplets for the states of the same spin are degenerate, i.e. the energy of the observed quantum levels does not depend on the spin orientation of quarks and their parities. The quark-spin
independence of the energy levels implies absence of the magnetic interactions in the system. The ultrarelativistic quark-antiquark system with only the color-electric interactions can be interpreted (or defined) as a dynamical QCD string. The symmetry group of the J>=1 levels of the string is SU(4).

Poster Session / 110

Solutions to QCD 't Hooft Equation in terms of Airy functions

Author: Roman Zubov[1]

Co-author: Evgeni Prokhvatilov [1]

[1] *Saint Petersburg State University*

Corresponding Author: roman.zubov@hep.phys.spbu.ru

We consider numerical solutions to 't Hooft equation. We find that the spectrum of eigenvalues coincide with that of Airy differential equation. Physically it corresponds to one dimensional Schrödinger equation for a particle in a triangular potential well. We use Fourier transform of 't Hooft eigenfunctions to get to the coordinate space. The squared eigenfunctions in this space turn out to be nothing else than the square of Airy function.

Parallel II: B3 Light Quarks / 111

A model of light front QCD zero mode and description of quark-antiquark bound states

Author: Roman Zubov[1]

Co-author: Evgeni Prokhvatilov [1]

[1] *Saint Petersburg State University*

Corresponding Author: roman.zubov@hep.phys.spbu.ru

We consider a transition to the light front Hamiltonian from theories quantized on spacelike planes approaching to the light front. In this approach we preserve the dynamics of zero mode present in the theories near the light front. We make the limit transition differently for zero and nonzero modes. This leads to the appearance of some phenomenological parameter which can be used to describe vacuum effects. As an illustration of our scheme we consider the quark-antiquark bound states problem in 2+1 dimensions. We use the lattice gauge invariant regularization in transverse coordinate space and obtain the analog of 't Hooft equation. The numerical solution to this problem suggests that the spectrum of eigenvalues coincide with the spectrum of Airy differential equation.

Parallel VI: G5 Strongly Coupled Theories / **113**

Dark matter on the lattice

Author: Randy Lewis[1]

[1] *York University*

Corresponding Author: randy.lewis@yorku.ca

An overview of recent lattice computations for dark matter will be presented.

Poster Session / **115**

Generalized Beth–Uhlenbeck approach to mesons and diquarks in hot, dense quark matter

Author: Daniel Zablocki[1]

Co-authors: Aleksandr Dubinin [2]; David Blaschke [2]; Michael Buballa [3]; gerd Roepke [4]

[1] *Uniwersytet Wrocławski*

[2] *University of Wroclaw*

[3] *T*

[4] *U*

Corresponding Author: zablocki@ift.uni.wroc.pl

An important first step in the program of hadronization of chiral quark models is the bosonization in meson
and diquark channels. This procedure is presented at finite temperatures and chemical potentials for the
SU(2) flavor case of the NJL model with special emphasis on the mixing between scalar meson and scalar
diquark modes which occurs in the 2SC color superconducting phase. The thermodynamic potential is
obtained in the gaussian approximation for the meson and diquark fields and it is given the Beth-Uhlenbeck
form. This allows a detailed discussion of bound state dissociation in hot, dense matter (Mott effect) in
terms of the in-medium scattering phase shift of two-particle correlations. It is shown for the case

without
meson-diquark mixing that the phase shift can be separated into a continuum and a resonance part. In the
latter, the Mott transition manifests itself by a change of the phase shift at threshold by π in accordance
with Levinson's theorem, when a bound state transforms to a resonance in the scattering continuum. The
consequences for the contribution of pionic correlations to the pressure are discussed by evaluating the Beth-
Uhlenbeck equation of state in different approximations. A similar discussion is performed for the scalar
diquark channel in the normal phase. Further developments and applications of the developed approach are
outlined.

Parallel II: B4 Light Quarks / **116**

Pion-photon reactions and chiral dynamics in Primakoff processes at COMPASS

Author: Jan (for the COMPASS collaboration) Friedrich[1]

[1] *CERN / TU Munich*

Corresponding Author: jan.friedrich@cern.ch

With the COMPASS experiment at CERN, pion-photon reactions are investigated via the Primakoff effect, implying that high-energetic pions react with the quasi-real photon field surrounding the target nuclei.

The production of a single hard photon in such a pion scattering, at lowest momentum transfer to the nucleus, is related to pion Compton scattering. From the measured cross-section shape, the pion polarisability is determined. The COMPASS measurement is in contradiction to the earlier dedicated measurements, and rather in agreement with the theoretical expectation from chiral perturbation theory.

In the same experimental data taking, reactions with neutral and charged pions in the final state are measured and analyzed. At low energy in the pion-photon centre-of-momentum system, these reactions are governed by chiral dynamics and contain information relevant for chiral perturbation theory. At higher energies, resonances are produced and their radiative coupling is investigated.

Parallel V: F1 Nuclear and Astroparticle Physics / **119**

Constraining the physics of matter at high densities with the r-mode instability

Author: Brynmor Haskell[1]

[1] *The University of Melbourne*

Corresponding Author: brynmor.haskell@unimelb.edu.au

Neutron stars are one of the most exciting nuclear laboratories in the universe. With internal densities above nuclear saturation density and temperatures well below the Fermi temperature, they

allow us to prove a regime of the strong interaction that is not accessible in terrestrial laboratories. In particular neutron stars are likely to be interesting sources of gravitational waves, which may be detected in the near future with ground based interferometers such as Advanced LIGO or Virgo.
In this talk I will focus on neutron stars in Low Mass X-ray Binaries and on gravitational waves emission due to unstable modes of oscillation of the star, in particular the so called 'r-mode'. I will show how current electromagnetic observations of these systems are not consistent with a neutron star model that only includes neutrons, protons and electrons in the stellar interior, but require additional, 'exotic' physics.
I will discuss which mechanisms are compatible with the observations and which steps are needed (both from a theoretical and an observational point of view) to further constrain the physics of dense matter in neutron star interiors.

Summary:

Neutron stars observations have the potential to constrain the physics of matter at high densities and low temperatures. In this talk I will discuss in particular the gravitational wave driven r-mode instability in accreting neutron stars. I will show how X-ray observations of these systems are not consistent with a simple model of a star that simply contains neutrons, protons and electrons, but require additional 'exotic' physics. I will discuss several possibilities and how to make progress towards further constraints on the physics of neutron star interiors.

Parallel III: C1 Heavy Quarks / 120

Pair double heavy diquarks production in high energy proton-proton collisions

Author: Anton Trunin[1]

Co-author: Alexei Martynenko [2]

[1] *BLTP JINR*

[2] *Samara State University & Samara State Aerospace University*

Corresponding Author: amtrnn@gmail.com

On the basis of perturbative QCD and relativistic quark model we calculate cross sections of pair double heavy diquarks production in proton-proton interaction. Both, nonrelativistic and relativistic results are obtained. Relativistic factors in the production amplitude connected with the relative motion of heavy quarks and the transformation law of the bound state wave function to the reference frame of the moving S-wave diquark bound states are taken into account. The gluon and quark propagators entering the production amplitude are expanded in the ratio of the relative quark momenta to the diquark masses up to the second order. Relativistic corrections to the quark-quark bound state wave functions in the rest frame are considered by means of the Breit-like potential. It turns out that the examined effects significantly decrease the nonrelativistic cross sections.

Parallel VI: G2 Strongly Coupled Theories / 121

Non-perturbative effects for the BFKL equation in QCD and in N=4 SUSY

Author: Lev Lipatov[1]

[1] *Petersburg NPI*

Corresponding Author: lipatov@thd.pnpi.spb.ru

We remind, that the high energy behavior of scattering amplitudes in QCD is described by the BFKL equation for the pomeron as a composite state of reggeized gluons. In
the leading logarithmic approximation its hamiltonian has a number of remarkable properties including its Moebius invariance, holomorphic separability and integrability.
These properties are valid also for the BKP equation describing the multi-gluon composite states in the t'Hooft limit. Generally the BFKL hamiltonian is integrable only at N=4 SUSY where we calculate its eigenvalues in a semiclassical approximation beyond perturbation theory. Due to the asymptotic freedom the spectrum of the BFKL hamiltonian in QCD is
discreet, but for its calculation one needs boundary conditions for eigenfunctions. We discuss various modifications of the BFKL equation in the confinement region, including
the Higgs mechanism and the conformal mapping of the imact parameter plane to the spaces with cylinder and compact topologies.

Parallel III: C6 Heavy Quarks / **122**

Poincaré Invariance in pNRQCD

Author: Sungmin Hwang[1]

Co-authors: Antonio Vairo [2]; Matthias Berwein [3]; Nora Brambilla [4]

[1] *Technical University of Munich*

[2] *Institut fuer Theoretische Physik-Ruprecht-Karls-Universitaet H*

[3] *TU Munich*

[4] *Institut fuer Theoretische Physik*

Corresponding Author: sungmin.hwang@tum.de

Potential non-relativistic QCD (pNRQCD) is an effective field theory that describes heavy quarkonia at the ultrasoft scale, i.e. at the scale of the binding energy. As a non-relativistic theory, full Poincaré invariance is no longer explicit in pNRQCD. However, since pNRQCD is ultimately derived from QCD, Poincaré invariance is still hidden in the theory, with the effect that the Wilson coefficients satisfy certain constraints. I will discuss how these constraints can be obtained through a non-linear implementation of Lorentz transformations, and how the Poincaré algebra is satisfied for these non-linear transformations.

Parallel V: F1 Nuclear and Astroparticle Physics / **123**

Gravitational waves from spinning neutron stars

Author: Ian Jones[1]

[1] *University of Southampton*

Corresponding Author: d.i.jones@soton.ac.uk

In this talk I will describe how spinning neutron stars can produce long-lived gravitational wave signals. I will explain how the strength of this emission relates to the properties of the star, and describe the connection with the properties of matter at very high density. I will also describe efforts to detect such gravitational waves directly, and outline the key issues in this large experimental endeavour.

Parallel IV: D1 Deconfinement / **124**

Jet physics at the LHC as probe of the QGP

Author: Pasquale Di Nezza[1]

[1] *Istituto Nazionale Fisica Nucleare (IT)*

Corresponding Author: pasquale.di.nezza@cern.ch

Hard partons produced in the initial stage of heavy-ion collisions are ideal probes to study the quark-gluon plasma (QGP). Those hard partons, that fragment into jets, experience a sizable energy degradation as they traverse the hot and dense medium generated in ultra-relativistic heavy-ion collisions. At the LHC regimes, the phenomena connected to the jet quenching unveils new interesting properties of strongly-coupled matter. In this talk results on jets measured in the heavy-ion environment at the LHC are presented. Comparison of the results to model calculations are also discussed.

Parallel IV: D7 Deconfinement / **125**

Direct photon production in high-energy nuclear collisions

Author: Thomas Peitzmann[1]

[1] *University of Utrecht (NL)*

Corresponding Author: thomas.peitzmann@cern.ch

Direct photons have always been considered a promising probe for the very early phases of high-energy nuclear collisions. Prompt photons reveal information about the initial state and its possible modifications in nuclei. In this context they should be one of the best probes for effects of gluon saturation. Thermal photons emitted from the produced matter in nuclear collisions carry information on the temperature of the very early phase. In particular a simultaneous measurement of yield and elliptic flow of thermal photons can put strong constraints on the early time dynamics of the system. Recent analysis at RHIC has shown very intriguing results, which are not fully understood theoretically.
I will review the status of results on direct photon measurements at RHIC and LHC and their interpretation. Furthermore I will discuss prospects for future measurements in particular at the LHC.

Parallel II: B9 Light Quarks / **127**

Influence of quark-gluon vertex corrections on the spectrum of Hadrons

Author: Richard Williams[1]

Co-author: Helios Sanchis-Alepuz [1]

[1] *University of Giessen*

Corresponding Author: richard.williams@theo.physik.uni-giessen.de

We present a calculation of the Hadron spectrum in the Dyson-Schwinger/Bethe-Salpeter approach to continuum QCD. A sophisticated truncation featuring all covariant structures of the quark-gluon vertex, with its inherent flavour dependence, is employed in a framework that preserves the dynamics of chiral symmetry breaking. The study is suggestive as to the relevance of additional resonant and non-resonant two- and three-body contributions.

Parallel IV: D10 Deconfinement / 128

Determination of classes of events in multiplicity and its relevance to centrality in high energy Pb-Pb and p-Pb collisions in different MC models

Author: Tatiana Drozhzhova[1]

Co-authors: Andrey Seryakov [2]; Grigori Feofilov [2]; Vladimir Kovalenko [2]

[1] *Saint-PetersburgState University*

[2] *St. Petersburg State University (RU)*

Corresponding Author: tatiana.drozhzhova@cern.ch

We present the critical review of estimates of centrality in AA and pA collisions that are usually done by selection of classes of events with certain charged particles multiplicity. Results of MC simulations in different models are presented. They include the Standard Glauber, the Modified Glauber model 1 and HIJING[2] event generator (with gluon shadowing) MC calculations. We present the estimates of the number of participants (Npart) and of the nucleon-nucleon collisions (Ncoll) and their distributions and relations to the impact parameter in AA, and pA interactions at the LHC energy. It is obtained that the distributions in Npart, relevant to the narrow (1%) multiplicity class selection in Pb-Pb collisions, are wider than could be expected. Results of models [1-2] are found to be in agreement with and AMPT[3] and the non-Glauber Model MC calculations [4], all these data are pointing at the considerable stopping of nucleons (or high role of gluon shadowing) in Pb-Pb and p-Pb interactions at the LHC energies. It is shown that, contrary to the Standard Glauber model, the account of the energy-momentum conservation in soft particles production, that is intrinsically present in the models [1-4], leads to the noticeable decrease in the mean number of nucleon collisions Ncoll in Pb-Pb and p-Pb interactions at the LHC energies. Importance of these effects in search of the critical phenomena at the SPS energies is also discussed.

The authors acknowledge Saint-Petersburg State University for a research
grant 11.38.66.2012

References:

1 G. Feofilov, A. Ivanov, Number of nucleon-nucleon collisions vs energy in modified Glauber calculations // Journal of Physics G CS, 5, (2005) 230-237
[2] HIJING, R. Xu, W.-T. Deng, and X.-N. Wang, arXiv:1204.1998
[3] AMPTJ. Albaete, N. Armesto, R. Baier, et al., Int. J. Mod. Phys. E 22, 1330007 (2013), arXiv:1301.3395 [hep-ph].
[4] V. Kovalenko, Phys. Atom. Nucl. 76, 1189 (2013), arXiv:1211.6209 [hep-ph]; arXiv:1308.1932 [hep-ph], 2013; V. Kovalenko, V. Vechernin. PoS(BaldinISHEPP XXI) 077, 2012, arXiv:1212.2590 [nucl-th]

Parallel IV: D2 Deconfinement / 129

Chiral gap effect in QCD in curved space

Author: Kenji Fukushima[1]

[1] *The University of Tokyo*

Corresponding Author: fukush@gmail.com

We discuss the effect of curved spacetime on QCD phase transitions. We point out a common feature that fermions are always gapped with a curvature in a way consistent with chiral symmetry, which we call the chiral gap effect. We can have intuitive understanding of the behavior of the chiral condensate as a function of positive and negative curvatures. We also address the decoupling of

the gluonic sector from dynamical quarks because of the mass gap. This suggests that QCD would become closer to the pure Yang-Mills theory under strong gravitational fields. We mention on a speculative scenario on the QCD surroundings near the black holes.

Plenary 9 / **130**

Highlights on the mechanism of confinement from lattice simulations (in memory of Misha Polikarpov)

Author: Vitaly Bornyakov[1]

[1] *Institute for High Energy Physics*

Corresponding Author: bornvit@gmail.com

I present an overview of the lattice studies of the confinement problem. I will concentrate on the dual superconductor scenario of confinement and on the center vortex theory of confinement. The talk is devoted to the memory of Misha Polikarpov who passed away one year ago. Misha was certainly one of the major figures in the lattice studies of the confinement problem. In my talk I will recall his most important results as well as results obtained by other groups.

Parallel V: D9 Deconfinement / **131**

Results from Cu+Au collisions at 200 GeV in PHENIX experiment

Author: Dmitry Kotov[1]

Co-authors: Alexei Safonov [1]; Dmitry Ivanishchev [2]; Viktor Riabov [3]; Vladimir Samsonov [3]; Yaroslav Berdnikov [1]; Yuriy.G Ryabov [3]

[1] *SPbSPU*

[2] *B.P. Konstantinov Petersburg Nuclear Physics Institute - PNPI*

[3] *B.P. Konstantinov Petersburg Nuclear Physics Institute - PNPI (*

Corresponding Author: dm_kotov@phmf.spbstu.ru

The flexibility of RHIC to collide different nuclei provides experiments with a rich set of data to systematically test models and scaling behaviors in various collision systems. In 2012 RHIC collided Cu+Au nuclei. These collisions promise an array of unique initial geometrical configurations. Such geometries present an opportunity to measure the wide range of initial energy densities of this system. They also allow the study of some unique features arising from these configurations. In particular, the odd harmonics from the Cu+Au system offer sensitivity to v3 generated from the collision geometry as opposed to fluctuations in a symmetric system.
The results from the global particle production and the challenges in analyzing this asymmetric system will be presented in the talk: spectra as a function of centrality, nuclear modification factors RAA and particle ratios such as proton/pion, and antiproton/proton will also be shown. The comparison with other colliding systems such as Au+Au will be carried out.

132

Polyakov loop correlators and cyclic Wilson loop from lattice QCD

Author: Johannes Weber[1]

Co-authors: Alexei Bazavov [2]; Antonio Vairo [3]; Matthias Berwein [4]; Nora Brambilla [5]; Peter Petreczky [6]

[1] *Technische Universität München*

[2] *Brookhaven National Laboratory*

[3] *Institut fuer Theoretische Physik-Ruprecht-Karls-Universitaet H*

[4] *TU Munich*

[5] *Institut fuer Theoretische Physik*

[6] *BNL*

Corresponding Author: johannes.weber@tum.de

We calculate the correlation function of Polyakov loops and the cyclic Wilson loops in 2+1 flavor QCD at non-zero temperature. In our investigations we use the highly improved staggered quark (HISQ) action and lattices with temporal extent Nt=4,6,8,10 and 12.
At high temperatures we compare our numerical results with perturbation theory.

Poster Session / **133**

Study of strange mesons in p+p, d+Au and Cu+Cu collisions at 200 GeV in PHENIX experiment at RHIC

Author: Dmitry Kotov[1]

Co-authors: Alexander Berdnikov [1]; Dmitry Ivanishchev [2]; Viktor Riabov [3]; Vladimir Samsonov [3]; Yuriy.G Ryabov [3]

[1] *SPbSPU*

[2] *B.P. Konstantinov Petersburg Nuclear Physcis Institute - PNPI*

[3] *B.P. Konstantinov Petersburg Nuclear Physics Institute - PNPI (*

Corresponding Author: dm_kotov@phmf.spbstu.ru

Strange hadrons are among the most interesting probes of the quark-gluon-plasma, created in the collisions of heavy ions at relativistic energy.

The PHENIX experiment at RHIC has measured invariant transverse momentum spectra and nuclear modification factor (R_{AA}) of strange mesons K^{*0} and K^0_S, in p+p, d+Au and Cu+Cu collisions at center of mass energy 200 GeV.
The invariant transverse momentum spectra for K^{*0} (K^0_S) is measured over a range of transverse momentum (p_T) from 1.1–1.4 GeV/c to 8–8.5 GeV/c (2–3 GeV/c to 12–13 GeV/c) depending on the collision systems.
Similar to the other light-quark mesons measurements, both these strange mesons show no cold-nuclear-matter effects in the measured p_T range in d+Au collisions. The (R_{dAu}) factor ~ 1 and is almost constant as a function of p_T.
It is interesting to have the quantitative study of (R_{CuCu}) of the strange mesons (K^{*0}, K^0_S) in heavy ion collisions as a function of centrality.

In case of peripheral collisions, no suppression are registered with respect to the p+p yield scaled with binary collisions. Where as in central collisions, both mesons suffer substantial amount of suppression at high p_T (> 5 GeV/c), which is similar to the suppression suffered by light-quark mesons.
In the intermediate p_T range (2 < p_T < 5 (GeV/c)), the strange mesons are less suppressed than the light-quark meson (π^0) and more suppressed than the baryons (p, $\bar{p}$).

Parallel V: F5 Nuclear and Astroparticle Physics / 134

MC generator HARDPING: nuclear effects in hard interactions of leptons and hadrons with nuclei

Author: Aleksei Ivanov[1]

Co-authors: Daniil Suetin [2]; Victor Kim [3]; Yaroslav Berdnikov [1]

[1] *SPBSPU & PNPI*

[2] *SPBSPU*

[3] *PNPI*

Corresponding Author: aleksei.ivanov@cern.ch

Hadron and lepton production in hard interaction of high-energy particles with nuclei are considered in context of developing of Monte Carlo generator HARDPING (Hard Probe Interaction Generator). Such effects as energy losses and multiple re-scattering initial and produced hadrons and their constituents are taken into account. These effects are implemented in the current version of generator HARDPING. The data on hadron production in lepton-nuclei collisions (HERMES Coll.) and on lepton pair production in proton-nuclei collisions (E866 Coll.) were described with current version of generator HARDPING. Predictions for lepton pair production in pA-collisions at the 120 GeV Fermilab Main Injector and at the LHC at sqrt(s) = 5 TeV are presented.

Parallel I: A5 Vacuum structure and confinement / 136

Dyson–Schwinger Equations of Hamiltonian Quantum Chromodynamics

Author: Davide Campagnari[1]

Co-author: Hugo Reinhardt

[1] *Eberhard-Karls-Universität Tübingen*

Corresponding Author: d.campagnari@uni-tuebingen.de

The general method for treating non-Gaussian wave functionals in the Hamiltonian formulation of a quantum field theory, which was previously proposed and developed for Yang-Mills theory in Coulomb gauge, is generalized to full QCD. Exploiting Dyson-Schwinger equation techniques, we express the various n-point functions, needed in expectation values of observables like the Hamiltonian, in terms of the variational kernels of our trial ansatz. Finally the equations of motion for these variational kernels are derived by minimizing the energy density.

Parallel III: C6 Heavy Quarks / 137

Phenomenology of the heavy quarkonium electric dipole transitions

Author: Hector Martinez[1]

[1] *TU Munich*

Corresponding Author: heedmane@gmail.com

We use the complete expression for the $\mathcal{O}(1/m^2)$ corrections to the quark-antiquark potential derived from QCD in terms of Wilson loop expectation values, and a mapping, valid at large distances, between those Wilson loop expectation values and correlators evaluated in the effective string theory (EST), to compute all $\mathcal{O}(1/m^2)$ potentials at large distances. In particular, we present previously unknown results for the spin-independent part of the potential and confirm known results for the spin and momentum dependent parts. We discuss the power counting and numerical size of these new corrections. Using the EST long-distance contributions as the infrared completion of the potential we calculate the corrections induced by these to the heavy quarkonium wavefunction. Finally, considering these corrections, we evaluate the heavy quarkonium electric dipole (E1) transition rates at NLO in the relativistic expansion. We show that our results compare favorable with the experiment and provide predictions for the rates for which no experimental data is yet available.

Parallel III: B6 Light Quarks / **138**

”Analysis of the reaction pi- Be -> pi- pi0 pi0 Be at VES.”

Author: Dmitri Ryabchikov[1]

[1] *Institute for High Energy Physics (RU)*

Corresponding Author: dmitri.riabtchikov@cern.ch

The upgraded VES detector has recently collected the highest
world statistics of the reaction pi- Be -> pi- pi0 pi0 Be
- about 14 000 000 events. This allows us to perform mass
independent partial wave analysis in 10 non-equidistant
intervals of squared momentum transfer t’ in the region
0 < t’ < 1 GeVˆ2.
The second stage of the analysis is the model-dependent
fit describing 2-dim dependence of PWA sub-density matrix
on (m(3pi) , t’) by resonant and background contributions.
Results of the fit demonstrate that production of resonances is observed
by both coherent and incoherent diffraction mechanisms.
The resonant parameters are discussed as well as t’-dependence
of their intensities and production phases.

Parallel IV: D4 Deconfinement / **139**

D and D* meson mixing in magnetic field from QCD sum rules

Author: Kei Suzuki[1]

Co-authors: Koichi Hattori [2]; Philipp Gubler [3]; Sho Ozaki [4]; Su Houng Lee [5]

[1] *Tokyo Institute of Technology*

[2] *RIKEN BNL*

[3] *RIKEN*

[4] *KEK*

[5] *Yonsei University*

Corresponding Author: k.suzuki.2010@th.phys.titech.ac.jp

Quantum chromodynamics (QCD) in strong magnetic field is one of the most exciting topic in hadron physics. Especially, one can expect that hadrons are modified by strong magnetic fields such as that

produced in ultrarelativistic heavy-ion collisions. In this study, we investigate the properties of the heavy-light (D) meson in magnetic field. QCD sum rule (QCDSR) is a method to investigate the properties of hadrons from QCD including non-perturbative effect. Recently, applications of QCDSR to systems in external magnetic field is tried by some authors. In this presentation, we report the result of the D meson mass shift in magnetic field from QCDSR and discuss mixing of the vector and pseudoscalar mesons by magnetic effect.

Parallel I: A1 Vacuum structure and confinement / **140**

Study of axial magnetic effect

Author: Victor Braguta[1]

Co-authors: ALEXANDER MOLOCHKOV [2]; Karl LANDSTEINER [3]; MAXIM CHERNODUB [4]; MAXIM ULYBYSHEV [5]; VLADIMIR GOY [2]

[1] *Institute for High Energy Physics*

[2] *Far Eastern Federal University*

[3] *Universidad Autonoma de Madrid*

[4] *Department of Physics and Astronomy, University of Gent*

[5] *ITEP*

Corresponding Author: victor.v.braguta@gmail.com

The axial magnetic field, which couples to left- and right-handed fermions with opposite signs, may generate an equilibrium dissipationless energy flow of fermions in the direction of the field even in the presence of interactions. In this report numerical observation of the Axial Magnetic Effect in SU(2) lattice gauge theory is presented. The temperature behavior of the Axial Magnetic Effect is studied. It is shown that in the confinement (hadron) phase the effect is absent. In the deconfinement transition region the conductivity quickly increases, reaching the asymptotic T^2 behavior in a deep deconfinement (quark-gluon plasma) phase.

Parallel IV: D8 Deconfinement / **141**

Two-color QCD with chiral chemical potential

Author: Andrey Kotov[1]

Co-authors: Alexander Schreiber [2]; Bengt Petersson [2]; Ernst-Michael Ilgenfritz [3]; Michael Mueller-Preussker [4]; Victor Braguta [5]

[1] *ITEP*

[2] *Humboldt-Universität zu Berlin, Institut für Physik*

[3] *Joint Institute for Nuclear Research Dubna, Russia*

[4] *Humboldt-Universitaet zu Berlin*

[5] *I*

Corresponding Author: kotov@itep.ru

We present preliminary results of the study lattice SU(2) QCD phase diagram with chiral chemical potential. The simulation is carried out with dynamical staggered fermions without rooting. The dependences of the chiral density, Polyakov loop, chiral condensate and corresponding susceptibilities on the chiral chemical potential and temperature are measured.

Poster Session / 142

Two dimensional thick center vortex model

Author: Shahnoosh Rafibakhsh[1]

Co-author: Alireza Ahmadi [1]

[1] *Department of Physics, Science and Research Branch, Azad University, Tehran, Iran*

Corresponding Author: rafibakhsh@ut.ac.ir

The potential between static color sources is calculated in the $SU(3)$ gauge group by introducing a two dimensional vortex flux. To generalize the model, the length of the Wilson loop is equal to R oriented along the x axis, and the vortex flux is considered as a function of x and y. The comparison between the generalized model and the original one shows that the intermediate linear regime is increased significantly and better agreement with Casimir scaling is achieved. Furthermore, the model is applied to calculate the potential between baryons.

Parallel I: A5 Vacuum structure and confinement / 143

A covariant variational approach to Yang-Mills theory

Author: Markus Quandt[1]

Co-authors: Hugo Reinhardt [1]; Jan Heffner [1]

[1] *Universität Tübingen*

Corresponding Author: markus.quandt@uni-tuebingen.de

We investigate the low-order Green's functions of *SU(N)* Yang-Mills theory in Landau gauge, using a covariant variational principle based on the effective action formalism. Employing an approximation to the Faddeev-Popov determinant established previously in the Hamiltonian approach in Coulomb gauge leads to a closed and renormalizable set of integral equations for the ghost and gluon propagator. We perform a full infrared analysis of this system, solve it numerically and compare our results to findings from lattice gauge theory and other functional approaches. We also discuss formal aspects such as the lack of full BRST symmetry and its implications on confinement in our approach. Furthermore, we demonstrate how the system can be extended to finite temperatures and search the renormalized numerical solution for signals of a phase transition in the shape of the propagators and, in particular, in the infrared exponents. Finally, we discuss briefly the inclusion of fermions and how the method could be extended to non-zero chemical potential.

Parallel VI: F4 Nuclear and Astroparticle Physics / 144

An analysis of the nucleon spectral function in the nuclear medium from QCD sum rule

Author: Keisuke Ohtani[1]

Co-authors: Makoto Oka [1]; Philipp Gubler [2]

[1] *Tokyo Institute of Technology*

[2] *RIKEN*

Corresponding Author: ohtani.k@th.phys.titech.ac.jp

The QCD sum rule method is a powerful tool for studying hadron properties directly from QCD. In this method, the correlation function of an interpolating field operator coupled to the hadron of interest,
which can be calculated in the deep Euclidean region by the operator product expansion (OPE), is related to the hadronic spectral function. The non-perturbative contributions in the correlation function
are expressed by vacuum condensates such as the chiral condensate.
In the traditional analysis, it is necessary to assume some specific functional form,
such as the “pole + continuum”-ansatz, for the spectral function.
On the other hand, our approach with the help of the Maximum Entropy Method (MEM) is able to extract the spectral
function without assuming a specific form.
The method has been successfully applied to the rho meson sum rule 1 and the nucleon sum rule [2] in vacuum.

We have applied this analysis method of QCD sum rules to the spectral function of the nucleon and its negative parity excited states in vacuum [3]. We construct the parity projected nucleon sum rules including the first order \alpha_{s} corrections by using a phase-rotated Gaussian kernel.
Both the positive and negative parity spectral function of the nucleon are extracted after the MEM is applied to the sum rule.
We find that the difference between the positive and negative parity spectral function is
mainly caused by the chiral condensate.

Applying this method to the analyses in nuclear medium, the mass modification of both the positive and
negative parity states can be examined.
An investigation of the nucleon spectral function in nuclear medium is now in progress.

1 P. Gubler and M. Oka, Prog. Theor. Phys. 124, 995 (2010).

[2] K. Ohtani, P. Gubler and M. Oka, Eur. Phys. J. A 47, 114 (2011).

[3] K. Ohtani, P. Gubler and M. Oka, Phys. Rev. D 87, 034027 (2013).

Parallel IV: D4 Deconfinement / **145**

Magnetic Properties of QCD Matter: Lattice Results

Author: Gunnar Bali[1]

[1] *University of Regensburg*

Corresponding Author: gunnar.bali@ur.de

We present recent lattice results of magnetic properties of QCD matter obtained with 1+1+1 sea quarks at physical mass and several lattice spacings at zero and at non-zero temperatures.

The results include the phase diagram, the magnetization and the equation of state.

Parallel VI: G1 Strongly Coupled Theories / **146**

The Impact of Resonaces in the Electroweak Effective Lagrangian

Author: Ignasi Rosell[1]

Co-authors: Antonio Pich [2]; Joaquin Santos [3]; Juan Jose Sanz-Cillero [4]

[1] *Universidad CEU Cardenal Herrera & IFIC, Valencia*

[2] *IFIC, Universitat de Valencia - CSIC*

[3] *IFIC, Universitat de Valencia - IFIC*

[4] *Universidad Autonoma de Madrid*

Corresponding Author: rosell@uch.ceu.es

We study strongly coupled models of electroweak symmetry breaking with a light Higgs boson. We use a resonance effective Lagrangian with bosonic massive resonances together with the Standard Model degrees of freedom, including a light Higgs. We consider constraints from the phenomenology and from the assumed high-energy behavior of the underlying theory. This resonance effective theory can be used to estimate the low-energy constants (LECs) of the Electroweak Effective Theory in terms of resonance parameters and to make predictions of low-energy observables like, for instance, the oblique parameters.

Parallel V: E3 QCD and New Physics / **147**

Status of the theoretical prediction for the muon g-2

Author: Massimo Passera[1]

[1] *INFN Padova*

Corresponding Author: passera@pd.infn.it

I will summarize the status of the theoretical prediction for the anomalous magnetic moment of the muon, focusing on its latest developments.

Parallel II: B9 Light Quarks / **148**

Regge trajectories of ordinary and non-ordinary mesons from their poles

Author: Jenifer Nebreda Manjon[1]

Co-authors: A. P. Szczepaniak [2]; J.A. Carrasco [3]; J.R. Pelaez [3]; J.T. Londergan [2]

[1] *YITP, Kyoto University*

[2] *Indiana University*

[3] *Universidad Complutense de Madrid*

Corresponding Author: jnebreda@yukawa.kyoto-u.ac.jp

Our results on obtaining the Regge trajectory of a resonance from its pole in a
scattering process and from analytic constraints in the complex angular momentum plane will be presented. The method, suited for resonances that dominate an elastic
scattering amplitude, has been applied to the rho(770), f_2(1275), f_2´(1525) and the f0(500) resonances.
Whereas for the first three we obtain linear Regge trajectories, characteristic of ordinary quark-antiquark states, for the latter we find a non-linear trajectory with a much smaller slope at the resonance mass. We also show that if a linear trajectory with a slope of typical size is imposed for the f0(500), the corresponding amplitude is at odds with the data. This provides a strong indication of the non-ordinary nature of the sigma meson.

Parallel II: B3 Light Quarks / 149

Green functions of currents in the odd-intrinsic parity sector of QCD

Authors: Jiri Novotny[1]; Karol Kampf[1]; Tomas Kadavy[1]

[1] *Charles University (CZ)*

Corresponding Author: tomas.kadavy@gmail.com

The independent operator basis of the most important resonances in the odd-intrinsic parity sector of QCD allows us to construct Lagrangians for corresponding Feynman diagrams of several types of interaction channels of the mesons and resonances.

In this talk, we will discuss all three-point current correlators non-trivial for this sector. We briefly summarize their basic properties and high energy bahaviour via the OPE framework. We also show that vector field formalism is not compatible with the OPE, and for this reason the antisymmetric field formalism is a more suitable choice. At the end we briefly introduce fundamental phenomological aspects that could be useful in the next studies.

Parallel II: B9 Light Quarks / 150

Tetraquarks as four-body bound states in a Bethe-Salpeter approach

Author: Walter Heupel[1]

Co-authors: Christian Fischer [2]; Gernot Eichmann

[1] *Justus-Liebeig University Giessen*

[2] *Justus-Liebig University Giessen*

Corresponding Author: walter.heupel@theo.physik.uni-giessen.de

In the framework of Dyson-Schwinger equations, we present the first calculation of a four-body Bethe-Salpeter equation as required for the covariant description of tetraquarks. In a first approach we focus on the lightest tetraquark candidate, the $f_0(500)$, with an aim to determine the complete scalar nonet. Further investigations in this approach will focus on tetraquarks in the vector channel, mixing with $q\bar{q}$ mesons and the inclusion of charm quarks.

Parallel III: B10 Light Quarks / 151

Meson Production in Low Energy e+e- Collisions and Its Applications

Author: Simon Eidelman[1]

[1] *Novosibirsk State University*

Corresponding Author: simon.eidelman@cern.ch

Experiments on e+e- annihilation into hadrons performed with the CMD-3 and SND detectors at the VEPP-2000 collider in Novosibirsk are described. We report preliminary results on various two-body and multibody final states

obtained with the integrated luminosity of 60/pb per detector in the center-of-mass energy range 320 MeV to 2000 MeV. Various applications of these measurements, in particular to the hadronic contribution to the muon anomalous magnetic moment are discussed.

Parallel I: A2 Vacuum structure and confinement / 152

Discriminating between two reformulations of SU(3) Yang-Mills theory on a lattice: Abelian monopole or non-Abelian monopole responsible for confinement

Author: Akihiro Shibata[1]

Co-authors: Kei-Ichi Kondo [2]; Seikou Kato [3]; Toru Shinohara [2]

[1] *High Energy Accelerator Research Organization (KEK)*

[2] *Chiba University*

[3] *Fukui National College of Technology*

Corresponding Author: ashibata@post.kek.jp

We have pointed out that the SU(3) Yang-Mills theory has a new way of reformulation using new field variables (minimal option), in addition to the conventional option adopted by Cho, Faddeev and Niemi (maximal option). The reformulation enables us to change the original non-Abelian gauge field into the new field variables such that one of them called the restricted field gives the dominant contribution to quark confinement in the gauge-independent way. In the minimal option, especially, the restricted field is non-Abelian U(2) and involves the non-Abelian magnetic monopole. This should be compared with the maximal option: the restricted field is Abelian U(1) x U(1) and involves only the Abelian magnetic monopole, just like the Abelian projection.

In the preceding lattice conferences, we have accumulated the numerical evidences for the non-Abelian magnetic-monopole dominance in addition to the restricted non-Abelian field dominance for quark confinement supporting the non-Abelian dual superconductivity using the minimal option for the SU(3) Yang-Mills theory.

In this talk, we focus on discriminating between two reformulations, i.e., maximal and minimal options of SU(3) Yang-Mills theory for quark confinement from the viewpoint of dual superconductivity. For this purpose, we measure the distribution of the chromoelectric flux connecting a quark and an antiquark and the induced magnetic-monopole current around the flux tube, etc.

Parallel V: E2 QCD and New Physics / 153

The JLab Eta Factory (JEF) Experiment

Author: Liping Gan[1]

[1] *University of North Carolina Wilmington, USA*

Corresponding Author: ganl@uncw.edu

Decays of the η meson provide a unique, flavor-conserving laboratory to probe the isospin violating sector of low energy QCD and search for new physics beyond the Standard Model. The JEF Experiment has been developed in Hall D at Jlab to measure η decays emphasizing on rare neutral modes with two orders of magnitude background reduction compared to the previous experiments. The projected results will have profound physics impact: the $\eta \to B\gamma \to \pi^0\gamma\gamma$ decay provides a

stringent constraint on a dark leptophobic gauge boson (B) coupled to baryon number in 140-550 MeV mass range; C-violating η decays offer the best window for direct constraint on C-violating and P-conserving (CVPC) new physics; the Dalitz distribution of $\eta \to \pi^0\gamma\gamma$ probes interplay of vector & scalar meson resonances in ChPT; $\eta \to 3\pi$ will offer an improvement in the uncertainty of the light quark mass ratio. The detail of the experiment will be presented.

Parallel VI: G4 Strongly Coupled Theories / 154

The conformal window in theories beyond QCD

Author: Esben Mølgaard[1]

Co-authors: Marc Gillioz [2]; Matin Mojaza [3]; Oleg Antipin [4]; Stefano Di Chiara [5]; francesco Sannino [2]

[1] *University of Southern Denmark*

[2] *CP3-Origins*

[3] *CP3-Orgins*

[4] *INFN, Florence*

[5] *University of Helsinki*

Corresponding Author: doonesbury@gmail.com

Fixed points in gauge theories with fermions have been studied for a long time, and their presence or absence has been mapped out quite thoroughly in the so-called conformal window. However, by adding scalar particles to the theory, many more things can happen as the Yukawa and quartic interactions greatly influence the running of the couplings. We will discuss the structure of fixed points in gauge-Yukawa theories, and see how dramatic features can occur as a results of including scalars. The question of how trustable these new features are is of the utmost importance, and one we will thoroughly address.

http://arxiv.org/abs/arXiv:1205.6157

http://arxiv.org/abs/arXiv:1303.1525

Plenary 8 / 155

Gauge field topology and the hadron spectrum

Author: Michael Creutz[1]

[1] *Brookhaven Lab*

Corresponding Author: creutz@bnl.gov

Topologically non-trivial gauge field configurations are an interesting aspect of non-abelian gauge theories. These become particularly important upon quantizing the theory, especially through their effect on the pseudo-scalar spectrum. These effects are closely tied to chiral anomalies and the possibility of CP violation in the strong interactions. This talk will review these topics.

Summary:

The importance of gauge field topology to understanding the pseudo-scalar spectrum will be reviewed.

Parallel II: B5 Light Quarks / **156**

Nucleon Compton scattering and the muon g-2

Author: Gernot Eichmann[1]

[1] *University of Giessen*

Corresponding Author: gernot.eichmann@theo.physik.uni-giessen.de

The light-by-light scattering contribution to the muon anomalous magnetic moment is discussed from the Dyson-Schwinger perspective. The structure of the four-photon amplitude and the various slices of the phase space that play an important role for the muon g-2 are examined. The systematic construction of the four-photon vertex from the quark level satisfies electromagnetic gauge invariance by construction; it contains quark loops but also all intermediate meson resonances in the two-photon channels. It depends on the quark-photon and quark-Compton vertices which also enter in the calculation of nucleon form factors and the nucleon Compton scattering amplitude. In this way it becomes possible to link together a variety of electromagnetic processes from the same underlying building blocks. I will present first results for the muon g-2 and discuss how they compare with present model calculations.

Parallel II: B7 Light Quarks / **157**

Strange Baryonic Resonances

Author: Laura Fabbietti[1]

[1] *TUM*

Corresponding Author: kirill.lapidus@cern.ch

The study of Baryonic resonances with strangeness content
produced in hadron-hadron collisions is important
not only to understand the production mechanisms and the
structure of the various resonates, but also as fundamental
input for the modelling and understanding of heavy ion collisions.
New analysis techniques have been employes by the HADES collaboration
to study quantitatively the production of Sigma(1385), Lambda(1405),
N*(1650-1950), Delta++(1900) emerging from p+p collisions measured
at 3.5 GeV. In this talk the results of these measurements will be discussed
with particular emphasis on the Partial wave analysis carried out
to study the pKLambda final state and the possible existence of kaonic
bound states and the intriguing nature of the Lambda(1405).
Perspective for the upcoming measurement at FAIR and NICA will also be
discussed.

Poster Session / **158**

True self energy function, mixing and reducibility in effective scalar theories.

Author: Vladimir Vereshagin[1]

[1] *St.-Petersburg State University*

Corresponding Author: vvv@av2467.spb.edu

I discuss the renormalization of the one-loop 2-leg functions in multi-component effective scalar theory. It is shown that only a part of numerous contributions that appear in the general expression for 2-leg graph can be considered as the true self energy function. This part is completely fixed by two conventional requirements – correctness of the pole position and the wave function normalization. This part is the only one which should be taken into account in the conventional process of simming Dyson's chain that results in explicit expression for the full propagator in S-matrix graphs. The other parts provide well defined finite corrections for the graphs with the number of legs n>2.
It is also shown that there is no need in attracting the prescriptions for the higher derivatives of the 2-leg function on the mass shell: the requirements of finiteness and diagonability turn out quite sufficient.

Poster Session / 159

Study of mean transverse momenta correlations in rapidity and azimuthal windows in heavy ion collisions

Author: Igor Altsybeev[1]

[1] *St. Petersburg State University (RU)*

Corresponding Author: igor.altsybeev@cern.ch

The reported study is dedicated to the correlations between mean transverse momenta p_{T} of particles in two observation windows in heavy-ion collisions.

Analysis approach of mean p_{T} correlations is described.
Dependence on rapidity and azimuthal acceptance of the windows is studied using AMPT event generator and toy Monte-Carlo simulations.
Influence of the selection cuts - p_{T} range and event centrality - is also investigated.

Predictions for mean p_{T} correlations for heavy-ion collisions at ALICE (LHC) are expressed.

Author acknowledges Saint-Petersburg State University for a research grant 11.38.197.2014.

Summary:

Analysis approach of mean p_{T} correlations is described.
Dependence on rapidity and azimuthal acceptance of the windows is studied using AMPT event generator and toy Monte-Carlo simulations.
Influence of the selection cuts - p_{T} range and event centrality - is also investigated.

Predictions for mean p_{T} correlations for heavy-ion collisions at ALICE (LHC) are expressed.

Parallel III: B10 Light Quarks / 160

Open Issues in Light Baryon Spectroscopy

Author: Volker Crede[1]

[1] *Florida State University*

Corresponding Author: crede@fsu.edu

Nucleons are complex systems of confined quarks and gluons and exhibit the characteristic spectra of excited states. These states serve as an excellent probe of quantum chromodynamics (QCD), the fundamental theory of strong interaction. Highly-excited states are sensitive to the details of quark confinement, which is only poorly understood within QCD. This is the regime of non-perturbative QCD and it is one of the key issues in hadronic physics to identify the corresponding internal degrees of freedom and how they relate to strong coupling QCD. In recent years, lattice-QCD has made significant progress toward understanding the spectra of hadrons but many open questions remain, in particular on the role of gluons. On the experimental side, high-energy electrons and photons are a remarkably clean probe of hadronic matter, providing a microscope for examining atomic nuclei and the strong nuclear force. For more than a decade, laboratories worldwide have accumulated data for such investigations, resulting in a number of surprising discoveries and contributing to our understanding of the nucleon. Current experimental efforts in light baryon spectroscopy utilize highly-polarized frozen-spin (butanol) targets and deuterium targets in combination with polarized photon beams. These are important steps toward so-called complete experiments that will allow us to unambiguously determine the scattering amplitudes in the underlying reactions and to identify resonance contributions. In my talk, I will give an overview of the excited light-baryon program and a discussion of the experimental as well as phenomenological challenges.

Parallel VI: F4 Nuclear and Astroparticle Physics / 161

Medium effects in proton-induced strangeness production

Author: Kirill Lapidus[1]

[1] *TU Munich*

Corresponding Author: kirill.lapidus@ph.tum.de

High-precision data on neutral kaon production collected by the HADES collaboration in proton-niobium collisions at a beam energy of 3.5 GeV were analysed with the aim to extract the kaon in-medium potential. Predictions of the Chiral Perturbation Theory (ChPT) for the kaon in-medium properties were tested by means of GiBUU transport model simulations. The uncertainties of the model were considered in detail. The data support the presence of a repulsive potential that amounts to ≈35 MeV at normal nuclear density for kaons at rest. These results set an important benchmark for future studies of dense nuclear matter by means of strange probes.

Parallel I: A1 Vacuum structure and confinement / 162

QCD with axial chemical potential: possible manifestations

Author: Alexander Andrianov[1]

[1] *Saint Petersburg State University*

Corresponding Author: andrianov@icc.ub.edu

The low energy realization of QCD in terms of mesons is studied when an axial chemical potential is present; a situation that may be relevant in heavy ion collisions. We also consider the 'two flavour' Nambu–Jona-Lasinio model in the presence of a vector and an axial external chemical potential as a QCD replica and study the phase structure of the model at zero temperature. The presence of an axial charge has profound consequences on meson physics and causes birefringence of vector mesons and photons in such a medium. We propose that local parity breaking induced by a large-scale fluctuation of topological charge at large temperatures and/or condensation of pseudoscalar mesons in the isotriplet channel for large baryon densities may be (partly) responsible for the substantial

dilepton excess that is found for low invariant masses and moderate values of pT in central heavy ions collisions.

Parallel IV: D10 Deconfinement / 164

Constraints on the percolation model from anomalous centrality evolution of two-particle correlations in Au-Au collisions at √sNN = 62 and 200 GeV

Author: Grigory Feofilov[1]

Co-authors: Igor Altsybeev [2]; Olga Kochebina [3]

[1] *Saint-Petersburg State University*

[2] *Saint Petersburg State University*

[3] *Laboratoire de l'Accélérateur Linéaire (LAL), CNRS : UMR8607 – IN2P3 – Université Paris XI - Paris Sud*

Corresponding Author: feofilov@hiex.phys.spbu.ru

Some sudden change in two-dimensional two-particle angular correlations (i.e. the onset of a so-called near-side «ridge» structure, localized in azimuth and extended in pseudorapidity) was observed by STAR collaboration at RHIC in AuAu collisions at 62 and 200 GeV 1. It was shown for the first time that this change occurs at a specific Au-Au centrality, common to both energies. These results motivated the study [2] where the hypothesis of string percolation phase transition was used as a natural explanation of the conditions of the given onset. More
detailed experimental data analysis appeared recently and the obtained centrality trends of Au-Au angular correlations were compared in [3] to generic models of nucleus-nucleus collisions including Glauber linear superposition of N-N collisions, parton/hadron rescattering in a dissipative medium and a locally thermalized "opaque» medium.
In the present work we continue studies started in [2] focusing at the onset and the more accurate determination of the string percolation model parameters by using the data [3]. String percolation model was successfully used recently in [4] to qualitatively explain the dependence of the pseudorapidty and azimuthal widths of ridge structure on multiplicity and energy.
Our approach developed previously in [2] is briefly described. Modified Bjorken formula calculations are performed for the local energy densities in AA collisions at different impact-parameters (centralities) and with account of the latest data available on the charged particles densities at midrapidity. Finally we compare variations of mean local energy and of string densities and match the occurrence of the critical percolation phenomenon with the critical energy density value, considering them at the same values of centrality. The condition of the onset of the near-side ridge in AA collisions, that happens at some definite ("critical") number of participating nucleons, is found to be consistent with the hypothesis of the string percolation phase transition. Extrapolations of model results to the other colliding systems and energies are discussed.

The authors G.F. and I.A. acknowledge Saint-Petersburg State University
for a research grant 11.38.66.2012

References:
1 M.Daugherity (STAR
Collaboration), J. Phys. G35 (2008) 104090, arXiv:0806.2121v2
[nucl-ex] 2008; M. Daugherity// Report on QM2008.;
[2] O.Kochebina, G.Feofilov , Onset of "ridge phenomenon" in AA and pp
collisions and percolation string model, arXiv.org (hep-ph
)arXiv:1012.0173, 1 Dec 2010.
[3] G.Agakishev et al., Anomalous centrality evolution of two-particle
angular correlations from Au-Au collisions at.sNN = 62 and 200 GeV,
Phys.Rev. C86, 064902(2012).
[4] C. Andres, A. Moscoso, and C. Pajares, On the onset of the ridge
structure in AA, pA and pp collisions, arXiv: 1405.3632v2[hep-ph]17 May 2012.

- List item

Summary:

The condition of the onset of the near-side ridge in AA collisions, that happens at some definite ("critical") number of participating nucleons, is found to be consistent with the hypothesis of the string percolation phase transition. Extrapolations of model results to the other colliding systems and energies are discussed.

Parallel II: B8 Light Quarks / **165**

Dispersive representation of the Kpi and pipi form factors: application to hadronic tau decays

Author: Emilie Passemar[1]

[1] *Indiana University/JLab*

Corresponding Author: passemar@itp.unibe.ch

In this talk, we review the recent theoretical progress towards a precise determination of some hadronic observables such as the Kpi and pipi form factors. We show that significant improvement can be achieved by combining dispersive techniques with chiral perturbation theory calculations, lattice results and experimental measurements. We will then present two applications for precise tests of the Standard Model and new physics effects using the measurements of the hadronic decays of the tau lepton.
The extraction of the CKM mixing matrix element |V_us| from tau -> K pi nu_tau decay will be discussed. Secondly, we will show how the knowledge of the pipi form factor can provide a unique handle to constrain lepton flavour violation in the Higgs sector studying
the tau -> l pi pi decays.

Parallel IV: D7 Deconfinement / **166**

Jet evolution and the Pomeron

Author: Simon Caron-Huot[1]

[1] *Niels Bohr Insitute*

Corresponding Author: schuot@nbi.dk

I will discuss the use of the Pomeron as a theoretical tool to describe the interactions between a high-energy jet and an underlying quark-gluon plasma. By varying the intercept and other properties of the Pomeron, I will argue that one obtains a robust class of models which interpolate and unify the phenomenology of weak-coupling (perturbative QCD) and strong-coupling (holographic) models.

Parallel V: F5 Nuclear and Astroparticle Physics / **168**

Supporting the existence of the QCD critical point by compact star observations

Author: David Edwin Alvarez Castillo[1]

Co-author: David Blaschke [2]

[1] *JINR*

[2] *University of Wroclaw*

Corresponding Author: alvarez@theor.jinr.ru

In order to prove the existence of a critical end point (CEP) in the QCD phase diagram it is sufficient to demonstrate that at zero temperature $T = 0$ a first order phase transition exists as a function of the baryochemical potential μ, since it is established knowledge from ab-initio lattice QCD simulations that at $\mu = 0$ the transition on the temperature axis is a crossover.

We present the argument that the observation of a gap in the mass-radius relationship for compact stars which proves the existence of a so-called third family (aka "mass twins") will imply that the $T = 0$ equation of state of compact star matter exhibits a strong first order transition with a latent heat that satisfies $\Delta\epsilon/\epsilon_c gt; 0.6$ [Alford et al., arxiv:1302.4732].
Since such a strong first order transition under compact star conditions will remain first order when going to symmetric matter, the observation of a disconnected branch (third family) of compact stars in the mass-radius diagram proves the existence of a CEP in QCD.
Modelling of such compact star twins in realistic models based on a QCD motivated nonlocal PNJL model with density-dependent vector coupling strength will be presented here.

Furthermore we show results of a Bayesian analysis (BA) using disjunct M-R constraints for extracting probability measures for cold, dense matter equations of state. In particular this study reveals that measuring radii of the neutron star twins has the potential to support the existence of a first order phase transition for compact star matter.

Parallel V: F5 Nuclear and Astroparticle Physics / 169

Solving reconfinement, masquerade and hyperon puzzles of compact star interiors

Author: David Blaschke[1]

[1] *University of Wroclaw*

Corresponding Author: david.blaschke@gmail.com

We aim at clarifying three of the fundamental puzzles related to the still unsolved problem of the structure of the dense core of compact stars (CS): (i) hyperon puzzle: how to reconcile pulsar masses of $2M_\odot$ with the hyperon softening of the equation of state (EoS); (ii) masquerade problem: modern EoS for cold, high density hadronic and quark matter are almost identical; and (iii) reconfinement puzzle: what to do when after a deconfinement transition the hadronic EoS becomes favorable again? We show that taking into account the compositeness of baryons (by excluded volume and/or quark Pauli blocking) on the hadronic side and confining and stiffening effects on the quark matter side results in an early phase transition to quark matter with sufficient stiffening at high densities which removes all three present-day puzzles of CS interiors.

Parallel III: C4 Heavy Quarks / 170

Potential description of the charmonium from lattice QCD

Author: Taichi Kawanai[1]

[1] *RIKEN*

Corresponding Author: trickstar.505@me.com

We present quark-antiquark potentials for the charmonium, that are calculated using a relativistic heavy quark action for charm quarks and PACS-CS Iwasaki gauge configurations with 2 + 1 flavors of dynamical clover light quarks. The light quark masses are almost physical (pion mass ˜ 156(7) MeV). The interquark potential with finite quark masses are defined through the equal-time Bethe-Salpeter amplitude. We solve the non-relativistic Schrodinger equation with resulting charmonium potentials as theoretical inputs.

Parallel I: A2 Vacuum structure and confinement / 171

Reformulations of the Yang-Mills theory toward quark confinement and mass gap

Author: Kei-Ichi Kondo[1]

Co-authors: Akihiro Shibata [2]; Seikou Kato [3]; Toru Shinohara [1]

[1] *Chiba University, Japan*

[2] *KEK, Japan*

[3] *Fukui National College of Technology, Japan*

Corresponding Author: kondok@faculty.chiba-u.jp

We propose a reformulation of the SU(N) Yang-Mills theory toward quark confinement and mass gap. In fact, we have given a number of new reformulations for the SU(N) Yang-Mills theory using new field variables, other than the framework given by Cho, Faddeev and Niemi, which is included in our reformulations as a special case called the maximal option. The advantage of the reformulations is that the original non-Abelian gauge field variables can be changed into the new field variables such that one of them called the restricted field gives the dominant contribution to quark confinement in the gauge-independent way. The reformulation is suggested from the SU(N) extension of the Diakonov-Petrov version of the non-Abelian Stokes theorem for the Wilson loop operator. Especially, in the minimal option, the restricted field is non-Abelian U(N-1) and involves the non-Abelian magnetic monopole. This suggests the non-Abelian dual superconductivity picture for quark confinement. This should be compared with the maximal option: the restricted field is Abelian U(1) x U(1) and involves only the Abelian magnetic monopole, just like the Abelian projection. We give some applications of this reformulation, e.g., large N treatment for deriving the dimensional transmutation and understanding the mass gap, stability for the homogeneous chromomagnetic condensation of the Savvidy type, numerical simulations (given by Dr. Shibata), etc.

Parallel V: D9 Deconfinement / 172

Mapping the Little Bangs Through Energy Density and Temperature Fluctuations

Author: Sumit Basu[1]

Co-authors: Basanta Kumar Nandi [2]; Rupa Chatterjee ; Tapan Nayak [1]

[1] *Department of Atomic Energy (IN)*

[2] *IIT- Indian Institute of Technology (IN)*

Corresponding Author: sumit.basu@cern.ch

Heavy-ion collisions at relativistic energies, which are accessible at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC), are often
referred to as little bangs. Experiments at these energies probe the conditions which prevail at freeze-out, and often it is not possible to define the correct equation-of-state (EoS) and the conditions at the initial stages of the collision. By employing hydrodynamic evolution of the fireball 1 created in the
collisions, we have generated maps of the energy density (ϵ) and temperature (T) of the system throughout its evolution. With the help of the maps, we obtain time evolution of the fluctuations in ϵ and T.
We have shown for the first time that the method of interpolation of fluctuations obtained from the maps can provide a powerful technique in looking back at the initial stages of the heavy-ion collisions.

In case of cosmic microwave background radiation (CMBR),
temperature maps of the sky [2], made by scanning in θ-ϕ bins, provide vital information regarding the age and composition of the Universe, galaxy formation, expansion rate, etc. This is possible by analyzing the map to
extract temperature fluctuations and making power spectrum. For heavy-ion collisions, we propose to make temperature maps in rapidity and azimuthal angle (y-ϕ). This is demonstrated by using the AMPT event generator. By making correspondence with the evolution of fluctuations from hydrodynamics,
vital information regarding the fireball can be obtained at very early stage
and throughout the evolution of the system [3]. We will present this new method, first results and make the proposal for its application to experimental data at RHIC and LHC.

1 H. Holopainen, H. Niemiand and K.J. Eskola, Phys. Rev.C 83, 034901(2011).

[2] C. L. Bennett et al. [WMAP Collaboration], Astrophys. J. Suppl. 148, 1(2003); E. Komatsu et al. [WMAP Collaboration], arXiv:0803.0547 [astro-ph].

[3] S. Basu, R. Chatterjee, B.K. Nandi and T.K. Nayak
(arxiv : 1405.3969).

Parallel IV: D6 Deconfinement / **173**

Lattice NRQCD study on the in-medium modification of Bottomonium spectra using a novel Bayesian reconstruction

Authors: Alexander Rothkopf[1]; Peter Petreczky[2]; Seyong Kim[3]

[1] *Institute for Theoretical Physics, Heidelberg University, Heidelberg, Germany*

[2] *Brookhaven National Laboratory - Department of Physics, Upton, USA*

[3] *Sejong University - Department of Physics, Seoul, South Korea*

Corresponding Author: rothkopf@thphys.uni-heidelberg.de

We present the results of a recent study on the in-medium modification of the spectral properties of Bottomonium S-wave (\Upsilon) and P-wave (\chi_b1) states. The light degrees of freedom of the surrounding medium are represented by 48^3x12 HotQCD lattices with Nf=2+1 HISQ flavors, which span the temperature range 140.40(MeV)(= 0.911T_C) < T < 248.63(MeV)(= 1.614T_C). The heavy quarks on the other hand are treated as probes, evolving in the background of the medium fields according to non-relativistic QCD (NRQCD) .

Spectral functions are extracted from the NRQCD propagators using a novel Bayesian approach, which is contrasted to the standard Maximum Entropy method. We confirm the finding of previous

studies that \Upsilon retains a well defined peak structure even at 1.6TC. Inspection of its mass reveal that medium effects only begin to play a role above T\sim175MeV, while its width appears to grow monotonously. For \chi_b1 we find that with the new Bayesian method, it is possible to resolve a ground state peak also up to T=248.6MeV, contrary to the MEM, which suggests ground state melting already at T>205MeV.

Parallel I: A7 Vacuum structure and confinement / 174

Baryon as dyonic instanton

Author: Alexander Gorsky[1]

[1] *IPPI*

Corresponding Author: gorsky@itep.ru

The generalized Skyrme model for the baryon motivated by the holography is formulated.
It involves the whole tower of vector and axial mesons as well as the chiral symmetry breaking. The origin of the Ioffe,s formula for the baryon mass is clarified.

Plenary 6 / 175

Equation of State of hot and dense QCD: Resummed perturbation theory confronts lattice data

Author: Jens Oluf Andersen[None]

Co-authors: Aleksi Vuorinen ; Aritra Bandyopadhyay [1]; Michael Strickland [2]; Mustafa Mustafa [1]; Najmul Haque [3]; Nan Su [4]; Sylvain Mogliacci [5]

[1] *Saha Institute*

[2] *Kent State University*

[3] *Saha Institute of Nuclear Physics*

[4] *Bielefeld University*

[5] *Bielefeld U*

Corresponding Author: jensoa@ntnu.no

The perturbative series for finite-temperature field theories has very poor convergence properties and one needs a way to reorganize it.
In this talk, I review two ways of reorganizing the perturbative series for field theories at finite temperature and chemical potential, namely hard-thermal-loop perturbation theory (HTLpt) and dimensional reduction (DR).
I will present results for the pressure and the quark susceptibilities from a 3-loop HTLpt calculation and for the quark susceptibilities using DR at four loops.
A careful comparison with available lattice data shows good agreement for a number of physical quantities.

Parallel VI: G3 Strongly Coupled Theories / 176

The Weyl Consistency conditions and their consequences

Author: Marc Gillioz[1]

[1] *CP3-Origins*

Corresponding Author: marc.gillioz@gmail.com

The conformal symmetry plays an important role in quantum field theories, even when it is explicitly broken by a renormalization group flow. The Weyl consistency conditions reflect its presence in the renormalized theory. They provide relations among the beta functions at different loop orders, with a broad range of applications, from the determination of the vacuum stability in the Standard Model to the mixing of higher-dimensional operators in effective theories.

Plenary 3 / **177**

Status of Precision Extractions of alpha_s and Heavy Quark Masses

Author: Jens Erler[1]

[1] *IF-UNAM*

Corresponding Author: erler@fisica.unam.mx

An overview of precision determinations of the strong coupling constant, as well as the top, bottom and charm quark masses is presented.

Plenary 1 / **178**

Jets in QCD: The Case for Jet Substructure

Author: Jesse Thaler[1]

[1] *MIT*

Corresponding Author: jthaler@mit.edu

This plenary talk will cover the latest development in jet substructure at the LHC.

Parallel III: C1 Heavy Quarks / **179**

A prediction of D^*-multi-ρ states

Author: Melahat Bayar[1]

Co-authors: Chu-Wen Xiao ; Eulogio Oset

[1] *Kocaeli University*

Corresponding Author: melahat.bayar@kocaeli.edu.tr

We present a study of the many-body interaction between a D^* and multi-ρ. We use an extrapolation to SU(4) of the hidden gauge formalism, which produced dynamically the resonances $f_2(1270)$ in the $\rho\rho$ interaction and $D_2^*(2460)$ in the ρD^* interaction. Then let a third particle, ρ, D^*, or a resonance collide with them, evaluating the scattering amplitudes in terms of the Fixed Center Approximation of the Faddeev equations. We find several clear resonant structures above 2800 MeV in the multibody

scattering amplitudes. They would correspond to new charmed resonances, D_3^*, D_4^*, D_5^* and D_6^*, which are not yet listed in the PDG, which would be analogous to the $\rho_3(1690)$, $f_4(2050)$, $\rho_5(2350)$, $f_6(2510)$ and $K_3^*(1780)$, $K_4^*(2045)$, $K_5^*(2380)$ described before as multi-ρ and K^*-multi-ρ states respectively.

Parallel II: B5 Light Quarks / **180**

Hadron spectroscopy at CLAS and CLAS12

Author: Marco Andrea Battaglieri[1]

[1] *INFN-Genova*

Corresponding Author: marco.battaglieri@cern.ch

The known hadron matter is made of two possible configurations: baryons, combination of 3 quarks and mesons, made by a quark and an anti-quark pair. QCD, the fundamental theory of strong interaction does not exclude the existence of states made by different combination of quarks and gluons: tetra-quarks, exotic and hybrid mesons, glue-balls. Precise determination of the hadron spectrum as well as finding evidence for such configurations would help in understanding one of the main open question in hadron physics: how the quark are confined within hadrons. In spite of a several decades of investigation, the experimental proof of the existence of such states is still under debate and the excited spectrum of mesons and baryons produced with different beams represent one of the main topic in the research programs of many existing (CERN, SLAC, BES, JLab ..) and future (JLAB12, FAIR ...) facilities. In my talk I will present the the results obtained at Jefferson Lab with the CLAS detector and the physic program that will be pursued in the Hall-B using the CLAS12 detector and the energy-upgraded beam of JLab. The physic case as well as the quasi-real photon tagger facility proposed for that experimental Hall will be described and some expected results will be shown.

Parallel III: C2 Heavy Quarks / **181**

semileptonic B decays

Author: Ricciardi Giulia[1]

[1] *Dipartimento di Fisica Univ. di Napoli Federico II*

Corresponding Author: ricciardi@na.infn.it

We review recent progress on semileptonic B decays

Parallel II: B1 Light Quarks / **183**

Overview and status of the proton radius measurements

Author: Miha Mihovilovic[1]

[1] *Johannes Gutenberg-Universitaet Mainz*

Corresponding Author: miham@kph.uni-mainz.de

The discrepancy between the proton charge radius extracted from the muonic hydrogen Lamb shift measurement and the best present value obtained from the elastic scattering experiments, remains unexplained and represents a burning problem of today's nuclear physics. After more than 50 years of research the radius of a basic constituent of matter is still not understood.

This discrepancy created a great excitement in the physics community, because it rigorously tests the theory of quantum electrodynamics and our understanding of nuclear physics. Since the observation of the discrepancy in 2010, various explanations for the problem have been offered, ranging from trivial experimental mistakes to those that suggest the need for physics beyond the Standard model. Some of the explanations have already been rejected, while the intriguing ideas, like the introduction of a new mediator particle, still need to be tested. Therefore, several new experiments have been proposed that will provide new constraints to the existing interpretations.

High-precision electron scattering experiments are scheduled at the Thomas Jefferson National Accelerator Facility and the Mainz Microtron accelerator at the Johannes Gutenberg University Mainz. As a complement to these measurements, a muon-proton scattering experiment is envisioned at the Paul Scherrer Institute. This will be the first experiment of its kind and will provide information on proton radius from a perspective yet unexplored. Together with the nuclear scattering experiments, new atomic experiments are also foreseen. Very precise measurements of Lamb shift in both hydrogen and deuterium will be performed in order to provide further insight into the proton radius puzzle.

Summary:

In the presentation results of existing proton radius measurements will be discussed together with an overview of ongoing and upcoming experiments, dedicated to remeasuring the proton radius with improved statistical and systematic precision.

Parallel I: A8 Vacuum structure and confinement / 184

Searching for calorons and dyons in SU(3) gluodynamic near to the transition and in deconfinement with the help of near-zero overlap modes

Author: Ernst-Michael Ilgenfritz[1]

Co-authors: Boris V. Martemyanov [2]; Michael Müller-Preussker [3]; Vitaly G. Bornyakov [4]

[1] *JINR Dubna, VBLHEP and BLTP*

[2] *ITEP Moscow*

[3] *Humboldt-Universität Berlin*

[4] *IHEP Protvino and ITEP Moscow*

Corresponding Author: ilgenfri@theor.jinr.ru

The topological structure of $SU(3)$ gluodynamics close to the infrared scale is studied near to the transition temperature with the help of zero and near-zero modes of the overlap Dirac operator. The associated UV filtered topological charge density is considered for antiperiodic and two other thermal boundary conditions. In this way three types of localized topological clusters can be identified as dyons with a characteristic pattern of the

local Polyakov loops. We can classify them either as constituents of (anti)calorons of van Baal type or as constituents of (anti)dyon pairs or as isolated (anti)dyons. Deeper in the deconfinement phase we complete the analysis of the topological structure by confronting it with the thermal monopoles visible in the Maximal Abelian gauge.

Parallel V: E2 QCD and New Physics / 185

Four-pomeron interaction

Author: Semyon Pozdnyakov[1]

Co-authors: Michail Braun [2]; Michail Salykin [2]; Michail Vyazovsky [2]

[1] *Saint Petersburg State University*

[2] *Saint-Petersburg State University, Russia*

Corresponding Author: noterial@mail.ru

Indico rendering error

```
Could not include image: [404] Error fetching image
```

We study the processes of nucleus-nucleus interaction. The bulk of the amplitude can be represented in terms of pomerons propagating from the multi-nucleon projectile to the multi-nucleon target. The pomeron couples to the separate valence quarks in a hadron, rather than to the hadron as a whole. This particular assumption forms the basis of an internally consistent and extremely successful model. It is consistent with experiment. Phenomenological properties of the pomeron are derived from high energy qq and $A_+^{B_1} A_+^{B_1} A_-^{b_1} A_-^{b_2} V_\nu^d$ total and differential cross-section data. Each pomeron can also split into two ones through a certain known triple pomeron vertex (pomeron fan diagrams).

Our aim is to analyse, if apart from the triple-pomeron coupling one has to account couplings of a larger number of pomerons in nucleus-nucleus interactions. Our immediate problem is to take into account the four-pomeron interaction, which appears when two nucleons from the projectile nucleus interact with two nucleons from the target nucleus in a non-trivial way, that is, with a connected diagram. In the lowest order each nucleon can be imitated by a quark-antiquark loop with at least two gluons attached to it. Still more simplifying, we can substitute the loop by a single quark, provided we assume that it interacts with a double gluon exchange in the colourless state.

This is the problem to be solved by calculating effective vertex $\bar{q}q$

To study this process we use the Lipatov effective action, which provides a powerful and constructive technique for the calculation of all Feynman diagrams in the Regge kinematics.

The effective Lagrangian is local in rapidity and describes the
self-interaction of gluons at a given rapidity by means of the usual
QCD Lagrangian
$A_+^{B_1} A_+^{B_1} A_-^{b_1} A_-^{b_2} V_\nu^d$
and their interaction with reggeons.

It has the form:

Indico rendering error

```
Could not include image: [404] Error fetching image
```

where

Indico rendering error

```
Could not include image: [404] Error fetching image
```

The shift $calL_{QCD}$ with $V_\mu \to V_\mu + A_\mu$ is done
to exclude direct gluon-reggeon transitions.
The reggeon fields are assumed to be subject to kinematic conditions
$A_\perp = 0$

In my report I would like to talk about the problem arising in 3 $\partial_- A_+ = \partial_+ A_- = 0$ 3 reggeons transition, which includes the effective vertex.

The authors (S.P. and M.B.) acknowledge Saint-Petersburg State University for a research grant 11.38.197.2014

Parallel I: A4 Vacuum structure and confinement / **187**

Continuity of the Deconfinement Transition in (Super) Yang Mills Theory

Author: Thomas Schaefer[1]

[1] *North Carolina State University*

Corresponding Author: tmschaef@ncsu.edu

Finding controlled, analytical approaches to the deconfinement transition in QCD is an old problem. Here we present a weak coupling calculation of the deconfinement transition in a deformed version of QCD. The deformation involves adding a fermion in the adjoint representation, subject to twisted boundary condistions along the thermal circle. We argue that the transition in the deformed theory is continuously connected to the transition in pure gauge theory, which takes place in strong coupling.

Parallel I: A3 Vacuum structure and confinement / **188**

Magnetohydrodynamics, charged currents and directed flow in heavy ion collisions

Authors: Dmitri Kharzeev[1]; Krishna Rajagopal[2]; Umut Gursoy[3]

[1] *Stony Brook U./BNL*

[2] *Massachusetts Inst. of Technology (US)*

[3] *University of Utrecht (NL)*

Corresponding Author: umut.gursoy@cern.ch

The hot QCD matter produced in any heavy ion collision with a nonzero impact parameter is produced within a strong magnetic field. We study the imprint that these fields leave on the azimuthal distributions and correlations of the produced charged hadrons. The magnetic field is time-dependent and the medium is expanding, which leads to the induction of charged currents due to the combination of Faraday and Hall effects. We find that these currents result in a charge-dependent directed flow v1 that is odd in rapidity and odd under charge exchange. It can be detected by measuring correlations between the directed flow of charged hadrons at different rapidities, ⟨v1±(y1)v1±(y2)⟩.

Parallel IV: D2 Deconfinement / **189**

QGP phenomenology from anisotropic lattice QCD

Author: Jon-Ivar Skullerud[1]

Co-authors: Alessandro Amato [2]; Aoife Kelly [1]; Chris Allton [2]; Gert Aarts [3]; Maria Paola Lombardo [4]; Pietro Giudice [5]; Seyong Kim [6]; Simon Hands [2]; Sinead Ryan [7]; Tim Harris [8]; Wynne Evans [2]

[1] *National University of Ireland Maynooth*

[2] *Swansea University*

[3] *S*

[4] *INFN*

[5] *Universität Münster*

[6] *Sejong University*

[7] *Trinity College Dublin*

[8] *Trinity College, University of Dublin*

Corresponding Author: jonivar@thphys.nuim.ie

The FASTSUM collaboration has been carrying out simulations of $N_f = 2 + 1$ QCD at high temperature in the fixed-scale approach using anisotropic lattices. I will present the status of these studies, including recent results for charmonium physics and the deconfinement transition.

Plenary 4 / **191**

Status of chiral meson physics

Author: Johan Bijnens[1]

[1] *Lund University*

Corresponding Author: bijnens@thep.lu.se

I will give an overview of mesonic Chiral Perturbation Theory concentrating on recent developments.

Parallel IV: D2 Deconfinement / **192**

Quark mass dependence of the nature of QCD phase transition at high temperature and density by a histogram method

Author: Shinji Ejiri[1]

[1] *Niigata University*

Corresponding Author: ejiri@muse.sc.niigata-u.ac.jp

We study the phase structure of QCD at high temperature and density by lattice QCD simulations focusing on the probability distribution function (histogram).
First, we investigate the quark mass and chemical potential dependence of the probability distribution functions as functions of appropriate physical quantities when all quark masses are sufficiently large.
Through the shape of the distribution, the critical surface, which separates the first order transition

and crossover regions in the heavy quark region, is determined for the 2+1-flavor case.
Next, we study the phase structure of (2+Nf)-flavor QCD, where two light flavors and Nf massive flavors exist.
Applying the reweighting method, the probability distribution function of the plaquette is calculated in (2+Nf)-flavor QCD.
From the distribution, we determine the critical mass of heavy flavors terminating the first order region, and find it to become larger with Nf.
Moreover, the first order region is found to become wider as increasing the chemical potential at finite density and the light-quark mass dependence of the critical mass seems to be small.
From the results of (2+Nf)-flavor QCD, we discuss the properties of 2-flavor QCD and (2+1)-flavor QCD at finite temperature and density.

Parallel III: C5 Heavy Quarks / **193**

D-meson production at the Tevatron and LHC in the Parton Reggeization Approach

Authors: Alexandra Shipilova[1]; Anton Karpishkov[1]; Maxim Nefedov[1]; Vladimir Saleev[1]

[1] *Samara State University*

Corresponding Author: nefedovma@gmail.com

The hadroproduction of Dˆ0, Dˆ*, Dˆ+ and D_s mesons is calculated in the LO of Parton Reggeization Approach, using the KMR1 set of unintegrated PDFs of the proton to take into account the factorisable effects of initial-state radiation, and the set of fragmentation functions 2.
The obtained accuracy of the description of the recent Tevatron (sqrt(S)=1960 GeV) and LHC (sqrt(S)=1960 GeV) data is comparable with the accuracy of the NLO Collinear Parton Model calculations of the Ref. 3.
This work continues the series of our studies of the production of jets [4] and heavy quarks [5,6,7] in the high energy hadron collisions, exploiting the kT-factorization and parton Reggeization hypothesis.

1 M. A. Kimber, A. D. Martin, and M. G. Ryskin, “Unintegrated parton distributions and prompt photon hadroproduction,” Eur. Phys. J. C 12, 655 (2000).

2 J. Binnewies, B.A. Kniehl, G. Kramer. Predictions for D*+- - photoproduction at HERA with new fragmentation functions from LEP-1, Phys.Rev. D58 (1998) 014014.

3 B.A. Kniehl, G. Kramer, I. Schienbein, H. Spiesberger. Inclusive photoproduction of D*+- mesons at next-to-leading order in the General-Mass Variable-Flavor-Number Scheme.
Eur.Phys.J. C62 (2009) 365-374.

[4] M. A. Nefedov, V. A. Saleev, and A. V. Shipilova, “Dijet azimuthal decorrelations at the LHC in the parton Reggeization approach,” Phys. Rev. D 87, 094030 (2013).

[5] V. A. Saleev and A. V. Shipilova, Inclusive b-jet and $\bar{b}$b-dijet production at the LHC via Reggeized gluons, Phys. Rev. D 86, 034032 (2012).

[6] M. A. Nefedov, V. A. Saleev, A. V. Shipilova, Heavy quarkonium production in the Regge limit of QCD: from Tevatron to LHC PoS(ConfinementX)314

[7] M. A. Nefedov, V. A. Saleev, A. V. Shipilova, Prompt Y(nS) production at the LHC in the Regge limit of QCD, Phys. Rev. D88, 014003 (2013)

Parallel II: B4 Light Quarks / **195**

Dispersive approach to hadronic light-by-light

Author: Gilberto Colangelo[1]

[1] *Bern University*

Corresponding Author: gilberto@itp.unibe.ch

I will describe our recent dispersive analysis of the hadronic light-by-light tensor. We relate the latter to the helicity amplitudes of the process $\gamma^*\gamma^* \to \pi\pi$ and provide a formula for the calculation of the hadronic light-by-light contribution to $(g-2)_\mu$.

Parallel III: B6 Light Quarks / 196

Overview of the HERMES results

Author: Vladislav Korotkov[1]

[1] *IHEP Protvino*

Corresponding Author: vladislav.korotkov@ihep.ru

Experiment HERMES at DESY collected a large set of DIS data using the 27.6 GeV polarized electron/positron beam and various, polarized and unpolarized, gaseous targets.
In this talk an overview of the results obtained in the experiment will be presented.

Poster Session / 197

Probing anomalous top quark couplings in diffractive events at the LHC

Authors: Sara Taheri Monfared[1]; farid taghinavaz[2]

Co-author: Shima Fayazbakhsh [3]

[1] *IPM*

[2] *sharif university*

[3] *I*

Corresponding Author: taghinavaz@physics.sharif.edu

We investigated the impact of anomalous chromomagnetic and chromoelectric dipole moments on the top pair production in diffractive events at the LHC. The exclusive diffractive production of top quarks provide clean environment due to having one proton intact. We found that the effect of these corrections is remarkable in $pp \to p\gamma p \to pt\bar{t}X$ processes.

Parallel IV: D8 Deconfinement / 198

2-color QCD at High Density

Author: Tamer Boz[1]

[1] *National University of Ireland, Maynooth*

Corresponding Author: tamersboz@yahoo.com

QCD at high chemical potential has interesting properties such as deconfinement of quarks. 2-color QCD, which enables numerical simulations on the lattice, constitutes a laboratory to study QCD at high chemical potential. The quark propagator in 2-color QCD at high density is referred to as the Gorkov propagator. We examine the Gorkov propagator and in particular, find the form factors of the Gorkov propagator making use of the symmetries it obeys.

Plenary 2 / **199**

Recent Experimental Developments in Heavy Quarkonium

Author: Matthew Shepherd[1]

[1] *Indiana University*

Corresponding Author: mashephe@indiana.edu

The study of bound states of a heavy quark and anti-quark continues to be an interesting way to probe QCD and the hadron spectrum. Even more interesting are those states that have masses similar to heavy quarkonium but cannot by interpreted as a bound state of a heavy quark and heavy anti-quark. For example, there have been recent discoveries of new states in the charmonium spectrum that have non-zero electric charge, and therefore cannot be charm anti-charm bound states. In this talk I will present the current experimental status of the spectrum of heavy quarkonium states and their unconventional counterparts. Recent results in heavy quarkonium production will also be discussed.

Plenary 3 / **200**

Advances in QCD sum rules calculations

Author: Dmitri Melikhov[1]

[1] *HEPHY*

Corresponding Author: dmitri_melikhov@gmx.de

Advances in QCD sum rules calculations

Plenary 7 / **201**

Review of hadrons in medium

Author: Gastao Krein[1]

[1] *UNESP*

Corresponding Author: gkrein@ift.unesp.br

I review the present status in the theoretical and phenomenological understanding of hadron properties in strongly interacting matter. I will start considering electromagnetic nucleon form factors and light vector meson spectral properties in cold nuclear matter. Next,

I will concentrate on in-medium properties of heavy flavored hadrons, with emphasis on the formation of charmonium and D-meson nuclear bound states and properties of charmonium and bottomonium in relativistic heavy-ion collisions.

Parallel IV: D2 Deconfinement / 202

The QCD parton-hadron phase boundary line located from Statistical Model analysis of the hadronic multiplicities in Pb+Pb collisions at SPS and LHC

Author: Reinhard Stock[1]

Co-authors: Francesco Becattini [2]; Jan Steinheimer ; Marcus Bleicher [3]

[1] *Johann-Wolfgang-Goethe Univ. (DE)*

[2] *Unversity of Florence*

[3] *Uni Frankfurt*

Corresponding Author: stock@ikf.uni-frankfurt.de

The QCD phase transformation line in the plane of temperature T and baryochemical potential mu(B) represents the major property of the QCD phase diagram at finite temperature and mu(B). Recent lattice QCD calculations(1,2) have made predictions for this line, not only at mu(B) near zero but also extending to finite mu(B), up to about 500MeV. At the experimental side, the hadronic multiplicities in A+A collisions reveal an approximate hadro-chemical equilibrium distribution, that is described in the Gibbs grand canonical hadron/resonance ensemble incorporated in the Statistical Hadronization Model(SHM). In priciple, if hadronic species freeze-out occured at, or in the close vicinity of the QCD hadronization line, SHM analysis (carried out at various center of mass energies in A+A collisions) could deliver an estimate of the (T,mu(B)) position of the QCD line.
We have studied hadron production in Pb+Pb collisions at SPS and LHC energies, and the detailed conditions of hadro-chemical freeze-out. We have determined the effects of inelastic and annihilation processes occuring after hadronization that have been traditionally ignored in SHM analysis. To this end we have empoyed the hybrid version of the microscopic transport model UrQMD(3), in which a hydrodynamic evolution phase is terminated by the Cooper-Frye hadronization prescription, and matched to a final hadron/resonance cascade stage.It turns out that, indeed, the inelastic sector (governing the bulk meson output) freezes out almost directly after hadronization, whereas baryon-antibaryon annihilation and regeneration modify he observed yields, in a pattern depending on the collisional energy(4). Thus, in order to reconstruct the hadronic composition prevailing at hadronization, we have determined the survival factors for all species, occuring during the final cascade stage, from UrQMD, then applying them in the subsequent SHM analysis of central and minimum bias Pb+Pb collisions from the SPS NA49 and the LHC ALICE experiments(4,5). For the latter data we resolve the much discussed

LHC “proton (and antiproton) anomaly” obtaining a universal hadronization temperature of T = 164+/-5MeV at mu(B)=0. And, overall, we shall report a sequence of (energy dependent) points in the (T,mu(B)) plane which follow, closely, the lattice QCD predictions(1,2) up to mu(B)=430MeV.

1. G.Endrodi et al., JHEP 1104(2011)001
2. O.Kaczmarek et al., Phys.Rev.D83(2011)014504
3. H.Petersen et al., Phys.Rev.C78(2008)044901
4. F.Becattini et al., Phys.Rev.Lett. 111(2013)082302
5. F.Becattini et al., arXiv:1405.0710, submitted to PRC

Parallel V: E2 QCD and New Physics / 203

Quantum Chromodynamics with massive gluons

Author: Sergey Larin[1]

[1] *Institute for Nuclear Research of the Russian Academy of Sciences*

Corresponding Author: larin@inr.ac.ru

It is shown that the QCD Lagrangian can be modified by the adding gluon masses. On mass-shell renormalizability of the resulting theory is discussed.

Parallel III: B10 Light Quarks / 204

Exclusive Electroexcitation of Baryon Resonances with CLAS and CLAS12

Author: Ralf W. Gothe[1]

Co-author: Viktor I. Mokeev [2]

[1] *University of South Carolina*

[2] *Jefferson Lab*

Corresponding Author: gothe@sc.edu

Meson-photoproduction measurements and their reaction-amplitude analyses can establish more sensitively, and in some cases in an almost model-independent way, the nucleon excitations and non-resonant reaction amplitudes. However, to investigate the strong interaction from explored – where meson-cloud degrees of freedom contribute substantially to the baryon structure – to still unexplored distance scales – where quark degrees of freedom dominate and the transition from dressed to current quarks occurs – we depend on experiments that allow us to measure observables that are probing this evolving non-perturbative QCD regime over its full range.

Transition form factors are uniquely suited to trace this evolution by measuring exclusive single-meson and double-pion electroproduction cross sections off the free proton. Recent efforts try to include their isospin dependence by analyzing the cross sections off the quasi-free neutron and proton in Deuterium. In the near future, these exclusive measurements will be extended to higher momentum transfers with the energy-upgraded CEBAF beam at JLab to study the quark degrees of freedom, where their strong interaction is responsible for the ground and excited nucleon state formations. After establishing unprecedented high-precision data, the imminent next challenge is a high-quality analysis to extract these relevant electrocoupling parameters for various resonances that then can be compared to state-of-the-art models and QCD-based calculations. Recent results will demonstrate the status of the analysis and of their theoretical descriptions, and an experimental and theoretical outlook will highlight what shall and may be achieved in the new era of the 12-GeV upgraded transition form factor program.

Plenary 2 / 205

Excited states in Lattice QCD

Author: John Bulava[1]

[1] *Trinity College Dublin*

Corresponding Author: john.bulava@gmail.com

Excited hadron properties are of great experimental and theoretical interest. Recent algorithmic advances in Lattice QCD have enabled many low-lying hadron resonances to be studied with unprecedented accuracy, while several interesting systems remain a challenge. After discussing algorithmic advances which enable the calculation of finite volume QCD spectra, I will discuss how physical properties of low-lying resonances can be obtained. Finally, I will review recent lattice results for these finite volume spectra in selected meson and baryon systems, as well as the masses and widths of some low-lying resonances.

Parallel III: C3 Heavy Quarks / **206**

The recent result about Charmonium (like) states at BESIII

Author: Weimin Song[1]

[1] *IHEP*

Corresponding Author: songwm@ihep.ac.cn

The result results about Charmonium states (etac(2S)…) and Charmonium-like states (Zc(3900)…) studied at BESIII will mentioned in the talk.

Parallel I: A4 Vacuum structure and confinement / **207**

Deriving Polyakov line actions from SU(3) lattice gauge theory at finite chemical potential

Author: Jeff Greensite[1]

[1] *San Francisco State University*

Corresponding Author: greensit@stars.sfsu.edu

The method of relative weights is used to extract, from an underlying SU(3) lattice gauge theory at finite chemical potential, an effective theory which depends only on Polyakov line holonomies. The effective theory can be solved by both mean field and complex Langevin methods, and the solutions from the two approaches can be compared. It is found that when the two methods agree, they agree almost perfectly, and when the results disagree, the complex Langevin approach suffers from the branch-cut problem pointed out by Mollgaard and Splittorff.

Plenary 9 / **208**

QCD and strongly coupled models versus holography and strings: news and highlights

Author: Alexander Gorsky[1]

[1] *IPPI*

Corresponding Author: gorsky@itep.ru

QCD and strongly coupled models versus holography and strings: news and highlights

Parallel IV: D6 Deconfinement / **209**

Open heavy-flavour and quarkonium measurements in heavy-ion collisions at the LHC

Author: Ermanno Vercellin[1]

[1] *Universita e INFN (IT)*

Corresponding Author: vercelli@to.infn.it

The LHC heavy-ion physics program aims at investigating the properties of strongly interacting matter in extreme conditions of temperature and energy density where the formation of the Quark Gluon Plasma (QGP) is expected. In high-energy heavy-ion collisions, heavy quarks and quarkonium states are regarded as efficient probes of the properties of the QGP as they are created on a short time scale with respect to that of the QGP, thus being sensitive to the whole evolution of the system. An overview of the main results on open heavy-flavour and quarkonium measurements in Pb-Pb (and p-Pb) collisions at the LHC will be presented and the results will be compared to theoretical models.

Parallel II: B8 Light Quarks / **210**

Does Confinement Influence High Energy Scattering?

Author: Vladimir Petrov[1]

[1] *IHEP*

Corresponding Author: vladimir.petrov@ihep.ru

Formulation of confinement is discussed in the framework of general principles of q.f.t. Characteristic space-time scales which define the bulk of high-energy hadron scattering are derived.

Summary:

Confinement leads to specific analytic properties of quark-gluon Green functions.
One of the general consequences is the degeneracy of Regge trajectories including the Pomeron.
The bulk of hadronic scattering at high energies is defined by large distances and long times.

Plenary 5 / **211**

News and highlights in the Quark Gluon Plasma characterization

Author: Sangyong Jeon[1]

[1] *McGill University*

Corresponding Author: jeon@physics.mcgill.ca

I will review recent progress in characterizing the properties of QGP.
Main focus will be on the much progress achieved in hydrodynamic simulations of the evolution of QGP. The role of not only the shear viscosity but the importance of including the bulk viscosity will be discussed.

Parallel I: A1 Vacuum structure and confinement / 212

Dyons and confinement at non-zero T

Author: Victor Petrov[1]

[1] *Petersburg Nuclear Physics Institute*

Corresponding Author: victorp@thd.pnpi.spb.ru

We consider a model for the vacuum of pure glue theory based on dyons. Temperatures of confinement-deconfinement, string tensions and other physical quantities for different gauge groups and representations are calculated. The relation with supersymmetric confining theories is discussed.
Considered mechanism of confinement/deconfinement implies specific behavior of the effective potential for Polyakov's loop in the Yang-Mills theory. Lattice measurements and theoretical description of this effective potential are presented.

Plenary 8 / 213

Spontaneous symmetry breaking and Nambu-Goldstone modes in QCD matter

Author: Yoshimasa Hidaka[1]

[1] *RIKEN*

Corresponding Author: hidaka@riken.jp

The theory of spontaneous symmetry breaking and Nambu-Goldstone modes (bosons) was developed in 1960's. When a global symmetry is spontaneously broken, there appears a gapless excitation mode, the Nambu-Goldstone (NG) mode. The theorem is based on Lorentz invariance of the grand state, and it implies that the number of NG modes coincides with the number of broken generators, and they have the linear dispersion relation. In QCD, the pions are nothing but the NG modes associated with spontaneous breaking of chiral symmetry.
In contrast, in non-Lorentz invariant systems, it is known that NG modes possessing quadratic dispersion relation may appear. The number of NG modes does not coincides with the number of broken generators. An example in QCD matter is the NG mode in the Kaon condensed color locked phase.
The relation between broken generators and NG modes were not completely understood until recently. I review recent developments in the theory of spontaneous symmetry breaking in non-Lorentz invariant systems. I also discuss the spontaneous breaking of space-time symmetries and NG modes.

Plenary 4 / 214

Recent Results on Flavour Physics

Author: Federico Mescia[1]

[1] *Universitat de Barcelona*

Corresponding Author: mescia@lnf.infn.it

I will present a summary of what we learned so far from low-energy flavour observables, concerning on physics beyond the Standard Model (SM). In the past few years there has been a great experimental progress in quark and lepton flavour physics. In the quark sector, the validity of the SM has been strongly reinforced by a series of challenging tests.
As I try to show, looking for physics beyond the SM via the Flavour Window is still a powerful tool thanks also to forthcoming results from LHC and future B Factories.

Parallel II: B1 Light Quarks / 215

Hadron Structure from Lattice QCD

Author: Jeremy Green[1]

[1] *Institut für Kernphysik, Johannes Gutenberg-Universität Mainz*

Corresponding Author: green@kph.uni-mainz.de

Recent progress in lattice QCD calculations of hadron structure will be presented, with an emphasis on nucleon structure. Calculations of nucleon form factors have long been difficult to reconcile with experiment, but with advances in both methodology and computing resources, this situation is changing. Agreement with experiment is beginning to be obtained for several key observables, and the improved understanding of systematics should increase confidence in predictions of unmeasured quantities. Finally, the long-omitted disconnected contributions are now seeing considerable attention and are being calculated.

Parallel I: A6 Vacuum structure and confinement / 216

Study of magnetic monopole condensation using surface operators

Author: Alexander Molochkov[1]

Co-author: Vladimir Goy [1]

[1] *Far Eastern Federal University*

Corresponding Author: molochkov.alexander@gmail.com

The most important probes for the phase states of a four-dimensional gauge field theory are the Wilson and t'Hooft line operators that are defined on one-dimensional curves in the space-time. However, for more detail understanding of four-dimensional gauge field theory dynamics and vacuum topology we need additional probes expressed by operators defined on the subspaces with higher dimensions. Possible candidates are operators that are defined on the two-dimensional surface in the four-dimensional space-time. The corresponding spatial surface operators are sensitive to the magnetic flux through a closed surface, what provides a tool for monopole condensate study. The area and volume dependence of the surface operator can provide a probe for the correlated and uncorrelated monopoles and antimonopoles condensation. The corresponding temporal surface operators

can provide new order parameters.
In the present work the surface operator dependence on the surface area and volume are studied in the confinement and deconfinement phases within the SU(2) pure gauge field theory on the lattice. It is obtained that the spatial surface operator exhibits areal law in the both phases, what points on the color dipole condensation. Indications on the volume law in the confinement phase are discussed.

Parallel VI: F4 Nuclear and Astroparticle Physics / 217

Lattice QCD study of strangeness S=-2 two-baryon system

Author: Kenji Sasaki[1]

[1] *Univ. of Tsukuva*

Corresponding Author: kenjis@het.ph.tsukuba.ac.jp

Knowledge of baryon-baryon interactions with strangeness is important to study the hypernuclear structures and exotic few body states.
Especially for the strangeness S=-2 two-baryon system, it is interesting to investigate the SU(3) structure and its breaking effect of baryon-baryon interactions because the flavor singlet combination is allowed only in this system.
We report our latest results of the S=-2 baryon-baryon interactions and mass of H-dibaryon from lattice QCD simulation.
Our approach to baryon-baryon interactions is deriving a potential from inverting coupled channel Schroedinger equation using Nambu-Bethe-Salpeter wave function simulated on lattice.
Our numerical results are obtained from 2+1 flavor full QCD gauge configurations provided by the PACS-CS Collaboration.
Flavor SU(3) breaking effects of the interactions are discussed by comparing with the results simulated with different quark masses.
We also discuss flavor SU(3) breaking effects of H-dibaryon mass.

Plenary 7 / 218

Recent Highlights in Light-Baryon Spectroscopy and Searches for Gluonic Excitations

Author: Volker Crede[1]

[1] *Florida State University*

Corresponding Author: crede@fsu.edu

The spectrum of excited hadrons - mesons and baryons - serves as an excellent probe of Quantum Chromodynamics (QCD), the fundamental theory of the strong interaction. The strong coupling however makes QCD very challenging. It confines quarks and breaks chiral symmetry, thus providing us with the world of light hadrons. Highly-excited hadronic states are sensitive to the details of quark confinement, which is only poorly understood within QCD. This is the regime of non-perturbative QCD and it is one of the key issues in hadronic physics to identify the corresponding internal degrees of freedom that give rise to excited hadrons and how these relate to strong coupling QCD. The quark model suggests mesons are made of a constituent quark and an anti-quark and baryons consist of three such quarks. The current experimental efforts toward mapping the baryon spectrum at several facilities around the world involve the challenging study of meson production off the nucleon using electromagnetic probes in so-called complete experiments utilizing beam and target polarization. Other questions in hadron spectroscopy remain open: What is the role of glue? Resonances with large gluonic components are predicted as bound states by QCD. The lightest hybrid mesons with exotic quantum numbers are estimated to have masses in the range from 1 to 2

GeV/c^2 and are well within reach of current experimental programs such as COMPASS at CERN and experiments at Jefferson Laboratory. In this talk, I will discuss recent highlights in light-baryon spectroscopy and efforts to search for gluonic excitations.

Plenary 8 / **219**

Mechanisms of chiral symmetry breaking in QCD: a lattice perspective

Author: Leonardo Giusti[1]

[1] *Universita & INFN, Milano-Bicocca (IT)*

Corresponding Author: leonardo.giusti@cern.ch

TBA

Parallel VI: G2 Strongly Coupled Theories / **220**

Supersymmetry and neutral bions: hints about deconfinement?

Author: Erich Poppitz[1]

Co-authors: Mithat Unsal [2]; Mohamed Anber [3]; Thomas Schaefer [2]; Tin Sulejmanpasic [4]

[1] *university of toronto*

[2] *NCSU*

[3] *Toronto*

[4] *Regensburg*

Corresponding Author: poppitz@physics.utoronto.ca

I will review the conjecture that the thermal deconfinement transition in pure Yang-Mills theory is continuously connected to a quantum phase transition in softly-broken N=1 supersymmetric Yang-Mills theory on R^3 x S^1. The latter is driven by a competition between various exotic "topological" molecules, and, since it occurs in a calculable weak-coupling regime, a great deal can be learned about its properties. I will present evidence, from past and ongoing work, in favor of the continuity conjecture. I will also discuss possible directions for future study and speculations on the implications for the pure Yang-Mills deconfinement transition.

Poster Session / **221**

The origin of thermal component in the transverse momentum spectra in high energy hadronic processes

Author: Alexandr Bylinkin[1]

Co-authors: Andrei Rostovtsev [1]; Dmitri Kharzeev [2]

[1] *ITEP Institute for Theoretical and Experimental Physics (RU)*

[2] *Stony Brook U./BNL*

Corresponding Author: alexandr.bylinkin@cern.ch

The transverse momentum spectra of hadrons produced in high energy collisions can be decomposed into the two components: the exponential ("thermal") and the power ("hard") ones.
Recently, the H1 Collaboration has discovered that the relative strength of these two components in Deep Inelastic Scattering depends drastically upon the global structure of the event - namely, the exponential component is absent in the diffractive events characterized by a rapidity gap. We discuss the possible origin of this effect, and speculate that it is linked to the mechanism of confinement. Specifically, we argue that the thermal component is produced in the fragmentation of the color string due to the effective event horizon introduced by confinement, in analogy to the Hawking-Unruh effect. In diffractive events, the t-channel exchange is color-singlet and there is no fragmenting string - so the thermal component is absent.
Analyzing the data on non-diffractive pp collisions, we find that the slope of the thermal component of the hadron spectrum is proportional to the saturation momentum that drives the deceleration in the color field, and thus the Hawking-Unruh temperature.

Parallel V: D9 Deconfinement / **222**

Quenching of hadron production spectra in heavy-ion collisions

Author: Alexandr Bylinkin[1]

Co-authors: Andrei Rostovtsev [1]; Nadezda Chernyavskaya [2]

[1] *ITEP Institute for Theoretical and Experimental Physics (RU)*

[2] *ITEP*

Corresponding Author: alexandr.bylinkin@cern.ch

The dependence of the spectral shape of produced charged hadrons on the size of a colliding system is discussed using a two-component model. As a result, the system-size hierarchy in spectral shape is observed. Next, a hydrodynamic extension of a two-component model for hadroproduction using recent theoretical calculations is suggested to describe the spectra of charged particles produced in heavy-ion collisions in the full range of transverse momenta pT. Data from heavy-ion collisions measured at the Relativistic Heavy Ion Collider and the Large Hadron Collider are analyzed using the introduced approach and are combined in terms of energy density. The observed regularities might be explained by the formation of a quark-gluon plasma during the collision.
Finally, the quenching of hadron production spectra in terms of number of participants (Npart) and number of collisions (Ncoll) is discussed using the two-component model.

Summary:

First part of the talk is published recently in Phys.Rev.C:
http://journals.aps.org/prc/abstract/10.1103/PhysRevC.90.018201

Parallel II: B4 Light Quarks / **223**

Pion electric polarizability from Lattice QCD

Author: Andrei Alexandru[1]

[1] *The George Washington University, USA*

Corresponding Author: aalexan@gwu.edu

Electromagnetic polarizabilities are important parameters for understanding the interaction between photons and hadrons. For pions these quantities are poorly constrained experimentally since they can only be measured indirectly. New experiments at CERN and Jefferson Lab are planned that will measure the polarizabilities more precisely. Lattice QCD can be used to compute these quantities directly in terms of quark and gluons degrees of freedom,
using the background field method. We present results for the electric polarizability for two different quark masses, light enough to connect to chiral perturbation theory. These are currently the lightest quark masses used in polarizability studies. For each pion mass we compute the polarizability at four different volumes and perform an infinite volume extrapolation. For one ensemble, we also discuss the effect of turning on the coupling between the background field and the sea quarks.

Parallel I: A8 Vacuum structure and confinement / **224**

Dynamical Chiral Polarization of QCD Dirac Spectrum

Author: Ivan Horvath[1]

Co-author: Andrei Alexandru [2]

[1] *University of Kentucky*

[2] *T*

Corresponding Author: iv.horvath@gmail.com

Dynamical polarization methods offer a novel way to characterize vacuum correlations of strong interactions in a model-independent manner. Selected aspects of this description are discussed with applications both for confinement and spontaneous chiral symmetry breaking.

Poster Session / **225**

Is the X(3915)⊠wJ/y resonance the cc0'?

Author: Stephen Lars Olsen[1]

[1] *Seoul National University*

Corresponding Author: solsensnu@gmail.com

The 2013 PDG tables lists the JPC=0++ X(3915)⊠wJ/y resonance, seen in B⊠KwJ/y decays and the gg⊠wJ/y fusion process by both the Belle and BaBar experiments, as the cc0', i.e., the cc0(2P) radial excitation of the cc0(1P) charmonium state. I (and others) dispute this assignment for a number of reasons, including its peak mass value, M=3918.4±1.9 MeV, narrow width G=20±5 MeV, and the absence of any evidence for decays to the DDbar open-charmed meson channel. Evidence for an alternative cc0' candidate with properties that more closely match charmonium model expectations in published Belle and BaBar measurements are shown and discussed.

226

Anisotropic flow fluctuations from p-Pb to PbPb

Author: Raimond Snellings[1]

[1] *NIKHEF (NL)*

Corresponding Author: raimond.snellings@cern.ch

the collective expansion of matter created in collisions of heavy-ions, ranging from collision energies of tens of MeV to a few TeV per nucleon pair, proved to be one of the best probes to study the detailed properties of these unknown states of matter. Collective expansion, also called flow, originates from the initial pressure gradients in the created hot and dense matter. These pressure gradients transform the initial spatial deformations and inhomogeneities of the created matter into momentum anisotropies of the final state particle production. These momentum anisotropies are experimentally characterised by so-called flow harmonics. In this talk I will present our current understanding from proton-nucleus to nucleus-nucleus collisions

Parallel II: B9 Light Quarks / **227**

Alpha_s determination from the C-parameter distribution

Author: Vicent Mateu[1]

[1] *University of Vienna*

Corresponding Author: vicent.mateu@univie.ac.at

For the e+e- C-parameter we use soft-collinear effective theory to derive a factorization theorem, and then compute the cross section at N3LL + O(alphasˆ3). Differences with Thrust are highlighted. Our result holds for C in the peak, tail, and far tail regions, and we treat hadronization effects using a universal nonperturbative soft function defined in field theory. We analyze all available C-parameter tail data and obtain a global fit for alphas(mZ) and one nonperturbative parameter Omega1ˆC with chiˆ2/dof close to 1. These C-parameter results for alphas(mZ) and Omega1 are in excellent agreement with earlier results from thrust. Furthermore, for the first time we include hadron mass effects in the analysis of thrust and C-parameter experimental data.

Parallel III: C2 Heavy Quarks / **228**

Primary and secondary production of heavy quarks in final state jets

Author: Vicent Mateu[1]

[1] *University of Vienna*

Corresponding Author: vicent.mateu@univie.ac.at

We present results for the production of primary heavy quarks in final state jets, as well as secondary radiation of heavy quark pairs related to gluon splitting. We focus in the thrust and C-parameter distributions for e+e- collisions. The results are given in the dijet limit where the hard interaction scale and the scales related to collinear and soft radiation are widely separated. In this limit one can use Soft-Collinear Effective Theory with the inclusion of mass modes in order to factorize the cross section and perform resummation of large Sudakov logs at N3LL order. When the invariant mass of the massive jet is close to the heavy quark mass we match onto a boosted Heavy Quark Effective Theory to sum up a new class of large logs along with the treatment of finite width effects. Our results are relevant for determining the bottom mass, and more importantly for the measurement of the top mass at a future linear collider.

Parallel IV: D5 Deconfinement / **229**

Bottom-up thermalization and heavy-ion collisions

Author: Eero Aleksi Kurkela[1]

[1] *CERN*

Corresponding Author: aleksi.kurkela@cern.ch

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

Parallel VI: G3 Strongly Coupled Theories / 230

Fundamental Composite Higgs Dynamics

Author: Giacomo Cacciapaglia[1]

[1] *IPN Lyon*

Corresponding Author: g.cacciapaglia@ipnl.in2p3.fr

The discovered Higgs boson has properties similar to the ones expected from the standard model, however the possibility that it may be a state composite of fundamental fermions is not excluded. It may in fact be either a heavy resonance of the dynamics, or a light pseudo-Goldstone boson. In truth, the two cases are limits of a more general scenario. I will review the state of the art of the construction of dynamical models of composite Higgses, with main focus on the interplay between lattice results, knowledge of the fundamental dynamics and study of a symmetry-based effective Lagrangian.

Poster Session / 231

The in-medium heavy-quark potential from quenched and dynamical lattice QCD

Authors: Alexander Rothkopf[1]; Yannis Burnier[2]

[1] *Heidelberg University*

[2] *EPFL*

Corresponding Author: rothkopf@thphys.uni-heidelberg.de

Heavy Quarkonium provides a unique opportunity to investigate the physics of the quark-gluon plasma created in relativistic heavy-ion collisions. From the measured suppression patterns in nucleus-nucleus collisions relative to the yields in proton-proton collisions, we ultimately aim at extracting the properties of the bulk matter created in the collision center.

Hence a thorough understanding of the real-time evolution of in-medium heavy quarkonium is called for. Due to the inherent separation of scales between the heavy quark rest mass and the surrounding energy densities it can actually be described in terms of a Schroedinger equation with

interaction potential, based on non-relativistic effective field theories such as NRQCD. Here we report on the current status of extracting the in general complex values of the potential from first principles lattice QCD simulations.

The real and imaginary part of this real-time potential is obtained from the position and width of the lowest lying peak in the Coulomb gauge Wilson line correlator spectral function. We extract spectral information from Euclidean time data using a novel Bayesian approach different from the Maximum Entropy Method. We find that Re[V] lies close to the color singlet free energies, while Im[V] is of the same order as the predictions from resummed perturbation theory (HTL) already close above the critical temperature.

Parallel VI: G5 Strongly Coupled Theories / **232**

Higgs Critical Exponents and Conformal Bootstrap in Four Dimensions

Author: Oleg Antipin[1]

[1] *INFN, Florence*

Corresponding Author: antipin@cp3-origins.net

We study properties of composite operators emerging in nonsupersymmetric, four-dimensional gauge-Yukawa theories with interacting conformal fixed points. The theories investigated are structurally similar to the standard model of particle interactions, but differ from the standard model by developing perturbative interacting fixed points. We investigate the physical properties of the singlet and the adjoint composite operators quadratic in the Higgs field. We show that, in the Veneziano limit, and at the highest known order in perturbation theory, the singlet sector decouples from the other operators. This fact allows us to test the numerical bootstrap constraints against precise four dimensional conformal field theoretical results.

Parallel I: A3 Vacuum structure and confinement / **233**

The confining baryonic Y-string on the lattice

Author: Ahmed Bakry[1]

Co-authors: Pengming Zhang [2]; Xurong Chen [2]

[1] *Chinese Academy of Sciences-Institute of modern Physics*

[2] *Institute of Modern Physics-Chinese Academy of Sciences*

Corresponding Author: abakry@impcas.ac.cn

We look for the signature of the confining Y-bosonic string in the gluonic profile due to a system of three static quarks on the lattice. The gluonic distribution is calculated in pure Yang-Mills lattice gauge theory at finite temperature with Polyakov loops operators. The analysis of the action density unveils a background of a filled-Δ distribution. However, we found an underlying structure of three string-like configuration that interpolates from Δ to a Y-configurations; all within the Δ-shaped background. The length of the revealed Y-string-like distribution is maximum near the deconfinment point. The action density width profile returns good fits to a baryonic string model only for large quark separation. The Y-string configurations provides good fits for both the in-plane and off-plane width profile.

Parallel VI: G4 Strongly Coupled Theories / 235

Recent progress in holographic QCD

Author: Matti Järvinen[1]

[1] *University of Crete*

Corresponding Author: mjarvine@cp3-origins.net

I will start by a generic review of holography and its application to QCD, including the top-down and bottom-up approaches. I will go on discussing some of the latest developments in the construction of holographic models for QCD, concentrating on the bottom-up ones. I will cover improved holographic QCD, which is a string-theory inspired model for the Yang-Mills theory. Finally I will discuss holographic modeling of QCD in the Veneziano limit by introducing quarks in improved holographic QCD, and letting them backreact fully.

Poster Session / 236

Partial restoration of chiral symmetry inside hadrons

Author: Shoji Hashimoto[1]

Co-authors: Guido Cossu [1]; Takumi Iritani [2]

[1] *KEK*

[2] *Yukawa Institute, Kyoto University*

Corresponding Author: shoji.hashimoto@kek.jp

The presence of color source may modify the chiral condensate that characterizes the spontaneous breaking of chiral symmetry in the QCD vacuum. Using the overlap-Dirac eigenmodes, we investigate this phenomenon around static color sources representing quark-antiquark and three-quark systems. We show that the chiral condensate is reduced inside the flux-tube that is formed between the color sources. Using the three-quark system in a finite box, we estimate the magnitude of partial chiral restoration at finite density.

Parallel II: B7 Light Quarks / 237

The COMPASS hadron program

Author: Florian Haas[1]

[1] *Technische Universitaet Muenchen (DE)*

Corresponding Author: florian.haas@cern.ch

COMPASS is a multi-purpose fixed-target experiment at the CERN Super Proton Synchrotron aimed at studying the structure and spectrum of hadrons. One main goal is the search for new hadronic states, in particular hybrid mesons and glueballs. Its large acceptance, high resolution, and high-rate capability make the COMPASS experiment an excellent device to study the spectrum of light-quark mesons in diffractive and central production up to masses of about 2.5 GeV/c^2. COMPASS is able to measure final states with charged as well as neutral particles, so that resonances can be studied in different reactions and decay channels. During 2008 and 2009, COMPASS took a large data sample using 190 GeV negative and positive hadron beams on various targets. We present new results from

the analyses of this data set. One focus lies on the search for new mesons in diffractively produced multi-particle final states. Here novel analysis methods are applied to study the dependence of partial waves on the squared four-momentum transfer t′ from the beam to the target. This also leads to a better separation of resonant and non-resonant contributions. In addition a new analysis scheme was developed that permits to extract information about the $\pi^+\pi^-$ subsystem in the $\pi^-\pi^+\pi^-$ final state with only inimal model bias. In addition central-production reactions are studied in order to search for glueball candidates in the scalar sector. Finally an update will be given on the recent analysis of the pion polarizability, well suited to test chiral dynamics.

Supported by BMBF, MLL and the Cluster of Excellence Exc153 "Origin and Structure of the Universe"

Parallel III: B10 Light Quarks / **238**

Recent results on the baryon spectrum from the CBELSA/TAPS experiment

Author: Jan Hartmann[1]

[1] *Bonn University*

Corresponding Author: hartmann@hiskp.uni-bonn.de

One of the remaining challenges within the standard model is to gain a good understanding of QCD in the low-energy, non-perturbative regime. One key towards this aim is baryon spectroscopy investigating the spectrum and the properties of baryon resonances. Unfortunately, most baryon spectroscopy data were obtained only using π N scattering. To gain access to resonances with small π N partial width, photoproduction experiments provide essential information. In order to extract the contributing resonances, partial wave analyses need to be performed. Here, a complete experiment is required to unambiguously determine the contributing amplitudes. This involves the measurement of carefully chosen single and double polarization observables.

The Crystal Barrel/TAPS experiment with a longitudinally or transversely polarized target and an energy tagged, linearly or circularly polarized photon beam allows the measurement of a large set of polarization observables. Due to its good energy resolution, high detection efficiency for photons, and the nearly complete solid angle coverage it is ideally suited for the measurement of photoproduction of neutral mesons decaying into photons.

In this talk recent results for various double polarization observables and their impact on the partial wave analysis will be presented.

Supported by DFG within CRC 16

Parallel III: C3 Heavy Quarks / **239**

A New Hadron Spectroscopy

Author: Stephen Lars Olsen[1]

[1] *Center for Underground Physics*

Corresponding Author: solsensnu@gmail.com

Recently, many candidate multiquark mesons, i.e., mesons with substructures that are more complex that the quark-antiquark prescription that is in the textbooks, have been observed. Many of the most recently observed candidate states are electrically charged and have the same spin and parity,

namely JP=1+. In this talk I will give an overview of the current experimental situation and try to identify some patterns among the recently discovered JP=1+ states that may give some hints about the underlying dynamics that are at play and suggest the existence of other states that should be accessible at LHC and the BelleII experiments.

240

Round table 1: Strongly coupled scenarios and the LHC: prospective for the next decade

Corresponding Authors: alfredo.urbano@le.infn.it, espriu@icc.ub.edu, poppitz@physics.utoronto.ca, g.cacciapaglia@ipnl.in2p3.fr, rauch@particle.uni-karlsruhe.de, ryttov@cp3.dias.sdu.dk

241

Round table 2: Challenges and impact of the lattice on hadron phenomenology in the near future

Corresponding Authors: e.pallante@rug.nl, mescia@lnf.infn.it, gilberto@itp.unibe.ch, guido.martinelli@sissa.it, shoji.hashimoto@kek.jp

242

Round table 3: What can we learn from large Nc gauge theories?

Corresponding Authors: a.armoni@swan.ac.uk, poppitz@physics.utoronto.ca, gunnar.bali@ur.de, goity@jlab.org

Plenary 1 / **243**

Strongly coupled scenarios BSM

Author: Elisabetta Pallante[1]

[1] *U. Groningen, Netherlands*

Corresponding Author: e.pallante@rug.nl

N/A

Plenary 7 / **245**

Neutron stars and quark stars

Author: Paulo Bedaque[1]

[1] *U. Maryland, USA*

Corresponding Author: bedaque@umd.edu

N/A

Plenary 1 / **246**

Highlights from LHC experiments

Author: Pierluigi Campana[1]

[1] *CERN-LNF*

Corresponding Author: pierluigi.campana@lnf.infn.it

N/A

Plenary 3 / **247**

Review of QCD and BSM with precision measurements and computations

Author: Susan Gardner[1]

[1] *U.Kentucky,USA*

Corresponding Author: gardner@pa.uky.edu

New Physics Searches at the Intensity Frontier: QCD Challenges and Prospects

Plenary 5 / **248**

Heavy probes in thermal baths in heavy ions

Author: Antonio Vairo[1]

[1] *Institut fuer Theoretische Physik-Ruprecht-Karls-Universitaet H*

Corresponding Author: antonio.vairo@ph.tum.de

N/A

Plenary 10 / **249**

The 1/Nc expansion in Baryons

Author: Jose Goity[1]

[1] *Department of Physics, Hampton University, Hampton, USA*

Corresponding Author: goity@jlab.org

N/A

Plenary 6 / 251

Problems and Highlights of QCD at finite chemical potential

Author: Gert Aarts[1]

[1] *Swansea University*

Corresponding Author: g.aarts@swan.ac.uk

N/A

Plenary 6 / 252

Project on Master Class in Particle Physics

Author: Yiota Foka[1]

[1] *GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE)*

Corresponding Author: yiota.foka@cern.ch

N/A

Parallel I: A7 Vacuum structure and confinement / 253

Chiral effects and physics of chiral media

Author: Andrey Sadofyev[1]

Co-author: Valentin Zakharov [2]

[1] *MIT*

[2] *I*

Corresponding Author: sadofyev@mit.edu

We consider chiral liquids,consisting of massless fermions and right-left asymmetric.In such media, one expects existence of new transports in equilibrium. Among them electric current flowing along external magnetic field which is predicted to be dissipation free. We argue that actually the chiral liquids in the hydrodynamic approximation should satisfy further constraints, like infinite classical conductivity.

Summary:

We have shown that conservation of the axial charge implies that classically chiral media are perfect liquids, with no dissipation. It was demonstrated recently that the chiral anomaly modifies hydrodynamics of chiral media on the classical level. What we are adding to this observation, is that for the consistency of the hydrodynamic approximation, the novel pieces in the axial charge should conserve

on the classical level as well.

Parallel III: B6 Light Quarks / 254

The inclusive production of the meson resonances in neutrino-nucleon interactions

Author: Alexandr Polyarush[1]

[1] *INR RAS*

Corresponding Author: polyarush@inr.ru

The inclusive production of the meson resonances $\rho^0(770)$, $f_0(980)$, $f_2(1270)$, $K^{*+}(892)$ in neutrino-nucleon interactions has been studied with the NOMAD detector. The detector was exposed to the wide band neutrino beam generated by 450-GeV protons at CERN SPS. For the first time the $f_0(980)$ meson is observed in neutrino interactions. The presence of $f_2(1270)$ in the neutrino interactions is reliably established. The average multiplicity of these three resonances is measured as a function of several kinematic variables.
The experimental results are compared to the multiplicities obtained from a simulation based on the Lund model.
Matrix element of spin density matrix for $K^{*+}(892)$ meson have been measured.

Parallel V: E2 QCD and New Physics / 255

Beyond the Standard Model Matrix Elements with the gradient flow

Author: Andrea Shindler[1]

[1] *DESY Zeuthen*

Corresponding Author: a.shindler@fz-juelich.de

With the gradient flow, we propose to calculate the QCD component of key beyond the Standard Model (BSM) matrix elements related to quark and strong theta-CP violations and the strange scalar content within the nucleon. The former set of matrix elements impacts our understanding of Electric Dipole Moments (EDMs) of nucleons and nuclei (a key signature of BSM physics), while the latter contributes to elastic recoil of Dark Matter particles of nucleons and nuclei. If successful, these results will lay the foundation for extraction of BSM observables from future low-energy, high-intensity and high-accuracy experimental measurements.

Parallel II: B1 Light Quarks / 257

Non-ordinary meson couplings in the 1/Nc expansion

Author: Jose R. Pelaez[1]

Co-authors: Felipe J. Llanes Estrada [2]; Jacobo Ruiz de Elvira [3]; Thomas Cohen [4]

[1] *Universidad COmplutense*

[2] *Universidad Complutense*

[3] *Bonn. Univ. HISKP*

[4] *University of Maryland*

Corresponding Author: jrpelaez@fis.ucm.es

We study the large Nc behavior of couplings among light meson states with different compositions in terms of quarks and gluons. We shortly review the most common compositions of mesons, which are of interest for the understanding of low-lying meson resonances, namely, the ordinary quark-antiquark states as well as the non-ordinary, glueball, tetraquark, etc. We dedicate special attention to Jaffe's generalization of the tetraquark with Nc-1 quark-antiquark pairs, that is the only type of state we have identified, whose width does not necessarily vanish with large Nc while it does decouple exponentially with Nc from the pion-pion channel, so that is weakly coupled to the meson-meson system. (see arXiv:1405.4831)

Parallel I: A7 Vacuum structure and confinement / 260

Chiral Symmetry Breaking and the Quantum Hall Effect in Monolayer Graphene

Author: Bitan Roy[1]

Co-authors: Malcolm Kennett [2]; Sankar Das Sarma [1]

[1] *CMTC, University of Maryland*

[2] *Department of Physics, Simon Fraser University*

Corresponding Author: broy@umd.edu

Monolayer graphene in a strong magnetic field exhibits quantum Hall states at filling fractions $\nu = 0$ and $\nu = \pm 1$ that are not explained within a picture of non-interacting electrons. In this talk I will argue that these states possibly arise from interaction induced chiral symmetry breaking orders on the honeycomb lattice, such as Neel antiferromagnetism and charge-density-wave order. In particular, I will show that when the chemical potential is at the Dirac point, weak onsite repulsion supports an easy-plane antiferromagnet state, which simultaneously gives rise to ferromagnetism oriented parallel to the magnetic field direction, whereas for $|\nu| = 1$ chiral symmetry breaking easy-axis antiferromagnetism and charge-density-wave orders coexist. I present self-consistent calculations of the magnetic field dependence of the activation gap for the $\nu = 0$ and $|\nu| = 1$ states and establish excellent agreement with recent experimental results. Our proposed scenario therefore may provide a strong experimental evidence of condensed matter realization of spontaneous chiral symmetry breaking phenomena, which has also occupied a central stage of high energy physics for long time.

Parallel VI: G4 Strongly Coupled Theories / 261

Higher order calculations and the phase diagram of strongly coupled theories

Author: Thomas Ryttov[1]

[1] *CP3 - Origins*

Corresponding Author: ryttov@cp3.dias.sdu.dk

In the past decade many advances have been made in the attempt to uncover the phase diagram of nonsupersymmetric strongly coupled gauge theories. Progress has come from both analytic computations and analysis as well as lattice simulations. In this talk I will present the most recent calculations and estimates of the phase boundary of the conformal window performed using higher order perturbation theory. Calculations are done in a variety of different explicit schemes in which comparison can then be made.

Poster Session / **262**

Neutrino photoproduction on pseudo Nambu-Goldstone bosons

Author: Ibragim Alikhanov[1]

[1] *I*

Corresponding Author: ialspbu@gmail.com

Production of single neutrinos as well as neutrino-antineutrino pairs by photons interacting with pseudo Nambu-Goldstone bosons is studied within the Standard Model. The corresponding cross sections are found analytically. The energy loss due to neutrino emission in a thermal plasma of photons and pions is calculated. It is shown that the obtained neutrino emissivity may be significantly enhanced in hot and dense matter due to in-medium modification of the pion decay constant. Phenomenological consequences for ultrarelativistic heavy-ion collisions and astrophysics are discussed.

Plenary 6 / **263**

QCD and Strongly Coupled Gauge Theories: Challenges and Perspectives

Author: Nora Brambilla[1]

[1] *TU Muenchen,Germany*

Corresponding Author: nora.brambilla@mytum.de

QCD and Strongly Coupled Gauge Theories: Challenges and Perspectives,
http://arxiv.org/abs/arXiv:1404.3723

Parallel II: B5 Light Quarks / **265**

Hadronic contributions to the muon g-2

Author: Thomas Blum[1]

[1] *UCONN*

Corresponding Author: tblum@phys.uconn.edu

After a brief introduction, I will review the current status of lattice calculations of the hadronic vacuum polarization and light-by-light scattering contributions to the muon anomalous magnetic moment. The errors on these contributions dominate the standard model error for this quantity and must be reduced to make the best use of new experimental measurements at Fermilab and J-PARC.

Parallel VI: G3 Strongly Coupled Theories / 267

Review of Minimal Walking Theories

Author: Kimmo Tuominen[1]

[1] *University of Helsinki*

Corresponding Author: kimmo.i.tuominen@helsinki.fi

Development of minimal walking theories and their properties are briefly reviewed. Recent lattice results relevant for these theories are considered and the applications to dynamical electroweak symmetry breaking and related LHC phenomenology are also discussed.

Parallel II: B2 Light Quarks / 268

Baryon spectroscopy from Lattice QCD

Author: Nilmani Mathur[1]

[1] *Tata Institute of Fundamental Research*

Corresponding Author: nilmani@theory.tifr.res.in

Baryon spectroscopy has played a crucial role in formulating the theory of strong interaction, particularly in the low-energy regime. In this talk I will review the recent progress in the excited state spectroscopy of baryons using lattice QCD and the implications of these results. In particular, excited state spectroscopy of heavy baryons will be emphasized where the experimental efforts are still at a rather elemental stage.

Plenary 10 / 269

When does the gluon reggeize

Author: Simon Caron-Huot[1]

[1] *Niels Bohr Institute*

Corresponding Author: schuot@nbi.dk

When does the gluon reggeize

Plenary 5 / 270

Experimental overview of heavy ions physics: open challenges and future

Author: Raimond Snellings[1]

[1] *NIKHEF (NL)*

Corresponding Author: raimond.snellings@cern.ch

Experimental overview of heavy ions physics: open challenges and future

Parallel III: C2 Heavy Quarks / **271**

Bottomonium spectroscopy at Belle

Author: Umberto Tamponi[1]

[1] *Universita e INFN, Torino (IT)*

Corresponding Author: tamponi@to.infn.it

The description of single meson transitions among quarkonium states represent both a challenging topic for current non-relativistic QCD models and a powerful tool for the study of the dynamic in heavy quarks systems. In particular, theoretical debates arose around the role of mesonic molecules and coupled channel effects in the description of the single meson transitions from Y(4S) and Y(5S).

Using the world largest samples of Y(4S) and Y(5S) collected by the Belle experiment at the KEKB e^+e^- collider, we present the most recent experimental discoveries on single and double meson transition from the Y(4S) and Y(5S), including the first observation of the non spin-flipping $Y(4S) \to \eta h_b(1P)$ decay and a new measurement of the $\eta_b(1S)$ mass.

Poster Session / **272**

QCD Sum Rules for Heavy-Meson Decay Constants: Impact of Renormalization Scale and Scheme

Authors: Dmitri Melikhov[1]; Silvano Simula[2]; Wolfgang LUCHA[None]

[1] *HEPHY*

[2] *INFN Roma Tre*

Corresponding Author: dmitri_melikhov@gmx.de

Within realm of QCD sum rules, one of the central fields of application is the prediction of the decay constants of heavy mesons. However, although the applied techniques are
very similar, we encounter rather dissimilar challenges and obstacles when extracting, from two-point correlators of appropriate heavy-light interpolating currents, characteristics of charmed mesons carrying different spin. In view of this, it appears worthwhile to us to revisit this issue for the case of charmed pseudoscalar and vector mesons.

Poster Session / **273**

$SU(4)$ magnetic monopoles and abelian gauge fixing

Author: Shahnoosh Rafibakhsh[1]

Co-authors: Mohammad Javad Kahnemouii [1]; Mojtaba Eshraghi [2]

[1] *Department of Physics, Science and Research Branch, Islamic Azad University, Tehran, Iran*

[2] *Institut für Theoretische Physik II, Heinrich Heine-Universität Düsseldorf, Universitätsstraße 1, 40225 Düsseldorf, Germany*

Corresponding Author: rafibakhsh@ut.ac.ir

Abelian gauge fixing procedure is used to create the $SU(4)$ magnetic monopoles in the vicinity of the points where the gluon filed becomes singular. The matrix of the scalar field is considered as almost diagonal in the $SU(2)$ and $SU(3)$ subspaces. The gauge transformation which diagonalizes the hedgehog field, transforms the gluon filed into two regular and singular parts. The abelian magnetic monopoles which appear in the latter part obey the quantisation condition.

Parallel II: B2 Light Quarks / 276

Electromagnetic corrections to weak matrix elements

Author: Guido Martinelli[1]

[1] *Scuola Int. Superiore di Studi Avanzati (IT)*

Corresponding Author: guido.martinelli@sissa.it

A new strategy to compute electromagnetic corrections to weak transitions is presented. The specific case of $\Gamma(\pi^H+ \to l^H + \nu + \gamma)$ is discussed in detail, and possible extensions of the method will also be discussed.

Parallel II: B2 Light Quarks / 277

Determination of the p-n mass difference in Lattice QCD

Author: Kalman Szabo[1]

[1] *Forschungszentrum Juelich*

Corresponding Author: k.szabo@fz-juelich.de

We compute the neutron-proton mass splitting and show that it is greater than zero by five standard deviations. Furthermore, splittings in the Sigma, Xi, D and Xi_cc isospin multiplets are determined providing also predictions. We perform lattice Quantum-Chromodynamics plus Quantum-Electrodynamics computations with four, non-degenerate Wilson fermion flavors. Four lattice spacings and pion masses down to 195 MeV are used.

Parallel V: E3 QCD and New Physics / 278

Non-Standard Charged Current Interactions in Beta Decay: Sources and Prospects

Author: Susan Gardner[1]

[1] *U*

Corresponding Author: gardner@pa.uky.edu

N/A

Poster Session / **279**

Bound states in Minkowski space in 2+1 dimensions

Authors: Cristian Gutierrez[1]; Tobias Frederico[2]; Vitor Gigante[2]

Co-author: Lauro Tomio [1]

[1] *Universidade Estadual Paulista Julio de Mesquita Filho, Instituto de Fisica Teorica , 01156-970, SP, Brasil.*

[2] *Instituto Tecnologico de Aeronautica 12228-900, Sao Jose dos Campos, SP, Brasil*

Corresponding Author: cristian@ift.unesp.br

The Nakanishi perturbative integral representation of the Bethe-Salpeter amplitude in three-dimensions (2+1) is investigated in order to derive a workable framework for bound states, which is solution of the homogeneous Bethe-Salpeter Equation (BSE) in Minkowski space. The projection onto the null-plane of the three-dimensional homogeneous BSE is used to derive an equation for the Nakanishi weight function for bound states. In this work, the formal development is illustrated in detail and applied to the bound system composed by two massive scalars interacting through the exchange of a massive scalar. The explicit forms of the integral equations are also obtained in ladder approximation.

After Dinner Talk / **280**

Wrecks on atomic reactors

Author: Boris Ioffe[1]

[1] *Institute for Theoretical and Experimental Physics (ITEP)*

Corresponding Author: ioffe@itep.ru

The After-dinner talk.

Poster Session / **282**

Symmetry-preserving contact interaction model for heavy-light mesons

Author: Fernando Serna[1]

[1] *Universidade Estadual Paulista*

Corresponding Author: fernandoserna@ift.unesp.br

We have calculated properties of pseudoscalar mesons using contact interaction in the Bethe-Salpeter equation. Contrary to the traditional treatment of the divergent amplitudes, we have implemented a novel approach in order to avoid the standard steps to evaluate divergent integrals which leads to symmetry violation. The basic idea of the novel approach is simples and consists in to assume a Poincar\'e invariant regularization in the amplitudes and then to perform subtractions on the propagators in order to obtain in general three kinds of terms at the end of the manipulations: quadratic and logarithmically divergent integrals, symmetry violating terms and a finite integral. Identifying the symmetries offending terms and removing them from the amplitudes using a consistent regularization scheme that does vanish the offending terms, we obtain amplitudes free of ambiguities and symmetry preserving. We have investigated the masses and electroweak decay constant of pseudoscalar mesons (π^0, K^0, D^0) finding good results.

Plenary 8 / **283**

Few-Body physics from lattice QCD

Author: Thomas Luu[1]

[1] *Forschungszentrum Juelich, Universitaet Bonn*

Corresponding Author: tluu@uni-bonn.de

I review the present status of few-body nuclear and hyper-nuclear calculations from lattice QCD, highlighting the challenges that have been overcome both theoretically and algorithmically within the past few years. I describe the current issues related to this field and conclude by discussing calculations that are anticipated in the near future and their potential impact on other physics disciplines.

Parallel VI: G1 Strongly Coupled Theories / **284**

Holographic Glueball Decay Rates in the Witten-Sakai-Sugimoto Model

Author: Anton Rebhan[1]

[1] *Vienna University of Technology*

Corresponding Author: rebhana@up.itp.tuwien.ac.at

The glueball spectrum of Witten's model for nonsupersymmetric Yang-Mills theory from type IIA supergravity is discussed with regard to the Sakai-Sugimoto model, which introduces chiral quarks through probe D8 branes. The couplings of glueballs with the mesons are worked out, leading to almost parameter-free predictions for the decay rates of glueballs.

Poster Session / **285**

Partial twisting for scalar mesons

Author: Dimitri Agadjanov[1]

[1] *University of Bonn*

Corresponding Author: dimaagajanov@gmail.com

The possibility of imposing partially twisted boundary
conditions is investigated for the scalar sector of lattice QCD.
According to the commonly shared belief, the presence of quark-antiquark annihilation diagrams in the intermediate state generally hinders the use of the partial twisting. Using effective field theory techniques in a finite volume, and studying the scalar sector of QCD with total isospin $I = 1$, it is demonstrated that partial twisting can still be performed, despite the fact that annihilation diagrams are present. The modified Luescher equation in case of partial twisting is given.

286

The nature of a1(1420) and triangle singularity mechanism

Author: Qiang Zhao[1]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences*

Corresponding Author: zhaoq@ihep.ac.cn

We demonstrate that the triangle singularity mechanism would account for the creation of the a1(1420) in the invariant mass spectrum of pi- pi- pi+ in the pi- p scattering observed by the COMPASS Collaboration. The same mechanism also accounts for the eta(1405/1475) puzzle since its interference will lead to significant changes to the lineshapes and peak positions for the same state when it decays into different channels such as K K-bar pi, eta pi pi, and 3pi. The property of its isospin-0 partner f1(1420) is also driven by the same mechanism.

Poster Session / **287**

In-medium neutral pion decay to two photons

Author: Jenifer Nebreda Manjon[1]

Co-author: Daisuke Jido [2]

[1] *Yukawa Institute for Theoretical Physics, Kyoto University*

[2] *Tokyo Metropolitan University*

Corresponding Author: jennifer222nm@gmail.com

We study the in-medium corrections to the neutral pion decay into two photons. For the calculation we use in-medium chiral perturbation theory. We take into account both the wave function renormalization and the medium correction to the one-particle irreducible vertex. Since it was previously shown that there are no medium corrections to the vertex up to O(pˆ5), that is, linear density in the density expansion, here we go up to next to linear order, or O(pˆ6). We study the dependence of the corrections with the nuclear density and find that, at normal nuclear density, the corrections to the decay width are of the order of a few percent.

Poster Session / **288**

Precise lattice calculation of nucleon form factor with all-mode-averaging

Author: Eigo Shintani[1]

[1] *M*

Corresponding Author: shintani@kph.uni-mainz.de

We present the high-statistics analysis of axial charge and isovector form factor of nucleon in Nf=2 Wilson-clover fermion configurations. Using all-mode-averaging techniques at $m_\pi = 190$–300 MeV in 2.5–4.0 fm lattice with three different lattice cut-off, we aim to compute these observables below 5% accuracy. In this poster we present preliminary study of rigorous calculation to search the region of ground-state nucleon dominance in which the excited state contamination is efficiently suppressed.

Poster Session / **289**

Zero modes of overlap fermions, instantons and monopoles (II)

Author: Masayasu Hasegawa[1]

Co-author: Adriano Di Giacomo [2]

[1] *Joint Institute for Nuclear Research*

[2] *University of Pisa*

Corresponding Author: hasegawa@theor.jinr.ru

University of Kanazawa and Pisa groups have shown a number of studies which support the confinement mechanism due to monopole condensations by the lattice simulations. The close relations between the instanton and chiral symmetry breaking are theoretically explained, moreover, the relations are revealed by numerical simulations. The purpose of our study is to show that the monopoles relate to the instantons and chiral symmetry breaking by using the overlap fermions as an analytical tool.

To show the relations, first we generate SU(3) configurations for the Wilson gauge action. We construct the overlap Dirac operator from link variables of the configurations, solve the eigenvalue problems by using of the subroutines (ARPACK), and save O(80) pairs of eigenvalues and eigenvectors each configurations. We count the number of the zero modes each ensemble. After analytical computations, we confirm that the instanton density is consistent with the instanton liquid model by E. V. Shuryak.

Second, we generate configurations adding monopoles and anti-monopoles with several charges by the monopole creation operator which is defined by the University of Pisa group. Third, we fix the maximally abelian gauge. After performed the abelian projection we localize the monopoles on the lattice. We measure the length of monopole loops to confirm that the monopoles are successfully added by the monopole creation operator.

The last, we diagonalize the overlap Dirac operator of the configurations without fixing the gauge which the monopoles are added. We quantitatively verify how many the monopoles and the monopole charges create the zero modes and instantons in order to show the relations between them. Moreover, we evaluate the pseudoscalar and scalar meson masses from the eigenvalues and eigenvectors.

I will present our preliminary results.

Parallel V: F1 Nuclear and Astroparticle Physics / **290**

Magnetic catalysis in nuclear matter

Author: Andreas SCHMITT[1]

[1] *Vienna University of Technology*

Corresponding Author: aschmitt@hep.itp.tuwien.ac.at

Due to magnetic catalysis, a strong magnetic field enhances the chiral condensate and thus can also be expected to increase the vacuum mass of nucleons. I will discuss resulting effect on the transition between vacuum and nuclear matter at zero temperature within two relativistic field-theoretical models. The results show that the creation of nuclear matter in a sufficiently strong magnetic field becomes energetically more costly due to the heaviness of magnetized nucleons, even though it is also found that nuclear matter is more strongly bound in a magnetic field. These results are potentially important for dense nuclear matter in compact stars, especially since previous studies in the astrophysical context have always ignored the contribution of the magnetized Dirac sea and thus the effect of magnetic catalysis.

Parallel V: E3 QCD and New Physics / 291

Theory of electric dipole moments of hadrons and nuclei

Author: Jordy de Vries[1]

[1] *Jülich Forschungszentrum*

Corresponding Author: j.de.vries@fz-juelich.de

Electric dipole moments (EDMs) break parity and time-reversal (T) symmetry and, by the CPT-theorem, CP-symmetry. If measured they are unambigious signs of new physics, since CP-violation in the quark mixing matrix predict EDMs orders of magnitude away from current experimental limits. The SM also contains the QCD vacuum angle (the theta term) whose value is unknown but strongly limited by neutron EDM experiments. This smallness leaves room for T-violation from physics beyond-the-SM which is expected to exist in order to explain the universal matter/antimatter asymmetry.
An open question remains: If an EDM is measured, is it caused by the theta-term or from physics beyond the SM?
Triggered by experimental plans to measure the EDMs of light nuclei with unprecedented accuracy in storage rings, this talk will be focused on these systems. After giving an overview of the field of EDMs and the relevant concepts, I will present a framework, based on effective field theories (in particular chiral perturbation theory), in which we calculate light-nuclear EDMs in a consistent framework. I will argue that measurements of a few of these EDMs could point towards the fundamental mechanism of time-reversal violation.

Parallel IV: D5 Deconfinement / 292

HYDJET++ : Ultrarelativistic heavy ion collisions - a hot cocktail of hydrodynamics, resonances and jets

Author: Larisa Bravina[1]

[1] *University of Oslo (NO)*

Corresponding Author: larissa.bravina@fys.uio.no

Poster Session / 293

Partition Function of Interacting Calorons Ensemble

Author: Sedigheh Deldar[1]

Co-author: Motahereh Kiamari [1]

[1] *University of Tehran*

Corresponding Author: sdeldar@ut.ac.ir

In this research we try to suggest computing the potential between interacting calorons with non-trivial holonomy. Two methods of sum ansatz and caloron-Dirac string interaction may be used to obtain the interacting potential between two calorons. With this potential, one can compute the partition function of the calorons ensemble with non interacting pairs (Interaction exists between calorons in each pair.) This partition function is essential to compute the ensemble average of two polyakov loops which calculates the heavy quark potential.