The 8th Asian Triangle Heavy-Ion Conference (ATHIC2021)

Report of Contributions

https://indico.cern.ch/e/athic2021

Contribution ID: **4** Type: **not specified**

Characterizing the initial conditions of ultra-relativistic heavy-ion collisions at the LHC

The primary goal of the ultrarelativistic heavy-ion collision program at the LHC is to study the quark-gluon plasma (QGP) properties, a state of strongly interacting matter that exists at high temperatures and energy densities. However, the lack of knowledge on the initial conditions of heavy-ion collision results in a significant uncertainty of the extraction of the transport properties of QGP.

In this talk, I will present the latest developments of multi-particle correlations. I will show that the newly proposed mixed harmonic correlation of various moments of anisotropic flow coefficients can provide strong constraints on the correlations between various moments of eccentricity coefficients in the initial conditions. Both hydrodynamic model predictions and ALICE measurements will be discussed. In addition, I will discuss the newly proposed correlation between mean transverse momentum and anisotropic flow coefficients, which could reflect the size and shape of the initial state and give direct access to the initial conditions. I will present the newest experimental measurements from both RHIC and the LHC experiments, as well as several recent theoretical model predictions. I will further show that the current state-of-the-art understanding of the initial conditions and the QGP properties relies on the Bayesian analyses, which are all based on the TRENTo initial state model and fail completely in describing the experimental data. These new studies pave a novel way to characterize the initial state in relativistic heavy-ion collisions.

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Session Classification: Invited Session 6

Track Classification: Track group 2: Experiment

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

K_1/K^* enhancement as a signature of chiral symmetry restoration in heavy ion collisions

Based on the fact that the mass difference between the chiral partners is an order parameter of chiral phase transition and that the chiral order parameter reduces substantially at the chemical freeze-out point in ultra-relativistic heavy ion collisions, we argue that the production ratio of K_1 over K^* in such collisions should be substantially larger than that predicted in the statistical hadronization model. We further show that while the enhancement effect might be contaminated by the relatively larger decrease of K_1 meson than K^* meson during the hadronic phase, the signal will be visible through a systematic study on centrality as the kinetic freeze-out temperature is higher and the hadronic life time shorter in peripheral collisions than in central collisions.

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Session Classification: Invited Session 2

Track Classification: Track group 2: Experiment

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

Quarkonium spectral functions in a bulk viscous QGP medium

Sunday 7 November 2021 14:04 (17 minutes)

In this talk, we will discuss how sensitive is the heavy quarkonia to the bulk viscous nature of the QGP medium. We will discuss the effects of bulk viscous correction on the properties of quarkonium states. The non-equilibrium bulk viscous correction is incorporated in the distribution functions of thermal quarks and gluons, with which we compute the dielectric permittivity within the hard thermal loop approximation at one-loop. The modified dielectric permittivity is used to calculate the in-medium heavy quark potential, that includes both Coulombic as well as string-like terms. Based on the modified heavy quark complex potential, we compute the quarkonium spectral functions by solving the Schr\"odinger equation. From the spectral functions, we compute the physical properties such as in-medium masses, binding energies and decay widths of quarkonium states. Finally, we will discuss the effects of bulk viscous correction on the physical observable, such as relative production yield of ψ' to J/ψ ratio.

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Session Classification: Contributed Session 3

Track Classification: Track group 2: Experiment

Contribution ID: **11** Type: **not specified**

Suppressed flow harmonics: A signature of the QCD critical point?

Saturday 6 November 2021 17:08 (17 minutes)

The fate of a perturbation (disturbance) imparted in the QGP fluid governed by the second-order Israel-Stewart viscous hydrodynamics has been studied when it passed through the Critical End Point (CEP). The effects of CEP have been incorporated in the system through the Equation of State (EoS). The dispersion relation for the perturbation in frequency (ω) wave vector (k) space has been derived. An expression for the threshold wavelength (λ_{th}) has been derived such that waves with wavelength, $\lambda > \lambda_{th}$ can propagate in the QGP but waves with lower λ will dissipate. Most interestingly, it is found that the value of λ_{th} at the CEP diverges, blocking waves of all wavelength irrespective of the value of transport coefficients. Near the CEP the correlation length (ξ) diverges, violating the hydrodynamic limit, $\xi << \lambda$ and the development of sound wave is prevented. The forbiddance of sound wave will lead to the vanishing of Mach cone (Mach angle, $\alpha = Sin^{-1}(c_s/v)$, v is the fluid velocity). Therefore, the vanishing of Mach angle will indicate the presence of the critical point. Also the presence of critical point makes the viscous horizon scale, $R_v \sim 1/k_{th} \sim \lambda_{th}$ to diverge and since the highest order of surviving harmonic vary as, $n_v \sim 2\pi R/R_v$. Therefore, ideally, the vanishing harmonics will indicate the presence of critical point.

However, the experimentally measure quantities are superposition of different temperatures and densities from the formation to the freeze-out stage, therefore, even if the system hits the critical point in the $T-\mu$ plane, the harmonics may not vanish, but will be suppressed. Hence we propose the suppressed flow harmonics to be a signature of the CEP.

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Session Classification: Contributed Session 2

Track Classification: Track group 2: Experiment

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

Interplay between core and corona components from p–p to Pb–Pb collisions at LHC energies

Saturday 6 November 2021 16:51 (17 minutes)

Hydrodynamics-based frameworks have been developed as powerful tools to extract properties of the quark-gluon plasma (QGP) from experimental data of relativistic heavy-ion collisions at RHIC and LHC. Although significant developments have been made so far, hydrodynamics-based frameworks still have open issues to be resolved. First, energy and momentum of incoming nuclei are not respected in initial conditions of hydrodynamics. Second, their application is limited to matter close to local equilibrium. Reconciliation of these issues is indispensable for the accurate extraction of QGP properties from comparisons between experimental data and hydrodynamics-based frameworks.

We develop the dynamical core–corona initialization framework (DCCI2) to resolve these open issues [1-3]. We model that QGP fluids are generated from initial partons obtained from PYTHIA [4] which reflect total energy and momentum of incoming nuclei. This dynamical initialization is formulated to strictly satisfy the energy-momentum conservation. Based on the core–corona picture, partons with sufficient secondary scatterings tend to deposit their energy-momentum and generate QGP fluids (core) as equilibrated matter. In contrast, partons with less secondary scatterings tend to survive as non-equilibrated matter (corona). By treating both equilibrated QGP fluids and non-equilibrated matter, we extend the application of this framework not only from low to high p_T but also from heavy-ion collisions to small colliding systems.

In this talk, we reveal the fraction of core and corona contributions in final hadron yield in p–p and Pb–Pb collisions. The core contribution overtakes corona one at $\langle dN/d\eta \rangle_{|\eta|<0.5} \sim 18$ regardless of collision systems and energies. Through the interplay between core and corona components, the DCCI2 describes the behavior of strangeness enhancement reported from the ALICE Collaboration in p–p and Pb–Pb collisions. We also discuss that non-negligible corona contribution appears at low p_T in Pb–Pb collisions, which behaves as a non-equilibrium correction to pure hydro results in $\langle p_T \rangle$ and $v_2\{2\}$. Through these analyses, we put an emphasis on importance of the corona contribution in extraction of the QGP properties from the experimental data.

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[3] Y.˜Kanakubo, Y.˜Tachibana, and T.˜Hirano, arXiv:2108.07943 [nucl-th].
[4] T. Sj\"{o}strand, S. Mrenna, and P. Z. Skands, Comput.
Phys. Commun. 178, 852 (2008).

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Session Classification: Contributed Session 2

Track Classification: Track group 1: Theory

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

Light nuclei production and QCD critical point

Saturday 6 November 2021 17:25 (17 minutes)

Light-nuclei production is one of the hot topics in heavy-ion collisions for the high-baryon-density region of the QCD phase diagram. It was found to exhibit a non-monotonic behavior with respect to the colliding energy in experiments and thus was suggested to be a possible signal of the QCD critical point.

This talk introduces a systematic expansion of the light-nuclei production within the framework of the coalescence model to deal with the effects of the non-trivial geometry of the fireball and flow-induced coordinate-momentum correlations of the phase-space density of nucleons. By considering the characteristic function of the phase-space density, we expand the yield of light nuclei in terms of cumulants of the phase-space density. We see that, while the second-order cumulants correspond to the Gaussian shape in phase-space, higher orders characterize various types of non-Gaussianity of the phase-space density. We find that the leading terms of the phase-space cumulants in the yields share a similar structure and can be canceled out in the ratio of light nuclei, whereas the higher-order ones remain in the ratio and play an important role. Thus the non-Gaussianity of the phase-space density of nucleons plays an important role in the interpretation of the behavior of the light-nuclei yield ratio. We also discuss the contribution of the critical correlations to the higher-order phase-space cumulants in this framework.

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Session Classification: Contributed Session 2

Track Classification: Track group 1: Theory

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

Hadronic resonance production in small colliding systems with ALICE at the LHC

Sunday 7 November 2021 17:25 (17 minutes)

Hadronic resonances are very useful to probe the late-stage evolution of ultra-relativistic nucleon-nucleon or nuclear collisions. Since they have lifetimes comparable to the hadronic phase timespan, rescattering and regeneration processes may affect the measured yields. These processes modify the resonance momentum distributions. Measurements of the differential yields of resonances with different lifetime, mass, quark content, and quantum numbers will enable understanding the mechanisms that influence the shape of particle momentum spectra, lifetime of the hadronic phase, strangeness production, parton energy loss, and collective effects. Recent multiplicity-dependent studies on particle production in pp and p–Pb collisions have shown similar features as in heavy-ion collisions. Resonance measurements could help to understand the possible onset of collective-like phenomena and a non-zero lifetime of the hadronic phase even in a small system. Furthermore, the measurements in small systems are used as a reference for heavy-ion collisions and help tune Quantum Chromodynamics (QCD) inspired event generators.

This talk presents recent ALICE results on various hadronic resonances in small collision systems at LHC energies. The results will be compared with model calculations and measurements at low energies

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Session Classification: Contributed session 4

Track Classification: Track group 2: Experiment

Contribution ID: **30** Type: **not specified**

Search for the Chiral Magnetic Wave using the ALICE detector in Pb–Pb collisions at √sNN = 5.02 TeV

Saturday 6 November 2021 15:12 (17 minutes)

In heavy-ion collisions, a strong magnetic field ($\sim 10^{15}$ T) is expected to be created, which in the presence of a non-zero electric and axial charge density, can lead to vector and axial currents in the produced system
$textendash$ the phenomena called the Chiral Magnetic Effect (CME) and Chiral Separation Effect (CSE), respectively. Their coupling gives rise to a collective excitation in the quark-gluon plasma (QGP) called the Chiral Magnetic Wave (CMW), which could cause a finite quadrapole moment of the collision system. As a result, elliptic flow, v_2, becomes charge dependent and the normalized difference of v_2 of positive and negative charges, $\Delta v_{2_{\rm Norm}}$, may exhibit a positive slope as a function of the asymmetry ($A_{\rm ch}$) in the number of positively and negatively charged particles in an event. However, interpretations of the experimental results get complicated by possible background contributions, like Local Charge Conservation (LCC). A similar measurement with v_3 can probe the effect of LCC, because v_3 is not expected to be affected by the CMW.

In this talk, we present ALICE measurement of v_2, $\Delta v_{2_{\rm Norm}}$, v_3 and $\Delta v_{3_{\rm Norm}}$ of charged hadrons in $0.2 < p_{\rm T} < 1.0$˜GeV/c and pions in $0.2 < p_{\rm T} < 0.5$˜GeV/c as a function of $A_{\rm ch}$ in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV. The slope parameters corresponding to $v_{2_{\rm Norm}}$ and $v_{3_{\rm Norm}}$ versus $A_{\rm ch}$ are measured and compared as a function of collision centrality to estimate the background contribution in CMW phenomena at LHC energies. We will further compare the ALICE results with those from the CMS experiment and with STAR measurements at lower collision energy. Finally, we compare our results with different model predictions.

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Session Classification: Contributed Session 1

Track Classification: Track group 2: Experiment

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

Effect of radiative hadronization on thermal photons

Tuesday 9 November 2021 11:42 (17 minutes)

Electromagnetic probes are one of promising tools to investigate properties of the hot and dense matter created in high-energy heavy-ion collisions. However, state-of-the-art phenomenological models which can correctly explain spectra and anisotropic flows of charged particles underpredict yield and elliptic flow of photons. It is known as "photon puzzle".
Here we propose photon emission at hadronization as a possible resolution to the photon puzzle. In particular, we discuss the effect of radiative hadronization on thermal photons which are calculated by relativistic viscous hydrodynamical models. As a result, we succeed to enhance both direct photon yield and elliptic flow as a same time and reproduce experimental data of yield and elliptic flow at RHIC and LHC.

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Session Classification: Contributed Session 6

Track Classification: Track group 1: Theory

Contribution ID: **36** Type: **not specified**

The anomalous enhancement of dilepton production from diquark correlations in dense quark matter

Tuesday 9 November 2021 10:51 (17 minutes)

One of the key ingredients in hadron physics based on QCD is the notion of diquark correlations, which in turn could lead to the color superconductivity (CSC) in dense and cold quark matter with a Fermi surface to be realized in a compact star. One of the main focuses of recent experiments using heavy-ion collision is to reveal possible rich physics in high baryon-density matter at relatively low temperature: Such experiments include the beam-energy scan program at RHIC, and HADES and NA61/SHINE collaborations as well as those to be performed in future experimental facilities such as FAIR, NICA and J-PARC-HI. In the present report, we show how diquark correlations or pair fluctuations in dense quark matter affects the dilepton production rate. On the basis of the two-flavor NJL model, we calculate the Aslamazov-Larkin, Maki-Thompson and Density of States terms due to diquark correlations, which are known to give rise to anomalous excess of electric conductivity in metals in the vicinity of the critical temperature of superconductivity. The calculations show that the dilepton production rate is enhanced in the low energy region in an anomalous way due to the diquark correlations which persist even away from the critical temperature of CSC, and thus confirms semi-quantitatively the previous result obtained with the use of the time-dependent Ginzburg-Landau theory.

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Session Classification: Contributed Session 6

Track Classification: Track group 1: Theory

Contribution ID: **37** Type: **not specified**

Detection feasibility evaluation of ultra-intense magnetic field with dimuons at ALICE in Runs 2 and 3

Saturday 6 November 2021 16:00 (17 minutes)

High energy heavy ion collisions at the LHC generate extreme magnetic field reaching 10^{14} T~10^{15} T when heavy ions cross each other at almost the speed of light in peripheral collisions. The intensity of this generated magnetic field is much higher than the critical magnetic field of electrons, 4×10^{9} T, and various nonlinear behaviors such as real photon decay are expected in the linear regime of QED. In addition, there have been interesting discussions about synchrotron radiation and chiral magnetic effects in ultra-intense magnetic fields. However, its generation has not yet been detected experimentally.

Virtual photon polarization, one of nonlinear QED phenomena, will be measured with dimuons to detect the ultra-intense magnetic field. The effect of virtual photon polarization will manifest itself as anisotropy of dilepton decay plane. Prompt photons and the ultra-intense magnetic field exist at the same time, and Prompt photons are dominant in $|p_T| > 4$ GeV/c. The ALICE experiment has muon track system with high muon identification capability, so muon's signal-background ratio is higher than electrons. In Run 3 (2022-), higher muon's signal-background ratio is expected due to installation of a new detector, Muon Forward Tracker (MFT), that improves the accuracy of track detection. We plan to measure the virtual photon polarization using dimuons with $|p_T| > 4$ GeV/c.

It is essential to discuss the detection feasibility of virtual photon polarization via dimuon measurement. The virtual photon polarization due to the ultra-intense magnetic field is calculated by the vacuum polarization tensor including the one-loop level. It is found that the polarization in the measurement region ($|p_T| > 4$ GeV/c) appears at least 0.05. Moreover, we estimated the statistics of dimuons decayed prompt virtual photon and background in Runs 2 and 3 by simulation. In Run 2, the significance is found to be 0.57 σ in $|p_T| > 4$ GeV/c. It was also found that the significance is expected to increase to 1.8σ in Run 3 due to the 10-fold increase in the number of muons. Furthermore, the significance in Run 3 can be expected to be improved by the signal background removal by MFT, the dimuon mass cut and so on. Therefore, there is a possibility that a significant signal of virtual photon polarization can be detected in Run 3.

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Session Classification: Contributed Session 2

Track Classification: Track group 2: Experiment

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

Low-mass dielectron measurement in ALICE at the LHC

Tuesday 9 November 2021 11:08 (17 minutes)

Dileptons and photons are unique tools to study the space-time evolution of the hot and dense matter created in ultra-relativistic heavy-ion collisions. Their main sources are hard QCD processes (prompt photons), thermal production and semi-leptonic heavy-flavour decays. They carry undistorted information about the various stages of the collision as they are either produced at early times (prompt) or in the QGP phase (thermal) and have negligible final state interactions.Dileptons from heavy-flavour decays also bring information on the early stages, when heavy quark production takes place.
In this contribution, we will present results from the recent measurements of e^+e^- pair production in pp, p–Pb and Pb–Pb collisions at the center-of-mass energy $\sqrt{s_{\rm NN}}$ = 5.02 TeV. Furthermore, our results on dielectrons at low $p_{\rm T,ee}$ in pp collisions at $\sqrt{s}$ = 13 TeV and in peripheral Pb–Pb collisions will be presented and compared with theoretical models.

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Session Classification: Contributed Session 6

Track Classification: Track group 2: Experiment

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

Fractional momentum loss of high-pT hadrons in QGP at RHIC-PHENIX

Sunday 7 November 2021 16:17 (17 minutes)

The phase transition from hadronic matter to quark-gluon plasma (QGP) is a phenomenon that occurs under extreme conditions of high temperature and high density. The QGP causes energy loss of high momentum particles which is observed as suppression of high momentum hadron production in A+A collisions relative to p+p collisions. PHENIX, one of the relativistic heavy ion collider (RHIC) experiments at Brookhaven National Laboratory, aims to measure various QGP signals from nuclear collision reactions. The study presented in this talk uses PHENIX data to evaluate the energy loss of partons in QGP in various collision systems. We systematically study the energy loss with π^0s in Au+Au and Cu+Au and Cu+Cu at $\sqrt{s_{NN}}$ = 200 GeV and charged hadrons in Au+Au at $\sqrt{s_{NN}}$ = 200 GeV using two quantities, S_{loss} and S'_{loss}. S_{loss} represents the fractional momentum loss of high-p_T hadrons. This quantity comes from the difference in particle yield in A+A and p+p collisions. Whereas, S'_{loss} represents the fractional momentum loss of high-p_T hadrons considering azimuthal anisotropy, v_2. This quantity comes from the difference in particle yield in-plane and out-of-plane. Previous studies reported the scaling properties of S_{loss} depending on path-length. In this analysis, we study the p_T and system size dependences of S_{loss} and S'_{loss} for π^0 and charged hadrons in various collision systems.
We will discuss the interpretation of these results and their impact on our understanding of the path-length dependence of energy loss in the QGP.

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Session Classification: Contributed session 4

Track Classification: Track group 2: Experiment

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

Analysis of thermalization of semiclassical Yang-Mills field in expanding geometry with use of Husimi function

Sunday 7 November 2021 16:34 (17 minutes)

We investigate the real time evolution of a highly occupied and weakly coupled Yang-Mills field in the expanding geometry using the semiclassical approximation, and study its thermalization in terms of the Husimi-Wehrl(HW) entropy that is defined by the Husimi function. The initial conditions are given to mimic the realistic grasma initial condition, where the color electric and color magnetic fields are boost-invariant and parallel to the collision axis. We also study the evolution of pressure isotropy and the change in the number of particles in order to discuss the relationship with the HW entropy. The results at $g = 0.1$ and 0.2 show that the HW entropy increases rapidly in the initial stage where the time evolution of pressure strongly depends on the initial condition and coupling constant. In the later stages, the HW entropy and the ratio of transverse to longitudinal pressure change slowly while maintaining a large pressure anisotropy. It is also shown that the generation of the HW entropy is associated with the production of particles.

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Session Classification: Contributed session 4

Track Classification: Track group 1: Theory

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

Beauty production with ALICE

Sunday 7 November 2021 14:21 (17 minutes)

The goal of the ALICE experiment is to investigate the quark-gluon plasma (QGP), a state of matter in which quarks and gluons are deconfined. Heavy quarks, charm and beauty, are efficient probes of the properties of the QGP since they are predominantly produced in initial hard scattering processes, and subsequently interact with the medium. In particular, beauty production can be utilized to study the mass dependent in-medium energy loss by comparison to charm production. The measurement of beauty production in pp collisions provides an important test of perturbative QCD calculations at the LHC energies and can be used as a reference for measuring the nuclear modifications. The measurement in p–Pb collisions is crucial to investigate the effects of cold nuclear matter (CNM) on their production.
In this contribution, the p_{T}-differential cross section of electrons from beauty-hadron decays, b-jet, and non-prompt D mesons in pp collisions at 5.02 TeV is reported. In addition, the nuclear modification factors of the beauty-hadron decay electrons and non-prompt D^0 and $\mathrm{D}_{\mathrm{s}}^+$ mesons in Pb−Pb collisions at 5.02 TeV are presented. The nuclear modification factor of b-jet in p−Pb collisions at 5.02 TeV is also shown.

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Session Classification: Contributed Session 3

Track Classification: Track group 2: Experiment

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

Kinetic theory based expressions of five shear viscosity components in presence of a magnetic field

Saturday 6 November 2021 14:04 (17 minutes)

After getting two remarkable scientific upgrades of quark-gluon plasma (QGP) physics - lowest viscous nature and strong magnetic field production, viscous properties of QGP in a strong magnetic field become one of the important matters of research. Instead of one isotropic shear viscosity, as we get in absence of magnetic field, five different components of shear viscosity $\tilde{\eta}_n(n = 0, .., 4)$ can appear due to magnetic fields \[Physical kinetics, Volume 10\]. In the previous decade, Xu-Guang Huang et al. introduced another set of five shear viscosity components η_n. P. Mohanty et al. \[Eur. Phys. J. A 55, 35 (2019)\] in kinetic theory approach and G.S. Denicol et al. \[Phys.Rev.D 98, 076009 (2018)\] in Grad's moment method, provided the expressions of $\tilde{\eta}_n$ and η_n respectively. We \[Pramana 95,125 (2021)\] have explored both sets in a common framework, based on the kinetic theory approach. From the interconnecting relations between them, we have pointed out three physically relevant components - parallel, perpendicular, and Hall, which are conventionally considered in the ADS/CFT calculations \[Phys.Rev.D 90, 066006 (2014)\] and in the calculations for anisotropic unitary Fermi gas \[Phys. Rev. A 96, 053601 (2017)\]. These components are estimated \[Int.J.Mod.Phys.E 30, 06, 2150044 (2021)\] for QCD matter in the entire temperature and magnetic field domain of experimental QGP by mapping LQCD data \[Phys.Rev.D 86, 071502(R) (2012)\], which unfolded the inverse magnetic catalysis phenomena near the quark-hadron phase transition.

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Session Classification: Contributed Session 1

Track Classification: Track group 1: Theory

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

Charm-baryon production and fragmentation fractions in pp collisions with ALICE

Sunday 7 November 2021 13:47 (17 minutes)

The production cross sections of open heavy-flavour hadrons can be obtained by the collinear factorisation approach of QCD, by means of a convolution of the initial parton distribution functions of the incoming partons, the perturbative QCD partonic cross section, and the fragmentation functions in $\mathrm{e^+e^-}$, ep collisions. Recent measurements of charm-baryon production at midrapidity performed by ALICE in small collision systems show a baryon-to-meson ratio significantly higher than in $\mathrm{e^+e^-}$ collisions. This enhancement cannot be explained by model calculations considering charm fragmentation functions obtained in \ee collisions and suggests that the charm fragmentation is not universal across collision systems. Therefore, measurements of charm-baryon production are crucial to investigate the hadronisation mechanism of charm quarks. Measurements of charm-baryon production in p–Pb collisions also provide information about Cold Nuclear Matter (CNM), helping to understand the possible presence of collective effects or the modification of hadronisation mechanisms.

In this contribution, the latest measurements of Λ_c^+, $\Xi_\mathrm{c}^{0,+}$, $\Sigma_\mathrm{c}^{0,++}$, and the first measurement of Ω_c^0 baryons performed with the ALICE detector at midrapidity in pp collisions at $\sqrt{s} = 5.02$ and $13\,\mathrm{TeV}$ are presented. Also, the first measurements of the total charm cross section at midrapidity and the fragmentation fractions at midrapidity in pp collisions at the LHC including the charm baryons are discussed. In addition, the Λ_c^+ measurement down to $p_\mathrm{T} = 0$ in p–Pb collisions will be discussed.

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Session Classification: Contributed Session 3

Track Classification: Track group 2: Experiment

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

Two-particle long-range correlations in small systems with ALICE

Monday 8 November 2021 11:42 (17 minutes)

In this talk, we will present the recent results on two-particle correlations in high-multiplicity pp collisions at $\sqrt{s}$ =˜13˜TeV and p–Pb collisions at $\sqrt{s_{\rm NN}}$ =˜5.02˜TeV from the ALICE Collaboration. The origin of long-range modulations remains an open question, and can be indicating collective dynamics in both small and large systems. We will present recent measurements of the second Fourier harmonic v_2 as a function of multiplicity in pp collisions using the Forward Multiplicity Detector, which makes it possible to measure the correlations between particles which are separated by up to eight units of pseudorapidity, the largest $\Delta\eta$ gap at the LHC. We will also present a differential study of the ridge in high-multiplicity pp collisions which contain a high-momentum charged particle or reconstructed jet, in order to determine whether long-range correlations are correlated with hard processes. Finally, we will discuss a flow extraction method using a low-multiplicity template, and present the non-flow free flow harmonic coefficients.

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Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

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

Multi-charmed and exotic hadron production in heavy ion collisions

Sunday 7 November 2021 13:30 (17 minutes)

We discuss multi-charmed and exotic hadrons in heavy ion collisions by focusing on their production based on both the statistical and coalescence models. Starting from the investigation on estimated yields of multi-charmed hadrons in the statistical hadronization model, we consider transverse momentum distributions of those hadrons produced at quark-hadron phase transition in the coalescence model. We also consider the transverse momentum distribution of charmed exotic hadrons such as X(3872) and recently measured Tcc mesons, and show transverse momentum distribution ratios between charmed hadrons. We show that the transverse momentum distribution ratios are closely related to kinds and numbers of quarks as well as the interplay between constituent quarks of those hadrons, and therefore we insist that studying both the transverse momentum distribution and transverse momentum distribution ratios of multi-charmed hadrons provides us with valuable information on charmed hadron production in heavy ion collisions.

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Session Classification: Contributed Session 3

Track Classification: Track group 1: Theory

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

Deconfining Phase Boundary of Rapidly Rotating Hot and Dense Matter and Analysis of Moment of Inertia

Saturday 6 November 2021 13:30 (17 minutes)

The effect of rotation changes the critical temperature in the phase diagram of hot and dense hadronic matter explored in heavy-ion collision experiments. The recent lattice-QCD calculation suggests that the rotation effect pushes up the critical temperature, and there has been some controversy over the interpretation of this result. In this talk, we use a parameter-free approach, which is the hadron resonance gas model, to address this issue. We found that the critical temperature should be lowered with increasing rotation. We also establish a method to quantitatively evaluate the radial dependence of pressure and the moment of inertia of hadronic matter. The talk will be based on PLB 816, 136184 (2021) [arXiv:2101.09173].

Author: FUJIMOTO, Yuki

Co-authors: FUKUSHIMA, Kenji (The University of Tokyo); HIDAKA, Yoshimasa (RIKEN)

Presenter: FUJIMOTO, Yuki

Session Classification: Contributed Session 1

Track Classification: Track group 1: Theory

Contribution ID: **62** Type: **not specified**

The coupled approach to solving the RAA-v2 puzzle in high-energy heavy-ion collisions

Saturday 6 November 2021 16:34 (17 minutes)

Hydrodynamic expansion and jet quenching are responsible for the production of low and high transverse-momentum (p_T) particle in heavy-ion collisions, respectively. However, it is still a challenge to simultaneously describe hadron nuclear modification factor RAA and elliptic flow v_2, especially in the intermediate pT region of 2<p_T<10 GeV/c. In this talk, besides hydrodynamics and jet quenching, we also study the effects of the quark coalescence and the hadron cascade on hadron spectra and flow. We find the key to solving the RAA-v_2 puzzle is the incorporation of quark coalescence into the state-of-the-art event-by-event simulations of heavy-ion collisions. Specifically, our new theoretical framework combines 1) the Coupled Linearized Boltzmann Transport and Hydrodynamic (CoLBT-Hydro) model, 2) a hadronization model including Cooper-Frye sampling, quark coalescence and string fragmentation, and 3) a hadron cascade model. For the first time, we can consistently describe and understand the experimental data on RAA and v2 along with their flavor dependence and hadron chemistry (proton-to-pion and kaon-to-pion ratios) from low to intermediate pT and high pT in high-energy heavy-ion collisions. We also predict a novel consequence of the strangeness enhancement and the quark coalescence that kaon v_2 larger than the pion v_2 in the transverse momentum region of 3<p_T<5 GeV/c. Our prediction is an example of high-precision tests of the quark coalescence model in nuclear collisions.

1 Wenbin Zhao, Weiyao Ke, Wei Chen, Tan Luo and Xin-Nian Wang, arXiv:2103.14657 [hep-ph].

2 Wenbin Zhao, Che-Ming Ko, YuXin Liu, Guangyou Qin and Huichao Song, Phys. Rev. Lett. 125, 072301 (2020).

Authors: LUO, Tan (IGFAE); KE, Weiyao (University of California, Berkeley; Lawrence-Berkeley National); ZHAO, Wenbin (Central China Normal University); CHEN, WEI (CCNU); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: ZHAO, Wenbin (Central China Normal University)

Session Classification: Contributed Session 2

Track Classification: Track group 1: Theory

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

Higher-Order Cumulants of Net-Proton Multiplicity Distributions in √sNN = 200 GeV Zr+Zr and Ru+Ru Collisions by the STAR Experiment

Tuesday 9 November 2021 10:34 (17 minutes)

Higher-order cumulants and their ratios of the conserved quantities are powerful tools used to understand the QCD phase diagram. They are sensitive to the phase structure and the correlation length of the medium created in the collisions. Non-monotonic energy dependence of fourth-order cumulant of net-proton multiplicity distributions has been reported by the STAR Collaboration. In addition, results of sixth-order net-proton cumulants with Lattice QCD calculations suggest a smooth crossover transition in central Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV.
In this talk, we will present results on net-proton cumulants and their ratios up to fourth-order and their multiplicity dependence using high statistics data of Zr+Zr and Ru+Ru collisions at $\sqrt{s_{NN}}$ = 200 GeV. Two billion events were collected by the STAR Experiment for each of the colliding systems. The new results on multiplicity dependence will be compared to the published net-proton cumulants from $\sqrt{s_{NN}}$ = 200 GeV Au+Au collisions. In addition, the results will be compared to Lattice QCD, Hadron Resonance Gas model, and hadronic transport model calculations. The physics implications will be discussed.

Authors: KO, Ho-San (Lawrence Berkeley National Laboratory); (STAR COLLABORATION)

Presenter: KO, Ho-San (Lawrence Berkeley National Laboratory)

Session Classification: Contributed Session 6

Track Classification: Track group 2: Experiment

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

Study of the nuclear deformation in relativistic isobar collisions at STAR

Monday 8 November 2021 10:17 (17 minutes)

Collective phenomena in heavy-ion collisions are very sensitive to initial geometry including nuclei deformation effects. In the hydrodynamic model description of heavy ion collisions, the final-state anisotropic flow v_n are linearly related to the strength of the multi-pole shape of the nucleon density distribution in the transverse plane ϵ_n, $v_n \propto \epsilon_n$. The ϵ_n are sensitive to the shape of the colliding ions, characterized by nuclear deformation. Results on the v_n from isobar collisions at $\sqrt{s_{NN}}$ = 200 GeV with the STAR detector will be presented. The precise calculations with Monte-Carlo Glauber and a multi-phase transport (AMPT) model could be helpful to understand the role of the shape of atomic nuclei in heavy-ion collisions.

Author: Dr ZHANG, Chunjian (stony brook university)

Co-authors: JIA, Jiangyong (Stony Brook University (US)); HUANG, Shengli (Stony Brook University)

Presenter: Dr ZHANG, Chunjian (stony brook university)

Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

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

Dibaryon searches and future prospects in the ALICE experiment

Tuesday 9 November 2021 10:00 (17 minutes)

Quarks are confined inside a hadron as a color-neutral composite particle. Quantum chromodynamics (QCD), the fundamental theory of strong interactions, does not rule out an existence of exotic hadrons other than mesons and baryons. However, a dibaryon consisting of six quarks has not yet been discovered. The discovery of dibaryons would lead to a deeper understanding of QCD. In particular, dibaryons containing s quarks can provide additional information on fundamental baryon-baryon interactions in the flavor SU(3) space.
In the ALICE experiment, dibaryon searches have been performed in Pb-Pb collision data at √(s_NN) = 2.76 TeV. The H dibaryon, a bound state of six quark (uuddss) was searched through its weak decay H dibaryon ⟶ Λpπˆ-, while the possible Λn bound state has been searched through the weak decay channel (Λn)¯ ⟶ d¯πˆ+. No signal was observed and upper limits of their production cross sections have been determined.
Nevertheless, the recent lattice QCD calculations by HAL QCD showed the attractive potentials between ΛΛ, NΞ, and NΩ, and the strong attractive potential between these hadrons has been recently tested using two-particle correlation measurements by the ALICE experiment. A consequence of these attractive potentials is that the H-dibaryon should be a resonant state of ΛΛ or NΞ, and NΩ should appear as a quasi-bound state. These dibaryon states should then strongly decay at the collision point.
In this talk, we will present the current status of the dibaryon searches and future measurements feasible in the ALICE experiment.

Author: TOKUMOTO FOR THE ALICE COLLABORATION, Ryoka (Hiroshima University (JP))

Presenter: TOKUMOTO FOR THE ALICE COLLABORATION, Ryoka (Hiroshima University (JP))

Session Classification: Contributed Session 6

Track Classification: Track group 2: Experiment

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

Gradient tomography in heavy-ion collisions

Sunday 7 November 2021 14:55 (17 minutes)

Transverse momentum broadening and energy loss of a propagating parton are dictated by the space-time profile of the jet transport coefficient $\hat{q}$ in dense QCD medium. Spatial gradient of $\hat{q}$ perpendicular to the propagation direction can lead to a drift and asymmetry in parton transverse momentum distribution. Such an asymmetry depends on both the spatial position along the transverse gradient and path length of a propagating parton as shown by numerical solutions of the Boltzmann transport in the simplified form of a drift-diffusion equation. In high-energy heavy-ion collisions, this asymmetry with respect to a plane defined by the beam and trigger particle (photon, hadron or jet) with a given orientation relative to the event plane is shown to be closely related to the transverse position of the initial jet production in full event-by-event simulations within the linear Boltzmann transport model. Such a gradient tomography can be used to localize the initial jet production position for more detailed study of jet quenching and properties of the quark-gluon plasma along a given propagation path in heavy-ion collisions

Authors: PANG, LongGang (Lawrence Berkeley National Laboratory); Dr HE, Yayun (South China Normal University); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: Dr HE, Yayun (South China Normal University)

Session Classification: Contributed Session 3

Track Classification: Track group 1: Theory

Contribution ID: **74** Type: **not specified**

Measurements of Λ-Λ and Ξ-Ξ correlations in Au+Au collisions at √sNN = 200 GeV at RHIC-STAR

Tuesday 9 November 2021 10:17 (17 minutes)

The interaction between hyperon-hyperon (Y-Y) is not well understood theoretically and experimentally.
The Y-Y interaction is important to understand the EOS of neutron star interior as well as to search for exotic hadrons such as H-dibaryon.
The H-dibaryon was proposed as a stable six-quark state resulting from combination of two ¥$Lambda$ hyperons. According to the lattice QCD calculation¥cite{QCD}, H-dibaryon could be in a deeply bound state or in a shallow bound state, or two ¥$Lambda$ hyperons have weak unbound attractive interaction, depending on quark mass. On the other hand, the observation of double hypernuclei¥cite{takahashi} suggests that they are not in a deeply bound state, although more experimental inputs are need to clarify the nature of possible H-dibaryon state.
It is also discussed that there exists a bound state of two ¥Xi.

In high-energy heavy-ion collisions, a large number of particles including (multi-)strangeness are produced, which allows us to study those interactions via femtoscopic measurements with better precision. The correlation function is affected by strong interaction, quantum statistics and Coulomb interaction in low relative momentum.

In this talk, the status of measurements of ¥$Lambda$-¥$Lambda$ and ¥Xi-¥Xi correlation functions in Au+Au collisions at ¥$sqrts_{¥rmNN}$ = 200 {¥rm GeV} at RHIC-STAR will be reported.

1 T. Inoue {¥it{et al}}.(HAL QCD Collaboration), Nucl. Phys. A881, 28 (2012)
1 H. Takahashi {¥it{et al}}., Phys. Rev. Lett. 87, 212502 (2001)

Author: Ms ISSHIKI (FOR THE STAR COLLABOARTION), Moe (University of Tsukuba)

Presenter: Ms ISSHIKI (FOR THE STAR COLLABOARTION), Moe (University of Tsukuba)

Session Classification: Contributed Session 6

Track Classification: Track group 2: Experiment

Contribution ID: **77** Type: **not specified**

Probing early-time longitudinal dynamics with the Λ hyperon's spin polarization in relativistic heavy-ion collisions

Monday 8 November 2021 10:34 (17 minutes)

We systematically study the hyperon global polarization's sensitivity to the collision systems' initial longitudinal flow velocity in hydrodynamic simulations. By explicitly imposing local energy-momentum conservation when mapping the initial collision geometry to macroscopic hydrodynamic fields, we study the evolution of systems' orbital angular momentum (OAM) and fluid vorticity. We find that a simultaneous description of the Λ hyperons' global polarization and the slope of pion's directed flow can strongly constrain the size of longitudinal flow at the beginning of hydrodynamic evolution. We extract the size of the initial longitudinal flow and the fraction of orbital angular momentum in the produced QGP fluid as a function of collision energy with the STAR measurements in the RHIC Beam Energy Scan program. We find that there is about 100-200 $\hbar$ OAM that remains in the mid-rapidity fluid at the beginning of hydrodynamic evolution. We further exam the effects of different hydrodynamic gradients on the spin polarization of Λ and $\bar{\Lambda}$. The gradients of μ_B/T can change the ordering between Λ's and $\bar{\Lambda}$'s polarization.

https://arxiv.org/abs/2106.08125

Authors: SHEN, Chun (Wayne State University); Dr RYU, Sangwook (Wayne State University); Mr JUPIC, Vahidin (Wayne State University)

Presenter: Dr RYU, Sangwook (Wayne State University)

Session Classification: Contributed Session 5

Track Classification: Track group 1: Theory

Contribution ID: **78** Type: **not specified**

The hypertriton and hyperquadron directed flow measurements in √sNN = 3 GeV Au+Au collisions from STAR

Monday 8 November 2021 11:25 (17 minutes)

Collective flow has been commonly used for studying the properties of matter created in high-energy heavy-ion collisions, due to its high sensitivity on early stage collision dynamics. The first-order Fourier coefficient of azimuthal distributions of produced particles v_1, also called directed flow, has been analyzed for different particle species from the lightest mesons to light nuclei in such collisions. In this talk, we report ${}^{3}_{\Lambda}\mathrm{H}$ reconstruction from its two-body and three-body pionic decay channels, and ${}^{4}_{\Lambda}\mathrm{H}$ reconstruction from its two-body pionic decay channel. Then, the first observation of the hyper-nuclei ${}^{3}_{\Lambda}\mathrm{H}$ and ${}^{4}_{\Lambda}\mathrm{H}$ directed flow v_1 from $\sqrt{s_{NN}} = 3$ GeV mid-central (5–40%) Au+Au collisions at RHIC will be presented. The directed flow of ${}^{3}_{\Lambda}\mathrm{H}$ and ${}^{4}_{\Lambda}\mathrm{H}$ are compared with those of the copiously produced particles such as p, Λ, d, t,^{3}He and ^{4}He. It is observed that the slopes of v_1 at midrapidity for the hyper-nuclei ${}^{3}_{\Lambda}\mathrm{H}$ and ${}^{4}_{\Lambda}\mathrm{H}$ follow a baryon number scaling implying that coalescence process is a dominant mechanism for the hyper-nuclei production in these collisions. Hypernuclei directed flow measurement would shed light on the hyperon-nucleon (YN) interaction in condensed nuclear medium with finite pressure.

Author: Dr ZHANG, Yapeng (Institute of Modern Physics, CAS)

Presenter: Dr ZHANG, Yapeng (Institute of Modern Physics, CAS)

Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

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

LAMPS experiment -Status and plan-

Tuesday 9 November 2021 11:59 (17 minutes)

LAMPS experiment is designed to research various physics topics in heavy ion physics, Symmetry energy, Collective flow, Mirror nuclei ratio, Dipole emission, etc.
LAMPS group developed and construct detectors for LAMPS experiment for several years.
RAON, the first laboratory for heavy ion physics research in Korea, is about to end its 1st step construction in 2021.
LAMPS experiment is in line with the completion, will end its development and construction of sub-detector systems from starting counter to neutron detector arrays.
We will talk about the current status and plan for LAMPS experiment.

Author: Dr LEE, Jongwon (Korea Univ.)

Presenter: Dr LEE, Jongwon (Korea Univ.)

Session Classification: Contributed Session 6

Track Classification: Track group 2: Experiment

Contribution ID: **83** Type: **not specified**

Electric charge and strangeness dependent splitting of the rapidity-odd directed flow between quarks and anti-quarks in Au+Au collisions

Monday 8 November 2021 11:08 (17 minutes)

We report the first measurement of the rapidity-odd directed flow (v_1) of multi-strange baryons (Ξ and Ω) in Au+Au collisions as recorded by the STAR detector at the Relativistic Heavy Ion Collider.

We focus on particle species where all constituent quarks are produced, as opposed to possibly transported, and demonstrate using a novel analysis method that the coalescence sum rule holds for hadrons with identical quark content. We examine the coalescence sum rule as a function of rapidity for non-identical quark content having the same mass but different strangeness (ΔS) and electric charge (Δq). The difference in the directed flow of different quark and anti-quark combinations, e.g., $v_1(\Omega^-(sss)) - v_1(\bar{\Omega}^+(\bar{s}\bar{s}\bar{s}))$, is a measure of coalescence sum rule violation, and we call it directed flow splitting (Δv_1) between quarks and anti-quarks. This measurement uses the latest high statistics data sample from $\sqrt{s_{NN}} = 27$ GeV Au+Au collisions where we take advantage of the improved event plane resolution of recently installed Event-Plane Detector (EPD). We measure v_1 as a function of rapidity; and then ΔS and Δq dependence of the Δv_1-slope ($d\Delta v_1/dy$) between produced quarks and anti-quarks in Au+Au collisions at $\sqrt{s_{NN}} = 27$ GeV and 200 GeV. The $d\Delta v_1/dy$ increases when ΔS and Δq increase. This $d\Delta v_1/dy$ signal becomes weaker going from collision energy $\sqrt{s_{NN}} = 27$ GeV to 200 GeV. We compare our measurements with the Parton-Hadron String Dynamics (PHSD) model + EM-field calculations.

Author: SHEIKH, Ashik Ikbal (Kent State University)

Presenter: SHEIKH, Ashik Ikbal (Kent State University)

Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

Contribution ID: **87** Type: **not specified**

Renormalization of equation of state by hydrodynamic fluctuations within dynamical model

Saturday 6 November 2021 16:17 (17 minutes)

Event-by-event fluctuations measured in the heavy-ion observables such as the flow coefficients and their correlations play an important role in extracting the matter properties. While the major origin of the observed flows are the initial fluctuations, other sources of the fluctuations become also important in smaller systems and in the quantitative determination of the matter properties.

Recently, hydrodynamic fluctuations are one of the hot topics as one of the sources of the event-by-event fluctuations. Hydrodynamic fluctuations are the thermal fluctuations of hydrodynamic description and are introduced as random noise fields in hydrodynamic equations, and such a framework is called fluctuating hydrodynamics. In dynamical models, hydrodynamic fluctuations are shown to have a considerable effect on observables, particularly for the longitudinal dynamics [1-3]. However, one issue of the fluctuating hydrodynamic model is that *the hydrodynamic fluctuations shift the bulk properties of the background matter through the non-linear interactions of the fluctuations* 1. The *bare* equation of state and transport coefficients appearing in the dynamical equations need to be *renormalized* as functions of the cutoff parameter of the hydrodynamic fluctuations so that the overall bulk properties (i.e., long-range behavior) of the matter become cutoff independent.

In this talk, we focus on the renormalization of the equation of state within the dynamical models. We first discuss the general properties of the renormalization of the equation of state and argue that the renormalization becomes important near the crossover or phase-transition temperature. We next reconstruct the bare equation of state from the lattice EoS based on the existing analytical results [4,5]. Such reconstruction is not unique in general, so we obtain the results assuming the existence of a single equation of state which is independent of the background. We examine the obtained equation of state in the dynamical code by calculating static equilibrium and find that the analytical results based on perturbation break down when the cutoff becomes shorter (i.e., higher in momentum space) and the fluctuations become large. We try to numerically improve the bare equation of state using the dynamical code for shorter cutoffs.

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- 2 A. Sakai, K. Murase, and T. Hirano, Nucl.Phys. A **982**, 339 (2019), Phys. Rev. C **102**, 064903 (2020), Nucl. Phys. A **1005**, 121969 (2021).
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- 4 P. Kovtun, G. D. Moore, and P. Romatschke, Phys. Rev. D **84**, 025006 (2011).
- 5 Y. Akamatsu, A. Mazeliauskas, and D. Teany, Phys. Rev. C **95**, 014909 (2017), Phys. Rev. C **97**, 024902 (2018).

Author: Dr MURASE, Koichi (Kyoto University)

Presenter: Dr MURASE, Koichi (Kyoto University)

Session Classification: Contributed Session 2

Track Classification: Track group 1: Theory

Contribution ID: **94** Type: **not specified**

Measurement of global polarization of Λ hyperons in Au+Au √sNN = 7.2 GeV fixed-target collisions at RHIC-STAR experiment

Monday 8 November 2021 10:51 (17 minutes)

Non-central heavy-ion collisions produce a large angular momentum that leads to vorticity of the created system.
Due to the spin-orbit coupling, spin directions of particles are aligned with the orbital angular momentum of the system.
Global polarization of Λ and $\overline{\Lambda}$ hyperons has been measured in Au+Au collisions from $\sqrt{s_{NN}}$ = 7.7 GeV to 200 GeV.[1,2]
The STAR fixed target program provides an opportunity to extend such measurements at even lower energies.
Additionally, Λ global polarization is also influenced by magnetic field at the initial stage. It would be interesting to investigate such a effect towards lower beam energies.
In this talk, measurement of global polarization of Λ hyperons in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.2 GeV with the fixed-target configuration is reported and compared with the results at other collision energies.

1L. Adamczyk et al.(STAR), Nature 548 62 (2017).
2J. Adam et al.(STAR), Phys. Rev. C 98 14910 (2018).

Author: Mr OKUBO (FOR THE STAR COLLABORATION), Kosuke (University of Tsukuba)

Presenter: Mr OKUBO (FOR THE STAR COLLABORATION), Kosuke (University of Tsukuba)

Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

Contribution ID: **96** Type: **not specified**

Covariant Spin Statistical Mechanics with Torsion and Its Applications on Spin Hydrodynamics and Chiral Transports

Saturday 6 November 2021 14:55 (17 minutes)

We derive semiclassical spin statistical mechanics in Riemann geometry with an external torsion field and use it to investigate spin hydrodynamics and chiral effects. We derive spin hydrodynamics with torsion at the first order of gradients in local equilibrium state. We show torsion plays a similar role as vorticity in spin hydrodynamics and induces spin polarization in equilibrium state. In the presence of the chiral electromagnetic and Nieh-Yan anomalies, we derive the chiral magnetic, vortical and torsional effects from the anomalous thermal potential current. We prove the chiral torsional effect is definitely the result of Nieh-Yan anomaly and discuss the related Chern-Simons-like term to it.

Author: LIU, Yu-Chen (Fudan University)

Co-author: HUANG, Xu-Guang (Fudan University)

Presenter: LIU, Yu-Chen (Fudan University)

Session Classification: Contributed Session 1

Track Classification: Track group 1: Theory

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

DJBUU: A new transport model for RAON experiments

Monday 8 November 2021 11:59 (17 minutes)

Transport theory can extract microscopic information in heavy-ion collisions of low-energy region. Though many transport codes have been emerged in recent years, there is not any codes optimized for Korean HIC acclerator. We initiated a new project so called DJBUU project with easy handling in order to prepare experiments in Rare isotope Accelerator complex for ON-line experiments (RAON). One branch of the transport models, Boltzmann-Uehling-Uhlenbeck (BUU), is based on the kinetic theory with microscopic interactions and quantum properties. As the name of DJBUU suggests, it is based on BUU-type and the interactions are based on the relativistic mean-field approximations. Dynamical evolution of heavy-ion can be simulated by introducing two significant ingredients, collisions and potential. In this talk, I will introduce a newly developed transport model, DJBUU which is optimized for RAON experiments and discuss about the hint of nuclear symmetry energy from transport calculations.

Author: Dr KIM, Myungkuk (UNIST)

Presenter: Dr KIM, Myungkuk (UNIST)

Session Classification: Contributed Session 5

Track Classification: Track group 1: Theory

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

Why chemical freezeout is at the QCD cross over ?

Sunday 7 November 2021 16:51 (17 minutes)

We analyze the chemical equilibration by computing relaxation time of a gas of the SU(3) octet of pseudoscalar mesons at finite temperature and zero baryon chemical potential 1. The amplitudes of all possible reactions in the system have been taken from next-to-leading-order chiral perturbation theory. The amplitudes are further unitarized using inverse amplitude method to calculate the cross-sections. This not only reproduces the correct behavior of cross-sections at low energies but also constrain the cross-sections to not grow indefinitely at large energies. With just 12 input parameters namely the pion decay constant (f_π), three masses (m_π, m_η, m_K) and 8 low energy constants, the amplitudes thus agree with the scattering data and generate resonances up to masses of about 2 GeV. Our results show that the relaxation time is large ($\sim$ 100 fm) near the chiral crossover temperature, $T_{CO} \approx 155$ MeV, and hence the system cannot remain in chemical equilibrium once it enters the chiral symmetry broken phase. The long relaxation time is directly related to the fact that these mesons are pseudo-Goldstone bosons of chiral symmetry breaking. Earlier calculations along this direction [2,3] based on non-unitarized cross-sections obtained a value of relaxation time which is about an order less than our results. Our results have immediate consequences for the chemical freezeout in heavy-ion collisions. It is argued that due to large relaxation time near T_{CO} compared to typical timescale for expansion ($\sim$ 10-20 fm), chemical freezeout has to occur at the chiral crossover temperature.

References:

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2 J.L. Goity, Phys. Lett. B 319 (1993) 401

3 C. Song and V. Koch, Phys. Rev. C 55, 3026 (1997)

Authors: NAYAK, JAJATI K. (V); GUPTA, Sourendu (TIFR); SINGH, Sushant Kumar

Presenter: NAYAK, JAJATI K. (V)

Session Classification: Contributed session 4

Track Classification: Track group 1: Theory

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

Imaging nuclear modifications on parton distributions with triple-differential dijet cross sections in pA collisions

Sunday 7 November 2021 16:00 (17 minutes)

Dijet production in proton-nucleus (pA) collisions at the LHC provides invaluable information on the underlying parton distributions in nuclei, especially the gluon distributions. Triple-differential dijet cross sections enable a detailed kinematic scan (over momentum fraction x and probing scale Q^2) of the nuclear parton distribution functions (nPDFs), i.e., $f_i^{\rm A}(x, Q^2)$.

In this work, we study several types of triple-differential cross sections for dijet production in proton-proton (pp) and proton-lead (pPb) collisions at the LHC, to next-to-leading order within the framework of perturbative quantum chromodynamics (pQCD). Four sets of nPDF parametrizations, EPPS16, nCTEQ15, TUJU19, and nIMParton16 are employed in the calculations for pPb collisions. For the first time, we show that the observable nuclear modification factor $R_{p\rm Pb}$ of triple-differential cross sections can serve as a nice image of the nuclear modifications on parton distributions, quantified by the ratio $r_i^{\rm A}(x, Q^2) = f_i^{\rm A,proton}(x, Q^2)/f_i^{\rm proton}(x, Q^2)$. Considerable differences among the $R_{p\rm Pb}$ predicted by the four nPDF sets can be observed and well interpreted.

Future measurements of such observables are expected to not only constrain the nPDF parametrizations, but also help confirm various nuclear effects, e.g., shadowing, anti-shadowing, EMC, and Fermi motion at different values of x and their variation with probing scale Q^2.

Authors: SHEN, Shuwan (Central China Normal Univercity); Dr RU, Peng (Central China Normal University / South China Normal University); Prof. ZHANG, Ben-Wei (Central China Normal University)

Presenter: Dr RU, Peng (Central China Normal University / South China Normal University)

Session Classification: Contributed session 4

Track Classification: Track group 1: Theory

Contribution ID: **117** Type: **not specified**

Investigation of the sensitivities of observables for CME search by the STAR experiment using AVFD framework

Saturday 6 November 2021 14:21 (17 minutes)

Yufu Lin (for the STAR collaboration)

The chiral magnetic effect (CME) is a novel transport phenomenon, arising from the interplay between quantum anomalies and strong magnetic fields in chiral systems.
In high-energy nuclear collisions, the CME may survive the expansion of the quark-gluon plasma fireball and be detected in experiments. Over the past two decades, the experimental searches for the CME have aroused extensive interest at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). The main goal of this study is to investigate three pertinent experimental observables: the γ correlator, the R correlator, and the signed balance functions. We use both simple Monte Carlo simulations and a realistic event generator (EBE-AVFD) to verify the equivalence in the core components among these observables and to ascertain their sensitivities to the CME signal and the background contributions in the context of the isobar collisions at RHIC1

1S. Choudhury, {\it et al.} arXiv:2105.06044 [nucl-ex]/

Author: Dr LIN, Yufu (Guangxi Normal University,)

Presenter: Dr LIN, Yufu (Guangxi Normal University,)

Session Classification: Contributed Session 1

Track Classification: Track group 2: Experiment

Contribution ID: **121** Type: **not specified**

MIS*: towards describing jet-medium response in the extended hydrodynamic regime

Sunday 7 November 2021 15:12 (17 minutes)

In the context of exploring the properties of QGP through jet-medium interaction, we consider the response of the near-equilibrium QCD-like theories to inhomogeneous energy/momentum disturbance. For both N=4 super-Yang Mills theory in strong coupling limit and kinetic equation under relaxation time approximation (RTA), we find that hydrodynamic modes continue dominating medium's response even in the region where Knudsen number is not small. However, in this extended hydrodynamic regime, neither the first-order nor second-order hydrodynamic equations describe the dispersion of hydrodynamic modes. We propose a simple yet not trivial extension of the Muller-Israel-Stewart theory, namely MIS. *We show that MIS* can quantitatively describe hydrodynamic modes in both hydrodynamic and extended hydrodynamic regimes with a suitable choice of model parameters for representative microscopic theories with and without quasi-particle descriptions. As an illustration, we apply MIS* to study how a Bjorken-expanding QGP responds to a moving energetic parton.

Authors: KE, Weiyao; YIN, Yi

Presenter: KE, Weiyao

Session Classification: Contributed Session 3

Track Classification: Track group 1: Theory

Contribution ID: **123** Type: **not specified**

Berry phase and color superconductivity with topology

Sunday 7 November 2021 17:42 (17 minutes)

We uncover novel topological properties of the color superconductivity phases of one-flavor QCD 1. We show the topological number associated with Berry monopole of chiral fermions will be "inherited"by the Copper pair composed by the quarks with opposite chirality in a non-trivial way. Our results generalize Li and Haldane's argument for superconducting Weyl semi-metals with topology 2 and account for new features induced by the color structure of QCD. We discuss the relevance of our findings to the topological phase diagram of QCD.

1 N. Sogabe and Yi Yin, in preparation.
2 Yi Li and F. D. M. Haldane, "Topological nodal Cooper pairing in doped Weyl metals,"Phys. Rev. Lett. 120, 067003 (2018).

Authors: SOGABE, Noriyuki (Keio University); YIN, Yi

Presenter: YIN, Yi

Session Classification: Contributed session 4

Track Classification: Track group 1: Theory

Contribution ID: **124** Type: **not specified**

Vacuum birefringence and dichroism in strong magnetic fields

Saturday 6 November 2021 14:38 (17 minutes)

I discuss effects of strong magnetic fields on the photon propagation in vacuum. I elaborate on the mechanism that leads to the vacuum birefringence and the vacuum dichroism, putting an emphasis on the fermion spectrum in magnetic fields and showing explicit diagrammatic computation. I also mention potential experimental feasibility with the strong magnetic field induced by the ultraperipheral heavy-ion collisions.

Author: HATTORI, Koichi (Yukawa Institute for Theoretical Physics)

Presenter: HATTORI, Koichi (Yukawa Institute for Theoretical Physics)

Session Classification: Contributed Session 1

Track Classification: Track group 1: Theory

Contribution ID: **126** Type: **not specified**

Review of quarkonia measurements in CMS

Sunday 7 November 2021 14:38 (17 minutes)

Quarkonia is a very useful tool to study the properties of the hot, dense matter, quark-gluon-plasma (QGP) in various collision systems. In this talk, we will review the recent results of the elliptic flow parameter (v2) of Upsilon(1S) and Upsilon(2S) mesons in PbPb collisions. Also, we present the cross-sections and nuclear modification factors of Psi(2S) and bottomonia in pPb collisions to investigate the medium effects in small collision systems. Additionally, we report the study of the fragmentation of jets containing the J/Psi meson in PbPb and pp collisions which provide information to understand the dynamics of charmonia in the QGP medium.

Author: LEE, Soohwan (Korea University (KR))

Presenter: LEE, Soohwan (Korea University (KR))

Session Classification: Contributed Session 3

Track Classification: Track group 2: Experiment

Contribution ID: **128** Type: **not specified**

QCD phase structure in strong magnetic fields

Saturday 6 November 2021 13:47 (17 minutes)

We have performed (2+1)-flavor QCD lattice simulations using the Highly Improved Staggered Quarks (HISQ) action on $N_\sigma = 32$ and $N_\tau = 96$ lattices. In our lattice simulations the strange quark mass is fixed to its physical quark mass $m_s^{\rm phy}$ and light quark mass is set to $m_s^{\rm phy}/10$ which corresponds to $M_\pi \approx 220$ MeV at zero temperature. We have studied the masses and magnetic polarizabilities of light and strange pseudo-scalar mesons, chiral condensates, decay constants of neutral pion and neutral kaon in the presence of background magnetic fields with eB ranging up to around 3.35 GeV^2 ($\sim 70\ M_\pi^2$) in the vacuum. We find that the masses of neutral pseudo-scalar mesons monotonously decrease and then saturate at a nonzero value as the magnetic field strength grows, while there exists a non-monotonous behavior of charged pion and kaon masses as magnetic field grows. We observe a qB scaling of the up and down quark flavor components of neutral pion mass, neutral pion decay constant as well as the quark chiral condensates in the magnetic field strength window (0.05GeV^2, 3.35 GeV^2). We show that the correction to the Gell-Mann-Oakes-Renner relation involving neutral pion is less than 6\%, and the correction for the relation involving neutral kaon is less than 30\% as eB up to 3.35 GeV^2. The validity of 2-flavor GMOR suggests that neutral pion is still the Goldstone boson, the mass reduction of neutral pion explains the reduction of the critical temperature of chiral symmetry breaking. And we further find that the reconciliation of magnetic catalysis and reduction of pion mass intrinsically lies in the Ward identity. This talk is based on Phys.Rev.D 104 (2021) 1, 014505.

Authors: TOMIYA, Akio (RIKEN BNL Research Center); DING, Heng-Tong (Central China Normal University); Dr LI, Shengtai; WANG, Xiao-Dan (Central China Normal University); ZHANG, Yu

Presenter: Dr LI, Shengtai

Session Classification: Contributed Session 1

Track Classification: Track group 1: Theory

Contribution ID: **130** Type: **not specified**

Thermal photons as a sensitive probe of α-cluster in C+Au collisions at the BNL Relativistic Heavy Ion Collider

Tuesday 9 November 2021 11:25 (17 minutes)

Different orientations of collisions of α-clustered carbon with a heavy ion can produce significantly large initial-state anisotropies due to the intrinsic geometry effects of the carbon. We expect that such large initial-state anisotropies have a profound impact on the photon flow observables. We calculate the transverse momentum spectra and anisotropic flow coefficients of thermal photons from collisions of triangular α-clustered carbon and gold at $\sqrt{s_{\rm NN}} = 200$ GeV at RHIC using a hydrodynamic model framework and compare the results with those obtained from unclustered carbon and gold collisions 1. The slope of the thermal photon spectra is found to vary moderately for different orientations of collisions. We find that the elliptic (v_2) and triangular flow (v_3) coefficients of direct photons for specific configurations are significantly larger and predominantly formed by the QGP radiation. A strong anti-correlation between initial spatial ellipticity and triangularity is observed in an event-by-event framework of α-clustered $\mathrm{C} + \mathrm{Au}$ collisions. Based on this behaviour, we find that the thermal photon v_3 for the most-central collisions in an event-by-event calculation is significantly larger for the clustered case than the case with the unclustered carbon 2.

References:
1. "Thermal photons as a sensitive probe of α-cluster in C+Au collisions at the BNL Relativistic Heavy Ion Collider", Pingal Dasgupta, Guo-Liang Ma, Rupa Chatterjee, Li Yan, Song Zhang, and Yu-Gang Ma, Eur. Phys. J. A 57 (4) 134 (2021).
2. In preparation.

Authors: Dr DASGUPTA, Pingal (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University,China); Prof. MA, Guo-Liang (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University)

Co-authors: Prof. CHATTERJEE, Rupa (Variable Energy Cyclotron Centre, India); Prof. YAN, Li (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University, China); Prof. ZHANG, Song (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University, China); Prof. MA, Yu-Gang (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University, China)

Presenter: Dr DASGUPTA, Pingal (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University,China)

Session Classification: Contributed Session 6

Track Classification: Track group 1: Theory

Contribution ID: **138** Type: **not specified**

New opportunities for nuclear shape imaging in high-energy heavy-ion collisions

Monday 8 November 2021 10:00 (17 minutes)

High-energy heavy-ion collisions, a branch of nuclear physics that focus on study of quark-gluon plama (QGP) and nuclear phase diagram, have always assumed an initial condition from the nuclear structure physics, e.g. the Woods-Saxon geometry. Recent progress in hydrodynamic modeling together with the wealth of precision collective flow data, especially from the Isobar collisions, however, allow us to not only perform quantitative extractions of the transport properties of the QGP, but very importantly start to strongly constrain the initial state of the colliding nuclei. In this talk, I will discuss the exciting possibility of imaging the shape of atomic nuclei using precision flow measurements, including the quadruple, triaxial and octupole deformations. I will discuss how the shape information probed by heavy ion collision might be different or complementary to those obtained in the nuclear structure experiments. I will argue how a carefully planned system scan of stable species in the nuclear chart in high-energy nuclear collisions may lead to new direction of research in nuclear physics.

Author: JIA, Jiangyong (Stony Brook University (US))

Presenter: JIA, Jiangyong (Stony Brook University (US))

Session Classification: Contributed Session 5

Track Classification: Track group 2: Experiment

Contribution ID: **139** Type: **not specified**

Prospective physics study at EIC

Tuesday 9 November 2021 14:00 (25 minutes)

Author: Dr GOTO, Yuji (RIKEN)

Presenter: Dr GOTO, Yuji (RIKEN)

Session Classification: Invited Session 6

Contribution ID: **140** Type: **not specified**

Future facilities and experiments: RISP at RAON

Tuesday 9 November 2021 14:50 (25 minutes)

Author: Dr SHIN, Taeksu (RISP)

Presenter: Dr SHIN, Taeksu (RISP)

Session Classification: Invited Session 6

Contribution ID: **141** Type: **not specified**

Future measurements from ALICE Run 3 and Run 4

Tuesday 9 November 2021 14:25 (25 minutes)

Presenter: GUNJI, Taku (University of Tokyo (JP))

Session Classification: Invited Session 6

Contribution ID: **142** Type: **not specified**

The FAIR project, status and prospects

Tuesday 9 November 2021 15:15 (25 minutes)

Author: GIUBELLINO, Paolo (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Presenter: GIUBELLINO, Paolo (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

Session Classification: Invited Session 6

Contribution ID: **145** Type: **not specified**

Higher moments of conserved charges

Author: Prof. NONAKA, Toshihiro (Tsukuba U.)

Presenter: Prof. NONAKA, Toshihiro (Tsukuba U.)

Session Classification: Contributed Session 1

Contribution ID: **146** Type: **not specified**

Studying the QCD phase structure through higher-order cumulants

Saturday 6 November 2021 10:50 (25 minutes)

Presenter: TOSHIHIRO NONAKA (Tsukuba U)

Session Classification: Invited Session 3

Contribution ID: **147** Type: **not specified**

Flavored hadron correlations and interactions from heavy ion collisions

Monday 8 November 2021 14:50 (25 minutes)

Presenter: AKIRA OHNISHI (Kyoto U.)

Session Classification: Invited Session 5

Contribution ID: **148** Type: **not specified**

Hadron correlations from Heavy Ion Collision

Author: Prof. OHNISHI, Akira (Kyoto U.)

Presenter: Prof. OHNISHI, Akira (Kyoto U.)

Session Classification: Contributed Session 1

Contribution ID: **149** Type: **not specified**

Recent measurements of hadron interactions from the Heavy-Ion Collision Experiments

Monday 8 November 2021 15:15 (25 minutes)

Presenter: NEHA SHAH (IIT Patna)

Session Classification: Invited Session 5

Contribution ID: **150** Type: **not specified**

Dynamics of quarkonium as an open quantum system

Sunday 7 November 2021 10:50 (25 minutes)

Presenter: AKAMATSU, Yukinao (Osaka U)

Session Classification: Invited Session 4

Contribution ID: **151** Type: **not specified**

Traces of nonequilibrium effects in the charm observables & quarkonia

Friday 5 November 2021 15:15 (25 minutes)

Presenter: SONG, Taesoo (GSI)

Session Classification: Invited Session 2

Contribution ID: **152** Type: **not specified**

Relativistic magnetohydrodynamics in heavy-ion collisions

Friday 5 November 2021 14:00 (25 minutes)

Presenter: Prof. ROY, Victor (HBNI)

Session Classification: Invited Session 2

Contribution ID: **153** Type: **not specified**

Collectivity in high energy heavy-ion collisions

Friday 5 November 2021 14:50 (25 minutes)

Author: Dr NASIM, Md. (IISER)

Presenter: Dr NASIM, Md. (IISER)

Session Classification: Invited Session 2

Contribution ID: **154** Type: **not specified**

Heavy flavor production in heavy-ion collisions

Sunday 7 November 2021 11:40 (25 minutes)

Presenter: ZHANG, Yi-Fei (USTC)

Session Classification: Invited Session 4

Contribution ID: **155** Type: **not specified**

Hydrodynamics: the best data machine of heavy-ion collisions

Friday 5 November 2021 14:25 (25 minutes)

Presenter: Prof. PANG, Long-Gang (CCNU)

Session Classification: Invited Session 2

Contribution ID: **156** Type: **not specified**

Quarkonia in heavy-ion collisions at RHIC and LHC

Sunday 7 November 2021 11:15 (25 minutes)

Presenter: PARK, Jaebeom (Korea U.)

Session Classification: Invited Session 4

Contribution ID: **157** Type: **not specified**

System size and energy dependence of resonance production

Friday 5 November 2021 11:40 (25 minutes)

Presenter: SONG, Jihye (Houston U.)

Session Classification: Welcome & Invited Session 1

Contribution ID: **158** Type: **not specified**

Welcome from the President of Inha University

Friday 5 November 2021 09:50 (5 minutes)

Presenter: Prof. CHO, Myeong Woo (Inha University)

Session Classification: Welcome & Invited Session 1

Contribution ID: **159** Type: **not specified**

Welcome from the Organizer

Friday 5 November 2021 09:55 (5 minutes)

Presenter: Prof. YOON, Jin-Hee (Inha University)

Session Classification: Welcome & Invited Session 1

Contribution ID: **160** Type: **not specified**

From Lattice to observables

Friday 5 November 2021 10:50 (25 minutes)

Presenter: KITAZAWA, Masakiyo (Osaka U.)

Session Classification: Welcome & Invited Session 1

Contribution ID: **161** Type: **not specified**

Jet and heavy-flavor physics in heavy-ion collisions

Sunday 7 November 2021 10:00 (25 minutes)

Author: Prof. CAO, Shanshan (Wayne State University)

Presenter: Prof. CAO, Shanshan (Wayne State University)

Session Classification: Invited Session 4

Contribution ID: **162** Type: **not specified**

Jet-induced medium response in heavy-ion collisions

Friday 5 November 2021 15:40 (25 minutes)

Author: LUO, Tan (Santiago de Compostela U.)

Presenter: LUO, Tan (Santiago de Compostela U.)

Session Classification: Invited Session 2

Contribution ID: **163** Type: **not specified**

Sound velocity in neutron stars: a new quality of dense matter

Friday 5 November 2021 10:25 (25 minutes)

Presenter: KOJO , Toru (CCNU)

Session Classification: Welcome & Invited Session 1

Contribution ID: **164** Type: **not specified**

Experimental results of jet physics in heavy-ion collisions

Sunday 7 November 2021 10:25 (25 minutes)

Author: Dr OH, Saehanseul (LBNL)

Presenter: Dr OH, Saehanseul (LBNL)

Session Classification: Invited Session 4

Contribution ID: **165** Type: **not specified**

Hyper-Nuclei Production in high-energy nuclear collisions

Friday 5 November 2021 11:15 (25 minutes)

Presenter: LEUNG, Yue-Hang (LBNL)

Session Classification: Welcome & Invited Session 1

Contribution ID: **166** Type: **not specified**

Charged particle yield evolution in particle multiplicity in pp, pPb and PbPb

Friday 5 November 2021 10:00 (25 minutes)

Author: Prof. KIM, Beomkyu (SKKU)

Presenter: Prof. KIM, Beomkyu (SKKU)

Session Classification: Welcome & Invited Session 1

Contribution ID: **167** Type: **not specified**

Collectivity in small collision systems

Saturday 6 November 2021 11:40 (25 minutes)

Presenter: LIM, Sanghoon (Pusan National University (KR))

Session Classification: Invited Session 3

Contribution ID: **168** Type: **not specified**

Dynamical modeling of high-energy nuclear collisions

Saturday 6 November 2021 11:15 (25 minutes)

Presenter: SHEN , Chun (Wayne State/RBRC.)

Session Classification: Invited Session 3

Contribution ID: **169** Type: **not specified**

CME: What is the next step after the isobar result?

Saturday 6 November 2021 10:00 (25 minutes)

Presenter: LIAO, Jinfeng (Indiana U.)

Session Classification: Invited Session 3

Contribution ID: **170** Type: **not specified**

Search for CME with STAR experiment

Saturday 6 November 2021 10:25 (25 minutes)

Presenter: WANG, Fuqiang (Purdue U.)

Session Classification: Invited Session 3

Contribution ID: **171** Type: **not specified**

Photo-production in heavy-ion collisions

Monday 8 November 2021 14:25 (25 minutes)

Presenter: KIM, Yongsun (Sejong University (KR))

Session Classification: Invited Session 5

Contribution ID: **172** Type: **not specified**

The Electromagnetic probes from coherent photon induced reactions in heavy-ion collisions

Monday 8 November 2021 14:00 (25 minutes)

Presenter: ZHA, Wang-Mei (USTC)

Session Classification: Invited Session 5

Contribution ID: **173** Type: **not specified**

Characterizing the initial conditions of ultra-relativistic heavy-ion collisions at the LHC

Saturday 6 November 2021 17:42 (17 minutes)

The primary goal of the ultrarelativistic heavy-ion collision program at the LHC is to study the quark-gluon plasma (QGP) properties, a state of strongly interacting matter that exists at high temperatures and energy densities. However, the lack of knowledge on the initial conditions of heavy-ion collision results in a significant uncertainty of the extraction of the transport properties of QGP.

In this talk, I will present the latest developments of multi-particle correlations. I will show that the newly proposed mixed harmonic correlation of various moments of anisotropic flow coefficients can provide strong constraints on the correlations between various moments of eccentricity coefficients in the initial conditions. Both hydrodynamic model predictions and ALICE measurements will be discussed. In addition, I will discuss the newly proposed correlation between mean transverse momentum and anisotropic flow coefficients, which could reflect the size and shape of the initial state and give direct access to the initial conditions. I will present the newest experimental measurements from both RHIC and the LHC experiments, as well as several recent theoretical model predictions. I will further show that the current state-of-the-art understanding of the initial conditions and the QGP properties relies on the Bayesian analyses, which are all based on the TRENTo initial state model and fail completely in describing the experimental data. These new studies pave a novel way to characterize the initial state in relativistic heavy-ion collisions.

Presenter: ZHOU, You (Niels Bohr Institute (DK))

Session Classification: Contributed Session 2

Contribution ID: **174** Type: **not specified**

□1/□* enhancement as a signature of chiral symmetry restoration in heavy ion collisions

Sunday 7 November 2021 17:08 (17 minutes)

Based on the fact that the mass difference between the chiral partners is an order parameter of chiral phase transition and that the chiral order parameter reduces substantially at the chemical freeze-out point in ultra-relativistic heavy ion collisions, we argue that the production ratio of □1 over □* in such collisions should be substantially larger than that predicted in the statistical hadronization model. We further show that while the enhancement effect might be contaminated by the relatively larger decrease of □1 meson than □* meson during the hadronic phase, the signal will be visible through a systematic study on centrality as the kinetic freeze-out temperature is higher and the hadronic life time shorter in peripheral collisions than in central collisions.

Presenter: SUNG, Haesom (Yonsei University)

Session Classification: Contributed session 4

Contribution ID: **175** Type: **not specified**

ATHIC 2021 Closing

Tuesday 9 November 2021 16:00 (10 minutes)

Presenters: KWEON, Min Jung (Inha University (KR)); KWEON, Min Jung (Inha University (KR))

Session Classification: Invited Session 6

Contribution ID: **176** Type: **not specified**

ATHIC 2023 Presentation

Tuesday 9 November 2021 15:40 (20 minutes)

Presenter: SHIGAKI, Kenta (Hiroshima University (JP))

Session Classification: Invited Session 6