Strangeness in Quark Matter 2022 (SQM 2022)

Report of Contributions

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Public Lecture

*Wednesday, 15 June 2022 19:30 (2 hours)*

*Lecture will be served in KOREAN language only, without official interpretation/translation service to other language (English etc.).*

Title: Us, in Universe, From Big-bang to Present
Time: 19h30-21h30 (2hrs.), 15 June 2022
Venue: 2F Grand ballroom, Paradise Hotel Busan
(296, Haeundae-hoeun-ro, Haeundae-gu, Busan, Republic of Korea)

Lecturer:
- Prof. Dr. In-Kwon Yoo (Dept. of Physics, Pusan National University)
- Prof. Dr. Chang-Hwan Lee (Dept. of Physics, Pusan National University)

Chair: Jinhee Yoon (Dept. of Physics, Pusan National University)

Organized by SQM2022 Local Organizing Committee and Secretariat

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[https://indico.kps.or.kr/e/sqm2022-public](https://indico.kps.or.kr/e/sqm2022-public)

Present via

Offline

**Presenters:** LEE, Chang-Hwan (Pusan National University); YOO, In Kwon (Pusan National University (KR))
Asymmetric longitudinal flow decorrelations in proton-nucleus collisions

We perform the first study on asymmetric longitudinal decorrelations of elliptic, triangular and quadrangular flows in proton-nucleus collisions at the LHC and RHIC energies. To measure the longitudinal flow decorrelations for asymmetric collision systems, we propose a new set of rapidity-asymmetric flow decorrelation functions. Our event-by-event hydrodynamic calculations show that the flow decorrelations in proton-going direction are larger than those in nucleus-going direction. We also find that proton-nucleus collisions at RHIC have larger longitudinal flow decorrelation effects than those at the LHC. Our study opens a new window to probe the longitudinal properties and the origin of flows in relativistic nuclear collisions.

Present via
Online

Primary authors: QIN, Guang-You (Central China Normal University); WU, Xiang-Yu
Presenter: QIN, Guang-You (Central China Normal University)
Session Classification: Poster
Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Effect of variation in relaxation time on elliptic flow in PbPb and AuAu collisions

Tuesday, 14 June 2022 17:11 (1 minute)

Hydrodynamics has been quite successful in explaining observables of heavy ion collisions especially in low transverse momentum regime across varied collision systems. Recently hydrodynamics has also been used satisfactorily to explain proton-proton collision. This has been puzzling and has led to the discussion about the smallest volume for which hydrodynamics can be applied. The meaning of hydrodynamics itself has been under scrutiny with non-requirement of local equilibrium or pressure isotropy for its applicability. The second order viscous hydrodynamics, requires a transport coefficient called relaxation time, to maintain casualty. This relaxation time acts as a regulator for non-hydro modes of the complete hydrodynamic evolution. In phenomenological studies this relaxation time has been taken as to be a constant and much attention has gone into fixing shear viscosity to entropy density ratio. But this regulator also serves as a tool to gauge the role of non-hydro modes especially in peripheral heavy ion collisions and small systems. In the present study, we analyze the effect of different relaxation times on elliptic flow of light mesons, for PbPb and AuAu collision systems with optical Glauber and IPGlasma initial conditions of hydrodynamics. We hence study sensitivity of non-hydro modes by varying relaxation time for different systems of collisions and energies.

Present via

Online

Primary authors: MISHRA, Madhukar; HATWAR, Nikhil

Presenter: HATWAR, Nikhil

Session Classification: Poster

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
The quark number scaling of strange quark and light quarks as well as the approach to solving the $R_{AA} - v_2$ puzzle in heavy-ion collisions

Tuesday, 14 June 2022 09:00 (20 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 $v_2$ and elliptic flow $v_2$, especially in the intermediate region of $2 < \langle p_T \rangle < 10 \text{ GeV}/c$. In this talk, we combine hydrodynamics, quark coalescence and jet quenching as well as the hadron cascade, and study their effects on hadron spectra and flow. We find the key to solving the $v_2$ 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 $v_2$ along with their flavor dependence and hadron chemistry (proton-to-pion and kaon-to-pion ratios) from low to intermediate and high $p_T$ in heavy-ion collisions at both RHIC and LHC energies. Our prediction is an example of high-precision tests of the quark coalescence model in nuclear collisions.

Then I will talk about the quark number scaling of strange quark and light quarks in RHIC and LHC within the Cooper-Frye, quark coalescence and string fragmentation framework. We can simultaneously describe the different quark number scaling behaviors of strange quark and light quarks at RHIC and LHC. We expound that such different NCQ scaling behaviors at these two energies is associated with the different relative weights of quark coalescence and string fragmentation contributions at intermediate $p_T$ range and the strangeness enhancement in the bulk medium. This results can also be used to quantitatively test the quark coalescence model in the future.

[1] Wenbin Zhao, Weiyao Ke, Wei Chen, Tan Luo and Xin-Nian Wang, Phys. Rev. Lett. 128 (2022) no.2, 022302.

[2] Wenbin Zhao, Weiyao Ke, Wei Chen, Tan Luo and Xin-Nian Wang, in preparation.

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

Present via
Online

Primary authors: ZHAO, Wenbin (Wayne State University); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: ZHAO, Wenbin (Wayne State University)

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Signatures of the spin Hall effect in hot and dense QCD matter

Tuesday, 14 June 2022 17:52 (1 minute)

The spin Hall effect (SHE) is a generation of spin polarization for moving spin carriers in materials under an external electric field and has been observed in semiconductors, metals, and insulators at or below room temperature. Recent theoretical analyses show that spin Hall current can be induced by the baryon chemical potential gradient which plays the role of the analogous electric field and which becomes sizable in the fireballs created in heavy-ion collisions at beam energy of $O(10)$ GeV. In this talk, we focus on this important mechanism and predict the signature of the SHE using a (3+1) D viscous hydrodynamic model MUSIC with AMPT initial condition. We propose to use the second Fourier coefficients of the net spin polarization of Lambda hyperon as sensitive probes to search for the SHE. Those SHE observables show a qualitative difference in both the sign and beam energy dependence for the situations with and without the SHE. Future experimental observation of these distinct qualitative features would provide strong evidence for the existence of the SHE in the hot and dense QCD matter at trillions of degrees.

Present via

Online

Primary authors: FU, Baochi; SONG, Huichao; PANG, LongGang (Central China Normal University); YIN, Yi (Institute of modern physics, Chinese Academy of Sciencesst)

Presenter: FU, Baochi

Session Classification: Poster

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Development of future electromagnetic calorimeter technologies and applications for the Electron-Ion Collider with GEANT4 simulations

Tuesday, 14 June 2022 16:10 (20 minutes)

The Electron-Ion Collider is a future collider planned to be built at BNL in about 2030. It will provide physicists with high luminosity and highly polarized beams of electrons, protons, and ions with a wide range of nuclei species at different collision energies, covering an extensive kinematic range. The EIC physical goals include measuring the generalized parton distribution from Deeply Virtual Compton Scattering (DVCS) and Deeply Virtual Meson Production (DVMP) experiments, performing precision 3D imaging of the nuclei structure, studying color confinement and hadronization mechanisms, and understanding the spin structure of the proton. In order for the EIC to achieve its physics goals, a high-resolution electromagnetic calorimeter (EMCAL) is required to measure electrons and photons and to achieve good particle identification. We propose two design options for EIC EMCALs. The first technique is to improve the resolution tungsten/scintillating fiber (W/SciFi) EMCAL being built for sPHENIX with new technologies. The other possibility is to develop tungsten/shashlik (W/shashlik) EMCAL with a highly segmented readout configuration to achieve better energy and position resolution. In this work, we carry out our studies on EIC EMCAL designs using GEANT 4 simulations. We will first present the general performance of the sPHENIX W/SciFi and shashlik EMCALs. In addition, we study fully reconstructed $\pi^0 \rightarrow \gamma\gamma$ from EIC endcap EMCALs in the hadron-going direction. The $\pi^0$ merging probability a function of $\pi^0$ energy with different EMCAL tower designs and light collection efficiency maps of the shashlik towers modeled by TracePro software will be reported. We will also present various designs, general performance, and $\pi^0 \rightarrow \gamma\gamma$ merging probability simulation studies for the forward EMCAL in ECCE, which has been approved by the United States Department of Energy and National Academy of Science to be the detector 1 for the EIC.

Present via
Online

Primary author: SHI, Zhaozhong (Los Alamos National Laboratory)
Co-authors: WOODY, Craig (Brookhaven National Laboratory (US)); LAJOIE, John; Mr DELK, Ian (Iowa State University)
Presenter: SHI, Zhaozhong (Los Alamos National Laboratory)
Session Classification: PA-Detector upgrades and Future experiments
Track Classification: Detector upgrades and Future experiments
Light (anti-)cluster production from nonlocal many-body scatterings in high-energy nuclear collisions

Tuesday, 14 June 2022 09:00 (20 minutes)

Understanding light (anti-)nuclei production mechanism is a long-standing challenge in heavy-ion physics. Besides its own importance, it can benefit the search of QCD critical point as well as the detection of dark matter in space. In this presentation, we present a unified description of the microscopic dynamics of light (anti-)nuclei production in high-energy nuclear collisions by solving the relativistic kinetic equations with their nonlocal collision integrals treated with a stochastic method. The stochastic method is benchmarked in a box calculation, in which the thermal limits are correctly reproduced. Besides, our kinetic approach describes well the production of light clusters in both pp and heavy-ion collisions. The application of using light nuclei production to probe QCD critical point is further discussed.

Present via
Online

Primary authors: KO, Che-Ming; Dr SUN, KaiJia (Cyclotron Institute); SHEN, Chun (Wayne State University); MA, Yugang (Fudan University (CN)); Dr WANG, rui (Key Laboratory of Nuclear Physics and Ion-beam Application (MOE);Institute of Modern Physics, Fudan University, Shanghai 200433, China)

Presenter: Dr SUN, KaiJia (Cyclotron Institute)

Session Classification: PA-Resonances and Hyper-nuclei

Track Classification: Resonances and Hyper-nuclei
Energy dependence of $N_t N_p / N_d^2$ in the vicinity of a first-order chiral phase transition

Tuesday, 14 June 2022 17:53 (1 minute)

Light (anti-)nuclei produced in relativistic heavy-ion collisions, due to their composite structures, naturally encode the many-nucleon correlations. The light nuclei production is thus sensitive to the density fluctuation/correlation developed during the non-smooth phase transition from QGP to hadronic matter in relativistic heavy-ion collisions providing a unique tool to probe the conjectured QCD critical point in the Beam Energy Scan program. In this talk, we present the most recent results of energy dependence of $N_t N_p / N_d^2$ in the vicinity of a first-order chiral phase transition. The dynamics of chiral phase transition is modelled within a Lagrangian-based transport model approach.

Primary authors: KO, Che-Ming; Dr SUN, KaiJia (Cyclotron Institute)
Presenter: Dr SUN, KaiJia (Cyclotron Institute)
Session Classification: Poster
Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Collectivity and baryon junctions in ultra-peripheral heavy-ion collisions

Tuesday, 14 June 2022 10:50 (20 minutes)

Intriguing experimental results on two-particle azimuthal correlations in ultra-peripheral Pb+Pb collisions (UPCs) have been measured at the Large Hadron Collider (LHC) [1]. In this talk, I will present the first full (3+1)D dynamical simulations to study collective behavior in UPC events at RHIC and the LHC with the 3DGlauber+MUSIC+UrQMD framework [2, 3]. First, extrapolating from asymmetric p+Pb collisions, we explore whether a quasi-real photon $\gamma^*$ interacting with the lead nucleus in an ultra-peripheral collision can create a many-body system exhibiting fluid behavior. Assuming the strong final-state interactions, we provide model results for charged hadron multiplicity, identified particle mean transverse momenta, and charged hadron anisotropic flow coefficients and compare them with experimental data from the ALICE and ATLAS Collaborations. The elliptic flow hierarchy between p+Pb and $\gamma^*$+Pb collisions is dominated by the difference in longitudinal flow decorrelations and reproduces the experimental data well. Second, the net proton rapidity distributions in UPC events can provide crucial information about early-time baryon stopping dynamics because the projectile $\gamma^*$ does not carry baryon charges. I will show theoretical predictions for the net-proton rapidity distributions in UPC events at RHIC and LHC, which have potential discriminate power for the baryon junction model [4]. Our theoretical framework provides a quantitative tool to study particle production and collectivity for all system sizes, ranging from central heavy-ion collisions to small asymmetric collision systems at RHIC and LHC and even at the future Electron-Ion Collider.

[1] ATLAS Collaboration, Phys. Rev. C 104, 014903 (2021).
[2] Chun Shen and Björn Schenke, Phys. Rev. C 97, 024907 (2018).
[3] Wenbin Zhao, Chun Shen and Björn Schenke, [arXiv: 2203.06094].
[4] D. Kharzeev, Phys. Lett. B 378, (1996), 238-246.

Present via

Online

Primary authors: SCHENKE, Bjoern (Brookhaven National Lab); SHEN, Chun (Wayne State University); ZHAO, Wenbin (Wayne State University)

Presenter: SHEN, Chun (Wayne State University)

Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Multistrange hyperon production on nuclear targets

Tuesday, 14 June 2022 17:23 (1 minute)

We consider the experimental data on yields of protons, strange Λ’s, and multistrange baryons (Ξ, Ω), and antibaryons production on nuclear targets, and the experimental ratios of multistrange to strange antibaryon production, at the energy region from SPS up to LHC, and compare them to the results of the Quark-Gluon String Model calculations. In the case of heavy nucleus collisions, the experimental dependence of the Ξ+/Λ, and, in particular, of the Ω+/Λ ratios, on the centrality of the collision, shows a manifest violation of quark combinatorial rules.

Present via

Online

Primary authors: Prof. ARAKELYAN, Gevorg H. (A.Alikhanyan National Scientific Laboratory (Yerevan Physics Institute)); Mrs CARLOS, Merino (Universidade de Santiago de Compostela); Prof. SHABELSKI, Yuli M. (Petersburg Nuclear Physics Institute NCR Kurchatov Institute)

Presenter: Mrs CARLOS, Merino (Universidade de Santiago de Compostela)

Session Classification: Poster

Track Classification: Light-flavor and Strangeness
Scaling properties of background- and chiral-magnetically-driven charge separation in Au+Au, Ru+Ru, and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV

The Anomalous Viscous Fluid Dynamics model, AVFD, is used in concert with the charge-sensitive correlator $R_{\Psi_2}(\Delta S)$ to study the scaling properties of background- and chiral-magnetically-driven (CME) charge separation ($\Delta S$), characterized by the inverse variance $\sigma_{R_2}^{-2}$ of the $R_{\Psi_2}(\Delta S)$ distribution, in Au+Au, Ru+Ru, and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$-GeV. The $\sigma_{R_2}^{-2}$ values for the background are event-shape-independent but show a characteristic scaling pattern with the charged-particle multiplicity, indicating an essential constraint for discerning background from the signal and a robust estimate of the difference between the backgrounds in Ru+Ru and Zr+Zr collisions. By contrast, the $\sigma_{R_2}^{-2}$ values for signal + background show scaling violations that characterize the CME-driven contributions. I will discuss these scaling patterns and their implication for the detection and characterization of the CME. Corrections to recent $R_{\Psi_2}(\Delta S)$ measurements that account for the background difference in Ru+Ru and Zr+Zr collisions will also be presented and discussed.

Present via

Offline

Primary author: LACEY, Roy
Presenter: LACEY, Roy
Session Classification: PA-Other topics
Track Classification: Other topics
By using gravity/gauge correspondence, we employ an Einstein-Maxwell-Dilaton model to compute the equilibrium and out-of-equilibrium properties of a hot and baryon rich strongly coupled quark-gluon plasma. The family of 5-dimensional holographic black holes, which are constrained to mimic the lattice QCD equation of state at zero density, is used to investigate the temperature and baryon chemical potential dependence of the equation of state [1]. We also obtained the baryon charge transport coefficients, the bulk and shear viscosities as well as the drag force and langevin diffusion coefficients associated with heavy quark jet propagation and the jet quenching parameter of light quarks in the baryon dense plasma, with a particular focus on the behavior of these observables on top of the critical end point and the line of first order phase transition predicted by the model [2].

[1] Grefa, J., Noronha, J., Noronha-Hostler, J., Portillo, I., Ratti, C., Rougemont, R. 10.1103/PhysRevD.104.034002

[2] Grefa, J., Hippert, M., Noronha, J., Noronha-Hostler, J., Portillo, I., Ratti, C., Rougemont, R. arXiv:2203.00139 [nucl-th]
(3+1)-D viscous hydrodynamics CLVisc at finite net baryon density: identified particle spectra, anisotropic flows and flow fluctuations across BES energies

To study the bulk properties of the quark-gluon-plasma (QGP) produced at the beam energy scan (BES) energies at the Relativistic Heavy Ion Collider (RHIC), we extend the (3+1)-dimensional viscous hydrodynamics CLVisc [1,2,3] to include net baryon number conservation and Israel-Stewart-like equation for baryon diffusion with the NEOS-BQS equation of state, fluctuating initial conditions from Monte-Carlo Glauber model, and the afterburner SMASH. This integrated framework is shown to provide a good description of identified particle spectra, mean transverse momenta and anisotropic flows for different centralities and over a wide range of collision energies (7.7-62.4 GeV). It is found that the mean momenta of identified particles and anisotropic flows increases mildly with the collision energy due to larger radial flow. We further compute the multiple-particle cumulant ratio v2(4)/v2(2) of elliptic flow across BES energies, and find that the relative fluctuations of elliptic flow are insensitive to the collision energy, consistent with the preliminary STAR data. Our model provides a benchmark for understanding the RHIC-BES data and studying the critical properties and phase structure of hot and dense QCD matter.

References:
[1] L.-G. Pang, H. Petersen, and X.-N. Wang, Phys. Rev. C97, 064918 (2018), arXiv:1802.04449
[2] L. Pang, Q. Wang, and X.-N. Wang, Phys. Rev. C86, 024911 (2012), arXiv:1205.5019.
[3] X.-Y. Wu, G.-Y. Qin, L.-G. Pang, and X.-N. Wang,(2021), arXiv:2107.04949

Present via
Online

Primary authors: WU, Xiang-Yu; QIN, Guang-You (Central China Normal University); PANG, LongGang (Central China Normal University); WANG, Xin-Nian (Lawrence Berkeley National Lab. (US))

Presenter: WU, Xiang-Yu

Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Charmonium production is a probe sensitive to deconfinement in nucleus-nucleus collisions. The production of $J/\psi$ via regeneration within the QGP or at the phase boundary has been identified as an important ingredient for the description of the observed centrality and $p_T$ dependence at the LHC. $\psi$(2S) production relative to $J/\psi$ is one possible discriminator between the two different regeneration scenarios. At RHIC and at the LHC, there is so far no significant observation of the $\psi$(2S) in nucleus-nucleus collisions in central events at low transverse momentum, where regeneration is the dominating process. The combined Run 2 data set of ALICE allows to extract a significant $\psi$(2S) signal in such a kinematic region at forward rapidity in the dimuon decay channel. In this contribution, we present for the first time results on the $\psi$(2S)-to-$J/\psi$ double ratio and the $\psi$(2S) nuclear modification factor in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, calculated with respect to a new pp reference with improved precision. Results are compared with model calculations.

Present via

Online

Primary author: HUSHNUD, Hushnud (Saha Institute of Nuclear Physics)

Presenter: HUSHNUD, Hushnud (Saha Institute of Nuclear Physics)

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
The production of quarkonia in hadronic collisions provides a unique testing ground for understanding quantum chromodynamics (QCD) since it involves both the perturbative and non-perturbative regimes of this theory. As the quarkonia formation is not yet fully understood, a variety of new experimental data serve as new insights and help to constrain the models. Additionally to the inclusive J/ψ production, the ALICE detector can access both the physics of charmonium systems and beauty-quark production since the charmonium can be experimentally separated from the contribution from long-lived weak decays of beauty hadrons. Also, new experimental observables like the angular correlation between J/ψ and charged particles bring new insights to quarkonium production in hadronic collisions. Measurements of the azimuthal correlation structure of emitted particles in high multiplicity proton-proton (pp) collisions can reflect the medium response to the initial collision geometry.

In this contribution, we present new results of the inclusive, prompt and non-prompt J/ψ production in pp collisions at √s = 5.02 and 13 TeV. The angular correlation between J/ψ and charged particles in pp collisions at √s = 13 TeV will also be shown. Finally, the elliptic flow (v2) of J/ψ in high multiplicity pp collisions at √s = 13 TeV will be presented.

Present via

Online

Primary author: \( \text{SADEK, Rita (Centre National de la Recherche Scientifique (FR))} \)

Presenter: \( \text{SADEK, Rita (Centre National de la Recherche Scientifique (FR))} \)

Session Classification: \( \text{PA-Bulk matter phenomena, QCD phase diagram, and Critical point} \)

Track Classification: \( \text{Bulk matter phenomena, QCD phase diagram, and Critical point} \)
Ground and excited quarkonium states as probes of MPI in small systems with ALICE

Our understanding of hadronic collisions has been challenged by the intriguing observation of collective phenomena in events with high charged-particle multiplicity density in small systems. Such high multiplicities are expected in events with multiple parton-parton interactions (MPI). At the LHC, MPIs affect the production of heavy-quarks (charm and beauty), and the large statistics samples available allow for the study of quarkonium production in association with other particles as well as of their relation to the underlying event. In proton-proton (pp) collisions, the study of pair production of quarkonia in the same event, besides helping to disentangle among different production mechanisms, is sensitive to double-parton scattering. Multiplicity dependent studies of quarkonia are fundamental for investigating the correlations between soft and hard components of high-multiplicity events in small collision systems. In particular, excited quarkonium states, characterized by lower binding energies than the corresponding ground states, are more sensitive to any possible dissociation mechanism at play at high multiplicities.

In this contribution, new multiplicity dependent results of excited quarkonium states, such as $\psi(2S)$, $Y(2S)$ and $Y(3S)$, reconstructed in pp and p-Pb collisions at forward rapidity, along with the corresponding excited-to-ground state ratios, will be presented. New measurements for $J/\psi$ will be also discussed. These include the first measurement of $J/\psi$ pair production in pp collisions at $\sqrt{s} = 13$ TeV, as well as the latest results on $J/\psi$ production as a function of multiplicity at forward rapidity in pp collisions at $\sqrt{s} = 5.02$ and 13 TeV. The status of similar multiplicity dependent measurements at midrapidity in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ will be shown. The comparison with available models will also be discussed.

Present via

Online

Primary author:  EDER, Tabea Maria (Westfaelische Wilhelms-Universitaet Muenster (DE))
Presenter:  EDER, Tabea Maria (Westfaelische Wilhelms-Universitaet Muenster (DE))
Session Classification:  Poster
Track Classification:  Heavy-flavor and Quarkonia
Measurement of quarkonium production and polarization in pp and Pb-Pb collisions with ALICE

Tuesday, 14 June 2022 09:00 (20 minutes)

Quarkonia are excellent probes of deconfinement in heavy-ion collisions. For $J/\psi$, a bound state of $c\bar{c}$ quarks, the (re-)generation is found to be the dominant production mechanism at the LHC energies. On the other hand, the non-prompt component of $J/\psi$ production originating from b-hadron decays allows one to access the interaction of b-quarks with the QGP. Polarization and spin alignment measurements could also be used to investigate the characteristics of the formed medium. Different polarization for the $J/\psi$ in Pb–Pb as compared to pp could be related to the modification of the $J/\psi$ feed down fractions, due to the suppression of the excited states in the QGP, but also to the contribution of the regenerated $J/\psi$ in the low $p_T$ region. Moreover, it has been hypothesized that quarkonium states could be polarized by the strong magnetic field, generated in the initial state of the collision, and by the large angular momentum of the medium in non-central heavy-ion collisions. In pp collisions, polarization measurements are useful tools to understand particle production mechanisms. In this talk, the measurements of the inclusive, prompt and non-prompt $J/\psi$ nuclear modification factor in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02\text{TeV}$ and midrapidity will be shown. The determination of the non-prompt $J/\psi$ fraction extends down to very low $p_T$ with a significantly improved precision compared to previous publications. The recently published results on the $J/\psi$ polarization with respect to the event-plane in Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02\text{TeV}$ and forward rapidity will be presented. The preliminary measurement of the $\psi(1S)$ polarization in pp collisions at $\sqrt{s} = 13\text{TeV}$ as a function of the transverse momentum will also be discussed. Results will be compared with available calculations.

Present via

Online

Primary author: BAI, Xiaozhi (University of Science and Technology of China (USTC))

Presenter: BAI, Xiaozhi (University of Science and Technology of China (USTC))

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Photon-photon and photonuclear reactions are induced by the strong electromagnetic field generated by ultra-relativistic heavy-ion collisions. These processes have been extensively studied in ultra-peripheral collisions with impact parameters larger than twice the nuclear radius. Since a few years, both the photoproduction of the J/ψ vector meson and the production of dileptons via photon-photon interactions have been observed in A–A collisions with nuclear overlap. Photoproduced quarkonia can probe the nuclear gluon distributions at low Bjorken-x, while the continuum dilepton production could be used to further map the electromagnetic fields produced in heavy-ion collisions and to study possible induced or final state effects in overlapping hadronic interactions. Both measurements are complementary to constrain the theory behind photon induced reactions in A–A collisions with nuclear overlap and the potential interaction of the measured probes with the formed and fast-expanding QGP medium. In this presentation, measurements of coherent J/ψ photoproduction cross-sections in Pb–Pb collisions in the 40%-90% centrality range, measured at midrapidity in the dielectron channel with ALICE will be presented for the first time using the full Run 2 data. Thanks to the excellent tracking resolution of the TPC, the transverse momentum distribution of coherently photoproduced J/ψ can be accurately measured. Final results on coherent J/ψ photoproduction cross-sections at forward rapidity in the dimuon decay channel in the 30-90% centrality range will also be shown. Finally, the measurement of an excess in the midrapidity dielectron yield at low mass and p_T, in the centrality interval 50-90% will be shown. Results will be compared with available models.
Thermal radiation and direct photon production in Pb-Pb and pp collisions with dielectrons in ALICE

Tuesday, 14 June 2022 15:00 (20 minutes)

Electromagnetic probes such as photons and dielectrons are a unique tool to study the space-time evolution of the hot and dense matter created in ultra-relativistic heavy-ion collisions. They are produced by a variety of processes during all stages of the collision with negligible final-state interactions. At low dielectron invariant mass ($m_{ee}$), thermal radiation from the hot hadron gas contributes to the dielectron spectrum via decays of $\rho$ mesons, whose spectral function is sensitive to chiral-symmetry restoration. At larger $m_{ee}$, thermal radiation from the QGP carries information about the early temperature of the medium. It is nevertheless dominated by a large background of correlated heavy-flavour hadron decays affected by energy loss and flow in the medium. Alternatively, the transverse momentum ($p_{T,ee}$) of virtual direct photons, including thermal photons at low $p_{T,ee}$, can be extracted from the dielectron data together with inclusive photon measurements.

In proton-proton (pp) collisions, such measurement serves as a fundamental test for perturbative QCD calculations and as a baseline for the studies in heavy-ion collisions. Recently, pp collisions with high charged-particle multiplicities have been found to exhibit interesting phenomena showing surprising similarities with those in heavy-ion collisions. Low-mass dielectrons could provide additional information regarding the underlying physics processes in such collisions.

In this talk, the latest ALICE results on dielectron studies in Pb-Pb and pp collisions at the center-of-mass energies of $\sqrt{s_{NN}} = 5.02$ TeV and 13 TeV will be presented using the large data sample collected during the LHC Run 2. The results will be compared to the expected dielectron yield from known hadronic sources and predictions for thermal radiation from the medium. The production of direct photons in the different colliding systems including high-multiplicity pp collisions will be discussed.

Present via
Online

Primary author: MURAKAMI, Hikari (University of Tokyo (JP))
Presenter: MURAKAMI, Hikari (University of Tokyo (JP))
Session Classification: PA-Other topics
Track Classification: Other topics
Measurement of quarkonium elliptic flow in pPb collisions at 8.16 TeV with the CMS detector

Tuesday, 14 June 2022 09:00 (20 minutes)

The second-order Fourier coefficients ($v_2$) of $\Upsilon$(1S) and $J/\psi$ mesons in high-multiplicity pPb collisions is studied using data collected by the CMS experiment at a nucleon-nucleon center-of-mass energy 8.16 TeV. The dimuons used to reconstruct the quarkonium states are coupled with charged hadrons using the long-range two-particle correlation technique. The measurement of the $\Upsilon$(1S) $v_2$ is reported for the first time in small collision systems. The results are discussed in terms of collectivity and modification of heavy quarks.

Present via
Offline

Primary author: LEE, Kisoo (Korea University (KR))
Presenter: LEE, Kisoo (Korea University (KR))
Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point
Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
To understand the in-medium effects of quarkonia in heavy ion collisions, it is necessary to perform differential studies of various observables to have a global picture of the quarkonium dynamics in the quark-gluon plasma (QGP). Recent results in proton-proton collisions have suggested that $J/\psi$ mesons are produced with much more jet activity than model predictions, which indicate that the amount of isolated $J/\psi$ mesons with respect to the total production cross section plays an important role in interactions between charmonia and the QGP medium. In this presentation, we present the second-order and third-order Fourier coefficients, $v_2$ and $v_3$, for prompt and nonprompt $J/\psi$, and prompt $\psi(2S)$ mesons, with reporting the $v_2$ and $v_3$ for prompt $\psi(2S)$ mesons for the first time in heavy ion collisions. The results are discussed with theoretical calculations and discussed in terms of suppression and recombination effects. Also, we show the final results of the measurement of $J/\psi$-jets in pp and PbPb collisions. The jet fragmentation function of jets containing a $J/\psi$ meson is studied to probe the dependence of quenching effects on the degree of associated hadro-production inside the jet.

Present via

Offline

Primary author: BAK, Gyeonghwan (Chonnam National University (KR))

Presenter: BAK, Gyeonghwan (Chonnam National University (KR))

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Detailed study of bottomonium suppression with the measurement of the $\Upsilon(3S)$ meson in PbPb collisions at 5.02 TeV with CMS

Because of the different binding energies, bottomonium mesons are particularly useful probes to understand the thermal properties of quark-gluon plasma. Previously, CMS observed the sequential suppression of $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$ in heavy ion (AA) collisions, which was widely accepted as evidence for the QGP formation. However, the $\Upsilon(3S)$ yield was excessively low, thus allowing us to report only statistical upper limits. In this talk, we present a detailed study of the measurement of excited bottomonium states with improved analysis technique and high-statistics data that enables us to observe the $\Upsilon(3S)$ meson in AA for the first time. The results are discussed together with the previous measurements in pPb collisions, which finally provides a full scan of all $\Upsilon(nS)$ states over the whole phase space.

Present via

Offline

Primary author: LEE, Soohwan (Korea University (KR))
Presenter: LEE, Soohwan (Korea University (KR))
Session Classification: PA-Heavy-flavor and Quarkonia
Track Classification: Heavy-flavor and Quarkonia
Understanding the initial state effects by the measurement of the Drell-Yan process in pPb collisions with CMS

Tuesday, 14 June 2022 15:20 (20 minutes)

Drell-Yan process is considered as one of the essential probes to understand the initial state of the nucleons presented as the parton distribution function (PDF) for stand-alone nucleon and nuclear PDF (nPDF) for confined nucleon in the nucleus. In LHC era, Z and W boson productions in pPb and PbPb collisions have been used to investigate the initial state effects. In this presentation, we report the results of the Drell-Yan process in pPb collisions at a center of mass energy of 8.16 TeV with the CMS detector. The differential cross sections are presented versus dimuon $p_T$, rapidity and $\phi^*$ in a wider dimuon mass region that includes not only the Z boson mass range but also the lower mass region down to 15 GeV. In addition, the forward-backward asymmetries are shown in both mass regions, where the uncertainties are found to be smaller than in model calculations. The results in the Z mass region are the most precise to date, while the measurements in the lower mass region allow access to a new phase space for nPDF studies with lower longitudinal momentum fraction $x$ and lower energy scale $Q^2$. All results are compared to EPPS16, and nCTEQ15WZ nPDFs, and the free-proton PDF CT14, to better understand the nuclear PDF and the sensitivity of the models in pPb collisions.

Present via

Offline

Primary author:  KIM, Hyunchul (Chonnam National University (KR))

Presenter:  KIM, Hyunchul (Chonnam National University (KR))

Session Classification: PA-Other topics

Track Classification: Other topics
Femtoscopic correlations of identified and unidentified hadrons are measured with data recorded by the CMS experiment at the LHC over a broad multiplicity range and pair transverse momentum. The first femtoscopy measurements carried in CMS for all pair combinations of $K^0_S$, $\Lambda$ and $\bar{\Lambda}$ are reported. These identified particles are employed to perform $K^0_SK^0_S$, $\Lambda\bar{\Lambda}$ and $K^0_S\Lambda \oplus K^0_S\bar{\Lambda}$ femtoscopic correlations in pPb collisions at $\sqrt{s_{NN}} = 8.16$ TeV, and of $\Lambda\Lambda \oplus \bar{\Lambda}\bar{\Lambda}$ in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, for the first time. The shape of the correlation function is observed to largely vary for different particle pair species, revealing the effect of the strong final state interaction in each case. Charged particle correlations measured in pp at $\sqrt{s} = 0.9$, 2.76, 7 and 13 TeV, pPb at $\sqrt{s_{NN}} = 5.02$ TeV and peripheral PbPb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the CMS detector are shown in addition. The invariant radii results for $K^0_SK^0_S$ in pPb and PbPb collisions show similar behavior with multiplicity and pair transverse momentum as observed for charged hadrons in all colliding systems and energies. The strong interaction scattering parameters, scattering length and effective range, are extracted from $\Lambda\Lambda \oplus \bar{\Lambda}\bar{\Lambda}$ and $\Lambda\bar{\Lambda}$ correlations using the Lednický-Lyuboshits model for both pPb and PbPb collisions, and compared with other experimental and theoretical results.

Present via

Online

Primary author: PRADHAN, Raghunath (Indian Institute of Technology Madras (IN))

Presenter: PRADHAN, Raghunath (Indian Institute of Technology Madras (IN))

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Correlations between multiparticle cumulants and mean transverse momentum in small collision systems with the CMS detector

Tuesday, 14 June 2022 17:54 (1 minute)

The azimuthal anisotropies observed in small systems can originate from the final state response to the initial geometry as well as from initial momentum anisotropies. Recently it has been proposed that the correlation between the flow coefficient $v_2^2$ and the mean $p_T$ carries information on the origin of flow in small collision systems by showing a characteristic sign change at very low multiplicity. However, this sign change exists in PYTHIA8 events as a result of nonflow effects. To reduce the nonflow dependence, a new correlator that correlates multiparticle cumulants and mean $p_T$ is suggested. In this talk, we present results for this correlator using two and four particle correlations in pp, pPb and peripheral PbPb collisions. We also report our high precision measurements of $v_2$ using four-, six-, and eight-particle correlations, together with $v_3$ from four particle correlations, in both pPb and peripheral PbPb collisions. The ratios between $v_n$ harmonics involving different numbers of particles are compared to model calculations to study the fluctuation-driven initial state anisotropies. The results provide insights to the origin of flow in small collision systems.

Present via

Online

Primary author:  TUO, Shengquan (Vanderbilt University (US))

Presenter:  TUO, Shengquan (Vanderbilt University (US))

Session Classification:  Poster

Track Classification:  Bulk matter phenomena, QCD phase diagram, and Critical point
Observation of $\gamma\gamma \rightarrow \tau\tau$ production in PbPb collisions with the CMS experiment

Tuesday, 14 June 2022 16:10 (20 minutes)

Ultraperipheral lead-lead collisions at $\sqrt{s_{NN}} = 5.02$ TeV produce very large photon fluxes that fundamental quantum-mechanical processes can be observed and well studied. Measurements of tau lepton pair in ultraperipheral PbPb collisions with data collected by CMS during the LHC Run 2 will be presented for the first time. The measurement paves the way for the determination of the anomalous magnetic moment of the tau lepton, currently poorly constrained.

Present via

Online

Primary author: KINTIRAS, Georgios (The University of Kansas (US))
Presenter: KINTIRAS, Georgios (The University of Kansas (US))
Session Classification: PA-Other topics
Track Classification: Other topics
Measurement of exclusive vector meson photoproduction in pPb and PbPb collisions with the CMS experiment

Tuesday, 14 June 2022 16:30 (20 minutes)

The exclusive photoproduction of vector mesons provides a unique opportunity to constrain the gluon distribution function within protons and nuclei. Measuring vector mesons of various masses over a wide range of rapidity and as a function of transverse momentum provides important information on the evolution of the gluon distribution within nuclei. A variety of measurements, including the exclusive J/ψ, ρ, and Υ meson production in pPb (at nucleon-nucleon center of mass energies of 5.02 and 8.16 TeV) and PbPb (5.02 TeV) collisions, will be presented as a function of squared transverse momentum and the photon-proton center of mass energy. Finally, compilations of these data and previous measurements are compared to various theoretical predictions.

Present via

Online

Primary author: BEHERA, Subash Chandra (Indian Institute of Technology Madras (IN))
Presenter: BEHERA, Subash Chandra (Indian Institute of Technology Madras (IN))
Session Classification: PA-Other topics
Track Classification: Other topics
Search for elliptic azimuthal anisotropies in photon-proton and pomeron-Pb interactions with ultraperipheral pPb collisions with the CMS experiment

For several years there has been a strong interest in measuring collective effects in small systems such as proton-proton (pp) and proton-lead (pPb). Such measurements give new insights into the nature of QCD and the meaning of collectivity. In recent years ALEPH, ATLAS, and ZEUS collaborations have extended these studies to electromagnetic interactions such as electron-positron (ee), photon-lead (γPb), and electron-proton (ep) systems, respectively. No evidence of collectivity as in pp or pPb (for the same degree of collectivity) was found, placing a bound on the multiplicity range of long-range collectivity. The CMS Collaboration further extends the measurements into photon-proton (γp) and pomeron-lead (PPb) interactions using ultraperipheral pPb collisions at 8.16 TeV. Such interactions provide unique initial conditions with event multiplicity lower than in pp and pPb systems but comparable with ee and ep systems, whereas, and in contrast to the other systems, PPb is a pure QCD interaction. This talk will summarize the first measurements of long-range particle correlations in γp and PPb systems.

Present via

Online

Primary author: BEHERA, Subash Chandra (Indian Institute of Technology Madras (IN))
Presenter: BEHERA, Subash Chandra (Indian Institute of Technology Madras (IN))
Session Classification: Poster
Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Observation of azimuthal angular decorrelation in dijet photoproduction in ultraperipheral lead-lead collisions at 5.02 TeV with the CMS experiment

*Tuesday, 14 June 2022 11:10 (20 minutes)*

Angular correlations present in dijet photoproduction are studied, for the first time, using ultraperipheral lead-lead collisions at a nucleon-nucleon center-of-mass energy of 5.02 TeV. The second moment of the angular distribution, $\langle \cos(2\Phi) \rangle$, where $\Phi$ is the angle between the vector sum $\vec{Q}_T$ and the vector difference $\vec{P}_T$ of the transverse momentum vectors of the jets, is measured as a function of $\vec{Q}_T$. This analysis amounts to the first, yet essential, step towards the extraction of the Wigner or Husimi gluon distributions, which are believed to be the most fundamental gluon distributions. It also introduces new techniques for the analysis of jet angular correlations in exclusive dijet events at colliders.

**Present via**

Offline

**Primary author:** BYLINKIN, Aleksandr (The University of Kansas (US))

**Presenter:** BYLINKIN, Aleksandr (The University of Kansas (US))

**Session Classification:** PA-Bulk matter phenomena, QCD phase diagram, and Critical point

**Track Classification:** Bulk matter phenomena, QCD phase diagram, and Critical point
Measurement of non-prompt and prompt $D^0$ azimuthal anisotropy in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

Tuesday, 14 June 2022 10:50 (20 minutes)

Heavy quarks are primarily produced via initial hard scatterings, and thus carry information about the early stages of the Quark-Gluon Plasma (QGP). Measurements of the azimuthal anisotropy of the final-state heavy flavor hadrons provide information about the initial collision geometry, its fluctuation, and more importantly, the mass dependence of energy loss in QGP. Due to the larger bottom quark mass as compared to the charm quark mass, separate measurements of charm and bottom hadron azimuthal anisotropy can shed new light on understanding the dependence of the heavy quark and medium interaction. Because of the high branching ratio and large $D^0$ mass, measurements of $D^0$ meson coming from $B$ hadron decay (nonprompt $D^0$) can cover a broad kinematic range and be a good proxy of the parent bottom hadrons results. In this talk we report both on the prompt $D^0$ and the first nonprompt $D^0$ measurements of the azimuthal anisotropy elliptic ($v_2$) and triangular ($v_3$) coefficients of nonprompt $D^0$ in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The measurements are performed as functions of transverse momentum $p_T$, in three centrality classes, from central to midcentral collisions. Compared to the prompt $D^0$ results, the nonprompt $D^0$ $v_2$ flow coefficients are systematically lower but have a similar dependence on $p_T$ and centrality. A non-zero $v_3$ coefficient of the nonprompt $D^0$ is observed. The obtained results are compared with theoretical predictions. The comparison could provide new constraints on the theoretical description of the interaction between heavy quarks and the medium.

Present via

Online

Primary author: STOJANOVIC, Milan (Purdue University (US))
Presenter: STOJANOVIC, Milan (Purdue University (US))
Session Classification: PA-Heavy-flavor and Quarkonia
Track Classification: Heavy-flavor and Quarkonia
New insights on heavy flavor dynamics and hadronization from small to large collision systems from $\Lambda_c^+$ production with CMS

The observation of collectivity signals in small hadronic collisions raises the question of whether the tiny droplet of quark-gluon plasma can form in small systems. Dynamics and hadronization of heavy flavor quarks in small-system collisions provide a powerful tool to address the origin of observed collective phenomena because of their early production time and sensitivity to the finite system size effect. In heavy-ion collisions, charm hadron production can occur via coalescence. One expects the effect to be more significant for baryons with three constituent quarks than mesons. Those motivate the studies of $\Lambda_c^+$ production in various collision systems.

In this talk, we report a comprehensive study of charm and bottom hadron elliptic flow in pp and pPb collisions with the LHC Run-2 data recorded by CMS, where a mass hierarchy is evident. We also present new measurements of the $\Lambda_c^+$ yields and ratios to prompt $D^0$ yields as functions of $p_T$ and event multiplicity. They are directly compared with light flavor strange baryon-to-meson ratios to provide constraints on the charm hadronization in small systems. Moreover, ratios of $\Lambda_c^+$ over $D^0$ yields in pp and PbPb collisions, as well as the $\Lambda_c^+$ nuclear modification factors, will also be reported. We compare results from various collision systems to theoretical models. They provide crucial new insights into charm hadronization mechanisms and the possible QGP medium effects in high-multiplicity events.

Present via

Online

Primary author: CHANDRA, Soumik (Purdue University (US))

Presenter: CHANDRA, Soumik (Purdue University (US))

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Studies of heavy flavor dynamics using $B^+, B^0_s$ and $B_c$ mesons with CMS

Tuesday, 14 June 2022 11:30 (20 minutes)

Heavy quarks are one of the most important probes to study the properties of quark-gluon plasma (QGP). Hadronization of beauty quarks is not as well understood as in the charm sector. Illuminating the hadronization mechanism is crucial for extracting the transport properties of the QGP. We present new results on nuclear modification factors of $B^0_s$ and $B^+$ mesons and their yield ratios in pp and PbPb collisions at 5.02 TeV, using data recorded with the CMS detector in 2017 and 2018. The reported B-meson nuclear modification factors over an extended transverse momentum range will provide important information about the diffusion of beauty quarks and the flavor dependence of in-medium energy loss. The $B^0_s/B^+$ yield ratio in pp and PbPb can shed new light on beauty hadronization mechanisms from small to large systems and on the relevance of parton recombination in the medium. We also report the first observation of the $B_c$ meson in nucleus-nucleus collisions, through partial reconstruction of the semi-leptonic decay $B_{c} \rightarrow (J/\psi \rightarrow \mu^+\mu^-) \mu^+\nu_\mu$. Given the low production cross-section in proton-proton collisions, its production could be dramatically enhanced by the combination of beauty quarks with the charm quarks present in the plasma, providing additional insights into the recombination mechanism. The $B_c$ nuclear modification factors are compared with similar (CMS) measurements for other heavy-flavor mesons and quarkonia.

Present via

Offline

Primary author: DAMAS, Florian (LLR - Centre National de la Recherche Scientifique (FR))

Presenter: DAMAS, Florian (LLR - Centre National de la Recherche Scientifique (FR))

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Joint ATLAS/CMS ZDC upgrade project for the High Luminosity LHC

Tuesday, 14 June 2022 16:30 (20 minutes)

The high luminosity LHC, or HL-LHC provides the opportunity to study heavy ion, proton-nucleus, photon-nucleus and photon-photon collisions with unprecedented luminosities. The LHC heavy ion community has mapped out a large range of physics measurements at the HL-LHC that will push forward our understanding of both QCD, QED and even electroweak physics. The measurement of forward neutrons and photons in Zero Degree Calorimeters, or ZDCs, is essential for event classification and triggering. In order to reach the required luminosities, the LHC interaction regions will be completely remodeled, necessitating the need to build new ZDCs that are both thinner and much more radiation hard. This challenge motivated the formation of a joint project between ATLAS and CMS to build new ZDCs for Run 4. The ZDCs are based on very radiation hard fused silica rods that produce Cherenkov light. These rods have been developed in collaboration with the LHC BRAN group and private companies. The Run 4 ZDCs are the first joint detector project between CMS and ATLAS. This talk will present the capabilities of the new ZDCs and recent test beam analysis.

Present via
Online

Primary author: LONGO, Riccardo (Univ. Illinois at Urbana Champaign (US))
Presenter: LONGO, Riccardo (Univ. Illinois at Urbana Champaign (US))
Session Classification: PA-Detector upgrades and Future experiments
Track Classification: Detector upgrades and Future experiments
Charm production: constraint to transport models and charm diffusion coefficient with ALICE

Tuesday, 14 June 2022 11:50 (20 minutes)

In this contribution the nuclear modification factor \( R_{AA} \) of prompt charm hadrons and leptons from heavy-flavour hadrons decays measured in Pb-Pb collisions at \( \sqrt{s_{NN}} = 5.02 \) TeV by the ALICE Collaboration are presented. The measurement of heavy-flavour leptons in Xe-Xe collisions is also discussed. Heavy quarks are a very suitable probe to investigate the quark-gluon plasma (QGP) produced in heavy-ion collisions, since they are mainly produced in hard-scattering processes and hence in shorter timescales compared to the QGP.

Measurements of charm-hadron production in nucleus-nucleus collisions are therefore useful to study the properties of the in-medium charm quark energy loss via the comparison with theoretical models. Moreover, the comparison of different colliding systems provide insights in the dependency on the collision geometry. Models describing the heavy-flavour transport and energy loss in an hydrodynamically expanding QGP require also a precise modelling of the in-medium hadronisation of heavy quarks, which is investigated via the measurement of prompt \( D_s^+ \) mesons and \( \Lambda_c^+ \) baryons. In addition, the measurement of the azimuthal anisotropy of strange and non-strange \( D \) mesons is discussed. The second harmonic coefficient provides information about the degree of thermalisation of charm quarks in the medium, while the third one relates to its sensitivity to event-by-event fluctuations in the initial stage of the collision. A thorough systematic comparison of experimental measurements with phenomenological model calculations will be performed in order to disentangle different model contributions and provide important constraints to the charmquark diffusion coefficient \( D_s \) in the QGP.

Present via

Online

Primary author: VOLKL, Martin Andreas (Ruprecht Karls Universitaet Heidelberg (DE))
Presenter: VOLKL, Martin Andreas (Ruprecht Karls Universitaet Heidelberg (DE))
Session Classification: PA-Heavy-flavor and Quarkonia
Track Classification: Heavy-flavor and Quarkonia
Electroweak W and Z bosons created in hard-scattering processes at the early stage of the collisions are efficient probes of the initial state of the collisions. While the measurements of W and Z bosons in p–Pb and Pb–Pb collisions provide insights on the nuclear modification of the parton distribution functions, the results in pp collisions are a stringent test of perturbative QCD-based calculations and production mechanisms. In pp collisions, W bosons can be produced by pair annihilation but also by higher order processes with additional hadron production. An investigation of these bosons, in relation to the hadrons in the rest of the event, can give insight into multiparton interactions in high-multiplicity events and the role of color-reconnection mechanisms. Electroweak bosons are studied with ALICE in pp collisions at $\sqrt{s} = 13$ TeV, p–Pb collisions at $\sqrt{s_{\text{NN}}} = 8.16$ TeV and Pb–Pb collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV via their leptonic decays in the muon and electron channels at forward rapidity ($-4 < \eta < -2.5$) and midrapidity ($|\eta| < 0.8$), respectively. The observations in p–Pb and Pb–Pb collisions at forward rapidity give access to low Bjorken-x values, a phase-space region poorly constrain by heavy-ion experiments.

A review of the most recent results on the production of $W^+$, $W^-$ and $Z$ bosons is presented. The results include differential measurements of the normalised production yields, production cross sections and nuclear modification factors as a function of rapidity, transverse momentum, collision centrality and charged-particle multiplicity. The lepton-charge asymmetry measurement is also reported. A particular emphasis will be placed on the new measurement of the production of $W$ bosons in association with hadrons as a function of the charged-particle multiplicity in pp collisions. Comparisons with theoretical model calculations, providing insights on production mechanisms and new constraints for the determination of the nuclear parton distributions functions will also be discussed.

**Present via**

Offline

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**Presenter:** TAILLEPIED, Guillaume (GSI - Helmholtzzentrum fur Schwerionenforschung GmbH (DE))

**Session Classification:** PA-Other topics

**Track Classification:** Other topics
Constraining hadronization processes with charm baryons in pp and p-Pb collisions with ALICE

Tuesday, 14 June 2022 12:10 (20 minutes)

In this contribution, we present the latest measurements of $D^0$, $D^+$ and $D_s^+$ mesons together with the final measurements of $\Lambda_c^+, \Xi_c^0, \Sigma_c^{0,++}$, and the first measurement of $\Omega_c^0$ baryons performed with the ALICE detector at midrapidity in pp collisions at $\sqrt{s} = 5.02$ TeV and $\sqrt{s} = 13$ TeV. Recent measurements of charm-baryon production at midrapidity in small systems show a baryon-to-meson ratio significantly higher than that in $e^+e^-$ collisions, suggesting that the fragmentation of charm is not universal across different collision systems. Thus, measurements of charm-baryon production are crucial to study the charm quark hadronization in a partonic rich environment like the one produced in pp collisions at the LHC energies. Furthermore, the recent $\Lambda_c^+/D^0$ yield ratio, measured down to $p_T = 0$, and the new $\Xi_c^{0,+}/D^0$ yield ratio measured in p-Pb collisions will be discussed. The measurement of charm baryons in p-nucleus collisions provides important information about possible additional modification of hadronization mechanisms as well as on cold nuclear matter effects and on the possible presence of collective effects that could modify the production of heavy-flavour hadrons. Finally, the first measurements of charm fragmentation fractions and charm production cross-section at midrapidity per unit of rapidity will be shown for both pp and p-Pb collisions using all measured single charm ground state hadrons.

Present via
Offline

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Presenter: SEO, Jinjoo (Inha University (KR))
Session Classification: PA-Heavy-flavor and Quarkonia
Track Classification: Heavy-flavor and Quarkonia
In this contribution, the final measurements of the centrality dependence of $R_{AA}$ of non-prompt $D^0$ and electrons from beauty hadron decays in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be presented. These measurements provide important constraints to the in-medium mass-dependent energy loss and hadronization of the beauty quark. The integrated non-prompt $D^0$ $R_{AA}$ will be presented for the first time and will be compared with the prompt $D^0$ one. This comparison will shed light on possible different shadowing effects between charm and beauty quarks. In addition, the first measurements of non-prompt $D_s$ production in central and semi-central Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be discussed. The non-prompt $D_s$ measurements provide additional information on the production and hadronization of $B_s$ mesons. Finally, the first measurement of non-prompt $D$-mesons elliptic flow in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will also be discussed. It will help to further investigate the degree of thermalization of beauty quark in the hot and dense QCD medium.

Present via

Offline

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Presenter: POLITANO, Stefano (Politecnico di Torino (IT))

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Heavy-flavour jet properties and correlations from small to large systems measured by ALICE

The early production of heavy-flavour partons makes them an excellent probe of the dynamical evolution of QCD systems. Jets tagged by the presence of a heavy-flavour hadron give access to the kinematics of the heavy partons, and along with correlation measurements involving heavy-flavour hadrons allow for comparisons of their production, propagation and fragmentation across different systems. The properties of heavy-flavour parton showers are driven by the large dead cone of heavy quarks, the presence of which is directly measured for the first time, using jets tagged with a fully reconstructed $D^0$ meson amongst their constituents, in pp collisions. Whilst traversing the QGP, these partons are expected to lose energy through interactions with the medium, at a different rate to their inclusive counterparts. To constrain the energy loss in the QGP, measurements of the nuclear modification factor of $D^0$ meson-tagged jets are presented in the $0 - 10\%$ most central Pb-Pb collisions. Properties of heavy-flavour jets are also investigated in small systems through measurements of the production and substructure of jets tagged with $D^0$ mesons or electrons originating from heavy-flavour decays. Measurements of the fragmentation function and radial shape of jets containing a $\bar{\Lambda}^+$, probing different dimensions of the hadronisation dynamics of charmed baryons, are also presented in pp collisions. Additionally, measurements of $D^0$-hadron correlations and the correlation of electrons from heavy-flavour decays with hadrons are presented, in both pp and p-Pb collisions, probing the impact of cold nuclear effects and providing a baseline for future Pb-Pb measurements.

Present via

Offline

Primary author: OLIVEIRA DA SILVA, Antonio Carlos (University of Tennessee - Knoxville)

Presenter: OLIVEIRA DA SILVA, Antonio Carlos (University of Tennessee - Knoxville)

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
A truly cylindrical inner tracker for ALICE

Wednesday, 15 June 2022 08:40 (20 minutes)

After the successful installation and first operation of the upgraded Inner Tracking System (ITS2), which consists of about 10 m² of monolithic silicon pixel sensors, ALICE is pioneering the usage of bent, wafer-scale pixel sensors for the ITS3 for Run 4. Sensors larger than typical reticle sizes can be produced using the technique of stitching. At thicknesses of about 30 µm, the silicon is flexible enough to be bent to radii of the order of 1 cm. By cooling such sensors with a forced air flow, it becomes possible to construct truly cylindrical layers which consist practically only of the silicon sensors. The reduction of the material budget and the improved pointing resolution will allow new measurements, in particular of heavy-flavour decays and electromagnetic probes. In this presentation, we will report on the sensor developments, the performance of bent sensors in test beams, and the mechanical studies on truly cylindrical layers.

Present via

Offline

Primary author: YUNCU, Alperen (Ruprecht Karls Universitaet Heidelberg (DE))

Presenter: YUNCU, Alperen (Ruprecht Karls Universitaet Heidelberg (DE))

Session Classification: PA-Detector upgrades and Future experiments

Track Classification: Detector upgrades and Future experiments
Constraints on hadron resonance gas interactions via first-principles Lattice QCD susceptibilities

Tuesday, 14 June 2022 09:40 (20 minutes)

We investigate extensions of the Hadron Resonance Gas (HRG) Model beyond the ideal case by incorporating both attractive and repulsive interactions into the model [1]. When considering additional states exceeding those measured with high confidence by the Particle Data Group, attractive corrections to the overall pressure in the HRG model are imposed. On the other hand, we also apply excluded-volume corrections, which ensure there is no overlap of baryons by turning on repulsive (anti)baryon-(anti)baryon interactions. We emphasize the complementary nature of these two extensions and identify combinations of conserved charge susceptibilities that allow us to constrain them separately. In particular, we find interesting ratios of susceptibilities that are sensitive to one correction and not the other. This allows us to constrain the excluded volume and particle spectrum effects separately. Analysis of the available lattice results suggests the presence of both the extra states in the baryon-strangeness sector and the repulsive baryonic interaction, with indications that hyperons have a smaller repulsive core than non-strange baryons. We note that these results are interesting for heavy-ion-collision systems at both the LHC and RHIC.

1. J. M. Karthein, V. Koch, C. Ratti, V. Vovchenko, Phys. Rev. D, 104, 094009 (2021)

Present via

Offline

Primary authors: RATTI, Claudia; KARTHEIN, Jamie (MIT); KOCH, Volker (LBNL); VOVCHENKO, Volodymyr (Lawrence Berkeley National Laboratory)

Presenter: KARTHEIN, Jamie (MIT)

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
The ALICE FoCal

The addition of a Forward Calorimeter (FoCal) to the ALICE experiment is proposed for LHC Run 4 to provide unique constraints on the low-x gluon structure of protons and nuclei via forward measurements of direct photons. A new high-resolution electromagnetic Si-W calorimeter using both Si-pad and Si-pixel layers is being developed to discriminate single photons from pairs of photons originating from $\pi^0$ decays. A conventional sampling hadron calorimeter is foreseen for jet measurements and the isolation of direct photons. In this presentation, we will report on results from test beam campaigns in 2019 and 2021 at DESY and CERN with Si-pad and pixel modules, a first prototype for the hadronic calorimeter, and a full-pixel calorimetry prototype based on ALPIDE sensors.

Present via

Online

Primary author:  KIM, Dong-Geon (Yonsei University (KR), Hanyang University (KR))
Presenter:  KIM, Dong-Geon (Yonsei University (KR), Hanyang University (KR))
Session Classification:  Poster
Track Classification:  Detector upgrades and Future experiments
Particle production as a function of underlying event-activity and very forward energy with ALICE

Tuesday, 14 June 2022 11:30 (20 minutes)

In this contribution, the similarity between small and large collision systems will be explored using the underlying event (UE) charged particle density, $N_T$, and the self-normalized observable based on transverse region multiplicity, $R_T$. A study of KNO-like scaling properties of the $N_T$ distributions in pp collisions at $\sqrt{s} = 2.76$, 5.02, 7 and 13 TeV will be presented. Final measurements of charged particle production as a function of $N_T$ in pp, p–Pb and Pb–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV will be presented in the toward, away and transverse regions. In addition, the UE contributions measured in the transverse region are subtracted from the toward and the away regions to search for jet-like modifications in small collision systems. The jet-like signals are studied both as a function of $N_T$ and of the leading particle transverse momentum. To explore the particle species dependence, the final results of $\pi$, K and p production as a function of $R_T$ in pp collisions at $\sqrt{s} = 13$ TeV are presented. In addition, results on very forward energy, measured by the ALICE zero degree calorimeters (ZDCs), and differential studies of particle production will be presented for $\sqrt{s} = 13$ TeV pp collisions and $\sqrt{s_{NN}} = 8.16$ TeV p–Pb collisions. The event-activity based on UE measurements and very forward energy for pp collisions will be compared with p–Pb collisions. Finally, the results will be compared with the expectations of QCD-inspired Monte Carlo event generators, such as PYTHIA and EPOS-LHC, to test if these models can describe both the UE and the forward fragmentation observables, which are mainly driven by non-perturbative QCD physics.

Present via

Online

Primary author: FAN, Feng (Central China Normal University CCNU (CN))

Presenter: FAN, Feng (Central China Normal University CCNU (CN))

Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Light-flavor hadron production in small collision systems with ALICE

Tuesday, 14 June 2022 10:00 (20 minutes)

High-multiplicity proton-proton collisions at LHC show the onset of phenomena typical of heavy-ion collisions, such as collective effects, suppression of short-lived resonances, and strangeness enhancement. These effects, whose origin is still under debate, suggest a complex particle production mechanism whose relative contributions evolve smoothly going from low to high multiplicity collisions. Light-flavor hadrons are the most abundant particles produced in pp collisions and multi-differential measurements of their production yields play a key role in the study of the hadronization mechanism.

In this contribution, recent measurements of light-flavor hadron production as a function of the charged-particle multiplicity and the (unweighted) transverse spherocity in pp collisions are presented and discussed in the context of phenomenological models implemented in general-purpose Monte Carlo generators. These results are complemented by detailed measurements of the neutral pion, eta, and omega mesons in several multiplicity classes in pp collisions at $\sqrt{s} = 13$ TeV up to an unprecedented high $p_T$. These measurements allow a test of perturbative QCD calculations and represent an important baseline for heavy-ion studies. Finally, preliminary results that show the ALICE performance in measuring particle production using the newest 900 GeV pp data sample collected in October 2021 will also be presented.

Present via
Offline

Primary author:  NASSIRPOUR, Adrian Fereydon (Lund University (SE))
Presenter:  NASSIRPOUR, Adrian Fereydon (Lund University (SE))
Session Classification:  PA-Light-flavor and Strangeness
Track Classification:  Light-flavor and Strangeness
(Anti)nucleosynthesis in heavy-ion collisions and (anti)nuclei as "baryonmeter" of the collision (ALICE)

Tuesday, 14 June 2022 10:50 (20 minutes)

The production mechanism of light (anti)nuclei in heavy-ion collisions has been extensively studied experimentally and theoretically for many decades. Two competing (anti)nucleosynthesis models are typically used to describe light (anti)nuclei yields and their ratios to other hadrons in heavy-ion collisions: the statistical hadronization model (SHM) and the nucleon coalescence model. The possibility to distinguish these phenomenological models calls for new experimental observables. On a different front, given their large baryon number, light (anti)nuclei have a high sensitivity to the baryon chemical potential ($\mu_B$) of the system created in the collision.

In this talk, the first measurement of event-by-event antideuteron number fluctuations in heavy-ion collisions is presented and compared with expectations of the SHM and coalescence model. In addition, the antinuclei-to-nuclei ratios are used to obtain a measurement of $\mu_B$ in heavy-ion collisions with unprecedented precision.

Present via
Offline

Primary author: CIACCO, Mario (Universita e INFN Torino (IT))
Presenter: CIACCO, Mario (Universita e INFN Torino (IT))
Session Classification: PA-Light-flavor and Strangeness
Track Classification: Light-flavor and Strangeness
In recent years, ALICE has extensively studied the production of light (anti)(hyper)nuclei in different collision systems and center-of-mass energies. The production mechanism of light (hyper)nuclei is still under debate in the scientific community. Two classes of models are used to describe nuclear production: the statistical hadronisation model (SHM) and the coalescence model. In heavy-ion collisions, both models describe well the production yields of light nuclei and their ratios to the yields of hadrons, making it difficult to distinguish between the two. On the contrary, collision systems such as pp and p–Pb collisions are ideal to study the (hyper)nuclei production mechanism. In particular, in high multiplicity pp collisions, by combining the measurements of the production of (anti)nuclei and femtoscopic measurements, the coalescence parameters are compared with parameter-free coalescence predictions. In addition, by comparing the production of in-jet and out-of-jet (anti)deuterons, it is possible to observe an increase of the (anti)deuteron production probability in the jet as compared to that out of the jet. Additional information can be extracted from the study of very large and extremely loosely bound objects such as $^{3}\Lambda H$. This particle has a large wavefunction, hence its production yield in pp and p–Pb collisions is extremely sensitive to the nucleosynthesis models. With the precision of the presented production measurements, some configurations of the SHM and coalescence models can be excluded leading to tighter constraints to available theoretical ones.

**Present via**

Offline

**Primary author:** PINTO, Chiara (Technische Universitaet Muenchen (DE))

**Presenter:** PINTO, Chiara (Technische Universitaet Muenchen (DE))

**Session Classification:** PA-Resonances and Hyper-nuclei

**Track Classification:** Resonances and Hyper-nuclei
Exploring the hadronic phase of relativistic heavy-ion collisions with resonances in ALICE

Tuesday, 14 June 2022 09:40 (20 minutes)

Hadronic resonances having short lifetimes are very useful to study the hadron-gas phase that characterizes the late-stage evolution of high energy nuclear collisions. Indeed, regeneration and rescattering processes occurring in the hadron gas modify the measured yields of hadronic resonances and can be studied by measuring resonance yields as a function of system size and by comparing to model predictions with and without hadronic interactions. Measurements of the differential yields of resonances with different lifetime, mass, quark content, and quantum numbers help in understanding particle production mechanisms, lifetime of the hadronic phase, strangeness production, parton energy loss, rapidity yield asymmetry and collective effects. With its excellent tracking and particle identification capabilities, the ALICE experiment has measured a comprehensive set of both meson and baryon resonances. We present recent results on resonance production in pp, p-Pb, Xe-Xe and Pb-Pb collisions at various centre-of-mass energies, highlighting new results on $\Sigma(1385)$ and $\Xi(1820)$, thus extending to higher mass the study of baryonic resonances at the LHC. The obtained results are used to study the system-size and collision-energy evolution of transverse momentum spectra, yields, mean transverse momentum, yield ratios to stable hadrons, and nuclear modification factors. These results are compared to lower energy measurements and model calculations where available.

Present via
Online

Primary author: MALLICK, Dukhishyam (National Institute of Science Education and Research (NISER) (IN))

Presenter: MALLICK, Dukhishyam (National Institute of Science Education and Research (NISER) (IN))

Session Classification: PA-Resonances and Hyper-nuclei

Track Classification: Resonances and Hyper-nuclei
We introduce a novel freeze-out procedure connecting the hydrodynamic evolution of a droplet of quark-gluon plasma (QGP) that has, as it expanded and cooled, passed close to a critical point on the QCD phase diagram with the subsequent kinetic description in terms of observable hadrons. The procedure converts out of equilibrium critical fluctuations described by extended hydrodynamics, known as Hydro+, into cumulants of hadron multiplicities that can be subsequently measured. We introduce a critical sigma field whose fluctuations cause correlations between observed hadrons due to the couplings of the sigma field to the hadrons. We match the QGP fluctuations obtained via solving the Hydro+ equations describing the evolution of critical fluctuations before freeze-out to the correlations of the sigma field. In turn, these are imprinted onto fluctuations in the multiplicities of hadrons, most importantly protons, after freeze-out via a generalization of the familiar half-a-century-old Cooper-Frye freeze-out prescription which we introduce. This framework allows us to study the effects of critical slowing down and the consequent deviation of the observable predictions from equilibrium expectations quantitatively. We can also quantify the suppression of cumulants due to the conservation of baryon number. We demonstrate the prescription in practice by freezing out the Hydro+ simulation in a simplified azimuthally symmetric and boost invariant background discussed previously.

Present via
Online

Primary authors: SUSHAMA PRADEEP, Maneesha; RAJAGOPAL, Krishna (Massachusetts Inst. of Technology (US)); STEPHANOV, Misha (UIC); YIN, Yi (Institute of modern physics, Chinese Academy of Sciences)

Presenter: SUSHAMA PRADEEP, Maneesha

Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Time evolution of global polarization within an improved microscopic approach

Tuesday, 14 June 2022 17:24 (1 minute)

Extremely large angular orbital momentum can be produced in non-central heavy-ion collisions, leading to a strong transverse polarization of partons that scatter through the quark-gluon plasma (QGP) due to spin-orbital coupling. To understand the hyperon polarization observed in relativistic nuclear collisions, we develop a microscopic approach to describe the formation and space-time evolution of quark polarization inside the QGP. Production of polarization both from the initial hard scatterings and during the QGP expansion have been consistently described using the quark-potential scattering approach, which has been coupled to realistic initial condition calculation and the subsequent (3+1)-dimensional viscous hydrodynamic simulation of the QGP for the first time. Within this improved approach, we have found that different rapidity-dependent initial energy density distributions generate different time evolution profiles of the longitudinal flow velocity gradient of the QGP, which further lead to an approximately 15% difference in the final polarization of quarks collected on the hadronization hypersurface of the QGP. Therefore, in addition to the collective flow coefficients, the hyperon polarization could serve as a novel tool to help constrain the initial condition of the hot nuclear matter created in high-energy nuclear collisions.

Present via

Primary authors: LI, Xiaowen (Shandong University); CAO, Shanshan (Shandong University)

Co-authors: JIANG, Zefang; DENG, Jian (Shandong University); LIANG, Zuo-tang (Shandong University)

Presenter: LI, Xiaowen (Shandong University)

Session Classification: Poster

Track Classification: Light-flavor and Strangeness
Differential study of Λ-hyperon polarization in a few-GeV regime within transport model approach

Tuesday, 14 June 2022 17:22 (1 minute)

We present a systematic study of Λ hyperon polarization in heavy-ion collisions at HADES energies within the framework of microscopic transport model UrQMD combined with the hadron-resonance gas statistical model. This study demands a complex analysis of the fireball evolution including time slices, extraction of temperature and chemical potentials, as well as freeze-out conditions of Λ hyperons and study of the formation and space-time evolution of thermal vorticity. Two systems and four impact parameters are considered: Au+Au at $\sqrt{s_{NN}} = 2.42$ GeV and Ag+Ag at $\sqrt{s_{NN}} = 2.55$ GeV with $b = 3.0, 5.5, 7.5, 9.0$ fm. Rapidity and transverse momentum dependence of the polarization are obtained and show a good agreement with preliminary experimental data as well as centrality and energy dependence of global polarization.

Present via
Online

Primary authors: Mr VITIUK, Oleksandr (University of Wroclaw, Institute of Theoretical Physics); BRAVINA, Larisa; ZABRODIN, Evgeny

Presenter: Mr VITIUK, Oleksandr (University of Wroclaw, Institute of Theoretical Physics)

Session Classification: Poster

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Hypernuclei and light nuclei production with phase space coalescence in UrQMD

Tuesday, 14 June 2022 10:00 (20 minutes)

In this talk we will present recent results on light nuclei and hypernuclei production in heavy ion collisions over a wide beam energy range from the SIS18 to the LHC. Light clusters with mass number up to $A=3$ can be well described by a phase-space coalescence approach implemented in the microscopic transport model UrQMD. I will show that the final multiplicities for nuclear clusters in many experiments can be well described with this approach which assumes the formation of nuclei after kinetic freeze out and using only the two phase space separation parameters for deuterons and tritons. As expected for coalescence the coalescence parameters $B_2$ and $B_3$ scale with the appropriate power of the system volume for central collisions. Results for the centrality dependence of nuclei production will be presented. They show a breaking of this scaling for peripheral collisions. In addition, some special ratios will be discussed, like the $t^*p/d^2$ or $\Lambda^*p/A$ ratio and how they depend on the beam energy. The possibilities of the creation of more exotic nuclei like those including a $\Xi$ or even charmed baryons will also be discussed.

This talk is based on:
[1] P. Hillmann, K. Käfer, J. Steinheimer, V. Vovchenko and M. Bleicher,[arXiv:2109.05972 [hep-ph]], accepted for publication in Journ.Phys.G.
[2] S. Sombun, K. Tomuang, A. Limphirat, P. Hillmann, C. Herold, J. Steinheimer, Y. Yan and M. Bleicher, Phys. Rev. C 99, no.1, 014901 (2019).
[3] J. Steinheimer, A. Botvina and M. Bleicher, Phys. Rev. C 95, no.1, 014911 (2017).

Present via

Online

Primary authors: Dr STEINHEIMER, Jan; KÄFER, Katharina (Goethe Universität); BLEICHER, Marcus; HILLMANN, Paula (Institut für theoretische Physik, Goethe-Universität Frankfurt); VOVCHENKO, Volodymyr (Lawrence Berkeley National Laboratory); REICHERT, Tom

Presenter: REICHERT, Tom

Session Classification: PA-Resonances and Hyper-nuclei

Track Classification: Resonances and Hyper-nuclei
Xi baryon production via hyperon resonances in sub-threshold heavy-ion collisions

Tuesday, 14 June 2022 17:25 (1 minute)

We have proposed a mechanism for Xi baryon production in proton-nucleus collisions in which hyperon resonances and anisotropic hyperon production played a role. Parameters of the model were chosen to account for the observed Xi multiplicity by the HADES collaboration (GSI, Darmstadt) in sub-threshold p+Nb collisions. [1] In the present contribution, we investigate whether a similar mechanism can explain the high Xi yield found by HADES in Ar+KCl collisions at $\sqrt{s_{NN}}=2.61$ GeV.

[1] M. Zétényi, Gy. Wolf, Phys. Lett. B 785 (2018) 226-231.

Present via

Primary author: ZÉTÉNYI, Miklós (Wigner RCP)
Presenter: ZÉTÉNYI, Miklós (Wigner RCP)
Session Classification: Poster
Track Classification: Light-flavor and Strangeness
The dark side of ALICE: from antinuclei interactions to dark matter searches in space

Wednesday, 15 June 2022 10:00 (20 minutes)

Space: the final frontier for antinuclei physics. There, antinucleosynthesis models already tested on the bench of hadronic colliders and particle physics experiments are put at work to crack one of the biggest problems of modern physics: the existence and nature of dark matter. In fact, the observation of an antinucleus in cosmic rays would most probably mean a breakthrough in searches for Dark Matter. However, to correctly interpret future results, precise knowledge of both the antinuclei production mechanism and their nuclear inelastic cross sections is needed. The ALICE collaboration already investigated in detail the antinucleosynthesis models in small and large collision systems at the LHC and has recently performed several measurements of antideuteron, $^3\text{He}$ and $^\Lambda\text{He}$ inelastic cross sections, providing the first experimental information of this kind.

In this talk, the final results on antideuteron and $^3\text{He}$ inelastic cross-sections and the new results on $^\Lambda\text{He}$ inelastic cross-sections are discussed as well how, thanks to them, it is possible to determine for the first time the transparency of the Galaxy to antinuclei stemming from dark matter and Standard Model collisions.

Present via

Online

Primary author: LARIONOV, Pavel (CERN)

Presenter: LARIONOV, Pavel (CERN)

Session Classification: PA-Other topics

Track Classification: Other topics
Understanding the nature of $f_0(980)$ with ALICE at the LHC

Tuesday, 14 June 2022 10:50 (20 minutes)

The $f_0(980)$ meson was observed several years ago in $\pi\pi$ scattering experiments. Despite a long history of experimental and theoretical studies, the nature of this short-lived resonance is far from being understood and there is no agreement about its quark structure. According to different models, it has been associated with $qq$ structures, considered as a tetraquark, or as a $KK$ molecule. In this talk, the nature of the $f_0(980)$ resonance is investigated exploiting the excellent tracking and particle identification of the ALICE experiment to measure the differential spectra and integrated yield of the $f_0(980)$ meson produced in pp and p-Pb collisions at an energy of $\sqrt{s} = 5.02$ TeV. The new results are discussed in the comparison with models and the properties of other hadrons. The nuclear modification factor shows hints of final-state effects in p-Pb collisions and will be presented and discussed in this perspective.

Present via

Offline

Primary author:  KIM, Junlee (Jeonbuk National University (KR))
Presenter:  KIM, Junlee (Jeonbuk National University (KR))
Session Classification:  PA-Resonances and Hyper-nuclei
Track Classification:  Resonances and Hyper-nuclei
Rescattering effects on resonances production in small systems with ALICE at the LHC

Tuesday, 14 June 2022 11:10 (20 minutes)

Recent multiplicity-dependent studies of particle production in pp and p-Pb collisions have shown similar features as in heavy-ion collisions. Measurements using resonances could help to understand the possible onset of collective-like phenomena and a non-zero lifetime of the hadronic phase in a small collision system. Measurements of the differential yields of resonances with different lifetimes, masses, quarks contents, and quantum numbers will provide information on the mechanisms that influence the shape of particle momentum spectra, the lifetime of the hadronic phase, strangeness production, parton energy loss, and collective effects. This talk presents new ALICE results on various hadronic resonances in small collision systems at LHC energies, including the multiplicity dependent measurements of $\Lambda(1520)$ and charged $K^*$ and the production of $\phi$-meson pairs. The results will be compared with model calculations and measurements at lower energies.

Present via

Online

Primary author: ROSANO, Antonina (Universita e INFN, Catania (IT))

Presenter: ROSANO, Antonina (Universita e INFN, Catania (IT))

Session Classification: PA-Resonances and Hyper-nuclei

Track Classification: Resonances and Hyper-nuclei
A multi-differential investigation of strangeness production in pp collisions with ALICE

Tuesday, 14 June 2022 11:10 (20 minutes)

The ratio of strange to non-strange hadron yields increases from low-multiplicity to high-multiplicity hadronic interactions, reaching values observed in heavy-ion collisions. The ALICE experiment investigates the microscopic origin of this striking phenomenon by performing dedicated multi-differential analyses in pp collisions at $\sqrt{s} = 13$ TeV.

To separate strange hadrons produced in jets from those produced in soft processes, the angular correlation between high-$p_T$ charged particles and strange hadrons is exploited. The near-side jet and out-of-jet yield of $K_S^0$ and $\Xi^\pm$ are studied as a function of the charged particle multiplicity, up to values comparable to those reached in peripheral Pb-Pb collisions.

In order to disentangle initial and final state effects, a new analysis exploits the concept of the effective energy available for particle production, which is anticorrelated with the forward energy deposited in the Zero Degree Calorimeters (ZDC). (Multi-)strange hadron production is studied as a function of the charged particle multiplicity measured at midrapidity and of the forward energy detected by the ZDC.

The results suggest that soft (i.e., out-of-jet) processes are the dominant contribution to strange particle production and provide new insights on the role of initial state effects on strangeness enhancement in pp collisions.

Present via

Offline

Primary author: SCHOTTER, Romain (Centre National de la Recherche Scientifique (FR))

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Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Scaling approach to nuclear structure in nuclear collisions

Tuesday, 14 June 2022 17:23 (1 minute)

In high-energy heavy-ion collisions, the energy density profile of the produced quark-gluon plasma and its space-time dynamics are sensitive to the shape and radial profiles of the nuclei, described by the collective nuclear structure parameters including quadrupole deformation $\beta_2$, octupole deformation $\beta_3$, radius $R_0$ and surface diffuseness $a$ [1-3]. Using AMPT simulations as a proxy for hydrodynamics, we find a general scaling relation between these parameters and a large class of experimental observables such as anisotropic flow $v_n$, particle multiplicity distribution $p(N_{ch})$ and mean transverse momentum $\langle p_T \rangle$ fluctuations. In particular, we show that the ratio of these observables between two isobar collision systems depends only on the differences of these parameters. Using this scaling relation, we show how the nuclear structure parameters of $^{96}$Ru and $^{96}$Zr conspire to produce the non-monotonic centrality dependence of ratios of $v_n$, $p(N_{ch})$ and mean $\langle p_T \rangle$ fluctuations between $^{96}$Ru+$^{96}$Ru and $^{96}$Zr+$^{96}$Zr collisions, in agreement with measurements by the STAR Collaboration. We investigate how these scaling relations depend on the transport properties and extend this study to include the systems with similar mass numbers. This scaling approach towards heavy-ion observables demonstrates that isobar collision is a precision tool to probe the shape and radial structures, including the neutron skin, of the atomic nuclei across energy scales.

[1] J. Jia and C. Zhang, arXiv:2111.15559.
[2] C. Zhang and J. Jia, Phys. Rev. Lett. 128, 022301 (2022).
[3] G. Giacalone, J. Jia and C. Zhang, Phys. Rev. Lett. 127, 242301 (2021).
Baryon number transport, strangeness conservation and Ω-hadron correlations

We will present model studies of dynamics of baryon number transport, strangeness conservation and their manifestation in Ω-hadron correlations. Although strange quarks are produced in $s\bar{s}$ pairs, the ratio of $\Omega^{-}$ to $\Omega^{+}$ is greater than one in heavy-ion collisions at RHIC. Thus the produced Ω hyperons must carry net baryon quantum numbers from the colliding nuclei. We will present results of $\Omega^{-} - K^{\pm}$, $\Omega^{+} - K^{\pm}$, $\Omega^{-} - \Xi$ and $\Omega^{+} - \Xi$ correlations from model simulations of Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and 14.6 GeV. These correlations can probe dynamics for baryon number transport to mid-rapidities at these two beam energies. In addition, we use AMPT (default and string-melting modes) and UrQMD models to illustrate how hadronization schemes of quark coalescence and string fragmentations could leave imprints on such correlations. Implications on the experimental program to measure these correlations with the STAR experiment at RHIC will also be discussed.

Present via

Online

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Presenters: WU, Xiatong (Department of Physics and Astronomy, University of California, Los Angeles, CA 90095, USA); WU, XIATONG

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Pseudo-gauge dependence of spin polarization in heavy-ion collisions

Tuesday, 14 June 2022 17:23 (1 minute)

The measurement of spin polarization of particles emitted in heavy-ion collisions has opened the possibility for new phenomenological investigations of spin physics in relativistic fluids. This motivates the development of hydrodynamic with spin degrees of freedom. One of the features of this theory is that different choices of the decomposition of orbital and spin angular momentum might give different descriptions. In this talk, I will discuss how observables in a relativistic fluid at local thermal equilibrium are affected by the choice of the stress-energy tensor and the spin tensor. In particular, I will discuss how the predictions of the spin polarization vector of spin 1/2 particles changes in different pseudo-gauges.

1 M. Buzzegoli, arXiv:2109.12084

Present via

Online

Primary author: BUZZEGOLI, Matteo

Presenter: BUZZEGOLI, Matteo

Session Classification: Poster

Track Classification: Other topics
We derive a quantum kinetic theory for QED based on Kadanoff-Baym equation\textsuperscript{1}. By assuming parity invariance and considering a complete set of self-energy diagrams, we find the resulting kinetic theory expanded to lowest order in $\hbar$ generalizes the well-known classical kinetic theory to massive case. It contains elastic and inelastic collision terms and integrates screening effect naturally. We also discuss generalization to QCD. The approach allows us to study complete collisional contribution to spin polarization in heavy ion collisions. We find a new collisional contribution to shear-induced spin polarization, which is not suppressed compared to contributions already included in current phenomenological studies. It may shed light on the spin polarization puzzle.

\textsuperscript{1}Shu Lin, "Quantum Kinetic Theory for Quantum Electrodynamics" arxiv:2109.00184.

Present via
Magneto-vortical effect and response functions from chiral kinetic theory in magnetized plasma

Tuesday, 14 June 2022 17:24 (1 minute)

The chiral magnetic effect and chiral vortical effect enable us to probe possible local parity violation in hot dense matter created in heavy ion collisions. While equilibrium description is simple, the situation in heavy ion collisions can be quite far from equilibrium: the axial charge is likely to peak at early stage of the collisions [1-3], and the magnetic field and vorticity are also dominant at early stage. These require theoretical frameworks for out-of-equilibrium dynamics for chiral fermions. Chiral kinetic theory (CKT) offers such a framework. It has been derived based on field theory [4,5]. Previous works on CKT are organized as an expansion in $\hbar$, which is valid for weak magnetic field. Its simplicity is lost at second order [6]. Recently, the CKT from Landau level basis is derived [7], which is valid for arbitrary magnetic field. In strong magnetic field limit, it reduces to CKT in the lowest Landau level approximation [8]. We will present a covariant chiral kinetic theory with Landau level basis. We use it to investigate a magnetized plasma with a transverse electric field and a steady vorticity as perturbations. We also study two-point functions from the above chiral kinetic theory which characterize the response to perturbative vector and axial gauge fields in magnetized chiral plasma.

[1] Yuji Hirono, Tetsufumi Hirano, and Dmitri E. Kharzeev, 1412.0311
[2] Yin Jiang, Shuzhe Shi, Yi Yin, and Jinfeng Liao, Chin. Phys., C42(1):011001, 2018
[3] Shu Lin, Li Yan, Gui-Rong Liang, Phys. Rev. C 98, 014903 (2018)
[4] Dam Thanh Son, Naoki Yamamoto, Phys.Rev.Lett.109:181602,2012
[5] M. A. Stephanov, Y. Yin, Phys. Rev. Lett. 109, 162001, 2012
[6] Jian-Hua Gao, Zuo-Tang Liang, Qun Wang, Xin-Nian Wang, Phys. Rev. D 98, 036019 (2018)
[7] Shu Lin, Lixin Yang, Phys.Rev.D 101 (2020) 3, 034006
[8] Koichi Hattori, Shiyong Li, Daisuke Satow, Ho-Ung Yee, Phys. Rev. D 95, 076008 (2017)

Present via

Primary authors: YANG, Lixin (Sun Yat-sen University); LIN, Shu
Presenter: YANG, Lixin (Sun Yat-sen University)
Session Classification: Poster
Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Enhancement of baryon-to-meson ratios around jets as a signature of medium response

Tuesday, 14 June 2022 11:50 (20 minutes)

We present a unique signal of jet-induced medium excitations: the enhancement of baryon-to-meson ratios around the quenched jets. To illustrate this, we study jet-particle correlations and the distributions of jet-induced identified particles with respect to the jet direction in Pb+Pb collisions at the LHC via a multi-phase transport model. We find a strong enhancement of baryon-to-meson ratios for associated particles at intermediate transverse momentum around the triggered jets in Pb+Pb collisions relative to p+p collisions, due to the coalescence of jet-excited medium partons. Since the lost energy from jets can diffuse to large angles, such baryon-to-meson-ratio enhancement is more pronounced for larger relative distance from the jet axis. We argue that the experimental confirmation of the enhancement of jet-induced baryon-to-meson ratios around the jets will provide an unambiguous evidence for the medium response to jet quenching in heavy-ion collisions.

Present via

Online

Primary authors: LUO, Ao; WANG, Enke (South China Normal University); QIN, Guang-You (Central China Normal University); ZHANG, Hanzhong (IOPP, CCNU); MAO, Yaxian (ALICE)

Presenters: LUO, Ao; LUO, Ao

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Hadronic resonances are effective tools for studying the hadronic phase in ultra-relativistic heavy-ion collisions. In fact, their lifetime is comparable to the hadronic phase and resonances are sensitive to the hadronic phase effects such as rescattering and regeneration processes which might affect the resonance yields and shape of the transverse momentum spectra. $\Lambda(1520)$ has a lifetime of around 13 fm/$c$, which lies in between the lifetimes of $K^*$ and $\phi$ resonances. The resonance to stable particle yield ratios can be used to study the properties of the hadronic phase. Recently, ALICE observed the suppression of the $\Lambda(1520)/\Lambda$ ratio in Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV as a function of centrality. It is therefore interesting to investigate the multiplicity-dependent study of $\Lambda(1520)/\Lambda$ ratio for pp collisions, since this can serve as a baseline for heavy-ion collisions.

In this contribution, we present new results on the measurement of the baryonic resonance $\Lambda(1520)$ as a function of the charged-particle multiplicity in pp collisions at $\sqrt{s} = 5.02$ and 13 TeV. The transverse momentum spectrum, the integrated yield ($dN/dy$), the mean transverse momentum ($\langle p_T \rangle$) and the $\Lambda(1520)/\Lambda$ yield ratio will be presented as a function of the charged-particle multiplicity.

Present via

Online

Primary author: PADHAN, Sonali (IIT- Indian Institute of Technology (IN))
Presenter: PADHAN, Sonali (IIT- Indian Institute of Technology (IN))
Session Classification: Poster
Track Classification: Resonances and Hyper-nuclei
We explore the ability of a recently proposed jet substructure technique, Dynamical Grooming, to pin down the properties of the Quark-Gluon Plasma formed in ultra-relativistic heavy-ion collisions. In particular, we compute, both analytically and via Monte-Carlo simulations, the opening angle $\theta_g$ of the hardest splitting in the jet as defined by Dynamical Grooming. Our calculation, grounded in perturbative QCD, accounts for the factorization in time between vacuum-like and medium-induced processes in the double logarithmic approximation. We observe that the dominating scale in the $\theta_g$-distribution is the decoherence angle $\theta_c$ which characterises the resolution power of the medium to propagating color probes. This feature also persists in strong coupling models for jet quenching. We further propose for potential experimental measurements a suitable combination of the Dynamical Grooming condition and the jet radius that leads to a pQCD dominated observable with a very small sensitivity ($\leq 10\%$) to medium response.

References:
[1] P. Cauca, A. Soto-Ontoso and A. Takacs, arXiv:2111.14768
[2] P. Cauca, A. Soto-Ontoso and A. Takacs, JHEP, 20 (2021)
Strange hadron production in Au+Au collisions at RHIC Beam Energy Scan

Tuesday, 14 June 2022 14:00 (20 minutes)

Strangeness production has been suggested as a sensitive probe to the early-time dynamics of the nuclear matter created in heavy-ion collisions. Transverse momentum distributions and yields of strange hadrons provide important information about the particle production mechanisms and help us to understand the properties of the created medium and its evolution in these collisions.

Thanks to the high statistical data taken from the STAR BES II program in 2018-2021, a series of measurements on production yields and properties of strangeness at low energies are carried out. In this talk, the productions of $K^0_S$, $\phi$, $\Lambda$, $\Xi^-$, and $\Omega^-$ from Au+Au collisions at $\sqrt{s_{NN}} = 3, 14.5, 19.6, \text{and } 27$ GeV will be presented. The strange hadron spectra, rapidity density distributions, particle ratios, and nuclear modification factors will be reported. These results will be compared with those from higher collision energies and discussed within the framework of model calculations.

Present via

Online

Primary author: ZHOU, Yingjie

Presenters: ZHOU, Yingjie; ZHOU, yingjie

Session Classification: PA-Light-flavor and Strangeness

Track Classification: Light-flavor and Strangeness
Measurements on the production and lifetime of light hypernuclei at STAR

Tuesday, 14 June 2022 11:30 (20 minutes)

Hypernuclei are bound states of nucleons and hyperons. The hyperon-nucleon \((Y-N)\) interaction, an important ingredient for the nuclear equation-of-state (EoS), remains poorly constrained. Precise measurements of hypernuclei intrinsic properties and production yields in heavy-ion collisions are crucial to the investigation of their production mechanisms and the strength of the \(Y-N\) interaction. Model calculations predict that hypernuclei are abundantly produced at low energies due to high baryon density.

Thanks to the high statistical data taken from the STAR BES II program in 2018-2021, a series of measurements on production yields and properties of light hypernuclei at low energies are carried out. In this talk, the rapidity and energy dependence of light hypernuclei \((^3\Lambda H, ^4\Lambda H, ^4\Lambda He)\) yields in \(\text{Au+Au } \sqrt{s_{NN}} = 3, 19.6,\text{ and } 27\ \text{GeV collisions will be presented. The ratio of hypernuclei to light nuclei production yields will also be presented. We will also report precise lifetime measurements of light hypernuclei } (^3\Lambda H, ^4\Lambda H, ^4\Lambda He)\text{ utilizing the BES datasets. The results will be compared with model calculations and physics implications will be discussed.}

Present via

Online

Primary author:  JI, Yuanjing (Lawrence Berkeley National Lab)
Co-author:  STAR COLLABORATION
Presenter:  JI, Yuanjing (Lawrence Berkeley National Lab)
Session Classification:  PA-Resonances and Hyper-nuclei
Track Classification:  Resonances and Hyper-nuclei
Initial electromagnetic field dependence of photon-induced production in isobaric collisions at STAR

Wednesday, 15 June 2022 09:40 (20 minutes)

Strong electromagnetic field arising from the Lorentz-contraction and a large number of charges ($Z$) in the colliding nuclei at ultrarelativistic speeds can generate a large flux of quasi-real photons. Consequent photon-induced interactions could reasonably explain the observed enhancements of $J/\psi$ and $e^+e^-$ pair productions at very low transverse momenta ($p_T$) in peripheral high-energy heavy-ion collisions, via photonuclear ($\propto Z^2$) and photon-photon ($\propto Z^4$) processes. The STAR experiment has collected a large sample of $^{96}_{44}$Ru+$^{96}_{44}$Ru and $^{96}_{40}$Zr+$^{96}_{40}$Zr collisions at $\sqrt{s_{NN}} = 200$ GeV in 2018. The isobaric collisions, with different number of charges and same number of nucleons in the colliding nuclei, provide a unique opportunity to test the electromagnetic field dependence of photon-induced production.

In this presentation, we will present the first measurement of the electromagnetic field dependence of $J/\psi$ and $e^+e^-$ pair productions at very low $p_T$, via comparisons between the new measurements in isobaric collisions as well as to the published results in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Besides, the angular modulation of dielectron pairs in isobaric collisions which is related to vacuum birefringence will also be presented. The physical implications of these results will be discussed.

Present via

Online

Primary author: SHEN, Kaifeng
Co-author: STAR COLLABORATION
Presenter: SHEN, Kaifeng
Session Classification: PA-Other topics
Track Classification: Other topics
Lifetime measurements of light hypernuclei in Au+Au collisions from STAR experiment

Tuesday, 14 June 2022 17:56 (1 minute)

Hypernuclei are bound nuclear systems of correlated nucleons and hyperons. Therefore, the production of hypernuclei in heavy-ion collisions provides an experimental avenue for studying hyperon–nucleon (Y-N) interaction, which is an important ingredient, not only in the equation-of-state of astrophysical objects such as neutron stars, but also in the description of the hadronic phase of a heavy-ion collision. The strength of the Y-N interaction can be investigated by measuring the properties of hypernuclei. For example, light $\Lambda$-hypernuclei containing one hyperon are conventionally understood as a weakly bound system of a $\Lambda$ and a nucleus, suggesting their lifetimes are close to the free-$\Lambda$ lifetime.

In heavy-ion collisions, light hypernuclei are expected to be abundantly produced at low collision energies due to the high baryon density. In this presentation, we will report precise lifetime measurements of $^{3}_{\Lambda}H$, $^{4}_{\Lambda}H$, and $^{4}_{\Lambda}He$ in Au+Au collisions at $\sqrt{s_{NN}} = 3$ GeV and 7.2 GeV, recorded by the STAR experiment at RHIC in the fixed-target mode in 2018. The results will be compared with model calculations and physics implications will be discussed.

Present via

Online

Primary author: LI, Xiujun (USTC)
Co-author: STAR COLLABORATION
Presenter: LI, Xiujun (USTC)
Session Classification: Poster
Track Classification: Resonances and Hyper-nuclei
Quantum Chromodynamics (QCD) predicts the existence of a deconfined state of matter called Quark-Gluon Plasma (QGP) at sufficiently high-temperature and/or high-energy density. In order to investigate the phase diagram of QCD matter, the first phase of the Beam Energy Scan (BES-I) program started at the Relativistic Heavy Ion Collider (RHIC) in the year 2010. In continuation of BES-I, a high statistics dataset from Au+Au collisions at $\sqrt{s_{NN}} = 54.4$ GeV was recorded by the STAR experiment at RHIC in the year 2017. The transverse momentum ($p_T$) spectra of identified hadrons are essential to study the bulk properties such as integrated yield (dN/dy), average transverse momenta ($\langle p_T \rangle$), particle ratios, and freeze-out parameters of the medium produced. The systematic study of bulk properties can shed light on the particle production mechanism in heavy-ion collisions.

In this talk, we will present the $p_T$-spectra of hadrons ($\pi^\pm$, $K^\pm$, $p$, and $\bar{p}$) at mid-rapidity ($|y| < 0.1$) in Au+Au collisions at $\sqrt{s_{NN}} = 54.4$ GeV. The centrality dependence of dN/dy, $\langle p_T \rangle$, particle ratios, chemical freeze-out and kinetic freeze-out parameters will also be presented and compared with the measurements at other beam energies.

**Present via**

Online

**Primary author:** GOPAL, Krishan (IISER Tirupati)

**Presenter:** GOPAL, Krishan (IISER Tirupati)

**Session Classification:** PA-Light-flavor and Strangeness

**Track Classification:** Light-flavor and Strangeness
Production of $K^*_{0}$ in Au+Au collisions at $\sqrt{s_{NN}} = 14.6$ and 19.6 GeV in BES-II from STAR

Tuesday, 14 June 2022 11:50 (20 minutes)

The production of short lived resonances like $K^*_{0}$ provides a unique opportunity to probe the hadronic phase formed in heavy-ion collisions. Due to its short lifetime the decay daughters may interact with the medium which may lead to a change in the properties of the resonances. The decay particles may undergo rescattering and re-generation effects. Hence $K^*_{0}/K$ provides a unique tool to investigate the interplay of re-scattering and regeneration effects in the hadronic phase of heavy-ion collisions. Recently STAR has completed the BES-II run resulting in high statistics Au+Au data with improved detectors and wider pseudorapidity coverage. This will help us to extend the measurement in both lower and higher $p_T$ range with less statistical uncertainty than that in BES-I.

We will report mass, width, and invariant yields of $K^*_{0}$ using the 14.6 and 19.6 GeV BES-II data. The average transverse momentum of $K^*_{0}$ will be shown and compared with other hadrons. The nuclear modification factor of $K^*_{0}$ will be shown. The resonance to non-resonance ratio will be shown as a function of centrality to study the rescattering/regeneration effects. Measurement of the hadronic phase lifetime will be shown as a function of centrality and will be compared with other RHIC and LHC energies.

Present via

Online

Primary author: SAHOO, Aswini Kumar (IISER,Berhampur)

Presenter: SAHOO, Aswini Kumar (IISER,Berhampur)

Session Classification: PA-Resonances and Hyper-nuclei

Track Classification: Resonances and Hyper-nuclei
Measurements of $J/\psi$ production in Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV from STAR experiment

Quarkonia are an important probe to study the properties of the quark-gluon plasma (QGP) created in heavy-ion collisions. In particular, the $J/\psi$ nuclear modification factor, $R_{AA}$, probes hot nuclear matter effects, such as the dissociation arising from the color screening effect and the regeneration by deconfined charm and anti-charm quarks. On the other hand, the $J/\psi$ elliptic flow, $v_2$, provides information about the charm quark thermalization and $J/\psi$ regeneration. Measurements of $J/\psi v_2$ and $R_{AA}$ together can provide a deep insight into the thermal and dynamical properties of the QGP. In 2018, the STAR isobar program (Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV) collected the largest heavy-ion data sample so far, which provides a unique opportunity to study the $J/\psi$ production in these collisions with good precision. In this talk, we will present measurements of $J/\psi v_2$ and $R_{AA}$ as a function of transverse momentum and centrality in Ru+Ru and Zr+Zr at $\sqrt{s_{NN}} = 200$ GeV.

Present via

Online

Primary author: YANG, Qian (Shandong University)

Co-author: STAR COLLABORATION

Presenter: YANG, Qian (Shandong University)

Session Classification: PA-Heavy-flavor and Quarkonia

Track Classification: Heavy-flavor and Quarkonia
Femtoscopic measurements of two-kaons combinations in Au+Au collisions at the STAR experiment

Tuesday, 14 June 2022 12:10 (20 minutes)

Relativistic heavy-ion collisions can study properties of nuclear matter in high-energy experiments like the STAR experiment. One of the methods to learn about bulk matter is the femtoscopy technique, which relies on information carried by the particles produced during the collisions. The emission source parameters, like space-time characteristics, are provided using femtoscopic quantities. High statistics data from RHIC can make it possible to study the correlations between strange particles, like charged and neutral kaons. The pair-wise interactions between the identical kaons that form the basis for femtoscopy are quantum statistics and the Coulomb interaction for $K^\pm K^\pm$, and quantum statistics and the final-state interaction through the $f_0(980)/a_0(980)$ threshold resonances for $K_0^0 K_0^0$. The interactions between non-identical kaons pairs of $K_0^0 K_{\pm}$ are essential, as the strong FSI is described only by the $a_0(980)$ resonance, which could be a four-quark state.

This talk will present the femtoscopic measurements of strange particles with charged and neutral kaons correlations in Au+Au collisions at the RHIC energy. The experimental results will be compared with the theoretical predictions.

Present via

Online

Primary author: PAWLOWSKA, Diana (Warsaw University of Technology)

Presenter: PAWLOWSKA, Diana (Warsaw University of Technology)

Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Higher-order cumulants of net-proton distributions are sensitive to the details of the phase structure of the QCD phase diagram. Lattice QCD and QCD-based model calculations indicate that the signs of sixth and eighth order cumulants have different combinations in the hadronic phase, partonic phase, and near the transition temperature.

We report the first measurements of seventh and eighth order cumulants of net-proton distributions in the high statistics Au+Au collisions at $\sqrt{s_{NN}} = 27, 54.4, \text{ and } 200 \text{ GeV}$. The measurements are performed at mid-rapidity $|y| < 0.5$ within $0.4 < p_T < 2.0 \text{ GeV/c}$ using the Time Projection Chamber and Time-of-Flight detector. The measurements in Au+Au collisions at 200 GeV will be compared to those from Zr+Zr and Ru+Ru collisions to understand the system size dependence. The signs of the measured sixth, seventh, and eighth order cumulants will be contrasted to those expected from the lattice QCD and QCD-based models. The ratios of the measured cumulants will also be compared with those obtained from the transport and thermal models to understand the role of baryon number conservation and the validity of the models.

Present via

Online

Primary author: PANDAV, Ashish
Co-author: STAR COLLABORATION
Presenter: PANDAV, Ashish
Session Classification: PA-Bulk matter phenomena, QCD phase diagram, and Critical point

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point
Measurements of global and local polarization of hyperons in 200 GeV isobar collisions from STAR

*Tuesday, 14 June 2022 14:20 (20 minutes)*

In heavy-ion collisions, the observation of the global and local polarization of hyperons has revealed the existence of large vorticities perpendicular to reaction plane due to systems’s orbital angular momentum and along beam direction due to collective velocity field, respectively. With the high-statistics data from isobar collisions of Ru+Ru and Zr+Zr at $\sqrt{s_{NN}} = 200$ GeV collected by the STAR experiment, we present differential measurements of global polarization for $\Lambda/\bar{\Lambda}$ and $\Xi^\pm$ as a function of centrality, $p_T$, and $\eta$. These measurements allow us to study the possible magnetic field driven effects through the polarization difference between Ru+Ru and Zr+Zr, owing to a larger magnetic field in the former. Furthermore, the first measurements of $\Lambda$ hyperon local polarization along beam direction relative to the third order event plane as well as the second order event plane will be presented. A comparison of results from isobar and Au+Au collisions provides important new insights into the collision system size dependence of the vorticities in heavy-ion collisions.

Present via

Online

**Primary author:** GOU, Xingrui (Shandong University)

**Presenters:** GOU, Xingrui (Shandong University); GOU, Xingrui

**Session Classification:** PA-Bulk matter phenomena, QCD phase diagram, and Critical point

**Track Classification:** Bulk matter phenomena, QCD phase diagram, and Critical point
Probing novel baryonic spin Hall effect using $\Lambda$ spin polarization at STAR

Tuesday, 14 June 2022 17:25 (1 minute)

The Spin Hall Effect (SHE) is a generation of spin polarization for moving spin carriers in materials under an external electric field and is instrumental in investigating quantum effects in many-body systems\(^1\). Recent theoretical calculations indicate that the gradient of baryonic chemical potential (analogous to the electric field) can induce a sizeable spin Hall current in Au+Au collisions at $\sqrt{s_{NN}} \sim 10$ GeV. Furthermore, at the RHIC Beam Energy Scan (BES) energies, the sign as well as the pattern of energy dependence of the difference between the harmonics of spin polarization of $\Lambda$ and $\bar{\Lambda}$ hyperons, can be significantly different with and without the presence of baryonic spin Hall current [2-4].

In this talk, we will present the harmonic coefficients of $\Lambda$ hyperons’ spin polarization ($P_x \sin(2\Delta \phi)$, $P_y \cos(2\Delta \phi)$, $P_z \sin(2\Delta \phi)$) as functions of transverse momentum, rapidity, and collision centrality in RHIC BES-II Au+Au collisions at $\sqrt{s_{NN}} = 7.7, 14.6, 19.6, \text{ and } 27$ GeV. These measurements serve as the first experimental probe of the predicted baryonic SHE in heavy-ion collisions.

\(^1\) Y. Kato \emph{et al.}, Science 306 (2004) 1910
\(^2\) S. Liu \emph{et al.}, JHEP 07 (2021) 181
\(^3\) B. Fu \emph{et al.}, Phys. Rev. Lett. 127 (2021) 142301
\(^4\) B. Fu \emph{et al.}, arXiv: 2201.12970 (2022)

Present via

Online

Primary author: HU, Qiang (Institute of Modern Physics of Chinese Academy of Science)

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Session Classification: Poster

Track Classification: Bulk matter phenomena, QCD phase diagram, and Critical point