第二届安徽省核物理研讨会

Report of Contributions

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Contribution ID: **2** Type: **not specified**

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Saturday, 4 January 2025 14:00 (30 minutes)

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TBD

Saturday, 4 January 2025 15:00 (30 minutes)

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

Measurements of proton-antiproton pairs from QED vacuum excitation in Au+Au ultra-peripheral collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV from STAR

Relativistic heavy-ion collisions generate extremely strong electromagnetic (EM) fields, providing an ideal environment to study the EM excitation of the vacuum. The Breit-Wheeler process, which involves the electron-position pair production via photon-photon interactions, represents the lowest-order decay mode of the QED vacuum excitation. This process was first observed by the STAR experiment in 2021, and has stimulated further exploration into higher-order decay modes, including hadron-antihadron pair production.

In this presentation, we will report the first measurement of proton-antiproton pairs resulting from QED vacuum excitation in Au+Au ultra-peripheral collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV by the STAR experiment. The pairs' invariant mass (from $M_{p\bar{p}}$ = 2.1 to 2.4 $\mathrm{GeV/c^2}$), transverse momentum p_{T}, and the azimuthal angular modulation caused by the polarized EM field will be presented. The measured results will be compared with theoretical calculations. These measurements will shed new light on the understanding of the QED vacuum.

Primary author: 吴, 鑫 (中国科学技术大学)

Presenter: 吴, 鑫 (中国科学技术大学)

Contribution ID: **6** Type: **not specified**

J/psi, 探测夸克物质的一杆冒烟的枪

我将回顾在相对论重离子碰撞中如何用重味粒子探测新的物质形态-夸克胶子等离子体。

Primary authors: Dr ZHAO, Jiaxing (Frankfurt University); ZHUANG, Pengfei (Tsinghua University)

Presenter: ZHUANG, Pengfei (Tsinghua University)

Contribution ID: **7** Type: **not specified**

Corrections from space-time dependent electromagnetic fields to Wigner functions and spin polarization

We have derived the Wigner equations at global equilibrium with constant vorticity but space-time dependent electromagnetic fields up to second order in semiclassical expansion. We obtain the new second-order contributions to the charge currents and energy-momentum tensor from the varying electromagnetic fields. We also compute the new corrections to the spin polarization pesudo-vector from both contant and varying electromagnetic fields. We also find that the space-time dependent
electromagnetic field provides a tighter constraint on the solutions of Wigner functions in global equilibrium compared with constant electromagnetic field.

Primary authors: PU, Shi (University of Science and Technology of China); YANG, Shizheng (USTC); 高, 建华 (山东大学（威海）)

Presenter: YANG, Shizheng (USTC)

Contribution ID: **8** Type: **not specified**

Estimate the magnetic field in heavy-ion collisions by virtual photon polarization and dilepton anisotropy

The measurement of the magnetic field created in high-energy heavy-ion collisions is challenging, due to the fact that the magnetic field decays so drastically that in a thermalized quark-gluon plasma the field strength becomes rather weak. By incorporating the weak magnetic effect into the medium, and especially into the production formalism of dileptons from the quark-gluon plasma, the effect of dilepton polarization is studied through the dilepton angular distribution. We find that the anisotropic coefficients in the dilepton spectrum are quite sensitive to the orientation and strength of the weak field. Accordingly, these coefficients provide ideal probes for the magnetic field in realistic experiments.

Primary authors: YAN, Li (复旦大学); Dr WEI, Minghua (Fudan University)

Presenter: Dr WEI, Minghua (Fudan University)

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

Measurements of thermal dielectron and QGP temperature in isobar collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV

Lattice QCD predicts a phase transition from hadronic matter to the Quark-Gluon Plasma (QGP) at high temperature and low baryon chemical potential. Thermal dileptons can be produced throughout the entire evolution of relativistic heavy-ion collisions and do not involve strong interactions. As a result, they can carry original information about their emission source, and are therefore suggested as the ideal probes of the hot and dense medium. In particular, the invariant mass distribution of thermal dielectrons is not subjected to blue-shift effects, which enables the extraction of the average temperature of the hot QCD medium at different stages of the evolution. In this presentation, we report the measurements of thermal dielectron invariant mass spectra in Ru+Ru and Zr+Zr collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV with the STAR experiment. The average temperature extracted from thermal dielectrons in the low-mass and intermediate-mass regions will be presented as a function of baryon chemical potential and compared with those from other collision energies and systems. These measurements will shed new light on the understanding of the QGP evolution and the in-medium properties of the ρ meson.

Primary author: 罗, 加宣 (University of Science and Technology of China)

Presenter: 罗, 加宣 (University of Science and Technology of China)

Contribution ID: **10** Type: **not specified**

关于原子核配对壳模型的研究

将原子核配对壳用于中重核素的研究中。

Primary author: 包, 莉娜 (陆军炮兵防空兵学院)

Presenter: 包, 莉娜 (陆军炮兵防空兵学院)

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

Exploration of the QCD Phase Diagram in Heavy-Ion Collisions

The phase diagram of Quantum Chromodynamics (QCD) is a fundamental framework for understanding strongly interacting matter under extreme conditions. Heavy-ion collision experiments provide a unique opportunity to study the QCD phase transition between hadronic matter and quark-gluon plasma (QGP) by recreating high-temperature and/or high-baryon-density environments. Investigating this phase diagram can reveal the potential existence of the QCD critical point (CP) and the nature of phase transitions, contributing valuable insights into the strong interaction.

This talk will focus on recent progress in probing the QCD phase diagram, with a particular emphasis on the precision measurement of net-proton number fluctuations from the RHIC Beam Energy Scan Program - Phase II (BES-II). The presentation will also discuss the challenges in interpreting the data and the future opportunities to further our understanding of the QCD phase structure.

Primary author: SI, Fan (University of Science and Technology of China)

Presenter: SI, Fan (University of Science and Technology of China)

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

Charmonium production in isobaric collisions with the STAR experiment

Charmonium is an important to probe the properties of the quark-gluon plasma (QGP) created in heavy-ion collisions due to the modification of its yield by the effects of dissociation and regeneration in QGP. About 2 billion events each in isobaric collisions ($^{96}_{44}Ru$ + $^{96}_{44}Ru$ and $^{96}_{40}Zr$ + $^{96}_{40}Zr$) at $\sqrt{s_{\rm NN}}$ = 200 GeV has been collected by STAR in 2018, providing a unique opportunity for the study of charmonium with observables has never been explored at RHIC before.

In this contribution, the J/ψ are reconstructed via the e^+e^- decay channel, and a machine learning technique is used when obtaining the $\psi(2S)$ signals. The first measurement of $\psi(2S)$ production in heavy ion collisions at RHIC will be presented. Centrality and transverse momentum dependence of J/ψ nuclear modification factor and the ratio of $\psi(2S)$ yield over that of J/ψ will be shown and physics implication will be discussed.

Primary author: SHEN, Kaifeng (University of Science and Technology of China)

Presenter: SHEN, Kaifeng (University of Science and Technology of China)

Contribution ID: **13** Type: **not specified**

Light hypernuclei measurements from STAR experiment

Nuclei containing strange quarks, which are called hypernuclei, are ideal hyperon-baryon bound systems for studying the hyperon-nucleon (Y-N) interactions and therefore been the subject of intense study.
The Y-N interaction, an important ingredient for the nuclear equation-of-state of astrophysical objects such as neutron stars, remains poorly constrained.
Moreover, the production mechanisms of hypernuclei are not well understood.
Measuring the hypernuclei can shed light on the production mechanisms and the role Y-N interaction plays at neutron stars densities.

Light hypernuclei are expected to be abundantly produced at low collision energies due to the high baryon density. The central-of-mass energies of STAR BES-II program including fixed target Au+Au collisions taken in 2018-2021 range from 3.0 GeV to 27 GeV, which offer great opportunity to study hypernuclei production.

In this talk, we will review the hypernuclei measurements from the STAR experiment, in which hypernuclei structure parameters such as yield, lifetime, flow, Λ binding energy, branch ratio have been studied.

Primary author: LI, Xiujun (USTC)

Presenter: LI, Xiujun (USTC)

Contribution ID: **14** Type: **not specified**

Measurements of ϒ and very low p_{T} J/ψ production in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV at STAR

Heavy quarkonium states, predominantly generated via initial hard scatterings, traverse the evolution of the Quark-Gluon Plasma (QGP), thus serving as ideal probes to study the properties of the QGP. The suppression of these states due to color screening suggests direct evidence of QGP formation. In heavy-ion collisions, the strong electromagnetic fields produced by colliding nuclei can be represented by a spectrum of photons, leading to photon-induced interactions. While such interactions are traditionally studied in ultra-peripheral collisions (UPC) without any nuclear overlap, significant enhancements of J/ψ production at very low transverse momentum (p_{T} < 0.3 GeV/c) above the expected hadronic interaction yields have been observed experimentally in non-UPC events, likely due to coherent photon interactions. Studies of very low p_{T} J/ψ production in peripheral collisions offer a chance to investigate photoproduction under more defined and confined conditions compared to UPC. Moreover, different ϒ states are expected to dissociate at different temperatures depending on their binding energies. Measurement of such sequential suppression of the ϒ states can be used to study the modification of the QCD force in the medium and the QGP’ s thermodynamic properties.

In this presentation, we will present heavy quarkonium states measurements in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV by the STAR experiment at RHIC. The ϒ yields and nuclear modification factors are presented as a function of centrality and p_{T}. The J/ψ yields and nuclear modification factors are presented as a function of p_{T}. The excess yields of very low p_{T} J/ψ are shown as a function of p_{T}^2 and N_{part}. Physics implications will also be discussed together with model comparisons.

Primary author: LI, Ziyang (University of Science and Technology of China)

Presenter: LI, Ziyang (University of Science and Technology of China)

Contribution ID: **15** Type: **not specified**

Data-driven measurements of the total beauty production in pp collisions at the LHC

Beauty hadron production in proton-proton (pp) collisions can be used to test the predictions of perturbative Quantum Chromodynamics (pQCD), providing constraints on parton distribution functions and hadronization processes. Furthermore, it serves as a reference for studying nuclear medium effects in heavy-ion collisions. This work presents Bayesian unfolding data-driven measurements of the open beauty hadron production, utilizing ALICE and LHCb data to recover full kinematic information from the measured non-prompt D^0 and non-prompt J/ψ. The beauty hadron production cross sections are consistent within their uncertainties across different decay channels from two collaborations. The precision of new results significantly improves upon worldwide measurements, providing valuable validation and constraints on mechanisms of heavy-flavour production in pp collisions at $\sqrt{s}$ = 5.02 and 13 TeV [1].

In this talk, the data-driven measurements of the p_{T}-differential $\mathrm{b\overline{b}}$ cross section $\mathrm{d}\sigma/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}$, p_{T}-integrated $\mathrm{b\overline{b}}$ cross section $\mathrm{d}\sigma/\mathrm{d}y$ as well as the total $\mathrm{b\overline{b}}$ cross section $\sigma_{\mathrm{b\overline{b}}}$ at midrapidity in pp collisions at $\sqrt{s}$ = 5.02 and 13 TeV will be reported. The results are compared with existing measurements and theoretical calculations.

Reference:

[1] X. Bai, G. Li, Y. Zhang et. al, JHEP11(2024)018, arXiv.2405.01444v2

Primary author: GUANGSHENG, Li (中国科学技术大学)

Presenter: GUANGSHENG, Li (中国科学技术大学)

Contribution ID: **16** Type: **not specified**

Rescattering effects on spin-interference for vector meson photoproduction in heavy-ion collisions

Photoproduction is the interaction with two nuclei collisions, a linearly polarized quasi-real photon from one nucleus can interact with the other nucleus to produce a vector meson, such as ρ^0. Recently, some measurements by various experiments in ultra-peripheral collisions have observed spin-interference in ρ^0 photoproduction from STAR, marking a breakthrough in Fermi-scale quantum interference experiments. Based on it, STAR extended the measurement to hadronic heavy-ion collisions, where significant rescattering effects on ρ mesons are expected.
In this report, we will discuss how these rescattering effects influence the measurement of spin-interference. By embedding ρ^0 mesons produced via photoproduction, modeled using the Vector Meson Dominance (VMD) model, into the Ultra-Relativistic Quantum Molecular Dynamics (UrQMD) framework, we estimate the effect on the $\cos 2\phi$ and $\cos 4\phi$ modulations, and account for rescattering effects when comparing theoretical predictions with experimental results in hadronic heavy-ion collisions.

Primary author: WANG, Yusong (University of Science and Technology of China)

Presenter: WANG, Yusong (University of Science and Technology of China)