第十一届粒子所“青年之星”
2025 年度学术论坛

Report of Contributions

https://indico.ihep.ac.cn/e/27851

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

Development of a simulation and analysis framework for NνDEx experiment

In this work, a simulation and analysyis framework for the NνDEx experiment is presented. NνDEx aims to search for the neutrinoless double beta decay in ^{82}Se using a high pressure $^{82}SeF_6$ gas time projection chamber (TPC). Direct charge collection for the drifting ion charge carriers using low-noise CMOS charge sensors is the main feature of the experiment.

Using density functional theory and two-temperature theory, the reduced mobilities of SeF_5^- and SeF_6^- ions in SeF_6 were calculated, obtaining values of 0.444 ± 0.133 and $0.430 \pm 0.129\,\mathrm{cm^2V^{-1}s^{-1}}$, respectively.

The TPC geometry, featuring a cathode–focusing plane–anode structure and a 10,000-pixel readout array, was modeled in COMSOL to compute electric fields. Signal and background events were generated with BxDecay0 and Geant4, while Garfield++ was used to simulate charge transport and signal induction. Three-dimensional tracks were reconstructed from drift-time differences using a breadth-first search algorithm.

To enhance signal–background separation, six topological variables were extracted from reconstructed tracks and used to define selection criteria. A boosted decision tree was applied for a preliminary analysis. The simulation framework thus provides a comprehensive tool for detector design and sensitivity studies in the NνDEx experiment.

Primary author: LIANG, Tianyu (Central China Normal University)

Presenter: LIANG, Tianyu (Central China Normal University)

Session Classification: Poster

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

通过重离子碰撞中逐事件 π 介子不对称性探测中子皮

Thursday, 27 November 2025 16:55 (15 minutes)

在这项研究中，我们提出一种新颖的方法，通过分析π^- 与π^+ 产额差Δn_π 的逐事件分布，来预测金核的中子皮厚度。借助 SMASH 模型，我们模拟了$\sqrt{s_{\rm NN}} = 3$~GeV 下的超偏心 Au+Au 碰撞。结果显示，Δn_π 的平均值、$(\pi^- + \pi^+)$ 与$(\pi^- - \pi^+)$ 之间的皮尔逊相关系数，均与中子皮厚度有显著的线性关系；更重要的是，逐事件分布中连接不同Δn_π 值点的直线斜率也表现出同样的线性依赖，其中，最敏感的Δn_π 对为$(-1, 1)$、$(-1, 2)$、$(0, 1)$ 和$(0, 2)$，为实验测定提供了全新的可观测量。最后，在完全相同的初始条件下对比 SMASH 与 UrQMD 模型结果，发现虽然斜率依赖于具体模型，但只需从实验逐事件数据中提取多组Δn_π 斜率并反推对应的中子皮厚度，即可判别哪个模型更贴近真实物理，从而有效降低理论不确定性。

Primary authors: 田, 栩华 (CCNU); 庞, 龙刚 (C)

Presenter: 田, 栩华 (CCNU)

Session Classification: Thursday Afternoon Second Session

Contribution ID: **38** Type: **not specified**

Neural network learning of multi-scale and discrete temporal features in directed percolation

Thursday, 27 November 2025 17:15 (1 minute)

Neural network methods are increasingly applied to solve phase transition problems, particularly in identifying critical points in non-equilibrium phase transitions, offering more convenience compared to traditional methods. In this paper, we analyze the (1+1)-dimensional and (2+1)-dimensional directed percolation models using an autoencoder network. We demonstrate that single-step configurations after reaching steady state can replace traditional full configurations for learning purposes. This approach significantly reduces data size and accelerates training time.Furthermore, we introduce a multi-input branch autoencoder network to extract shared features from systems of different sizes. The neural network is capable of learning results from finite-size scaling. By modifying the network input to include configurations at discrete time steps, the network can also capture temporal information, enabling dynamic analysis of non-equilibrium phase boundaries. Our proposed method allows for high-precision identification of critical points using both spatial and temporal features.

Primary author: 高, 峰

Presenter: 高, 峰

Session Classification: Poster

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

Relaxation dynamics and the free energy near the phase boundary of the 3D kinetic Ising model

Thursday, 27 November 2025 17:16 (1 minute)

We study the relaxation dynamics of the three-dimensional kinetic Ising model along the phase boundary, focusing on the relaxation behavior [1] and the evolution of the underlying free-energy landscape[2]. We find that the average equilibration time increases significantly as the temperature moves far below the critical point T_c, and exhibits ultraslow relaxation along the first-order phase transition line. Dynamic scaling persists both near T_c and at T « T_c, with the latter showing a larger dynamic exponent. By tracking the time evolution of the free-energy landscape, we show that complex fine structures emerging at low temperatures trap random initial configurations, producing a strong delay in equilibration - the effect we identify as ultra-slow relaxation. This phenomenon is characterized by a self-divergence of the relative variance of equilibration times, revealing a previously unrecognized dynamic signature of first-order phase transitions.
[1]Xiaobing Li, Ranran Guo, Mingmei Xu et al., Phys. Rev. E 111, 064115 (2025).
[2] Ranran Guo, Xiaobing Li,Yuming Zhong et al., arXiv:2504.14878v2.

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Presenter: 郭, 冉冉 (ccnu)

Session Classification: Poster

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

一类分段光滑不连续映象中的边界碰撞分岔和余维分岔

Thursday, 27 November 2025 14:45 (15 minutes)

本文研究了一类分段光滑不连续一维映象的动力学。当周期轨道失稳时，系统会进入混沌状态。而不连续性的出现导致了边界碰撞分岔的发生，可以使稳定的周期轨道转变为混沌状态或者另外一个稳定的周期状态。在这类转变点的附近，常常伴随着吸引子共存现象。此外，随控制参数减小出现周期递增现象。得到了求解这类不连续映象在任意参数下边界碰撞分岔临界控制参数的一般方法。基于稳定性和边界碰撞分岔的解析分析, 获得了双参数平面中系统动力学的相平面, 讨论了系统的动力学行为，发现了三类余维-2 分岔点，并给出了其坐标通式。同时，在相平面中还发现了余维分岔点的融合，构成一类特殊的三相点，并解析得到其存在的条件。

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Session Classification: Thursday Afternoon First Session

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

CGC-induced longitudinal ridge in p-Pb collisions

Thursday, 27 November 2025 15:00 (15 minutes)

Within the Color Glass Condensate (CGC) effective field theory, we investigate the long-range rapidity correlations in proton-lead (p-Pb) collisions at √ s NN = 5.02 TeV. As expected, the long-range rapidity correlations rebound after bottoming, which is successfully reproduced by the CGC. It is also found that the correlation rebound appears around the sum of the saturation momenta of the projectile and target, and moves to larger rapidities at higher collision energies. Beyond that,the longitudinal rapidity correlations are asymmetrically distributed in p-Pb collisions when the transverse momenta of two particles differ, while become symmetric when the transverse momenta of two particles coincide. This feature of rapidity correlations is unique to asymmetric pA collisions,
and directly results from the saturation and the quantum evolution of gluons within the framework
of the CGC.

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Session Classification: Thursday Afternoon First Session

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

Nucleon structure from holographic QCD

Thursday, 27 November 2025 14:00 (15 minutes)

We employ the Veneziano quantum chromodynamics (VQCD) model, a holographic approach that dynamically simulates essential QCD characteristics, including linear mass spectra, confinement, asymptotic freedom, and magnetic charge screening, while incorporating quark flavor effects. Using this model, we first calculate the proton mass spectrum and the wave function, incorporating anomalous dimensions to refine our results. Next, we compute the proton structure functions across a range of Bjorken values using consistent parameters. Furthermore, we derive the proton electromagnetic form factor by solving the electromagnetic field’ s motion equation, accounting for background effects, and demonstrate qualitative consistency with results from free electromagnetic fields coupled to fermions. Finally, we calculate the gravitational form factors by introducing an effective graviton mass arising from chiral symmetry breaking and the proton energy-momentum tensor. Our calculations yield results that are in excellent agreement with experimental data and lattice QCD computations, validating the VQCD model as a robust tool for studying proton properties.

Based on: Phys.Rev.D 112 (2025) 3, 036011

Primary authors: 邓, 家力; 侯, 德富

Presenter: 邓, 家力

Session Classification: Thursday Afternoon First Session

Contribution ID: **43** Type: **not specified**

Rotation effect on the spectral function of heavy vector mesons in holographic QCD

Thursday, 27 November 2025 17:22 (1 minute)

探究 J/ψ 和 Y(1S) 这类重矢量介子对于理解重离子碰撞中形成的夸克胶子等离子体（QGP）至关重要。本研究通过在全息 QCD 中引入旋转介质，考察了旋转效应对 J/ψ 和 Y(1S) 性质的影响。研究发现，温度、化学势以及旋转半径效应会促进 J/ψ 和 Y(1S) 态在介质中的解离过程。这种旋转诱导的效应对于横向的重矢量介子比纵向更为显著。本文首次在全息框架下研究了均匀旋转系统半径对矢量介子谱的影响，发现旋转半径的增大会促进 J/ψ 和 Y(1S) 的解离。我们还发现，在较大旋转半径下，垂直于旋转角速度方向的解离比平行方向的解离更为显著。

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Presenter: 王, 晓龙 (华中师范大学)

Session Classification: Poster

Contribution ID: **44** Type: **not specified**

Nonextensive (3+1)-dimensional hydrodynamics for relativistic heavy-ion collisions

Thursday, 27 November 2025 16:25 (15 minutes)

A nonextensive (3+1)-dimensional hydrodynamic model for multiparticle production processes, NEX-CLVisc, is developed in the framework of CLVisc where the viscous corrections are turned off. It assumes that the nonextensive effects consistently exist in the initial conditions set by the optical Glauber model, the equation of state and the hadron kinetic freeze-out procedure. The model is then applied to simulate the pseudorapidity (\eta) distribution, the transverse momentum (pT) spectra and the pT-differential elliptic flow (v2) of charged particles in Pb-Pb collisions at \sqrt{sNN} = 2.76 TeV and 5.02 TeV,respectively. It is found that the model can reasonably well reproduce the experimental data of the \eta distribution and the charged-particle spectra in a pT range up to 6–8 GeV/c. When compared with the ideal hydrodynamic model, the pT-differential v2 of charged particles is suppressed in the NEX-CLVisc model, which is similar to that observed in the hydrodynamic model with a shear viscous correction. Moreover, due to the lack of the viscous corrections and the event-by-event fluctuation, the model can only describe the pT-differential v2 up to 3–4 GeV/c, which is smaller than its applicable range for the particle pT spectra.

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Presenter: 石, 佳豪 (华中师范大学物理科学与技术学院)

Session Classification: Thursday Afternoon Second Session

Contribution ID: **45** Type: **not specified**

Investigation of $T^*_{cs0}(2870)^0$ in pp collisions at $\sqrt{s}$ = 7 TeV with the PACIAE model

Thursday, 27 November 2025 11:40 (15 minutes)

报告人：Qiang Wang (王强)，博研 (导师：周代梅)
关联论文预印本号：arXiv: 2506.20145

摘要：We have used the parton and hadron cascade model PACIAE together with the Dynamically Constrained Phase-space Coalescence model (DCPC) to study the $T^*_{cs0}(2870)^0$ production in pp collision at $\sqrt{s}$ = 7 TeV, following the LHCb observation of $T^*_{cs0}(2870)^0$ in the $B^- \to D^- D^0 K^0_S$ decays in pp collisions at $\sqrt{s}$ = 7, 8, and 13 TeV [PRL 134(2025)101901]. The final hadronic states of the pp collisions at $\sqrt{s}$ = 7 TeV are first simulated by the PACIAE model. Four sets of $T^*_{cs0}(2870)^0$ candidates are then recombined by the DCPC model using the constituent meson pair of $D^0 K^0_S$, $D^+ K^-$, $D^{*+} K^{*-}$, and $D^{*0} \bar{K}^{*0}$ based on the above simulated final hadronic states, respectively. We calculate their rapidity distributions, transverse momentum spectra, and angular distribution between the two component mesons, as well as angular distribution between D component meson and $T^*_{cs0}(2870)^0$. Our results show that the yields of four $T^*_{cs0}(2870)^0$ candidates follow the magnitude order of $D^0 K^0_S > D^+ K^- > D^{*+} K^{*-} \sim D^{*0} \bar{K}^{*0}$. Similar ordering behavior is also observed in the aforementioned distributions.

Primary author: WANG, Qiang (Central China Normal University)

Co-authors: SHE, Zhilei (Wuhan Textile University); LEI(雷), Anke(安科) (Guizhou Normal University (贵州师范大学)); 周, 代梅 (CCNU); 郑, 华 (陕西师范大学); ZHANG, Wenchao (陕西师范大学); BENHAO, Sa (China Institute of Atomic Energy); YAN, Yu-Liang (China Institute of Atomic Energy)

Presenter: WANG, Qiang (Central China Normal University)

Session Classification: Thursday Morning Second Session

Contribution ID: **46** Type: **not specified**

Precision measurement of CP violation and branching fractions in $B^{\pm} \to K^0_{\rm S} h^{\pm}$ $(h = \pi, K)$ decays and search for the rare decay $B^{\pm}_c \to K^0_{\rm S} K^{\pm}$

Thursday, 27 November 2025 09:35 (15 minutes)

This Letter presents the world’ s most precise measurements of direct CP asymmetries in $B^+ \to K^0_{\rm S}\pi^+$ and $B^+ \to K^0_{\rm S}K^+$ decays. The measurement precision in the theoretically clean $B^+ \to K^0_{\rm S}\pi^+$ mode reaches the
$calO(0.01)$ level for the first time, providing a stringent test of the Standard Model prediction of zero CP asymmetry, and offering input to resolve the long-standing ‘$K\pi$ puzzle’, where hadronic effects limited the interpretation. These results represent a significant step forward in the study of charmless B decays for testing the Standard Model and probing new sources of CP violation.

Primary author: 侯, 睿文

Presenter: 侯, 睿文

Session Classification: Thursday Morning First Session

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

Differentiating Energy-Energy Correlators with Charged Particle Multiplicities within a Jet

Thursday, 27 November 2025 11:10 (15 minutes)

Recent CMS results reveal that jets with extremely high multiplicity exhibit novel substructure patterns not seen in ordinary jets, including long-range correlations. However, standard Monte Carlo tools struggle to access this regime due to its rarity and complexity. In this work, we develop a theoretical framework to study high-multiplicity jets, incorporating both multiplicity evolution and Energy-Energy Correlators (EEC) as key probes of jet substructure. Using the normalized multiplicity ratio m=n/⟨n⟩, we investigate how jet properties evolve across multiplicity classes and compare our findings with Pythia8 simulations. This provides new insights into perturbative QCD dynamics in extreme jet events.

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Presenter: 段, 丕 (CCNU)

Session Classification: Thursday Morning Second Session

Contribution ID: **48** Type: **not specified**

γ -氨基丁酸 (Gaba) 受体介导麻醉的蛋白质组学研究

Thursday, 27 November 2025 09:50 (15 minutes)

麻醉剂在外科手术和治疗干预中至关重要，但它们具有副作用和不同程度的有效性，因此需要提供更精确和可控效果的新型麻醉剂。针对中枢神经系统中的主要抑制性受体——γ 氨基丁酸（GABA）受体，可以增强其抑制作用，从而可能减少副作用，同时提高麻醉药的效力。在这项研究中，我们考虑了蛋白质-蛋白质相互作用 (PPI) 网络中的 4000 多种蛋白质和超过 150 万种已知的结合化合物，介绍了基于 24 种 GABA 受体亚型的 GABA 受体介导的麻醉的蛋白质组学学习。我们开发了相应的药物-靶标相互作用网络，以确定新型麻醉剂设计的潜在先导化合物。为了确保稳健的蛋白质组学学习预测，我们整理了一个数据集，其中包含 PPI 网络内 980 个目标池中的 136 个目标。我们采用了三种机器学习算法，集成了先进的自然语言处理（NLP）模型，例如预训练的变压器和自动编码器嵌入。通过全面的筛选过程，我们评估了超过 180,000 种针对 GABRA5 受体的候选药物的副作用和再利用潜力。此外，我们还评估了这些候选药物的 ADMET（吸收、分布、代谢、排泄和毒性）特性，以确定那些具有接近最佳特性的候选药物。这种方法还涉及优化现有麻醉剂的结构。我们的工作提出了一种创新策略，用于开发新麻醉药物、优化麻醉剂使用以及更深入地了解潜在的麻醉相关副作用。

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Presenter: Dr 陈, 龙

Session Classification: Thursday Morning First Session

Contribution ID: **49** Type: **not specified**

Machine learning predictions from unpredictable chaos

Thursday, 27 November 2025 17:17 (1 minute)

Chaos is omnipresent in nature, and its understanding provides enormous social and economic benefits. However, the unpredictability of chaotic systems is a textbook concept due to their sensitivity to initial conditions, aperiodic behaviour, fractal dimensions, nonlinearity and strange attractors. In this work, we introduce, for the first time, chaotic learning, a novel multiscale topological paradigm that enables accurate predictions from chaotic systems. We show that seemingly random and unpredictable chaotic dynamics counterintuitively offer unprecedented quantitative predictions. Specifically, we devise multiscale topological Laplacians to embed real-world data into a family of interactive chaotic dynamical systems, modulate their dynamical behaviours and enable the accurate prediction of the input data. As a proof of concept, we consider 28 datasets from four categories of realistic problems: 10 brain waves, four benchmark protein datasets, 13 single-cell RNA sequencing datasets and an image dataset, as well as two distinct chaotic dynamical systems, namely the Lorenz and Rossler attractors. We demonstrate chaotic learning predictions of the physical properties from chaos. Our new chaotic learning paradigm profoundly changes the textbook perception of chaos and bridges topology, chaos and learning for the first time.

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Presenter: 窦, 博正

Session Classification: Poster

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

Shear and bulk viscosities of gluon plasma across the transition temperature

Thursday, 27 November 2025 17:24 (1 minute)

Shear and bulk viscosities are two key transport coefficients that characterize the fundamental properties of quark-gluon plasma.They quantify the response of the energy-momentum tensor to shear flow and divergent flow,serving as crucial input parameters for the phenomenological and transport models that interpret experimental data, such as the elliptic flow v_2.

However, calculating these inherently non-perturbative viscosities within lattice QCD presents challenges due to strong ultraviolet fluctuations in the relevant operators. The traditional approach using the multi-level algorithm is highly effective in suppressing UV fluctuations but is limited to the quenched approximation. Recently, the gradient flow method was introduced to address this issue [1], opening the path to full QCD studies. However, Ref. [1] examined only a single temperature,$1.5T_c$.

This work extends the Ref. [1]'s results to a wide temperature range from 0.76□□ to 2.25□□, focusing on the high-temperature regime while also probing the system's behaviour across the phase transition. The former enables a fair comparison with the next-to-leading-order perturbative estimates which become more reliable at high temperatures, while the latter allows us to study the system's critical dynamics—a topic of wide community concern. The methodology developed in this work provides the foundation for future full QCD calculations.

Reference

[1] L. Altenkort, A.M. Eller, A. Francis, O. Kaczmarek, L. Mazur, G.D. Moore, and H.-T. Shu, Phys. Rev. D 108, 014503 (2023).

Primary authors: ZHANG, Cheng (Central China Normal University); SHU, Hai-Tao; DING, Heng-Tong (Central China Normal University)

Presenter: ZHANG, Cheng (Central China Normal University)

Session Classification: Poster

Contribution ID: **51** Type: **not specified**

Collectivity in Heavy-Ion Collisions at High Baryon Density from STAR BES-II

Thursday, 27 November 2025 09:05 (15 minutes)

Directed and elliptic flow (v_1 and v_2), are sensitive to the dynamics during the early stages of the system
evolution and equation of state of the medium.
The v_1 slope (dv_1/dy) at mid-rapidity of net-baryons is expected to be sensitive to the first-order phase transition, while the Number of Constituent Quark (NCQ) scaling of elliptic flow is regarded as a signal of formation of Quark-Gluon Plasma (QGP).
From the measurements based on the first phase of RHIC beam energy scan (BES-I), the dv_1/dy of net-proton exhibits non-monotonous dependence on collision energy, with a minimum between 11.5 and 19.6 GeV.
The elliptic flow of identified particles at 3 GeV is negative and NCQ scaling is absent unlike at top RHIC energies.
Measurements at more energies within these regions would provide crucial insight into the stages of the medium evolution.

In this talk, the measurements of v_1 and v_2 for light and (multi-)strange particles at $\sqrt{s_{\rm NN}}$ = 3 - 19.6 GeV
from the second phase of the RHIC beam energy scan (BES-II) program will be presented.
The rapidity and transverse momentum (p_T) dependence of v_1 and v_2 will be shown. Also,
the centrality and energy dependence of v_1 slope, NCQ scaling, and p_T-integrated v_2 will be discussed.
The experimental results will be compared with model calculations.
Implications of these measurements on understanding of QCD phase structure will be discussed.

Primary authors: 刘, 利珂 (Central China Normal University); Prof. SHI, Shusu (Central China Normal University)

Presenter: 刘, 利珂 (Central China Normal University)

Session Classification: Thursday Morning First Session

Contribution ID: **52** Type: **not specified**

Production of K+K− pairs through the decay of ϕ mesons

Thursday, 27 November 2025 14:30 (15 minutes)

X.-N. Zhu, Defu Hou, X.-L. Sheng, Phys. Rev. D 112, 056011 (2025)

We develop a theoretical framework for the production of K+K- pairs through the decay of ϕ mesons produced from a thermal background, based on the Nambu-Jona-Lasinio (NJL) model. The differential production rate of K+K- is related to the self-energy of the ϕ meson, incorporating the contributions of the quark loop at leading order and the kaon loop at next-to-leading order in the 1/Nc expansion. We numerically evaluate the invariant mass spectrum of the K+K- pair both in vacuum and at finite temperature. The inclusion of the kaon loop results in a finite width of the spectrum, improving agreement with experimental data. We also investigate the spin alignment of the ϕ meson induced by its motion relative to the thermal background. In the NJL model with only chiral condensates, we find that deviations from the unpolarized limit of 1/3 are negligible.

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Co-authors: 盛, 欣力; 侯, 德富

Presenter: 朱, 鑫男 (Central China Normal University)

Session Classification: Thursday Afternoon First Session

Contribution ID: **53** Type: **not specified**

Chiral Properties of (2+1)-Flavor QCD in Strong Magnetic Fields at Zero Temperature

Thursday, 27 November 2025 17:25 (1 minute)

We present a lattice QCD study of the chiral properties of (2+1)-flavor QCD in background magnetic fields at zero temperature with physical pion masses. Simulations are performed using the highly improved staggered quark (HISQ) action across four different lattice spacings to enable a controlled continuum extrapolation. We compute the renormalized chiral condensates, pseudoscalar meson masses, and decay constants of pions, kaons, and the $\eta_{s\bar{s}}$ as functions of the magnetic field strength. Our results show that magnetic fields enhance the chiral condensates and lead to characteristic modifications in the meson spectrum: the masses of neutral mesons are reduced, while those of charged mesons exhibit a non-monotonic behavior. The decay constants of neutral pseudoscalar mesons are found to be suppressed with increasing magnetic field. To elucidate the origin of the non-monotonic behavior in charged meson masses, we separately analyze the sea and valence quark contributions. These results provide new insights into the interplay between QCD chiral symmetry breaking and strong magnetic fields.

Primary authors: DING, Heng-Tong (Central China Normal University); ZHANG, dan (华中师范大学)

Presenter: ZHANG, dan (华中师范大学)

Session Classification: Poster

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

$\bar{B}^0_{s,d} \to J/\psi\mu^+\mu^-$ Decays in QCD Factorization

Thursday, 27 November 2025 09:20 (15 minutes)

Motivated by the first LHCb searches for the rare $\bar{B}^0_{s,d} \to J/\psi\mu^+\mu^-$ decays, we perform a detailed study of these processes within the QCD factorization formalism. Since the transverse size of the J/ψ meson is small in the heavy quark mass limit, this formalism is generally expected to hold for these decays. We include both the leading- and the next-to-leading-order QCD corrections to the hard-scattering kernels, which are convoluted with the light-cone distribution amplitudes (LCDAs) of the initial- and final-state hadrons. It is numerically found that, depending on the model parameters for the leading-twist B-meson LCDA, the maximum branching ratios of $\bar{B}^0_s \to J/\psi\mu^+\mu^-$ and $\bar{B}^0_d \to J/\psi\mu^+\mu^-$, integrated over the dimuon invariant mass squared q^2 from $1\,\mathrm{GeV}^2$ to $(m_{B_{s,d}} - m_{J/\psi})^2$, can reach, respectively, up to 2.21×10^{-9} and 7.69×10^{-11} at the leading order in α_s. After incorporating the non-factorizable one-loop vertex corrections, these branching ratios are further reduced by about one order of magnitude, with $\mathcal{B}(\bar{B}^0_s \to J/\psi\mu^+\mu^-)|_{q^2 \geq 1\,\mathrm{GeV}^2} = 2.88 \times 10^{-10}$ and $\mathcal{B}(\bar{B}^0_d \to J/\psi\mu^+\mu^-)|_{q^2 \geq 1\,\mathrm{GeV}^2} = 1.07 \times 10^{-11}$. In addition, we have presented the dimuon invariant mass distributions of the individual and total helicity amplitudes squared, as well as the differential and integrated longitudinal polarization fractions of the J/ψ meson, which could be probed by the future LHCb and Belle II experiments with more accumulated data.

Primary authors: ZHAO, Chun-Yang; LI, Xin-Qiang; SHI, Yan; YUAN, Xing-Bo; YANG, Ya--Dong

Presenter: SHI, Yan

Session Classification: Thursday Morning First Session

Contribution ID: **55** Type: **not specified**

D_s elliptic flow as evidence of the sequential hadronization mechanism in the hot QCD medium

Thursday, 27 November 2025 16:40 (15 minutes)

Heavy flavor production serves as an ideal probe of the hadronization mechanism in the hot and dense QCD medium created in relativistic heavy-ion collisions. Heavy quarks acquire elliptic flow through strong coupling with the medium, making v_2 a sensitive observable for probing the hadronization time. In this Letter, we study the production and elliptic flow of D_s and D^0 mesons in $Pb + Pb$ collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV within a Langevin dynamics framework for heavy quarks in the QCD medium, combined with the sequential or simultaneous coalescence plus fragmentation at the hadronization hypersurface. We find that, within the sequential hadronization framework, the earlier-produced D_s exhibits a smaller v_2 than the D^0 in the intermediate $p_{\rm T}$ region. This reversed ordering behavior aligns with preliminary ALICE measurements and provides strong evidence for the heavy flavor sequential hadronization mechanism.

Primary author: XU, Zi-Xuan (Central China Normal University)

Co-authors: ZHAO, Jiaxing (Tsinghau University); DAI, Wei (China University of Geosciences); ZHANG, Ben-Wei (Central China Normal University); ZHUANG, Pengfei (Tsinghua University)

Presenter: XU, Zi-Xuan (Central China Normal University)

Session Classification: Thursday Afternoon Second Session

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

Diffusion Signals Reveal Hidden Connections: A Physics-Inspired Framework for Link Prediction via Personalized PageRank Signals

Thursday, 27 November 2025 17:18 (1 minute)

Link prediction in complex networks–identifying the missing or future connections–remains a cornerstone problem for understanding network evolution and function, yet existing methods struggle to balance computational efficiency with theoretical rigor across heterogeneous topologies. This work introduces a physically principled framework, Diffusion Distance with Personalized PageRank (D-PPR), which unifies static topology with dynamic information flow by modeling nodes as signal sources propagating through the network via Personalized PageRank (PPR) vectors. The method quantifies node-pair similarity through the graph Laplacian-governed diffusion distance between their topology-aware signal distributions, thereby bridging microscopic interactions with macroscopic network dynamics. Systematic benchmarking on synthetic (Barabási-Albert, LFR) and seven large-scale real-world networks spanning technology, biology, and social domains demonstrates that D-PPR achieves highly competitive performance, yielding favorable results when compared to representative local and global heuristics, particularly in sparse and modular networks. These findings establish a rigorous foundation for physics-inspired link prediction by revealing that incorporating dynamical processes into structural similarity metrics enables deeper insights into network connectivity patterns, offering both methodological advances and new theoretical perspectives on the interplay between topology and dynamics.

Primary authors: 邓, 为炳 (华中师范大学物理科学与技术学院); 王, 慧林 (华中师范大学)

Presenter: 王, 慧林 (华中师范大学)

Session Classification: Poster

Contribution ID: **57** Type: **not specified**

Event-by-event jet-induced hydro response from machine learning

Thursday, 27 November 2025 17:26 (1 minute)

In high-energy heavy-ion collisions, energetic partons traverse the quark-gluon plasma (QGP) and deposit energy into the medium, leading to Mach-cone-like jet-induced medium response which modifies the internal structure of jet and impacts jet substructures, such as jet shape and jet fragmentation function. However, accurately simulating jet-induced medium responses requires a complete model that is capable of describing the concurrent evolution of hard and soft partons, as well as significant computational resources for full-scale simulations. In this study, we trained two generative neural networks using Flow matching model with gamma jet events in 0-10\% Pb+Pb collisions at 5.02 TeV to estimate the final-state effects of jet-induced medium response on the 2D and 3D particle spectra. Our findings indicate that with only the initial jet information, that is, the energy momentum of gamma and the jet, along with their initial positions, the network can conditionally generate the final state particle spectra from hydro response. The marginal distribution of the generated spectra along the η and ϕ direction align well with the marginal distribution of the training data from CoLBT. The difference between the distributions generated by the generative model and the CoLBT model is quantified using K-L divergence method, a common technique in the generative field. A low K-L divergence of 10^{-2} order of magnitude was achieved. Furthermore, our generative model demonstrated a significant computational advantage, running million times faster than the CoLBT model to produce the jet-induced medium response spectra.

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Session Classification: Poster

Contribution ID: **58** Type: **not specified**

A Centrality-independent Framework for Revealing Genuine Higher-Order Cumulants in Heavy-Ion Collisions

Thursday, 27 November 2025 16:10 (15 minutes)

We propose a novel centrality definition-independent method for analyzing higher-order cumulants, specifically addressing the challenge of volume fluctuations that dominate in low-energy heavy-ion collisions. This method reconstructs particle number distributions using the Edgeworth expansion, with parameters optimized via a combination of differential evolution algorithm and Bayesian inference. Its effectiveness is validated using UrQMD model simulations and benchmarked against traditional approaches, including centrality definitions based on particle multiplicity. Our results show that the proposed framework yields cumulant patterns consistent with those obtained using number of participant nucleon (N_{part}) based centrality observables, while eliminating the conventional reliance on centrality determination. This consistency confirms the method's ability to extract genuine physical signals, thereby paving the way for probing the intrinsic thermodynamic properties of the produced medium through event-by-event fluctuations.

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Presenter: WANG, Zhaohui (CCNU)

Session Classification: Thursday Afternoon Second Session

Contribution ID: **59** Type: **not specified**

Observation of Strange Dibaryon ($|S| = 3$)

Thursday, 27 November 2025 10:55 (15 minutes)

Dibaryons, exotic states composed of six quarks, have long been a subject of interest in understanding the strong interaction beyond conventional hadrons. Among these, strange dibaryons, which contain strange quarks, offer an important role of studying the hyperon-nucleon (YN) and hyperon-hyperon (YY) interactions . Of particular interest are the spin-0 H (S = -2) and the spin-2 $N\Omega$ (S = -3) dibaryon state, which are considered promising candidates for the strange dibaryon bound state. In heavy-ion collisions, two-particle femtoscopy is a powerful and unique method for extracting information about the spatio-temporal properties of the source, characterising the final state interactions (FSI), and searching for the possible bound states.

In this talk, we will present the measurement of the baryon–baryon correlation function for the p–Ω^- pair in Isobar (Ru+Ru, Zr+Zr) collisions. The correlation function is analyzed within the Lednicky–Lyuboshitz formalism. The extracted scattering length and effective range will be presented and compared with recent lattice QCD and effective-theory model calculations. Most importantly, the physics implications for the possible formation of a strange dibaryon ($S = -3$) bound state will be discussed.

Primary author: ZHANG, Kehao (华中师范大学)

Presenter: ZHANG, Kehao (华中师范大学)

Session Classification: Thursday Morning Second Session

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

Observation of the rare baryonic decay B->p Lambda_bar and measurement of the weak decay parameter

Thursday, 27 November 2025 11:25 (15 minutes)

Charmless two-body B-meson decays to baryon-antibaryon pairs serve as key probes for strong interaction dynamics and CP violation but remain underexplored. This is the first observation of the rare baryonic decay B->p Lambda_bar. The significantly improved branching fraction measurement and the first measurement of the weak decay parameter in this work are of great interests for testing theoretical calculations and understanding the properties of other charmless baryonic B decays

Primary authors: XIE, Yuehong (Central China Normal University); 王, 淦蓉 (CCNU)

Presenter: 王, 淦蓉 (CCNU)

Session Classification: Thursday Morning Second Session

Contribution ID: **61** Type: **not specified**

Revisiting semileptonic B decays via U (2)5 flavor symmetry: SMEFT meets SM

Thursday, 27 November 2025 17:27 (1 minute)

在标准模型有效场理论（SMEFT）框架中，若仅依据味量子数并要求重子数与轻子数守恒，可构造出 2499 个独立的维六算符，其对应的威尔逊系数皆为独立自由参数。如此高的参数自由度不仅削弱了理论的预测性，也限制了不同物理过程之间的关联性。

在引入 U(2)^5 味对称性后，上述情况发生显著改变：该对称性能够大幅减少独立威尔逊系数的数量，使得多个看似无关的过程可由同一组有效参数统一描述。同时，U(2)^5 对称性还能有效抑制 SMEFT 中可能出现的过大味改变中性流（FCNC），并在对称性结构允许的范围内，自然解释为何第三代 Yukawa 耦合能够远大于前两代，从而在味物理中提供了更为合理的一致性描述。

Primary author: 高, 孟超 (华中师范大学)

Presenter: 高, 孟超 (华中师范大学)

Session Classification: Poster

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

imaging nuclear modifications on parton distributions in proton-nucleus collisions

Thursday, 27 November 2025 15:55 (15 minutes)

Nuclear modifications to collinear parton distribution functions are conventionally quantified by the ratios $r_i^{\rm A}(x,Q^2) = f_i^{\rm A,proton}(x,Q^2)/f_i^{\rm proton}(x,Q^2)$. For a given nucleus A, these ratios generally depend on the parton momentum fraction x, the probing scale Q^2, and the parton species i. Determining these dependencies relies on a global analysis of diverse experimental data. However, in realistic observables, these dependencies are intricately intertwined, making their extraction challenging. In this paper, we propose a novel approach to effectively image the nuclear modification factors $r_i^{\rm A}(x,Q^2)$ at the observable level in proton-nucleus collisions at the Large Hadron Collider. Specifically, through a combined study of Z-boson production, Z+jet production, and $Z+c$-jet production, we separately enhance signals arising from light-quark, gluon, and heavy-flavor (charm) distributions in nuclei. This enables us to effectively image the $r_i^{\rm A}(x,Q^2)$ for specific parton species. The feasibility of this method is validated through perturbative calculations at next-to-leading order in the strong coupling constant, employing three sets of nuclear PDF parametrizations: EPPS21, nCTEQ15, and TUJU19. Future measurements of these observables are expected to provide better-motivated parametrization form of nuclear PDFs and yield new insights into the detailed partonic structures of nuclei.

Primary author: YANG, Mengquan (Central China Normal University)

Co-authors: Dr RU, Peng (South China Normal University); Prof. ZHANG, Ben-Wei (Central China Normal University)

Presenter: YANG, Mengquan (Central China Normal University)

Session Classification: Thursday Afternoon Second Session

Contribution ID: **63** Type: **not specified**

Bayesian inference of the critical end point in a (2 + 1)-flavor system from holographic QCD

Thursday, 27 November 2025 10:40 (15 minutes)

We present a Bayesian holographic model constructed by integrating the equation of state and baryon number susceptibility at zero chemical potential from lattice QCD. The model incorporates error estimates derived from lattice data. With this model, we systematically investigate the thermodynamic properties of the 2+1-flavor QCD system. Using Bayesian Inference, we perform precise calibration of the model parameters and determined the critical endpoint (CEP) position under the maximum a posterior (MAP) estimation to be $(T^c, \mu_B^c) = (0.0859\ \mathrm{GeV}, 0.742\ \mathrm{GeV})$. Additionally, we predict the CEP positions within 68% and 95% confidence levels, yielding $(T^c,\ \mu_B^c)_{68\%}$=(0.0820–0.0889, 0.71–0 and $(T^c,\ \mu_B^c)_{95\%}$=$(0.0816–0.0898,\ 0.71–0.79)$ GeV, respectively. Moreover, to validate the reliability and predictive power of our approach, we conduct a comprehensive comparison between our predictions and potential CEP locations proposed by other theoretical models. This work not only establishes a novel Bayesian framework for holographic modeling but also provides valuable insights and theoretical support for exploring phase transitions in strongly-interacting matter under extreme conditions.

Primary author: 朱, 力强 (Central China Normal University)

Presenter: 朱, 力强 (Central China Normal University)

Session Classification: Thursday Morning Second Session

Contribution ID: **64** Type: **not specified**

Addressing the Ultra-Central Puzzle with Initial-State Nuclear Structures

Thursday, 27 November 2025 17:19 (1 minute)

Hydrodynamic models fail to describe the near-equal v_3/v_2 ratio observed in ultra-central heavy-ion collisions, despite their success in other centrality classes. This failure can not be resolved by adjusting the shear viscous coefficient, as shear viscosity suppresses higher-order anisotropic flows more strongly, leading to an underestimation of v_3 when v_2 matches experimental data. To address this issue, we explore two initial-state modifications to resolve this puzzle: (1) impose a minimum distance between nucleons to simulate the homogenization effect arising from short-range nucleon-nucleon repulsion; and (2) introduce sub-nucleonic structures, specifically 'hot spots' within protons, to provide a more refined description of initial-state fluctuations. Using TRENTo initial conditions and 3+1D viscous hydrodynamic model CLVisc, both approaches significantly lower geometric eccentricity, reduce required viscosity, and narrow the v_2–v_3 gap in ultra-central collisions. Our results implicate initial-state nuclear and sub-nucleon structures as critical factors in addressing this puzzle. Resolving it would advance nuclear structure studies and improve precision in extracting QGP transport coefficients (e.g., shear viscosity), bridging microscopic nuclear features to macroscopic quark-gluon plasma properties.

Primary authors: 王, 新年 (华中师范大学); 庞, 龙刚 (华中师范大学); 王, 琪 (华中师范大学)

Presenter: 王, 琪 (华中师范大学)

Session Classification: Poster

Contribution ID: **65** Type: **not specified**

A Novel Deep Learning Method for Detecting Nucleon-Nucleon Correlations

Thursday, 27 November 2025 11:55 (15 minutes)

This study investigates the impact of nucleon-nucleon correlations on heavy-ion collisions using the hadronic transport model SMASH in $\sqrt{s_{\mathrm{NN}}} = 3$ GeV ^{197}Au+^{197}Au collisions. We developed an innovative Monte Carlo sampling method that incorporates both single-nucleon distributions and nucleon-nucleon correlations. By comparing three initial nuclear configurations – a standard Woods-Saxon distribution (un-corr), hard-sphere repulsion (step corr), and ab initio nucleon-nucleon correlations (nn-corr) –we revealed minimal differences in traditional observables except for ultra-central collisions. When distinguishing between un-corr and nn-corr configurations, conventional attention-based point cloud networks and multi-event mixing classifiers failed (accuracy ˜50\%). To resolve this, we developed a novel deep learning architecture integrating multi-event statistics and high-dimensional latent space feature correlations, achieving 60\% overall classification accuracy, which improved to 70\% for central collisions. This method enables the extraction of subtle nuclear structure signals through statistical analysis in high-dimensional latent space, offering a new paradigm for studying initial-state nuclear properties and quark-gluon plasma characteristics in heavy-ion collisions. It overcomes the limitations of traditional single-event analysis in detecting subtle initial-state differences.

Primary author: Mr HUANG, Yu-Jing

Co-authors: Prof. PANG, Long-Gang; Mr MENG, Zhu; Prof. WANG, Xin-Nian

Presenter: Mr HUANG, Yu-Jing

Session Classification: Thursday Morning Second Session

Contribution ID: **66** Type: **not specified**

Suppression of elliptic anisotropy inside jets in high-energy nuclear collisions

Thursday, 27 November 2025 17:20 (1 minute)

Particle azimuthal anisotropies inside jets, defined within the momentum plane perpendicular to the jet axis, carry the information of the QCD cascade process for jet formation. In this work, we propose to measure the medium-induced modifications of the elliptic anisotropy inside jets in relativistic heavy-ion collisions to provide novel insight into the jet quenching phenomenon. By simulating the jet propagation in the hot and dense nuclear medium with a Linear Boltzmann Transport model, we observe a de-correlation in the two-particle azimuthal angular distribution for inclusive jet production in AA collisions relative to that in *pp* collisions, which results in significant suppression of the in-jet elliptic anisotropy coefficient v_2. This phenomenon arises from the stochastic and strong interactions with the thermal QGP medium undergone by the jet particles. Furthermore, the nuclear modifications of the in-jet v_2 are found to be sensitive to the medium properties in the model study, which provide a potential probe for the jet tomography of nuclear matter.

Primary author: YANG, Mengquan (Central China Normal University)

Co-authors: ZHANG, Ben-Wei (Central China Normal University); RU, Peng (South China Normal University); KONG, Wei-Xi (Central China Normal University)

Presenter: KONG, Wei-Xi (Central China Normal University)

Session Classification: Poster

Contribution ID: **67** Type: **not specified**

A deep learning approach for predicting multiple observables in Au+Au collisions at RHIC

Thursday, 27 November 2025 14:15 (15 minutes)

We develop a neural network model, based on the processes of high-energy heavy-ion collisions, to study and predict several experimental observables in Au+Au collisions. We present a data-driven deep learning framework for predicting multiple bulk observables in Au+Au collisions at RHIC energies. A single neural network is trained exclusively on experimental measurements of charged-particle pseudorapidity density distributions, transverse-momentum spectra and elliptic flow coefficients over a broad range of collision energies and centralities. The network architecture is inspired by the stages of a heavy-ion collision, from the quark-gluon plasma to chemical and kinetic freeze-out, and employs locally connected hidden layers and a structured input design that encodes basic geometric and kinematic features of the system. We demonstrate that these physics-motivated choices significantly improve test performance compared to purely fully connected baselines. The trained model is then used to predict the above observables at collision energies not yet explored experimentally at RHIC, and the results are validated using the energy dependence of the total charged-particle multiplicity per participant pair as well as comparisons to a CLVisc hydrodynamic calculation with TRENTo initial conditions. Our findings indicate that such physics-guided neural networks can serve as efficient surrogates to fill critical data gaps at RHIC and to support further phenomenological studies of QGP properties.

Primary authors: 陶, 俊琦 (华中师范大学); 樊, 翔 (Central China Normal University); 周, 凯 (CUHK-Shenzhen); 郑, 华 (陕西师范大学); ZHANG, Ben-Wei (Central China Normal University)

Presenter: 陶, 俊琦 (华中师范大学)

Session Classification: Thursday Afternoon First Session

Contribution ID: **68** Type: **not specified**

Left-right splitting of elliptic flow in heavy ion collisions: TRENTo-3D initialization and CLVisc hydrodynamic simulations

Thursday, 27 November 2025 15:40 (15 minutes)

Using the TRENTo-3D initial condition model coupled with (3+1)-dimensional CLVisc hydrodynamic simulations, we systematically investigate the left-right splitting of elliptic flow (Δv_2) for soft particles in relativistic heavy-ion collisions. Our study reveals that the final distribution characteristics of Δv_2 are primarily depend on the odd flow harmonics and v_2 itself. We find that the parton transverse momentum scale k_{T} not only determines the geometric tilt of the QGP fireball but also significantly affects the rapidity dependence of both v_1 and Δv_2, providing new insights into the splitting mechanism of Δv_2.
Furthermore, our results demonstrate that $\Delta v_2(p_{\mathrm{T}})$ exhibits significant sensitivity to influences such as the sub-nucleonic degrees of freedom (or 'hotspots'), transverse momentum scale, and fragmentation region profile. By analyzing the Δv_2 and $\Delta v_2/v_2$ ratio, our findings provide new constraints on the uncertainties of the QGP initial state and provide additional constraints for refining model parameters.

Primary author: 江, 泽方 (Hubei Engineering University)

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Presenter: 樊, 翔 (Central China Normal University)

Session Classification: Thursday Afternoon Second Session

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

Quantum wetting transition in the cluster Ising model

Thursday, 27 November 2025 17:21 (1 minute)

The wetting transition in the one-dimensional cluster Ising model with opposite boundary fields is studied. Tuning one boundary field while fixing another leads to the occurrence of phase transitions, where the transition points depend on the cluster coupling. Furthermore, the phase diagram is divided into three regions with different phase transition. For weak and strong cluster coupling, the phase transition is continuous and belongs to the same universality of transverse Ising model with boundary fields. For intermediate cluster coupling, the phase transition is first order. In the strong cluster coupling region, the critical region becomes exponentially small andthe asymptotic behavior is absent even for lattice size up to 104. A numerical method to solve the energy gap and the
correlation length is proposed on an infinite long spin chain. With this method, one can get the critical behavior as close to the critical point as possible
provided that the numerical accuracy is high enough. In the light of this method, we clearly show that there is a preasymptotic regime in which the apparent critical exponents depend on the cluster coupling. Moreover, we obtain the accurate energy gap exponent ⌧⌧ and the correlation length exponent ⌧ in the asymptotic critical region.

Primary authors: Dr 胡, 坤; 邹, 银涛 (华中师范大学)

Presenter: 邹, 银涛 (华中师范大学)

Session Classification: Poster

Contribution ID: **70** Type: **not specified**

Photon radiation induced by rescattering in strong-interacting medium with a magnetic field

Thursday, 27 November 2025 08:50 (15 minutes)

The photon radiation induced by rescattering in a magnetized medium is investigated in relativistic heavy-ion collisions. Within the high-energy limit, the photon emission rate and the associated electromagnetic energy loss are derived using the Gyulassy-Levai-Vitev formalism at first order in opacity, for a quark jet propagating a quark-gluon plasma under a background magnetic field. Quantitative analysis shows a slight suppression of the overall photon radiation over a broad range of jet energies in this process. This reduction in photon yield consequently leads to a moderate decrease in the electromagnetic energy loss of the jet. Our results contribute to a better understanding of the electromagnetic properties of strongly interacting matter in high-energy nucleus-nucleus collisions and motivate experimental comparison of photon yields from quark-gluon plasma with similar properties but distinct magnetic field strengths.

Primary authors: ZHANG, Yue (Central China Normal University); ZHANG, Han-Zhong

Presenter: ZHANG, Yue (Central China Normal University)

Session Classification: Thursday Morning First Session