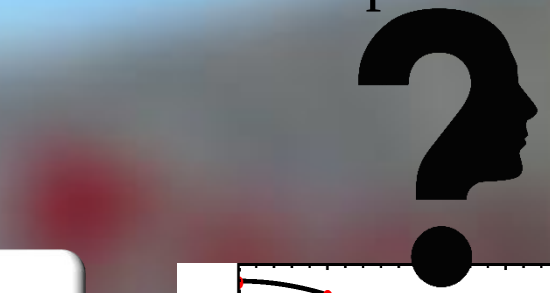
Gluon polarization contribution to the spin alignment of vector mesons from holography

Hiwa Ahmed (UCAS)

中国科学院大学
University of Chinese Academy of Sciences

holographic QCD

How do the vector mesons Φ and J/Ψ behave in rotating quark-gluon plasma?

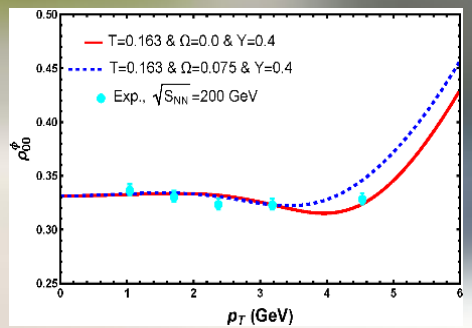


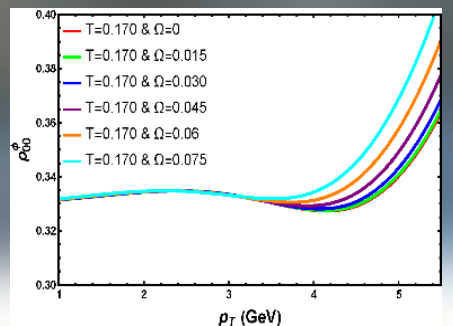
Φ

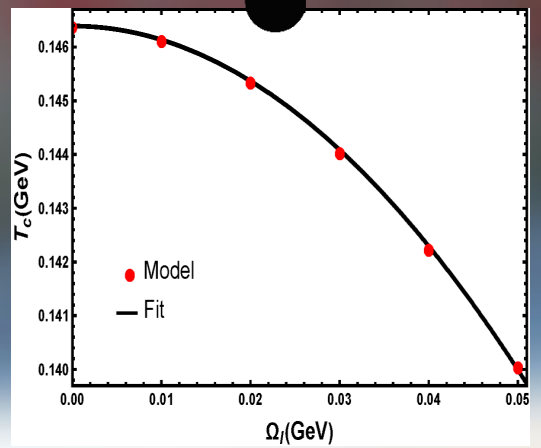
- Rotation delays dissociation
- Strong ρ_{00} dependence on azimuthal angle φ
- Rotation enhances spin alignment (spin-orbit coupling)
- Sensitive to both temperature and rotation

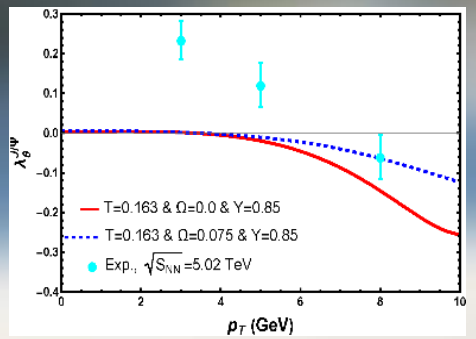
J/Ψ

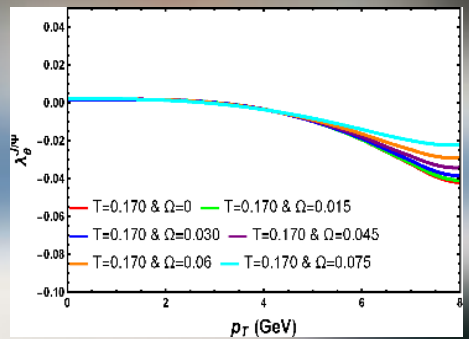
- Resists melting due to heavy charm quarks
- ρ_{00} insensitive to T and Ω below $p_T = 5$ GeV
- Slight suppression at very high p_T (needs further study)
- Heavy mass "shields" it from rotation







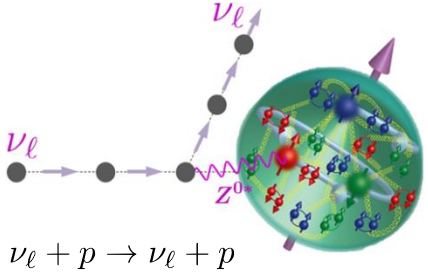




Nucleon relativistic weak-neutral axial-vector structure and axial radius

Yi Chen, Yang Li, Cédric Lorcé, Qun Wang

陈毅（中国科学技术大学）



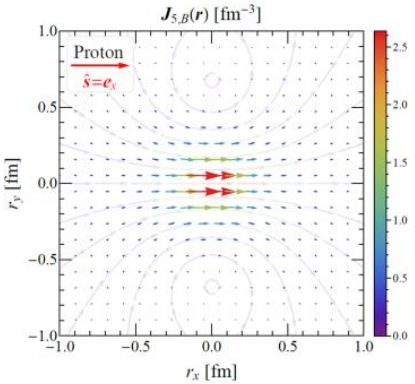
$\nu_\ell + p \to \nu_\ell + p$

Hadronic matrix elements:

$$N\langle p',s'|\hat{j}_5^\mu(0)|p,s\rangle_N = \bar{u}(p',s')\left[\gamma^\mu G_A^Z + \frac{\Delta^\mu}{2M}G_P^Z - \frac{\sigma^{\mu\nu}\Delta_\nu}{2M}G_T^Z\right]\gamma^5 u(p,s)$$

Axial — Induced pseudoscalar — Induced pseudo-tensor

$$\Delta = p' - p$$
$$\Delta^2 = t \equiv -Q^2 \le 0$$
$$G_{A,P,T}^Z = G_{A,P,T}^Z(Q^2)$$



3D axial-vector four-current distributions (e.g., the weak content of the proton):

$$J_{5,B}^0(\boldsymbol{r}) = \int \frac{\mathrm{d}^3\Delta}{(2\pi)^2} e^{-i\boldsymbol{\Delta}\cdot\boldsymbol{r}} \frac{i\boldsymbol{\Delta}\cdot\boldsymbol{\sigma}}{2M} G_T^Z$$

→ **3D axial charge density is parity-odd.**

$$\boldsymbol{J}_{5,B}(\boldsymbol{r}) = \int \frac{\mathrm{d}^3\Delta}{(2\pi)^3} e^{-i\boldsymbol{\Delta}\cdot\boldsymbol{r}} \left\{\boldsymbol{\sigma} G_A^Z - \frac{\boldsymbol{\Delta}(\boldsymbol{\Delta}\cdot\boldsymbol{\sigma})}{4P_B^0 M}\left[\frac{M}{P_B^0+M}G_A^Z + G_P^Z\right]\right\}$$

3D axial radius $R_A^2 \equiv -\dfrac{6}{G_A^Z(0)}\dfrac{\mathrm{d}G_A^Z(Q^2)}{\mathrm{d}Q^2}\Big|_{Q^2=0}$

QCD equation of motion

$$S^{\mu\alpha\beta} = \tfrac{1}{2}\epsilon^{\mu\alpha\beta\lambda}J_{5\,\lambda},\ \epsilon_{0123} = +1$$
$$S^i = \tfrac{1}{2}\epsilon^{ijk}S^{0jk} = \tfrac{1}{2}J_5^i$$

→ $\boldsymbol{S} = \boldsymbol{J}_5/2$ → **3D spin radius**

$$\langle r_{\rm spin}^2\rangle = R_A^2 + \frac{1}{4M^2}\left[1 + \frac{2G_P^Z(0)}{G_A^Z(0)}\right]$$

Key conclusions:

(1). 3D axial charge distribution is related to $G_T^Z(Q^2)$ rather than $G_A^Z(Q^2)$, and it is parity-odd. Meaningful 3D axial charge radius does not exist for any spin-1/2 hadrons. Clearly, R_A does not characterize the weak content size of the proton.

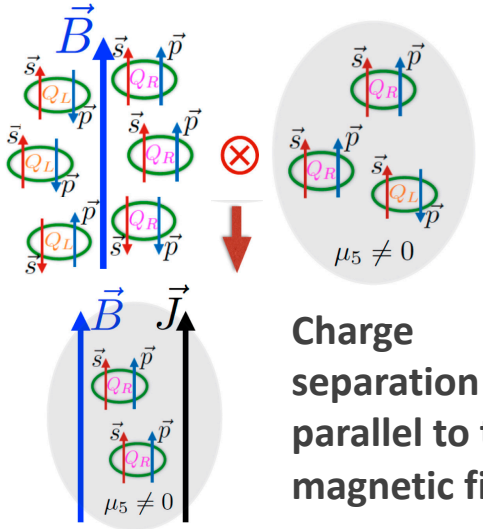
(2). 3D spin radius $r_{\rm spin}$ depends on not only R_A but also the ratio $G_P^Z(0)/G_A^Z(0)$. This provides thus further motivation for measurements or lattice QCD calculations of $G_P^Z(Q^2)$.

[T. Cai *et al.* (MINERvA Collaboration), Nature (London) 614, 48 (2023)]
[YC, Yang Li, Cédric Lorcé, Qun Wang. PRD 110, L091503 (2024); JHEP04(2025)132]

Reconstructing the Chiral Magnetic Effect in Initial QGP Using Deep Learning

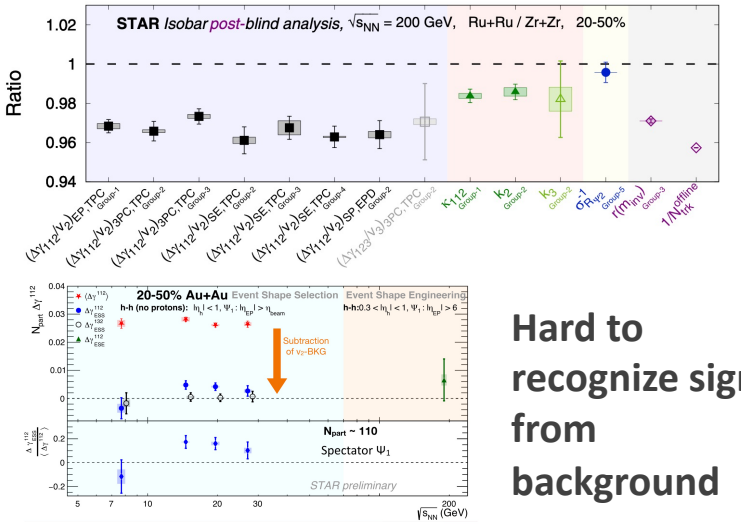
Reporter: **Shuang Guo (郭爽)** Supervisor: **Guoliang Ma** Cooperator: **Lingxiao Wang, Kai Zhou**

Theoretically



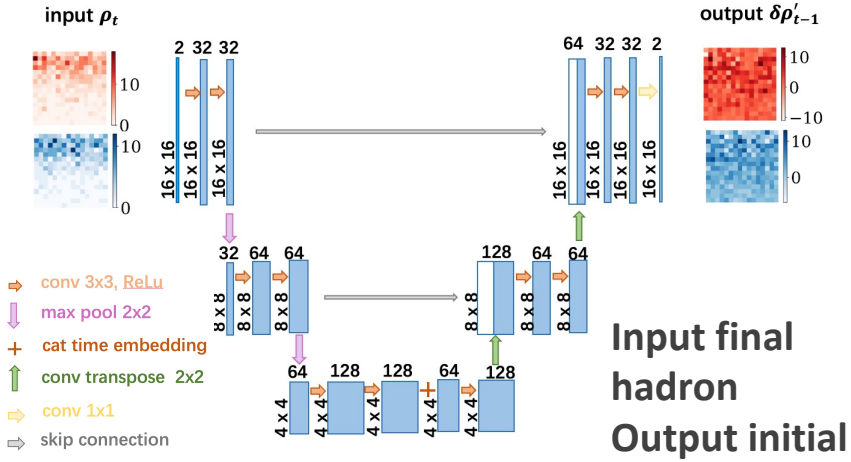
Charge separation parallel to the magnetic field

Experimentally



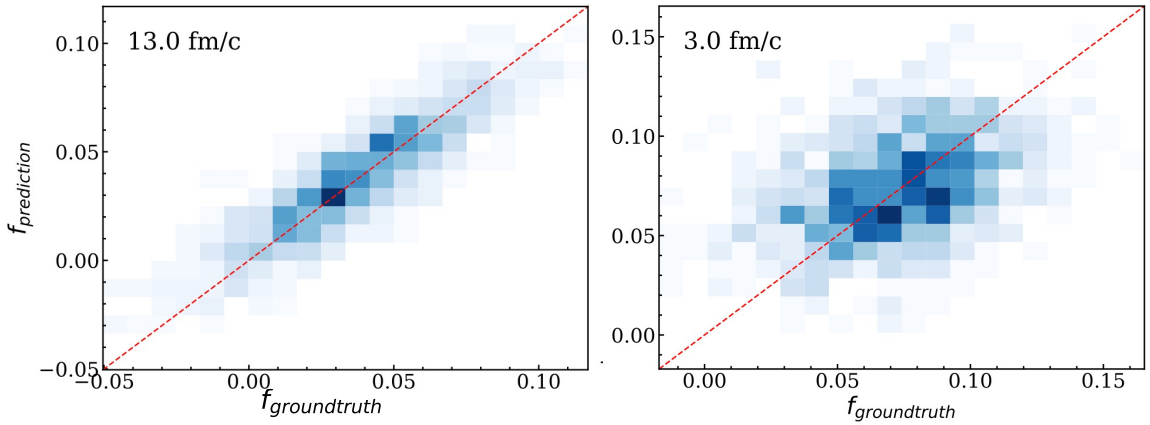
Hard to recognize signal from background

Methodologically

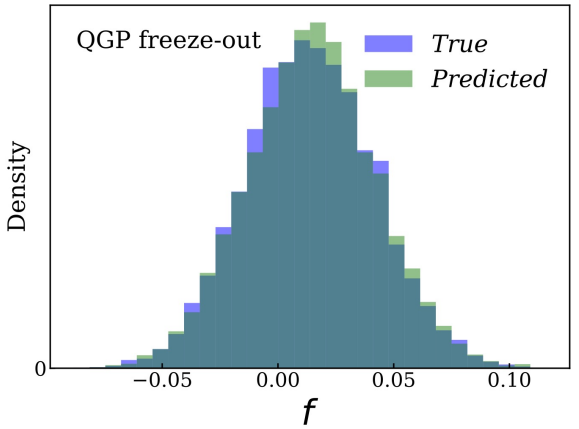


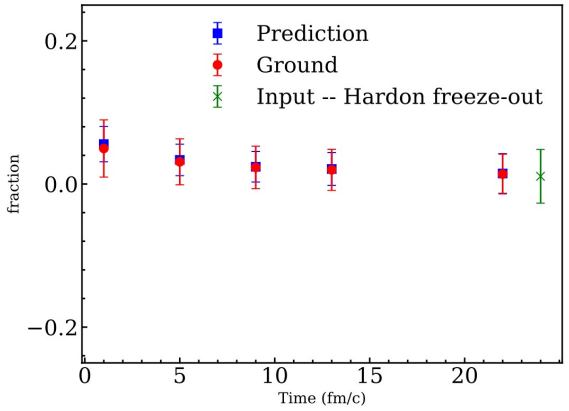
Input final hadron Output initial QGP

Event by Event



Event Average



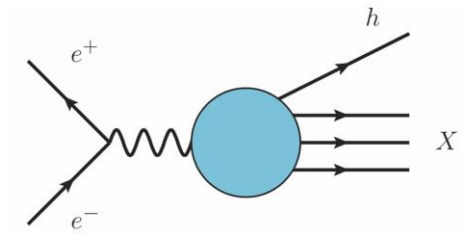


Test leading twist QCD factorization at BESIII

Mengyang Li[1], Daniele Anderle[1], Hongxi Xing[1], Yuxiang Zhao[2], BESIII

[1] South China Normal University (SCNU)
[2] Institute of Modern Physics (IMP)

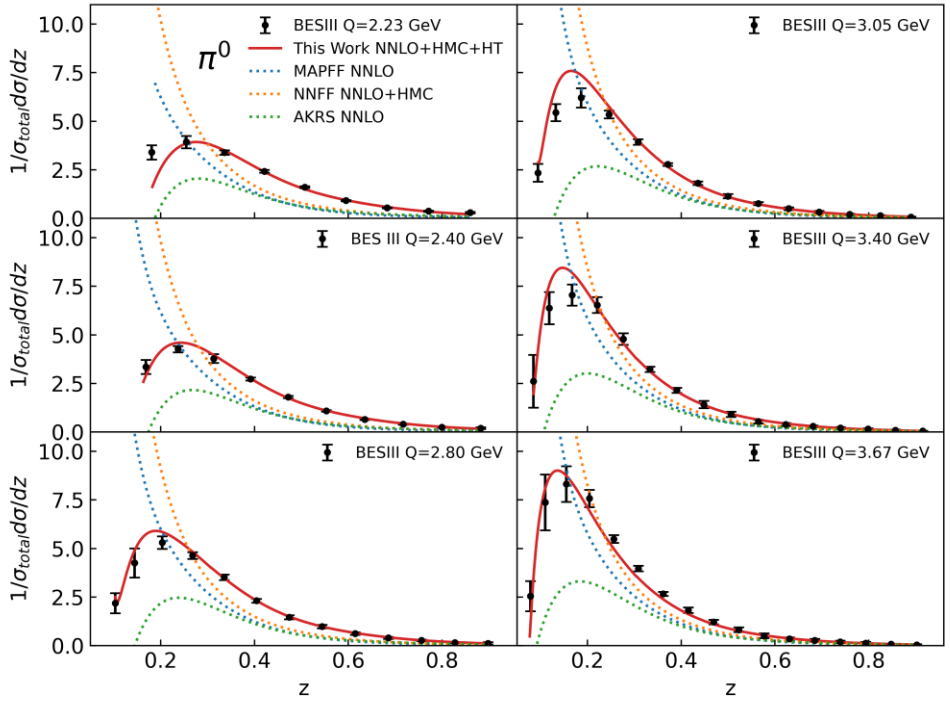
✦ QCD factorization in electron-positron annihilation



$$\sigma^{e^+e^-\to hX} = \hat{\sigma}_{e^+e^-\to i} \otimes D_{i\to h}$$

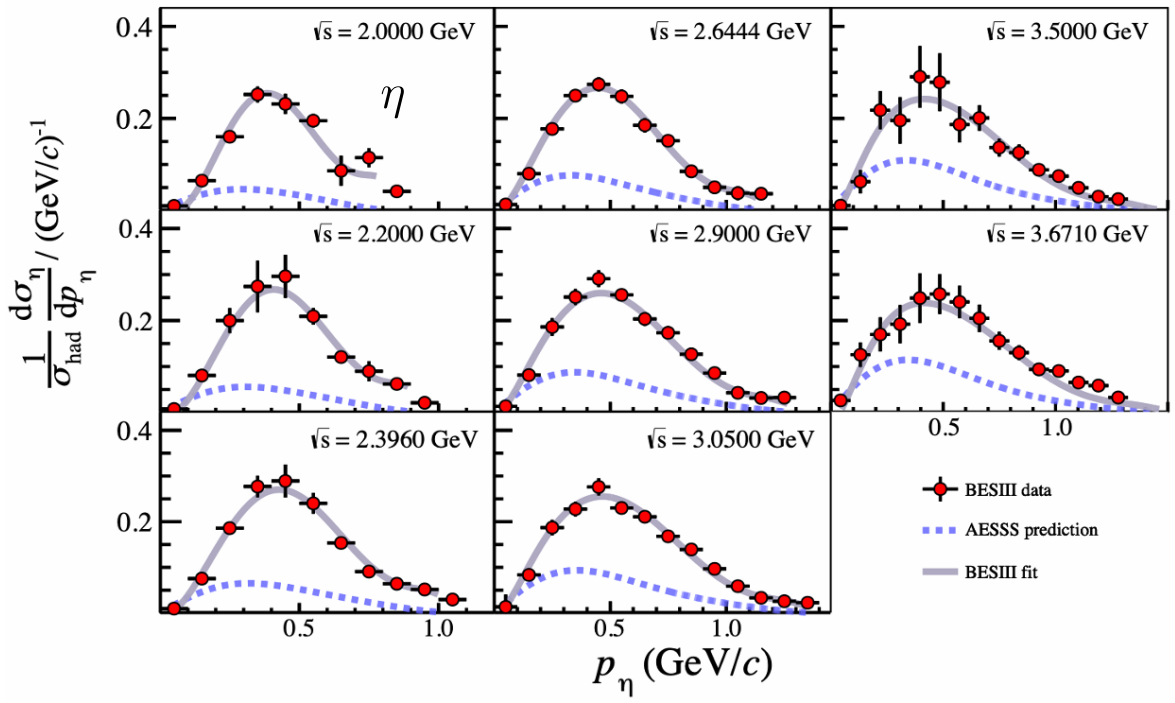
✦ A test from data driving analysis on higher-twist contribution

LMX, *Anderle, Xing, Zhao, PRD, 2025*



- Hadron mass correction $\xi = \frac{z}{2}(1+\sqrt{1-\frac{4m_h^2}{Q^2z^2}})$

*BESIII+**LMY**, Anderle, Xing, PRL, 2024*



- High twist correction $\sigma \approx \sigma^{LT}\left[1+\sum_i N_i \frac{x^{a_i}1-x_i^b}{Q^{2i}}\right]$

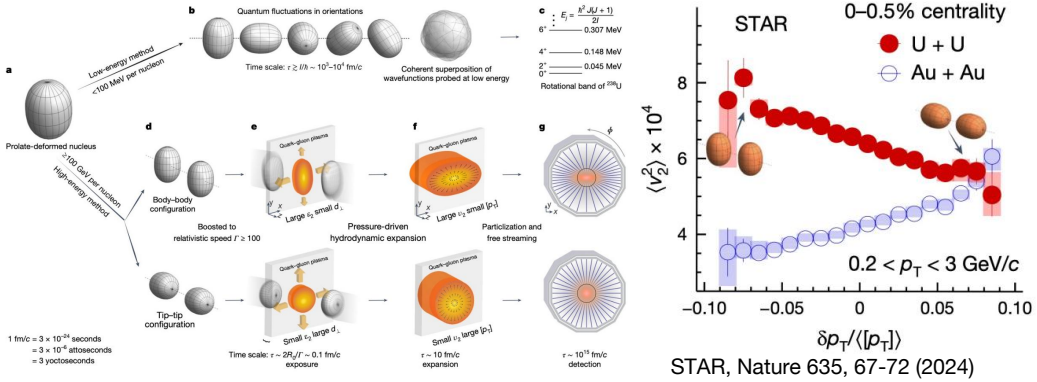
Identifying α-cluster configurations in ^{20}Ne via ultracentral Ne+Ne Collisions

Pei Li, Bo Zhou, Guo-Liang Ma

arXiv:2504.04688

email: lip24@m.fudan.edu.cn

➢ Probe nuclear structure with heavy ion collisions



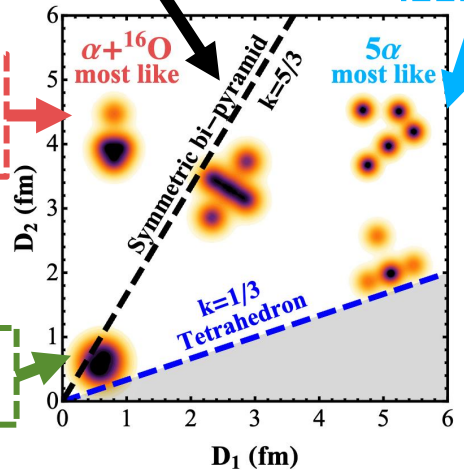
STAR, Nature 635, 67-72 (2024)

➢ The puzzle of ^{20}Ne cluster structure in low-energy physics

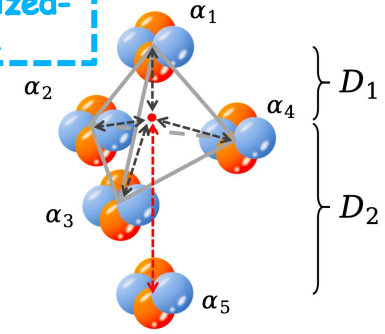
ACM model (D_{3h} symmtry)

Loose and nonlocalized-like

AMD model (localized two-cluster)



Shell model (Spherical)



high degree of freedom

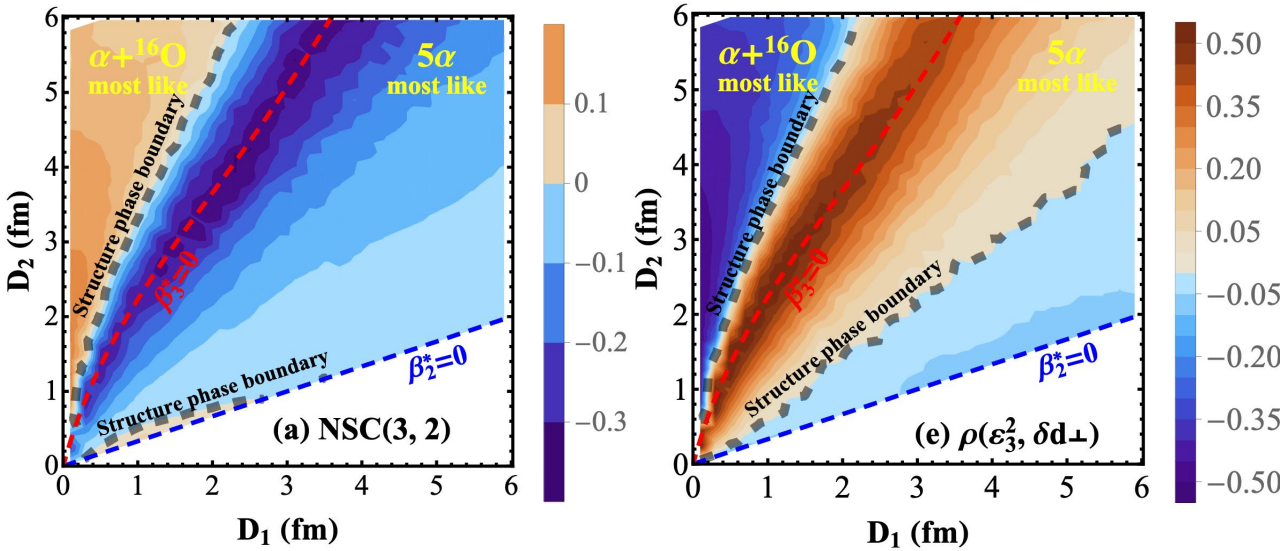
Complicated cluster structure

➢ Theoretical framework with cluster wave function

$$\Phi^{Brink}_{^{20}Ne}(R_1, R_2, R_3, R_4, R_5) = \frac{1}{\sqrt{20!}} A[\phi_1(R_1)\ldots\phi_5(R_2)\ldots\phi_{20}(R_5)]$$

Density distribution ρ_{Ne} → analytical → shape and size ε_n $d_\perp$ → analytical → Correlation observables in initial state NSC(m,n) $\rho_n(\varepsilon_n^2, \delta d_\perp)$

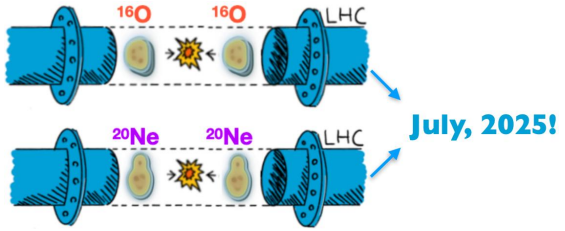
➢ Correlation observables in central Ne+Ne collision



✓ Structure phase boundary is very obvious between a+^{16}O and 5a.

✓ The strength of correlation observables is related only to structure.

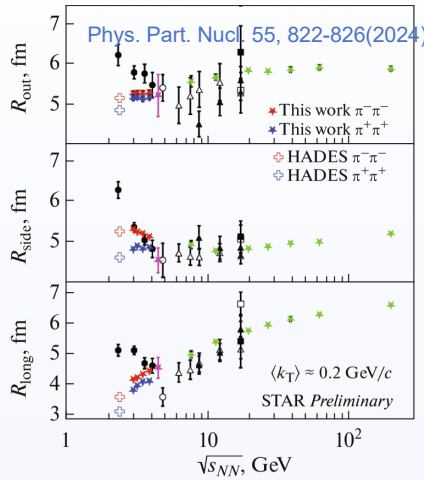
We can predict for single small collision system in LHC experiment!



Unlocking the neutron density distribution with two-pion HBT correlation functions in HICs at $\sqrt{s_{NN}}$=3 GeV

Pengcheng Li, Yongjia Wang, Qingfeng Li, Zhigang Xiao, and Gaochan Yong

Motivation

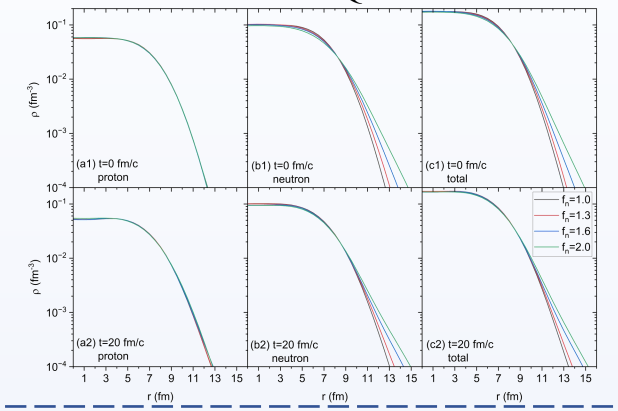


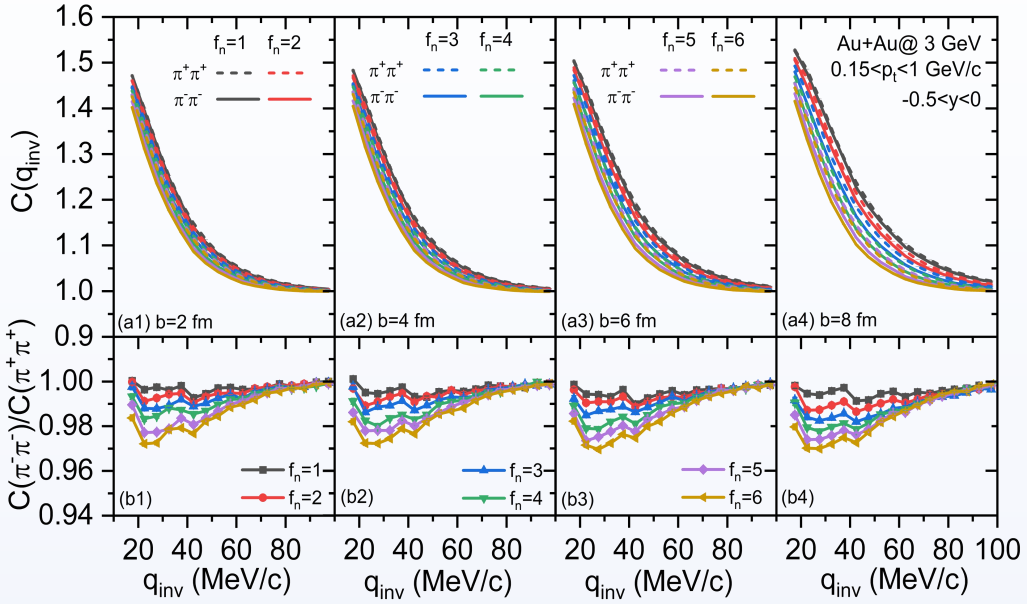
$$p + p \rightarrow n + \Delta^{++} \rightarrow n + p + \pi^+$$
$$n + n \rightarrow p + \Delta^{-} \rightarrow p + n + \pi^-$$

HBT correlation can provide information about different initial nuclear structures.

Methodology

To explore the effects of the initial neutron density distribution, the different density distributions of proton and neutron are used in the initialization of UrQMD mode.



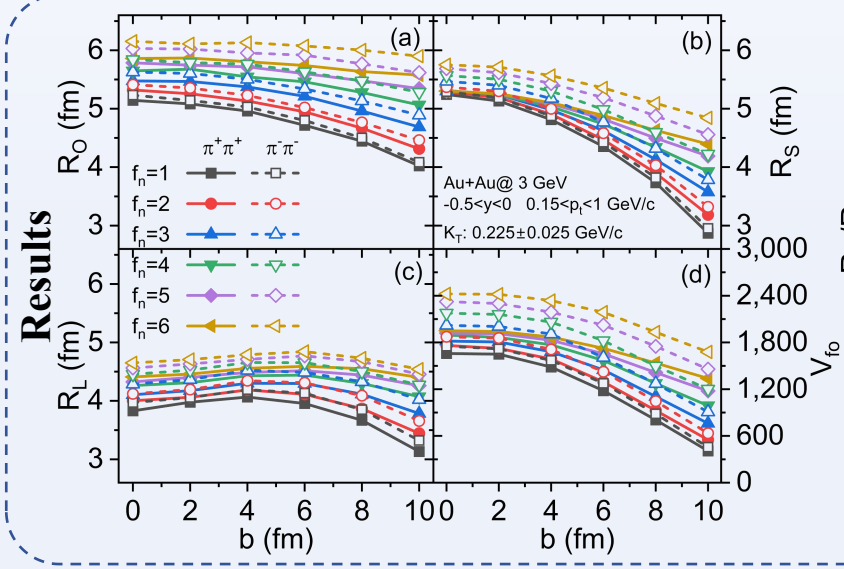


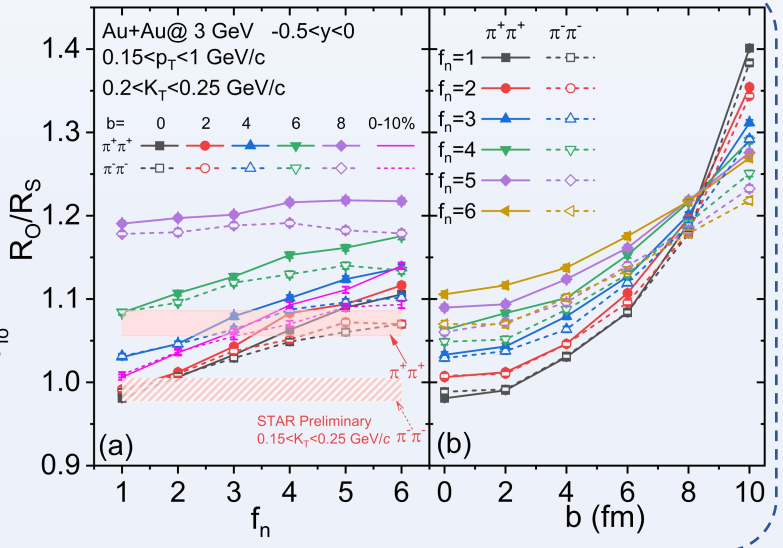
Innovation: Constraining the neutron density distribution of nuclei by using two-pion HBT correlation in intermediate-energy heavy ion collisions.

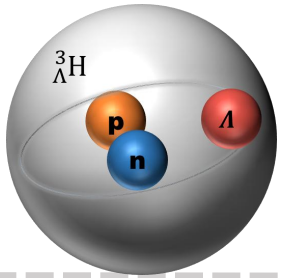
Conclusions: The experimentally observed charge splitting in source radii is not due to the structure effect, but is mainly influenced by the Coulomb effect.

The difference in the correlation functions and the source radii parameters between $\pi^+\pi^+$ and $\pi^-\pi^-$ could be used as a probe for the neutron density distribution of nuclei.

Results





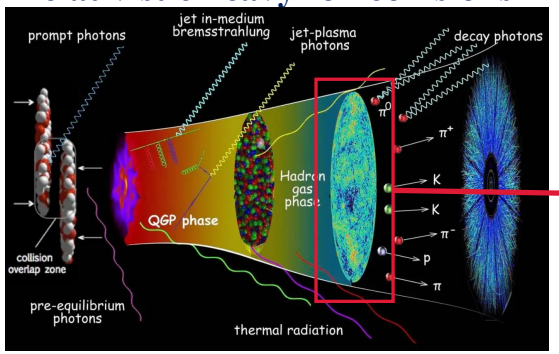


Understanding the Spatial and Spin Structure of (Anti-) Hypertriton in Heavy-ion Collisions

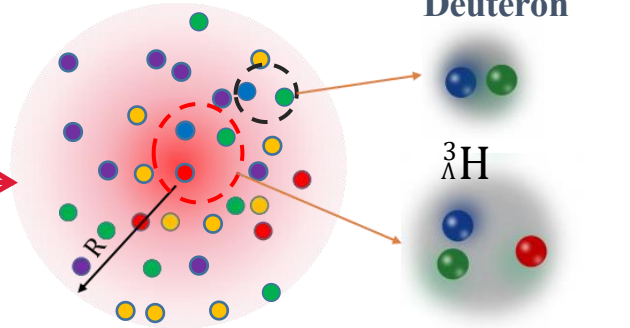
$B_{\Lambda d} \approx 0.41 \pm 0.12$ MeV, STAR, Nat. Phys. 16, 409 (2020)

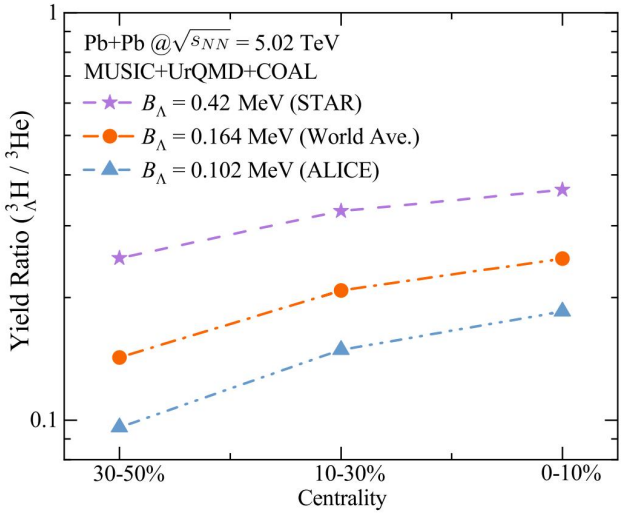
$B_{\Lambda d} \approx 0.102 \pm 0.063$ MeV, ALICE, PRL 131, 102302 (2023)

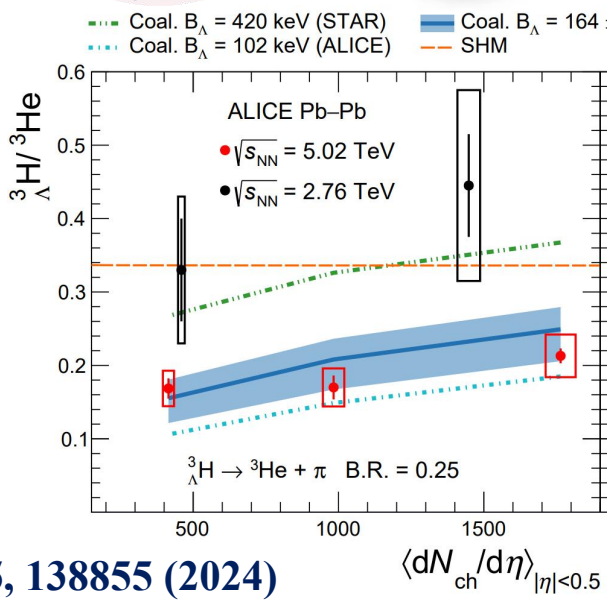
Relativistic heavy-ion collisions



Coalescence Model

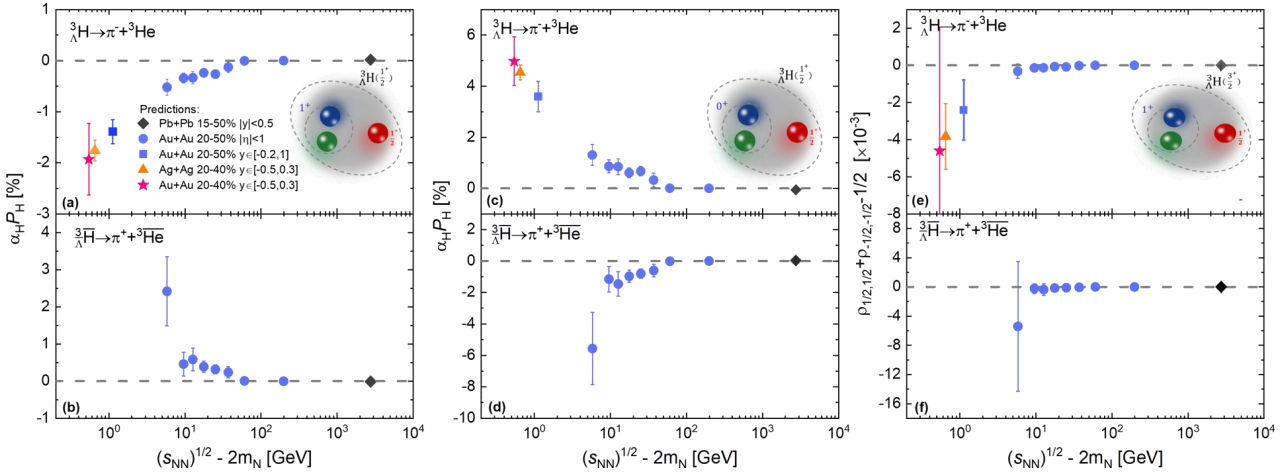




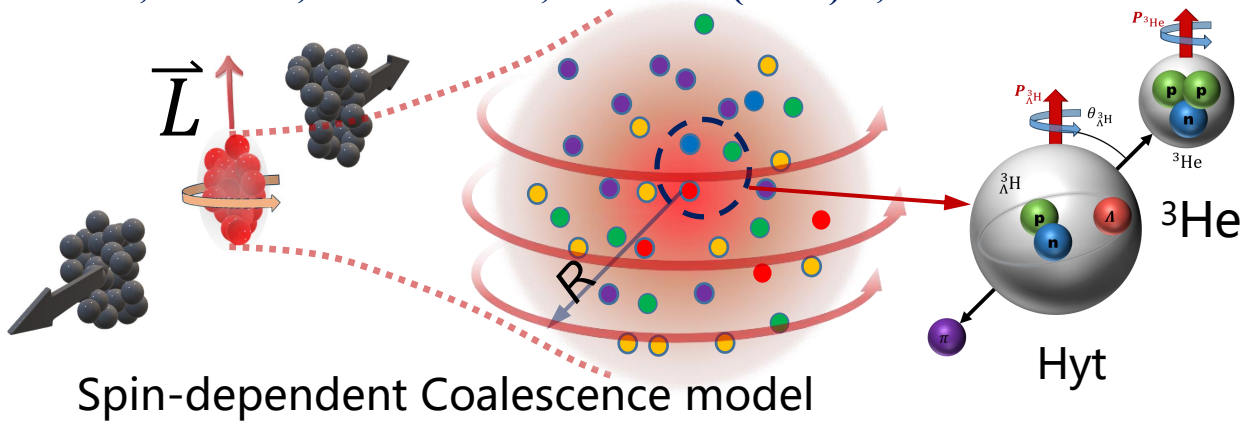


D. -N. Liu *et al.*, Phys. Lett. B 855, 138855 (2024)

ALICE, Phys. Lett. B 860, 139066 (2025)



KJ Sun, DN Liu, YG Ma et.al, PRL 134 (2025) 2, 022301



Dai-Neng Liu（刘代能）DNLIU17@FUDAN.EDU.CN

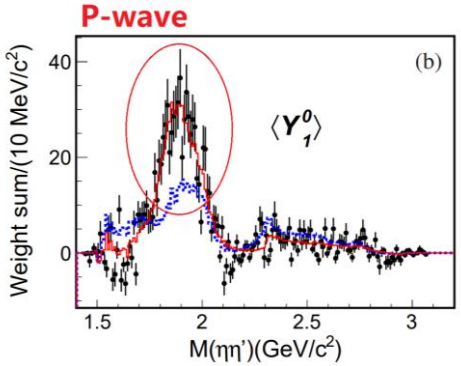
Institute of Modern Physics, Fudan University

Mixing angle of $K_1(1270/1400)$ and the $K\bar{K}_1(1400)$ molecular interpretation of $\eta_1(1855)$

Zheng-Shu Liu, Xu-Liang Chen, Ding-Kun Lian, Ning Li, Wei Chen

Sun Yat-sen University · PHYSICAL REVIEW D 111, 014014 (2025)

In 2022, BESIII observed an exotic state $\eta_1(1855)$ with $J^{PC} = 1^{-+}$ in the process $J/\psi \to \gamma\eta\eta'$:



1^{-+} hybrid nonet:

$\eta_1(1855)$	$I^G J^{PC} = 0^+1^{-+}$
$\pi_1(1600)$ / $\pi_1(1400)$	$I^G J^{PC} = 1^-1^{-+}$

$K\bar{K}_1(1400)$ molecular:

K	$K\bar{K}_1(1400)$	$\eta_1(1855)$
495 MeV	1898 MeV	1855 MeV

PhysRevLett.129,192002; PhysRevD.106,072012

$K_1(1270)$ and $K_1(1400)$ are mixtures of two P-wave $K_{1A}(^3P_1)$ and $K_{1B}(^1P_1)$ states:

$$J_A^\mu = \bar{s}\gamma^\mu\gamma_5 q$$

$$|K_1(1270)\rangle = |K_{1A}\rangle \sin\theta + |K_{1B}\rangle \cos\theta$$

$$|K_1(1400)\rangle = |K_{1A}\rangle \cos\theta - |K_{1B}\rangle \sin\theta$$

$$J_B^{\mu\nu} = \bar{s}\sigma^{\mu\nu}\gamma_5 q$$

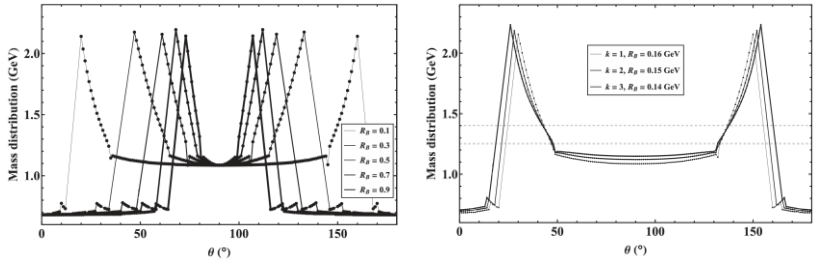
A new construction for the operator of $K_1(1270/1400)$:

$$J_B^\mu \propto J_B^{\mu\nu} x_\nu$$

$$J^\mu_{K_1(1270)}(x) = J_A^\mu(x)\sin\theta + J_B^\mu(x)\cos\theta$$

$$J^\mu_{K_1(1400)}(x) = J_A^\mu(x)\cos\theta - J_B^\mu(x)\sin\theta$$

Determine the mixing angle by reproducing the masses:



$$\theta = \left(46.95^{+0.25}_{-0.23}\right)^\circ,\ R_B = (0.16 \pm 0.01)\ \text{GeV}$$

The current operator for $K\bar{K}_1$:

$$J^\mu_{K\bar{K}_1}(x) = \left[\bar{s}(x)\mathrm{i}\gamma_5 q(x)\right] J^{\mu\dagger}_{K_1}(x) + \left[\bar{q}(x)\mathrm{i}\gamma_5 s(x)\right] J^\mu_{K_1}(x)$$

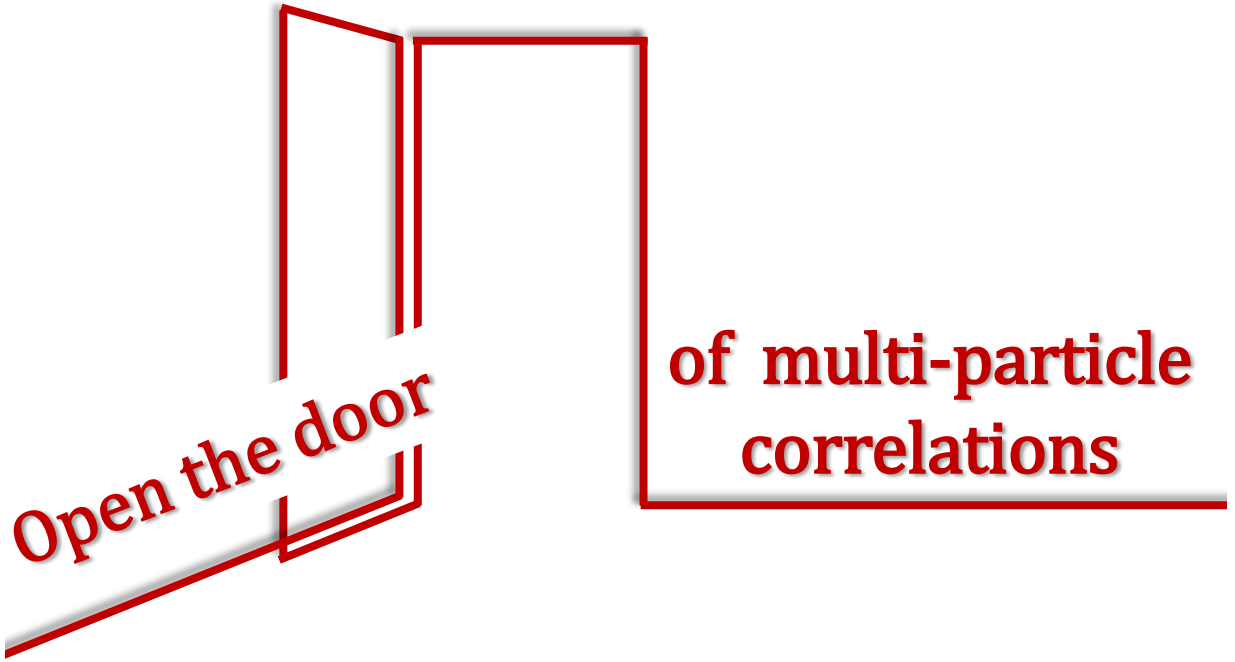
- The newly observed particle $\eta_1(1855)$ is theoretically interpreted as either a hybrid meson $\bar{s}sg$ or a molecular state $K\bar{K}_1(1400)$.
- To obtain the interpolating current operator for $K\bar{K}_1(1400)$, we propose a new construction for the operators of $K_1(1270)$ and $K_1(1400)$.
- By reproducing the masses of $K_1(1270)$ and $K_1(1400)$ through a fully automated procedure, we determine the mixing angle $\theta = \left(46.95^{+0.25}_{-0.23}\right)^\circ$.
- The numerical analysis of the $K\bar{K}_1(1400)$ current does not yield results supporting the molecular interpretation of $\eta_1(1855)$.

From BBGKY hierarchy to spectral BBGKY hierarchy

——an analytically equivalent and numerically tracable reformulation

解析计算玻尔兹曼方程碰撞项

$$\mathrm{Cost}_{\mathrm{nonlin}} = \mathrm{Cost}_{\mathrm{lin}}$$



Spectral BBGKY Hierarchy

$$d_t \boldsymbol{P}_{(n)} = \boldsymbol{C} \cdot \boldsymbol{P}_{(n)} + \boldsymbol{A} \cdot \boldsymbol{P}_{(n+1)}$$

$\boldsymbol{A}, \boldsymbol{C}$: Integral Factor, Analytic Calculation

- **体系的平衡态携带关联信息**
- … 更多结果下次汇报

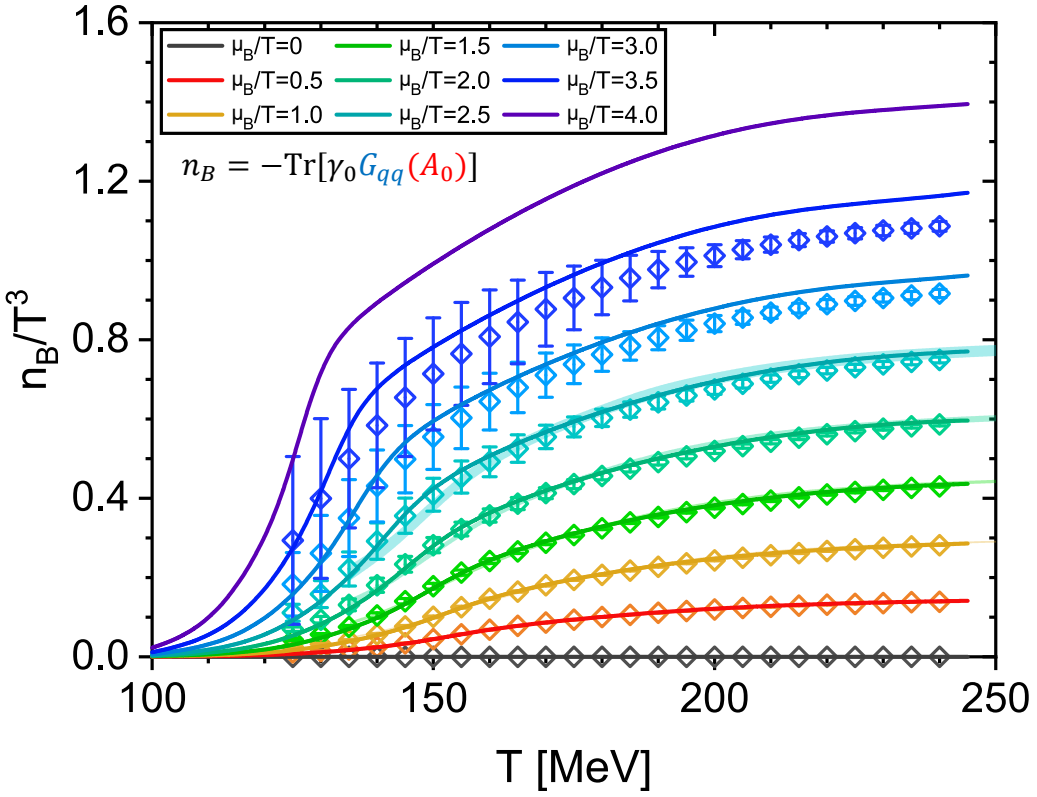
清华大学 路帅
导师 施舒哲

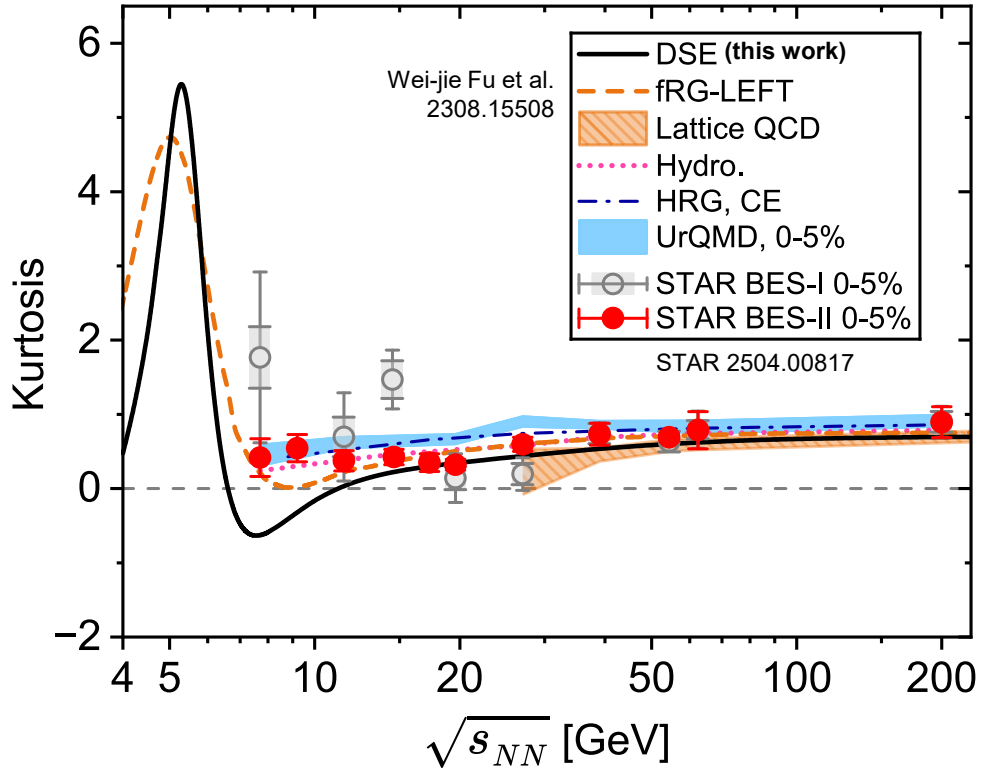
YL, Fei Gao, Yu-xin Liu and Jan M. Pawlowski, arXiv:2504.05099

- Gluonic background field (A_0) approach on QCD confinement and center symmetry:
  - Functional QCD, in particular Dyson-Schwinger equations (DSE), and their self-consistent resolutions on QCD thermodynamics (via G_{qq} and A_0)

$$\frac{\delta(\Gamma - S)}{\delta A_0} = \frac{1}{2} - - G_{qq} - \frac{1}{6} +$$

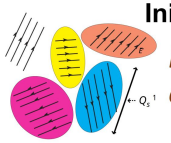
- Equation of state at high density: valuable inputs for hydrodynamic simulations at low $\sqrt{s_{NN}}$;
- Equilibrium baseline of (net-baryon) kurtosis: indications on the CEP search in beam energy scans.





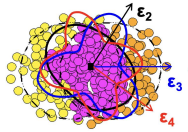
Probing initial geometry through collectivity in d+Au and O+O collisions at STAR

Where do the final *anisotropy* and *fluctuations* comes from?



Initial state effect

Initial momentum correlation(CGC): ε_p



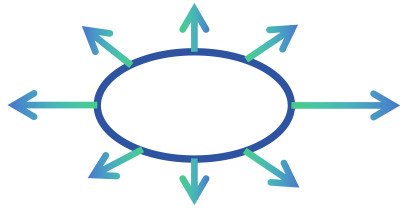
Initial eccentricity: ε_n

$F = -\nabla P(\varepsilon)$

Hydro-response

Hydro flow: v_n^{Hydro}

Final state anisotropy



Measured flow: $v_n^{Measure}$

①

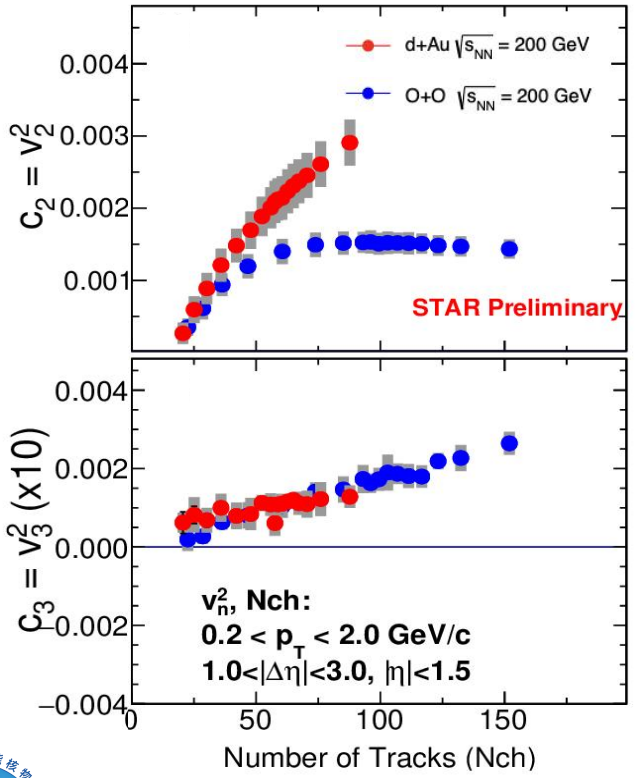
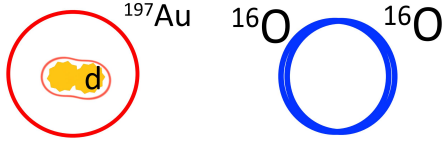


Fig. 1 Collective flow v_2^2, v_3^2 comparison in d+Au and O+O at $\sqrt{s_{NN}} = 200$ GeV

- The elliptic flow shown as v_2(d+Au) > v_2(O+O), captures the average geometry dominated by the nucleon configurations in deuteron.



②

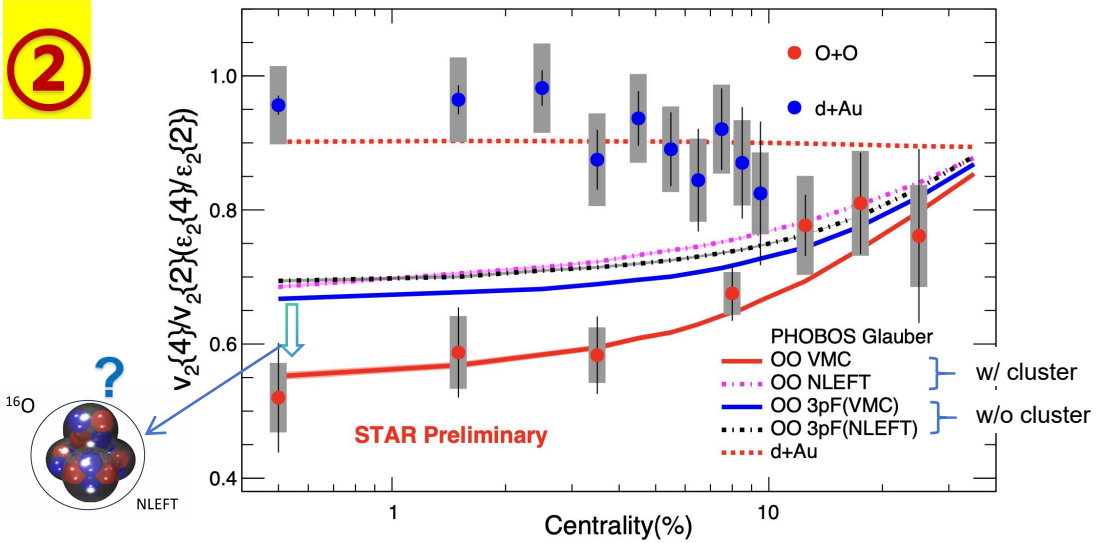


Fig. 2 Flow fluctuations $v_2\{4\}/v_2\{2\}$ in d+Au and O+O at $\sqrt{s_{NN}} = 200$ GeV

- Different *flow fluctuations* in d+Au and O+O collisions reveal the possible existance of **cluster** effects in ^{16}O.
- Input from low energy cluster models is necessary!

Reference

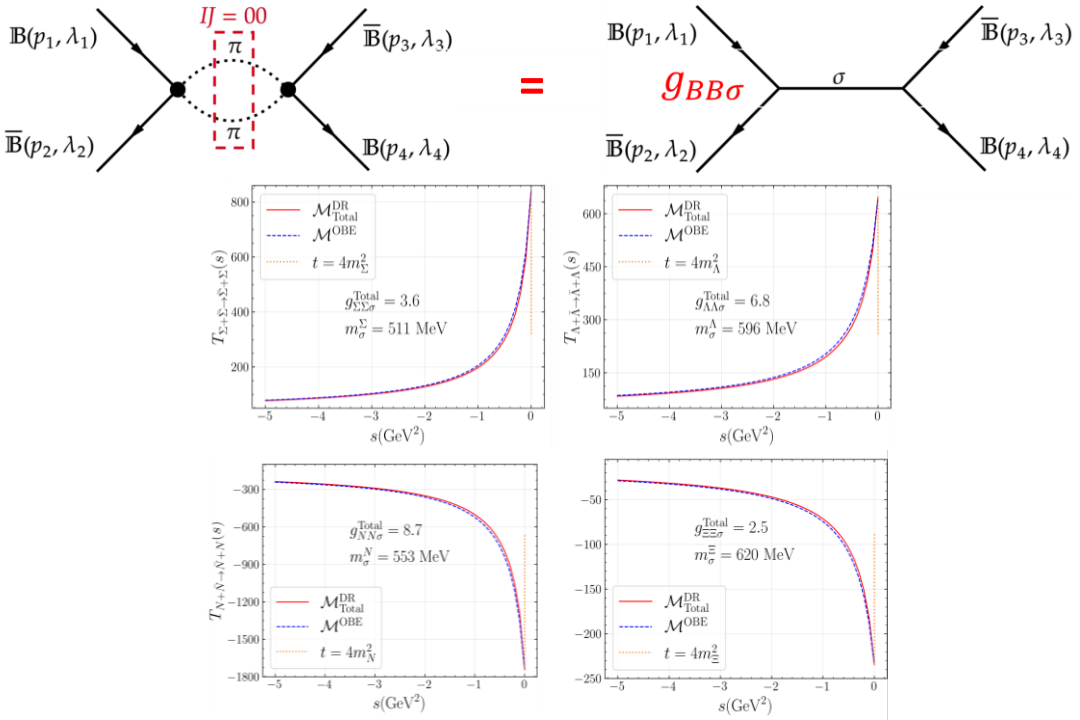
[1] STAR Collaboration, Nature, 635(8037):67–72, 2024.
[2] STAR Collaboration, Phys. Rev. Lett., 130(24):242301, 2023.

Calculating the σ couplings and J/ψ-nucleon scattering length with dispersion relation

Bing Wu (吴兵) **University of Electronic Science and Technology of China (电子科技大学)**

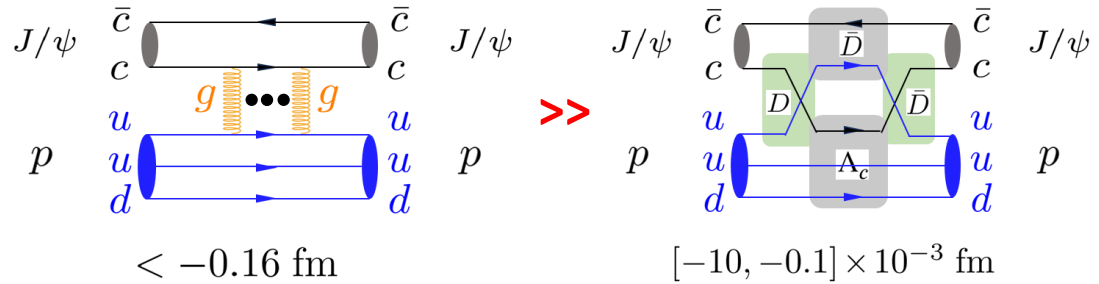
In collaboration with Xiong-Hui Cao, Xiang-Kun Dong, Meng-Lin Du, Feng-Kun Guo, and Bing-Song Zou

σ couplings



the complex $\pi\pi$ dynamics can be rigorously approximated by a single σ-exchange process when m_σ and its couplings are properly tuned

$J/\psi N$ scattering length



In the low-energy interaction of $J/\psi N$, the contribution from soft gluon exchange is dominant

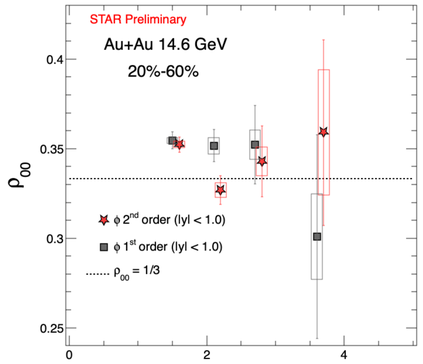
↓

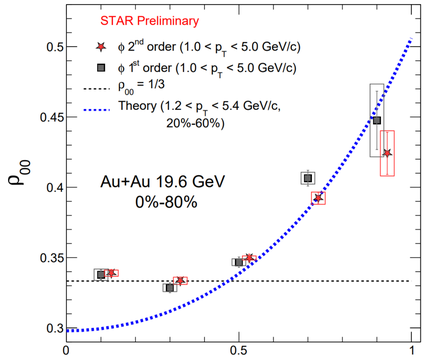
study the origin of nucleon mass with the J/ψ as a probe is possible

New Insights into Global Spin Alignment of Vector Mesons Using Relativistic Heavy-Ion Collisions

Baoshan Xi[1, 2]

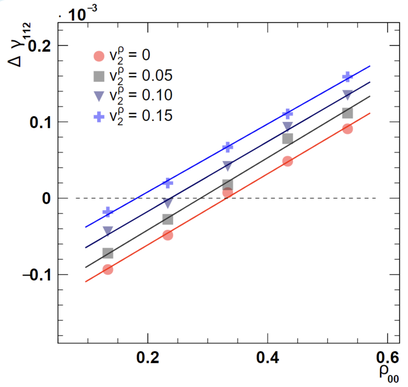
1. Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), Institute of Modern Physics, Fudan University, Shanghai 200433, China
2. Shanghai Research Center for Theoretical Nuclear Physics, NSFC and Fudan University, Shanghai 200438, China





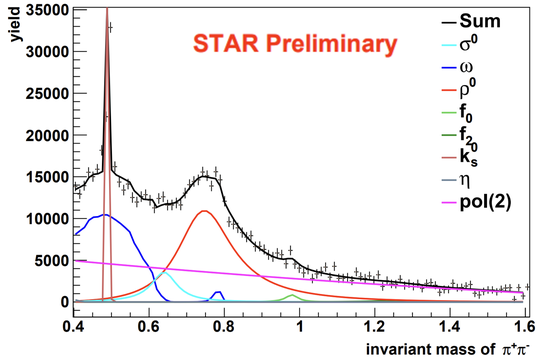
- ***p_T* dependence of ϕ meson ρ_{00}** with 1st and 2nd order EP show significant signals.
- The trend of rapidity dependence is observed, which is **consistent with theoretical** calculation.

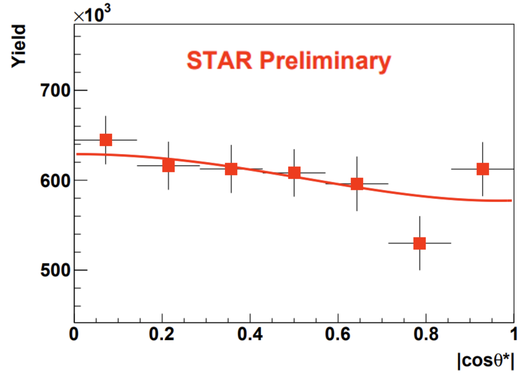
X. L. Sheng, S. Pu, Q. Wang, Phys.Rev.C 108 (2023) 5, 054902.



Implications of ρ^0 spin alignment on CME search.

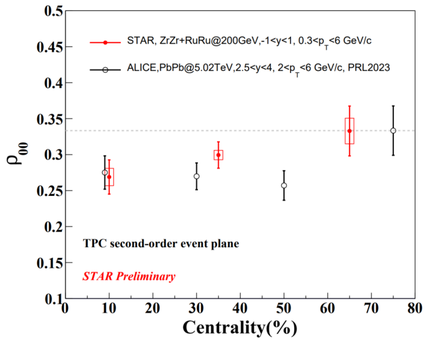
A. H. Tang, Chin. Phys. C 44 (2020) 054101.
D. Shen, J. Chen, A. Tang and G. Wang, Phys. Lett. B 839 (2023) 137777.





- **Mixture** of **quark flavor** $(u\bar{u}- d\bar{d})/\sqrt{2}$
- Constantly being **destroyed** and **regenerated**.
- Due to the complex background of ρ^0 meosns, this work is progressing.

Baoshan Xi, EPJ Web of Conferences 296 (2024), 04004.



ρ_{00} of J/ψ is less than 1/3 in Isobar (Ru+Ru & Zr+Zr at 200GeV).

D. D. Shen for STAR, SPIN 2023.

Conclusion

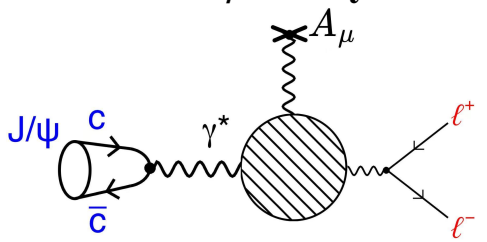
- The energy-dependent spin alignment for ϕ mesons from BES-II data is consistent with that published from BES-I and have a significant improvement in precision.
- Rapidity dependence of ϕ meson ρ_{00}, which is consistent with theoretical predictions.
- Global spin alignment of J/ψ mesons less then 1/3.
- Working progress well on measuring global spin alignment of ρ^0 mesons.

ElectroMagnetic Effects For Spin Alignment of J/ψ in Heavy Ion Collisions

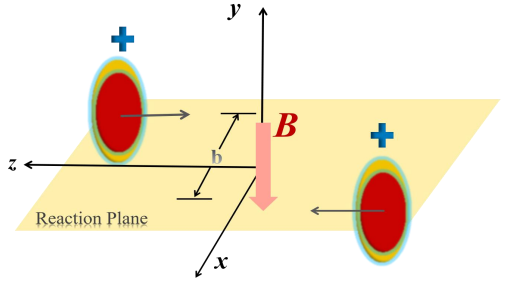
Author: Shu Lin Guowei Yan

➢ Angular Distribution of J/ψ Decay & SA

$J/\psi \to \gamma^* \to l^+ l^-$



$$dN = \frac{3}{4}[(1+\rho_{00}) + (1-3\rho_{00})\cos^2\theta] d\cos\theta$$



$$dN = \frac{e^4}{Q^4} l^{\mu\nu} \frac{2\,\mathrm{Im}\Pi^{\mu\nu}(Q)}{e^{-\beta q_0}-1} \frac{d^3p_1}{(2\pi)^3}\frac{d^3p_2}{(2\pi)^3}$$

➢ Direct coupling between magnetic and spin

- Weak Field $\quad \hat{H}_1 = g\frac{e\hbar}{2M_{J/\psi}}\vec{B}\cdot\vec{S}$

$$\hat{\rho} \propto \exp[-\beta(\hat{H}_0 + \hat{H}_1)]$$

- Strong Field

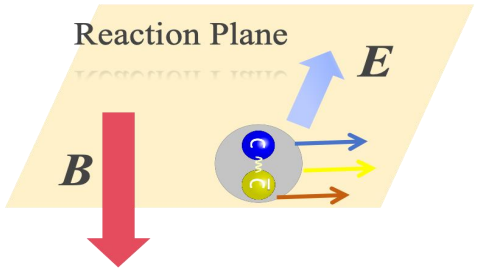
$$\Pi_R^{\mu\nu} = m_B^2 e^{\frac{|\mathbf{q}_\perp|^2}{2|q_f B|}}\left[1 - I\left(\frac{q_\parallel^2}{4m^2}\right)\right]\left(g_\parallel^{\mu\nu} - \frac{q_\parallel^\mu q_\parallel^\nu}{q_\parallel^2 + i\omega\epsilon}\right)$$

❖ *Results show* $\quad \rho_{00} - 1/3 > 0$

❖ *Electric Field & Orbital Angular momentum*

➢ J/ψ is S-wave L=0

➢ E from moving J/ψ

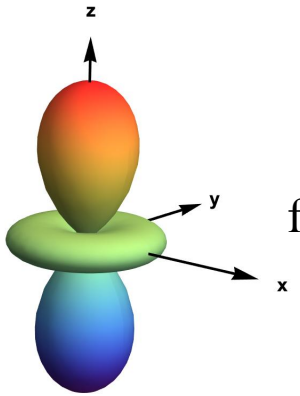


➢ Stark effect transits states to higer L

$$|\psi_n\rangle = |\psi_n^{(0)}\rangle + e\sum_{k\neq n}|\psi_k^{(0)}\rangle \frac{\langle\psi_k^{(0)}|\hat{H}_1|\psi_n^{(0)}\rangle}{E_n^{(0)} - E_k^{(0)}} + \cdots$$

1st order: L=0 → L=1

2nd order: L=0 → L=2

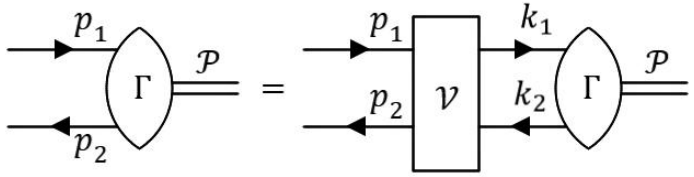


$$|n\,2\,0\rangle \propto (3\cos^2\theta - 1)$$

wave function ⇄ decay product

$$\frac{dN}{d\cos\theta} \propto (a + b\cdot\cos^2\theta)$$

➢ Bethe Salpeter Equation



$$\Gamma(p,\mathcal{P}) = \int_k \mathcal{V}(p,k;\mathcal{P})\,G(k,p)\,\Gamma(k,\mathcal{P})$$

- By ladder &Non-Retarded approx. we retrieve:

$$\left(\frac{\vec{p}^2}{m} - E\right)\psi(\vec{p}) + \int U(\vec{p}-\vec{q})\psi(\vec{q})\frac{d^3q}{(2\pi)^3} = 0$$

➢ New Photon Self Energy from E

$$\Pi^{ij} = \frac{1}{P^2 - m^2 + i\epsilon}\times \int\frac{d^3q}{(2\pi)^3}\Delta^i(\vec{q})\psi^*(\vec{q})\int\frac{d^3l}{(2\pi)^3}\Delta^j(\vec{l})\psi(\vec{l}) \propto A\cdot E^iE^j + B\cdot\delta^{ij}$$

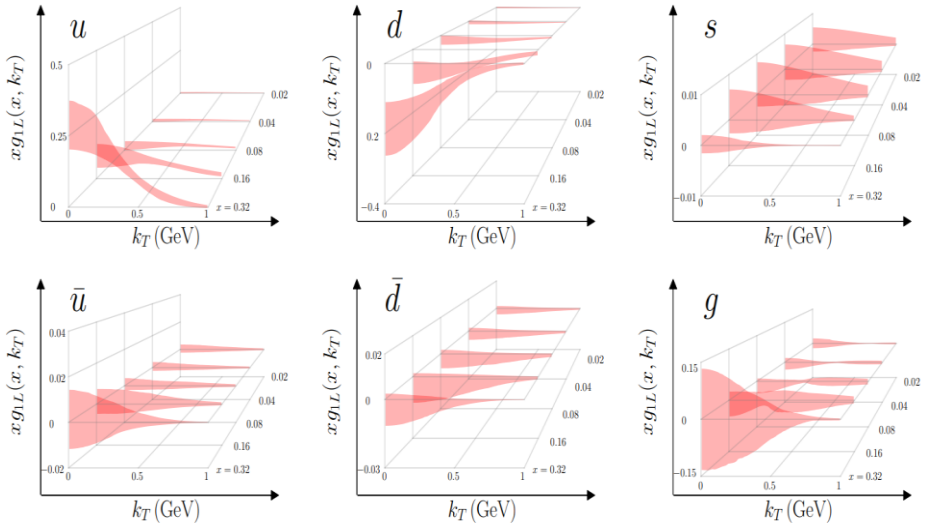
$$L_{ij} = \int d\cos\theta\,[l_i l_j\cos^2\theta + \frac{1}{2}(\delta_{ij} - l_i l_j\cos^2\theta)]$$

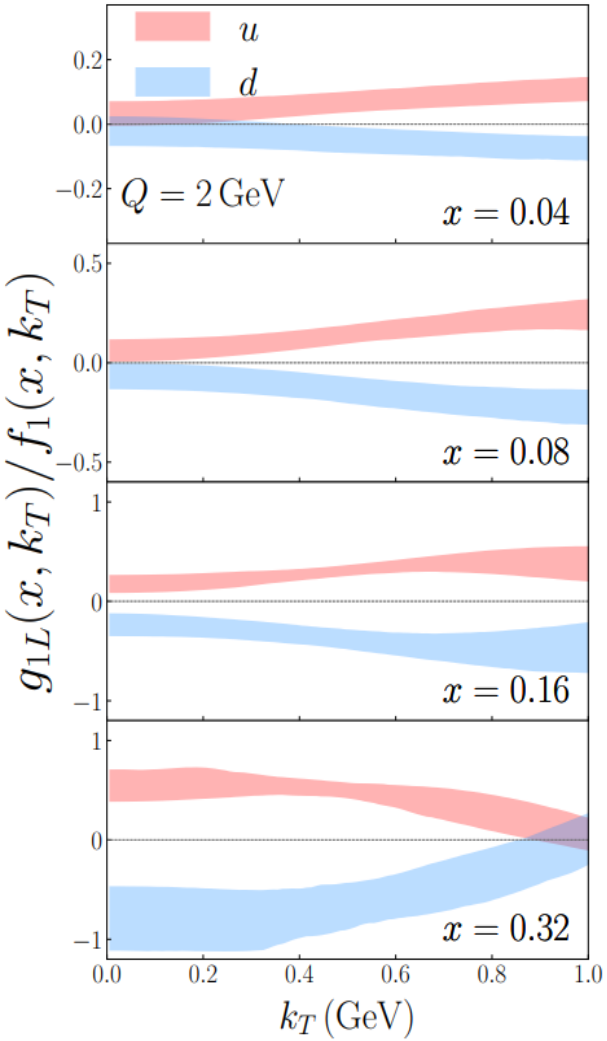
PosterID:185

三维螺旋度分布的首次提取

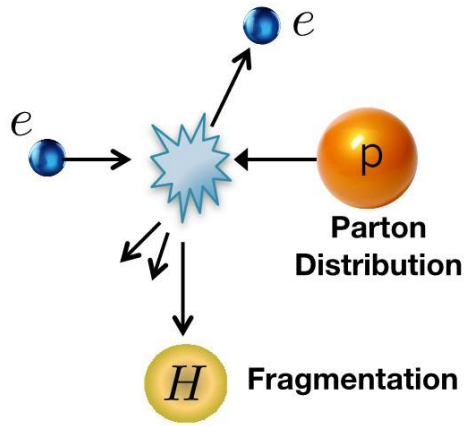
Leading Quark TMDPDFs — Nucleon Spin / Quark Spin

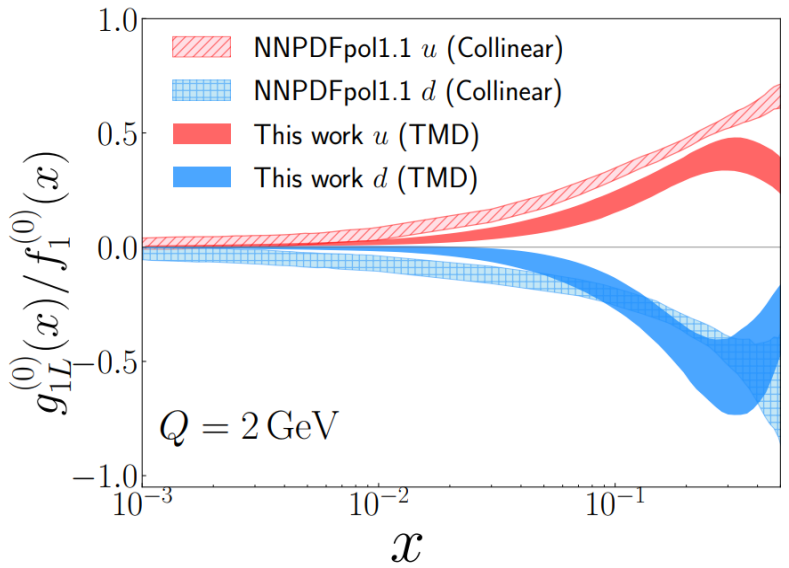
Nucleon Polarization	Un-Polarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
U	f_1 Unpolarized		$h_1^\perp$ Boer-Mulders
L		g_1 Helicity	$h_{1L}^\perp$ Worm-gear
T	$f_{1T}^\perp$ Sivers	$g_{1T}^\perp$ Worm-gear	h_1 Transversity; $h_{1T}^\perp$ Pretzelosity





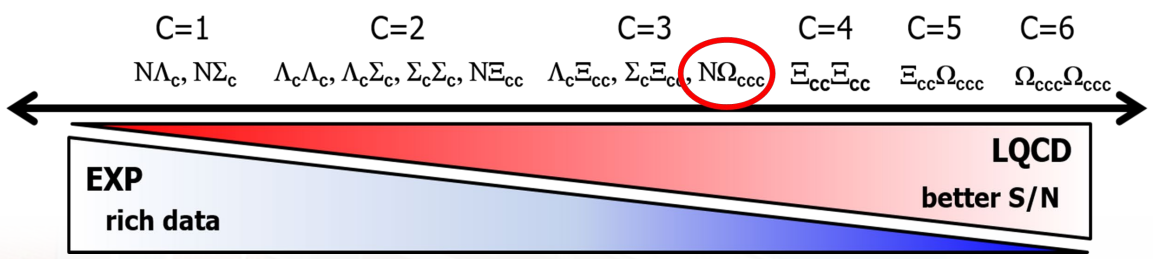
Semi-Inclusive DIS



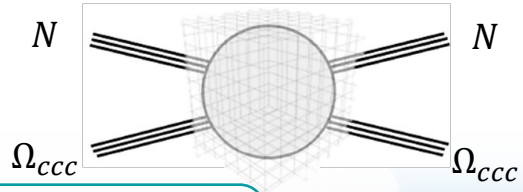


K. Yang, T. Liu, P. Sun, Y. Zhao, and B-Q. Ma, Phys. Rev. Lett.134(2025)121902

Lattice QCD study on $N\Omega_{ccc}$ interaction at physical point

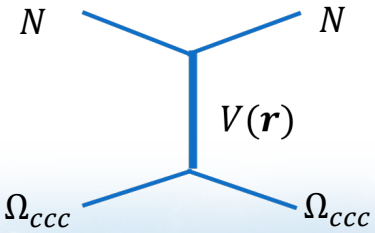


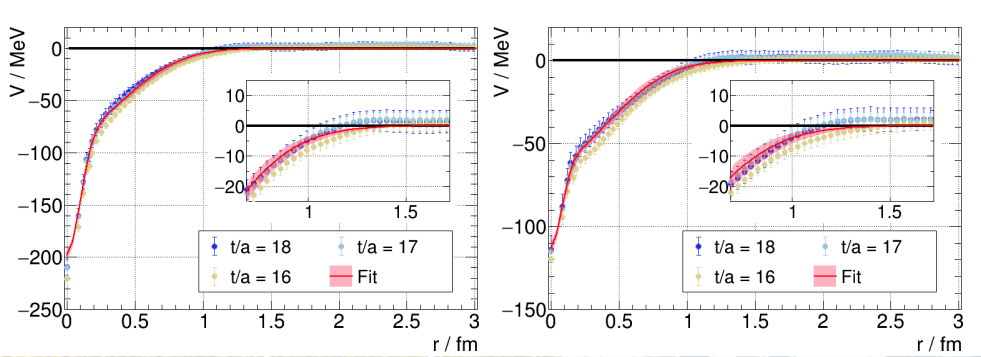
4-point correlation function form lattice

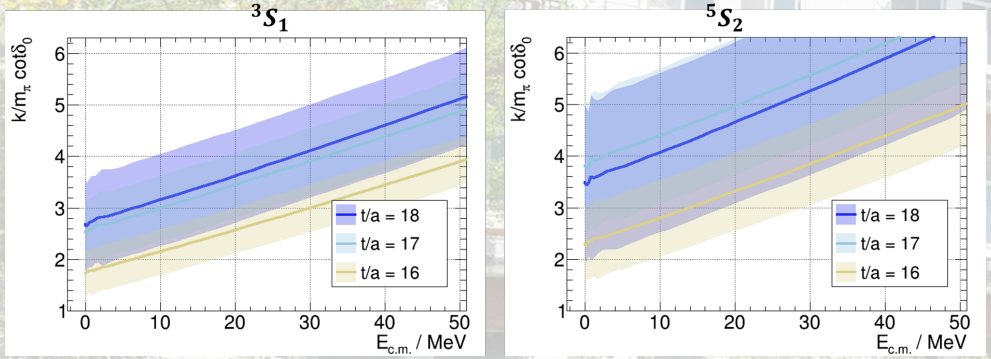


HAL QCD method

potential



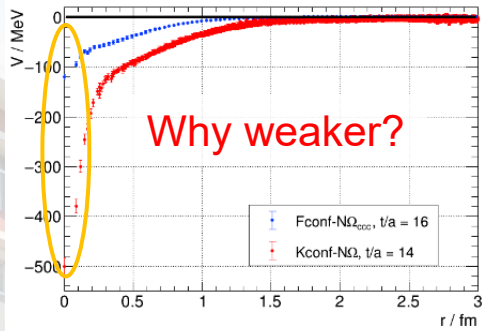


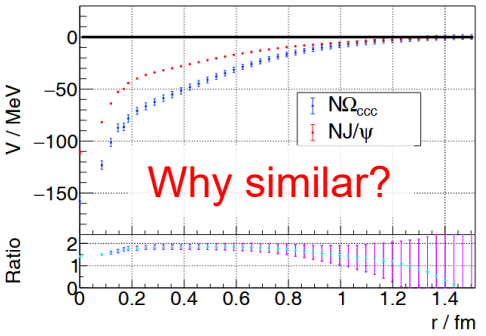


◆ $\Omega_{ccc}N$ interaction
- Full attractive potential
- No bound state is found

◆ Scattering mechanism
- Color-magnetic interaction in short range
- Soft-gluon exchange

◆ Outlook
- Better understanding of interaction mechanism of $N\Omega_{ccc}$
- Investigating heavy-baryon interactions
- Foundation for heavy-flavor physics.



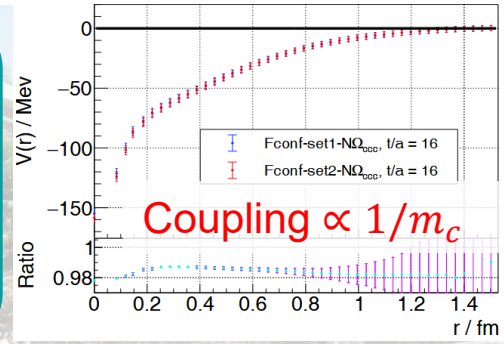


Above compare between $N\Omega_{ccc}$ and $N\Omega$

$$V_{N\Omega_{ccc}} < V_{N\Omega}$$

Upper Right compare between $N\Omega_{ccc}$ and NJ/ψ

Lower Right compare different charm mass



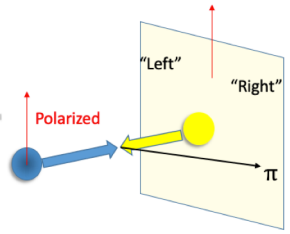
Transverse single-spin asymmetries of jets and hadrons within jets from polarized pp collisions at RHIC

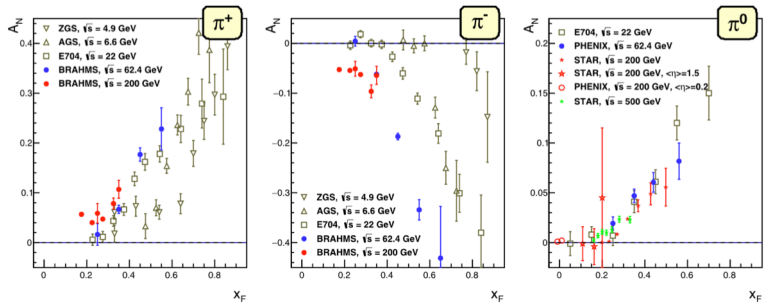
Yixin Zhang, Shandong University

➢ Anomalously large A_N observed for nearly 50 years

$$A_N = \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}}$$

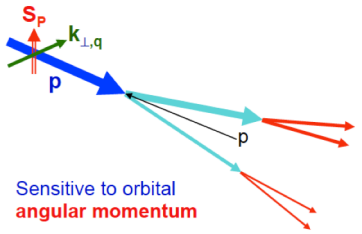
- LO QCD predicts $A_N \sim 0$





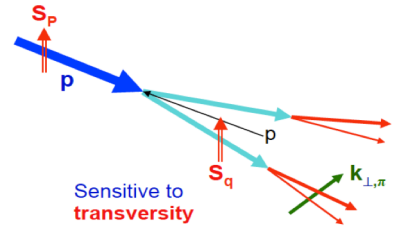
➢ Transverse Momentum Dependent (TMD) Mechanisms

Sivers distriubtion function:



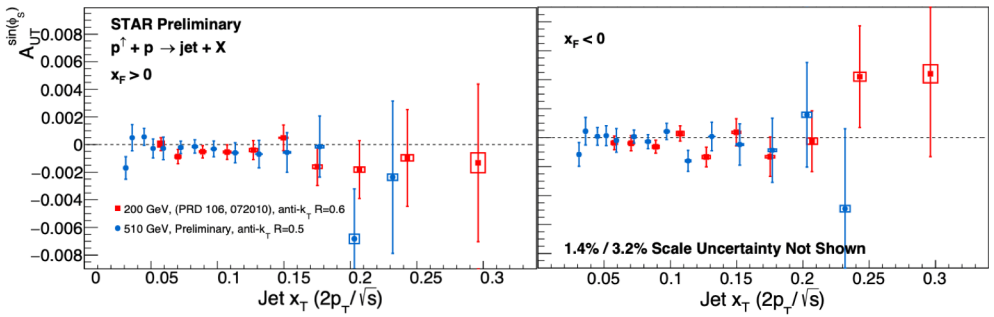
$$\vec{S} \cdot (\vec{p} \times \vec{k}_{\perp})$$

Collins fragmention function:



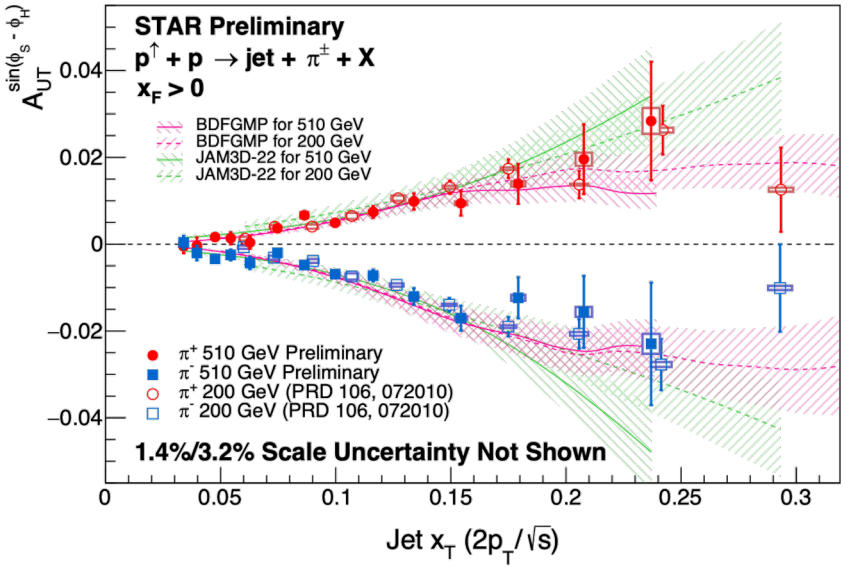
- Parton spin and $k_{\perp}$ correlation in initial state (related to orbital angular momentum)
- Quark spin and $k_{\perp}$ correlation in fragmentation process (coupled with transversity)

➢ Inclusive jet asymmetry



- Sensitive to twist-3 correlators associated with the gluon Sivers function
- Consistent with zero within uncertainty

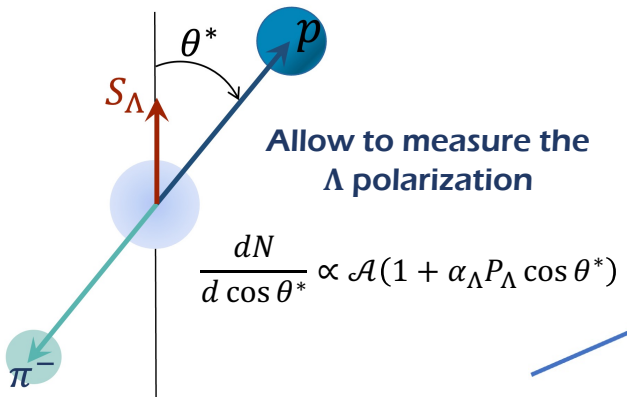
➢ $\pi^{\pm}$ Collins asymmetry



- Significant Collins asymmetry observed
- π^+ and π^+ exhibit opposite signs, with the asymmetry increasing as p_T grows
- Asymmetries of 200GeV & 510GeV are nicely align with jet x_T scale, giving almost no energy dependence.
- Providing important constraints on the TMD evolution and universality

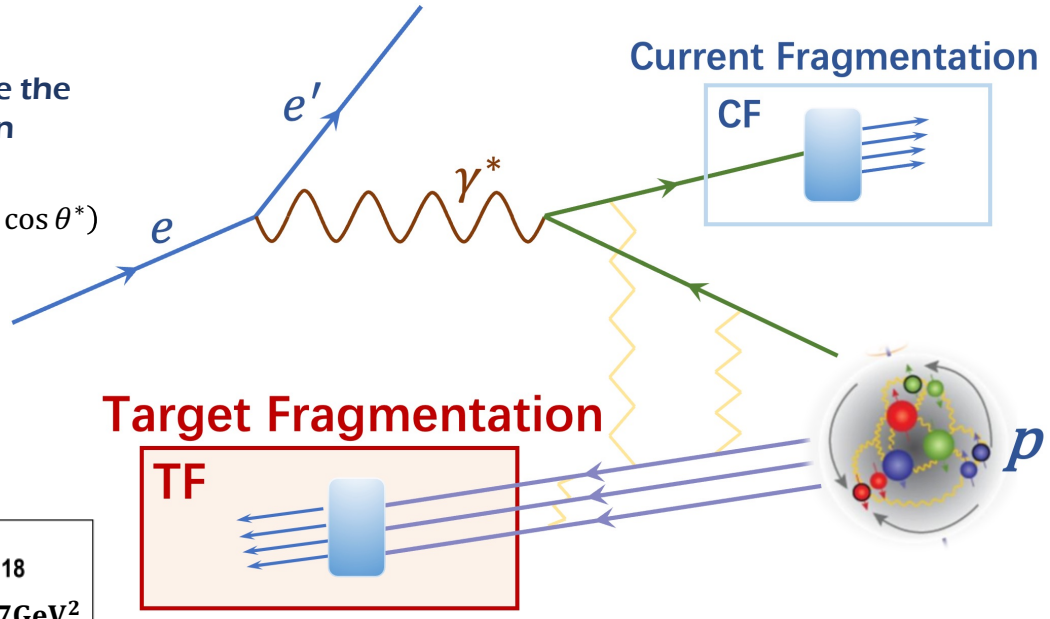
Suppression of Spin Transfer to Λ in Deep Inelastic Scattering

Xiaoyan Zhao, Zuo-tang Liang, Tianbo Liu, Ya-jin Zhou

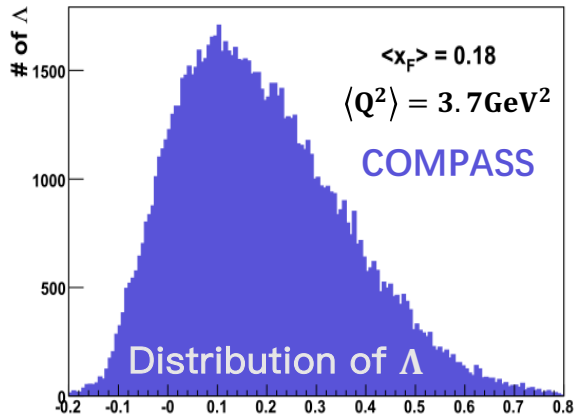


Allow to measure the Λ polarization

$$\frac{dN}{d\cos\theta^*} \propto \mathcal{A}(1 + \alpha_\Lambda P_\Lambda \cos\theta^*)$$



No clear separation between CF and TF :

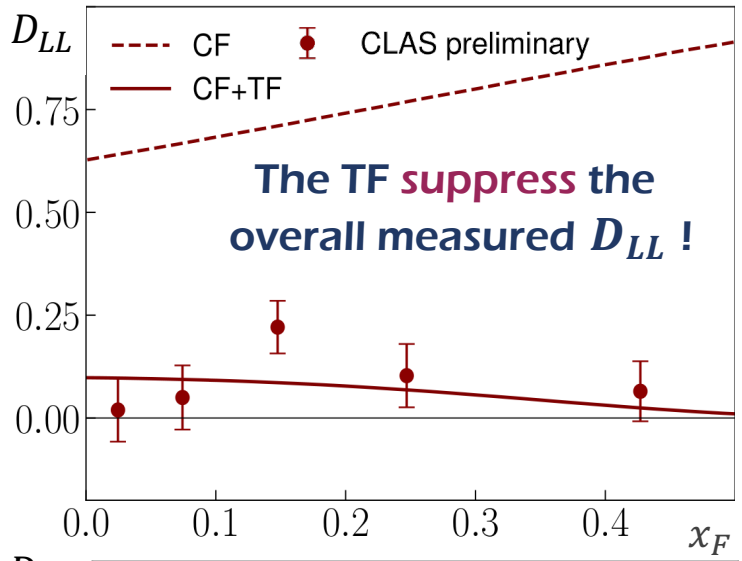


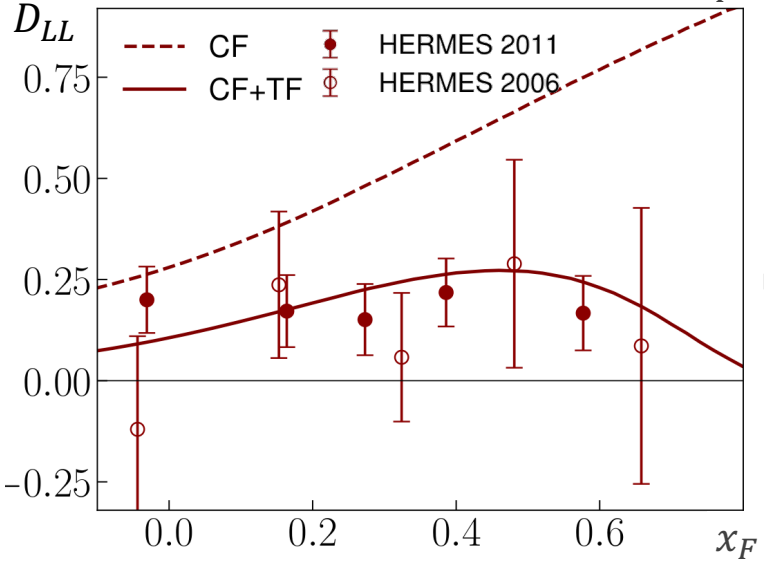
$x_F = 2P_{hL}/W$

- Target fragmentation plays an important role in understanding spin-related observables.
- Future experiments at EIC, EicC, HIAF and other facilities may help to clarify this issue !

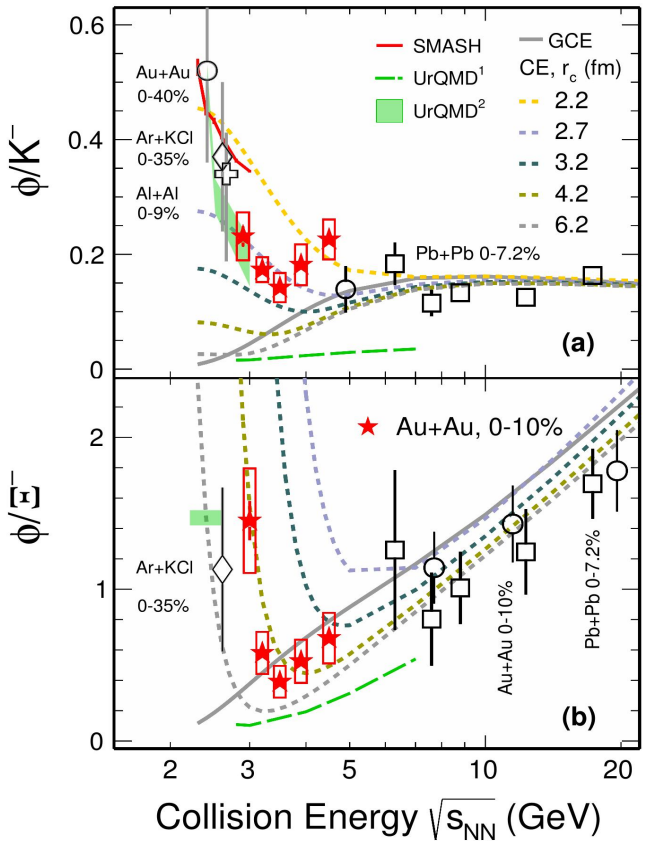
arXiv:2411.06205

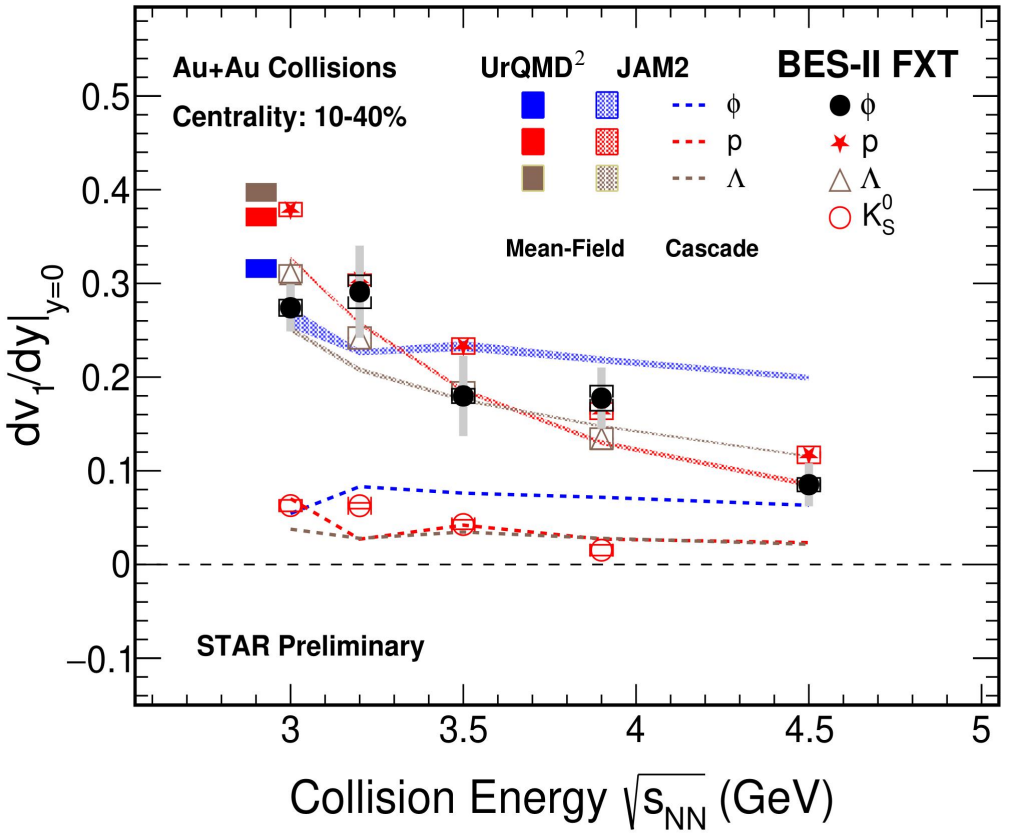
Longitudinal spin transfer D_{LL}





Energy dependence of ϕ meson production and directed flow in Au+Au collisions at high baryon density region (#171)





- Measurement of ϕ meson yield and v_1 in Au+Au collisions at 3.0 - 4.5 GeV.
- Strangeness CE or UrQMD with high mass resonances decay is required to describe the non-monotonic energy dependence of ϕ/K^- and ϕ/Ξ^- yields ratio.
- ϕ meson v_1 has the similar strength with that of proton and Λ baryon, JAM2 and modified UrQMD qualitatively describe the trend with baryonic mean field.

郑光裕 (ZHENG Guangyu)
中国科学院大学 (UCAS)

- Indicating that ϕ meson production at high baryon density region is closely coupled to the baryon. $NN \rightarrow NN^*$, $N^* \rightarrow N\phi$

Guangyu Zheng (zhengguangyu23@mails.ucas.ac.cn)

Bayesian Inference of the Critical Endpoint in 2+1-Flavor System from Holographic QCD

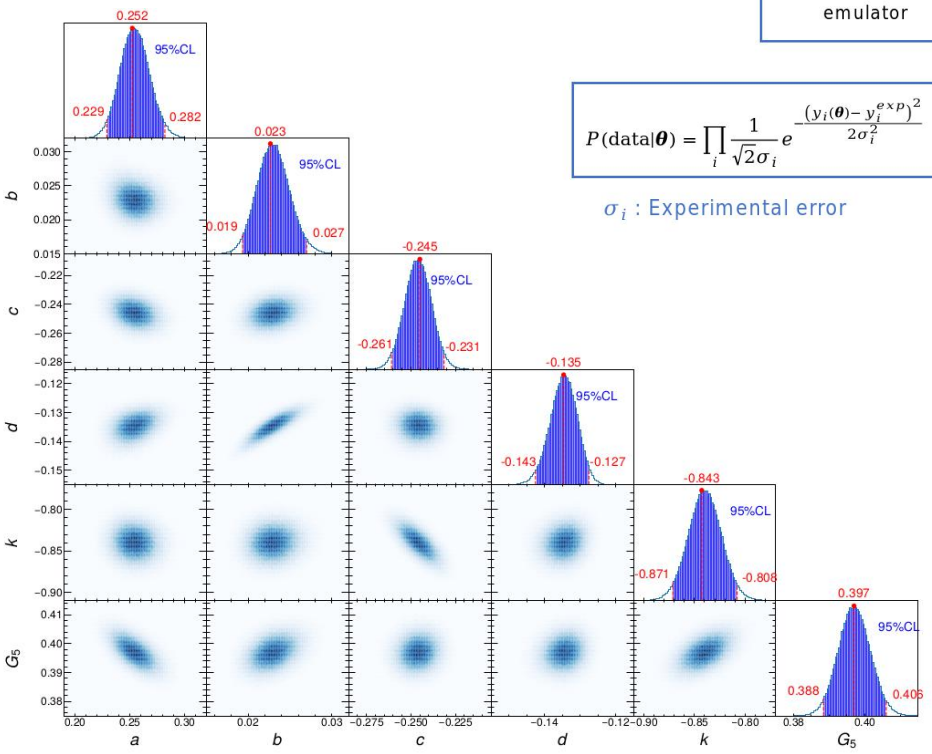
姓名：朱力强　单位：华中师范大学

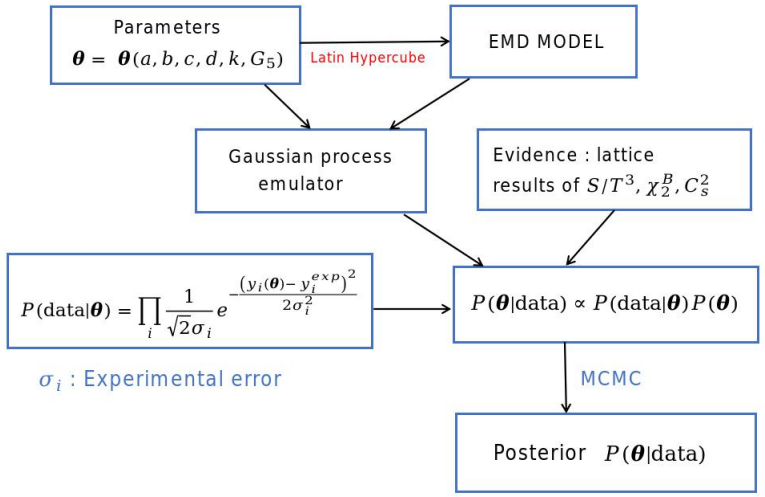
Einstein-Maxwell-dilaton(EMD) model:

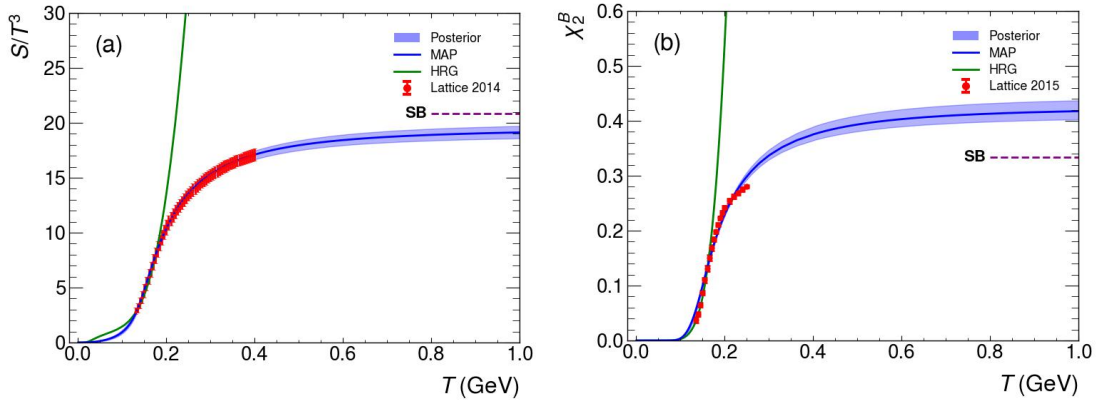
$$S_E = \frac{1}{16\pi G_5}\int d^5x\sqrt{-g}\left[R - \frac{f(\phi)}{4}F^2 - \frac{1}{2}\partial_\mu\phi\partial^\mu\phi - V(\phi)\right]$$

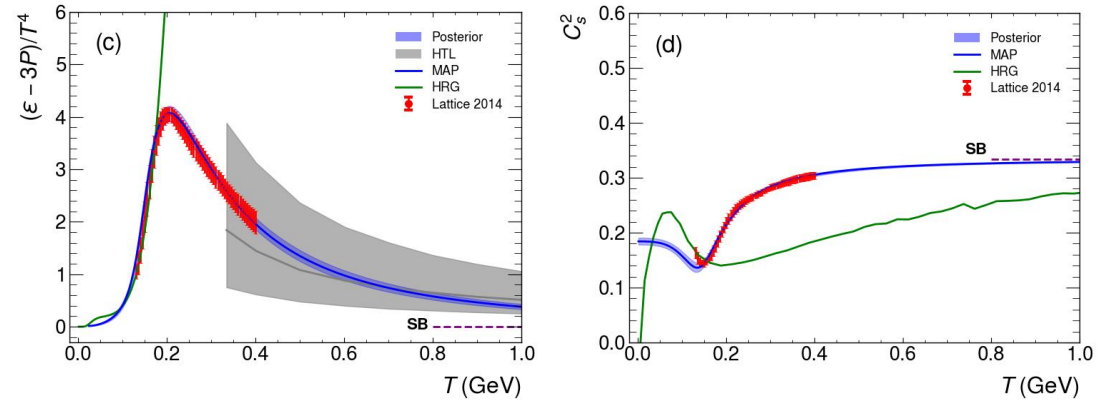
$$A(z) = d\ln(az^2+1) + d\ln(bz^4+1),\ f(z) = e^{cz^2 - A(z) + k}$$

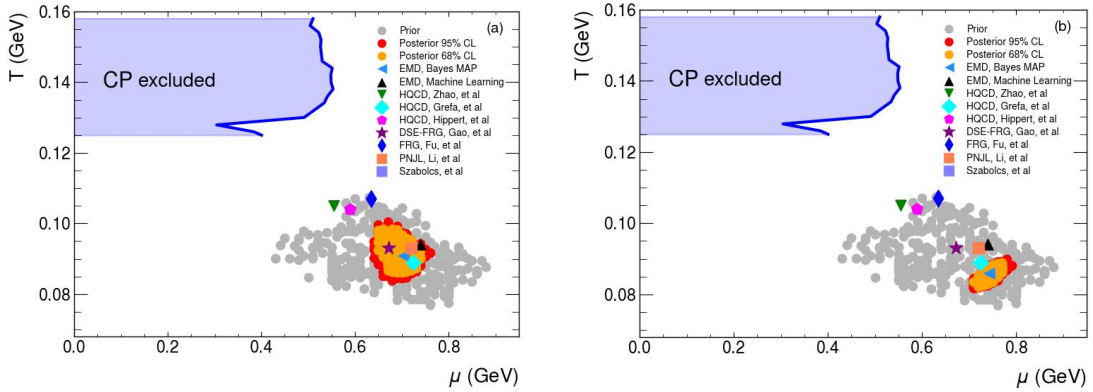
$$s = \frac{e^{3A(z_h)}}{4G_5 z_h^3} \qquad \chi_2^B = \frac{1}{T^2}\frac{\partial\rho}{\partial\mu}$$











Liqiang Zhu, Xun Chen, Kai Zhou, Hanzhong Zhang, Mei Huang, arXiv:2501.17763