Toward Solving the Puzzle of Local Lambda Polarization

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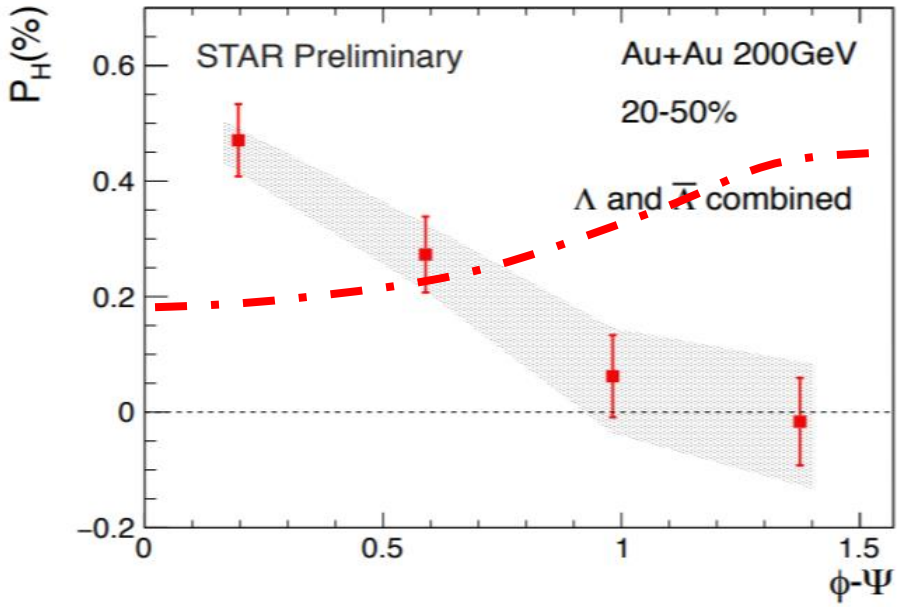
In collaboration: Yifeng Sun and Che Ming Ko

Quark Matter 2019, Wuhan, China

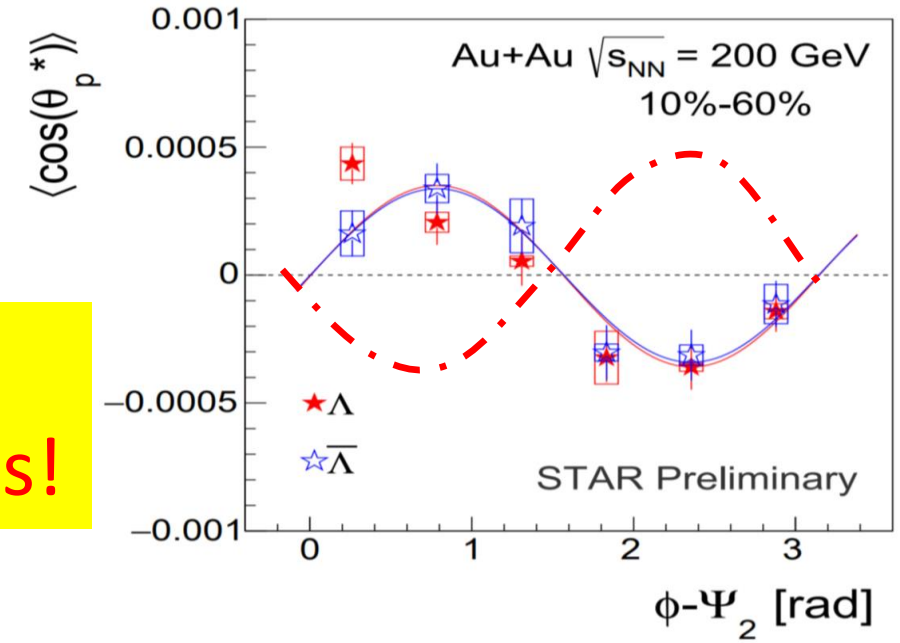
Based on work, Liu, Sun, Ko, arXiv:1910.06774



Schematic Sketch

Thermal model prediction

Spin puzzle for heavy-ion collisions!



Three Key Components Toward Solving the Spin Puzzle

Total Angular Momentum Conservation

Covariance

Chiral Vortical Effect
Axial Charge Dipole

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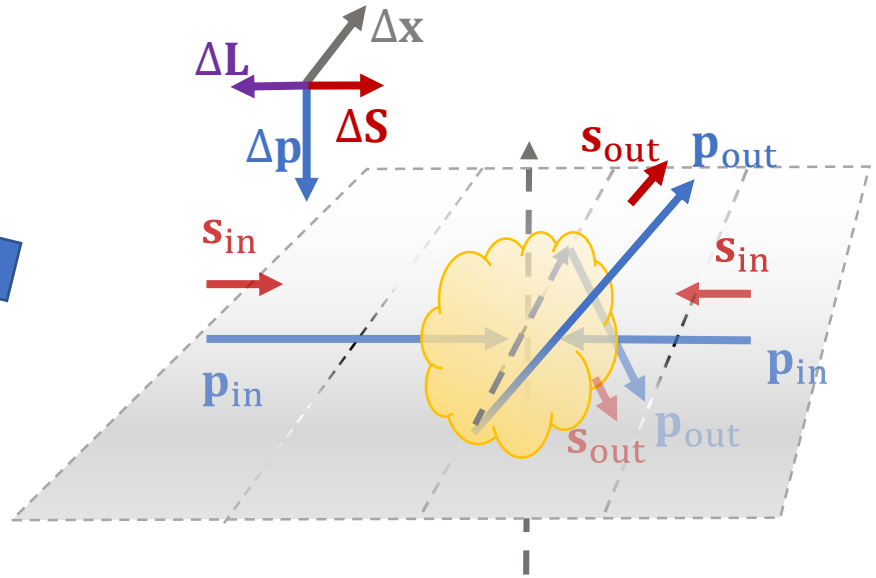

Chen, Son, Stephanov, Yee, Yin, PRL, 2014
Chen, Son, Stephanov, PRL 2015

First model that conserves *J=L+S*

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Scattering: $J^{\mu\nu}_{\text{in}} = J^{\mu\nu}_{\text{out}}$

Definition of covariant spin :

$$s^{\mu} = \sum \int \widetilde{d^3p}\, p^{\mu} f_{\lambda} + S^{\mu\nu}\partial_{\nu} f_{\lambda}$$

Total Spin

Normal Spin

Jump spin, **Required by covariance**

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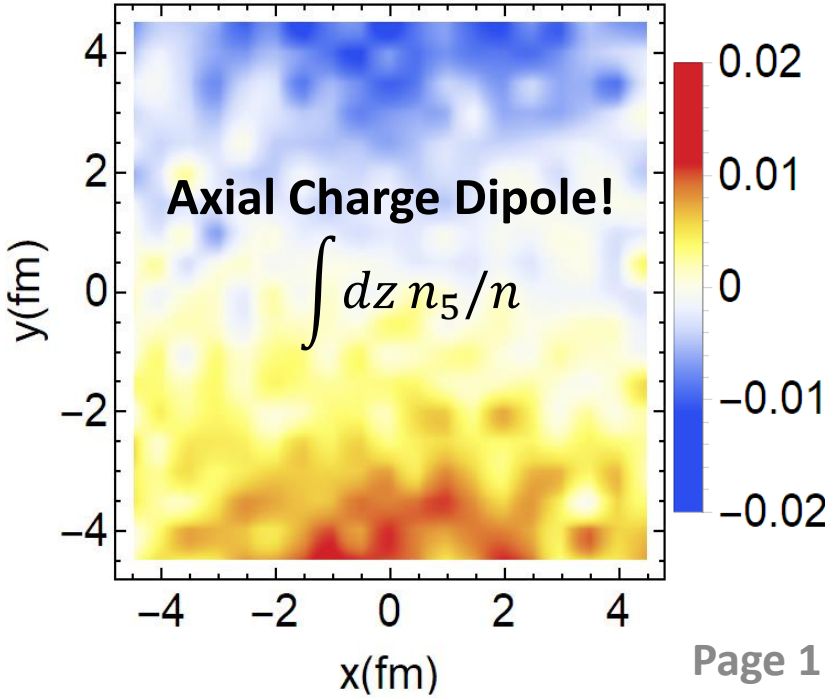
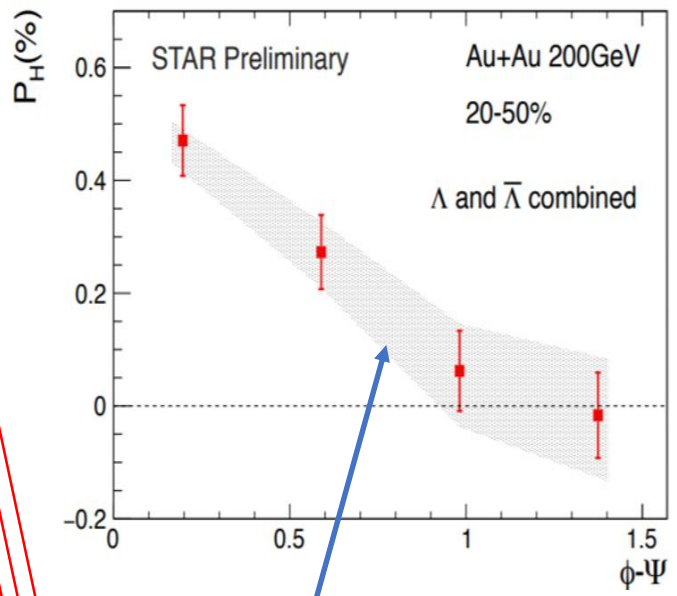


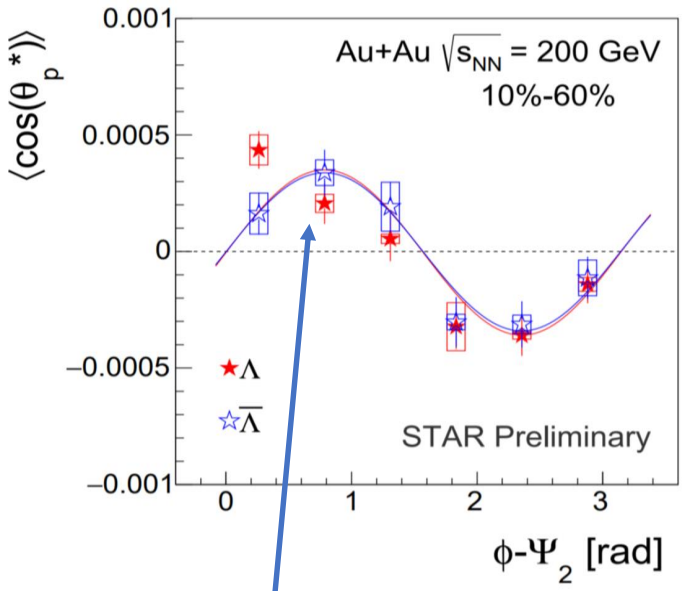
Results

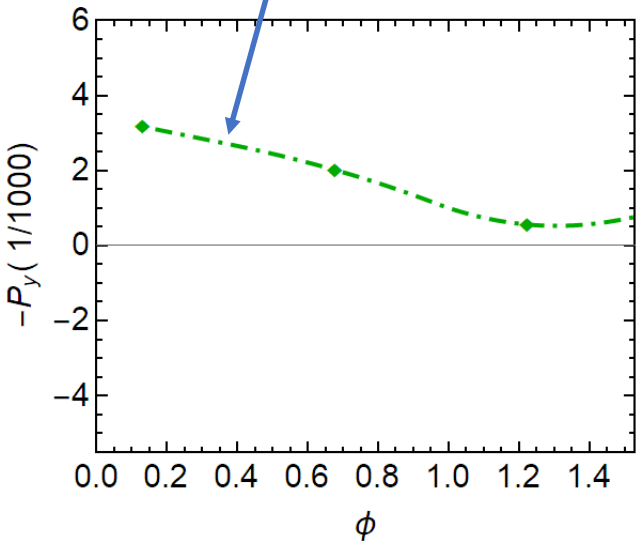
Total Angular Momentum Conservation

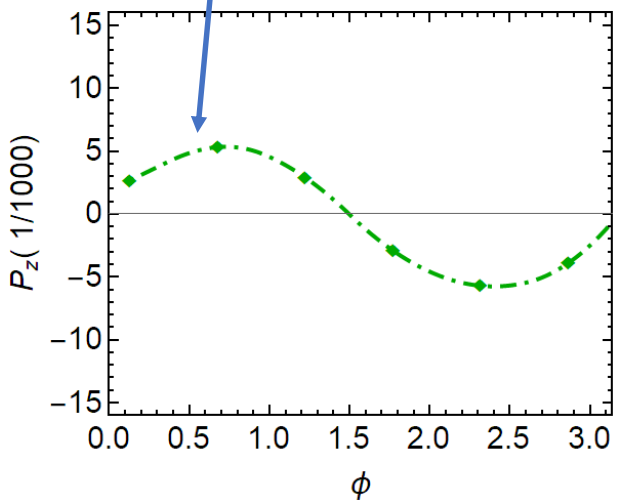
Covariance

Chiral Vortical Effect
Axial Charge Diploe









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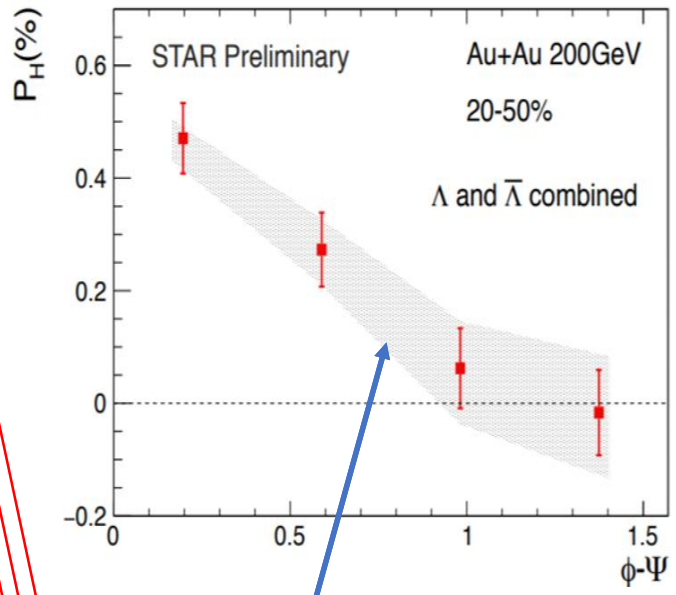

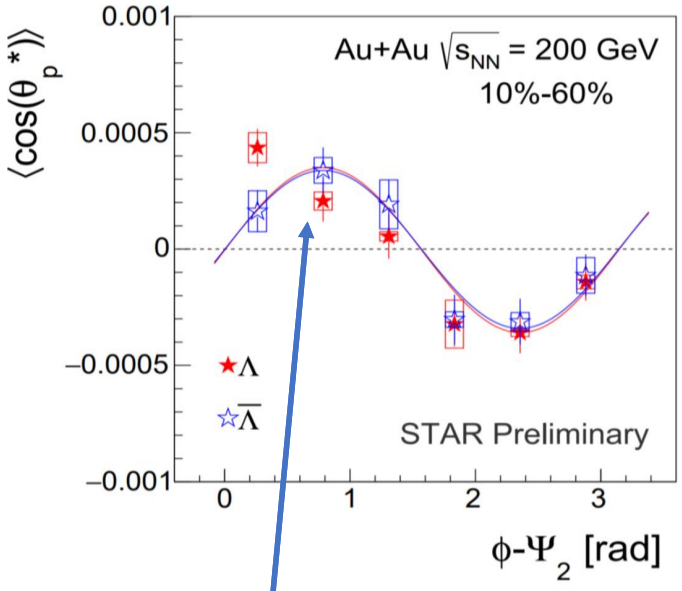

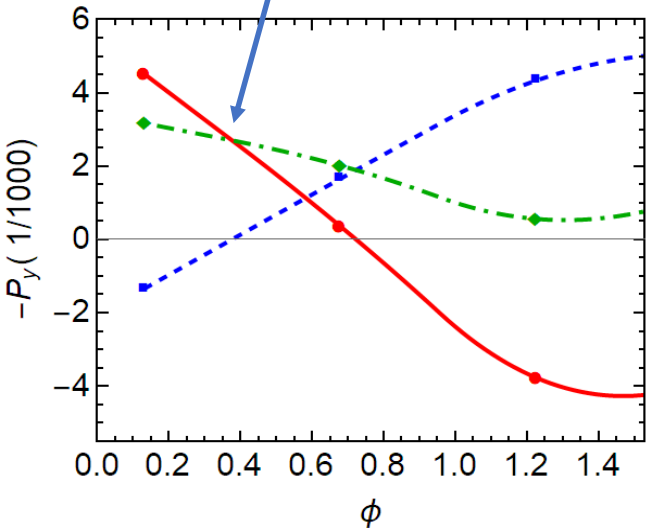

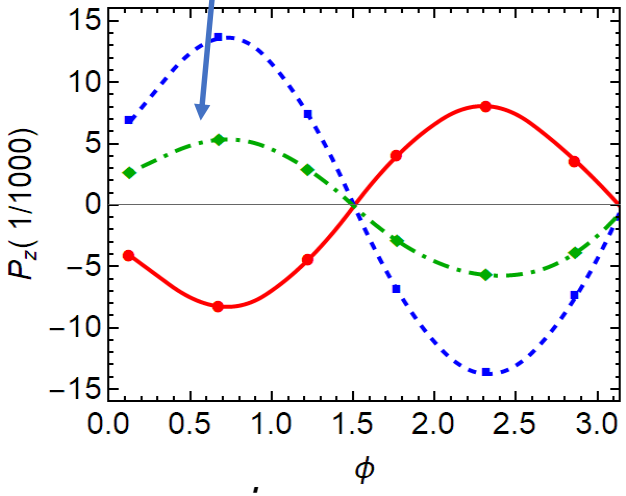

$$s^{\mu} = \sum \int \widetilde{d^3p}\, p^{\mu} f_{\lambda} + S^{\mu\nu}\partial_{\nu} f_{\lambda}$$

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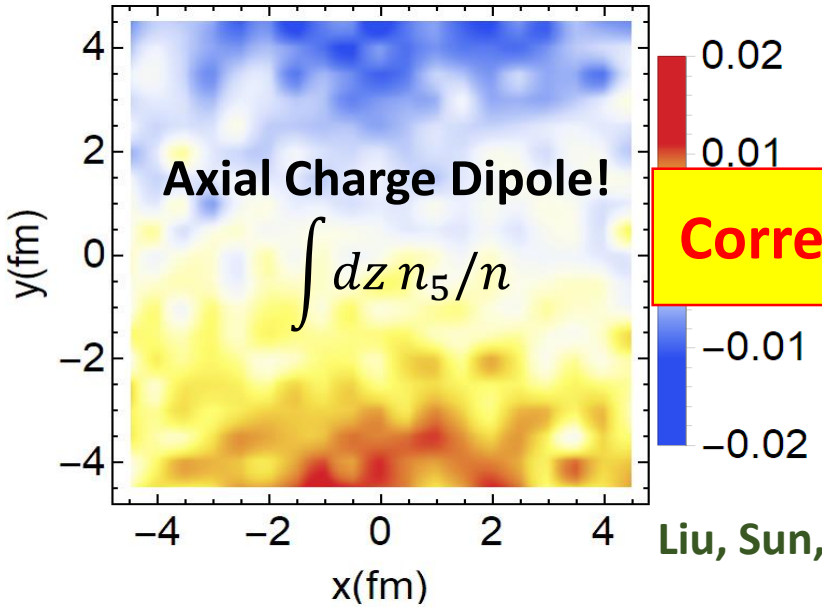
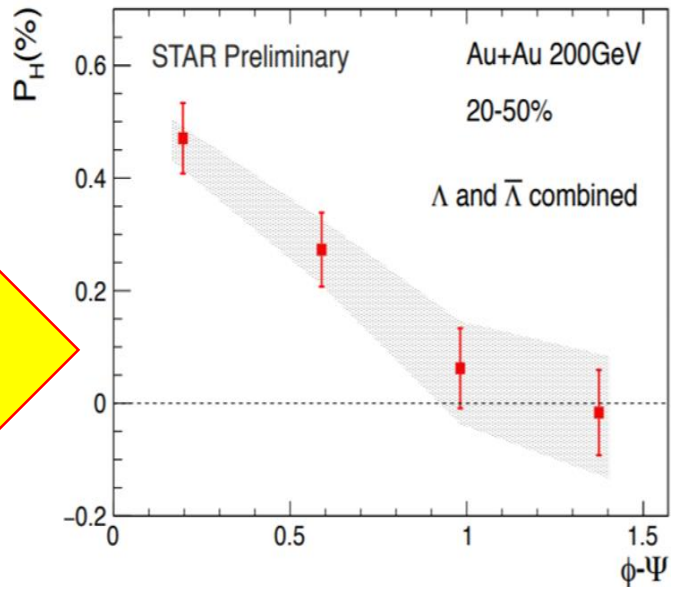


Correlated!



Liu, Sun, Ko, arXiv:1910.06774

Chiral Vortical Effect
Axial Charge Dipole

Summary

- Conclusions
  - The first model conserving $J=L+S$ covariantly
  - Normal Spin + Jump Spin, both important
  - Axial charge redistribution induced by chiral vortical effect is essential
- Remaining issues
  - Just quark polarization in chiral limit! How does it relate to Lambda spin? What is the mass effect? How does it relate to and help spin hydrodynamics?
  - Just a start, full solution to the puzzle requires efforts from all different perspectives!