Toward Solving the Puzzle of Local Lambda Polarization

Shuai Liu

Institute of Modern Physics & Texas A&M University

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
Three Key Components Toward Solving the Spin Puzzle

Total Angular Momentum Conservation

Covariance

Chiral Vortical Effect
Axial Charge Dipole

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

First model that conserves $J=L+S$
Three Key Components Toward Solving the Spin Puzzle

**Total Angular Momentum Conservation**

**Covariance**

**Chiral Vortical Effect**

**Axial Charge Dipole**

Scattering: $J_{in}^{\mu \nu} = J_{out}^{\mu \nu}$

Definition of covariant spin:

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

- **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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Total Angular Momentum Conservation

Covariance

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\[
S^\mu = \sum \int d^3 p \; p^\mu f_\lambda + S^{\mu \nu} \partial_\nu f_\lambda
\]
Results

Chiral Vortical Effect
Axial Charge Dipole

\[ \int dz \frac{n_5}{n} \]

Liu, Sun, Ko, arXiv:1910.06774
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!