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**Ilya Selyuzhenkov** for the **STAR** Collaboration

# Global polarization measurements in Au+Au collisions

**Wayne State University** Detroit MI 48021 **E-mail:** IlyaSelyuzhenkov@wayne.edu

# Global hyperon's polarization

**Source:** **Large angular orbital momentum** $\vec{L}$ of the system in non central relativistic nuclear-nuclear collisions

**Effect:** **transformation of the angular momentum** $\vec{L}$ **into the particles spin**

**Method:** $\vec{L}$ is perpendicular to the reaction plane

→ Correlations wrt the reaction plane

→ **Anisotropic flow technique can be applied**

# Analysis overview

**Theory input:**

| | |
|---|---|
| **Z.-T. Liang and X.-N. Wang** | Phys. Rev. Lett. 94, 102301 (2005) [**erratum**: 039901(2006)] |
| **Z.-T. Liang and X.-N. Wang** | nucl-th/0411101 |
| **Sergei A. Voloshin** | nucl-th/0410089 |

**Measurement technique:** Two particle correlations wrt reaction plane estimated from STAR Forward TPC

**Results:** Lambda global polarization in Au+Au at 62 and 200 GeV

**Systematics study:** 2 different collision energies
Reversed Full Field vs Full Filed data for 200GeV
FTPC event plane resolution: FTPC saturation in 200GeV
centrality cuts
event plane from different charges

# Angular distribution for the global polarization

$$\frac{dN}{d\cos\theta^*} \sim 1+\alpha_H P_H \cos\theta^*$$

$P_H$ hyperon polarization wrt reaction plane (**global polarization**)

$\alpha_H$ decay constant ( $\alpha_\Lambda = 0.642$ for $\Lambda \to p\pi^-$ )

$\theta^*$ angle between normal for the reaction plane and the hyperon's decay product 3-momentum in the hyperon's rest frame

# Lambda global polarization: **measurement technique**

$$P_\Lambda = \frac{8}{\pi \alpha_\Lambda} \langle \sin(\varphi_{p^*_\Lambda} - \Psi_{RP}) \rangle$$

$\varphi_{p^*_\Lambda}$ - angle of the decayed proton in the $\Lambda$ rest frame

**Scalar product technique**
**(two particle correlations)**

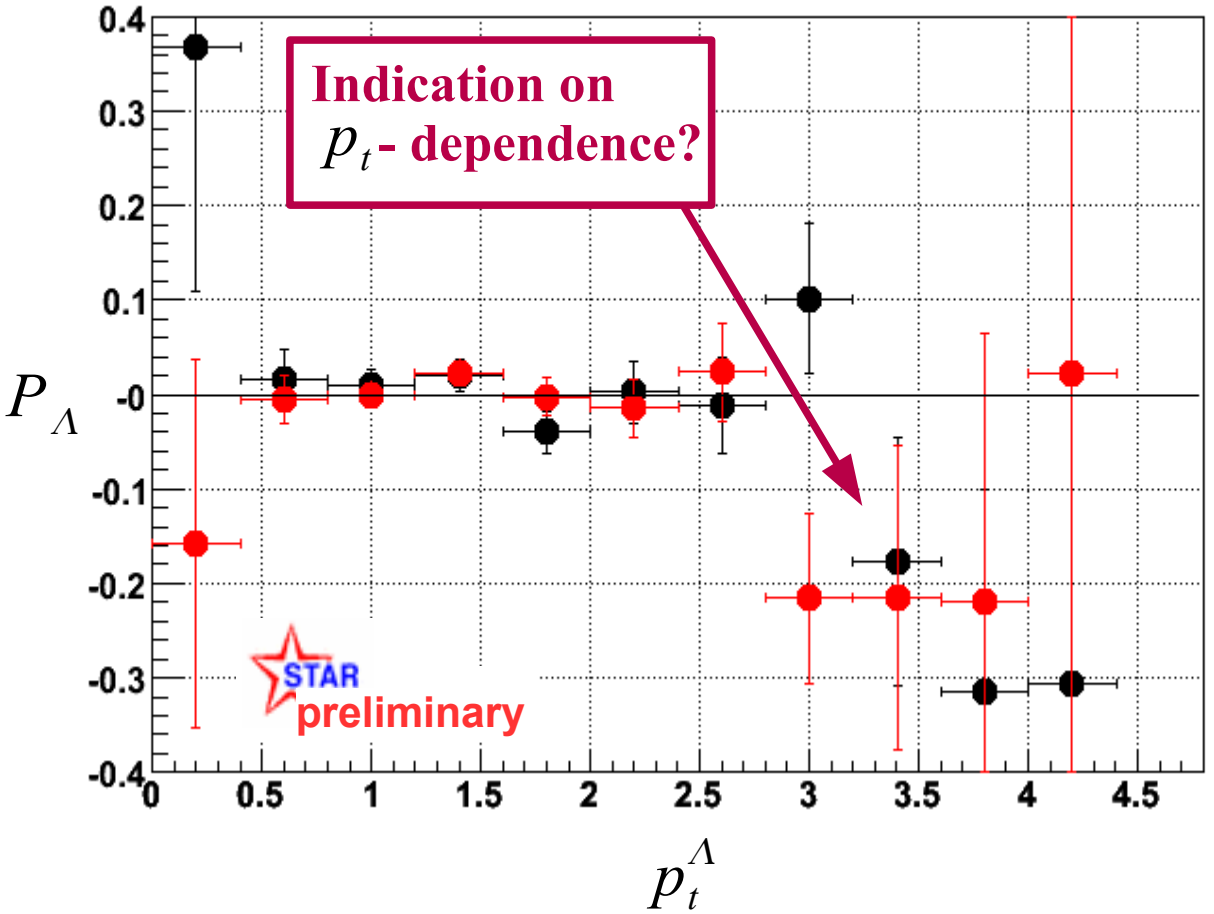
$$P_\Lambda = \frac{8}{\pi \alpha} \frac{\langle \sin\varphi_{p^*_\Lambda} X_{EP} \rangle - \langle \cos\varphi_{p^*_\Lambda} Y_{EP} \rangle}{R_{EP}}$$

$Q_{EP} = (X_{EP}, Y_{EP})$ - **1st order event plane vector (from FTPC)**

$R_{EP}$ - **FTPC event plane resolution**:
from **two particle correlations**
(FTPC[East-West] to suppress non-flow from momentum conservation)
or **mixed harmonic**
(need more statistics, but efficiently suppress non-flow)

# Lambda global polarization: **transverse momentum dependence**

**RHIC Run IV data**




**AuAu@200GeV (20-70%)**

**AuAu@62GeV (0-80%)**

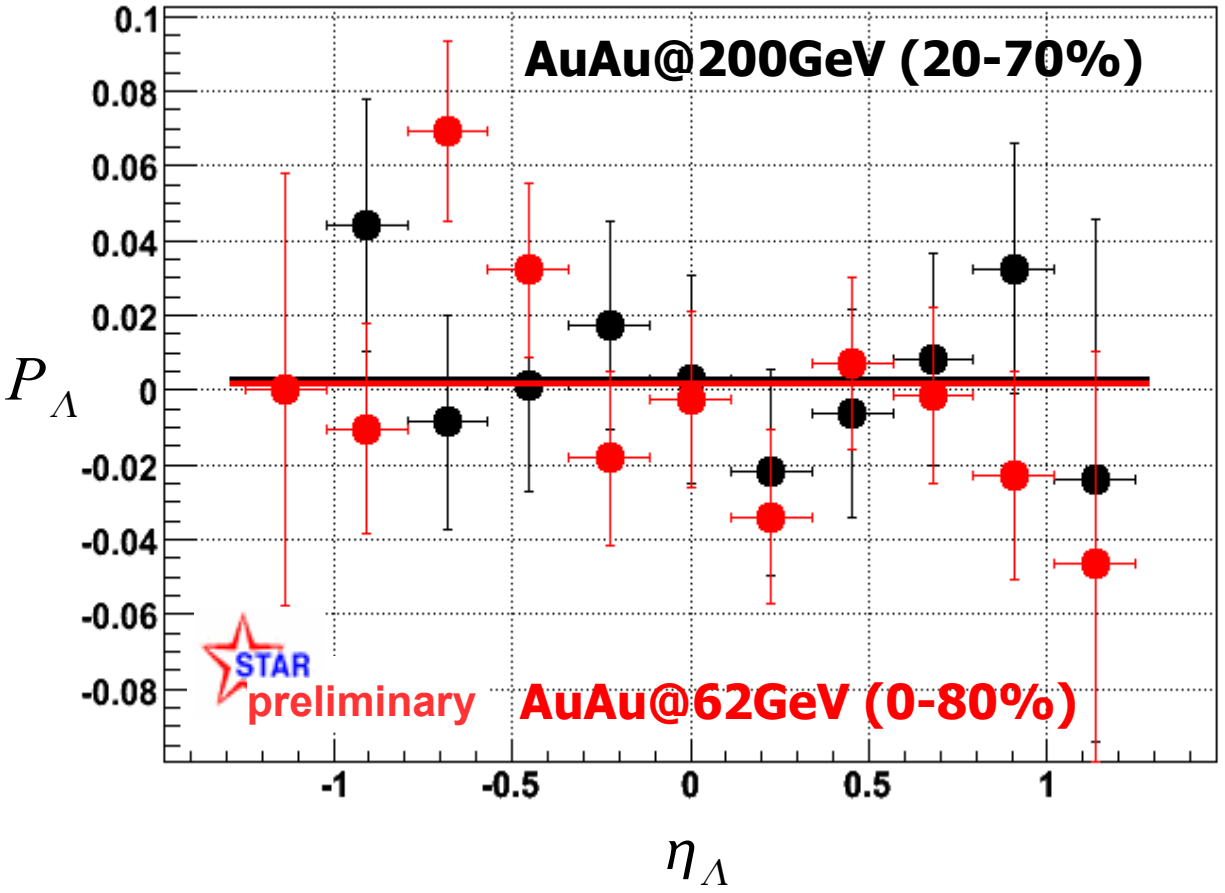
**Global polarization is zero for small Lambda $p_t$**

**Pure statistics for high $p_t$**

**No theory curves on $p_t$ dependence for the moment**

# Lambda global polarization: **pseudo-rapidity dependence**

**RHIC Run IV data**




**Line fit for AuAu@200GeV**

$$P_\Lambda = (2.6 \pm 9.5) \times 10^{-3}$$

**line fit for AuAu@62GeV**

$$P_\Lambda = (1.9 \pm 8.0) \times 10^{-3}$$

**Available theory value**

$$P_\Lambda = -0.3$$

**Z.-T. Liang and X.-N. Wang**
PRL94, 102301 (2005)

# Conclusion

- The **Lambda global polarization has been measured in Au+Au** collisions at the center of mass **energies 62 and 200 GeV** with the **STAR detector** at RHIC

- An **upper limit for the Lambda global polarization** is obtained:

$$\left|P_{\Lambda}\right| \leq 10^{-2}$$

This **value is far below** the one **discussed in the recent theoretical papers**:

$$P_{\Lambda}^{theor} = -0.3$$

- The **reason for this** significant **discrepancy is not clear** now and there are still extensive **theoretical discussion** on this subject. As it was found later by the original authors the **predicted value of** $P_{\Lambda}^{theor} = -0.3$ **could be incorrect** due to inapplicability of the approximations used and the correct estimation for RHIC energies requires **more realistic theoretical calculations** (see **Phys. Rev. Lett. 96, 039901 (2005)** for details).