Directed flow of $^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He in Au+Au Collisions at $\sqrt{s_{NN}}$ = 3.0 GeV at STAR

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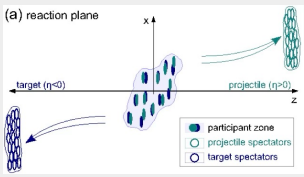
Abstract

Studying hyper-nuclei yields and their collectivity can shed light on their production mechanism as well as the hyperon-nucleon interactions. Heavy-ion collisions from the RHIC beam energy scan phase II (BES-II) provide a unique opportunity to understand these at high baryon density.

In this poster, we will present the first measurement of directed flow (v_1) for $^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He from fixed-target Au+Au collisions at $\sqrt{s_{NN}}$ = 3.0 GeV, made possible by the collection of 2 billion minimum-bias events by the STAR experiment during BES-II. The rapidity dependence of the $^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He v_1 are studied in mid-central collisions. The results are compared to that of other hyper-nuclei and light nuclei.

Directed flow

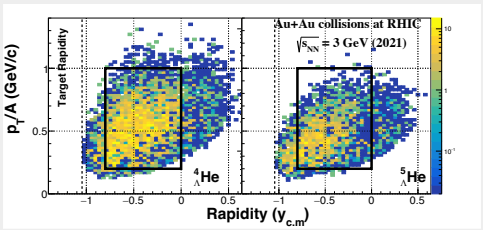


- The particle differential distribution can be written in the form of a Fourier series, directed flow(v_1) is the first expansion coefficient:

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}(1 + \sum_{n=1}^{\infty} 2v_n \cos(n(\phi - \psi)))$$

- Collective flow is sensitive to the equation of state of nuclear matter.
- Directed flow provides a good opportunity to explore hyper-nuclei production mechanism.

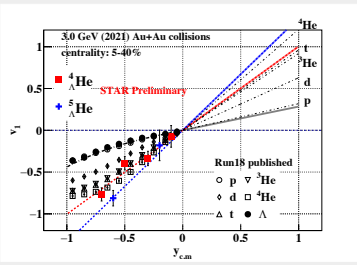
Light- and Hyper-Nuclei Acceptance



- Collective flow of light nuclei and hyper-nuclei are calculated within the selected p_T/A range as indicated by the boxes.

Directed flow Results

- Directed flow measured with invariant mass method. Light nuclei results are represented by open markers, and hyper-nuclei are solid markers.
- Shows mass number dependence in v_1(y) distribution both for light nuclei and hyper-nuclei.

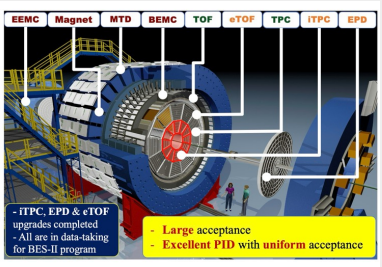


Reference

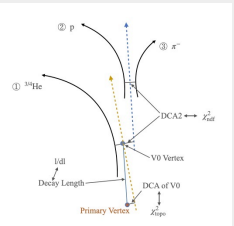
[1] B.Abelev et al. Phys. Rev. Lett. 111, 232302(2013)
[2] A. M. Poskanzer and S. A. Voloshin, Phys. Rev. C 58, 1671 (1998)
[3]. KF Particle Finder: M. Zyzak, Dissertation thesis, Goethe University of Frankfurt, 2016.
[4]. H. Masui et al., Nucl. Instrum. Methods Phys. Res. A 833, 181 (2016)

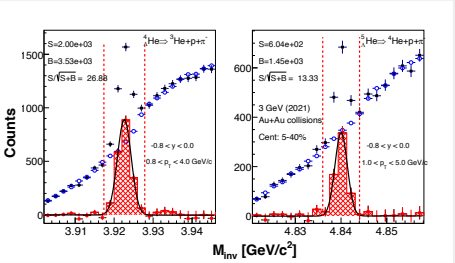
STAR Detector

- The STAR detector has full azimuthal coverage, and tracking and PID coverage for $|\eta|$<1.5 with the iTPC and eTOF upgrades.
- The EPD, which is used for event-plane reconstruction covers 2.1<$|\eta|$<5.1.



$^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He Reconstruction

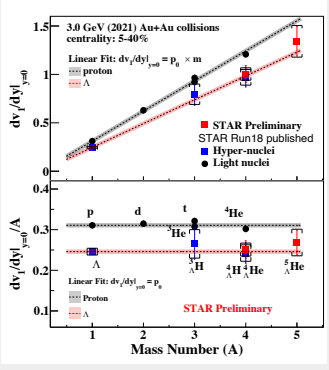




- $^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He are reconstructed with KFParticle package based on Kalman filter method to improve signal significance.

v_1 slope mass dependence

- The $dv_1/dy|_{y=0}$ of the light nuclei is obtained by fitting v_1(y) with a first-order plus third-order function, while that of the hyper-nuclei is obtained by fitting a first-order function.
- The $dv_1/dy|_{y=0}$ ($dv_1/dy|_{y=0}$ /mass) vs. mass shows mass ordering both for light nuclei and hyper-nuclei.



Conclusion

- First measurements of directed flow of $^{4}_{\Lambda}$He and $^{5}_{\Lambda}$He in Au+Au collisions at $\sqrt{s_{NN}}$ = 3.0 GeV.
- Mass ordering of hyper-nuclei v_1 slope at mid-rapidity are observed, v_1 slopes of hyper-nuclei are smaller than that of light nuclei.

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