Hypertriton Production in Au+Au Collisions from $\sqrt{s_{NN}}$ = 7.7 to 27 GeV from STAR

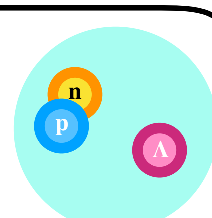
Yue Hang Leung (yhleung001@gmail.com),
Heidelberg University, for the STAR Collaboration

Abstract

Hypernuclei, bound states of nucleons and hyperons, serve as a natural laboratory to investigate the hyperon-nucleon (*Y-N*) interaction, which is an important ingredient for the nuclear equation-of-state. Furthermore, precise measurements of their production yields in heavy-ion collisions are crucial for understanding their production mechanisms. In addition, the strangeness population factor, $S_3 = ({}^3_\Lambda\mathrm{H}/{}^3\mathrm{He})/(\Lambda/\mathrm{p})$ is of particular interest as it has been suggested to be sensitive to baryon-strangeness correlations and the onset of deconfinement.

The STAR Beam Energy Scan II program provides a unique opportunity to investigate the collision energy and system size dependence of hypernuclei production. In this poster, we present new measurements on the transverse momentum and centrality dependence of ${}^3_\Lambda\mathrm{H}$ yields in Au+Au collisions from $\sqrt{s_{NN}}$ = 7.7 to 27 GeV. The ${}^3_\Lambda\mathrm{H}/\Lambda$ ratio and S_3 will be presented as functions of collision energy and centrality. These results are compared to model calculations, and their physics implications will be discussed.

Motivation



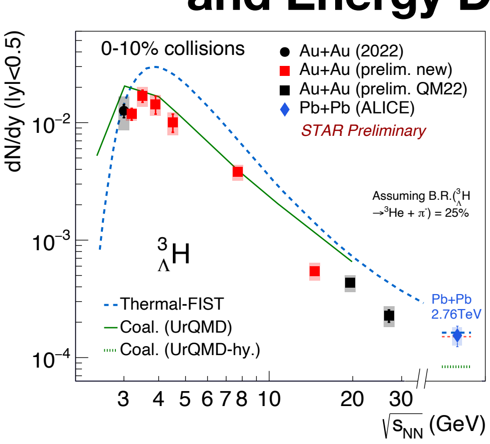
- Hypernuclei serve as important probes of the Y-N interaction
- Their production yields in heavy-ion collisions may be sensitive to the medium properties
- Their production mechanism are not well understood
- The hypertriton, the loosest bound hypernuclei, gives a unique constraint compared to normal nuclei

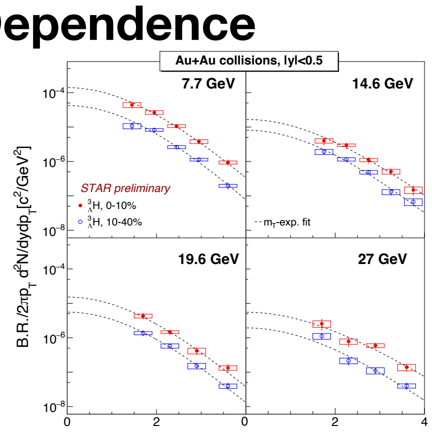
Datasets and Analysis Method

Collision Energy	7.7 GeV	14.6 GeV	19.6 GeV	27 GeV
Year	2021	2019	2019	2018
# of events	101M	324M	478M	555M

- Hypertritons are reconstructed via ${}^3_\Lambda\mathrm{H} \rightarrow {}^3\mathrm{He} + \pi^-$
- KFParticle package [1] for secondary vertex reconstruction, GEANT3 embedding for efficiency corrections

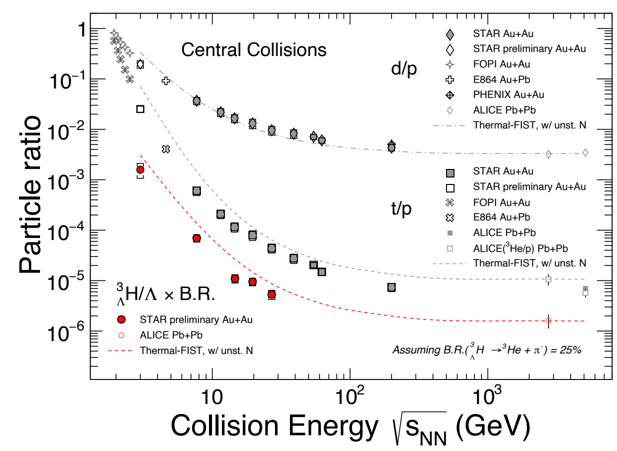
Hypernuclei p_T Spectra and Energy Dependence





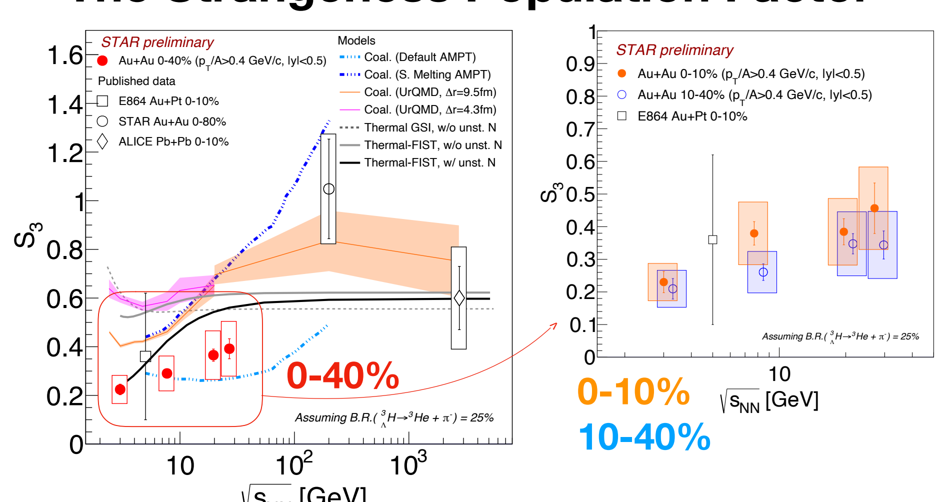
- Extrapolate to $p_T = 0$ using functional forms (e.g. m_T-exp)
- Yield increases strongly from $\sqrt{s_{NN}}$ = 27 GeV to 7.7 GeV, reaching a maximum at 3-4 GeV
- Energy dependence of hypertriton production can be qualitatively explained by an interplay between increasing baryon density and stronger strangeness canonical suppression towards low energies

Hypernuclei Ratios



- Although d/p is well described by thermal model [2], t/p and ${}^3_\Lambda\mathrm{H}/\Lambda$ are overestimated by a factor of ~2
- Thermal model is disfavored by the new BES-II data
- Both hypertriton and triton yields are not fixed at chemical freeze-out along with the light particles, likely fixed at a later stage

The Strangeness Population Factor



- Observed an increasing trend for $S_3 = ({}^3_\Lambda\mathrm{H}/{}^3\mathrm{He})/(\Lambda/\mathrm{p})$
- May be driven by increasing feed-down to ${}^3\mathrm{He}$ from unstable nuclei and/or suppression of ${}^3_\Lambda\mathrm{H}$ at low energies
- Observed a hint of suppression for S_3 in 10-40% collisions compared to 0-10% collisions
- Measurements may help constrain coalescence models and help draw connection to the hypertriton radius [3]

[1] "Real-Time Event Reconstruction and Analysis in CBM and STAR Experiments", J.Phys.Conf.Ser. 1602 (2020) 1, 012006
[2] V. Vovchenko et al. (Thermal-FIST) Comp. Phys. Comm. 244 (2019) 295
[3] T. Reichert et al. Phys.Rev.C 107 (2023) 1, 014912

Supported in part by: U.S. DEPARTMENT OF ENERGY Office of Science

The STAR Collaboration https://drupal.star.bnl.gov/STAR/presentations