Baryon-Strangeness Correlations in $\sqrt{s_{NN}}$ = 3 GeV Au+Au Collisions from RHIC-STAR

Yu Zhang (zhangyu@gxnu.edu.cn)

for the STAR Collaboration

Guangxi Normal University

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Abstract

Fluctuations and correlations of conserved quantities are proposed as key signatures for studying the QCD phase structure and for exploring the phase boundary and the critical point. It is suggested that the correlation between baryon and strangeness number is a diagnostic to the degree of freedom of strongly interacting matter and may be used to identify the onset of deconfinement. In this poster, we report the second-order baryon-strangeness correlation using proton, K±, and Λ in Au+Au collisions at $\sqrt{s_{NN}}$ = 3 GeV from the fixed-target program at the STAR experiment. Physics implications of the results as well as comparisons with model calculations are discussed.

Observable

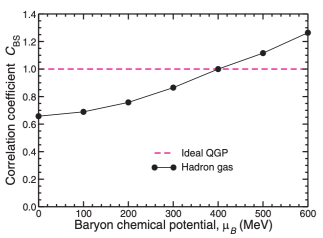
Baryon-strangeness correlation:

$$C_{BS} = -3 \times \frac{\langle BS \rangle_c}{\langle S^2 \rangle_c} = -3 \times \frac{\langle BS \rangle - \langle B \rangle \langle S \rangle}{\langle S^2 \rangle - \langle S \rangle^2}$$

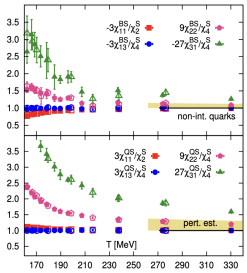
$\langle\cdot\rangle_c$ indicates calculating cumulants.

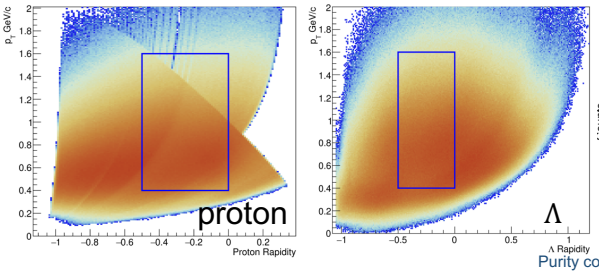
- Sensitive to the d.o.f. of hot dense matter.
- Confirm indications that hadronic d.o.f. dominates at 3 GeV according to measurements from STAR on proton fluctuation, collective flow, strangeness production.

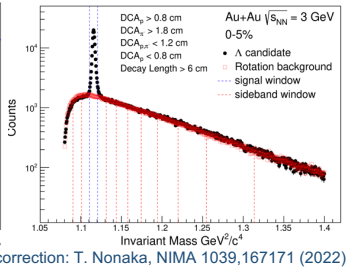
STAR: PRL 128(2022)202303, PLB 827(2022)137003, JHEP 10(2024)139



V. Koch, A. Majumder, and J. Randrup, PRL 95, 182301 (2005)
M. Cheng et al. PRL 111, 082301 (2013).







Analysis Details

Data: $\sqrt{s_{NN}}$ = 3 GeV Au+Au from STAR Run 21

Acceptance: -0.5<y<0 used currently, |y|<0.5 is accessible in future with eTOF calibration which is needed for p, $K^{\pm}$ PID.

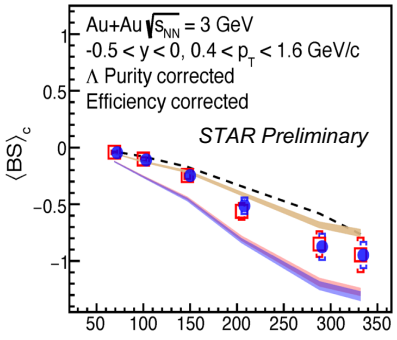
Centrality: $\pi^{\pm}$ multiplicity.

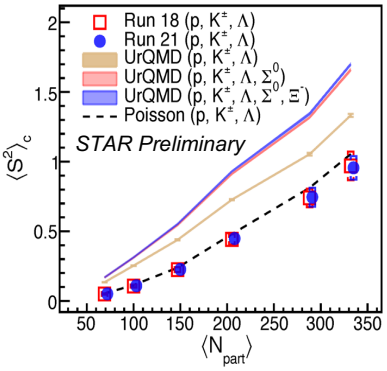
Analysis: p, $K^{\pm}$, and Λ used.

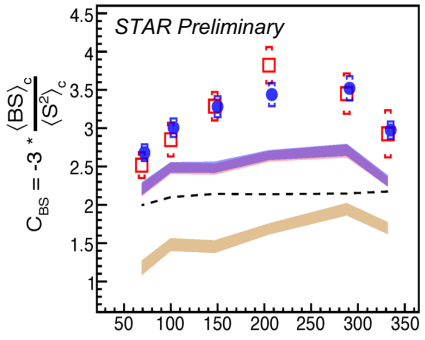
Λ purity correction: use sideband to statistically remove reconstruction background.

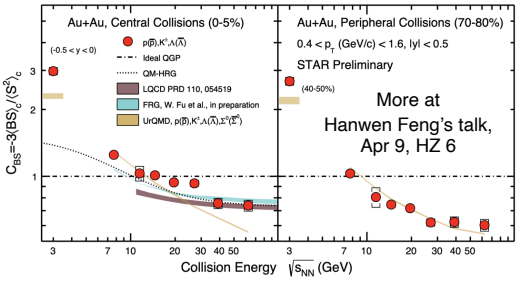
Purity correction: T. Nonaka, NIMA 1039,167171 (2022)

Results









1. The negative $\langle BS \rangle_c$ indicates negative correlation between baryon number and strangeness in each centrality.
2. Large positive C_{BS} in data is qualitatively reproduced by UrQMD.
3. Possible effect of initial volume fluctuation needs to be considered for quantitative comparison.
4. At collider energies, the C_{BS} in central collisions, shows consistency with LQCD and FRG at high energy 39 and 62.4 GeV, while it agrees well with UrQMD at 7.7 and 11.5 GeV. The intermediate energy cannot be reproduced by any calculations. UrQMD calculation agrees with data in peripheral collisions.

Summary

1. Baryon strangeness correlations are measured in $\sqrt{s_{NN}}$ = 3 GeV Au+Au collisions at STAR fixed-target experiment.
2. The centrality dependence of C_{BS} is qualitatively reproduced by UrQMD.
3. Working on energies between 3 and 7.7 GeV, as well as an extension to |y|<0.5, for full comparison with models.

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