Contribution ID: **671** Type: **Poster**

Analysis of the critical fluctuations in the light-nuclei production

Tuesday, 5 September 2023 17:30 (2h 10m)

We investigate the critical fluctuations in light-nuclei production in heavy-ion collisions based on the coalescence model, where we introduce corrections to the distribution function from critical correlators from the Ising model.

The measurement of the yield ratio of light nuclei, $N_t N_p / N_d^2$ (with N_t, N_p, and N_d being triton, proton, and deuteron numbers, respectively), in STAR collaboration [1], has shown a non-monotonic behavior as a function of collision energy in a heavy-ion collision. Based on the analyses with idealized setups, it was also suggested that the yield ratio is one of the observables for a possible signal of the QCD critical point [2]. However, it is non-trivial how the yield ratio is affected by the other contributions in realistic setups of heavy-ion collisions. In our previous study, we expanded the distribution function of nucleons in terms of phase-space cumulants [3] and found that the effect of cumulants cancels in the yield ratio up to the second order, which also includes the effect of radial expansions.

In the first part of this talk, we further investigate the effect of non-trivial phase-space distributions [3] by example distributions including the Woods-Saxon distribution, two Gaussian forms, and the blast-wave-type anisotropic flows. We find that the spatial structure decreases the ratio while the momentum anisotropy increases it. In the second part, we extend our analysis by evaluating the critical effect in the generalized light-nuclei ratio $N_p^{B-A} N_B^{A-1} / N_A^{B-1}$ [4,5] with N_A being the nuclei yield of mass number A. We introduce the critical correction to the phase-space distribution by employing the critical fluctuations from the Ising model. We find that the overall non-monotonic behavior of the yield ratio arises from the increasing correlation length near the critical point. In addition, if the strength of the critical fluctuation is sufficiently significant, the collision energy dependence of the ratio exhibits double peaks by the interplay between the two- and three-point critical corrections.

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[2] K.J.Sun, L.W.Chen, C.M.Ko and Z.Xu, Phys. Lett. B **774**, 103-107.
[3] S. Wu, K. Murase, S. Tang and H. Song, Phys. Rev. C **106**, 034905 (2022).
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[5] S. Wu, K. Murase, S. Zhao and H. Song, in preparation.

Category

Theory

Collaboration (if applicable)

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Presenter: WU, Shanjin

Session Classification: Poster Session

Track Classification: Critical point searches