Event-by-event antideuteron multiplicity fluctuation in Pb+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

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Event-by-event multiplicity fluctuations and correlations have been suggested as a sensitive probe to the production mechanism of fragile antinuclei in high-energy nuclear collisions [1]. Using the nucleon coalescence model based on kinetic freeze-out nucleons from the hybrid model of MUSIC hydrodynamics [2] for the quark-gluon stage and UrQMD transport model [3] for the hadronic stage of ultrarelativistic heavy ion collisions, as in Ref. [4], we have studied the production of antideuteron and its event-by-event fluctuation in Pb+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV [5]. The adopted MUSIC+UrQMD+COAL model is found to give a good description of the proton and deuteron yields in Pb+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, especially the suppressed *d*/*p* ratio in peripheral collisions. However, this model overestimates the net-proton number fluctuation due to the lack of exact baryon number conservation at particlization when the QGP is converted to the hadronic matter as shown in the left window of Fig. 1. To mimic the effect of baryon number conservation, we have selected a subset of events so that the net-proton number fluctuation is reduced to the level shown in the ALICE data. As shown in panel (a) of right window of Fig. 1, we have

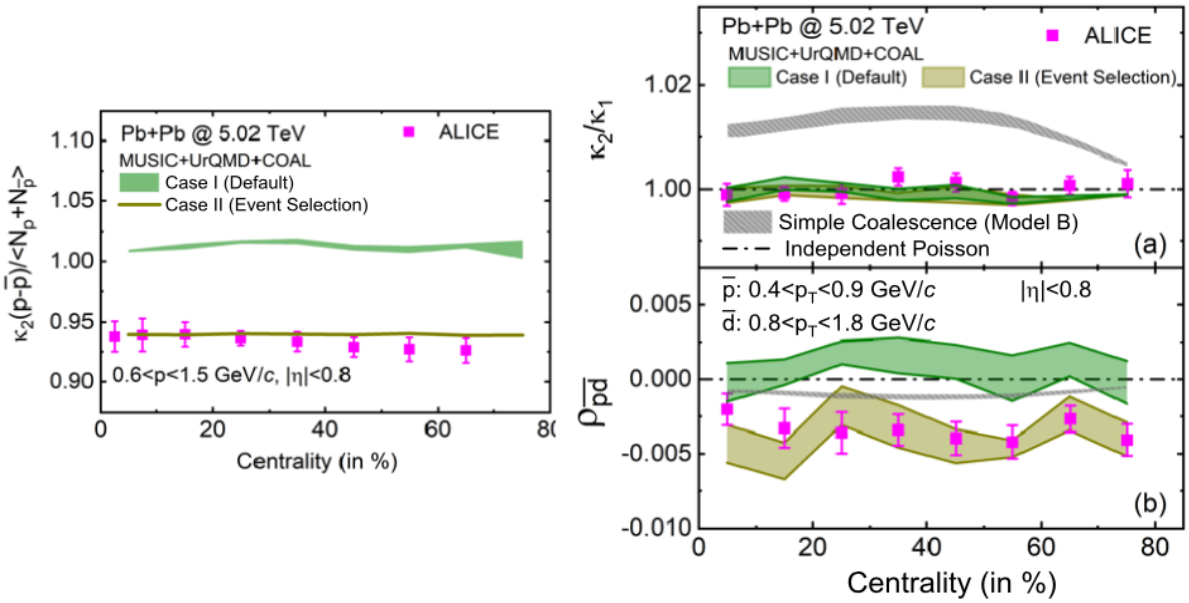

Fig. 1. Centrality dependence of the normalized second-order cumulants of net-proton distribution (left window) and antideuteron distribution (panel (a) of right window) as well as the correlation between antiproton and antideuteron multiplicities (panel (b) of right window)) in Pb+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. The ALICE data are shown by solid squares with combined statistical and systematic uncertainties [6,7].

found that the resulting scaled moment κ_2/κ_1 of the antideuteron multiplicity distribution agrees with the

Poisson limit for a grand canonical ensemble but is smaller than that obtained from the simple coalescence model that assumes the same probabilities for all antiproton and antineutron pairs to form a deuteron. As for the antiproton and antideuteron number correlation $\rho_{\bar{p}\bar{d}}$, which is shown in panel (b) of right window, its value from our model calculations based on the event-selection method is seen to agree with the ALICE data within uncertainties, although calculations including all events in our model fails. Our study has thus shown that the event-by-event fluctuation of net-proton number and also the negative correlation between the antiproton and antideuteron multiplicities measured in relativistic heavy ion collisions can be understood only if the baryon number conservation is preserved in theoretical models. Implementation of baryon number conservation at particlization in the (3+1)-dimensional viscous hydrodynamic model MUSIC is therefore urgently needed.

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