Effects of QCD critical point on light nuclei production

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Based on the nucleon coalescence model, we have obtained an explicit expression that relates the yield ratio $N_t N_p / N_d^2$ to the nucleon density correlation length ξ in the hadronic matter produced in heavy-ion collisions, which could be appreciable if the produced matter is initially close to the critical end point (CEP) in the QCD phase diagram. This ratio is found to increase monotonically with the dimensionless quantity ξ/σ where $\sigma \approx 2$ fm denotes the size of deuteron or triton. This enhancement is in addition to that due to the large neutron density fluctuation that could be developed during a first-order quark-gluon plasma to hadronic matter phase transition as previously studied in Refs. [2,3,4]. Consequently, the collision energy dependence of this ratio is expected to have a double-peak or a broad one-peak structure depending on the closeness between the signal of the CEP and that of the first-order phase transition. Such a non-monotonic behavior in the collision energy dependence of $N_t N_p / N_d^2$ has indeed been seen in the preliminary data from the STAR Collaboration [5]. Our study has thus led to the possibility of extracting the information of the CEP and the phase boundary of QCD phase diagram from comparing the precisely measured data on the yields of light nuclei in heavy-ion collisions with those from theoretical models based on the transport approach and the various hydrodynamic approaches.

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