Light nuclei production as a probe of the QCD phase diagram

K.J. Sun,[1] L.W. Chen,[1] C.M. Ko, J. Pu,[1] and Z. Xu[2,3]

[1]*School of Physics and Astronomy and Shanghai Key Laboratory for Particle Physics and Cosmology, Shanghai Jiao Tong University, Shanghai 200240, China*
[2]*Brookhaven National Laboratory, Upton, NY 11973, USA*
[3]*School of Physics & Key Laboratory of Particle Physics and Particle Irradiation (MOE), Shandong University, Jinan, Shandong 250100, China*

We have proposed in Ref.[1] a double-peak structure in the collision energy dependence of the baryon density fluctuation in heavy-ion collisions as a probe to the structure of the QCD phase diagram, with the lower energy one due to the spinodal instability associated with a first-order quark-hadron phase transition and the higher energy one induced by the second-order phase transition at the critical end point (CEP). This double-peak structure seems to be supported by the collision energy dependence of the relative neutron density fluctuation $\Delta\rho_n$ at kinetic freeze-out that we have extracted from analyzing the measured yields of *p*, d and 3H in central heavy-ion collisions at AGS and SPS [2] energies within the coalescence model. In particular, we have found $\Delta\rho_n$ to display a clear peak at $\sqrt{s_{NN}} = 8.8$ GeV and also a possible strong enhancement at $\sqrt{s_{NN}} = 4.86$ GeV as shown in Fig. 1, suggesting that the CEP could have been reached or closely approached in central Pb+Pb collisions at $\sqrt{s_{NN}} = 8.8$ GeV and the first-order phase transition could have occurred in central Au+Au collisions at $\sqrt{s_{NN}} = 4.86$ GeV. Our results thus provide a complementary evidence for the occurrence of a first-order phase transition and a critical

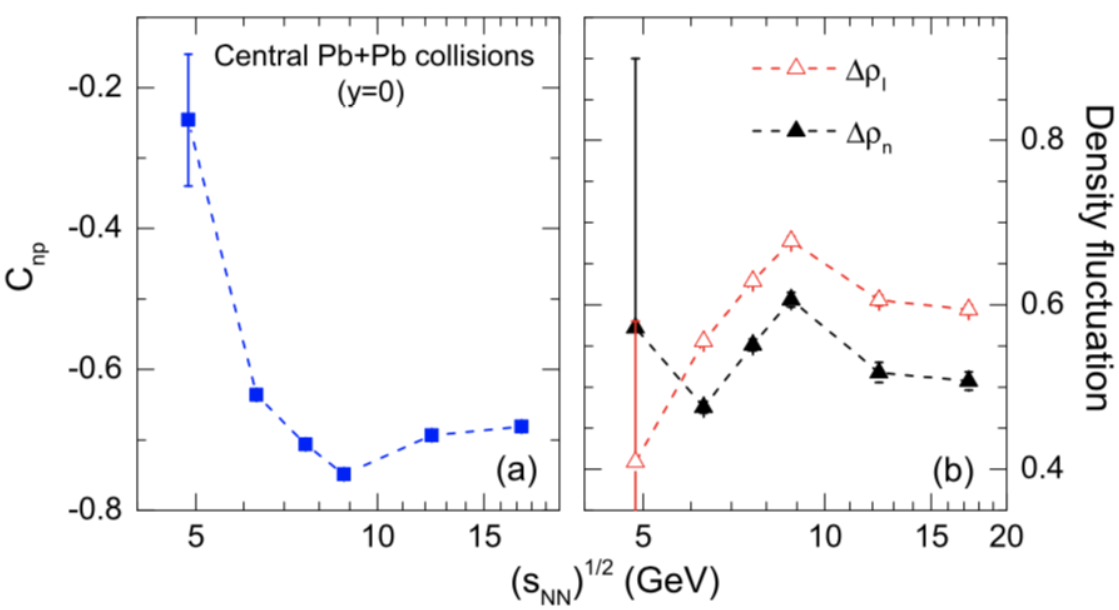

FIG. 1. Collision energy dependence of the neutron and proton density correlation C_{np} (panel (a)) and the neutron and isospin density fluctuations $\Delta\boldsymbol{\rho_n}$ and $\Delta\boldsymbol{\rho_I}$ (panel (b)) in central Pb+Pb collisions at SPS energies and Au+Au collisions at AGS energies.

endpoint in the QCD phase diagram to those that have been suggested in the literatures.

[1] K.J. Sun, L.W. Chen, C.M. Ko, J. Pu, and Z. Xu, Phys. Lett. B **781**, 499 (2018).
[2] K.J. Sun, L.W. Chen, C.M. Ko, and Z. Xu, Phys. Lett. B **774**, 103 (2017).