Isospin-dependent pion in-medium effects on charged pion ratio in heavy ion collisions

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We have studied [1] the dependence of the pion spectral function in asymmetric nuclear matter on the charge of the pion by using results from the chiral perturbation theory for the pion-nucleon *s*-wave interaction [2] and from the Δ-hole model for the pion-nucleon *p*-wave interaction [3,4]. Because of increasing π^- and decreasing π^+ in-medium masses due to the pion-nucleon *s*-wave interaction in neutron-rich matter, the strength of π^+ spectral function at low energies is somewhat larger than that of π^- spectral function, and the strength around the peak of the Δ resonance mass distribution decreases while that near the threshold increases with increasing charge of the Δ resonance. In a thermal model that assumes that nucleons, pions, and Δ resonances produced in heavy ion collisions are in thermal but not chemical equilibrium, with the latter needed to maintain the final pion to nucleon ratio, the π^-/π^+ ratio is slightly reduced in comparison with the case without pion in-medium effects. As shown in Fig. 1, this is the case for all values of nuclear symmetry energy parameter x=0, 0.5, and 1, corresponding to increasingly softer nuclear symmetry energy at high densities, and of the Migdal parameter g' that describes the repulsive Δ-hole interaction. Taking into consideration of the isospin-dependent pion in-medium effects in the transport model thus will have some, albeit not very significant, influence on the extraction of the nuclear symmetry energy from the measured π^-/π^+ ratio of about 3, which is also shown in Fig.1 with a large error bar, by the FOPI Collaboration [5]. Further theoretical work is needed to understand the relation between

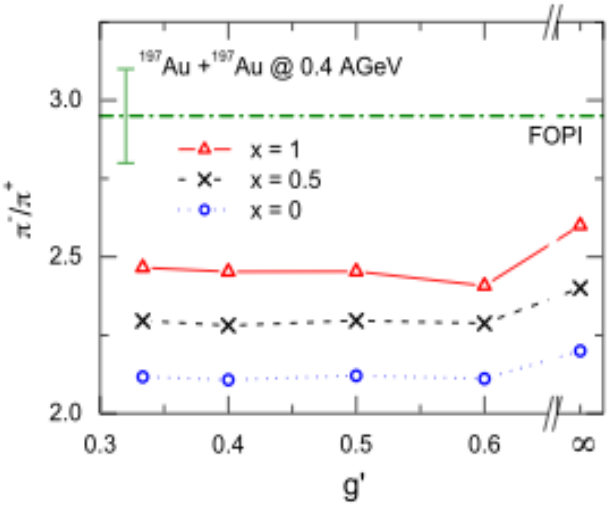

FIG. 1. The π^-/π^+ ratio in Au+Au collisions at the beam energy of 0.4 AGeV for different values of nuclear symmetry energy (x=0, 0.5, and 1) and the Migdal parameter g'=0.3, 0.4, 0.5, and 0.6. Results for g'=∞ correspond to the case without the pion medium effects.

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the π^-/π^+ ratio and the behavior of the nuclear symmetry energy at high densities in the transport model description of heavy ion collisions.

[1] J. Xu, C.M. Ko, and Y. Oh, Phys. Rev. C **81**, 024910 (2010).
[2] N. Kaiser and W. Weise, Phys. Lett. B **512**, 283 (2001).
[3] G.E. Brown and W. Weise, Phys. Rep. **22**, 279 (1975).
[4] C.M. Ko, L.H. Xia, and P.J. Siemens, Phys. Lett. B **231**, 16 (1989).
[5] W. Reisdorf *et al.* (FOPI collaboration), Nucl. Phys. **A781**, 459 (2007).