Effects of medium modification of pion production threshold in heavy ion collisions and the nuclear symmetry energy

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Using the relativistic Vlasov--Uehling-Uhlenbeck equation based on the nonlinear relativistic mean-field models [1-3], we have studied the covariant threshold effect on the pion yield and the π^-/π^+ ratio in Au+Au collisions [4]. We have found that besides enhancing the pion yield and the π^-/π^+ ratio, the threshold effect also reverses the effect of nuclear symmetry energy on the π^-/π^+ ratio as shown in the left two panels of Fig. 1. Although including the threshold effect leads to a better description of the measured π^-/π^+ ratio from the FOPI Collaboration [5], it gives too large a total pion yield compared to the experimental data. Introducing a density dependence in the Delta resonance production cross section, we have been able to describe both the pion yield and the π^-/π^+ ratio measured in experiments as shown in the right two panels of Fig. 1. The large errors in the experimentally measured π^-/π^+ ratio prevent, however, the distinction between the predictions from the NLρ and NLρδ models [6], which correspond to the soft and stiff nuclear symmetry energies, respectively. Since the in-medium threshold effect has an opposite effect on the π^-/π^+ ratio in heavy ion collisions from the effect due to the stiffness of nuclear symmetry energy at high density, it is important to include this effect in extracting the high-density behavior of nuclear symmetry energy from experimentally measured π^-/π^+ ratio.

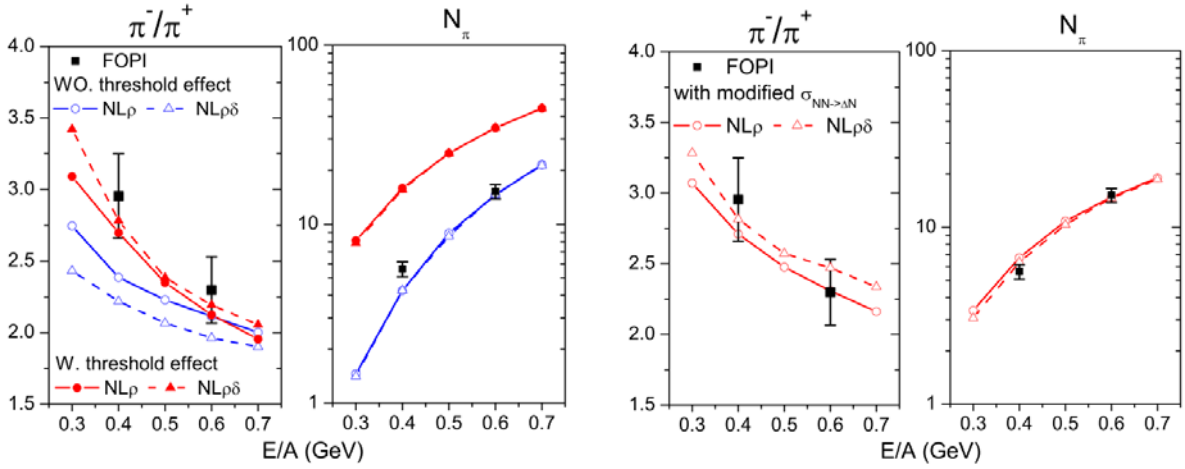

FIG. 1. The π^-/π^+ ratio and pion yield as functions of collision energy with and without the threshold effect in Au+Au collisions at impact parameter of 1 fm from the NLρ and NLρδ models for the case of free (left two panels) and density-dependent (right two panels) Delta resonance production cross section. Experimental data are from the FOPI Collaboration [5].

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