Subthreshold cascade production in heavy ion collisions

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We have calculated the cross sections for the reaction YY→NΞ (Y = Λ, Σ) based on a gauged SU(3)-invariant hadronic Lagrangian in the Born approximation [1] and found that these cross sections, given in the left window of Fig. 1, are almost four times the cross sections for the reaction KY→πΞ that was considered in previous studies [2]. We then used these cross sections to study Ξ production in ^{40}Ar+KCl collisions at the subthreshold energy of 1.76 AGeV within the framework of a relativistic transport model that includes explicitly the nucleon, delta, pion, and perturbatively the kaon, antikaon, hyperons, and Ξ [3]. We found that the reaction YY→NΞ would enhance the abundance by a factor of about 16 compared to that from the reaction KY→ πΞ [4] as shown in the right window of Fig. 1, resulting in an abundance ratio $\Xi^-/(\Lambda+\Sigma^0) = 3.38 \times 10^{-3}$ that is essentially consistent with that measured by the HADES Collaboration at GSI [5]. Our study has thus helped in resolving one of the puzzles in particle production from heavy ion collisions at subthreshold energies.

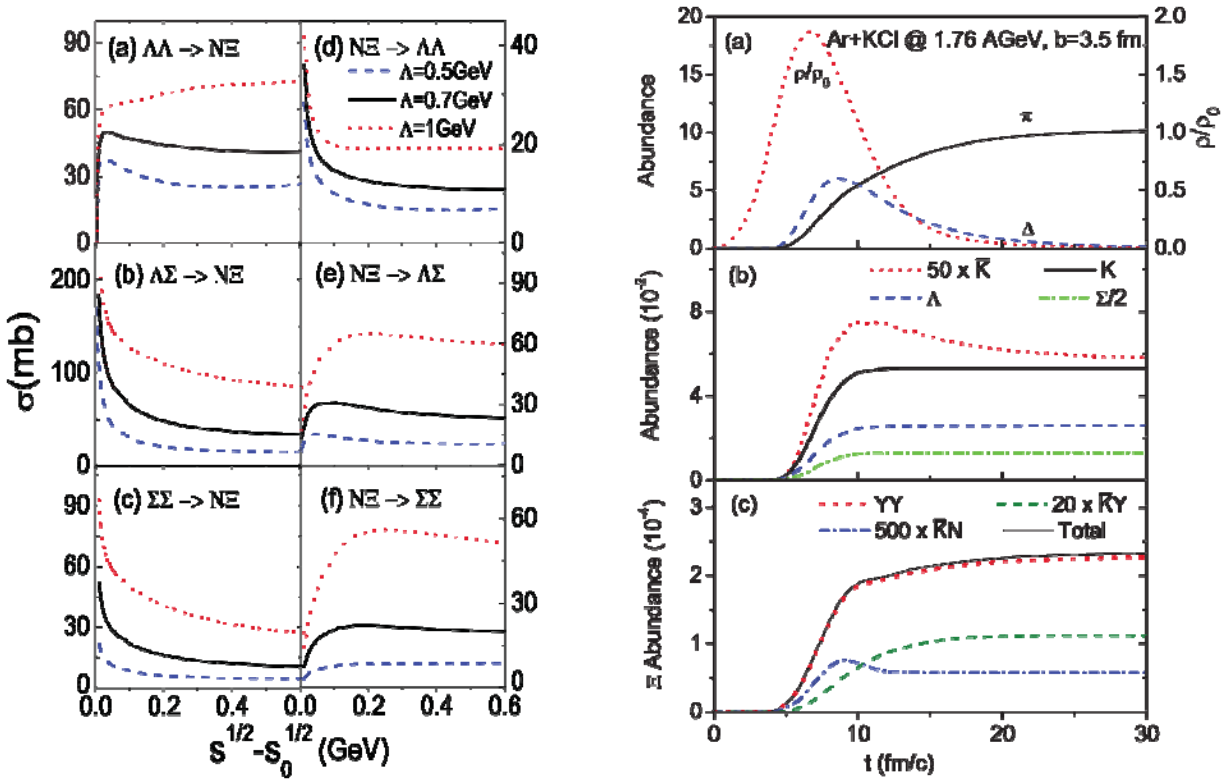

FIG. 1. Left window: Cross sections for (a) ΛΛ→NΞ, (b) ΛΣ→NΞ, (c) ΣΣ→NΞ, (d) NΞ→ΛΛ, (e) NΞ→ΛΣ, and (f) NΞ→ΣΣ as functions of the center-of-mass energy from the Born approximation with cutoff parameters Λ = 0.5 GeV (dashed lines), Λ = 0.7 GeV (solid lines), and Λ = 1 GeV (dotted lines). Right window: Time evolutions of (a) central baryon density (right scale) and the abundances (left scales) of π and Δ, (b) K, Λ, Σ, and antikaon, and (c) Ξ produced from different reactions.

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