

Kaon and Antikaon Production in Au + Au Collisions at 1.5 AGeV^{B,G}

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Heavy ion collisions provide the unique possibility to study strange mesons in baryonic matter at densities well above saturation density. Of special interest is their production and propagation at and below the NN-threshold [1]. Here we present data on the production of K^+ and K^- in Au + Au collisions at a beam energy of 1.5 AGeV measured recently with the Kaon Spectrometer at SIS/GSI. The acceptance in transverse momentum and rapidity covered by measuring at laboratory angles $\theta_{lab} = 32^\circ, 40^\circ, 48^\circ, 60^\circ,$ and 72° and laboratory momenta $p_{lab} = 280 - 1120$ MeV/c is shown in figure 1.

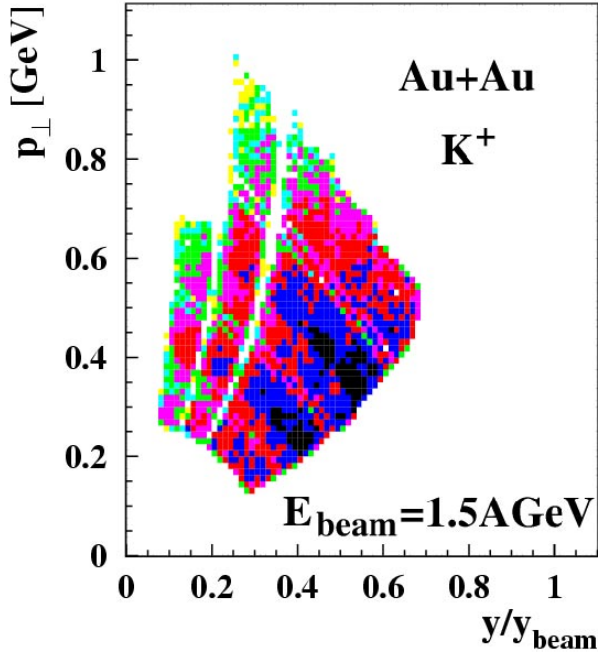


Figure 1: Transverse momentum as a function of rapidity for K^+ . The different bands correspond to different spectrometer angles in the laboratory.

The resulting wide angular coverage in the center of momentum frame allows to extract information on the polar angle distribution which is expressed as the deviation of the kaon and antikaon emission from isotropy $\sigma_{inv}(\theta_{cm}) / \sigma_{inv}(90^\circ)$. This ratio is shown in figure 2 for two centrality classes ($b > 6.3$ fm and $b < 6.3$ fm according to the geometrical model). Here the anisotropy is more pronounced for K^+ than for K^- and is decreasing with increasing centrality. Near central K^- data are isotropically distributed. Similar trends have been observed in Ni + Ni collisions at a higher beam energy of 1.93 AGeV [2]. The solid lines represent fits assuming a quadratic dependence on $\cos(\theta_{cm})$

$$\frac{d\sigma}{d(\cos(\theta_{cm}))} \sim 1 + a_2 \cdot \cos^2(\theta_{cm}) \quad (1)$$

The resulting values for a_2 are given in figure 2.

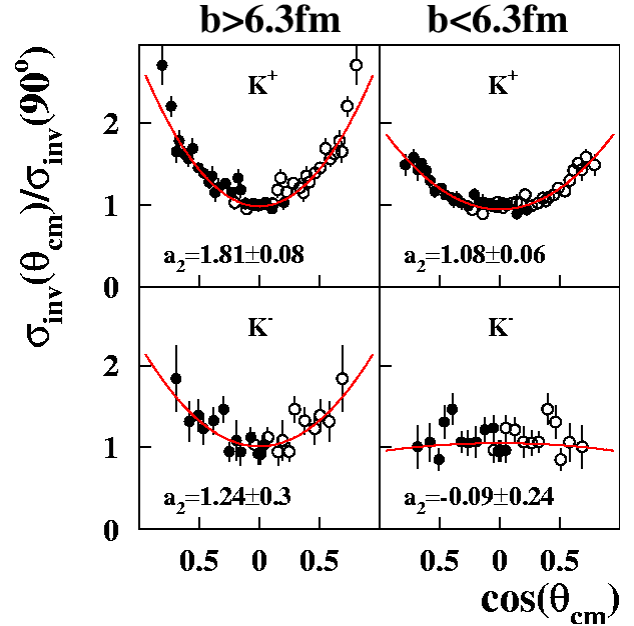


Figure 2: Preliminary polar angle distributions for K^+ and K^- in Au + Au collisions at $E_{beam} = 1.5$ AGeV. The left panel shows data for impact parameters $b > 6.3$ fm, the right one for $b < 6.3$ fm. The open symbols are reflected at $\theta_{cm} = 90^\circ$. The solid lines represent a parametrization according to equation 1.

To investigate the centrality dependence of the kaon and antikaon production we have divided the data measured close to midrapidity ($\theta_{lab} = 40^\circ \pm 4^\circ$) into five centrality classes according to 5% (most central collisions), 15%, 15%, 25%, and 40% (most peripheral collisions) of the total reaction cross section. The upper part of figure 3 shows the energy spectra of K^+ and K^- for Au + Au collisions at $E_{beam} = 1.5$ AGeV for the different centrality classes. The lines represent Boltzmann distributions fitted to the data. The resulting inverse slope parameters for the K^+ spectra are about 20 MeV larger than those for the K^- spectra for all centrality classes. The lower part of figure 3 shows the corresponding spectra for π^+ and π^- .

The dependence of the particle multiplicity on the number of participating nucleons A_{part} as determined from the measured centrality by the geometrical model is found to be the same for kaons and antikaons yielding a constant K^-/K^+ ratio as a function of A_{part} (figure 4, upper part).

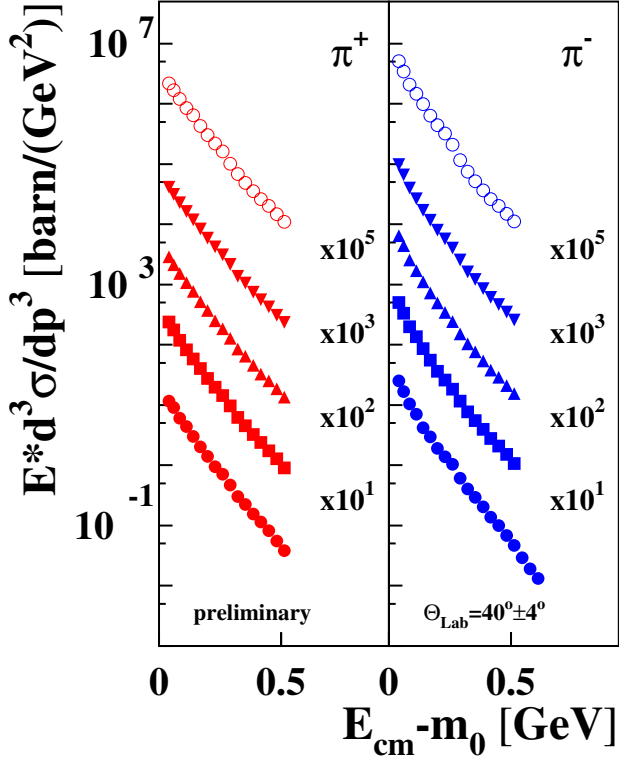
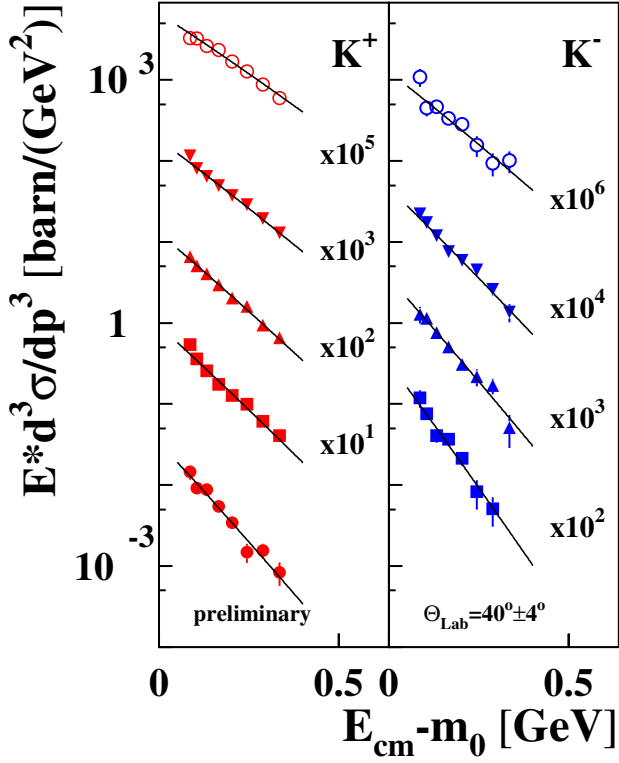


Figure 3: The upper part shows the invariant cross sections for K^+ and K^- in Au + Au collisions at $E_{beam} = 1.5$ AGeV for 5 centrality classes. The open circles depict the most central data with decreasing centrality from the top to the bottom of the figure. The most peripheral K^- data are not shown due to low statistics. The lower part shows the corresponding π^+ and π^- spectra.

A similar ratio is observed in Ni + Ni collisions at the same beam energy [2]. Even the absolute values of the multiplicity per A_{part} at a given A_{part} are the same for

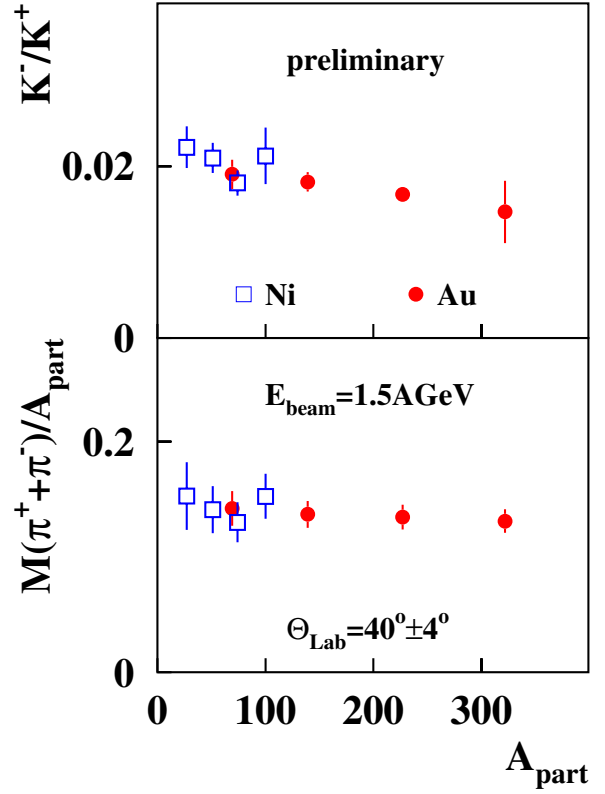


Figure 4: The upper part of this figure shows the K^-/K^+ ratio, the lower part the multiplicity of π^- and π^+ per A_{part} both as a function of A_{part} .

Au and Ni. The K^+ and K^- production seems to depend only on the number of participating nucleons. In addition the pion multiplicity per A_{part} is constant as a function of A_{part} and collision system as shown in the lower part of figure 4.

In summary the data presented shed further light on the mechanisms of kaon and antikaon production in heavy ion collisions. The observed differences in the inverse slope parameters of K^+ and K^- are at variance with the simple picture of an equilibrated source. On the other hand the K^-/K^+ ratio and the pion multiplicity per A_{part} being constant as a function of A_{part} and independent of the size of the collision system supports the idea that the antikaon production at SIS energies is dominated by the strangeness exchange reaction



as suggested by recent transport calculations [3, 4].

References

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