What determines the K^- Multiplicities at Energies Around 1–2 A·GeV?[B,G]

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In heavy ion reactions at energies around 1-2 AGeV the measured K^- yields appear rather high in comparison to pp collisions as shown by the KaoS collaboration [1]. Even more astonishing is that the K^-/K^+ ratio occurs to be nearly independent of the impact parameter [1, 2].

These observations may have a simple explanation, i.e. the contribution of the strangeness exchange channel $\Lambda\pi \rightleftharpoons K^-N$. For our study we use IQMD simulations [3]. A more detailed theoretical study can be found [4].

Figure 1 displays the integrated number of produced K^- and the net number of K^- present in the system as a function of time. Two production channels $\pi\Lambda \to K^-B$ and $BB \to BBK^+K^-$ occur where B is either a nucleon or a Δ. The difference between "sum" and "net" is due to absorption. From Fig. 1 can be concluded that $\pi\Lambda \to K^-B$ is the dominant K^- production channel. The K^- from the BB channel (dotted line) are produced in the high-density phase. Produced early, the K^- from the BB channel have a high chance to be absorbed and finally almost all of them have disappeared (dashed line).

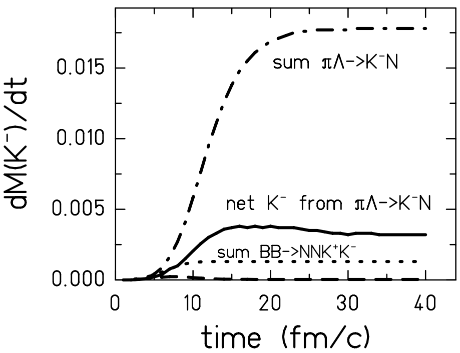

Figure 1: *Integrated number of produced K^- and the net number of K^- present at time t for the different K^- production channels for Au+Au collisions at 1.5 A·GeV.*

Up to now we have studied the K^- production assuming that both, the K^- and the K^+, have a mass as given by the relativistic mean field calculation [5]. These calculations are yet far from being confirmed by experimental results. It is therefore important to see how the predicted mass change of the kaons in the medium influences their multiplicity. The K^-N potential is attractive, leading to lower "in-medium" masses, while the K^+N potential is slightly repulsive. Therefore, We compare the standard calculation (K^+ : w, K^- : w, where w stand for "with potential") with those in which either the K^+N potential or the K^-N potential switched off as well as with a calculation in which no KN potential is applied (K^+ : w/o, K^- : w/o).

The results shown in Fig. 2 evidence that the final K^- yield depends strongly on the K^+N potential but is almost independent on the K^-N potential. The K^+N potential determines how many Λ are produced in the initial $BB \to \Lambda K^+B$ reaction. This reaction takes place when the baryon density is high. The K^+N potential increases the "mass" of the K^+ and hence lowers the Λ multiplicity. On the contrary, the mass change of the K^- has little influence on the result because the observed K^- are created very late at a density where the mass change due to the K^-N potential is small.

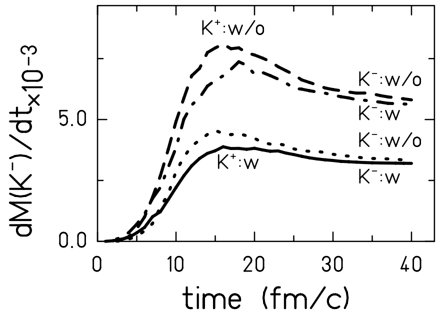

Figure 2: *Influence of the KN potentials on the final K^- yields for central Au+Au collisions at 1.5 AGeV. The net K^- yields for the various combinations of with and without KN potential as a function of time.*

This discussion raises the question whether the strangeness-exchange channel has reached chemical equlibrium. An attempt to answer this question based on experimental results is given in [2].

In conclusion, we have given an interpretation of the experimental observation that a) in heavy ion reactions the yields for K^- compared to K^+ is much higher than in pp collisions and b) that the K^+/K^- ratio is independent of the impact parameter. Almost all K^- are produced by the pionic channel $\Lambda\pi \to K^-B$ which is not available in pp. Because the Λ is produced simultaneously with the K^+, the K^- and the K^+ production are strongly correlated. The final yield of kaons depends on the K^+N potential (which determines how many Λ are produced initially) but depends very little on the K^-N potential because the observed K^- are produced very late at low densities where this potential is small.

References

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