Strangeness production in ^{32}S+Pb collisions at 200 GeV/n
Results from the NA36 experiment

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ABSTRACT

Cross sections for Λ, $\bar{\Lambda}$ and K° production in S+Pb reaction at 200 GeV/c/n have been measured. Transverse momentum and rapidity distributions as well as cross section dependence on event multiplicity are presented. Enhancement of strangeness production in mid-rapidity is observed.

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Cross sections for production of strange particles contain important information about the reaction mechanism in relativistic heavy-ion collisions[1]. While the total strangeness enhancement may not be sufficient as a direct signature of the Quark-Gluon plasma formation, it is expected that the differential cross sections, m_t and rapidity distributions should be very useful in distinguishing between QGP and hadron gas.

The NA36 experiment was set-up to measure the production of strangeness as a function of global event parameters. The design emphasized large acceptance and statistics. In order to achieve this a Time Projection Chamber was designed for high track density. The TPC was placed in a 2.7 Tesla magnetic field 60 cm from the target. This position prevented most of the low energy target fragments from entering the TPC but still produced reasonable acceptance for neutral strange particles. Very high track density in the TPC placed special requirements on the track finding software. The pattern recognition program was developed on the basis of the ALEPH track finding algorithm[2] It uses two passes of the track-following method. The magnetic field is not uniform (changes of up to 15% within the TPC volume) and the final track fit is made using a precise track model with Runge-Kutta tracking in the measured field. Neutral strange particles, Λ, $\bar{\Lambda}$ and K° were identified from their characteristic 'V°' decay topology. The search for secondary vertices was done with simple geometric cuts which were set to minimize the effect of combinatorial background. The V° reconstruction efficiency was obtained by inserting Monte-Carlo V°s into real events and then analysing the data as usual.

The acceptance differs slightly for Λ, $\bar{\Lambda}$ and K° but the limits of $p_\perp$ and rapidity have been selected to be common for all particles in order to be able to compare the yields. The limits are: $1.25<y_{lab}<3.5$, $p_\perp>0.2$ GeV./c

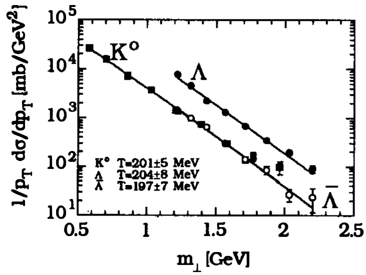

Fig. 1 Transverse mass distributions for Λ, $\bar{\Lambda}$ and K°

Fig. 1 shows transverse mass $m_\perp = \sqrt{p_\perp^2+m^2}$ distributions for Λ, $\bar{\Lambda}$ and K° in the whole range of rapidities and multiplicities. The temperature has been obtained by fitting the data with an approximate Hagedorn[3] formula:

$$\frac{1}{p_\perp}\frac{dN}{dp_\perp} \sim \frac{1}{T}\sqrt{m_\perp}\,\exp\left(-\frac{m_\perp}{T}\right)$$

The resulting temperature values are all around 200 MeV, very close to those observed by NA35 for S+S reaction[4] and lower than those reported by WA85 for S+W reaction[5]. The difference is probably due to a very different acceptance of WA85 as compared to both NA35 and NA36.

Strangeness production as a function of event multiplicity is of special interest. The low multiplicity events are mostly the result of peripheral interaction while the high multiplicity is the result of more central collisions. If the Quark-Gluon Plasma is created it is more likely to manifest itself in high multiplicity events.

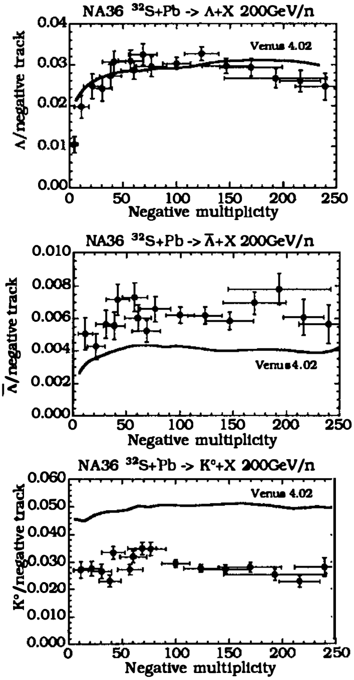

Fig. 2 Multiplicity dependence of strange particle production

Fig. 2 presents the Λ, $\bar{\Lambda}$ and K° production as a function of negative multiplicity. The ratio of Λ to all negative particles (mainly π^-) increases with multiplicity and then seems to 'saturate'. The picture for $\bar{\Lambda}$ is less clear because of larger errors, but some indication of a possible increase with multiplicity exists. K°/"π^-" ratio does not depend on the multiplicity. Venus 4.02 predictions are shown with the data. It is interesting to note that - as expected[6] - the double string fragmentation process of the new Venus code produces an increase of Λ/π^- ratio with multiplicity for low multiplicities.

Fig.3 shows rapidity distributions for Λ,$\bar{\Lambda}$ and K° together with Venus 4.02 and Fritiof 1.7 predictions. The most striking feature of the rapidity distributions is a strong increase of Λ cross section around mid-rapidity. As a result - the general features of all distributions are similar - even if the slopes differ - the $\bar{\Lambda}$ peaks more strongly, as expected and the K° is flatter - there is a maximum in the central region for all of them.

The dominance of the central region is clearly more pronounced in the S+Pb collision than in the S+S[4]. The cross section ratio of $\Lambda/\bar{\Lambda}$ is about 4 for all multiplicities. This is close to the result obtained by WA85[5]. The increase of the Λ cross section in the central region is accompanied by an even stronger increase of $\bar{\Lambda}$ production.

It should be stressed that the distributions on Figs 2 and 3 are not corrected for the effect of Ξ°,Ξ^- and Ω^- decaying with a Λ which then would be detected. More detailed conclusions may be made when the yield of Ξ^- is measured. This work is in progress now.

Obviously the most interesting result in these data is the shape of the rapidity distributions, especially for Λ. The fact that Λ and $\bar{\Lambda}$ as well as K° show similarities in their distributions suggests that they are produced 'together'.

Even more important is to note that while the overall strangeness production and the overall $\bar{\Lambda}/\Lambda$ ratio are close to those predicted by Venus 4.02, the picture changes suddenly for the central rapidity region where $\bar{\Lambda}/\Lambda$ increases rapidly.

While the details of these distributions could change if the contribution of multistrange decays is large it is very unlikely that the overall picture would change substantially.

The multiplicity dependence, especially for Λ shows a steep increase with multiplicity for low multiplicities and flat behaviour for higher multiplicities - the double string fragmentation process in Venus 4.02 seems to reproduce this effect. K° production does not change with multiplicity.

The temperature obtained from $m_{\perp}$ distributions is about 200 MeV in all cases.

Neither Fritiof 1.7 nor Venus 4.02 reproduce the rapidity distributions.

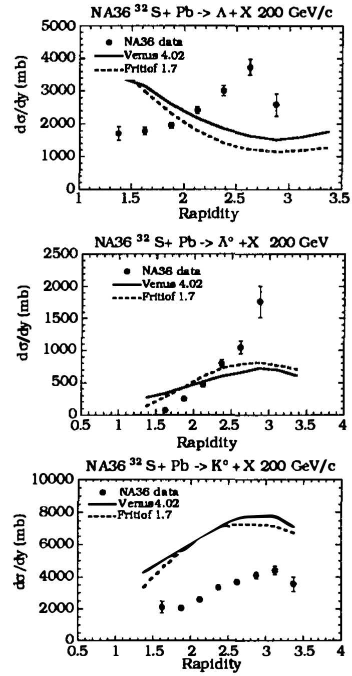

Fig. 3 Rapidity distributions (uncorrected for cascades)

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