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Hyperon Production in Pb + Pb Collisions at 158 A GeV/c

Presented by H. Helstrup, Bergen, Norway*

The WA97 Collaboration

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Abstract. Preliminary results from WA97 measurements on Λ, Ξ and Ω production in lead-lead and proton-lead collisions are presented, along with a comparison of WA97 proton-lead data with previous WA85 proton-tungsten results. The ratio Ω/Ξ seems to be enhanced in lead initiated reactions compared to proton initiated reactions.

1. Introduction

An enhanced production of strange particles has long been suggested as a tool to identify the establishment of a flavour equilibrated system in particle reactions [1, 2]. The equilibration times are expected to be much shorter in a Quark Gluon Plasma than in a hadron gas [3, 4]. In particular, multistrange (anti-)baryons have been suggested as a useful probe of the early phases of the collision [5], since hadronic production of such particles is strongly suppressed due to high mass thresholds.

An enhanced production of multistrange (anti-)baryons has already been observed in sulphur initiated reactions by the WA85 and WA94 collaborations [6, 7].

2. Experimental setup

The experimental setup is discussed in detail in ref. [8].

Tracks are identified in a silicon telescope placed 90 cm from a lead target, both placed inside the homogenous region of the magnetic field of the CERN Omega spectrometer. The central part of the telescope consists of 7 silicon microstrip detectors with a 50 μm pitch, and 3 silicon pixel planes with a pixel size of 75×500 μm^2. An additional station containing a pixel plane and a microstrip plane is placed 150 cm from the target. Lever arm measurements are made by three MWPCs with pad cathode readout, located just outside the magnetic field at a distance of 4 m from the target.

The telescope is configured as to give acceptance in the region of central rapidity and medium transverse momentum. The geometric acceptance is the same for particles and antiparticles, since our apparatus is symmetric in the magnetic bend direction.

Multiplicity detectors located close to the target provide a centrality trigger of about 30% of the cross section. Additional silicon microstrip multiplicity detectors allow for more detailed offline analysis of centrality dependences. Furthermore, a zero degree calorimeter is placed about 26 m from the target.

The results presented here are based on analysis of 9 M lead-lead events and 60 M proton-lead events.

3. Analysis and selection criteria

Strange particles are identified by reconstructing their decay tracks in the silicon telescope. All decays are required to take place in a decay region, starting at 50 cm from the target and ending just before the first plane of the telescope. All decay tracks are required to pass all the planes in the compact part of the telescope (30 cm).

Λ and $\overline{\Lambda}$ candidates are selected using the Podolanski-Armenteros variables α and q_t, $|\alpha| > 0.45$ and $0.03 < q_t < 0.40$ GeV/c. Additionally, to avoid ambiguities, a V^0 is rejected as a Λ candidate if the reconstructed K^0 mass is within 25 MeV of the table value.

Cascade candidates ($\Xi \rightarrow \Lambda\pi$, $\Omega \rightarrow \Lambda K$) are selected by combining an already reconstructed V^0 with a third track. The Ω candidates are required to be unambigous with respect to Ξs, by rejecting Ω candidates if their reconstructed Ξ mass is less than 1.38 GeV (Ξ table value 1.321 GeV).

4. Comparison to WA85 proton data

The WA97 proton data have been compared to previous proton-tungsten data from WA85 [9]. The preliminary WA97 data are corrected for geometrical acceptance, but not for reconstruction efficiency and feed-down from cascade decays. The WA85 proton-tungsten data are fully corrected.

The inverse slopes, β, for lambdas and antilambdas, fitted by the expression $\left(\frac{1}{m_t}\right)^{\frac{3}{2}} \frac{\mathrm{d}N}{\mathrm{d}m_t} \propto e^{-m_t\beta}$ in the $\mathrm{m_t}$ range > 1.5 GeV/c, are shown in the upper part of table 1. The errors quoted for the WA97 data are statistical only. The uncorrected $\overline{\Lambda}/\Lambda$ ratio is compared to WA85 values in the lower part of table 1. Altogether, there is a good agreement between the two experiments.

Table 1: Inverse slopes and particle ratios measured by WA85 and WA97

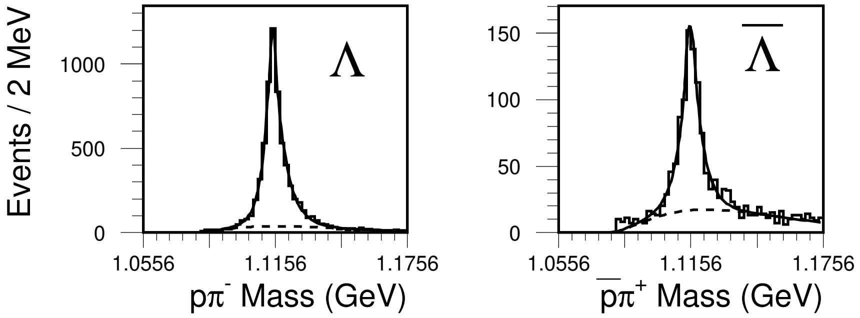
Particle	Inverse slope (MeV) WA85 (pW)	Inverse slope (MeV) WA97 (pPb)
Λ	197 ± 2	212 ± 7
$\overline{\Lambda}$	185 ± 5	179 ± 10
Ratio	$2.3 < y_{lab} < 2.8$, $m_t > 1.9$ GeV	$2.9 < y_{lab} < 3.1$, $m_t > 1.8$ GeV
$\overline{\Lambda}/\Lambda$	0.19 ± 0.02	0.20 ± 0.03

5. Lead beam results

5.1. Lambda results

The lambda and antilambda mass spectra extracted from the 1994 lead data in the rapidity range $2.5 < y_{lab} < 3.4$, are shown in figure 1.

Figure 1: Lambda and antilambda mass spectra in 2 MeV bins. Full line shows fitted function, dashed line shows background component only.



Preliminary $\overline{\Lambda}/\Lambda$ ratios are calculated after background subtraction, but not corrected for geometrical acceptance or reconstruction efficiency. However, to a first approximation these corrections should cancel, due to the symmetry of the $\Lambda/\overline{\Lambda}$ system. The ratios are not corrected for feed-down from cascade decays, but the effect of this correction is expected to fall within the quoted errors. Table 2 presents the $\overline{\Lambda}/\Lambda$ ratio in three different bins of transverse momentum, both for WA97 proton and lead data. The $\overline{\Lambda}/\Lambda$ ratio presented in section 4 is calculated with the cut $m_t > 1.8$ GeV. This correspond to a p_t cut around 1.4 GeV/c, and is thus consistent with the values presented in table 2.

Table 2: Antilambda/lambda ratio in different p_t bins

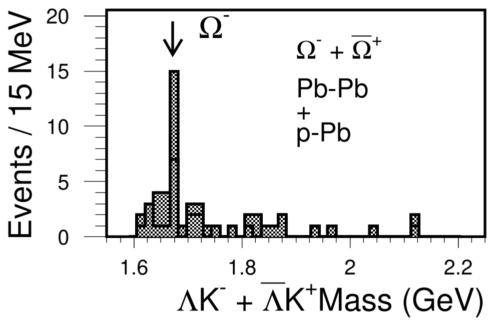
	$2.9 < y_{lab} < 3.1$	
p_t	p+Pb	Pb+Pb
0.6-0.9	0.27 ± 0.03	0.14 ± 0.02
0.9-1.2	0.26 ± 0.03	0.13 ± 0.02
1.2-2.0	0.23 ± 0.03	0.13 ± 0.02

5.2. Cascade results

Multistrange hyperons are identified by their cascade decays ($\Xi \to \Lambda\pi$, $\Omega \to \Lambda K$). The results presented here are neither corrected for geometrical acceptance, nor for reconstruction efficiency. These correction factors will be similar for Ωs and Ξs, and are expected to cancel when Ω/Ξ ratios are calculated, as both Ξ and Ω are measured by identification of three decay tracks in the telescope.

The total sample of Ωs reconstructed by WA97 so far (in proton-lead and lead-lead data) is shown in figure 2. This mass spectrum shows a clear peak at the Ω mass, well above background.

Figure 2: Total sample of Ωs reconstructed by WA97



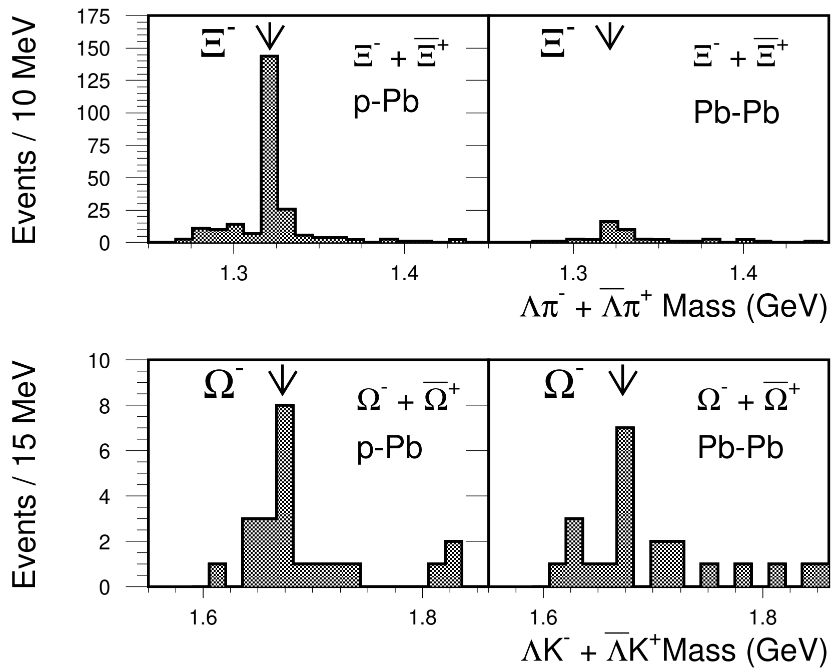
Special trigger conditions to select events with tracks in the telescope were applied in the proton run. Therefore, the number of identified hyperons cannot be compared directly between the two experimental runs. The Ω and Ξ mass spectra obtained from the WA97 runs are shown in figure 3. The number of identified Ξs is much higher in the proton sample than in the lead sample, whereas the number of identified Ωs is similar in the two data samples. This suggests an enhanced production of Ωs with respect to Ξs in lead initiated reactions compared to proton initiated reactions, since the normalisation between the two runs is the same for Ωs and Ξs.

6. Conclusions

First results from WA97 lead-lead and proton-lead data are presented. WA97 proton-lead data are in good agreement with previous WA85 proton-tungsten data.

Uncorrected values for the $\overline{\Lambda}/\Lambda$ ratio are presented in different bins of p_t. The values obtained from the lead data are significantly lower than the values obtained from the proton data and from previous sulphur data [6, 7].

Figure 3: Uncorrected Ξ and Ω mass spectra from WA97



Comparisons of raw mass spectra of Ξs and Ωs suggest that the Ω production is enhanced with respect to Ξ production in lead initiated reaction with respect to proton initiated reactions.

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