HYPERON AND ANTIHYPERON PRODUCTION IN Pb-Pb COLLISIONS AT 158 AGeV/c

Presented by I. KRÁLIK

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The WA97 Collaboration

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Results from the WA97 experiment on strange baryon and antibaryon production in lead-lead collisions at the CERN SPS are presented. The $\overline{\Lambda}/\Lambda$ ratio in Pb-Pb collisions is found to be smaller than in p-Pb, and stays constant in the selected collision centrality range. The first look at the Ω/Ξ ratio suggests an increase of this ratio in Pb-Pb compared to p-Pb reactions.

1 Introduction

Production of multiply strange baryons and antybaryons in nucleus-nucleus collisions has been suggested to be a good diagnostic tool for a phase transition to a Quark-Gluon Plasma (QGP) [1,2]. If a QGP is formed during the collision an enhanced yield of strange and multiply strange particles relative to their yield in hadron induced reactions is expected. A strangeness enhancement could also appear if there exists a dense hadronic fireball with sufficiently long lifetime [3]. In such a purely hadronic scenario however, one does not expect any strong enhancement of multiply strange (anti)baryons, during the fireball lifetime since their production cross sections are too small. Therefore such an enhancement would suggest the onset of a QGP phase during the collision.

In addition, data on strange and multistrange baryon production are important benchmarks for the models which attempt a comprehensive description of hadron abundances in ion-ion collisions [4,5,6,7,8].

Results showing an increased yield of strange antibaryons and multistrange baryons in S-W and S-S collisions compared to p-W or p-S reactions have already been published by the WA85 [9] and WA94 [10] collaborations. Although these data do not contradict the QGP scenario, it is not clear whether sufficiently hot and dense system can be created in S-W or S-S collisions. That is why it is interesting to see how this picture will change, when one starts looking at the first really heavy ion collisions available at CERN SPS energy. A first hint that something new is emerging has already been given by the NA50 collaboration [11].

2 Experimental set-up and analysis

2.1 WA97 spectrometer

The WA97 experiment is a continuation of the heavy ion experiments in the CERN Omega spectrometer. It is designed to measure the decays of strange baryons into charged particles in a multiparticle environment produced in Pb-Pb collisions (details can be found in [12]).

The main part of the detector is a silicon telescope consisting of 7 silicon microstrip planes with 50 μm pitch and 3 silicon pixel planes with 75×500 $\mu\mathrm{m}^2$ pixels, placed inside the 1.8 T magnetic field of the Omega spectrometer[a]. The telescope is placed 90 cm behind the target. It is followed by an additional station containing one pixel and one microstrip planes placed 150 cm behind the target. To improve the momentum resolution of fast tracks, three MWPC's with pad cathode readout are located just outside the magnetic field (4 m from the target).

The geometric acceptance of the telescope covers the region of central rapidity and medium transverse momentum, and is the same for particles and antiparticles.

Silicon multiplicity detectors located near the target provide a centrality trigger selecting about 30% of the Pb-Pb cross section.

2.2 Hyperon identification

Hyperons are identified using decays with only charged partices in the final state i.e. $\Lambda \rightarrow \mathrm{p}\pi^-$, $\Xi^- \rightarrow \Lambda(\mathrm{p}\pi^-)\pi^-$ and $\Omega \rightarrow \Lambda(\mathrm{p}\pi^-)\mathrm{K}^-$. The fiducial volume for decays starts at 50 cm from the target and ends just before the first plane of the silicon telescope. All decay tracks are required to pass through all the planes in the main part of the telescope.

Λ and $\overline{\Lambda}$ candidates are distinguished from K^0's using cuts on the Podolanski-Armenteros variables $|\alpha| > 0.45$ and $0.03 < q_\perp < 0.40$ GeV/c, and rejecting all Λ candidates with reconstructed $\pi^+\pi^-$[b] mass within 25 MeV of the K^0 table value.

Ξ and Ω candidates are selected by combining a reconstructed V^0 with another charged track. Ω candidates are rejected if their assumed $\Lambda\pi$ mass is less than 1.38 GeV (Ξ mass is 1.321 GeV/c^2).

2.3 Data samples

In this paper the data from two runs are analyzed

- 9×10^6 Pb-Pb triggers from 1994 run
- 60×10^6 p-Pb triggers from 1995 run.

The proton data were taken with an additional trigger requirement of having at least two charged particles in the silicon telescope.

3 Results

3.1 Λ and $\overline{\Lambda}$ ratios

Preliminary $\overline{\Lambda}/\Lambda$ ratios not corrected for the geometrical acceptance and reconstruction efficiency have already been presented [13]. In this paper we present the ratios after corrections (mean acceptance and reconstruction efficiency for Λ was found to be 0.25% and 28% , respectively) as a function of the collision centrality.

[a] This corresponds to the set-up used during the 1994 run. In 1995 new pixel planes were added to the silicon telescope.

[b] The mass calculated under the assumption that both decay products are pions.

Table 1: $\overline{\Lambda}/\Lambda$ ratio in different collision centrality bins. The labels 'corrected' and 'uncorrected' refer to the correction for the geometrical acceptance and reconstruction efficiency.

Centrality	$\overline{\Lambda}/\Lambda$ Uncorrected	$\overline{\Lambda}/\Lambda$ Corrected
100$\leq$Nr. Participants $\leq$ 250	0.13$\pm$0.03	0.14$\pm$0.03
250$\leq$Nr. Participants $\leq$ 400	0.15$\pm$0.03	0.14$\pm$0.03

For the investigation of the $\overline{\Lambda}/\Lambda$ ratio as a function of the collision centrality we restricted the kinematic region to

$$2.9 < \quad y_{lab} \quad < 3.1 \tag{1}$$
$$0.6 < \quad p_{\perp} \quad < 2 \text{ GeV}/c. \tag{2}$$

The Λ and $\overline{\Lambda}$ signal is shown in fig. 1.

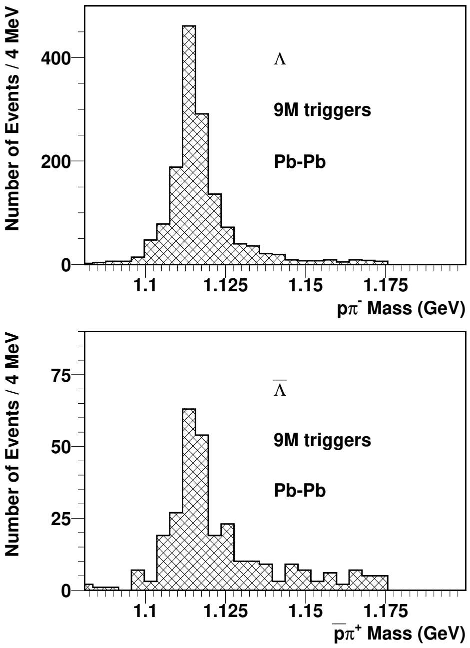

Figure 1: Λ and $\overline{\Lambda}$ signal in the selected kinematic window.

The multiplicity trigger selected about 30% of the Pb-Pb cross section, which corresponds to $\sim$100 — 400 participants. The estimation is based on MC simulation using the VENUS model[14].

The ratios uncorrected as well as corrected for the geometrical acceptance and reconstruction efficiency are summarized in Table 1. One can see that the corrections have a very small effect on the $\overline{\Lambda}/\Lambda$ ratio. The ratios are not corrected for feed-down from the cascade decays, but the effect of this correction is expected to fall within quoted errors.

The values in Table 1 can be compared with the $\bar{\Lambda}/\Lambda = 0.26 \pm 0.04$ found in p-Pb reactions in the same kinematic window.

3.2 The first glance at Ω v.s. Ξ

Since the full analysis of the Ω and Ξ production is not yet finished, we present here a first look at the data reconstructed so far. The uncorrected signal observed in p-Pb and Pb-Pb collisions is shown in fig. 2. In order to judge the significance of these plots, one has to keep in mind the different sizes of p-Pb and Pb-Pb samples and the fact that the proton data were taken with an additional trigger enhancing the probability of registering a reconstructible V^0.

Since the Ω and Ξ decays have similar topologies, the correction factors due to the geometrical acceptance are expected not to be very different.

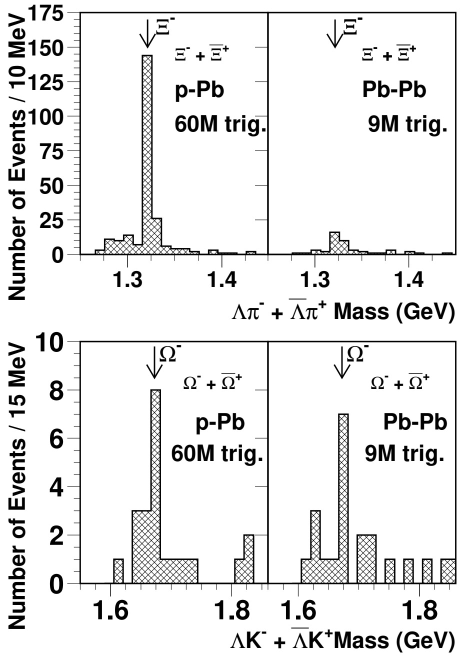

Figure 2: Uncorrected Ξ and Ω mass spectra.

The number of identified Ξ's is much higher in the proton sample than in the lead sample, whereas the number of reconstructed Ω's are comparable in both samples. This suggests an enhancement in the Ω production relative to Ξ in the lead reactions compared to proton initiated reactions.

4 Conclusions

Results from the WA97 Pb-Pb and p-Pb data are presented.

Corrected values of $\overline{\Lambda}/\Lambda$ ratio are shown. The values from the lead data are significantly lower than those from the proton data. No variation with collision centrality is observed in the lead sample.

Comparison of uncorrected Ω and Ξ signals in Pb-Pb and p-Pb collisions suggests an enhancement of the Ω production with respect to Ξ's in Pb-Pb compared to p-Pb reactions.

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