$K^0_S$ AND $\Lambda$ PRODUCTION IN $pp$ AND Pb–Pb COLLISIONS WITH ALICE AT LHC*

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We have studied the $K^0_S$ and $\Lambda$ particles production in $pp$ interactions at $\sqrt{s} = 7$ TeV and Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. The $p_T$ and centrality dependence of the $\Lambda/K^0_S$ ratio are presented and analyzed. Our results are compared with the previous results obtained in $\sqrt{s} = 0.9$ TeV $pp$ collisions from ALICE experiment and with the Au–Au results from the STAR experiment at $\sqrt{s_{NN}} = 0.2$ TeV.

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1. Introduction

Two experiments (PHENIX [1] and STAR [2]) showed that the ratio $p(\bar{p})/\pi$ is growing monotonically from low $p_T$ approximately up to 2.5 GeV/c. This baryon/meson measurement was later extended to higher $p_T$ region (up to 6 GeV/c) with $\Lambda/K^0_S$ ratio. A strong dependence of this ratio on centrality of the collision was observed. It was also observed that baryon/meson ratio reaches its maximum at $p_T$ around 3 GeV/c. At higher $p_T$ this ratio decreases for all collision centralities and the centrality dependence is not significant for transverse momentum above 6 GeV/c.

Experimental results were compared to several models based on different hadronization mechanisms and flow effects. Based on this comparison, the final effect could be described as an interplay between quark recombination, flow and string fragmentation [3,4].

We present the $\Lambda/K^0_S$ ratios measured by the ALICE experiment at the LHC in $1.1 \times 10^7$ minimum bias Pb–Pb events at $\sqrt{s_{NN}} = 2.76$ TeV as a function of transverse momentum and for different collision centrality bins, as well as in $pp$ collisions at $\sqrt{s} = 0.9$ TeV and 7 TeV.

2. Reconstruction of $K^0_S$ and $\Lambda$

$K^0_S$ and $\Lambda$ particles can be reconstructed with the ALICE detector in a quite broad momentum range using their V0 decay topology. The $p_T$ limits of the results presented here are defined by our current knowledge of the underlying systematic uncertainties. The extraction of V0 signal was performed using the distributions of invariant mass computed from kinematical values obtained from reconstructed daughter tracks (Fig. 1). All combinations of oppositely charged tracks which passed a certain set of topological cuts were accepted as the V0 candidates [5].

![Fig. 1. Left: Invariant mass distribution for $K^0_S$ mesons within $p_T$ range 0.5 GeV/c < $p_T$ < 1.5 GeV/c and 0–5% centrality class (left upper panel), 80–90% centrality class (left lower panel). Right: Invariant mass distribution for $\Lambda$ within $p_T$ range 0.5 GeV/c < $p_T$ < 1.5 GeV/c and 0–5% centrality class (right upper panel), 80–90% centrality class (right lower panel). In all cases a high $p_T$ bin is also shown.](image-url)
Polynomial functions of first or second order (depending on the background shape) were used to fit the background and subtract it from invariant mass distributions.

Extracted yields were then corrected with a reconstruction efficiency computed for each \( p_T \) bin using Monte Carlo simulation. This efficiency saturated at 40% for \( K^0_S \) and 30% for \( \Lambda \) at \( p_T \sim 3 \text{ GeV}/c \) (close to \( \Lambda/K^0_S \) maximum). The variations of the ratio of the efficiencies for \( K^0_S \) and \( \Lambda \) for intermediate \( p_T \) interval (from 2.5 \( \text{ GeV}/c \) to 5.5 \( \text{ GeV}/c \)) was lower than 2%.

\( K^0_S \) spectra from Pb–Pb collisions were compared to the charged \( K^\pm \) spectra reconstructed by ALICE Time Projection Chamber and the Time-of-Flight detector. For \( p_T > 1 \text{ GeV}/c \) the spectra were found to be compatible within 1–2% [5].

The spectra of \( \Lambda \) were corrected for the contribution of \( \Lambda \)s coming from decays of \( \Xi^- \) and \( \Xi^0 \). The corresponding feed-down correction to the spectra was found to be about 20% and varied only by a few per cent within \( p_T \) and centrality range discussed here.

We considered the following sources of the systematic uncertainties listed here together with their estimations: signal extraction (3%), efficiency correction (7% for \( p_T < 1 \text{ GeV}/c \), 1% for \( p_T > 2.5 \text{ GeV}/c \)), feed-down correction (5%), admixture of \( \Lambda \)s generated in the detector material (2%).

### 3. Preliminary results

The \( \Lambda/K^0_S \) ratio was computed for minimum bias sample in \( pp \) collisions (\( \sqrt{s} = 7 \text{ TeV} \)) and for several centrality classes in Pb–Pb collisions (\( \sqrt{s_{NN}} = 2.76 \text{ TeV} \)) and shown in (Fig. 2). A strong centrality dependence of \( \Lambda/K^0_S \)
is observed. The ratio increases with centrality and for most central events reaches its maximum at $p_T \sim 3$ GeV/c. The value of ratios for two most central classes is bigger than unity within $p_T$ ranges: $2 \text{ GeV}/c < p_T < 4 \text{ GeV}/c$ (20–40% centrality class) and $2 \text{ GeV}/c < p_T < 5 \text{ GeV}/c$ (0–5% centrality class). There is a modest increase, of around 20%, in the ratio in the most peripheral centrality class (80–90%) over that observed in $pp$ collisions (at $\sqrt{s} = 0.9$ and 7 TeV).

4. Comparison with previous measurements

The results obtained were compared to the ratios previously measured in Au–Au collisions at $\sqrt{s_{NN}} = 0.2$ TeV by the STAR Collaboration (Fig. 3). The preliminary STAR data points used for this comparison are multiplied by $\bar{A}/A = 0.8$ factor calculated from the data reported in [6] (to account for the non-unity of the anti-baryon/baryon ratio at RHIC) and subtracted a 10% feed-down correction quoted in [4]. The ALICE ratio measured in the most central events shows a considerably broader maximum than at RHIC, and converges towards the peripheral ratio at higher $p_T$.

![Fig. 3. Comparison of $\Lambda/K_S^0$ ratio measured by the ALICE and STAR collaborations for two different centrality classes (0–5% and 60–80%).](image)

A comparison of the position of $\Lambda/K_S^0$ maximum measured by the ALICE Collaboration in $pp$ collisions ($\sqrt{s} = 7$ TeV) and Pb–Pb collisions ($\sqrt{s_{NN}} = 2.76$ TeV) to the position of $\Lambda/K_S^0$ maximum measured by the STAR Collaboration, shows the shift of this position towards higher $p_T$ with increasing number of participants and the energy of colliding systems (Fig. 4).
Fig. 4. The position of $\Lambda/K_S^0$ maximum as a function of number of participants for different colliding systems and energies. The results from the ALICE experiment (Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, pp collisions at $\sqrt{s} = 0.7$ TeV) and the STAR experiment (Au–Au collisions at $\sqrt{s_{NN}} = 0.2$ TeV) are compared.

Also the maximum value of $\Lambda/K_S^0$ ratio increases with number of participants and with the energy of colliding systems, as seen in Fig. 5. For the most central events, this value is $\sim 1.5$. The Au–Au points at 62.4 GeV are plotted as they are published in [7]. To compare the STAR measurements at 0.2 TeV with ALICE measurements we multiply the STAR values from [8] by the same $\Lambda/\Lambda$ factor and perform the aforementioned feed-down correction.

Fig. 5. The maximum value of $\Lambda/K_S^0$ ratio as a function of number of participants measured by the ALICE Collaboration compared to the STAR results.
5. Conclusions

We presented the preliminary $\Lambda/K_S^0$ ratios measured by the ALICE Collaboration for two different collision systems ($pp$ and Pb–Pb) and two energies ($\sqrt{s} = 7$ TeV and $\sqrt{s_{NN}} = 2.76$ TeV). In the case of Pb–Pb collisions, the ratios were computed for five different centrality classes (Fig. 2). The observed dependence of $\Lambda/K_S^0$ ratio on collision centrality is significant. The production of baryons appears to be higher than the one of mesons for most central event classes within the $p_T$ range: $2 \text{ GeV/c}< p_T < 5 \text{ GeV/c}$ (0–5% centrality class) and $2 \text{ GeV/c}< p_T < 4 \text{ GeV/c}$ (20–40% centrality class). The maximum value of $\Lambda/K_S^0$ ratio for most central events is $\sim 1.5$. $\Lambda/K_S^0$ ratio for most peripheral events is close (within $\sim 20\%$) to the ratios computed for $pp$ data. The ratios measured in Pb–Pb collisions decrease more slowly, than the ones measured in Au–Au collisions by the STAR Collaboration. The ratio computed for most central class and $p_T$ bin $\sim 6 \text{ GeV/c}$ is approximately two times higher then the one measured in Au–Au collisions at RHIC for same centrality class.

The position of maximum of $\Lambda/K_S^0$ ratios measured in Pb–Pb collisions at the LHC are shifted towards higher $p_T$ with respect to the ones measured in Au–Au collisions at RHIC. This shift increases with the centrality.

REFERENCES