Multistrange Hyperon Production in Pb+Pb collisions at 30, 40, 80 and 158 A·GeV

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A non-monotonic energy dependence of the K^+/π^+ ratio with a sharp maximum close to 30 A·GeV is observed in central Pb+Pb collisions [1]. Within a statistical model of the early stage [2], this is interpreted as a sign of the phase transition to a QGP, which causes a sharp change in the energy dependence of the strangeness to entropy ratio. This observation naturally motivates us to study the production of multistrange hyperons (Ξ, Ω) as a function of the beam energy.

Furthermore it was suggested that the kinematic freeze-out of Ω takes place directly at QGP hadronization. If this is indeed the case, the transverse momentum spectra of the Ω directly reflect the transverse expansion velocity of a hadronizing QGP [3, 4].

In this report we show preliminary NA49 results on Ω^- and $\bar{\Omega}^+$ production in central Pb+Pb collisions at 40 and 158 A·GeV and compare them to measurements of Ξ^- and $\bar{\Xi}^+$ production in central Pb+Pb collisions at 30, 40, 80 and 158 A·GeV.

The NA49 detector [5] is a large acceptance hadron spectrometer at the CERN SPS, consisting of four TPCs. Two of them, the Vertex TPCs (VTPC), are inside a magnetic field for the determination of particle momenta and charge. The ionisation energy loss (dE/dx) measurements in the two Main TPCs (MTPC), which are outside the magnetic field, are used for mass determination. Central collisions were selected by a trigger using information from a downstream calorimeter (VCAL), which measures the energy of the projectile spectator nucleons.

In Fig.1 the NA49 $\bar{\Omega}^+/\Omega^-$ and $\bar{\Xi}^+/\Xi^-$ ratios as a function of the collision energy ($\sqrt{s_{NN}}$) are shown and compared to results of NA57 [6, 7] and STAR [8, 9]. The NA49 and NA57 results measured at the same energies are consistent. The data show a clear increase of the $\bar{\Omega}^+/\Omega^-$ ratio from a value of about 0.4 at SPS energies to about 1 at RHIC energies. The $\bar{\Xi}^+/\Xi^-$ ratio also increases from SPS energies to about

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0.8 at RHIC energies.

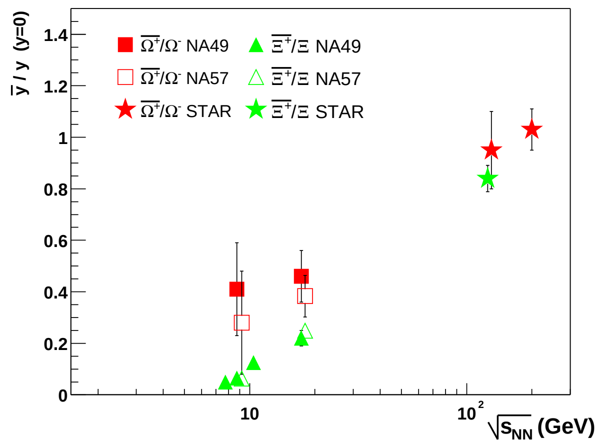

Figure 1: The antihyperon/hyperon ($\bar{Y}/Y$) ratio at midrapidity in the SPS-RHIC energy range.

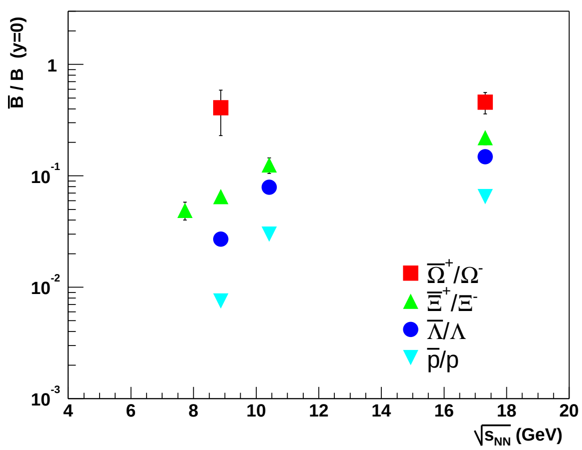

Figure 2: The antibaryon/baryon ratio ($\bar{B}/B$) at midrapidity in the SPS energy range measured by NA49.

The midrapidity $\bar{\Omega}^+/\Omega^-$ ratio is estimated to be 0.46 ± 0.1 and 0.41 ± 0.18 for central Pb+Pb collisions at 158 and 40 A·GeV, respectively. The values for the midrapidity $\bar{\Xi}^+/\Xi^-$ ratio are estimated to be 0.13 ± 0.02, 0.065 ± 0.05 and 0.0049 ± 0.009 for central Pb+Pb collisions at 80, 40 and 30 A·GeV, respectively. In Fig.2 the antibaryon/baryon ratios are shown as a function of the beam energy in the SPS energy domain. In addition to $\bar{\Xi}/\Xi$ and $\bar{\Omega}/\Omega$ ratios the results on $\bar{\Lambda}/\Lambda$ [10] and $\bar{p}/p$ [11] are shown. The energy dependence of $\bar{B}/B$ ratios gets weaker with increasing strangeness content.

Fig. 3 shows the energy dependence of the midrapidity

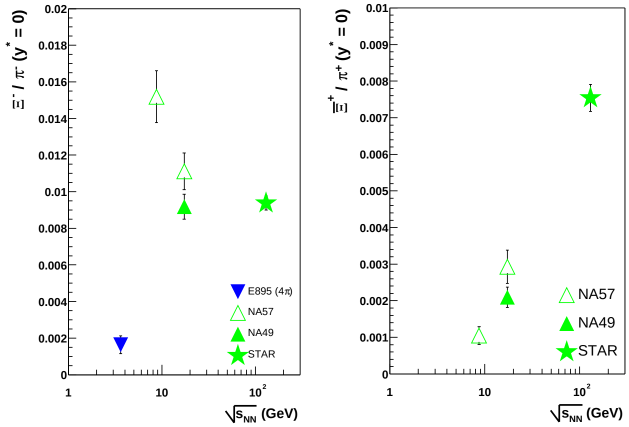

Figure 3: Energy dependence of the midrapidity Ξ^-/π^- (left) and $\bar{\Xi}^+/\pi^+$ (right) ratio in central Pb+Pb and Au+Au collisions.

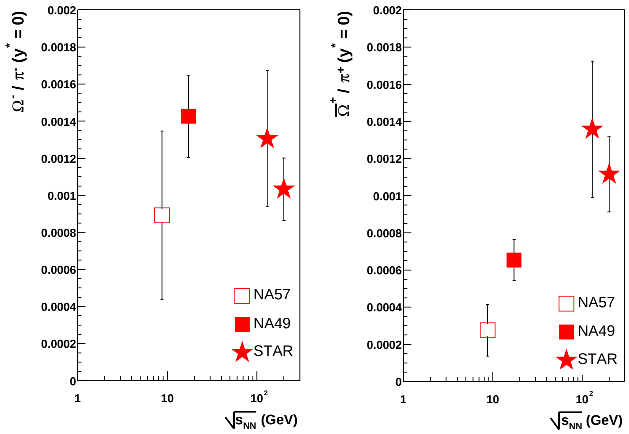

Figure 4: Energy dependence of the midrapidity Ω^-/π^- (left) and $\bar{\Omega}^+/\pi^+$ (right) ratio in central Pb+Pb and Au+Au collisions.

Ξ^-/π^- (left) and $\bar{\Xi}^+/\pi^+$ (right) ratio in central Pb+Pb and Au+Au collisions. The Ξ^-/π^- ratio suggests that there is a non-monotonic energy dependence at SPS energies. The $\bar{\Xi}^+/\pi^+$ ratio increases with energy from SPS to RHIC energies. The Ω^-/π^- ratio shown in Fig. 4 seems to be energy independent, but the $\bar{\Omega}^+/\pi^+$ ratio shows again an increase from SPS to RHIC energies.

At 158 A·GeV, a high statistics data sample of central Pb+Pb collisions is available, which allows us to obtain fully corrected spectra of Ω^- and $\bar{\Omega}^+$. The transverse mass spectra are fitted by an exponential function :

$$\frac{1}{m_t}\frac{d^2N}{dm_t dy} = C \cdot e^{-m_t/T}, \qquad (1)$$

where the fit parameters are a normalization factor C and the inverse slope parameter T. The slope parameter is similar for Ω^- and $\bar{\Omega}^+$: $T(\Omega^-) = 276 \pm 23$ MeV and $T(\bar{\Omega}^+) = 285 \pm 39$ MeV [11]. Our values agree with those measured by the NA57 collaboration ($T(\Omega^-) = 280 \pm 16$ MeV and $T(\bar{\Omega}^+) = 324 \pm 29$ MeV) [12]. The large acceptance of the NA49 experiment allows us to measure the Ω^- ($\bar{\Omega}^+$) spectra in a large rapidity interval. The rapidity distributions for Ω^- and $\bar{\Omega}^+$ are obtained by extrapolating p_t spectra using the exponential. Both y-spectra were fitted by a Gaussian. The width of the Ω^- distribution ($\sigma(\Omega^-) = 1.0 \pm 0.2$) seems to be larger than the one of the $\bar{\Omega}^+$ ($\sigma(\Omega^-) = 0.7 \pm 0.1$). Mean multiplicities in full phase-space were estimated as integrals over measured points corrected for the missing rapidity coverage using the Gaussian parametrisations. The resulting yields are $<\Omega^-> = 0.47 \pm 0.07$ and $<\bar{\Omega}^+> = 0.15 \pm 0.02$, where the errors are statistical only.

Acknowledgments

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