Status of the Omega at 158 AGeV
Paper Draft

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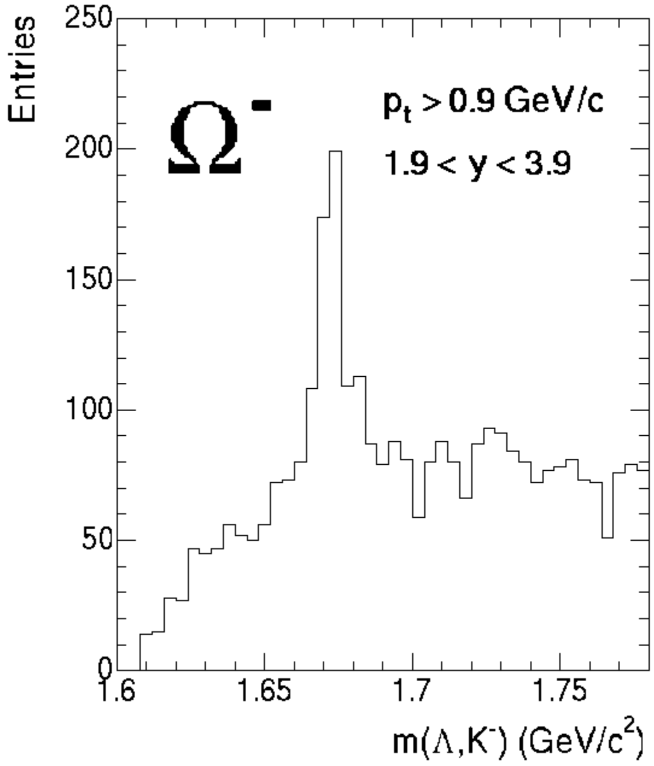
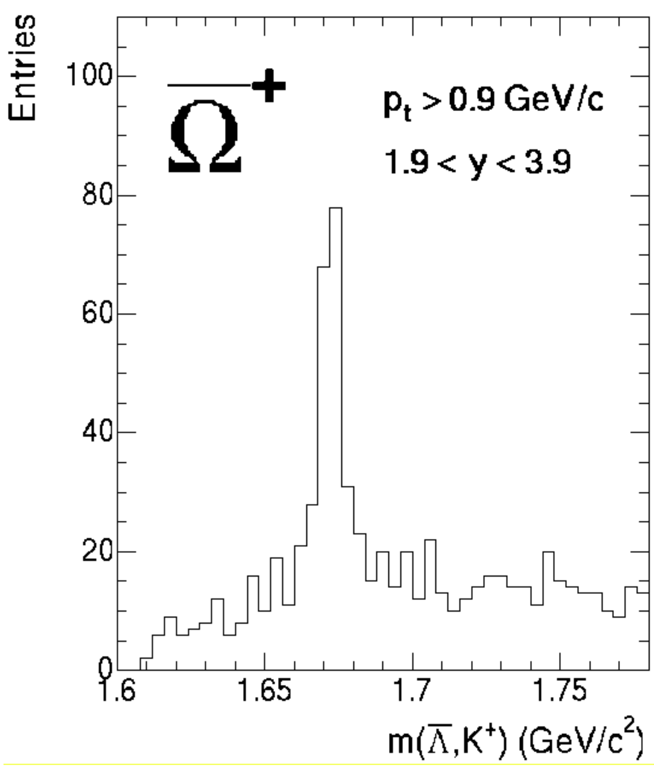
Status of Omega Paper

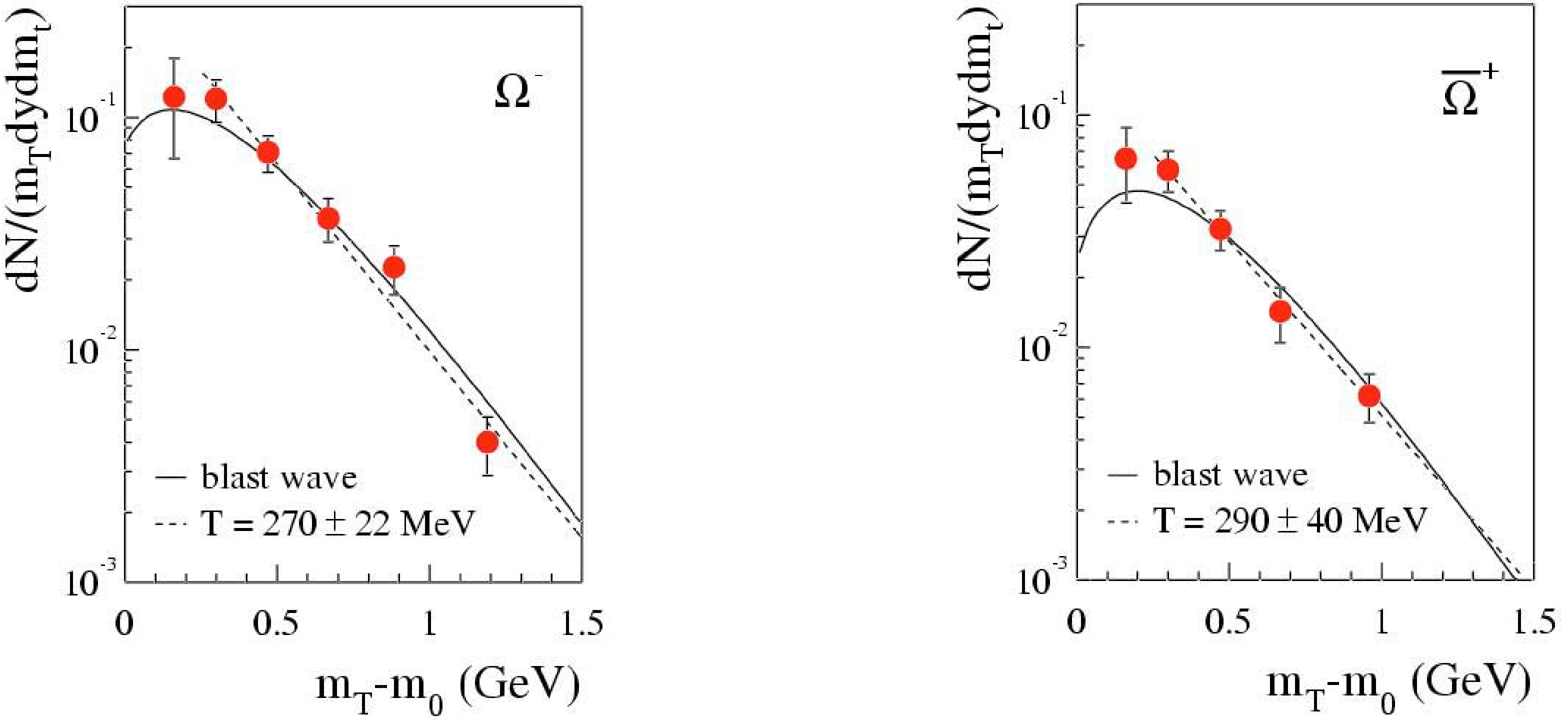
- Dataset: central (20%) Pb+Pb at 158 AGeV (01I)
- First results shown on QM02
- For publication:
    - Redo simulations
        - Old simulated data lost
        - Refined procedure
        - Statistics
    - Cross checks
        - ✓ Validity of signal
        - ✓ Comparison of simulation results and data (x_{targ}, y_{targ}, etc.)
        - ✗ Stability of final results with respect to cut variation

Omega and Antiomega Signal

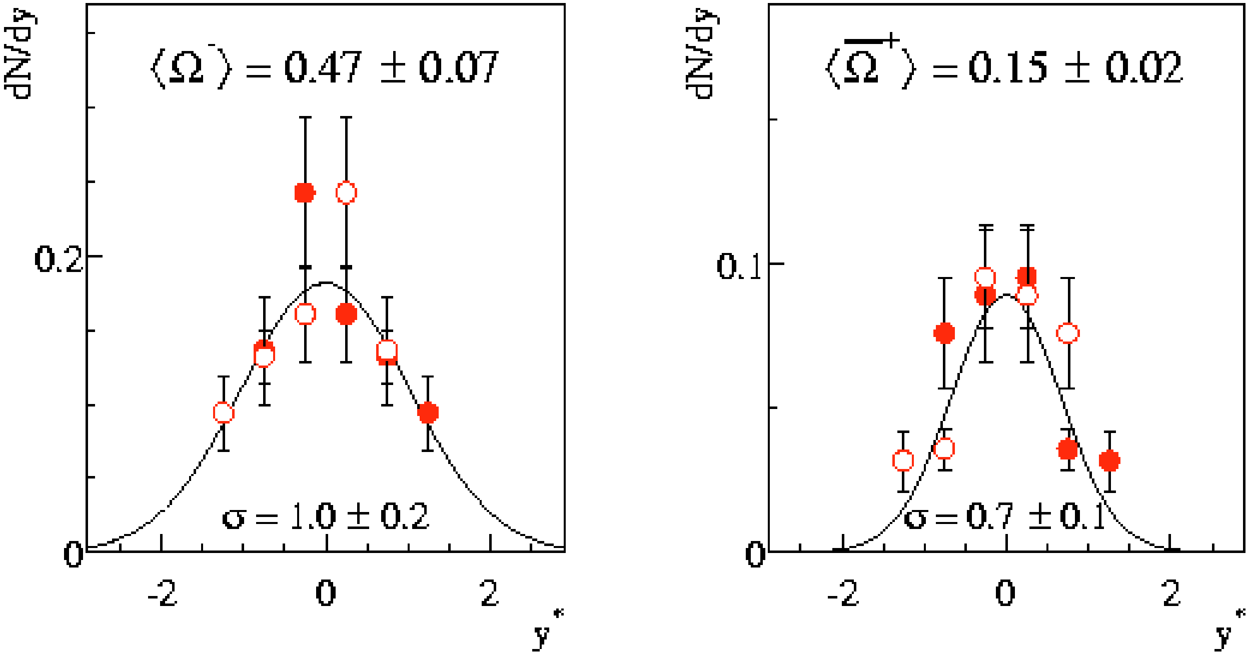




QM02 Result: m_t Spectra



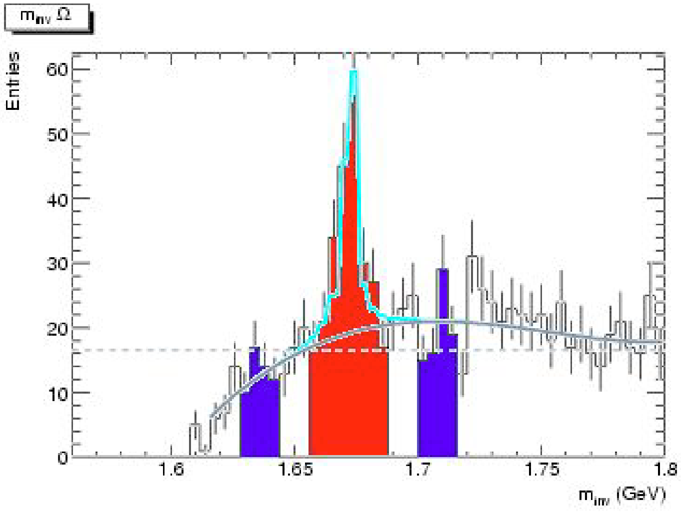
QM02 Result: Rapidity Spectra

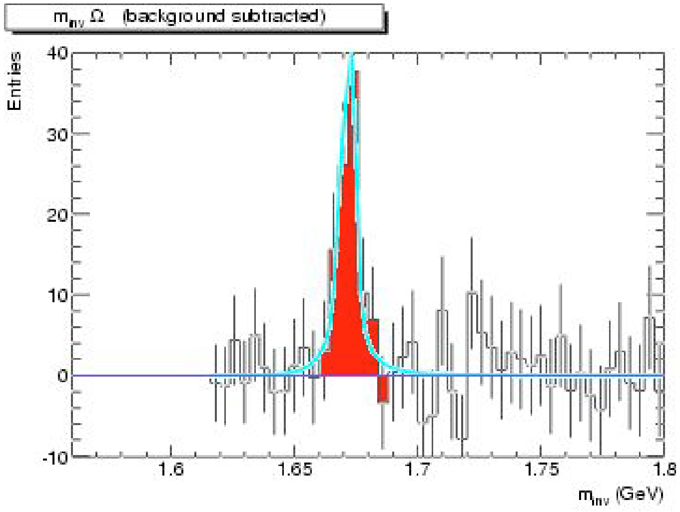


New Analysis

- Improved background fit
  - Fit with peak+polynomial
  - Peak description from simulation
  - Peak simulated for each phase space bin → variation of width included
- Open question:
  - Include Ω from Bham cut selection to increase statistics?
  - Seems to be less stable
- Simulation
  - So far 2×10^6 Omegas and 2×10^6 Antiomegas generated
  - Aim for 6×10^6 total
  - Work in progress

New Fitting Procedure





$1.9 < y < 3.9$

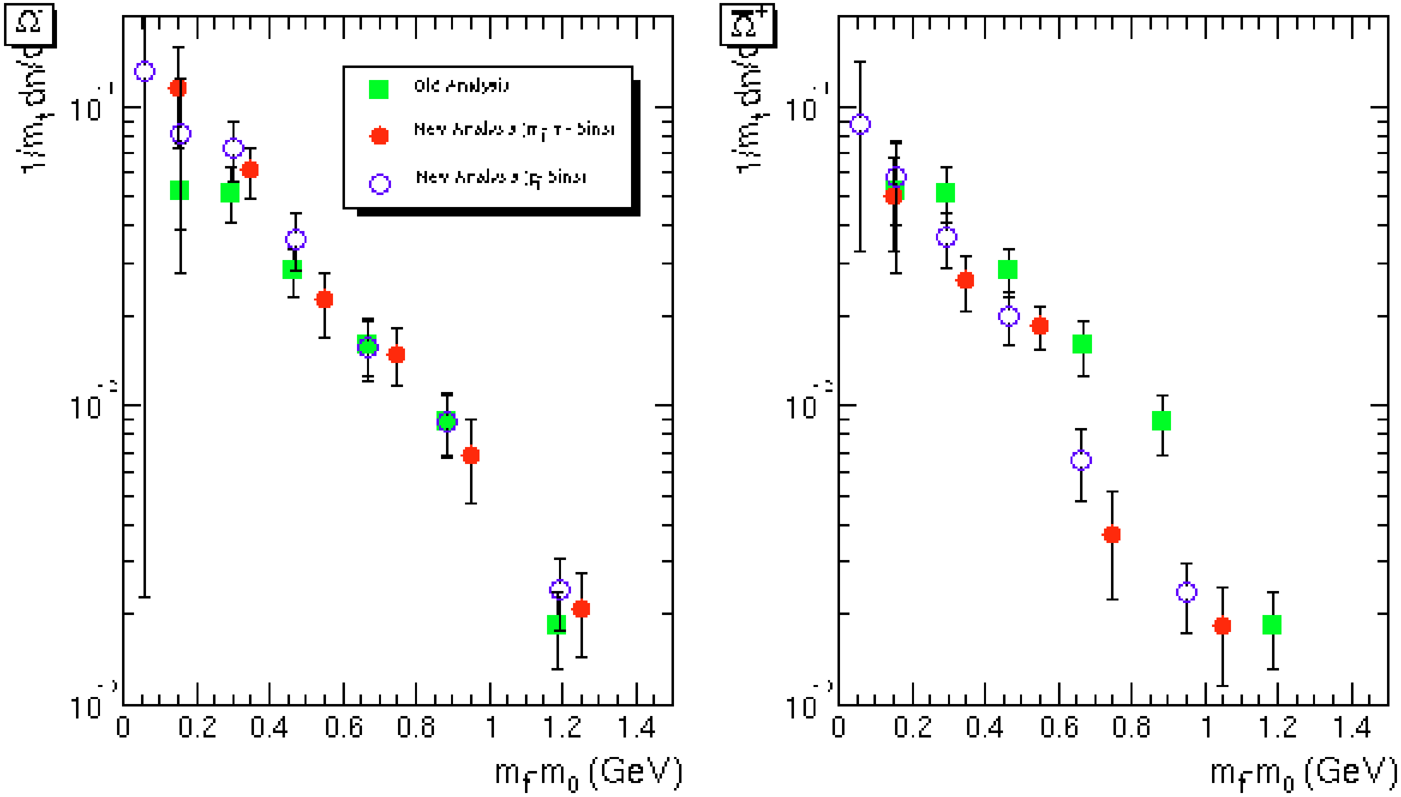
$1.2 < p_t < 1.5$

Degree of polynomial = 7

Fit range = 1.615 - 1.800

Constant background:	**Fitted background:**
S = 116.0 ± 19.5	**S = 96.1 ± 19.5**
B = 132.0 ± 11.5	**B = 151.9 ± 11.5**
S/B = 0.88 ± 0.17	**S/B = 0.63 ± 0.14**
	Wid = 1.00 ± 0.00
$0.040 \cdot 10^{-3}$ Ω/event	**$0.033 \cdot 10^{-3}$ Ω/event**
	χ^2/NDF = 0.907

New Analysis: Comparison of m_t Spectra



Conclusion

- Finish new simulation in next weeks
  - Rapidity spectra
  - Consistency checks
- Paper draft existing and could be distributed to editorial comittee

Ω^{-} and $\bar{\Omega}^{+}$ production in central Pb+Pb collisions at 158 *A*GeV

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(DRAFT 0.1)

The production of Ω^{-} and $\bar{\Omega}^{+}$ in central Pb+Pb collisions at 158 *A*GeV has been measured by the NA49 collaboration. While the transverse mass spectra do not show any significant difference between particle and anti particle, there appears to be a clear difference between the longitudinal distributions. From the integration of the rapidity spectra the total yield can be extracted as $\langle\Omega^{-}\rangle$ =??±?? and $\langle\bar{\Omega}^{+}\rangle$ =??±??.

Keywords

Heavy ion collisions at ultra-relativistic energies produce strongly interacting matter under extreme conditions. The main goal of studying heavy ion reactions is to create a state in which the confinement of quarks and gluons inside hadrons is no longer valid, the so-called quark-gluon plasma [1]. The measurement of multiple strange particles is of special interest in this context. Especially the Ω^{-} and $\bar{\Omega}^{-}$, consisting entirely of s ($\bar{s}$) quarks, provide a very stringent test on the various hadronization scenarios. Microscopical models that produce Ω^{-} ($\bar{\Omega}^{-}$) via string fragmentation would predict a $\bar{\Omega}^{-}$ /Ω^{-} ratio ¿ 1, due to the topology of the string which must include the non-strange valence quarks at their ends [2]. Statistical models on the other side would predict a $\bar{\Omega}^{-}$ /Ω^{-} ratio ¡ 1 as the effect of a non-vanishing baryonic chemical potential [*citations*].

Due to their low cross section with the surrounding hadronic matter,

The here presented data have been measured with the NA49 apparatus. A detailed description of the experimental setup can be found in [3]. The analysed data set contains $3 \cdot 10^{6}$ (??) Pb+Pb event with a beam energy of 158 AGeV, taken in the year 2000 running period. The centrality selection corresponds to the 20% most central part of the total inelastic cross section, resulting in an averaged number of wounded nucleons of $\langle N_w \rangle = 300 \pm ??$ [11]. Omegas are reconstructed via their charged decay branch ($\Omega^- \rightarrow \Lambda K^-$, resp. $\bar{\Omega}^- \rightarrow \bar{\Lambda} K^-$), with a branching fraction of 67.8% [4]. The Ω^- ($\bar{\Omega}^-$) candidates are formed by combining Λ ($\bar{\Lambda}$) candidates, reconstructed in the invariant mass region [1.101 GeV/c^2 - 1.131 GeV/c^2], with all found charged tracks. In order to identify a secondary vertex, both are extrapolated back to the target, following the same procedure as employed in the Ξ analysis [6]. The resulting combinatorial background can be reduced substantially by applying various cuts: The contribution of fake Λ ($\bar{\Lambda}$) candidates can be reduced by identifying the decay (anti-)protons via the measurement of their energy loss in the TPCs. In the same way an enriched Kaons sample is extracted from the charged tracks. A further reduction is achieved by requiring a minimal distance of the secondary vertex to the target position. Additionally, the Ω^- ($\bar{\Omega}^-$) candidate must point back to the interaction vertex, while on the other side the Kaon track should point away from it. Therefore both are extrapolated back to the target plane and corresponding cuts are placed on the distance of their impact parameter to the interaction point. Figure 1 shows the resulting invariant mass distribution for the sum of Ω^- and $\bar{\Omega}^-$. A clear signal at the expected position ($M_\Omega = 1.67245$ GeV/c^2 [4]) is observed.

In order to subtract the remaining combinatorial background, a fitting procedure is employed. In a first step signal and background are fitted together with the sum of a Lorentz-function and a polynomial. The first one turned out phenomenologically to provide the best description of the peak region, while the latter one is used to fit the underlying background. In the second step the fitted background is subtracted and the remaining signal is integrated in the invariant mass interval $[M_\Omega - \Delta M, M_\Omega + \Delta M]$, with $\Delta M = ??$ GeV/c^2. *signal/background, syst. error of peak extraction* The raw Ω^- ($\bar{\Omega}^-$) yield has to be corrected for the effects of the geometrical acceptance and the reconstruction efficiency. The latter one is strongly influenced by the high track density that is prevailing in central Pb+Pb reactions of this beam energy. Therefore a very careful evaluation of this effect is mandatory. The here employed procedure starts with generating simulated Ω^- and $\bar{\Omega}^-$ of equal amount, covering the full phasespace accessible to our measurement. The Geant3.21 package [7] is used to track the generated particles through a detailed description of the NA49 detector geometry. Taking into account all known detector effects, from these simulated tracks a readout pad response in ADC values is derived. The simulated raw data of a single Ω^- ($\bar{\Omega}^-$) is added to the raw data taken from a measured event and the summed up data is subjected to the same reconstruction procedure as the normal data. By extracting the fraction of all simulated Ω^- ($\bar{\Omega}^-$) that are reconstructed after being embedded this way, the reconstruction efficiency in the environment of a central Pb+Pb event is evaluated. Finally, the correction is applied to the data in the corresponding phase space bin.

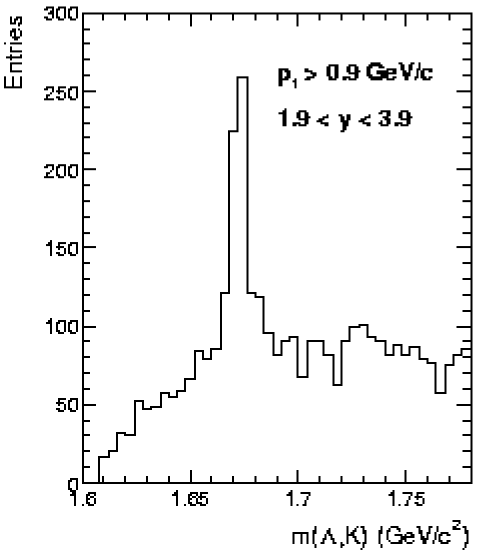

FIG. 1: The invariant mass distribution of Λ K^- and $\bar{\Lambda}$ K^+ pairs for central Pb+Pb reactions at 158 AGeV. The signal is integrated over the phasespace region $p_t > 0.9$ GeV/c and $1.9 < y < 3.9$.

Figure 2 displays the resulting transverse mass spectra of Ω^- and $\bar{\Omega}^-$ in a region of two units of rapidity around mid-rapidity. No significant difference in the spectral shape between particle and anti-particle can be observed. Consequently, the slope parameters, extracted from a fit with an exponential function (dashed lines in Fig. 2) of the form

$$\frac{dN}{m_t dy dm_t} \propto \exp - \frac{m_t}{T} \qquad (1)$$

are in good agreement: $T(\Omega^-) = ??? \pm ??$ MeV and $T(\bar{\Omega}^-) = ??? \pm ??$ MeV. These numbers are slightly above the measurement of the WA97 collaboration [8], but still consistent, considering the relatively large statistical errors. However, from this fit the first data points ($m_t - m_0 < 0.25$ GeV), which seem not to follow the exponential behaviour, are excluded. A better description of the data points in the whole measured m_t-range is achieved by a model based on a hydrodynamical picture and assuming a transversely expanding emission source

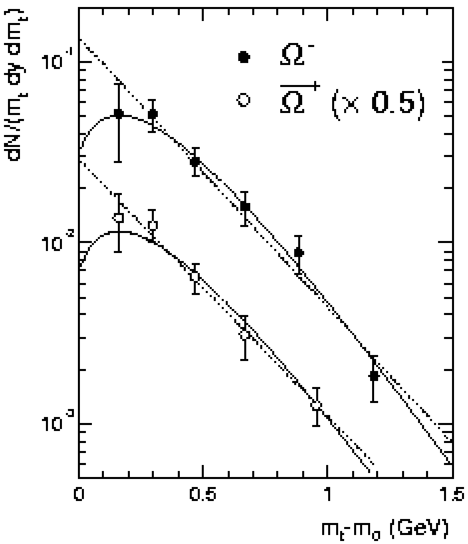

FIG. 2: The transverse mass spectra of Ω^- (filled symbols) and $\bar{\Omega}^+$ (open symbols, scaled by a factor 0.5) in central Pb+Pb reactions at 158 AGeV, measured in the rapidity range $1.9 < y < 3.9$. The dashed lines represent fits with an exponential, while the solid line displays the result of a model including transverse expansion with the parameters $T = 120$ MeV and $\beta_t = 0.5$ (see text).

[9]. The parameters of this model are the freeze-out temperature T and the mean transverse flow velocity β_t ($\rho = \tanh^{-1} \beta_t$):

$$\frac{dN}{m_t dm_t dy} \propto m_t K_1 \left(\frac{m_t \cosh \rho}{T}\right) I_0 \left(\frac{p_t \sinh \rho}{T}\right) \qquad (2)$$

The curves shown in Fig. 2 (solid lines) are calculated for the parameters $T = 120$ MeV and $\beta_t = 0.5$, which provide a reasonable simultaneous fit to all particle species [10]. This would imply that, even though a pure exponential fit yields a relatively low slope parameter, the Ω^- ($\bar{\Omega}^-$) transverse mass spectra are still in agreement with the assumption of strong radial flow.

The large acceptance of the NA49 experiment also allows to measure the Ω^- ($\bar{\Omega}^-$) spectra in longitudinal direction. Since the signal/background ratio in the region $p_t < 0.9$ GeV/c is too low to extract a signal, the measured yield has to be extrapolated to the whole p_t-range. The used extrapolation factor f is derived from the fits to the p_t-spectra and assumed to be rapidity independent: $f =$??±?? The uncertainty of the extrapolation includes the differences between the various fits. Figure 3 shows the resulting rapidity spectra for the Ω^- and $\bar{\Omega}^-$.

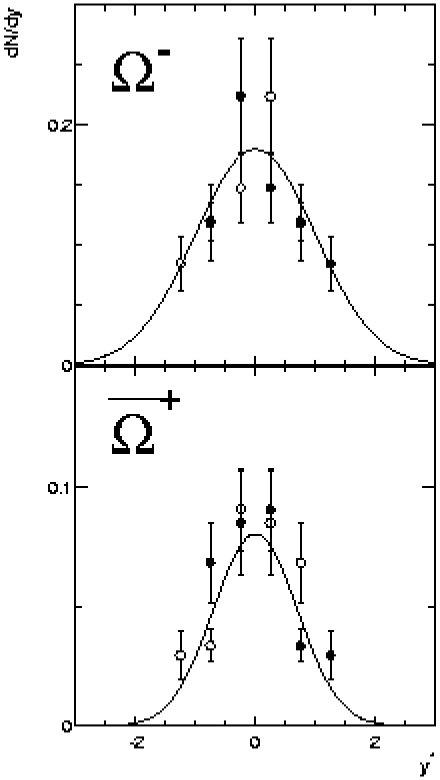

FIG. 3: The rapidity spectra of Ω^- and $\bar{\Omega}^+$ in central Pb+Pb reactions at 158 AGeV. The full symbols are the measured data points, while the open ones show their reflection around midrapidity. The total yields were extracted by integrating the Gaussian fits (solid lines).

Both spectra can be fitted with Gaussian, resulting in a slightly larger width for the Ω^- ($\sigma(\Omega^-) = 1.0 \pm 0.2$) as for the $\bar{\Omega}^-$ ($\sigma(\bar{\Omega}^-) = 0.7 \pm 0.1$). The fits are used to extrapolate into the unmeasured rapidity region, therefore allow to deduce values for the total multiplicities per event: $\langle\Omega^-\rangle = 0.47 \pm 0.07$ and $\langle\Omega^-\rangle = 0.15 \pm 0.02$. The corresponding yields at mid-rapidity ($2.4 < y < 3.4$) are: $\Omega^- = 0.?? \pm 0.??$ and $\Omega^- = 0.?? \pm 0.??$.

summary: omega and anti-omega, first rapidity measurement ever, thermal model

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