NEW RESULTS FROM NA49

V. FRIESE FOR THE NA49 COLLABORATION
Fachbereich Physik der Universität Marburg
Renthof 5, 35032 Marburg, Germany
E-mail: volker.friese@physik.uni-marburg.de

We present recent results of the SPS experiment NA49 on production of strange particles and event-by-event fluctuations of mean p_t and of charged particle ratios in central Pb+Pb collisions at various beam energies (40, 80, 158 AGeV) as well as in different collisions at 158 AGeV, going from p+p over light-ion collisions to peripheral and central Pb+Pb.

1 Introduction

A possible interpretation of the data collected by the various heavy-ion experiments at the CERN-SPS over the past few years is that a deconfined state of nuclear matter is already reached in central Pb+Pb collisions at top SPS energy (158 AGeV)[1]. This immediately triggers the question whether the transition point can be experimentally pinned down by varying the collision energy or the size of the collision system. The experiment NA49[2] aims to investigate this question by studying hadronic observables, predominantly strangeness production, for different beam energies (40, 80 and 158 AGeV) as well as for different colliding systems, such as p+p, C+C and Pb+Pb at various centralities. Further data taking at even lower beam energies (20, 30 AGeV) is foreseen for the year 2002.

2 Energy Dependence of Hadronic Observables

2.1 Kaon and Λ Production

NA49 can identify charged kaons by time-of-flight measurement near midrapidity and by the specific energy loss at forward rapidities. Λ baryons are identified in NA49 by their V0 decay topology. The m_t spectra for both particles types are well described by exponentials. For the kaons, we find comparable slopes (220-240 MeV) for all three energies, the slopes for K^- being slightly lower than those of K^+. In the case of Λ, the slopes increase slightly with beam energy.

The rapidity distributions for kaons are shown in fig. 1a for 40 AGeV. We observe the K^+ to have a somewhat broader distribution than the K^-, which also holds for the other energies. The rapidity distribution of the Λ (fig. 2)

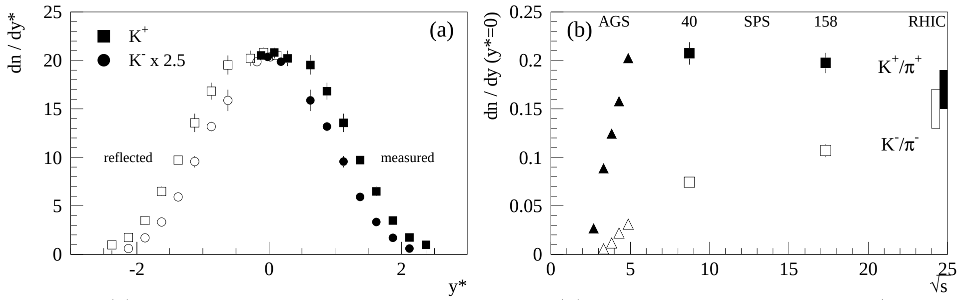

Figure 1. (a) kaon rapidity distributions for 40 AGeV; (b) energy dependence of the K/π ratio at midrapidity. Note that the RHIC results are not on horizontal scale.

seems to develop a plateau around midrapidity when going from 40 AGeV to 158 AGeV. For the latter case, the shape of the distribution at large $|y|$ is not yet determined, leaving some uncertainty to the 4π extrapolation.

Fig. 1b shows the K/π ratio at midrapidity as a function of $\sqrt{s}$. For 80 AGeV, the analysis of pion production is not yet finished, so we restrict ourselves to the data at 40 and 158 AGeV. While a continuous rise in K^-/π^- from AGS[3] over SPS to RHIC energies is observed, the K^+/π^+ ratio seems to reach a maximum at or slightly above top AGS energy. This behaviour is more pronounced in the case of Λ (fig. 2).

The K/π ratios in full phase space are shown in fig. 3. In contrast to K^-/π^-, the K^+/π^+ ratio clearly shows a non-monotonic behaviour. Most models, including hadron gas models as well as microscopic transport models, fail to reproduce such a trend. It is therefore interesting that the statistical

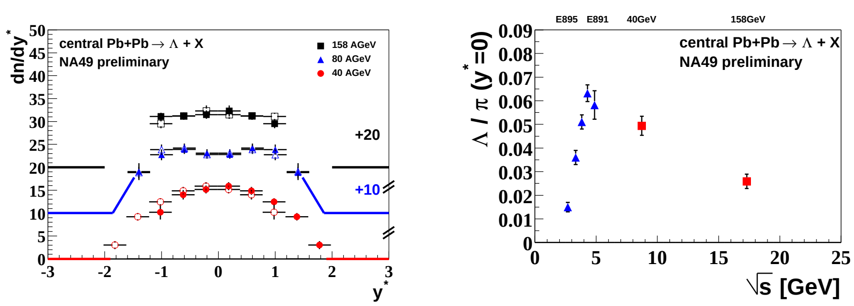

Figure 2. (left) Λ rapidity distributions in central Pb+Pb at 40, 80 and 158 AGeV; (right) Λ/π ratio at midrapidity as function of beam energy. AGS data taken from[4]

model of the early stage[5] indeed predicts a non-monotonic behaviour in the strangeness-to-pion ratio, assuming a phase transition at about 40 AGeV.

2.2 Charge Fluctuations

Event-by-event charge fluctuations have lately been proposed as a signal of the quark-gluon plasma[6]. As a measure of these fluctuations, we have determined $\tilde{D} = \langle N_{ch} \rangle \langle \delta R^2 \rangle / (C_\mu C_y)$, where $\langle \delta R^2 \rangle$ denotes the fluctuations in the ratio of the numbers of positively and negatively charged hadrons, as a function of the rapidity window Δy. We obtain similar values around 4 for all three beam energies, corresponding to the expectation for an uncorrelated pion gas, whereas a QGP was predicted to yield values between 1 and 2. However, the correction factors C_μ and C_y, which account for the finite net charge within the acceptance and global charge conservation[7], are still under debate; hence at the moment we do not draw a definite conclusion from the data observed.

3 System Size Dependence of Hadronic Observables

3.1 Kaon and ϕ Production

The ϕ meson is measured in NA49[8] via the invariant mass of its decay products K^+K^-. When comparing the ϕ/π ratio in central collisions of light ions to that in peripheral collisions of heavy nuclei, we find that the number of participants may not be the right variable to characterise the reaction, because it does not take into account the collision geometry[9]. When using the variable $R - b/2$, with R being the nuclear radius and b the impact parameter of the collision, we find a smooth evolution in ϕ enhancement when going from p+p over C+C to peripheral and central Pb+Pb. The same is true when studying

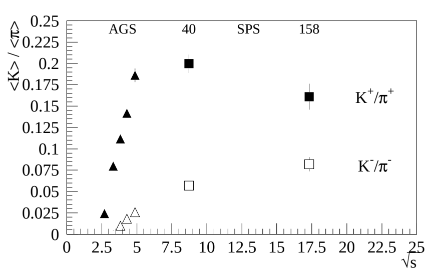

Figure 3. Full phase space K/π ratio in Pb+Pb as a function of beam energy.

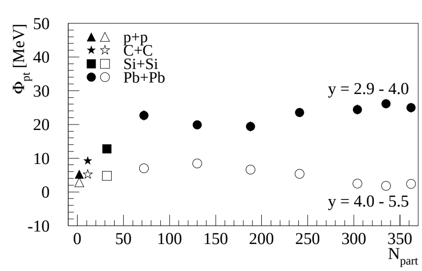

Figure 4. Φ_{pt} as a function of the number of participants at 158 AGeV for two different rapidity ranges

the K/π ratio in p+p, C+C, Si+Si and Pb+Pb at different centralities (fig. 5).

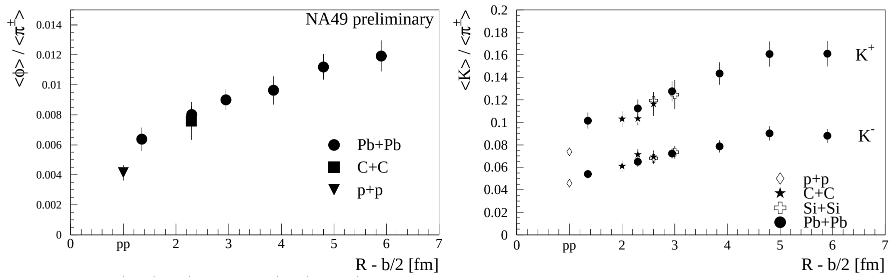

Figure 5. ϕ/π (left) and K/π (right) ratios for different collisions types at 158 AGeV as a function of $R - b/2$ ($\langle\pi^{\pm}\rangle = (\langle\pi^{+}\rangle + \langle\pi^{-}\rangle)/2$)

3.2 Mean p_T fluctuations

The observable Φ_{pt}, measuring the non-statistical event-by-event fluctuations in the mean p_T[10], has been studied by NA49 at 158 AGeV for the set of collision types mentioned in the previous sections. Fig. 4 gives the result as a function of N_{part} for two different rapidity windows. At forward rapidity, we obtain very small values of Φ_{pt}, almost indepent of N_{part}. Around midrapidity, however, we observe a rise in Φ_{pt} up to $N_{part} \approx 100$, from where it stays constant up to central Pb+Pb. This is contrary to the expectations, which suggest a decrease in Φ_{pt} when going from elementary collisions to larger systems where increasing equlibration suppresses the fluctuations. An interpretation of this findings is still lacking.

References

1. R. Stock, *Phys. Lett.* B **456**, 277 (1999)
2. S. V. Afanfasiev *et al*, *Nucl. Instrum. Methods* A **430**, 210 (1999)
3. L. Ahle *et al*, *Phys. Rev.* D **57**, 466 (1998)
   L. Ahle *et al*, *Phys. Rev.* D **58**, 3523 (1998)
   L. Ahle *et al*, *Phys. Lett.* B **476**, 1 (2000)
4. S. Ahmad *et al*, *Phys. Lett.* B **382**, 35 (1996)
   G. Rai *et al*, *Nucl. Phys.* A **661**, 162c (1999)
5. M. Gaździcki and M. I. Gorenstein, *Acta Phys. Pol.* B **30**, 2705 (1999)
6. S. Jeon and V. Koch, *Phys. Rev. Lett.* **85**, 2076 (2000)
7. M. Bleicher, S. Leon and V. Koch, PRC **62**, 061902(R) (2000)
8. S. V. Afanasiev *et al.*, *Phys. Lett.* B **491**, 59 (2000)

9. C. Blume, Proceedings of *Quark Matter 2001*, to be published
10. M. Gaździcki and S. Mrówczyński, *Z. Phys.* C **54**, 127 (1992)