Vol. 29 (1998) *ACTA PHYSICA POLONICA B* No 11

PARTICLE PRODUCTION SYSTEMATICS FROM SIS TO SPS*

Dieter Röhrich

Institut für Kernphysik, Universität Frankfurt
August–Euler Str. 6, D–60486 Frankfurt/M, Germany

(Received July 24, 1998)

The mean multiplicity of negatively charged hadrons per participant nucleon for central nucleus–nucleus collisions is lower than the corresponding multiplicity for nucleon–nucleon interactions for $p_{\rm LAB} \leq 15A\,{\rm GeV}/c$, whereas the result at 158–200 $A\,{\rm GeV}/c$ is above the corresponding nucleon–nucleon multiplicity. The ratio of strange particle multiplicity to pion multiplicity is larger for central nucleus–nucleus collisions than for nucleon–nucleon interactions at all studied energies. Single particle momentum spectra and two particle correlations suggest a significant transverse flow at thermal freeze-out for central heavy ion collisions.

PACS numbers: 13.85.–t

The systematics of particle production as a function of the beam energy and the system size may shed light on the onset of the formation of a state of deconfined quarks and gluons.

In Fig. 1 the rapidity distribution for negatively charged hadrons (mostly pions) in central Pb+Pb collisions at the SPS (upper left) and in central Au+Au collisions at the AGS (lower left) are shown in comparison to properly scaled data for nucleon + nucleon collisions [1]. The mean multiplicity of negatively charged hadrons per participant nucleon for central nucleus–nucleus collisions is lower than the corresponding multiplicity for nucleon–nucleon interactions at $p_{\rm LAB} \leq 15\ A\,{\rm GeV}/c$, whereas the result at 158–200 $A\,{\rm GeV}/c$ is above the corresponding nucleon–nucleon multiplicity (Fig. 1, right plot) [2].

The K/π ratio (in 4π) for various systems at SPS-energy is shown in Fig. 2. The ratio is similar for the heavy ion reactions, nucleon–nucleon and p+A data are lower. Strangeness enhancement is therefore observed

* Presented at the Meson'98 and Conference on the Structure of Meson, Baryon and Nuclei, Cracow, Poland, May 26–June 2, 1998.

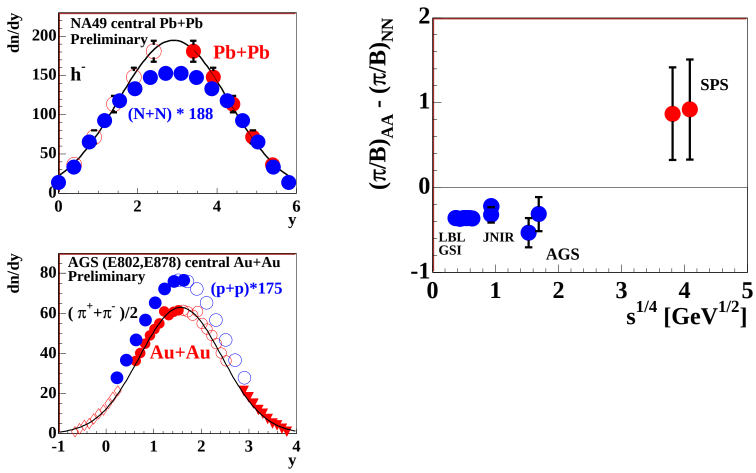

Fig. 1. Pion rapidity distributions and pion production per participating nucleon for $A+A$ collisions at various collision energies.

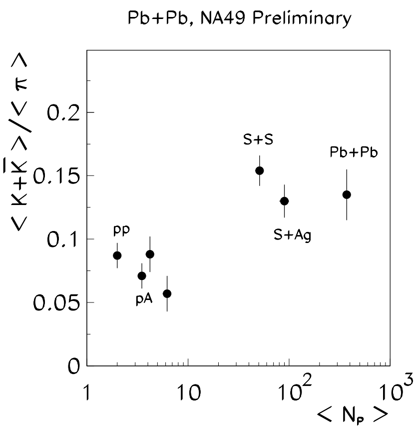

Fig. 2. Ratio of the multiplicities of kaons and pions for various target–projectile systems as a function of the number of participants.

in S+S and Pb+Pb collisions. In order to quantify the total production of strangeness we define the E_S ratio as

$$E_S = \frac{\langle \Lambda \rangle + \langle K + \overline{K} \rangle}{\langle \pi \rangle}\,, \tag{1}$$

where $\langle \pi \rangle$ is the mean multiplicity of all pions produced. The E_S ratio is larger for central nucleus–nucleus collisions than for nucleon–nucleon interactions at the same energy. This is observed for all analyzed energies. We do not observe any significant dependence of the E_S ratio on the target nucleus mass number at fixed projectile and collision energy. The data at AGS and SPS energies suggest a possible saturation of the E_S ratio with the volume of the system for collisions of sufficiently large nuclei [3].

The energy dependence of the E_S ratio for nucleon–nucleon interactions and central nucleus–nucleus collisions is shown in Fig. 3. The E_S ratio increases with the energy in a monotonic way for nucleon–nucleon interactions. A qualitatively different behaviour is observed for central nucleus–nucleus collisions; the fast increase of the E_S ratio occurs between Dubna and AGS energies, but the E_S values at AGS and SPS energies are similar.

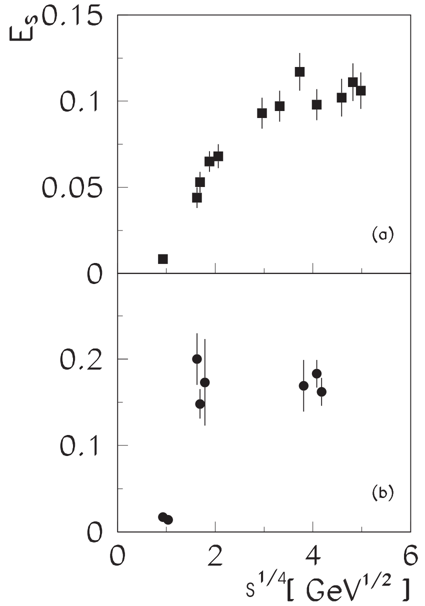

Fig. 3. Strangeness contents E_S for nucleon–nucleon interactions (top) and central heavy ion collisions (bottom) as a function of the bombarding energy.

Fig. 4 shows the inverse slope parameter T for Pb+Pb collisions at SPS, where T was obtained from a fit to the transverse mass spectrum. One clearly observes an increase in the inverse slope parameter, for both mesons and baryons, with increasing particle mass.

A similar trend is observed at AGS energies as shown in Fig. 5 [4]. Such high inverse slope parameters might be explained by a large transverse flow. Although temperature and flow velocity are anticorrelated and usually many $(T,v_\perp)$-values fit the data equally well, the dependence of the two-pion Bose–Einstein correlation on the average transverse momentum of the pion pair can constrain the range of transverse flow velocities [5]. A temperature of about 120 MeV and average transverse flow velocities of 0.5–0.6 c are

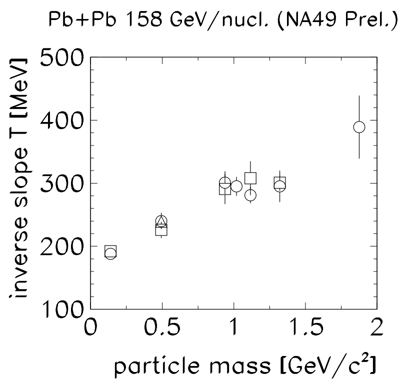

Fig. 4

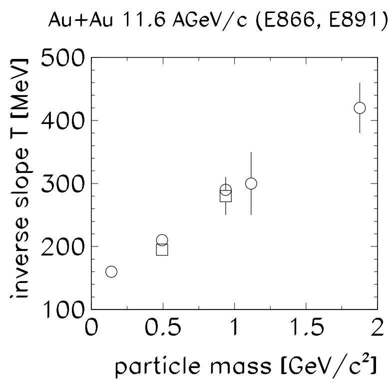

Fig. 5

Fig. 4. Inverse slope parameters of various particles produced in central Pb+Pb collisions at SPS energy.

Fig. 5. Inverse slope parameters of various particles produced in central Au+Au collisions at AGS energy.

consistent with both the transverse mass spectra and $R_\perp$ dependence of the correlation in Pb+Pb collisions at the SPS.

REFERENCES

[1] $p+p, p+n$ at 200 GeV/N: Y. Eisenberg *et al.*, *Nucl. Phys.* **B154**, 239 (1979); C. De Marzo *et al., Phys. Rev.* **D26**, 1019 (1982); $p+p$ at 12 GeV/N: V. Blobel *et al.*, *Nucl. Phys.* **B69**, 454 (1974); AGS Au+Au data: Y. Akiba for E802, *Nucl. Phys.* **A610**, 139 (1996); R. Lacasse for E877, *Nucl. Phys.* **A610**, 153 (1996); SPS Pb+Pb data: G. Roland for NA49, Proceedings QM97 (1997).

[2] M. Gaździcki, D. Röhrich, *Z. Phys.* **C65**, 215 (1995).

[3] M. Gaździcki, D. Röhrich, *Z. Phys.* **C71**, 55 (1996).

[4] Z. Chen *et al.* (E866 Collaboration), Proceedings of the Heavy Ion Physics at the AGS HIPAGS '96, WSU-NP-96-16 (1996) p.5.

[5] U. Heinz, *Nucl. Phys.* **A610**, 264c (1996).