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PROTON-NUCLEUS INTERACTIONS AT 200 Gev/c

(Alma-Ata-Leningrad-Moscow-Tashkent collaboration)

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INTRODUCTION

The investigation of interactions of hadrons with the nucleus in recent time became very important, and there is a hope that it can give the information about the systems produced in this process(lifetime,cross sections etc.) The nuclear photoemulsions are a good detector at the investigation of hadron-nucleus interactions due to a high spatial resolution and a possibility of detection of particles nearly at all energies that enables to study the characteristics of both fast and slow particles. The consistence of emulsion enables to obtain the characteristics of interactions both on light (CNO, $\langle A \rangle = 14$) and on heavy(Ag,Br, $\langle A \rangle = 94$) nuclei.

EXPERIMENT

The emulsions of BR-2 type were irradiated by 200 Gev/c protons at NAL(Batavia)accelerator. On the total length of 3303 m of proton tracks by scanning along the track 9333 inelastic interactions were found from which 1620 are the quasinucleon interactions: (630 pp and 690 pn, about 300 events with $n_s = 1,3,5,7$ we regard as coherent interactions on nuclei). The general characteristics of pN, coherent and p-nucleus interactions are presented elsewhere [1-5]. In [5] on the total number of p-nucleus events 3255 the distributions of n_s, N_h were obtained $\langle n_s \rangle = 13,8 \pm 0,2$; $\langle N_h \rangle = 7,3 \pm 0,1$).

The comparison of the angular characteristics of secondary particles from p-nucleus and pp-interactions shows their coincidence up to $n_s = 16$ while for $n_s \geq 17$ they essentially differ, especially in the region of large angles.

The data about the multiplicity of relativistic particles in different regions of rapidity and different total n_s also presented in [5] shows that in a projectile fragmentation region p-nucleus and pp-interactions are similar while for a target fragmentation region they differ.

This work is mainly devoted to the investigation of characteristics of interaction of protons on light and heavy nuclei at 200 Gev. For each of 1634 p-nucleus interactions found along the track there were obtained n_s -the number of relativistic particles, n_g -the number of "gray" tracks ($J \geqslant 1,4 J_{min}$,30 MeV< E_p < 400 MeV, n_b -the number of "black" tracks-evaporation particles ($E_p \leqslant$ 30 MeV) and polar angles of relativistic particles also.

All interactions were divided into four groups according to the criteria described in [6].

1. The quasinucleon group consists of pp-,pn- and coherent inelastic interactions.

2. The "light" group consists of the events with $1 \leqslant N_h \leqslant 6$ and with a black track having $R_{min} \leqslant 80 \mu$.

3. The "heavy T1" - the events with $1 \leqslant N_h \leqslant 6$ and $R_{min} > 80 \mu$.

4. The "heavy T2" - the events with $N_h > 7$.

To obtain characteristics of interactions on CNO and AgBr nuclei the groups "light" and "heavy" were supplemented by the events from the quasinucleon group according to the geometrical cross sections.

THE MULTIPLICITY OF CHARGED PARTICLES ON LIGHT AND HEAVY NUCLEI

As it is seen in Fig.1 the distributions of multiplicity for light and heavy 1 are alike, but the heavy 2 group differs from them. The mean values of n_s , n_g , n_b both for all groups and interactions on CNO and AgBr are presented in Table 1.

Table 1

Group of interactions	$\langle n_s \rangle$	$\langle n_b \rangle$	$\langle n_g \rangle$	Number of stars
All nuclei	13,5 ± 0,2	4,7 ± 0,1	2,5 ± 0,1	1634
Quasi-nucleon	7,4 ± 0,3	0	0,15±0,02	294
p-N	8,4 ± 0,3	0	0,19± 0,03	241
" Light L "	11,7 ± 0,4	2,7 ± 0,1	0,89± 0,06	303
T1	11,2 ± 0,3	1,83± 0,07	1,17± 0,06	423
T2	18,9 ± 0,4	10,0 ± 0,2	5,3 ± 0,15	612
C N O	10,6 ± 0,3	1,9 ± 0,1	0,70± 0,05	415
Ag Br	15,0 ± 0,3	6,1 ± 0,2	3,3 ± 0,1	1131

The mean values of n_s for light and heavy 1 group are also the same, and they differ from heavy 2 group. The relation $R = \frac{\langle n_s \rangle_{p\text{-nucleus}}}{\langle n_{ch} \rangle_{pp}}$ is 1.4±0,04 and 2.0±0,05 for CNO and AgBr, respectively. If consider n_s versus A as $\langle n_s \rangle_{pA} = \langle n_{ch} \rangle_{pp} A^{\alpha}$ then we obtain $\alpha_{CNO} = 0{,}10 \pm {,}01$; $\alpha_{AgBr} = 0{,}15 \pm {,}01$ and for mean emulsion nuclei $\alpha = 0{,}1$ that coincides with the values at lower energies both for incident π -mesons and protons.

THE MULTIPLICITY OF RELATIVISTIC PARTICLES IN DIFFERENT REGIONS OF RAPIDITY

In Fig.2 is presented the distribution $\frac{1}{N}\frac{dn_s}{dy}$ $(y = -\ln tg\,\theta_L/2)$ for different groups of interactions. In Fig.3,4 are presented differential $\left(R = \frac{\langle n_s \rangle_{pA}(\Delta y)}{\langle n_{ch} \rangle_{pp}(\Delta y)}\right)$ and integral $\left(R'(>y) = \frac{\langle n_s \rangle(>y)_{pA}}{\langle n_{ch} \rangle(>y)_{pp}}\right)$ relation of the mean multiplicity (per interval of Δy or $> y$) for p-nuc-

Table 2

Group of interaction \ Range of rapidity	⟨n_1⟩ y > 4.65	⟨n_2⟩ 2.0 ≤ y ≤ 4.65	⟨n_3⟩ y < 2.0	Number of stars
		n_s = I - 8		
" Light L "	I,45 ± 0,I0	2,7 ± 0,2	0,9 ± 0,I	99
TI	I,47 ± 0,08	2,75± 0,I5	I,I ± 0,I	I57
T2	I,65 ± 0,I5	2,8 ± 0,2	I,75± 0,I7	68
		n_s = 9 - I6		
" Light L "	2,0 ± 0,I	7,2 ± 0,2	3,0 ± 0,2	I4I
TI	2,0 ± 0,I	7,2 ± 0,2	2,9 ± 0,2	I74
T2	2,0 ± 0,I	6,6 ± 0,2	4,6 ± 0,I	207
		n_s ≥ I7		
" Light L "	I,8 ± 0,2	I2,9 ± 0,6	6,2 ± 0,4	65
TI	I,9 ± 0,2	II,9 ± 0,4	6,2 ± 0,3	87
T2	I,5 ± 0,I	I3,6 ± 0,3	I0,0 ± 0,3	337
		n_s ≥ I		
" Light L "	I,79 ± 0,08	6,9 ± 0,3	3,0 ± 0,2	305
TI	I,78 ± 0,06	6,5 ± 0,2	2,9 ± 0,I	4I8
T2	I,70 ± 0,05	I0,0 ± 0,2	7,2 ± 0,2	6I2
		n_{ch} ≥ I		
pp	I,77 ± 0,07	4,9 ± 0,I5	I,80± 0.07	630

leus and pp-interactions. It is seen from these figures that in a projectile fragmentation region all groups are simălar, while the group heavy 2 (T_2) differs from both pp,light and heavy 1 (T_1) groups in the region of pionisation and especially in a target fragmentation region.

In Table 2 are presented the values of the mean multiplicity in the projectile fragmentation region as in the target fragmentation region and in the region of pionisation at different n_s and in all groups. It follows from Table 2 that in a forward cone the mean multiplicity for all groups does not differ. This leads to the conclusion that a fast cluster produced in interaction of protons on light (CNO) and heavy (AgBr)nuclei does not feel the nuclei.

In the pionisation region the multiplicity of groups "light" and "heavy 1" is the same and 1,4 times as much than for pp-interactions, for "heavy 2" group the multiplicity is 2 times as much than in pp-group.

It follows from Fig.3,4 that in groups of light,heavy 1 and heavy 2 in a region $y>6\div7$ the mean multiplicity is lower than for pp-interactions, it is perhaps caused by secondary interactions of leading particles inside the nuclei.

The essential increase of multiplicity in heavy 2 group suggests that the slow cluster decays inside the nuclei, and the secondary particles interact once more producing the nuclear cadcade.

To clear up the mechanism of interaction of protons with nuclei more detailed investigations are necessary.

R E F E R E N C E S

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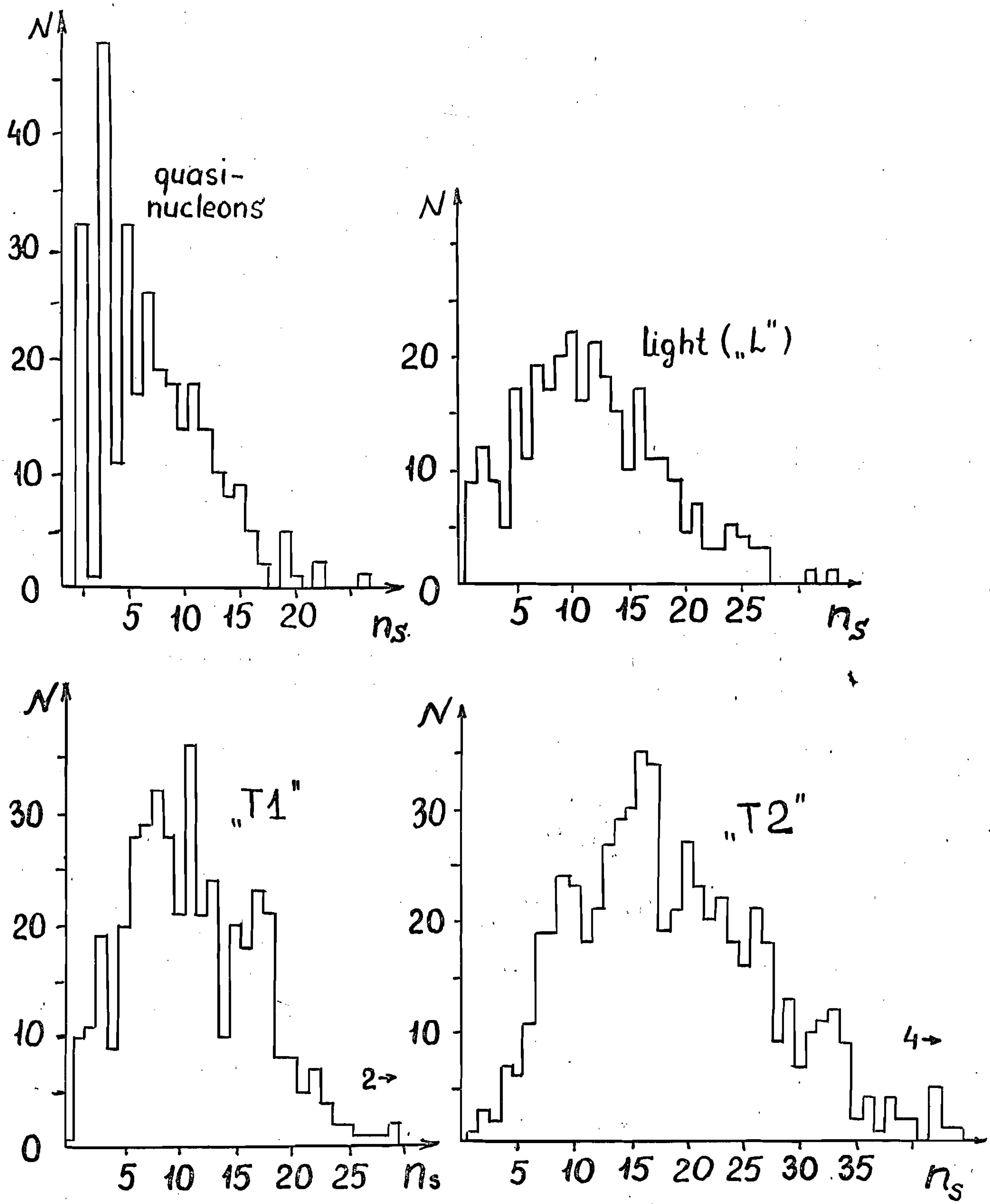

Fig.I. The distribution of n_s for different groups of interactions.

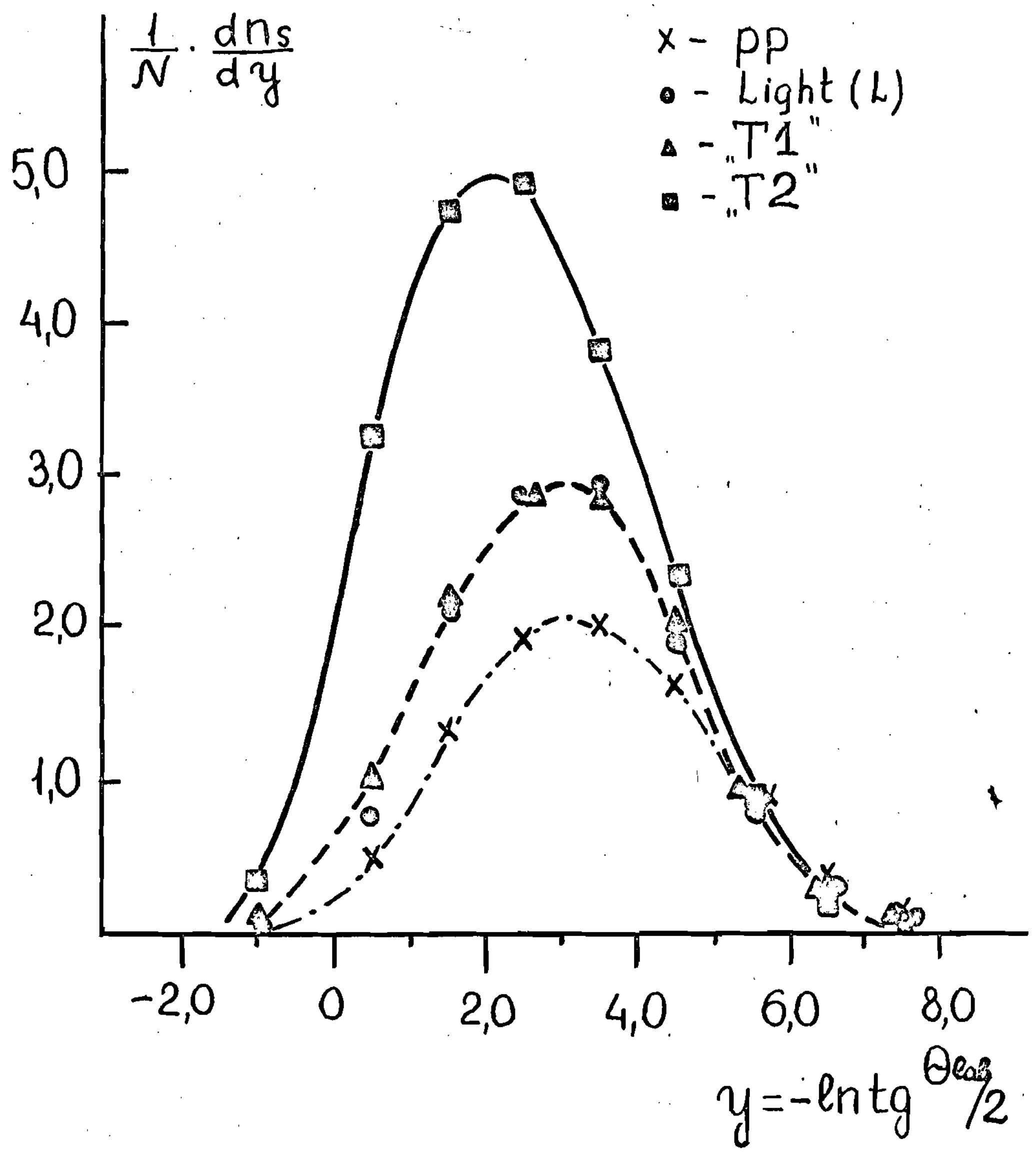

Fig.2. Angular distributions of secondary charged particles for p-nucleus and pp-interactions.

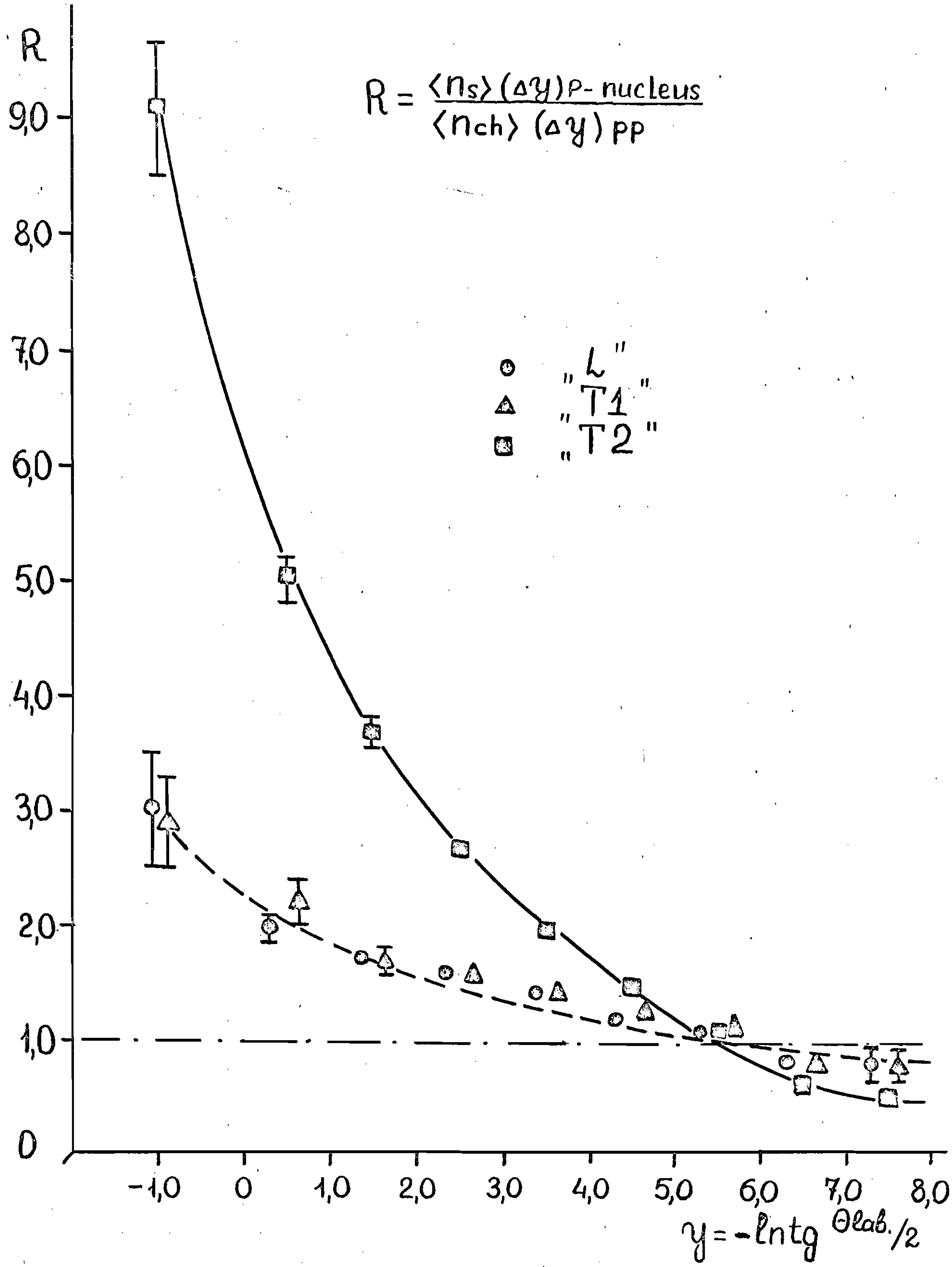

Fig.3. The relation of the mean multiplicities in rapidity interval Δy for p-nucleus and pp-interactions.

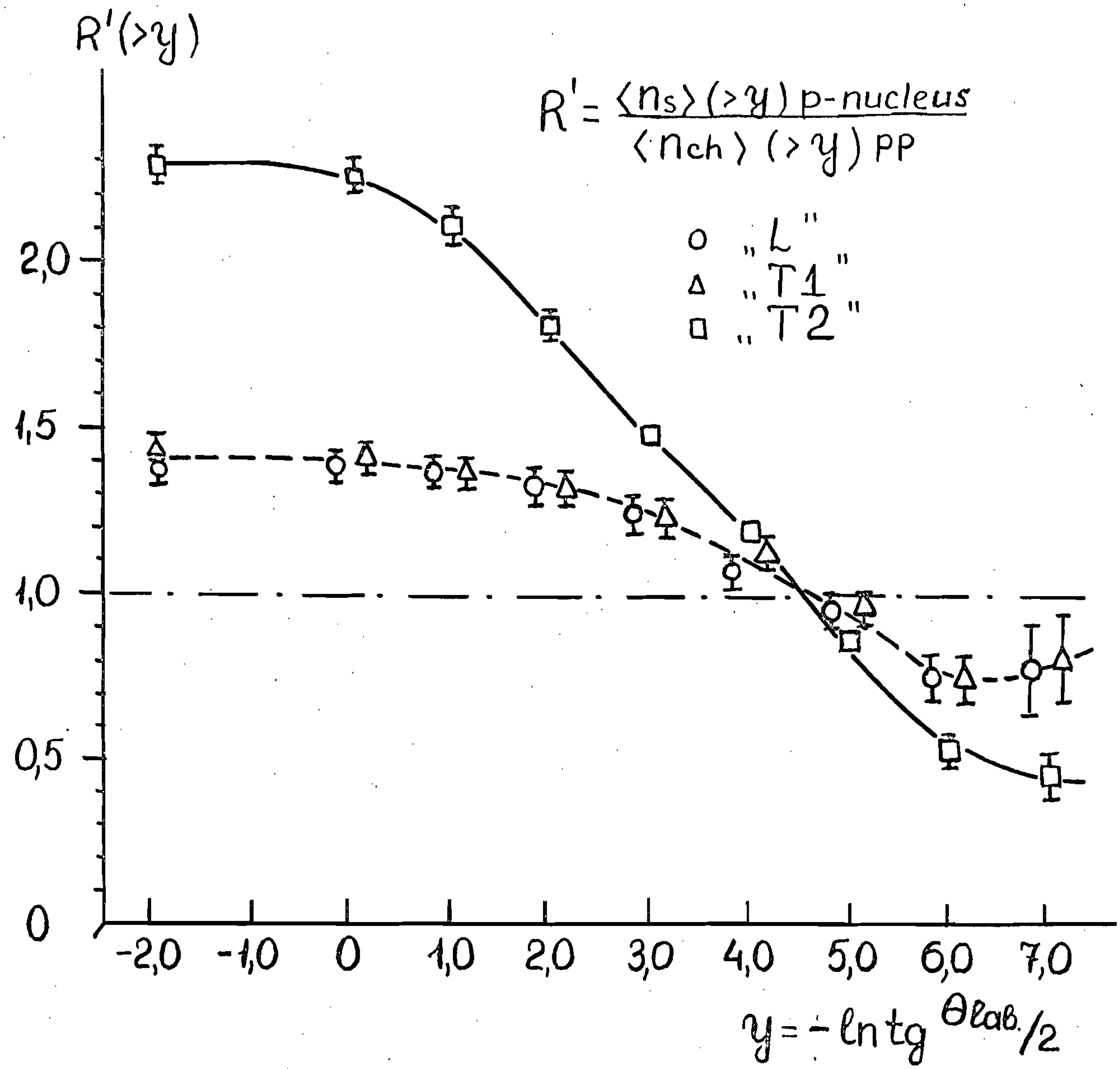

Fig.4. The relation of the mean multiplicities (for interval $> y$)-for p-nucleus and pp-interactions.