ACADEMY OF SCIENCES OF THE USSR
P. N. LEBEDEV PHYSICAL INSTITUTE

Preprint N43

High Energy Physics and Cosmic Rays.

MULTIPLICITY OF CHARGED SECONDARIES IN INTERACTIONS OF PROTONS IN AN EMULSION AT 400 Gev/c

Alma-Ata-Gatchina-Moscow-Tashkent
Collaboration.

Moscow 1977

Experiment # 463

FERMILAB-PUB-77-150-E

Preprint N43

High Energy Physics and Cosmic Rays.

MULTIPLICITY OF CHARGED SECONDARIES IN INTERACTIONS OF PROTONS IN AN EMULSION AT 400 Gev/c

Alma-Ata-Gatchina-Moscow-Tashkent
Collaboration.

Moscow 1977

MULTIPLICITY OF CHARGED SECONDARIES IN INTERACTIONS OF PROTONS IN AN EMULSION AT 400 Gev/c

(Alma-Ata-Gatchina-Moscow-Tashkent-Collaboration)

E.G.Boos, A.I.Borisenko, A.N.Kazanskaja, P.V.Morozova, N.P.Pavlova, A.V.Kholmetskaja. IHEP of Kazakh Academy of Sciences. Alma-Ata.

F.G.Lepekhin, B.B.Simonov. Leningrad Institute of nuclear Physics of Academy of Sciences. Gatchina.

M.I.Adamovich, V.G.Larionova, N.N.Maslennikova, G.I.Orlova, M.I.Tretjakova, S.P.Kharlamov, M.M.Chernyavsky, F.R.Yagudina. P.N.Lebedev Physical Institute of Academy of Sciences. Moscow.

Sh.Abdushamilov, S.A.Azimov, S.I.Gadzhieva, K.G.Gulamov, V.I.Petrov, N.S.Skripnik, T.P.Trofimova, L.P.Chernova, G.M.Chernov. Phys. Techn. Inst. of Uzbek Academy of Sciences. Tashkent.

FERMILAB-PUB-77-150-E

ABSTRACT

The preliminary results on multiplicities of charged secondaries in proton-nucleus interactions at 400 Gev/c are presented. Multiplicity of produced particles is consistent in the first approximation with the KNO scaling hypothesis for hadron-nucleus interactions. The relations between different moments of multiplicity distribution in proton-nucleus interactions at high energies are discussed too.

I. We present here the preliminary data on multiplicity of charged secondary particles in interactions of 400 gev/c protons with an emulsion nuclei. The Experiment was performed in stacks of nuclear emulsions of the type GOSNIIHIMPhOTOPROEKT BR-2 exposed to protons with the momentum 400 gev/c at the Fermilab accelerator (Batavia, USA).

We analyse 1202 events of inelastic collisions of incident protons in emulsion recorded without any discrimination during the "along-the-track" scanning. All charged particles in these events were classified according their ionization and range into relativistic ($J < 1,4 J_o$, J_o is the ionization of the beam particles), gray ($J > 1,4 J_o$, the kinetic energy of protons $T_p > 25$ Mev) and black ($T_p < 25$ Mev) tracks. The emission angles of all relativistic charged secondaries were measured carefully. The coherent events, which were analyzed separately in the paper [1] , were excluded in the present paper, except the cases specially noted.

II. Table 1 presents the mean multiplicities of various types of charged secondary particles in proton-nucleus interactions at 400 (this work) and 200 [2] Gev/c. One can see, that:

1. The mean multiplicities of heavily ionising particles ($\langle n_g \rangle$, $\langle n_b \rangle$, $\langle n_h \rangle$) within experimental uncertainties do not change in the interval 200-400 Gev/c.

2. The mean multiplicity of relativistic particles increases in the range 200-400 Gev/c, but the ratio

FERMILAB-PUB-77-150-E

$R = \langle n_s \rangle_{pA} / \langle n_{ch} \rangle_{pp}$, characterising the multiplication of particles in hadron-nucleus interactions, does not depend on energy in this range. This fact means that in the range 200-400 Gev/c the energy dependence of $\langle n_s \rangle_{pA}$ coincides exactly with that for $\langle n_{ch} \rangle_{pp}$.

Multiplicity distributions of heavy tracks (not shown here) are the same practically as at lower energies of the projectile [2] .

In Fig. 1a we plotted multiplicity distribution of relativistic particles in pA-interactions at 400 Gev/c and in Fig.1b this distribution is shown in the scaling variables. The stroked columns in the Fig. 1a show the contribution of one-, three- and five-prong coherent events in multiplicity distribution. The curve in Fig 1b represents the KNO-scaling function for p-nucleus interactions, the shape of which has been defined in the reference [2] from an analysis of experimental data. As it is seen from the Fig.1b, multiplicity in pA-collisions is consistent in the first approximation with the KNO-scaling law.

It is well known [3,4] that the KNO-scaling leads to the certain relations between moments of multiplicity distribution. Fig. 2a,b present dependences of the quantities $\sqrt[2]{\mu_2} = D$, $\sqrt[3]{\mu_3}$, $\sqrt[4]{\mu_4}$ ($\mu_K = \langle (n_s - \langle n_s \rangle) \rangle^K$) on the mean multiplicity of shower particles $\langle n_s \rangle$ (so called Wroblewski's plots). The data at lower energies in these plots were taken from the paper [5] . We see, that these quantities are the linear functions of $\langle n_s \rangle$; moreover the slopes of linear functions in pA-and pp-interactions are close to each other. This fact could be considered as an indication to the similarity of production mechanism in pA-and pp-collisions.

Finally, consider the energy dependence of normalized moments $C_k = \langle n_g^k \rangle / \langle n_g \rangle^k$ of multiplicity distribution, shown in Fig.3. One can see, that C_k do not depend on energy in the range 20-400 Gev/c and their values coincide with the moments in pp interactions.

In conclusion, we are glad to thank the managements of FNAL and Division of Nuclear Physics of the Academy of Sci. of USSR for the organisation of experiments. The help of prof.'s L.Voyvodic and I.V.Chavilo during the exposition of emulsion stacks is greatly acknowledged.

REFERENCES

1. AGMT collaboration, Lebedev Institute Preprint N , 1977
2. ALMT collaboration, Lebedev Institute Preprint # 9 , 1974
3. A.Wroblewski, Acta Phys.Polonica B4, 857, 1973
4. K.Moller, Nucl. Phys. B79,(1974) 1451
5. S.A.Azimov et al., Paper A6-3(446) presented at the XVIII Intern. Conf. on High Energy Physics, Tbilisi, 1976

Figure Captions

Fig. 1 - a) Multiplicity distribution of relativistic particles in pA-interactions at 400 Gev/c. The stroked regionscocorrespond to the contribution of coherent interactions;

b) n_s - distribution in scaling variables, the curve is taken from [2].

Fig. 2 - $\sqrt[2]{\mu_2} = D$ (a) and $\sqrt[3]{\mu_3}$, $\sqrt[4]{\mu_4}$ (b) as functions of $\langle n_s \rangle$. The solid lines are hand drawn fits to guide the eyes, the dotted line represents PP data.

Fig. 3 - The energy dependence of C_2, C_3 and C_4. The dotted lines correspond to pp data.

Table 1

Average multiplicities in p-nucleus interactions at 400 Gev/c and comparison of them with the 200 Gev/c data [2]

	$\langle n_s \rangle$	$\langle n_g \rangle$	$\langle n_b \rangle$	$\langle n_h \rangle$	R	
All pA events	15.5±0.3	2.8±0.1	4.9±0.2	7.7±0.3	1.72±0.04	this work
	13.6±0.2	2.48±0.08	4.79±0.12	7.26±0.19	1.77±0.03	200 Gev/c [2]
pA without coherent events	16.4±0.3	2.9±0.1	5.0±0.2	8.0±0.3	1.81±0.04	this work
	14.0±0.2	2.57±0.08	4.97±0.13	7.54±0.20	1.83+0.03	200 Gev/c [2]

FERMILAB-PUB-77-150-E

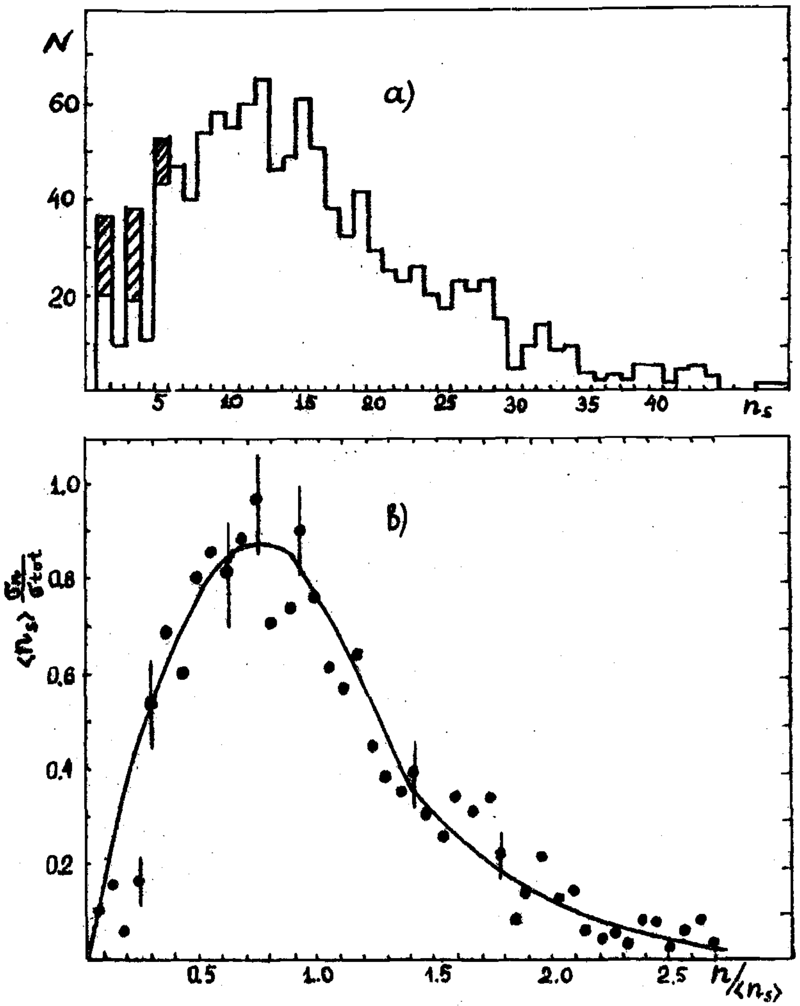

Fig.1

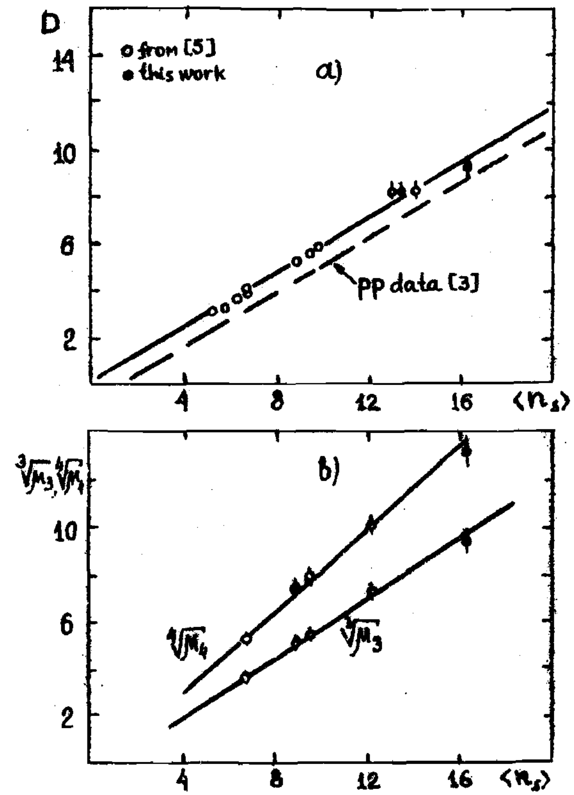

Fig. 2

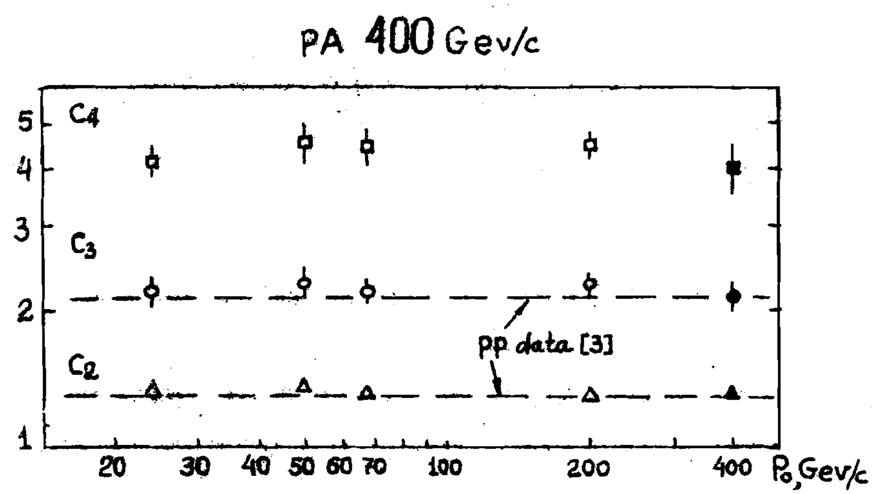
PA 400 Gev/c
C4
C3
C2
pp data [3]
5
4
3
2
1
20
30
40
50
60
70
100
200
400
P₀, Gev/c

Fig.3