объединенный
институт
ядерных
исследований
дубна

E2 - 12825

G.B.Alaverdyan, A.S.Pak, A.V.Tarasov,
Ch.Tseren, V.V.Uzhinsky

THE CORRELATION OF (n_s, n_g) PARTICLES IN HADRON-NUCLEUS INTERACTIONS

1979

E2 - 12825

G.B.Alaverdyan,[*] A.S.Pak,[**] A.V.Tarasov,
Ch.Tseren, V.V.Uzhinsky

THE CORRELATION OF (n_s, n_g) PARTICLES IN HADRON-NUCLEUS INTERACTIONS

Submitted to ЯФ

* Yerevan State University, Yerevan.
** IHEP, Academy of Science, Kazakh SSR, Alma-Ata.

Алавердян Г.Б. и др. **E2 - 12825**

Корреляция (n_s, n_g) -частиц в адрон-ядерных взаимодействиях

В рамках модели каскада лидирующей частицы рассмотрены корреляции для процессов соударения налетающего адрона с легкой (CNO) и тяжелой (AgBr) компонентами фотоэмульсии. Учитываются вклады квазиупругого рассеяния лидирующей частицы на ядре и неэффективности регистрации "антилидирующих" частиц. Расчеты дают удовлетворительное согласие с экспериментальными данными.

Работа выполнена в Лаборатории ядерных проблем ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1979

Alaverdian G.B. et al. **E2 - 12825**

The Correlation of (n_s, n_g) Particles in Hadron-Nucleus Interactions

The (n_s, n_g) correlations in the collisions of incident hadron with light (CNO) and heavy (AgBr) components of nuclear emulsion are considered in the framework of the cascade model of a leading particle.

The quasielastic scattering of a leading particle and the detection uneffectivity of "antileading" particles are taken into account.

The comparison of the calculation results with experimental data gives satisfactory agreement.

The investigations has been performed at the Laboratory of Nuclear Problems, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1979

I. INTRODUCTION

The majority of the experimental investigations of the inelastic hadron-nucleus (hA) collisions at high energies have been carried out by means of the nuclear emulsions. Only recently were here undertaken a series of experiments over the electron method studying some (mainly rapidity) characteristics of the particles produced in the hA-collisions. A noticeable share is also contributed by the experimental data, obtained over the chamber method.

Being aware of the photoemulsion method's drawbacks (mixing of the nuclei with largely different A numbers, comparatively small statistics) one should note its strong point-high angular and sometimes energetic resolution which enables reliable registration and identification of the low energy particles (more than 0.2 MeV).

Presently, however, the most complete data on the characteristics of the charged fragments (mainly protons) knocked out of the nuclei is obtained by the photoemulsion method. According to the length and density of their tracks the particles are divided into "black" (b-particles) of $p < 0.2$ GeV/c momentum and "grey" (g-particles), corresponding generally to the protons of 0.2 GeV/c $< p < 1$ GeV/c momentum. The particles of up to 20 MeV energy which are identified with the decay products of the nuclei excited by the interaction are referred to "black" particles. "Grey" particles are usually regarded as charged "antileading" particles, i.e., as protons emitted in the hadron-proton (hp) interactions and carrying approximately one half of the energy in the hp center of mass system or as protons knocked out by the charged and neutral "antileading" particles in their collisions with other intranuclear nucleons.

The mean energy of the "antileading" particles in the laboratory system is of the order of $(250 \div 300)$ MeV and energetically they are capable of knocking several g-protons out of the nucleus. In each concrete case the number of the knocked out particles depends on the dimentions of the nucleus, the "antileading" particle free-path length and the place of the interaction (the periphery or the center of the nucleus).

The number of such particles can be estimated more or less accurately only by modelling over the Monte Carlo Method. We are not determining the g-protons multiplication factor but we are trying to estimate using the experimental value of the factor the number of characteristics of the hA-interactions related in any way to g-particles.

The present paper discusses the following problems:

- the distribution according to the number of g-particles,
- the so-called (n_s, n_g) correlations,
- the shift of the shower particles (s-particles) rapidity distribution centers as the selection of events with a definite number of g-particles, and, lastly,
- the distribution moments of the shower particles at the fixed number of g-particles.

2. THE CORRELATION OF THE n_s, n_g PARTICLES FOR THE PROCESSES OF HADRON INTERACTIONS WITH THE PHOTOEMULSION'S LIGHT COMPONENT (CNO)

In the photoemulsion method there are some criteria (though not identical) for the distribution of events which correspond to the hadron interaction with the photoemulsion light (CNO) and heavy (AgBr) components.

It is known [1], that the g-particles' mean number (n_g) for the interaction with the photoemulsion light component only weakly depends on the energy of the incident hadron and equals approximately one half of the collision mean number ($\bar{\nu}$).

$$(\bar{n}_g)_L \approx 0.5\bar{\nu} = \frac{Z}{A}\bar{\nu} \qquad (1)$$

then for the photoemulsion heavy component

$$(\bar{n}_g)_H \approx \bar{\nu} = 2\frac{Z}{A}\bar{\nu}, \qquad (2)$$

where z is the number of protons; A , the number of nucleons.

Thus, the experimental data agree with the assumption that the g-particle multiplication does not occur in the photoemulsion light nuclei and that each "antileading" particle knocks, on the average, one nucleon out of the nucleus. Approximately one half of these nucleons are the protons. Such an assumption is, undoubtedly, rough for it does not take into account a number of the process specific properties. For example, the "antileading" particles from the central collisions and the ones from the peripheric collisions can multiply differently. Therefore the predictions of a thus simplified model can only claim to interpret quantitatively the experimental data.

Let us consider the distribution in the hadron - (CNO) interactions according to the number of g-particles. By the above assumption these particles are the charged recoil nucleons - the protons.

The natural generalization of the relation $W_\xi = N_\xi(\sigma, A)/N(0,\sigma)$, where $N_\xi(\sigma, A)$, $N(0,\sigma)$ - are the effective numbers [2], giving the probability of the leading particle ξ-fold collision with the nucleons in the nuclei is shown by the following expression

$$F(n_g=\xi) = W_\xi = \frac{1}{\sigma N(0,\sigma)} \binom{z}{\xi} \int \chi^\xi(b)\,[1-\chi(b)]^{z-\xi}\, d^2b\,, \qquad (3)$$

where $\chi(b) = \sigma T(b)/A$; $T(b)$, the thickness function; σ , the inelastic cross section of the hN-interaction. The relation (3) defines the probability of the hadron interaction with the ξ protons irrespective of the number of its interaction with the neutrons. To include the probability of hadron's interaction with the ξ protons and η neutrons the expression

$$W_{\xi,\eta} = \frac{1}{\sigma N(0,\sigma)} \binom{z}{\xi}\binom{N}{\eta} \int \chi^{\xi+\eta}(b)[1-\chi(b)]^{z+N-\xi-\eta}\, d^2b \quad (4)$$

can be written with the conditions

$$\sum_{\xi+\eta=\nu} W_{\xi,\eta} = W_\nu\,, \qquad \sum_{\xi+\eta\geq 1} W_{\xi,\eta} = 1\,.$$

The expression (4) is the probability of the g-particles under the condition that the "antileading" particles do not multiply in the nucleus and are not absorbed by it.

Let us define the probability of finding no charged particles as

$$F(n_g=0) = \sum_{\eta=1}^{N} W_{0,\eta} = \int \{[1-\chi(b)]^{z} - [1-\chi(b)]^{N+z}\} \frac{d^2 b}{\sigma N(0,\sigma)} . \qquad (5)$$

In fig.1 the $F(n_g)$ distributions, calculated by formulae (3) and (5) are compared with the experimental data[3] for the emulsion effective light nucleus $N(A=14)$.

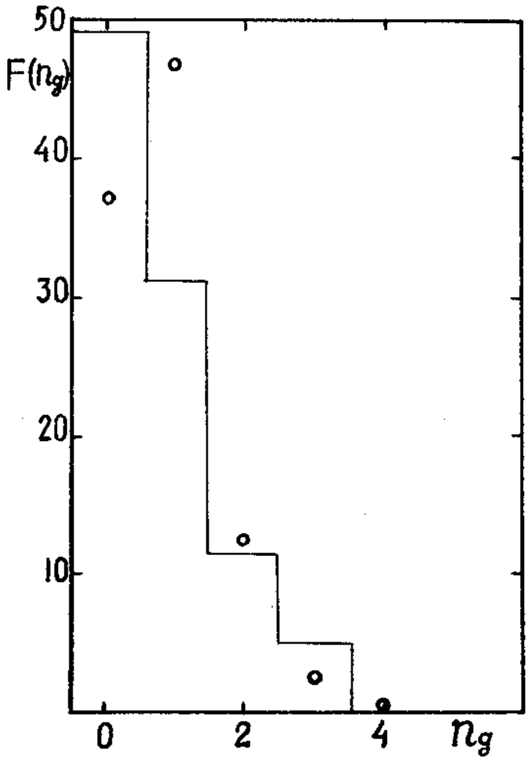

Fig.1. g -particles distribution in pA collisions. Points are the results of calculations by expressions (4) and (5) at A =14; the experimental data of ref.[3] about p-(CNO) interactions at p = = 200 GeV/c represents by the hystogram.

It is evident that upon the whole the model reflects correctly the ratio of the probability for the number of g-particles $n_g \geq 1$ and gives a decreased value for $F(n_g=0)$.

Besides the purely methodic uncertainties related to the separation of events from the light and heavy nuclei and being, possibly, one of the reasons for the difference of the calculations from the data- there can be other possible reasons.

First of all it is necessary to note that the "stars" in which we observe neither g-particles nor s-particles but b-particles only - are also referred to the inelastic events and are identified with the (pion) neutral particles' production processes at the interaction of hadrons with the nucleus neutrons. These events can be imitated by the processes of the quasielastic scattering of the leading hadron on the nucleus which causes the excitation of the nucleus. The excited nucleus starts emitting the slow (low speed) b-protons. The cross section of such processes makes for the emulsion light component 9% out of the "truly" inelastic processes taking place together with the particle production. It can noticeably increase the observed probability of the process in which no g-particles but b-particles only are emitted.

Besides it is evident, that not all of the charged "antileading" particles are identified with g-particles. Though, as it was already mentioned, their mean energy is of the order 250 MeV, some of them are mistaken for b-particles with $P_{lab.} < 0.26$ GeV/c due to the energy loss fluctuations.

It is easy to find out that for the collisions of the relativistic hadrons with the nuclei

$$P_{lab} \cong m_N \frac{1 - X^2_{c.m.}}{2\,|X_{c.m.}|}, \qquad (6)$$

where $X_{c.m.}$ is the part of the energy in the centre of mass system, which is carried away by the "antileading" particle after the collisions. From the condition $P_{lab} <$ < 0.2 GeV/c it follows that $|X_{c.m}| \geq 0.8$. The share of such particles flactuates from 15% to 20% depending on the value of the inelasticity coefficient(K_N) in the hN-collision.

Besides it is necessary to take into account that on losing the energy the particles(produced in the interaction) with a slightly greater momentum also get into the kinematic region corresponding to b-particles. Thus it is possible to make a conclusion that the P probability of identifying an "antileading" particle does not exceed 80%. Taking both these effects into account (the contribution of the quasi-elastic scattering and the inefficiency of the "antileading" particles registration) we get for the probability of the k of g-particles observation the following expression

$$F(n_g = k) = \frac{1}{1+\delta} \sum_{\xi=k}^{z} \binom{\xi}{k} W_\xi = \frac{1}{1+\delta} \frac{1}{\sigma N(0,\sigma)} \binom{z}{k} * \\ * \int [P\chi(b)]^k [1 - P\chi(b)]^{z-k} d^2 b, \tag{7}$$

where

$$\delta = \sigma^{qel}_{hA} / \sigma^{in}_{hA}, \quad \sigma^{qel}_{hA} = \sigma_t N(0,\sigma_t) - \sigma^{in}_{hA}, \quad \sigma^{in}_{hA} = \sigma N(0,\sigma).$$

And for the probability of finding not a single g-particle

$$F(n_g = 0) = \frac{1}{1+\delta} \{ \delta + \frac{\int [(1 - P\chi(b))^z - (1-\chi(b))^{z+N}] d^2 b}{\sigma N(0,\sigma)} \}. \tag{8}$$

Figure 2 shows that the calculations by the more precise formula is in a better agreement with the experimental data. The value $P = 0.85$ represents to some extent the upper limit for the probability of the charge "antileading" particle identification with a g-particle. The P value is decreased by the effects of its deceleration in the nucleus. It is impossible to take these effects into account. By selecting the expressions (7) and (8) so that they could describe correctly the ratio of $F(n_g = 0)$ to $F(n_g = 1)$ (the most precisely measured values) we get $P = 0.8$. Let us note this value and proceed to the discussion of s-particle characteristics from the events in which the k of g-particles is simultaneously observed. The simplest of these "so-called" $(\bar{n}_s, n_g)$ -correlations is the mean multiplicity value $\bar{n}_s$ at the fixed number of g-particles (n_g).

It is evident that in the calculation of this value it is necessary to take into account not only the particles produced in the hadron's collision with the proton but also the ones produced in the hadron's collision with the neutrons of the nucleus.

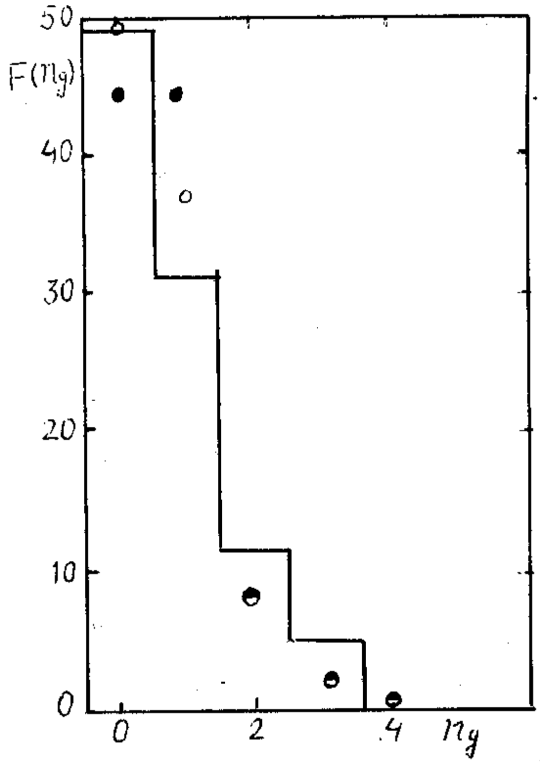

Fig.2. The same as in fig.1 but with and without quasielastic scattering contribution (light and black points respectively). The probability of "antileading" particles detection was taken equal to P = 0.85.

On taking into account the ratio for the number of particles, produced in the ν-fold collision of the leading hadron

$$\bar{n}_s^{(\nu)} = \bar{n}_{hN}(1-a^{\nu})/(1-a), \qquad (9)$$

where $\bar{n}_{hN} \sim (E/E_0)^{\alpha}$ is the mean number of particles produced in the hN collision; E is the energy of the incident hadron; E_0, the scale parameter; $a = f^{\alpha}$; f , the part of the energy which is carried away by the leading particle after its inelastic collision with the intranuclear nucleons, we obtain

$$\bar{n}_s(n_g = k) = \sum_{\xi+\eta\geq k} W_{\xi,\eta} \, (\bar{n}_s)_{\xi+\eta} \, P^k (1-P)^{\xi-k} \binom{\xi}{k} / [W_k (1+\delta)] =$$

$$= \frac{\bar{n}_{hN}}{1-a} \Big\{ 1 - \frac{\int [aP\chi(b)]^k [1-\chi(b)(1-(1-P)a)]^{z-k} [1-\chi(b)(1-a)]^N d^2 b}{\int [\chi(b)P]^k [1-\chi(b)P]^{z-k} d^2 b} \Big\} \quad (10)$$

$$\bar{n}_s(n_g = 0) = \sum_{\xi+\eta\geq 1} W_{\xi,\eta} \, (\bar{n}_s)_{\xi+\eta} \, (1-P)^{\xi} / [W_0 (1+\delta)] =$$

$$= \frac{\bar{n}_{hN}}{1-a} \; \frac{\int [(1-\chi(b)P)^z - (1-\chi(b)+a\chi(b)-aP\chi(b))^z (1-\chi(b)+a\chi(b))^N] d^2 b}{\int [(1-P\chi(b))^z - (1-\chi(b))^A] d^2 b + \delta\sigma N(0,\sigma)} \quad (11)$$

Figure 3 compares the results of the calculation by (10) and (11) formula with the experimental data [4] on p-(CNO)-interaction at 70 GeV. The agreement can be regarded as satisfactory if one takes into account the uncertainty in the calculation of the $F(n_g = k)$ values.

By substituting the value $\bar{n}_s^{(\nu)}$ is (9) by the value $\frac{dn^{(\nu)}}{dy} = \sum_{i=1}^{\nu} \frac{dn}{dy}(E_i)$ we get the expression for the rapidity distribution of s-particles at the fixed values n_g. Since the selection of a definite number of the recoil nucleons (g-particles) excludes automatically the collisions with $\nu < k$, the following properties of the s-particle rapidity distributions become evident at the fixed n_g value.

1. The rapidity distribution centers of mass at $n_g \geq 2$ should be more shifted towards the smaller rapidities than the rapidity distribution centers of mass in the hA-interactions, averaged by $\bar{\nu}$. For $n_g=0$ they should be less shifted towards the smaller rapidities.

2. The ratio of the rapidity distributions in the hA-interactions at the fixed n_g to the rapidity distribution in the hN-collisions, i.e., $R_y(n_g) = (\frac{dn}{dy})_{hA}(n_g)/(\frac{dn}{dy})_{hN}$

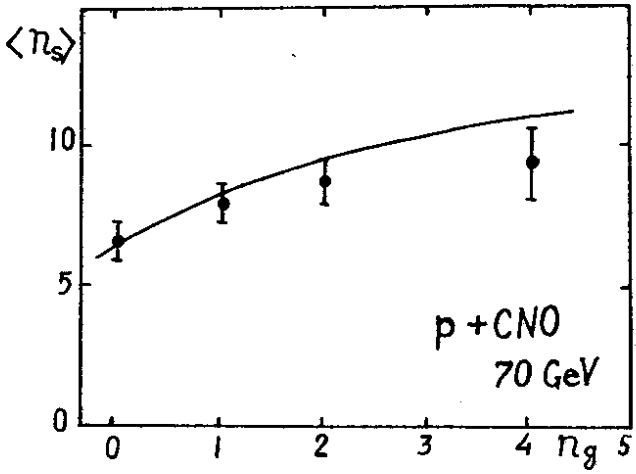

Fig.3. (n_s, n_g) -correlation in p-CNO interactions. Points - experimental data of ref. [4] at $E_p = 70$ GeV. The curve is result of calculation by expressions (10) and (11).

in the target fragmentation region ($y \approx 0$), defined by the mean number of collisions, is greater than the corresponding ratio in the hA-, hN-collisions, i.e., $R_y = (\frac{dn}{dy})_{hA} / (\frac{dn}{dy})_{hN}$ at $n_g \geq 1$ and is smaller at $n_g = 0$.

If you introduce the value $R_A(n_g) = \bar{n}_s(n_g) / \bar{n}_{hN}$ as a function of the α parameter (see formulae (9)) the shifting of the rapidity distribution center of mass $(\frac{dn}{dy})_{hA}(n_g)$ is defined with respect to $(\frac{dn}{dy})_{hN}$ as

$$\Delta \bar{y}(n_g) = \bar{y}_{hA}(n_g) - \bar{y}_{hN} = \frac{1}{2} \frac{\partial}{\partial \alpha} \ln R_A(n_g) . \qquad (12)$$

To exclude the uncertainties related to taking into account the effects of the nucleons intranuclear motion it is convenient to compare the calculated and the experimental values of the quantities

$$\frac{R_y(n_g)|_{y \approx 0}}{R_y|_{y \approx 0}} ,$$

where

$$R_y(n_g)|_{y\sim 0} = [(\frac{dn}{dy})(n_g)/(\frac{dn}{dy})_{hN}]|_{y\sim 0} = R_A(n_g)_{\alpha=0} \quad (13)$$

Figures 4 and 5 represent the calculations of the quantities

$$r_1 = \frac{\bar{y}_{hA}(n_g) - \bar{y}_{hN}}{\bar{y}_{hA} - \bar{y}_{hN}} \quad \text{and} \quad r_2 = \frac{R_y(n_g)|_{y\sim 0}}{R_y|_{y\sim 0}} \quad (14)$$

and the quantity r_2 is compared to the experimental data[1,4] for πA- and pA-interactions at E =200 GeV and fixed number of g-particles. It is evident that the agreement is satisfactory.

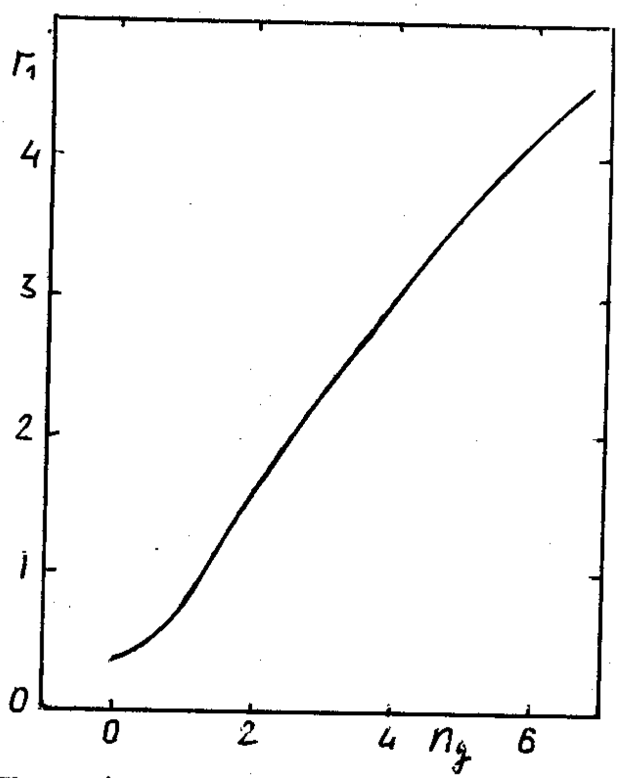

Fig.4. The ratio r_1 calculated by expression (14) as a function of n_g.

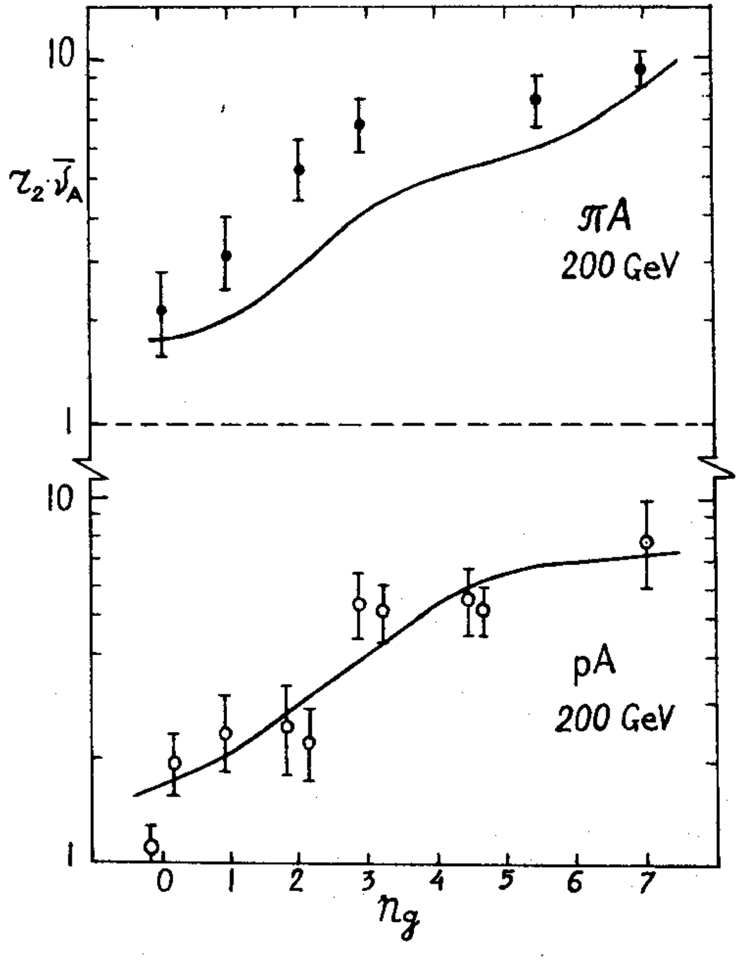

Fig.5. The comparison of calculation results of $r_2\bar{\nu}_{EM}$ with experimental data [1,5] about π- EM and p-EM interactions at p_0 = 200 GeV/c.

3. THE CORRELATION OF n_s, n_g -PARTICLES FOR THE PHOTOEMULSION HEAVY COMPONENT

The processes of the "antileading" particle multiplication are possible in the photoemulsion heavy nuclei (AgBr) due to their big dimensions.

The present consideration is carried under the assumption that each "antileading" particle can have not more than one collision with the nucleons of the nuclei resulting in their knocking out. The charged products of such a reaction are identified as the g-particles if their energy exceeds 20 MeV.

Assuming for the sake of simplicity that a collision of an "antileading" particle with the resting nucleon results in the equal distribution of energy between the collision products, we obtain that only the "antileading" particles with the kinetic energy $T \geq 40$ MeV ($P_{lab} \geq 0.36$ GeV/c) can cause the formation of g-particles.

It is not difficult to notice that the "antileading" particles, preserving in the center of mass system not more than $X = 0.7$ of the initial energy (the probability of which equals $P = X^{1+\beta} \approx 0.7-0.8$) satisfy this condition.

Actually the "threshould" energy $T \geq 40$ MeV can shift towards bigger values due to the losses of energy in the nucleus excitation. Thus the real share of the "antileading" particles, responsible for the appearance of the g-particles can be somewhat smaller.

Later on these values are varied to ensure the better agreement of the calculation with the experiment.

The distribution by the number of the protons and neutrons produced in the hA-interactions and capable of further production of g-particles is equal, evidently, to

$$\tilde{W}_{\xi,\eta} = \frac{1}{\sigma N(0,\sigma)} \frac{1}{1+\delta} \binom{z}{\xi}\binom{N}{\eta} \int \chi_p^{\xi+\eta} (1-\chi_p)^{N+z-\xi-\eta} d^2 b, \quad (15)$$

where

$$\chi_p = P\chi(b) = PT(b)/A.$$

Since the cross sections of the pp- and pn-interactions at low energies (of the order of several tens of MeV) are different, the probabilities of knocking out the g-protons by protons and neutrons are also different. We show these probabilities through W_{pp} and W_{pn} respectively.

It is evident that the probability of detecting k of g-particles is expressed through the quantities (15) W_{pp} and W_{pn}.

Thus

$$F(n_g=k) = \sum_{\substack{\ell, m \\ \xi \geq \ell, \eta \geq m}} \binom{\xi}{\ell}\binom{\eta}{m} W_{pp}^{\ell}(1-W_{pp})^{\xi-\ell} W_{pn}^{m}(1-W_{pn})^{\eta-m} \times \tag{16}$$

$$\times W_{\xi\eta}\,\delta_{k,\xi+\ell+m} .$$

In eq. (16) m is the number of g-protons knocked out by an "antileading" neutron; ℓ the number of g-particles knocked out by an "antileading" proton; ξ , the number of charged "antileading" particles with $p > 0.3$ GeV/c produced in the incident hadron collision with the nucleus; η is the number of neutral "antileading" particles.

For $\eta \ll z, N$ from (16) we obtain

$$F(n_g=k) = \sum_{\ell=0}^{[k/2]} \int d^2b \frac{(zW_{pp}\chi_p)^{\ell}\,[(1-W_{pp})z\chi_p + NW_{pn}\chi_p]^{k-2\ell}}{\sigma N(0,\sigma)\,\ell!\,(k-2\ell)!} * \tag{17}$$

$$* \exp\{-(z+NW_{pn})\chi_p\}$$

$$F(n_g=0) = \frac{1}{\sigma N(0,\sigma)} \int [e^{-(z+NW_{pn})\chi_p} - e^{-A\chi(b)}]\,d^2b. \tag{18}$$

Assuming that there takes place only one collision of the "antileading" particle with the nucleons of the nuclei due to the charge symmetry we must get $W_{pn} = 1 - W_{pp}$.

The distribution by the number of g-particles, calculated according to formulae (17) and (18) is in its best agreement with the experimantal data at $P=0.75$, $W_{pp} = 0.5$. This result if given in Figure 6. The quantity $R_A(n_g) = \bar{n}_s(n_g)/\bar{n}_{hN}$ is shown by the expression.

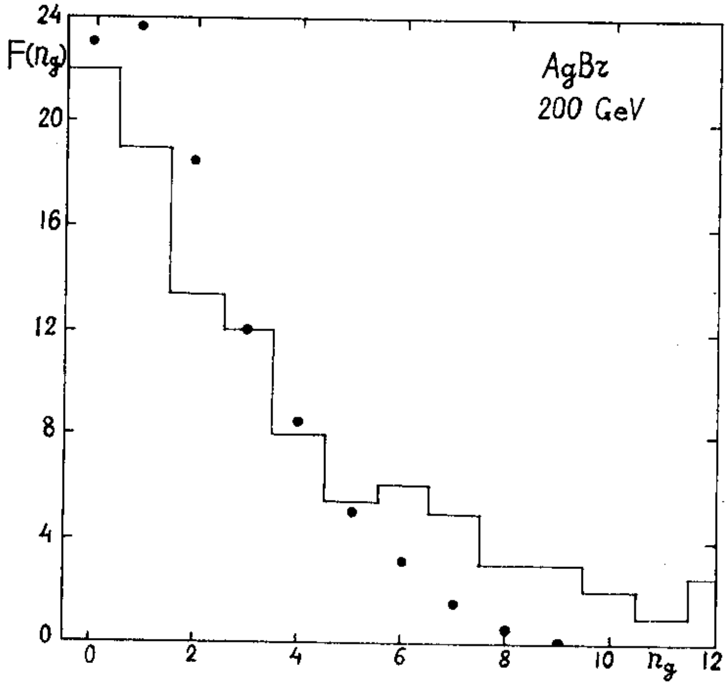

Fig.6. g-particle distributions in p-AgBr interactions at P_0 = 200 GeV/c. The hystogram presents the experimental data [1,5]. The calculation results by expression (17) and (18) are presented by points.

$$R_A(n_g=k)=$$

$$=\frac{1}{1-a}\Big\{1-\frac{\sum_{\ell=0}^{[k/2]}\int (zW_{pp}\chi_p a)^{\ell}\,[W_{pn}z\chi_p a+Na\chi_p W_{pp}]^{k-2\ell}/[\ell!(k-2\ell)!]}{\sum_{\ell=0}^{[k/2]}\int (zW_{pp}\chi_p)^{\ell}\,[W_{pn}z\chi_p+N\chi_p W_{pp}]^{k-2\ell}/[\ell!(k-2\ell)!]}\;* \qquad (19)$$

$$*\;\frac{\exp[(1-W_{pn})Na\chi_p-A(1-(1-P)a)\chi(b)]\,d^2b}{\exp[(1-W_{pn})N\chi_p-A\chi_p]\,d^2b}\Big\}$$

$$R_A(n_g=0) = \frac{1}{1-a}\{1 - \frac{\int[e^{W_{pp} N a \chi_p - A(1-(1-P)a)\chi(b)} - e^{-A\chi(b)}]d^2b}{\int[e^{-(z+NW_{pn})\chi_p} - e^{A\chi(b)}]d^2b}\}. \quad (20)$$

The calculated values for the quantities (19) and (20) are compared in Fig.7 with the experimental data [4] for p-(AgBr) interaction at $E_p = 70$ GeV.

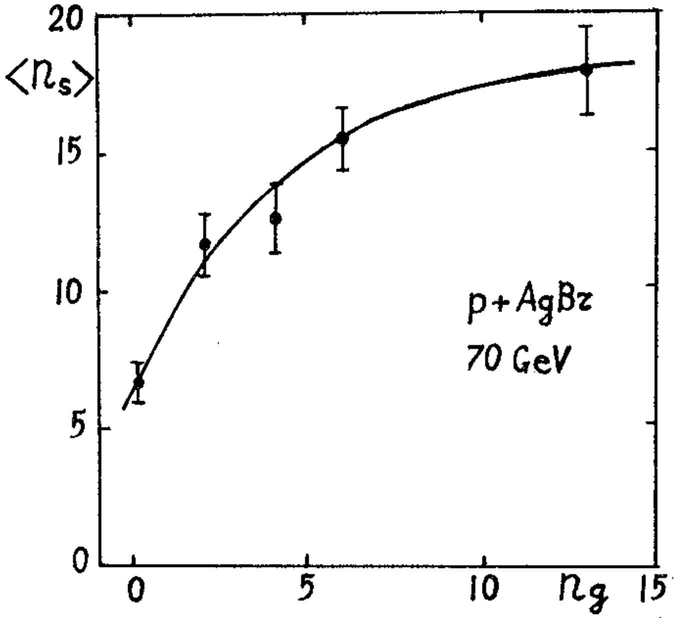

Fig.7. The comparison of experimental data [4] about p-(AgBr) interactions at $E_p = 70$ GeV with the values calculated by expressions (19) and (20).

The model reproduced qualitatively the dependence of the mean number of produced shower particles on the number of the observed g-particles. Knowing about the obvious dependence of the quantity $R_A(n_g)$ on $a = f^{\alpha}$ one can determin like in the previous item

a) the shift of the rapidity distributions' centers of mass of the s-particles at fixed n_g, i.e.,

$$\Delta\bar{y}(n_g) = \frac{\partial}{\partial\alpha}\ln R_A(n_g),$$

b) the value of $R_y(n_g)$ in the target fragmentation region $R_y(n_g)|_{y\sim 0} = R_A(n_g)|_{\alpha=0}$,

c) the values of the highest normalized moments of distribution according to the number of produced s-particles (at the fixed number of g-particles).

The authors are thankful to K.G.Gulamov, L.I.Lapidus and G.M.Chernov for some useful discussions.

One of us (A.S.P.) would like to thank Dz.S.Takibayev for his interest in the work and continuous support.

REFERENCES

1. Gulamov K.G., Gulyamov U.G., Chernov G.M. Elem.chastits. at.yadra, 1978, Dubna, 9. p.554.
2. Kolbig K.S., Margolis B. Nucl.Phys.,1968, B6, p.85.
3. A-A-L-M-T collaboration. Prep. FIAN 1974, No.9; Yad.fiz., 1975, 22, p.730.
4. Abdo K.M., et al. Prep. JINR, 1974, E1-8021.
5. Azimov S.A., et al. Yad.fiz., 1977, 26, p.346; A-A-L-M-T collaboration. Yad.fiz. 1978, 27, p.1011; Yad.fiz. 1978, 28, p.697.

Received by Publishing Department
on October 3 1979.