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STUDY OF THE PARTICLE PRODUCTION PROCESS USING NUCLEAR TARGETS

II. Experimental Testing, Intermediate Objects

1981

1. INTRODUCTION

In the studies of the particle production process in hadron-nucleon collisions at energies of a few GeV, applying the target-nuclei as detectors [1], some features of it have been revealed which allowed to put forward, in part I of this work, following working hypothesis: the particle production process in hadron-nucleon collisions proceeds through an object which decays after some lifetime into the commonly observed in experiments "produced" particles; we called this object preliminarily the intermediate object. The subject matter of this II part is: a) to put to an experimental test the consequences of this hypothesis detectable in hadron-nucleus collision experiments; b) a description of this intermediate object, if it exists in the nature.

It has been shown that in hadron-nucleus collision some number $m=0,1,2,3,..$ of such intermediate objects may be emitted from the target-nucleus [2]. The main consequence is, therefore, that the observed in the hadron-nucleus collisions at a given incident hadron energy E_h characteristics of the particle production process - the particle multiplicity distribitions, angular distributions, energy spectra, etc., - are the compositions of $m=1,2,3,..$corresponding statistically independent characteristics observed in hadron-nucleon collisions at incident hadron energy in average of E_h/m.

The quantity m is defined by the expressions (4) and (5), in part I, in which the hadron-nucleon collision mean free path $<\lambda_0>$ and the nuclear matter layer thickness λ which incident hadron has to overcome, if collides with a given target-nucleus at a definite impact parameter b, are used. Both the quantities are experimentally determined [3,4]: the $<\lambda_0>$, by corresponding hadron-nucleon collision cross-section [2,3,4] at the incident hadron energy E_h; the λ, by the target-nucleus size and nucleon density distribution in it, part I and former our works [2-4].

It has been shown that the nuclear matter layer thickness λ is related to the multiplicity n_p of emitted protons in the hadron-nucleus collisions as [2-4] $\lambda = n_p$, on the basis of expression (1) in part I, if λ is expressed in the number of protons per the area $\pi D_0^2 = \pi \cdot 1.81^2 f^2$.

The characteristics of the particle production process in the hadron-nucleon collisions are known well from various experiments and many can be taken from the HERA tables [5], for example.

The simple relations between characteristics of the hadron-nucleus collisions and corresponding characteristics of the hadron-nucleon collisions, being the consequence of our working hypothesis, do not contain any free parameters, part I and former our papers [2]. Thus, we are able to predict various characteristics of the particle production process in hadron-nucleus collisions, using appropriate data on the elementary hadron-nucleon collisions, and to test them accurately in corresponding hadron-nucleus experiments.

The following section will deal at length with such experimental testing.

2. TESTING OF THE WORKING HYPOTHESIS

We intend to confront the existing hadron-nucleus collision data with corresponding predictions being the consequence of our working hypothesis put forward in part I. Let us start with the produced particle mean multiplicities.

2.1. Produced Particle Mean Multiplicities

It has become conventional to present data on the produced particle multiplicities in hadron-nucleus collisions in terms of few parameters [6]. These parameters unfortunately in the literature are not used very consistently. It shall be usefull to define them now in a way I consider most convenient for the interpretation of the experimental data.

A measure of the average multiplication of particles inside a nucleus is given by

$$R_A = \frac{\langle n\rangle_{hA}}{\langle n\rangle_{hp}}, \tag{1}$$

where $\langle n\rangle_{hA}$ is the average number of produced particles in an inelastic and incoherent interaction between a hadron h and nucleus A; $\langle n\rangle_{hp}$ is the average number of particles produced in an inelastic collision of the same hadron with a proton. The quantities $\langle n\rangle_{hA}$ and $\langle n\rangle_{hp}$ can be treated as the average numbers of produced pions or as the average numbers of charged relativistic particles, of the velocity $\beta > 0{,}7$, observed in experiments. In emulsion- and electronic-technique-made experiments they are referred to as $\langle n_s\rangle$, the "s" is for "shower particles". In many experiments, for example in the bubble chamber experiments, produced pions of any electric charge are identified well with an efficiency closed to 100%.

From the working hypothesis, part I, follows that, using formulas (1) and (5) from the part I, the quantity R_A can be rewritten as:

$$R_A = \langle m \rangle \frac{\langle n(\frac{E_h}{\langle m \rangle}) \rangle_{hp}}{\langle n(E_h) \rangle_{hp}} . \qquad (1')$$

The average multiplicity of produced particles $\langle n(E_h) \rangle_{hp}$ changes not by much with the projectile energy E_h; for example, it increases proportionally nearly 5 times only, if E_h increases 1000 times[7]. Usually the value of $\langle m \rangle$ is no larger than 3, then $\langle n(E_h) \rangle_{hp}$ and $\langle n(\frac{E_h}{m}) \rangle_{hp}$ can be treated practically to be equal one to another at any E_h. Using formula (5), part I, for the quantity $\langle m \rangle$, it can be written, therefore

$$R_A = e^{\frac{\langle \lambda \rangle}{\langle \lambda_0 \rangle}} , \qquad (1'')$$

R_A is E_h- and A-dependent quantity, because the mean free path $\langle \lambda_0 \rangle$ is E_h-dependent quantity and the average nuclear matter layer thickness $\langle \lambda \rangle$ is A-dependent quantity [3,4].

The proton multiplicity n_p-dependent average multiplicity $\langle n \rangle_{hA}$ of the produced particles in hadron-nucleus collisions

$$\langle n \rangle_{hA} = f_1(n_p) \qquad (2)$$

is expressed, within the frames of our working hypothesis,as:

$$\langle n(E_h) \rangle_{hA} = \langle m \rangle \langle n(\frac{E_h}{\langle m \rangle}) \rangle_{hp} , \qquad (3)$$

as it has been shown in part I and in our former papers[2]; $\langle n(E_h) \rangle_{hA}$ and $\langle n(\frac{E_h}{m}) \rangle_{hp}$ are quantities $\langle n \rangle_{hA}$ and $\langle n \rangle_{hp}$, defined above, at incident hadron energies E_h and $E_h/\langle m \rangle$ correspondingly; $\langle m \rangle$ is defined by formula (5) in part I.

In fig.1 the quantity R_A for the pion-xenon nucleus collisions at 2.34-8 GeV/c momentum, determined by K.Miller, T.Pawlak, W.Peryt, J.Pluta, Z.Strugalski and K.Wosinska in the 26 and 180 litre xenon bubble chambers[8], is shown; solid line presents the R_A dependence on the incident pion momentum P_π predicted by formula (1'). In fig.2 the quantity $R_A = R_{Em}$ is

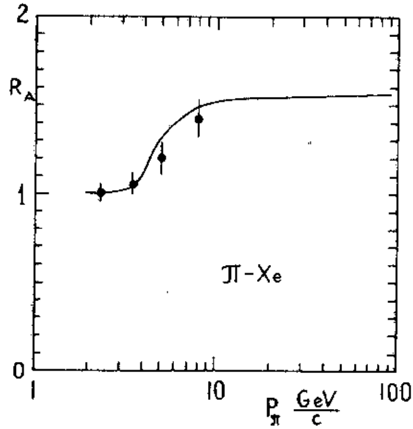


Fig.1. Incident pion momentum P_π -dependence of the produced pion average multiplication for the pion-xenon nucleus collisions. The solid line superimposed on the experimental data is calculated using formula (1′).

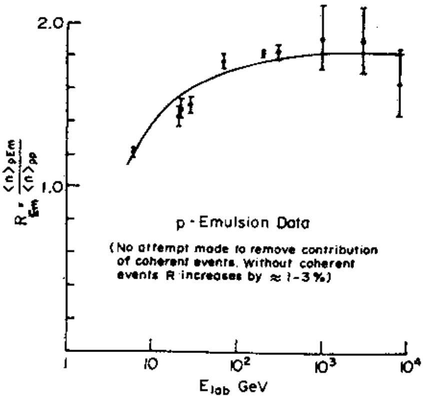


Fig.2. Incident proton energy E_{lab}-dependence of the quantity $R_A = R_{Em}$ for the proton-nucleus collisions in photonuclear emulsions. The solid line superimposed on the experimental data /6/ is calculated using formula (1′).

presented for the proton-nucleus collisions in photonuclear emulsions at various incident proton energies $E_h = E_{lab}$. Experimental data are taken from the Busza's review /6/; solid line is predicted by formula (1′). It should be stated that the energy-dependence of the quantity R_A is described well quantitatively by our formula (1′).

The A-dependence of the quantity R_A for the proton-nucleus and pion-nucleus collisions at various incident hadron momenta is presented in fig.3. One can conclude that formula (1′) describes quantitatively the experimental data for various nuclei at incident pion and proton momenta 50, 100 and 200 GeV/c.

The proton multiplicity n_p-dependences of produced pion average multiplicities $\langle n_\pi(n_p)\rangle$ in pion-xenon nucleus collisions at various incident pion momenta, from 2.34-8 GeV/c, are shown in fig.4. Experimental data, a), are the result of investigations performed by K.Miller et al.; predictions, b), are given by formula (3). In calculations values of the quantities $\langle n(\frac{E_h}{\langle m\rangle})\rangle_{hN}$ in hadron-nucleon collisions at $E_h/\langle m\rangle$ incident hadron energies are taken from the pion-xenon nucleus col-

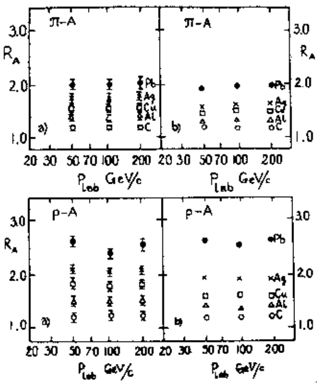


Fig.3. Incident hadron momentum P_{lab} - dependence of the produced particle multiplication R_A in C , Al , Cu , Ag and Pb nuclei: a) experimental data[6]; b) predictions given by formula (1′).

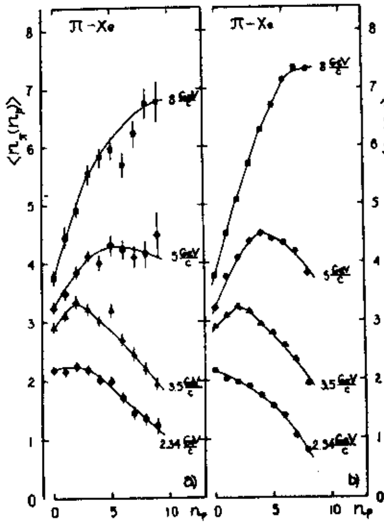


Fig.4. Proton multiplicity n_p - dependence of the produced pion average multiplicities $\langle n_\pi(n_p)\rangle$ in pion-xenon nucleus collisions at various incident pion momenta: a) experimental data; b) predictions given by formula (3). Solid lines are eye guided.

lisions with $n_p=0$;it can be proved that such values are in fact equal corresponding data from the elementary hadron-nucleon collisions.

The gray-track-producing particle multiplicity N_g-dependences of the produced shower particle average multiplicity $\langle N_s\rangle$ in the pion-nucleus collisions at 20 and 37 GeV/c incident pion momenta, for various nuclear targets, are shown in fig.5, in its upper part[9]; corresponding n_p -dependences of the produced pion average multiplicities $\langle n_\pi\rangle$, at the same incident pion energies and for the same target-nuclei, predicted by formula (3), are presented in fig.5 as well, in its lower part. It can be stated quantitative agreement of the experimental data with the predictions given by formula.

Similar dependences of the average multiplicity of the shower particles $\langle n_s\rangle$ on the number N_g of the gray-track-producing particles for the pion-nucleus and proton-nucleus collisions in photonuclear emulsions at 200 GeV energy of the incident particles[10] are shown in fig.6. Solid and dotted lines are calculated by formula (3); they describe quantitatively the experimental data as well.

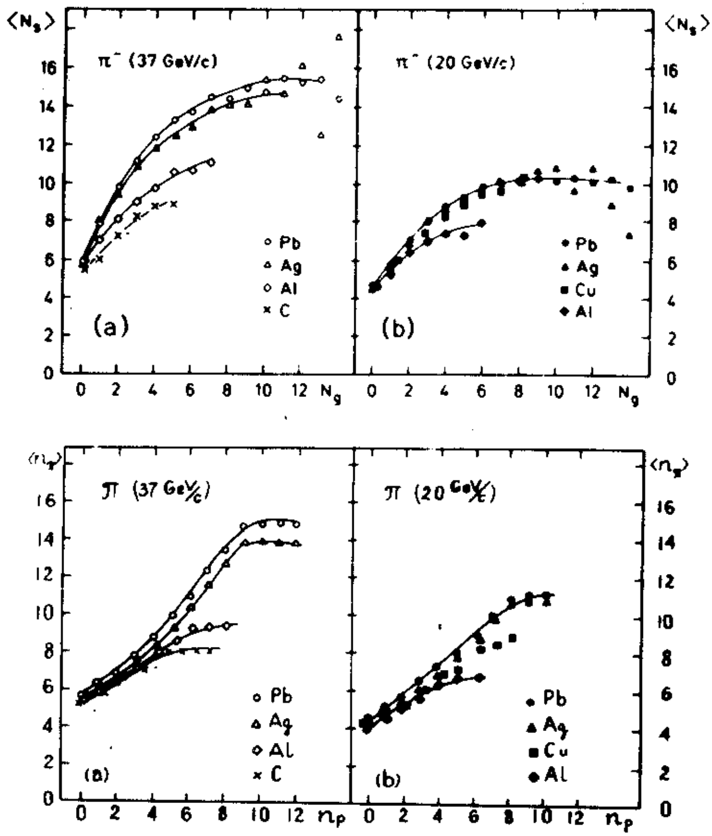


Fig.5. Dependences of the mean number $<N_s>$ of fast particles on the number N_g of slow particles in pion-nucleus collisions at 20 and 37 GeV/c momentum for various target nuclei, from the experiment of Faessler et al./9/, upper pictures. Corresponding dependences of the mean number $<n_\pi>$ of produced charged pions on the emitted proton multiplicity n_p predicted by formula (3), lower, pictures. Lines are drawn to guide the eye.

2.2. Produced Particle Multiplicity Distributions

The number N_p of produced particles, called particle multiplicity, in particular the number n_π of produced pions or the number n_s of produced "shower" particles characterizes the particle production intensity. The intensity distribution is de-

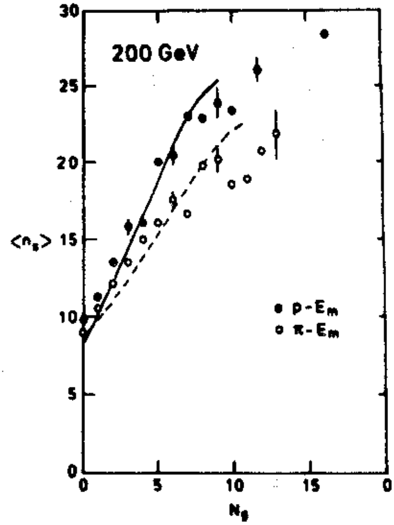


Fig.6. Dependence of the mean number $\langle n_s \rangle$ of fast particles on the number N_g of slow particles, in pion-nucleus and proton-nucleus collisions registered in photonuclear emulsions at 200 GeV energy of incident hadrons /10/. Solid line is calculated using formula (3) for the proton-nucleus collisions for an average nucleus of $A = 66.6$ and $Z = 29.3$; dotted line is calculated for collisions of pions with the same average target-nucleus.

fined usually as the frequency $f(N_p, A, E_h)$ of events versus the number N_p of produced particles, when a hadron of an energy E_h collides with a target-nucleus of the mass-number A.

Within the frames of our working hypothesis this frequency can be expressed as /2/:

$$f(N_p, A, E_h) = e^{-\frac{\langle\lambda\rangle}{\langle\lambda_0\rangle}} \sum_{m=1}^{m=k} \left(1 - e^{-\frac{\langle\lambda\rangle}{\langle\lambda_0\rangle}}\right)^{m-1} p_m(N_p), \tag{4}$$

where the meaning of the symbols used: m , $\langle\lambda\rangle$, $\langle\lambda_0\rangle$ is as above. The term $p_m(N_p)$ is the probability to appear N_p produced particles if m intermediate states decay "simultaneously"; it is determined by the probabilities $p(u)$, $p(v)$, $p(w)$,... for appearance of u , v , w,... particles in decaying each of intermediate objects created in hadron-nucleon collisions /2/; they can be taken from hadron-nucleon collision experiments at E_h/m energy.

In order to test formula (4), being the consequence of our working hypothesis, a series of frequencies $f(n_s) = f(N_p, A, E_h)$ has been calculated for C , Al , Cu , Ag and Pb nuclei at $E_h = 40$ GeV/c momentum /2/, corresponding experimental data exist at $P_h = 37.5$ GeV/c momentum /9/. In calculations only $k=3$ terms in formula (4) were taken into account /2/. Results are presented in fig.7. It should be concluded that formula (4) reconstructs qualitatively well the series of corresponding frequencies received in the Faessler et al. experiment /9/; the quan-

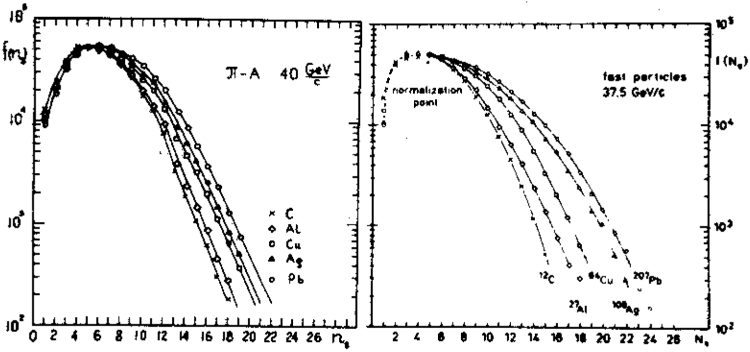


Fig.7. Frequency $f(n_s) = f(N_p, A, E_h)$ of the pion-nucleus collision events with the multiplicity $n_\pi = n_s = N_p$ of produced pions, predicted by formula (4) - left; frequency $f(n_s) = f(N_s)$ of the pion-nucleus collision events with the multiplicity $N_p = N_s$ of observed produced shower particles, from the experiment of Faessler et al. /9/ - right.

titative prediction given by this formula does not differ by much from the experimental data as well, especially at $n_s \leq 10$. It should be remembered that not all terms in formula(4) have been taken into account; we expect this reproduction would be better, if higher terms, with m>3, could be used.

2.3. Proton Multiplicity Dependence of the Normalized Dispersion of the Produced Particle Multiplicity

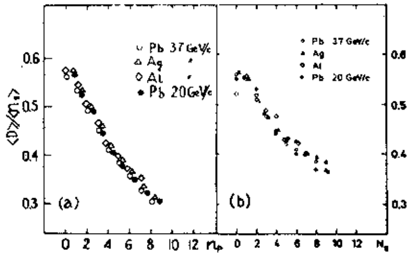
The normalized dispersion Z of the produced particle multiplicity N_p we express as:

$$Z = \frac{\langle D(N_p)\rangle}{\langle N_p\rangle} = \frac{(\langle N_p^2\rangle - \langle N_p\rangle^2)^{1/2}}{\langle N_p\rangle}, \tag{5}$$

where instead of N_p the produced pion multiplicity n_π or the produced "shower" particle multiplicity n_s can be used.

Using the commonly known formulas for the mean value and the dispersion for a distribution being a sum of some number of statistically independent corresponding distributions, relation (3) in part I has been written, between the quantity $Z_{hA}(E_h)$ for the hadron-nucleus collisions at energy E_h of an incident hafron and $Z_{hN}(\frac{E_h}{\langle m\rangle})$ for the hadron-nucleon collisions at energy $E_h/\langle m\rangle$ of the same hadron. Taking into account that

Fig.8. Normalized dispersion $\langle D\rangle/\langle n_\pi\rangle$ of produced pion average multiplicity $\langle n_\pi\rangle$ as a function of the number n_p of emitted protons, calculated using formula (5′) - a); normalized dispersion $\langle D\rangle/\langle N_s\rangle$ of fast particle average multiplicity $\langle N_s\rangle$, from the experiment of Faessler et al.[9] b).



$Z_{hN} = k_0 = 0.576 \pm 0.008$ = constants for any hadron energy[11] higher than nearly 1 GeV, we can rewrite this relation (3) from part I as:

$$Z_{hA}(E_h) = k_0 \frac{1}{\sqrt{\langle m\rangle}}, \tag{5′}$$

where $\langle m\rangle$ is expressed by formula (5) in part I; it is n_p-dependent, because λ used in formula (5) in part I is n_p-dependent, formula (1) in part I and our former papers[2-4]. The quantity $\langle m\rangle$ is E_h-dependent as well, by the E_h-dependence of the mean free path $\langle\lambda_0\rangle$.

In order to test formula (5′) the n_p-dependences of Z_{hA} have been calculated for the pion collisions with Pb, Ag and Al nuclei at 37 GeV/c momentum of incident pion, and with Pb nuclei at 20 GeV/c momentum; corresponding data exist for the pion-nucleus collisions[9]. Results are presented in fig.8.

It should be concluded that the distributions given by formula (5′) correspond quantitatively to the experimental ones.

2.4. Pseudorapidity Distribution

It has been shown[2] that the experimentally determined average pseudorapidity distribution of produced particles in collisions of the pions with various nuclear targets at P_h = = 37.5 GeV/c momentum[9] can be reconstructed well emough by means of simple formula[2] from the pseudorapidity distributions of produced particles in elementary pion-nucleon collisions at $P_h/\langle m\rangle$ momentum; formula was derived in assumption that in elementary hadron-nucleon collisions particles are produced through an intermediate object[2].

We have shown[2], as well, that the calculated n_p-dependence of the pseudorapidity distribution $\Delta\langle n_s\rangle/\Delta\eta$ for the pion-lead nucleus collisions at 40 GeV/c momentum reconstructs

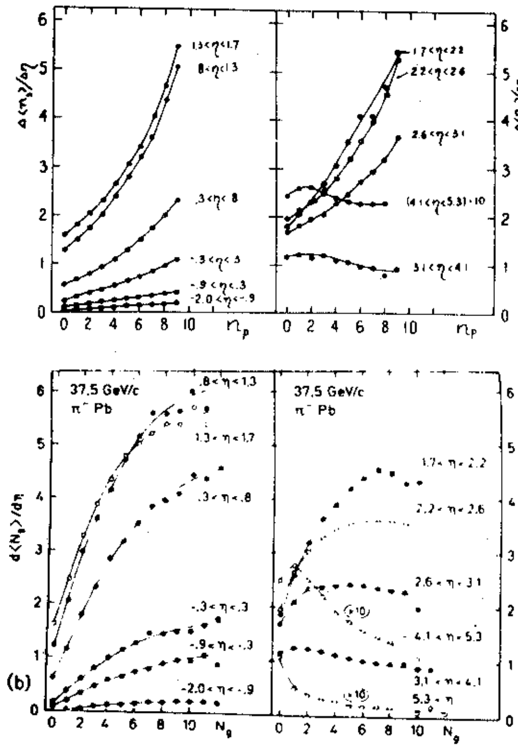


Fig.9. Pseudorapidity distribution as a function of the number n_p of emitted protons for pion-lead nucleus collisions at 40 GeV/c momentum, calculated in our former paper[2] - upper; corresponding distribution as a function of the number N_g of observed slow particles, from the work of Faessler et al.[9] - lower.

qualitatively well enough corresponding N_g -dependence of the pseudorapidity distribution $d\langle N_s\rangle/d\eta$ received from the Faessler et al. experiment[9] at 37.5 GeV/c momentum, fig.9.

2.5. Dispersion as a Function of Average Multiplicity of Produced Particles in Pion-Nucleus Collisions

It follows from formula (5) and (5') that the relation between the dispersion $\langle D\rangle$ and the produced particle, pion for example, average multiplicity $\langle N_p\rangle$ in hadron-nucleus collisions at incident hadron energy E_h can be written:

$$\langle D(E_h)\rangle_{hA} = \frac{1}{\sqrt{\langle m\rangle}} k_0 \langle N_p(E_h)\rangle_{hA} , \qquad (6)$$

where the meaning of the symbols used is as in various formulas above.

It should be amphasized that the total region of the target nucleus, not only the core region[4], should be used here for an estimation of the quantity $\langle\lambda\rangle$ which $\langle m\rangle$ is depending on.

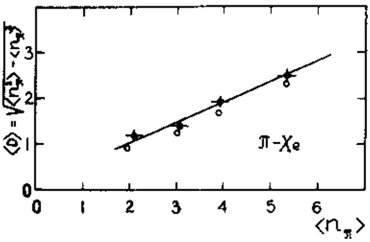


Fig.10. Produced pion average multiplicity $\langle n_\pi \rangle$-dependence of the dispersion $\langle D \rangle$ in pion-xenon nucleus collisions at 2.34 - 8 GeV/c momentum of incident pions. Full circles and line - the experimental data; empty circles - predictions by formula (7).

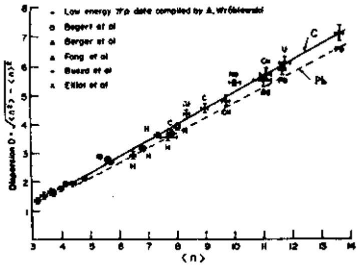


Fig.11. Dispersion D as the function of average multiplicity $\langle n \rangle$ in pion-nucleus collisions [6]. Solid line - predictions given by formula (6) for pion-carbon nucleus collisions; dotted line - predictions for pion-lead nucleus collisions.

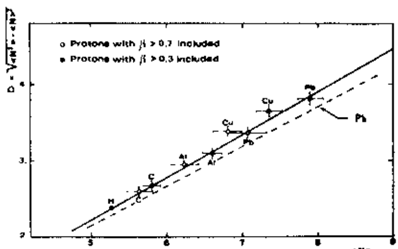


Fig.12. The dispersion plotted versus the mean multiplicity - from the experiment of Abrosimov et al. [12]. Dotted line - predictions given by formula (6) for the pion-lead nucleus collisions; the straight line corresponds to the best fit to the world pion-proton collisions.

Using formula (6) the dispersion $\langle D \rangle_{hA} = \langle D \rangle$ as the function of the average multiplicity $\langle n_\pi \rangle$ of produced pions in the pion-xenon nucleus collisions at 2.34-8 GeV/c, and dispersions as the functions of the produced "shower" particle average multiplicities $\langle N_p \rangle = \langle n_s \rangle = \langle n \rangle$ for various hadron-nucleus collisions were calculated and compared with the existing experimental data [6,12], fig.10-12; the data for the pion-xenon nucleus collisions are taken from the above-mentioned investigations of K.Miller et al.

3. EVIDENCE FOR THE INTERMEDIATE OBJECTS

It should be emphasized once again that all the simple expressions describing quantitatively many various characteristics of the particle production process in the hadron-nucleus collisions are the consequence of the assumption that in the hadron-nucleon collisions particles are produced through the intermediate object decaying after some time τ into observed so-called "produced" particles and resonances. The lifetimes of these objects are long enough them to be possible to leave the most heavy parent nucleus, if produced on nucleon in it.

It can be concluded, therefore, that our working hypothesis put forward in part I corresponds to the reality, and we think that the intermeaidte objects exist in the nature. They mediate the particle production in the hadron-nucleon collisions.

In fact, in part I of this series, in analysing the relations between the intensities of produced pions and emitted protons, we were compelled to state that the final many-particle states in hadron-nucleus collisions appear outside the target-nuclei, and then to assume that the particle production process proceeds through an intermediate objects. In this part of our paper we have shown how it is possible to account for corresponding hadron-nucleus data in terms of our knowledge of hadron-nucleon collisions, if the existence of the intermediate objects, through which the particle generation proceeds, is assumed. Presently there is no any other model which in a convincing manner can account for all those hadron-nucleus data in terms of our knowledge of hadron-nucleon interactions; the model presented in our previous paper[2], based mainly on our working hypothesis formulated in part I as well, allows one to express the relations between the characteristics of the particle production process in hadron-nucleus and the particle production process in hadron-nucleon collisions by means of simple formulas giving predictions which agree well enough with existing experimental hadron-nucleus data[2].

All these, above presented, arguments may be treated as the evidence for the existence in the nature of the intermediate objects taking part in the particle generation process. We propose to call these objects GENERONS.

It is of great importance to discuss now various properties of the intermediate objects. Let us start to do it in the next section.

4. PROPERTIES OF THE INTERMEDIATE OBJECTS

In this section, we intend to discuss properties of the intermediate objects. The purpose of this discussion is not to give their exhaustive and final description, but to look at all sides of the problem, to sum up the mostly evident experimental information about these objects, and to state, as correctly as we can now, whether they can be treated as individual newly known microobjects, like commonly known resonances for example, or not. It should be unbiased free discussion; we will try to avoid any prefabricated structures, limiting ourselves to the facts following from various experiments. Some of properties of these objects are assumed in our working hypothesis; we found to be necessary to point out them explicitly here once again.

4.1. The Mass

In general the scattering of two strongly interacting particles may lead to several final states observed in experiments, differing in numbers and kinds of the particles emerging, and, therefore, in various quantum numbers. But, as we have seen, the results of experimental investigations of the particle production mechanism prompt to us that the observed final states are in fact a result of decay of some intermediate objects; they can be "observed" using nuclear targets as "detectors". When these objects, of some definite internal energy, decay into secondary objects of less internal energies they emit the "quanta" with substantial mass: mesons, resonances, etc. It could be reasonable to attribute appropriate mass to the intermediate objects, like it is commonly practiced in the case of the resonant states. Probably, some of the simplest resonant states registered at yet in various experiments are in fact some of the intermediate objects, in many cases. It is reasonable to expect that the intermediate objects, in general, belong to a family of such objects with a discrete mass spectrum, or, correctly - with a discrete internal energy spectrum.

4.2. The Electric Charge

Depending on the electric charge of the collising particles, the intermediate objects may be of neutral, positive or negative electric charge.

4.3. The Baryonic Charge

Depending on the baryonic charge of the particles creating the intermediate objects, they should be of 0 or 1 baryonic charge.

4.4. Various Quantum Numbers

A major property of the particle resonant states, found until now, is that they all are eigenstates of certain symmetry operators: spin, isospin, strangeness, parity, G-parity, etc. Per analogy, it is reasonable to think the intermediate objects are of such property as well.

The quantum numbers of the intermediate objects may be determined in principle in studying the particle production process in the elementary particle-particle collisions.

4.5. The Lifetime

In the light of our experimental results the mean lifetime τ of the intermediate objects generated in hadron-nucleon collisions is no less than $\tau = \frac{2R_m}{c}$, where R_m is the radius of some of the most heavy nuclei. If $c = 3 \cdot 10^{10}$ cm s^{-1}, $R_m = 13 \cdot 10^{-13}$ cm, we have τ larger than about 10^{-22} s.

4.6. Decay Modes

The intermediate objects may decay into finally observed, so called "generated", particles in various ways; different channels can occur with various frequencies. They can decay into the well known resonant states as well.

Taking into account the order of the lifetime value, it is reasonable to think that the decays of the intermediate objects are caused by the strong interactions. But, some different kind of forces is not excluded now.

4.7. Behaviour of the Intermediate Objects in Their Passing through Nuclear Matter

The pion-xenon nucleus collision events were observed in which the incident pion undergoes the deflection only without the particle production, in accompaniment of some number of emitted protons /13,14/. In such cases the deflection angles $\theta_h < 150$ degrees are presented only /14/. This fact has been treated as an indication that the particle production takes place in rather central hadron-nucleon collisions and the intermediate objects produced move along the collision line which is the incident hadron course. Because of relatively low confidence level of corresponding data, a sample of nearly 1000 event was analysed only, this property of the particle production process has been treated as the fragment of our working hypothesis, in part I.

In moving through nuclear matter the intermediate object behaves itself similarly as any hadron does it; it indergoes probably all the processes assumed to be peculiar to any hadron traversing a layer of nuclear matter [15]. In particular, it can produce new intermediate objects in colliding with the nucleons inside the target nucleus.

In order to explain the experimental data presented in figs.1-12 we were forced to postulate that in such production process an incident intermediate object transfers a part of its internal energy to the newly produced intermediate object. We are inclined to think that in result of the collision of the intermediate object with a resting nucleon two intermediate objects emerge being in average of the same internal energy.

5. CONCLUSIONS AND REMARKS

Our considerations and experimental results presented in both parts of this paper allow us to state: the particle production in hadron-nucleon collisions proceeds through the GENERON - an intermediate object which can be treated as a new kind of microobjects, like the well known particles and resonances. The observed in hadron-nucleon collision experiments many-particle final states are the result of the decays of the GENERONS into resonances and particles.

Additional evidences are desired, from elementary hadron-nucleon collision experiments mainly; investigations of the jet structure [16] should provide appropriate data.

The nature of the intermediate objects will be the subject matter of the next III-th part of this work. Various ideas concerning the particle production mechanism shall be considered from this point of view. In particular, the idea of fireballs reviewed in Męsowicz work [17], and the idea of the excited nucleon discussed in Weisskopf papers [18] shall be widely analysed.

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