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EXPERIMENTAL INVESTIGATIONS OF THE PARTICLE PRODUCTION PROCESS AT THE STAGE BEFORE THE DECAY OF RESONANCES

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1. INTRODUCTION

In searches for plausible mechanisms to explain the particle production in hadron-nucleon collisions, in nucleon-nucleon collisions in particular, characteristics of the collision reaction products appeared after relatively long time after the collision - not shorter than the lifetimes of resonances - are usually analysed. The only directly observable quantities that one can obtain are that on the final state produced; using them, indirectly some information about what happened in the earlier stages after the collision can be obtained. For example by looking at the correlations between the various particles, one can deduce if the particles are decay products of some systems. But, this kind of analysis becomes more and more difficult as the energy of colliding hadrons and subsequent number of produced particles increases. It cannot be excluded a priori that the known particles and resonances are the decay products of some super-particle or super-particles created firstly, as well.

In the analysis of the data and in the invention and formulation of models of the particle production process, human imagination plays now an important role first of all, therefore. Faced with new experimantal facts, a physicist searches for a new model of the process. But, he is surprised almost every day by new experimantal facts. Moreover, the new facts are again and again from the final outcome only; these sometimes incomprehensible facts are in addition often inadequate for an explanation of the particle production process in its initial stage. The human imagination does not manage to follow the infernal race. New experimental information about the particle production process is needed, information of a new and adequate quality, in particular relevant to the time intervals much shorter than the lifetime τ of the most short-living particles known up to now, and within the spatial distances z much smaller than the product $\tau \cdot c \cdot \gamma$, where $\gamma = E/m = (1 - v/c)^{-1/2}$ accounts the Lorentz dilatation of the lifetime in the laboratory.

The typical width Γ of the most short-living particles - of the strongly decaying resonances - is of the order of a few hundred MeV, which corresponds to the shortenest decay time τ_s of some 10^{-23} s and to the smallest spatial distances z of some 10^{-13} cm in the laboratory, when $\gamma \approx 1$. With an increase of the incident hadron energy, most particles emerging from a hadron-nucleon collision become to be relativistic; above tens GeV the factor γ is some tens for the incident protons and some hundreds for the incident pions. It leads to the increase of the τ and z.

So, the qualitatively new and adequate experimental information which has to be used for elucidation of the process in question should be obtained at the times $\tau \leq 10^{-23}$ seconds within the spatial distances $z \leq 10^{-13}$ cm. These space distances and time intervals we shall call "short" later. Experimental information about the particle production process obtained at larger time intervals and spatial distances only may yield false ideas of the collision reaction products and of the particle systematics in a whole as well.

The collision reaction products appeared in its initial stage - within the short time intervals and spatial distances - should interact with a surrounding medium and the interaction must produce observable effects, if one will study these products experimentally. The surroundidng medium may be the nuclear or nucleon matter only; we call here "nuclear matter" the collection of nucleons known in nature as the atomic nucleus, the term "nucleon matter" is used here for the inner content of the nucleon. The only tool available now to realize such experiments is to apply massive target nuclei as fine detectors, therefore.

The subject matter in this paper is to present results of our experimental study of the space-time development of the particle production process in hadronic collisions at its initial stage. In the study, our own experimental data on pion-xenon nucleus collisions obtained at 2-9 GeV/c momentum [1-15] and the wealth of experimental data on hadron-nucleus [16-23] and hadron-nucleon [24,25] collisions collected in the past by other physicists were used.

In the studies we apply massive target nuclei as detectors or indicators of the properties of the particle production process development within time intervals $\tau \leq 10^{-22}$ s and spatial distances $z \leq 10^{-12}$ cm. For simplicity, we assume that the target nuclei are at rest in the laboratory. It will be convenient to define here the incident hadron energy as "high" if it is higher than the pion production threshold.

2. METHOD

As has been said above, collisions of hadrons with atomic nuclei provide the only tool available which allows, in a direct way, the experimental study of the space-time development of the particle production process within time interval $\leq 10^{-22}$ s and spatial distance $\leq 10^{-12}$ cm and, therefore, to study hadrons in statu nascendi. The claim that massive nuclei may serve as suitable fine detectors which can in principle provide plausible information about the phenomena in question can be found in many papers on hadron-nucleus collisions at high energies [26-39].

In this section, we will show how the atomic nucleus may be applied in fact; we start our consideration with a definition of the atomic nucleus as a detector and then we will discuss shortly about the method of application of this detector in practice.

2.1. The Atomic Nucleus as a Detector

A massive atomic nucleus, used as the target in hadron-nucleus collisions and treated as a collection of many nucleons spatially distributed in a definite manner within a definite spatial region, may be imagined as a lens-shaped "piece" of nuclear matter with definite maximum thickness λ_{max}, mean thickness $\langle\lambda\rangle$, and the thickness $\lambda(b)$ at the distance b from the nucleus center [38,40] measured in number of nucleons per some area S fm^2 - in units nucl/S, fig.1. Such piece of nuclear matter is in fact a stack of axially centered discs of nuclear matter with various diameters and thicknesses. A hadron, if fell on it, may interact inside it and the reaction products may interact there as well giving rise to some observable phenomena - nucleon emission, particle production, nuclear fragment evaporation, etc. It has been shown [38,40-43] that characteristics of the observed phenomena can vary in a definite manner, depending on the collision impact parameter b and on some reactions occurring inside the nuclear matter piece.

In short, the atomic nucleus used as the target in hadron-nucleus collisions may serve in principle as a fine detector. Its size r_A can be [44] from ~2 up to ~10 fm, roughly

$$r_A = 1.3\,A^{1/3} \text{ fm}, \qquad (1)$$

where A is the atomic mass number. Owing to high density ρ nucleons/fm^3 of nucleons inside the atomic nucleus, the nuclear detector is exclusively efficient - the hadrons which appear inside it interact in it with high efficiency because the mean

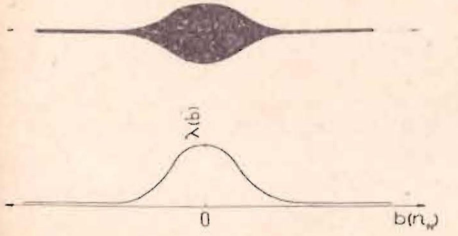


Fig. 1. The atomic nucleus as the nuclear matter "slab". The cross section, if the thickness is expressed in nucl/fm^2 - upper; typical dependence of the nuclear matter layer thickness $\lambda(b)$, *expressed in nucl/fm^2, on the impact parameter* b - *lower.*

free path for any hadron-nucleon collision is

$$\lambda = \frac{1}{\rho \cdot \sigma_{tot}} , \qquad (2)$$

where $\rho = 0.168$ nucl/fm^3 and σ_{tot} - the total cross-section fm^2/nucl. For proton-nucleon collisions $\lambda \approx 1.5$ fm, for pion-nucleon $\lambda \approx 2$ fm.

The size (1) and the mean free path (2) have to be discussed in connection with the duration of the strong interaction τ_s. The characteristic time of the interaction is $\tau_s = 1$ fm/c $\approx 3 \cdot 10^{-24}$ s, and the characteristic spatial distance $z = \tau_s \cdot c = 10^{-13}$ cm. It should be borne in mind that with increase of the incident hadron energy, most of particles produced in hadron-nucleon collisions become to be relativistic, and their lifetimes become Lorentz dilated.

In any of detectors some physical process accompanying the passage of particles through a medium is used as a basis of its action; such process should proceed in a strictly determined manner and must be simply observed. In the case when an atomic nucleus is to be used as a detector the basic physical process is the emission of fast nucleons - of kinetic energy from about 20 up to about 400 MeV, resognized as the so-called g-track leaving particles in nuclear emulsions. We will call these fast nucleons simply as "nucleons" later.

Our investigations in detail of the nucleon emission process in hadron-nucleous collisions /1-15,38,41-43/ allowed to conclude that /43,45/:

I. Any hadron with a kinetic energy higher than the pion production threshold causes nucleon emission from the target nucleus in traversing it along a path λ fm; the number n_N of emitted nucleons equals the number of nucleons contained within the cylindrical volume $v = \pi D_0^2 \lambda$ fm^3 centered on λ in the target nucleus:

$$n_N = \pi D_0^2 \lambda <\rho> , \qquad (3)$$

where D_0 fm is the diameter of the nucleon and $<\rho>$ nucl/fm^3 is the mean nucleon density inside the volume v; relation (3) may be expressed simpler and more conveniently for applications

$$n_N = \lambda \cdot S , \qquad (3')$$

when λ is expressed in nucl/S and $S = \pi D_0^2$ fm^2.

II. In passing through nuclear matter, any hadron with kinetic energy larger than the pion production threshould loses monotonically its kinetic energy; the energy ΔE_h MeV of the hadron lost on the path length $\Delta\lambda$ nucl/S equals

$$\Delta E_h = \epsilon_h \cdot \Delta\lambda , \qquad (4)$$

where ϵ_h MeV/(nucl/S) depends on the hadron identity.

Usually, the multiplicities n_p of protons are observed only and relation (3') should be rewritten for the protons:

$$n_p = n_N \cdot \frac{Z}{A} = \lambda \cdot S \cdot \frac{Z}{A} \ \text{prot/S} , \qquad (5)$$

where Z is the charge number of the target nucleus. The quantity $\Delta\lambda$ in formula (4) should be then in protons/S and ϵ_h in MeV/(prot/S). The quantity ϵ_h is measurable one /43,46/.

It should be mentioned here that the proton-neutron ratio within atomic nuclei along hadron path in them can be accepted as amounting Z/(A-Z) in average; as we can conclude from our experiments this ratio fluctuates in a definite manner, and the fluctiations are measurable ones.

It has to be borne in mind that the monotonically proceeding nucleon emission does not depend on the presence or absence of the particle production process in a collisions; the monotonic emission is disturbed usually in about 10% of the hadron-nucleus collisions, it is the smallest one, almost negligible practically in about 90% of all collision events - when $n_p \cdot S \leq D$ prot/S, where D prot/S is the diameter of the target nucleus.

It follows, therefore, from what has been said above, that an atomic nucleus massive enough may serve in fact as a fine detector for studies of effects taking place within short time intervals and small spatial distances.

2.2. Method of Investigations of the Particle Production Process Using Target Nuclei as Detectors

The clarification of the physical meaning of the observed multiplicity n_p of fast protons emitted in hadron-nucleus collisions provided new possibilities for a new interpretation of the data obtained in hadron-nucleus collision studies. In particular, the information about the thickness of nuclear matter layer the hadron fell on in a collision gives the possibility of determining the collision impact parameter, what in turn allows one to treat the target nucleus as a nuclear matter slab /40/. Such a treatment allows one to consider results of investigations of a sample of hadron-nucleus collisions as results obtained in an absorption experiment in which a beam of incident hadrons fell on the sheets of nuclear matter of definite thicknesses $\lambda = 1, 2, 3, \ldots, n_p(D)$ protons/S, of definite mean thickness $<\lambda>$ protons/S, and definite maximum thickness λ_{max} protons/S, where $n_p(D)$ is the proton multiplicity when the incident hadron course is along the diameter D.

Obviously, definite relations between the input and output in hadron-nucleus collisions may be obtained this way; these relations may be expressed in terms of corresponding input-output relations in hadron-nucleon collisions.

In practice, an application of the target nucleus as a detector will consists in the preparation of various output characteristics - characteristics of the reaction products, of produced pions predominantly - in dependence on the thickness $\lambda = n_p/S$ of the nuclear matter layer involved in the collisions under testing, and of a search for relations betweet the output characteristics in hadron-nucleus collisions and corresponding characteristics of collisions of the same hadron with nucleons.

Contrary to the commonly known opinion that new information about hadron-nucleus collisions will be obtained predominantly at extremely high energies, much higher than about 10 GeV, I would like to emphasize that just at energy region from the pion production threshold up to about 10 GeV, when the characteristic times τ_s are not Lorentz-dilated by much, the information obtained is of decisive importance as well, because at the small energies of incident hadrons the reaction products may be widely distributed through the space what allows one to detect them simpler by means of the target nucleus used as a detector.

We have stated above that the atomic nucleus may serve as a detector responsible to provide information about space-time development of the particle production process within the times shorter than 10^{-22} s and spatial distances smaller than 10^{-12} cm. But, such detector cannot work as one isolated nucleus and, moreover, it is completely destroyed in any of collision reactions and in the next collision other identical nucleus is used. This fact, together with the operation principle of such fine detector, requires some exclusive conditions in which it can work successfully. Namely, the atomic nucleus must be inside track-sensitive medium of the 4Pi solid angle geometry, where nucleon emission and produced particles, pions in particular, may be effectively recorded and identified.

3. SPACE-TIME DEVELOPMENT OF THE PARTICLE PRODUCTION PROCESS IN ITS INITIAL STAGE

Experimental investigations of the particle production process in its initial stage - before resonance decays - have been undertaken by us in pion-xenon nucleus collisions at 2-9 GeV/c momentum, using 26 and 180 litre xenon bubble chambers /47,48/. In the xenon bubble chambers the massive xenon nuclei $_{54}Xe^{131}$ were used as fine detectors for the studies in question; the chambers fulfilled all the conditions in which the atomic nucleus should work as such detector. In the chambers almost all emitted protons and almost all generated pions are registered; in particular, the neutral pions with kinetic energy E_{kpi^0} equal or larger 0 are registered with almost 100% efficiency and their energies and momenta, and emission angles are measurable with an accuracy high enough. Because the angular and energy distributions of the neutral pions in collisions under study are the same as the distributions for the charged pions, as has been proved experimentally, it is possible for the study of the pion generation process to use characteristics of the produced neutral pions only.

Later, characteristics of the pion production in pion-xenon nucleus collisions will be analysed in dependence on the nuclear matter layer thickness λ protons/S involved in a collision.

The mostly accurate analysis is made of the pion-xenon nucleus collisions at 3.5 CeV/c momentum; at this momentum, the particle creation occurs intensively enough and the produced pions are widely spread - in average through the emission angle of about 70 degress - which allows one to observe whether the pions appear immediately inside the parent nucleus or not. On the basis of the data obtained at 3.5 GeV/c momentum, data at smaller and larger momenta - up to maximal met in experiments - available in many works may be analysed in the new manner. This way, the development of the particle production process can be analysed within all the incident energy range, starting from the pion production threshold.

Let us analyse in this aspect experimental data /1-15,41-43,46/ firstly.

3.1. Characteristics of the Particle Production Process in Pion-Xenon Nucleus Collisions at 3.5 GeV/c Momentum

The mostly interesting and informative characteristic is a change of the pion production mean intensity, expressed by the mean pion multiplicity $\langle n_{\pi^{\pm}} \rangle$, in dependence on the nuclear matter layer thickness λ prot/S involved in the collision or, in other words, on $\lambda S = n_p = 0, 1, 2, \ldots, \leq 9$ prot/S; to $n_p = 0$ corresponds the thickness $\lambda = 1.4$ neutrons/S in the xenon nucleus. The n_p - dependence is shown in fig.2, for collisions at 3.5 GeV/c momentum. The produced pions are widely spread, in the laboratory system, fig.3; the mean emission angle of pions is $\langle \theta_\pi \rangle \approx 60$ degrees. The kinetic energies of the pions are within energy region from 0 up to about 2000 MeV; the mean kinetic energy is $\langle E_{k\pi} \rangle = 330$ MeV.

If pions with such characteristics appeared inside massive xenon nucleus, the mean thickness of which is $\langle \lambda \rangle = 8.4$ nucl/S,

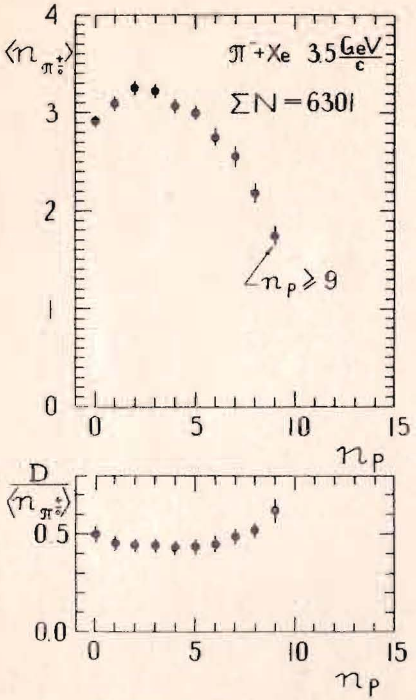
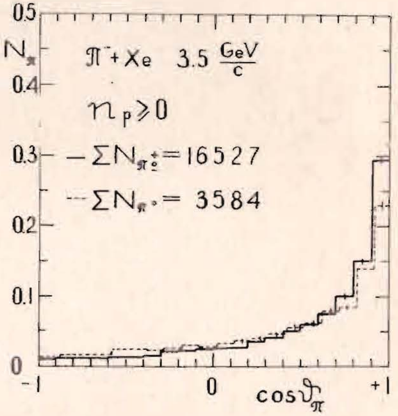


Fig. 2. The mean multiplicity $\langle n_\pi \rangle$ *of produced pions in dependence on the namber* n_p *of emitted protons;* n_p *is connected simply with the thickness* λ *prot/S of nuclear matter layer:* $\lambda S = n_p = 0, 1, 2, \ldots, \geq 9$ *protons; at* $n_p = 0$ *protons the layer of nuclear matter is of the thickness 1.4 nucl/S, in the xenon target nucleus.* $D/\langle n_\pi \rangle$ *is the normalized dispersion,* ΣN *is total number of events analysed.*

Fig. 3. Angular distribution of pions produced in collisions with any number of emitted protons; distributions for neutral pions is presented separately as well. ΣN *-number of pions in a histogram,* n_p *- multiplicity of emitted protons,* N *- number of events at a given interval of* $\cos\theta_\pi$ *values.*



they would produce new pions in turn, and the production intensity would increase markedly. With the increase of the number of pions traversing the target nucleus, the intensity of the emitted nucleons should increase markedly as well. But what is observed is not the case (fig.2). The intensity of the produced pions $\langle n_\pi \rangle$ increases slowly, from $\langle n_\pi \rangle \approx 3$ at $\lambda S = n_p = 0$ prot/S up to $\langle n_\pi \rangle \approx 3.3$ at $\lambda S = n_p \approx 3$ prot/S or at $\lambda S \approx 7$ nucl/S. The intensity of emitted nucleons $\langle n_p \rangle$ does not increase with increase of the multiplicity or produced pions.

From what is said above, one can conclude that the produced pions cannot be produced indirectly inside the parent nucleus; some intermediate objects must be produced which decay into observed pions after having left the target nucleus.

But, the intensity of produced pions $\langle n_\pi \rangle$ increases with increase of the thickness λ prot/S of nuclear matter layer involved in the collision, fig.2, from $\langle n_\pi \rangle \approx 3$ at $\lambda = 0$ prot/S up to $\langle n_\pi \rangle \approx 3.3$ at $\lambda = 3$ prot/S, or at about the mean thickness $\langle \lambda \rangle$ prot/S of the xenon nucleus. At larger thicknesses λ prot/S, at $\lambda S \geq 4$ protons, the mean intensity decreases up to about $\langle n_\pi \rangle = 2.2$ at $n_p = 8$. The initial increase is due to the increase of the nuclear matter layer thickness λ prot/S involved in the collision. The decrease of $\langle n_\pi \rangle$ at $\lambda \geq 4$ prot/S is due to the energy loss of the incident hadron and of the intermediate objects in nuclear matter /41,46/; at $n_p \geq 4$ the mean kinetic energy of produced pions is less than the pion production threshold /15/.

The only cause for the $\langle n_\pi \rangle$ increase with increase of the nuclear matter layer thickness λ prot/S involved in the collision may be a secondary production of the intermediate objects in collisions of the objects created at first with the downstream nucleons. In other words, a cascade of the intermediate objects should develop inside the target nucleus massive enough. The question arises, therefore: how do the intermediate objects behave themselves in passing through nuclear matter? The answer to it has to be found experimentally, and we try to obtain it now. In order to do it, we have prepared the n_π - dependences of the mean multiplicities $\langle n_p \rangle$, mean kinetic energies $\langle E_{kp} \rangle$, mean transverse momenta $\langle P_{Tp} \rangle$ and longitudinal momenta $\langle P_{Lp} \rangle$, and mean cosine of the emission angle $\langle \cos\theta_p \rangle$ of the emitted protons. The mean proton multiplicity in events with $n_\pi = 0$ equals $\langle n_p \rangle = 7.2$, what is almost the same as the number of protons corresponding the diameter of the target nucleus D prot/S times S. The mean proton multiplicity in events with $n_\pi = 1$ equals $\langle n_p \rangle = 3.2$, what is almost the same as the number of protons corresponsing to the mean thickness $\langle \lambda \rangle$ prot/S of the target nucleus times S. The mean proton multiplicities do not increase with the increase of the multiplicity of emitted pions n_π. It should be emphasized here that the mean proton multiplicity at incident hadron energies high enough, above about 10 GeV, is in hadron-nucleus collisions almost the same /43/ as the target nucleus mean thickness $\langle \lambda \rangle$ prot/S times S. The n_π - dependences of the $\langle E_{kp} \rangle$, $\langle P_{Lp} \rangle$, $\langle P_{Tp} \rangle$, and $\langle \cos\theta_p \rangle$ are shown in fig.4; the means are n_π - independent. We know as well that the energy spectra and angular distributions of the emitted protons are independent of the multiplicity of emitted protons at higher energies as well, as it has been proved experimentally /10,13/ up to about 400 GeV.

The absence of the nucleon emission intensity $\langle n_p \rangle$ increase with the increase of the produced pion multiplicity n_π may take

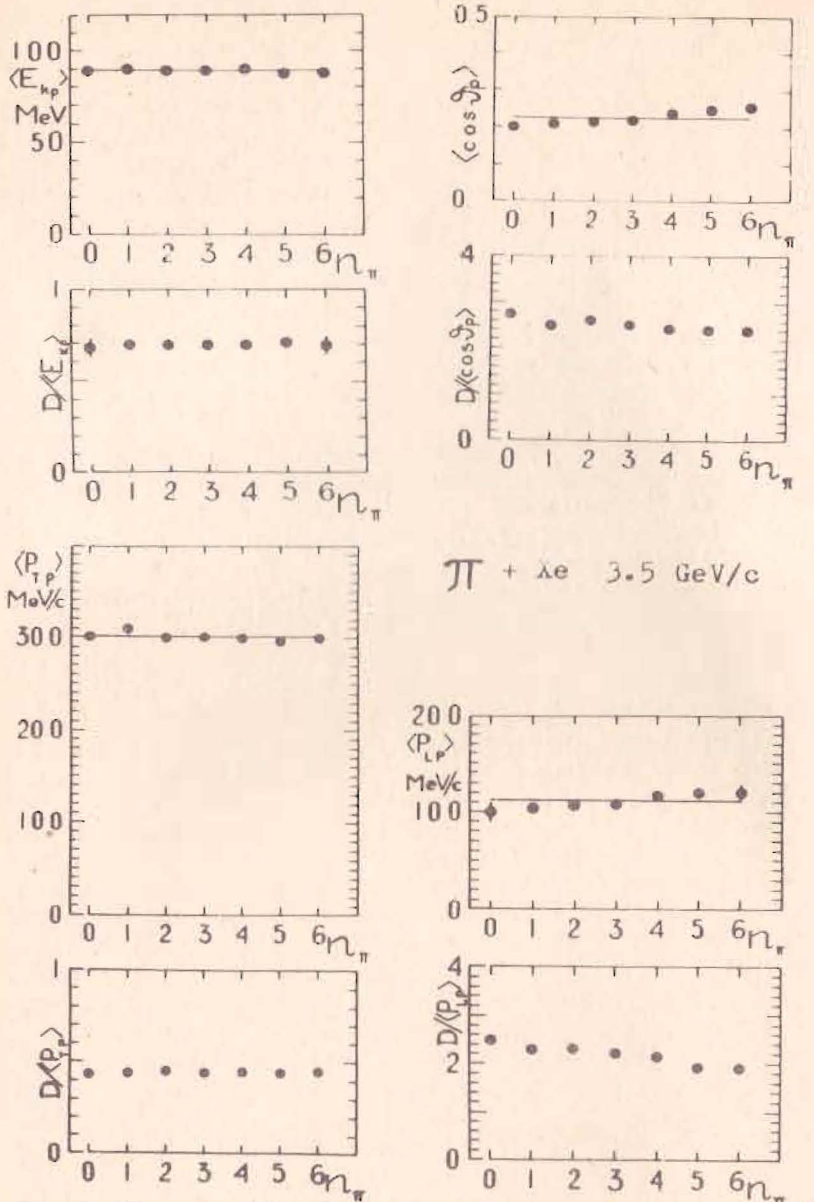


Fig.4. The mean kinetic energy $<E_{kp}>$, *mean longitudinal momentum* $<P_{Lp}>$, *mean transverse momentum* $<P_{Tp}>$, *mean emission angle* $<\cos\theta_p>$, *normalised dispersions* $D/<E_{kp}>$, $D/<P_{Lp}>$, $D/<P_{Tp}>$, $D/<\cos\theta_p>$ *in dependence on the multiplicity* n_π *of produced pions, in pion-xenon nucleus collisions at 3.5 GeV/c momentum. Solid lines - means over any pion multiplicity.*

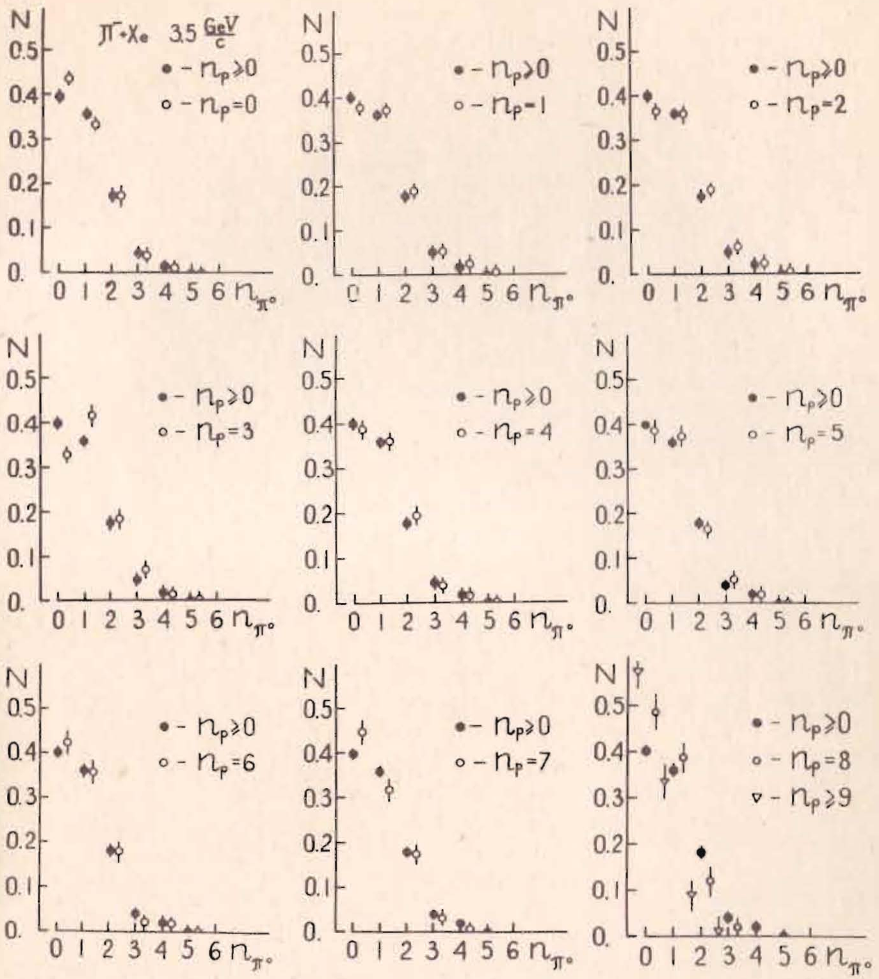


Fig.5. Distributions of multiplicities n_{π^0} *of produced neutral pions in pion-xenon nucleus collisions at 3.5 GeV/c momentum, when multiplicities of emitted protons* n_p *are* $n_p = 0, 1, 2, \ldots, 8; \geq 0, \geq 9$. N - *number of events at a given multiplicity of produced pions.*

place in two cases: a) when the intermediate objects do not cause the monotonic nucleon emission, as any hadron does it; b) when the intranuclear cascade of the intermediate objects is almost linear - not spread widely. The first case a) should be refused - because the mean intensity $<n_p>$ of emitted protons increases with incident hadron energy increase, up to $<n_p> = S<\lambda>$, where $<\lambda>$ prot/S is the mean thickness of the target nucleus; when $\langle n_p \rangle$ arrives the value $S\langle\lambda\rangle$, the increase of the incident hadron energy makes not an increase of the value of the mean intensity $\langle n_p \rangle$. The proton multiplicity distribution in collisions of a hadron with a definite target nucleus changes its shape when the incident hadron energy increases starting from the energy threshold for the pion production, it becomes energy-independent at energies above some GeV.

So, the intranuclear cascade of the intermediate objects is linear, practically without transverse spread.

The pion multiplicity distributions in events with 0 and 1 emitted protons, when a collision of the incident hadron with a quasifree nucleon at the periphery of the target nucleus occurs, is identical as the pion multiplicity distribution in pion-nucleon collisions at the same kinetic energy of the incident hadron[51,52]. Because the distributions of the pion multiplicity at $n_p = 0, 1, \ldots, \geq 9$ do not differ in the main, fig.5, we may conclude that the particle-producing collisions of hadrons inside target nuclei can be treated as the collisions of the hadrons with single nucleons.

3.2. Characteristics of the Particle Production Process in Hadron-Nucleus Collisions at Various Energies

The normalized multiplicity $R = \langle n \rangle_{hA} / \langle n \rangle_{hN}$ is expressed simply by formula $R = \langle m_0 \rangle = e^t$, where $\langle n \rangle_{hA}$ and $\langle n \rangle_{hN}$ are the mean multiplicities of produced pions in hadron-nucleus and in hadron-nucleon collisions correspondingly, $t = \langle \lambda \rangle / \langle \lambda_p \rangle$ and $\langle \lambda \rangle$ is the mean thickness of the target nucleus in nucl/S $\langle \lambda_p \rangle$ is the mean free path for particle-producing collisions in target nuclei obtained experimentally and connected to the cross-section for particle-producing collision of the hadron with free nucleon[53], $\langle m_0 \rangle$ has a simple physical meaning[54,55]. A-dependence of R is through the A-dependent mean thickness of the target nucleus $\langle \lambda \rangle$, enrgy-dependence of R is through the energy dependent mean free path $\langle \lambda_p \rangle$.

The energy-dependence of the mean multiplicity $\langle n \rangle_{hA}$ of produced pions in hadron-nucleus collisions at an energy above a few GeV obeys formula $\langle n(E) \rangle_{hA} = \langle m_0 \rangle \langle n(E/m_0) \rangle_{hN}$, where $\langle n(E/m_0) \rangle_{hN}$ is the mean multiplicity of produced pions in collisions of the same hadron with a nucleon at the energy E/m_0; A-dependence of $\langle n(E) \rangle_{hA}$ is through A-dependent quantity $\langle m_0 \rangle$.

4. DISCUSSION AND RESULTS

In result of the above described discussion about a physical meaning of the n_π-dependences of the characteristics of emitted protons, taking into account the physical meaning of the coefficient m_0, we can conclude that: In hadron-nucleus collisions particles are produced via some intermediate objects which decay after having left the parent nucleus into usually observed resonances and particles. The objects, produced in collisions of the incident hadrons with single nucleon, can produce new intermediate objects in collisions with downstream nucleons in nuclear matter in ones turn, and this way an intranuclear cascade of the intermediate objects develops inside the parent nucleus; in most cases this cascade is collinear with the incident hadron course. This conclusion we have formulated in our former works as well[54,55]; we have called there the intermediate objects "GENERONS".

It is reasonable to accept that the particle production in elementaty hadron-nucleon collisions, in nucleon-nucleon collisions in particular, goes through such long-lived intermediate objects as well; the objects decay into the commonly observed produced resonances and particles. In other words, some particle called GENERON exists which is created in quasiendoergic 2 → 2 type collision reaction firstly; the commonly observed resonances and particles are the decay product of it.

The nature of the GENERON have been already discussed[55,56], it should be investigated experimentally more in details later on, by means of the target nuclei used as detectors.

It has been shown[57] that the above described mechanism of the particle production allows one to derive formulas for frequency distributions of various quantities describing hadron-nucleus collisions in terms of frequency distributions of corresponding quantities in hadron-nucleon collisions. Some of the relations were tested experimentally at kinetic energy of incident hadrons from about 2 GeV up to about 2000 GeV; the predicted energy- and A-dependences of the distributions tested agree well with corresponding experimental data[54,55,58,59].

We have already stressed[55] that the discovery of generons can be regarded as a support for the V.F.Weisskop's concept of the nature of the particles produced in hadronic collisions[60].

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SUBJECT CATEGORIES
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17.	Theory of condenced matter
18.	Applied researches
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Стругальский З. E1-85-231
Экспериментальные исследования процесса рождения
частиц в стадии перед распадом резонансов

Процесс рождения частиц в его ранней стадии развития исследовался с помощью ядра мишени, примененного как прецезионный индикатор свойств этого процесса - во временных пределах меньше 10^{-22} секунды и в пространственных областях меньше 10^{-12} см. В столкновениях адронов с нуклонами, в частности, в столкновениях нуклонов с нуклонами, рождение частиц протекает через промежуточные объекты в двухчастичных эндоэргических реакциях типа 2 → 2. Промежуточные объекты распадаются на обычно наблюдаемые резонансы и частицы.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1985

Strugalski Z. E1-85-231
Experimental Investigations of the Particle Production
Process at the Stage before the Decay of Resonances

Experimental study of the space-time development of the particle production process in hadronic collisions at its initial stage was performed. Massive target nuclei have been used as fine detectors of properties of the particle production process development within time intervals smaller than 10^{-22} s and spatial distances smaller than 10^{-12} cm. In hadron-nucleon collisions, in nucleon-nucleon collisions in particular, the particle production process goes through intermediate objects in endoergic 2 → 2 type reactions. The objects decay into the commonly observed resonances and particles.

The investigation has been performed at the Laboratory of High Energies, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna 1985