сообщения
объединенного
института
ядерных
исследований
дубна

E1-83-850

Z.Strugalski

STOPPING AND ENERGY DEPOSITION OF HADRONS IN TARGET NUCLEI

1983

1. INTRODUCTION

In our study of pion-xenon nucleus collisions at 2.34-9 GeV/c momentum we were able to discover[1] and investigate in detail [2-11] the events in which incident pions were completely stopped and deposited their energies in target nuclei. The energy deposition was studied in detail in the events of such a kind[3]. An attempt to understand better this phenomenon motivated further investigations in other experimental groups using other incident hadrons of similar momentum values[12,13]. In study of inelastic collisions of 4.5 GeV/c momentum protons with emulsion nuclei approximately 12% of the events were found in which the emission of heavily ionizing particles is not accompanied by any shower particle[12,13].Many of events in this sub-class may be identified as events discovered in our work[12,13].

In 1983 the work of the group of physicists from Japan was published[14] in which the authors communicate that they were able to identify hadron-nucleus collision events in which leading particles were completely (or mostly) stopped and deposited their energies up to 4 GeV in target nuclei. They define the "stopped" events as the events with "high" multiplicity of charged secondaries and no "forward particle". Their investigations were performed in order to obtain an answer to the question of a common interest "Whether and how can we produce high enough excited states to study a possible new phase of nuclear matter?" In particular, they attempted to obtain an answer to the question "Which is the best energy for production of the high enough excited states?".

We are sure that results of our previous studies can throw light on the results which are or will be obtained in this field by other groups.

The knowledge about the hadron-nucleus collision events without particle production, in which incident hadrons stop and deposit completely their energy, may help to understand such phenomenon as high excitation of the target nuclei and intensive emission of "fast" nucleons - of kinetic energy from about 20 to about 400 MeV, accompanying hadron nucleus collisions.

In this paper, the stopping and energy deposition of hadrons in target nuclei are considered, using experimental material sampled in our previous works[1-11].

2. EXPERIMENTAL PROCEDURE

Stopping and energy deposition of pions in xenon target nuclei were studied using the 180 litre xenon bubble chamber of the Institute of Theoretical and Experimental Physics at Moscow and the 26 litre xenon bubble chamber of the Joint Institute for Nuclear Research at Dubna.

The characteristics of the xenon bubble chambers used in those experiments and detailed information about the experimental procedure can be found in our works/1,11,15,16/;we limit ourselves here to the presentation of the most important information, therefore.

Tracks of the length larger than nearly 5 mm are visible well and detectable with the constant efficiency which is close to 100%. To this minimum length there corresponds the minimum kinetic energy of the registered protons of nearly 20 MeV and of the registered charged pions of nearly 10 MeV. The tracks of smaller lengths are visible as well, but in this case the detection efficiency is not constant. In the 180 litre chamber, the protons of energies from nearly 20 up to nearly 200 MeV, the secondary pions: the negatively charged of kinetic energy from nearly 10 up to nearly 100 MeV, positively charged of energy from 0 up to 100 MeV, and the neutral pions of any kinetic energy over 0 MeV, including 0 MeV, are recorded with the efficiency near to 100% within the total solid angle 4π ;the kinetic energy of protons emitted within the 60 degrees cone and stopping inside the chamber is no more than nearly 350 MeV. In the 26 litre chamber, the protons of kinetic energy from nearly 20 MeV up to nearly 120 MeV, the secondary pions: the negatively charged of kinetic energy from nearly 10 up to about 80 MeV, positively charged of kinetic energy from 0 up to about 80 MeV, and the neutral pions of any kinetic energy over 0 MeV, including 0, are recorded with the efficiency being near to 100% within the total 4π solid angle.

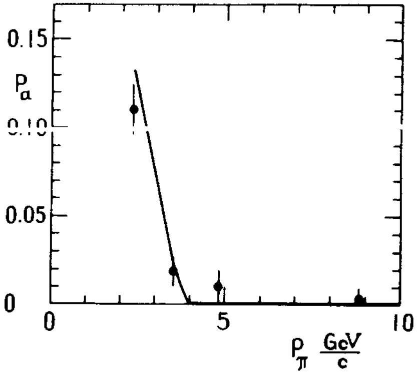
We are able, using these chambers, to select pion-xenon nucleus collision events in which incident pion is absorbed or it traverses the target nucleus without causing particle production, in particular - pion production. The analysis of the possible contamination of the sample of events selected as the events without particle production with the events in which various particles are produced in fact, in particular with the events in which produced particles leave V-shaped tracks, showed that this contamination is negligible; the sample of events in which incident pion is absorbed includes no more than about 5% of events in which pions or kaons are produced, but not detected in scanning.

3. SHORT REVIEW OF EXPERIMENTAL DATA

In our study of the pion-xenon nucleus collisions/1-11,15/, various facts were discovered experimentally which may characterize stopping and energy deposition of pions in target nucleus or, in general, in nuclear matter:

1. Among the pion-xenon nucleus collisions at 2.34-9 GeV/c momentum a sub-class of events can be distinguished in which incident pion does not cause particle production, in particular pion production, but it underwent a deflection only in its passage through the target nucleus, accompanied by fast nucleon emission, or it underwent an absorption inside the target nucleus, accompanied by fast nucleon emission. At 3.5 GeV/c momentum, the pion-xenon nucleus collisions without particle production are registered in (10.6±0.5)% of all collision events/5/; the pion deflection events are in about 88% and the pion absorption events in about 12% in them.
2. The percentage of the pion absorption events decreases with increasing the momentum of the incident pions, fig.1.

Fig. 1 Probability P_a of the appearance of the pion-xenon nucleus collision events in which incident pion is stopped inside the target xenon nucleus, in dependence on the incident pion momentum P_π. ● - experimental data, —— - calculations using formula (5).



3. The pion-xenon nucleus collisions with and without particle production are accompanied by "fast" nucleon emission - by the emission of nucleons of kinetic energy from about 20 up to about 400 MeV.
4. The multiplicity n_p distributions of the fast protons depend on the incident pion momentum at its values smaller than about 3.5 GeV/c, at higher momenta the distributions seem to be energy-independent.
5. Fast proton multiplicity n_p distributions in pion-xenon collisions in which incident pion is absorbed in the target nucleus are evidently different at 2.34 and 3.5 GeV/c momentum/5,11/,figs.2 and 3. The mean number of fast protons $\langle n_p \rangle$

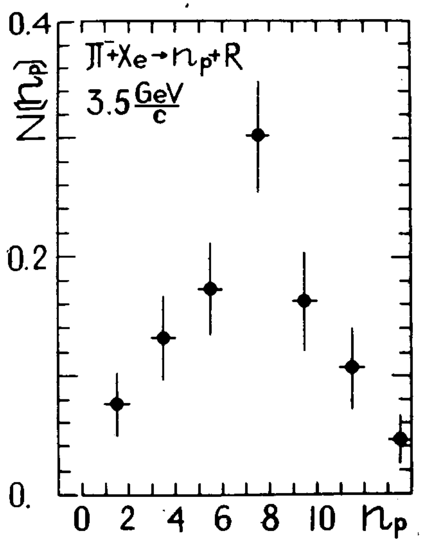


Fig.2. Proton multiplicity n_p distribution $N(n_p)$ in pion-xenon nucleus collisions in which incident pion is absorbed in the xenon target nucleus, at 3.5 GeV/c momentum.

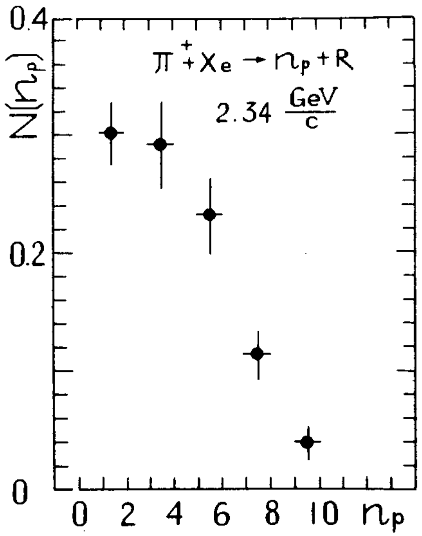


Fig.3. Proton multiplicity n_p distribution $N(n_p)$ in pion-xenon nucleus collisions in which incident pion is absorbed in the xenon target nucleus, at 2.34 GeV/c momentum.

emitted in pion-xenon nucleus collisions at 3.5 GeV/c momentum, in which incident pion is absorbed, equals the number of protons contained inside cylindrical volume $\pi D_0^2 \lambda$ within the xenon nucleus, where D_0 is the nucleon diameter and the length $\lambda \approx D$, where D is the xenon nucleus diameter[17]. The mean number of fast protons emitted in pion-xenon nucleus collisions at 2.34 GeV/c momentum, in which incident pion is absorbed, equals the number of protons contained inside cylindrical volume centered on the nucleus diameter, where $\lambda \approx 0{,}6\,D$. (The mean number of protons contained in any volume $\pi D_0^2 \lambda$ inside a target nucleus can be estimated on the basis of experimental data on nuclear sizes and nucleon density distributions in them[18]).

6. Simple relation exists between the target nucleus geometry - its size and nucleon density distribution in it - and the multiplicity distribution of the emitted protons[19]. Distributions of nuclear matter layer thicknesses λ in atomic nuclei, measured in protons per $S = \pi D_0^2$, are similar to observed proton multiplicity n_p distributions in hadron-nucleus collisions at energies higher than a few GeV, when $n_p \leq n(D)$, where $n_p(D)$ is the number of protons within cylindrical volume $\pi D_0^2 D$ inside the target nucleus, Do is the diameter of the nucleon and D is the target nucleus diameter[18].

7. Only in about a few per cent of the hadron-nucleus collisions the number of emitted fast protons is larger than the number of protons contained within the cylindrical volume $\pi D_0^2 D$ inside the target nucleus.

8. The mean multiplicity $\langle n_p \rangle$ of fast protons emitted in hadron-nucleus collisions at energies above a few GeV is almost the same as the average thickness $\langle \lambda \rangle$ of the target nucleus, measured in protons per $S = \pi D_0^2$.

9. Energy and momentum spectra, and angular distributions, of the emitted fast protons are identical in the sample of events with particle production and in the sub-samples of events without particle production - in which incident pions are deflected or absorbed in the target nucleus[9,10]. The energy spectra in pion-xenon nucleus collisions at 3.5 GeV/c momentum are the same[9] as the energy spectra of fast protons, or "g -particles", in proton-emulsion nuclei collisions at 4.5 and 400 GeV/c momentum. The angular distribution of the fast protons in pion-xenon nucleus collisions at 3.5 GeV/c momentum is the same as the angular distribution of the fast protons, or " g-particles", in proton-emulsion nuclei collisions at 400 GeV/c[10].

10. The knocking-out mechanism of the fast mucleon emission does not seem to play any important role in fast nucleon emission observed[9,10].

11. The fast nucleon emission process proceeds independently of the particle production process[4,9,10]. In many cases, the fast proton emission process starts in advance of the multiple meson creation[4].

12. Definite simple relation exists between the incident pion deflection angle and the mean number $\langle n_p \rangle$ of the emitted protons, in pion-xenon nucleus collisions without particle production[20].

13. Asymmetry in proton emission intensity angular distribution exists relatively to the plane perpendicular to the hadron deflection plane and containing the incident pion course[21].

4. DISCUSSION AND RESULTS

Experimental data presented above allow one to conclude that any high energy hadron causes nucleon emission from the target nucleus, when passes through it. The intensity of this emission, expressed by nucleon multiplicity n_N, equals in average the number of nucleons contained within the cylindrical volume $\pi D_0^2 \lambda$ centered on the hadron path λ in nuclear matter.

If the hadron path λ is measured in a number of nucleons n_N per the area $S = \pi D_0^2$, then n_N nucleons/S = λ nucleons/S. Because the ratio between the proton number and the neutron number inside the atomic nucleus can be treated[22,23] as radially independent and equal to the ratio $Z/(A-Z)$, λ can be expressed in protons per S as well, and λ protons/S = $(Z/A)\cdot\lambda$ nucleons/S. We have, therefore, that the observed proton multiplicity n_p should be treated as the number n_p protons/S of protons contained within the cylindrical volume $\pi D_0^2 \lambda$, and the relation takes place

$$n_p \text{ protons/S} = \lambda \text{ protons/S} \qquad (1)$$

which meaning is that the observed proton multiplicity in hadron-nucleus collisions is simply the measure of the nuclear matter layer thickness λ protons/S the incident hadron interacts with in a hadron-nucleus collision.

Hadrons lose a fraction of their energy by causing nucleon emission. The energy loss can be observed simply in a study of the hadron absorption, or hadron stopping, in nuclear matter - in atomic nuclei.

The beam pions of 3.5 GeV/c momentum lose in average 300 MeV of their energy before to collide in the center of the chamber with xenon nuclei. Then, pions of kinetic energy $E_\pi = 3.2$ GeV falling on xenon nuclei are absorbed by nuclear matter layer of the mean thickness $\langle\lambda\rangle$ nucleons/S = $\langle n_N \rangle = 17.2$ nucleons/S. Therefore, the incident pion energy loss ϵ_π for one nucleon emission is

$$\epsilon_\pi = \frac{E_\pi}{\langle\lambda\rangle} = \frac{3.2}{17.2} = 0.186 \; \frac{\text{GeV}}{\text{nucl./S}} \; . \qquad (2)$$

When the kinetic energy E_π of the incident pion is smaller, than the mean thickness $\langle\lambda\rangle$ nucleons/S of nuclear matter layer by which this pion will be absorbed should be

$$\langle\lambda\rangle \text{ nucleons/S} = \frac{E_\pi}{\epsilon_\pi} \text{ GeV/GeV/(nucl./S)} \cdot \qquad (3)$$

For example, pions of kinetic energy $E_\pi = 2.12$ GeV, used in our experiment[11], interacting within central area of the chamber with xenon nuclei should be absorbed by nuclear matter layer in xenon nucleus of the mean thickness $\langle\lambda\rangle$ nucleons/S = $= 2.12/0.186 = 11.4$ nucleons/S or, if measured in protons per S, $\langle\lambda\rangle$ protons/S = 4.6 protons/S. The observed mean number of the emitted fast protons is $\langle n_p \rangle = 4.1 \pm 0.3$ protons/S, which agrees satisfactorily with the predicted one.

It is known experimentally[1-11] that characteristics of the nucleon emission process, mainly the energy spectra and momentum and angular distributions of the emitted fast protons, are the same for any hadron-nucleus collisions - when particles are produced or not. It can be concluded, therefore, that hadrons undergo some process in passage through nuclear matter, monotonously along their paths, which leads to fast nucleon emission and energy loss of these hadrons. This process is similar to the ionization process accompanying the passage of charged particles through materials, but it is of different nature, as caused by nuclear forces.

Stopping and energy deposition of hadrons in nuclei, proceeding in such a way, should lead to various observable effects. Let us analyse some of them. Firstly, the mean number of fast protons emitted in hadron-nucleus collisions at energies higher than a few GeV should be almost energy-independent and approximately as large as the average thickness $\langle\lambda\rangle$ protons/S of the target nucleus, because the effective cross-section for total hadron-nucleon collision changes weakly with projectile energy. Secondly, the mean number of fast protons emitted $\langle n_p \rangle$ in hadron-nucleus collisions at energies smaller than a few GeV should be energy-dependent; the mean proton multiplicity $\langle n_p \rangle$ should increase with increasing of the projectile energy from $\langle n_p \rangle = 1$ up to $\langle n_p \rangle \approx \langle\lambda\rangle$ protons/S, where $\langle\lambda\rangle$ is the mean thickness of the target nucleus. One can prove, using available data, that it is observed in fact[24-28].

The stopping and energy deposition of hadrons in nuclear matter varies for various hadrons. From the data on proton-emulsion nuclei collisions[13], it is possible to estimate mean energy loss ϵ_p for protons - it is $\epsilon_p = 0.36 \; \frac{\text{GeV}}{\text{nucl./S}}$ which is almost two-times larger than for pions.

The mechanism of the nucleon emission is still unclear. One possible mechanism[29] could be such that along the projectile path in nuclear matter mesons appear of such energies at which they are simply absorbed by two or more adjacent nucleons; the systems formed in such a way, of relatively small kinetic energy, might drift inside the target nucleus without causing nucleon emission in ones turn and decay, after having left it, into nucleons.

In the light of our picture of the fast nucleon emission process in hadron-nucleus collisions and of the picture of the incident hadron stopping and its energy deposition in nuclear matter, the energy- and A-dependence of probability of occurrence of the events without particle production P_w and of probability P_a of occurrence of events in which incident hadron is absorbed may be expressed simply in terms of the hadron nucleus size and nucleon density distribution in it, and of the cross-section σ_i for inelastic hadron-nucleon collision:

$$P_w = \sum_{n_p=1}^{n_p = n_p(D)} W(n_p, A)\, e^{-n_p/\langle\lambda_i\rangle} \qquad (4)$$

$$P_a = \sum_{n_p=n_p(\lambda_{ef})}^{n_p=n_p(D)} W(n_p, A)\, P_w, \qquad (5)$$

where $W(n_p, A)$ is the distribution of nuclear matter layer thicknesses /18/ λ protons/S = n_p protons/S in the atomic nucleus with the mass number A; $n_p(D)$ is the proton multiplicity in protons/S when the incident hadron traverses the target nucleus along its diameter D; $n_p(\lambda_{ef})$ is the proton multiplicity in protons/S when the incident hadron traverses the nuclear matter layer thickness λ_{ef} protons/S, where $\lambda_{ef} < D$ is the thickness defined as $\lambda_{ef} = E_h/\epsilon_h$, where E_h is the incident hadron energy and ϵ_h is given as above; $\langle\lambda_i\rangle$ protons/S $= 1/\sigma_i \; 1/\frac{S}{\text{proton}}$ is experimentally known from hadron-nucleon collision studies.

Calculations performed for pion-xenon nucleus collisions at 2.34-9 GeV/c momentum give that P_w is about 0.26 and P_a is energy-dependent, and varies from 0.13 to 0 with incident hadron momentum increase, fig.1. Results of calculations do not contradict the results of the experiment.

Hadrons of energies smaller than $E_h = D \cdot \epsilon_h$ are easily absorbed in atomic nuclei of the diameter D. The ranges in nuclear matter of hadrons should be measured precisely in hadron-nucleus collisions at various energies $E_h < D \cdot \epsilon_h$, in future experiments. Now, we can present first data on the range-energy relation in nuclear matter of the pions, determined here using data on pion-xenon nucleus collisions /1-11/, and of the protons, determined using data on proton-emulsion nuclei collisions /12, 13/. The range-energy relation in nuclear matter of pions and protons is shown in fig.4.

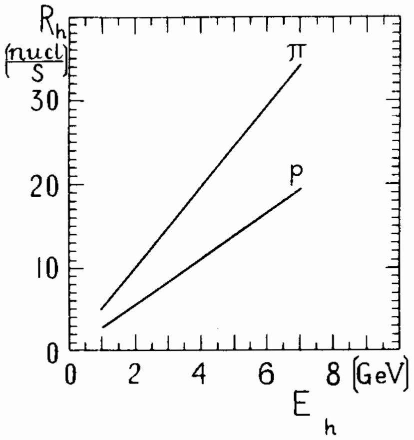


Fig.4. Range R_h -energy E_h relation in nuclear matter for pions and protons.

In attempts to answer, whether and how we can produce high enough excited states to study a possible new phase of nuclear matter, we come to the conclusion that: 1. In hadron-nucleus collisions, hadrons deposit their kinetic energy in the target nuclei predominantly by causing fast nucleon emission. 2. The fast nucleon emission, and then the energy deposition of the projectile in nuclear matter, proceeds monotonically; an increasing of the projectile energy above $E_h = D \cdot \epsilon_h$ does not cause an increasing of the fraction of the energy deposited in the target nucleus.

3. The minimum hadron energy $E_{h\,min}$ which should be applied in order to obtain maximum intensity of the fast nucleon emission is $E_{h\,min} = D \cdot \epsilon_h$.

The degree of the target nucleus excitation depends as well, in my opinion, on the fact how much is the target nucleus destroyed in a collision; it depends probably on the collision impact parameter. The destroyed nucleus goes into residual stable nuclei, the transition may be exoergic and accompanied by the emission of relatively energetic nuclear fragments. These fragments are emitted mainly owing to the inner energy of the destroyed target nucleus.

In pion-xenon nucleus collisions without particle production at about 3.2 GeV energy in which incident pion is completely stopped, total projectile energy is lost inside the target nucleus and $\langle n_N\rangle \approx A/Z \langle n_p\rangle \approx 18$ nucleons are emitted in average, where $\langle n_p\rangle$ is the mean number of emitted protons. The mean kinetic energy of the emitted nucleons is about 0.09 GeV. Then, the total kinetic energy of emitted nucleons is nearly 1.6 GeV, what is almost two times smaller than the energy lost inside the target nucleus. Possible explanation of this effect is given in my previous work /3/; a discussion about the nature of this effect will be the subject matter in our next work.

REFERENCES

1. Strugalski Z., Pluta J. Journ.of Nucl.Phys.(Russian), 1974, 27, p.504.
2. Strugalski Z. et al. JINR, E1-11975, Dubna, 1978.
3. Strugalski Z. JINR, E1-12086, Dubna, 1979.
4. Strugalski Z. JINR, E1-12522, Dubna, 1979; 8 Int.Conf. on High Energy Phys. and Nucl.Struct. Vancouver, Canada, 1979.
5. Strugalski Z., Pawlak T., Pluta J. JINR, E1-82-718, Dubna, 1982.
6. Strugalski Z., Pawlak T., Pluta J. JINR, E1-82-719, Dubna, 1982.
7. Strugalski Z., Pawlak T., Pluta J. JINR, E1-82-841, Dubna, 1982.
8. Strugalski Z., Pawlak T., Pluta J. JINR, E1-82-234, Dubna, 1982.
9. Strugalski Z. JINR, E1-83-158, Dubna, 1983.
10. Strugalski Z. JINR, E1-83-344, Dubna, 1983.
11. Strugalski Z. et al. JINR, E1-81-578, Dubna, 1981; Wosińska K. Warsaw Technical University. Thesis, Warsaw, 1983.
12. Bannik B.P. et al. 7 Konference CS Fyziků. Praha, 24-28 August, 1981, 01-20.
13. Sumbera M., Vokal S. Acta Phys.Slov., 1982, 32, p.265.

14. Nakai K.T. et al. Phys.Lett., 1983, 121B, p.373.
15. Peryt W. et al. JINR, E1-81-803, Dubna, 1981.
16. Strugalski Z. et al. JINR, E1-5349, Dubna, 1970.
17. Strugalski Z. JINR, E1-11976, Dubna, 1978.
18. Strugalski Z., Pawlak T. JINR, E1-81-378, Dubna, 1981.
19. Strugalski Z. JINR, E1-80-216, Dubna, 1980.
20. Strugalski Z. JINR, E1-82-455, Dubna, 1982.
21. Strugalski Z. JINR, E1-82-802, Dubna, 1982.
22. Strugalski Z. Nucl.Phys., 1966, 87, p.280.
23. Strugalski Z., Miller K. JINR, E1-81-781, Dubna, 1981.
24. Bannik B.P. et al. JINR, P1-13055, Dubna, 1980.
25. Tsai-Chü et al. Nuovo Cim.Lett., 1977, 20, p.257.
26. Babecki J., Nowak G. Acta Phys.Pol., 1978, B9, p.401.
27. Mayer H. et al. Nuovo Cim., 1963, 28, p.1399.
28. Abdrakhmanov E.O. et al. Journ.of Nucl.Phys.(Russian), 1978, 27, p.1020.
29. Strugalski Z. JINR, E1-80-215, Dubna, 1980.

Received by Publishing Department
on December 15, 1983.

WILL YOU FILL BLANK SPACES IN YOUR LIBRARY?

You can receive by post the books listed below. Prices - in US $, including the packing and registered postage

D4-80-385	The Proceedings of the International School on Nuclear Structure. Alushta, 1980.	10.00
	Proceedings of the VII All-Union Conference on Charged Particle Accelerators. Dubna, 1980. 2 volumes.	25.00
D4-80-572	N.N.Kolesnikov et al. "The Energies and Half-Lives for the α- and β-Decays of Transfermium Elements"	10.00
D2-81-543	Proceedings of the VI International Conference on the Problems of Quantum Field Theory. Alushta, 1981	9.50
D10,11-81-622	Proceedings of the International Meeting on Problems of Mathematical Simulation in Nuclear Physics Researches. Dubna, 1980	9.00
D1,2-81-728	Proceedings of the VI International Seminar on High Energy Physics Problems. Dubna, 1981.	9.50
D17-81-758	Proceedings of the II International Symposium on Selected Problems in Statistical Mechanics. Dubna, 1981.	15.50
D1,2-82-27	Proceedings of the International Symposium on Polarization Phenomena in High Energy Physics. Dubna, 1981.	9.00
D2-82-568	Proceedings of the Meeting on Investigations in the Field of Relativistic Nuclear Physics. Dubna, 1982	7.50
D9-82-664	Proceedings of the Symposium on the Problems of Collective Methods of Acceleration. Dubna, 1982	9.20
D3,4-82-704	Proceedings of the IV International School on Neutron Physics. Dubna, 1982	12.00
D2,4-83-179	Proceedings of the XV International School on High-Energy Physics for Young Scientists. Dubna, 1982	10.00
	Proceedings of the VIII All-Union Conference on Charged Particle Accelerators. Protvino, 1982. 2 volumes.	25.00
D11-83-511	Proceedings of the Conference on Systems and Techniques of Analitical Computing and Their Applications in Theoretical Physics. Dubna,1982.	9.50
D7-83-644	Proceedings of the International School-Seminar on Heavy Ion Physics. Alushta, 1983.	11.30
D2,13-83-689	Proceedings of the Workshop on Radiation Problems and Gravitational Wave Detection. Dubna, 1983.	6.00

Orders for the above-mentioned books can be sent at the address:
Publishing Department, JINR
Head Post Office, P.O.Box 79 101000 Moscow, USSR

SUBJECT CATEGORIES OF THE JINR PUBLICATIONS

Index	Subject
1.	High energy experimental physics
2.	High energy theoretical physics
3.	Low energy experimental physics
4.	Low energy theoretical physics
5.	Mathematics
6.	Nuclear spectroscopy and radiochemistry
7.	Heavy ion physics
8.	Cryogenics
9.	Accelerators
10.	Automatization of data processing
11.	Computing mathematics and technique
12.	Chemistry
13.	Experimental techniques and methods
14.	Solid state physics. Liquids
15.	Experimental physics of nuclear reactions at low energies
16.	Health physics. Shieldings
17.	Theory of condenced matter
18.	Applied researches
19.	Biophysics

Стругальский З. E1-83-850
Остановка и передача энергии адронов в ядрах-мишенях

При исследовании столкновения пион-ксенон при 2,34-9 ГэВ/с мы смогли выделить события,в которых налетающий пион полностью останавливается,передав свою энергию ядру-мишени. Вероятность появления таких "остановок" среди всех столкновений пион-ксенон зависит от импульса налетающего пиона и составляет: ~0,15 при 2,34 ГэВ/с, ~0,02 при 3,5 ГэВ/с и ~0 при высших значениях импульса. Выведена формула для вероятности появления " остановок". Приводится зависимость пробег - энергия для пионов и протонов в ядерной материи.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1983

Strugalski Z. E1-83-850
Stopping and Energy Deposition of Hadrons in Target Nuclei

In an analysis of pion-xenon nucleus collisions at 2.34-9 GeV/c momentum we were able to identify events in which incident pions were completely stopped and deposited their energy in target nucleus.Probability of appearance of such "stopped" events among any-type pion-xenon collision events depends on the incident pion momentum and is: ~0.15 at 2.34 GeV/c, ~0.02 at 3.5 GeV/c, and ~0 at higher momenta. Formula expressing probability of appearance of the "stopped" events is derived. Range-energy relation in nuclear matter for pions and protons is given.

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

Communication of the Joint Institute for Nuclear Research. Dubna 1983