Preprint YERPHI-1270(56)-90

ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ
ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ
YEREVAN PHYSICS INSTITUTE

V.M. ZHAMKOCHYAN

# LEADING HADRON SPECTRA IN HADRON-NUCLEUS INTERACTIONS

ЦНИИатоминформ
ЕРЕВАН-1990

Նախատպություն ԵՖԻ-1270(56)-90

Վ.Մ.ԺԱՄԿՈՉՅԱՆ

# ՀԱԴՐՈՆ-ՄԻՋՈՒԿԱՅԻՆ ՓՈԽԱԶԴԵՑՈՒԹՅՈՒՆՆԵՐՈՒՄ ԱՌԱՋԱՏԱՐ ՀԱԴՐՈՆՆԵՐԻ ՍՊԵԿՏՐՆԵՐԻ ՄԱՍԻՆ

Միջանկյալ առաջատար վիճակներով մոդելում հաշվարկված է վրա թռչող մասնիկների հատվածավորման տիրույթում միջուկների վրա առաջատար հադրոնների ինկլյուզիվ սպեկտրները: Ստացվել է համաձայնություն 1 փորձարարական տվյալների հետ $hA \to hX$ $(h \equiv p, \pi^+, K^+)$ գործընթացների համար, երբ $P_\perp = 0{,}3$ ԳէՎ/c և $P_\perp = 0{,}5$ ԳէՎ/c :

Երևանի Ֆիզիկայի ինստիտուտ

Երևանի Ֆիզիկայի ինստիտուտ

Երևան 1990

Препринт ЕФИ-1270(56)-90

В.М.ЖАМКОЧЯН

# О СПЕКТРАХ ЛИДИРУЮЩИХ АДРОНОВ В АДРОН-ЯДЕРНЫХ ВЗАИМОДЕЙСТВИЯХ

В модели с промежуточными лидирующими состояниями проведен расчет инклюзивных спектров лидирующих адронов на ядрах в области фрагментации налетающей частицы. Получено хорошее согласие с экспериментальными данными I по процессам $hA \to hX (h = p, \pi^+, K^+)$ при $P_\perp = 0,3 \frac{\text{ГэВ}}{c}$ и $P_\perp = 0,5 \frac{\text{ГэВ}}{c}$.

Ереванский физический институт

Ереван 1990

Preprint YERPHI-1270(56)-90

V.M. ZHAMKOCHYAN

# LEADING HADRON SPECTRA IN HADRON-NUCLEUS INTERACTIONS

The inclusive spectra of leading hadrons on nuclei in the projectile fragmentation region are described on the basis of the model with intermediate leading states. A good agreement with experimental data [1] is obtained on processes $hA \to hX$ ( $h \equiv p, \pi^+, K^+$ ) at $P_\perp = 0.3$ GeV/c and $P_\perp = 0.5$ GeV/c.

Yerevan Physics Institute

Yerevan 1990

The study of the space-time picture of multiple production processes is one of the most urgent problems in the strong-interaction physics. It is generally known that from this point of view the investigations of the processes on nuclear targets can serve as a source of unique information.

The published in the 80-ies experimental data [1,2] on inclusive hadron spectra in hadron-nucleus collisions at $E_0 \gg 100$ GeV stimulated the development of a number of phenomenological models [3-9] which described them with a different extent of accuracy. Common for the mentioned models was that they all were valid, strictly speaking, only to describe the spectra integrated over transverse momentum of final hadrons, $P_\perp$ . The comparison with the data [1] at $P_\perp = 0.3$ GeV/c was carried out [3-8] using the normalization procedures (including the fitting of effective slopes for the processes with a certain number of collisions [8] ), which obviously is not quite grounded theoretically.

The problem of the correct description of inclusive spectra on nuclei at fixed transverse momenta was solved in Ref. [11] in the framework of noncovariant Glauber-Watson formalism [10]

Further on, on the basis of the found expressions with account of the hypothesis of intermediate hadronic states [12] the calculation of inclusive spectra of leading hadrons on nuclei at large $P_\perp$ was carried out. The achieved agreement with experimental data [13] pointed out the validity of the basic assumptions of the applied model.

Below in the present paper the calculation in the mentioned model is extended to include processes $hA \to hX$ with not large finite $P_\perp$, which enabled us to carry out correct comparison with experimental data [1] at $P_\perp = 0.3$ GeV/c and $P_\perp = 0.5$ GeV/c.

Briefly, the essence of the proposed approach [3, 12] consists in the following assumptions:

1. In the soft processes $hN \to hX$ the formation of final hadrons in the fragmentation region of $h$ includes the stage of the intermediate state $H$ whose valence composition is identical to that of $h$.

2. At the considered energies the leading state $H$ produced after the inelastic hN-interaction displays hadron-like properties in the nucleus and is capable of successive interactions with a cross section equal to that of the parent hadron.

3. Fragmentation of $H$ to final hadrons proceeds outside the nucleus because of the large value of the Lorentz factor, $E/m$.

4. The fragmentation process does not depend substantially on the number of collisions of the leading system with the nucleus nucleons.

In these assumptions the methods similar to [11] lead to the following expression for invariant cross section of the process $hA \to hX$ :

$$E\frac{d\sigma_{inel}^{hA\to hX}}{d^3p}=\frac{x}{(2\pi)^2}\sum_{n=1}^{A}\int \exp\left\{-\sigma_{hN}^{tot}T(-\infty,\infty,\vec{B})+i\vec{P}_\perp\vec{\beta}\right\}\times$$

$$\times d^2B\,d^2\beta\,\delta(x-x_1\ldots x_n x')dx_1\ldots dx_n dx'\,\Omega_{\mathcal{D}}(x_n,x',\vec{\beta})\times$$

$$\times \exp\left\{\omega_{el}(x'\vec{\beta})T(z_n,\infty,\vec{B})\right\}\prod_{i=1}^{n}\left[\exp\left\{\omega_{el}(x_i\cdots x_n x'\vec{\beta})\times\right.\right.$$

$$\left.\left.\times T(z_{i-1},z_i,\vec{B})\right\}\rho(\vec{B},z_i)dz_i\,\Omega_{inel}(x_i,x_{i+1}\cdots x_n x'\vec{\beta})\,\theta(z_i-z_{i-1})\right],$$

where

$$\omega_{el}(\vec{\gamma})=\int\frac{d\sigma_{h(H)N}^{el}}{d^2P_\perp}\exp\left\{-i\vec{P}_\perp\vec{\gamma}\right\}d^2P_\perp\,;$$

$$\Omega_{inel}(x_i,\vec{\gamma})=\int\frac{d\sigma^{h(H)N\to HX}}{dx_i\,d^2P_\perp}\exp\left\{-i\vec{P}_\perp\vec{\gamma}\right\}d^2P_\perp\,; \qquad (2)$$

$$\Omega_{\mathcal{D}}(x_n,x',\vec{\beta})=\int\mathcal{D}^{H\to hX}(x_n,x',\vec{P}_\perp')\exp\left\{-i\vec{P}_\perp'\vec{\beta}\right\}d^2P_\perp'\,;$$

$$T(z_1,z_2,\vec{B})=\int_{z_1}^{z_2}\rho(\vec{B},z)dz\,;$$

$\rho(\vec{B},z)$ is one-particle nuclear density; $z_0\equiv-\infty$ ; $x$ , $x'$ and $x_i$ are the Feynman variables.

Expression (1) takes into account only terms diagonal over inelastic acts in the differential cross section on the nucleus, which restricts its validity mainly to nondiffractive region

( $x \lesssim 0.9$). (The corrections due to the interference of partial amplitudes with different configurations of collisions [11] in general, may turn out essential for the diffractive processes.)

According to the model applied, the differential cross sections of $hN$ - and $HN$ -interactions in (2) were assumed identical.

The fragmentation function $\mathcal{D}^{H\to hX}(x_H, x', \vec{P}_\perp')$ in (2) is determined by the relation:

$$\frac{d\sigma^{h(H)N\to hX}}{dx\, d^2P_\perp} = \int \mathcal{D}^{H\to hX}(x_H, x', \vec{P}_\perp') \frac{d\sigma}{dx_H\, d^2P_{\perp H}} \delta(x - x_H x') \times \tag{3}$$

$$\times\, \delta(\vec{P}_\perp - \vec{P}_\perp' - x'\vec{P}_{\perp H})\, d^2P_{\perp H}\, d^2P_\perp'\, dx_H\, dx'.$$

At spectra parametrization in (3) ( $h \equiv p, \pi^+, K^+$ ) in the nondiffractive region there were used experimental data [14] :

$$\frac{d\sigma^{hN\to hX}}{dx\, d^2P_\perp} = f_h(x, P_\perp) \frac{d\sigma^{hN\to hX}}{dx}.$$

$$f_h(x, P_\perp) = \begin{cases} \dfrac{b_h^2(x)}{2\pi} \exp\{-b_h(x) P_\perp\}, & x \geq 0.5 \\[2ex] \dfrac{b_h(x)}{\pi} \exp\{-b_h(x) P_\perp^2\}, & 0.3 \leq x < 0.5 \end{cases} \tag{4}$$

The quantities $d\sigma^{hN\to hX}/dx$ and $b_h(x)$ were approximated by expressions $d\sigma^{hN\to hX}/dx \simeq (1-x)P(x)$ and $b_h(x) \simeq R(x)$ , where $P(x)$ and $R(x)$ are polynomials of 2-6 th power.

The inclusive spectra $h(H)N \to HX$ , just as in Ref.[12], were parametrised for nondiffractive processes in the form:

$$\frac{d\sigma^{h(H)N\to HX}}{dx\,d^2P_\perp} = \frac{b_H^2}{2\pi} \exp\{-b_H P_\perp\} \frac{d\sigma^{h(H)N\to HX}}{dx},$$

$$\frac{d\sigma^{h(H)N\to HX}}{dx} = \sigma_{hN} x^{\nu}(\nu+1) \equiv \sigma_{\nu}(x) \quad (5)$$

with the parameter $b_H$ independent of $x$ and the inelasticity coefficient $K_H^{el} = (\nu+2)/(\nu+1)$.

The quantity $\sigma_{hN}$ in (5) is the total cross section of nondiffractive $hN$ -interaction, $\sigma_{hN} = \sigma_{hN}^{tot} - \sigma_{hN}^{diff}$ .

The diffractive part of spectra (5) was taken into account by terms of the form of

$$\sigma_{hN}^{diff} \cdot \frac{b_h^{el}}{\pi} \exp\{-b_h^{el} P_\perp^2\} \delta(x-1) \quad (6)$$

where $b_h^{el}$ is the diffractive cone slope in the elastic $hN$ - scattering, $\sigma_{hN}^{diff}$ is the sum of elastic and diffractive dissociation cross sections on nucleon.

The simplified notation (6) seemed to be justified, since a description of the diffractive peak in processes $hA \to hX$ was beyond the scope of the present work, and some difference in the slopes for the processes of elastic scattering and diffractive dissociation on the nucleon is highly inessential in calculations of inclusive spectra (1) in nondiffractive region.

Taking into account (3)-(6), the expression for spectra $hA \to hX$ can be reduced to the form:

$$E\,\frac{d\sigma_{inel}^{hA\to hX}}{d^3p} \simeq \frac{x}{(2\pi)^2}\int J_0(P_\perp\beta)\,d^2\beta\int \mathcal{D}(x')\,dx' \times$$

$$\times \sum_{n=1}^{A}\Big\{\big[\delta(x-x_1\dots x_n x')\,dx_1\dots dx_n\,dx'\,\Phi_h(x_n,x',\beta)\times \tag{7}$$

$$\times\,\Phi_H(x_{n-1},x_n x'\beta)\dots\Phi_H(x_1,x_2\dots x_n x'\beta)\big]\times$$

$$\times \sum_{\ell=0}^{A-n}\Big[\frac{N_{n+\ell}\,(\sigma_{hN}^{tot})}{(\sigma_{hN}^{tot})^{n+\ell-1}}\,(\varphi_H(x'\beta))^{\ell}\Big]\Big\},$$

where

$$N_n(\sigma) = \frac{1}{\sigma n!}\int(\sigma T(-\infty,\infty,\vec{B}))^n\exp\{-\sigma T(-\infty,\infty,\vec{B})\}\,d^2B,$$

$$\varphi_H(z) = \sigma_{hN}^{diff}\exp\Big\{-\frac{z^2}{2B_h^{el}}\Big\};$$

$$\Phi_H(x,z) = \sigma_\nu(x)\,\frac{B_H^3}{(B_H^2+z^2)^{3/2}} + \delta(x-1)\,\varphi_H(z).$$

the factors

$$\Phi_h(x_n,x',\beta) = \begin{cases}\sigma_\nu(x_n)\,\dfrac{B_h^3\,(x_n x')}{(B_h^2(x_n x')+\beta^2)^{3/2}}, & x_n x' \geqslant 0.5\\[2ex] \sigma_\nu(x_n)\exp\Big\{-\dfrac{\beta^2}{2B_h(x_n x')}\Big\}, & 0.3\leqslant x_n x' < 0.5\end{cases}.$$

correspond to the last nondiffractive act of interaction of the intermediate hadron in the nucleus and its fragmentation to observed hadrons $h$ outside the nucleus.

The explicit form of function $\mathcal{D}(x')$ in (7) at parametrization chosen in the paper is:

$$\omega(x') = \frac{1}{(\nu+1)\,\sigma_{hN}}\left\{\left[\nu+(1-\nu)x'\right]P(x') - x'(1-x')\,\frac{\partial P(x')}{\partial x'}\right\} \qquad (8)$$

The effective nucleon numbers $N_h$ ( [illegible] ) were calculated in the Fermi model with parameters from [15]; the quantities $\sigma_{hN}^{tot}$, $\sigma_{hN}^{dif}$, $\sigma_{hN}$, $\sigma_h^{el}$ for three types of hadrons ( $p, \pi^+, K^+$ ) were determined according to [16].

We dwell firstly on the description of processes $pA \to pX$ in the region of data [1].

In expression (7) there are figuring, generally speaking, two parameters whose values cannot be derived directly from the available experimental data on processes $pN \to pX$. These are the quantities $\sigma_H$ and $\nu = 2(K_{Hp}^{el}-1)/(1-K_{Hp}^{el})$ which characterize the interaction of the intermediate hadron $H$ with the nucleon.

It was shown in Ref. [12] that the optimal description of processes $pA \to pX$ at considerable (up to 6-7 GeV/c) $P_\perp$ is attainable in the similar model at $K_{Hp}^{el} \simeq 0.65$.

In the calculations of the present work there are used the mentioned value of the elasticity coefficient for nondiffractive processes $H_pN \to H_pX$ and the value of parameter $\sigma_{H_p}$ = = 5.5 $(GeV/c)^{-1}$. The obtained results together with experimental data [1] for the different nuclei are presented as curves in Fig.1a ( $P_\perp$ = 0.3 GeV/c) and Fig.1b ( $P_\perp$ = 0.5 GeV/c).

We notice that the fragmentation function (8) which corresponds to spectra $pp \to pX$ [14] and $K_{Hp}^{el}$ = 0.65 has a sharp peak at $x' = 1$, which substantiates the approximate factorization of (3) over $x'$ and $\vec{P}_\perp'$.

The similar calculation and comparison with the results [1] were carried out for processes $\pi^+ A \to \pi^+ X$ . The curves given in Fig.2a and 2b correspond to $b_{H_\pi} = 5.5$ (GeV/c)$^{-1}$ and $K^{el}_{H_\pi} =$ $= 0.63$.

The latter value for the elasticity coefficient exceeds somewhat the value $K^{el}_{H_\pi} = 0.60$ found in [12] in the description of spectra $\pi^- A \to \pi^- X$ with large $P_\perp$ ; however, such a difference at substantially changed characteristic transverse momenta $P_{\perp_H}$ , obviously, is not contradictory.

As for the description of processes $K^+ A \to K^+ X$ , here because of the large experimental errors we present only results of the calculations for two nuclei, $^{12}C$ and $^{64}Cu$ (Fig. 3a and 3b). The curves presented correspond to $b_{H_K} =$ $= 5.5$ (GeV/c)$^{-1}$ and $K^{el}_{H_K} = 0.70$.

It should be noted that in the calculation of spectra $hA \to hX$ the values of parameters $b_H$ for all the three processes were taken equal to $b_H = 5.5$ (GeV/c)$^{-1}$ *), which is close to the upper limit ( $\simeq 5$ (GeV/c)$^{-1}$ at $x \to 1$) [14] for the similar parameters $b_h$ ( $h \equiv p, \pi^+, K^+$ ) in nondiffractive processes $hp \to hx$ . From this point of view the experimentally observed [14] fall-off in $\langle P_{\perp_h} \rangle$ with increasing $x$ in these processes can be explained by a decrease in the mean decaying mass of the intermediate hadron which at $x \to 1$ must but insignificantly differ from the mass of hadron $h$ .

---

*) In the choice of the distribution $\sim e^{-b_H P_\perp^2}$ for spectra $HN \to HX$ the results rather close to the above-cited ones can be obtained at $b_H = b_h^{el}$

Now we discuss briefly the distinction of the approach suggested in this paper (see also Ref. [12] ) from some like models that have appeared in the recent years.

As was mentioned above, their main drawback is the phenomenological description of the processes only at the level of inclusive spectra $d\sigma^{hA\to hX}/dx$ integrated over $\vec{P}_{\perp_h}$ . In this connection it is appropriate to mark out Ref. [9] where experimental data [2] on spectra $d\sigma(p(\bar{p})A \to p(\bar{p})X)/dx$ are described in the model with leading baryonic (antibaryonic) cluster. The elementary inclusive cross sections of the leading clusters in nondiffractive processes here were normalized to the value of total inelastic cross section on the nucleon with subtracted (for antibaryons) annihilation cross section. This resulted in artificial overstating of energy losses, since the noticeable part of inelastic cross section ( ~ 5 mb) corresponds to the diffractive processes for which the energy losses are inessential. As a result, for a satisfactory description of the A dependence [2] the authors of [9] introduced the spectra $d\sigma^{HN\to HX}/dx \sim x^2$ with an overstated ( = 0.75) elasticity coefficient. The latter equally refers to Ref. [4] where just like in [3, 5-7] the comparison with experimental data [1] at $P_\perp =$ = 0.3 GeV/c was carried out with the use of the normalization factor. In general, to our opinion, not quite correct account of the diffractive part of the spectrum in elementary interactions is typical practically of all the works [4-9] .

It should be also indicated that the authors [5,6] used the model with constant nuclear density, which lead to a noticeable difference from the calculations of effective nucleon numbers at a more realistic nuclear density (of the Fermi t[illegible]

As a result, the introduced by authors [5,6] free parameter having a meaning of average energy losses in elementary collisions turned out to be unnaturally small.

* * * *

One of the assumptions of the present paper is that the leading hadrons in the fragmentation region are produced mainly owing to decays of intermediate leading hadrons $\bar{H}$. This, generally speaking, does not imply that the fragmentation of $\bar{H}$ describes all the objects in the projectile fragmentation region. Thus, in the formation of nonleading particles there may turn out essential some other mechanisms related in particular with hadronization of the sea partons of the leading system.

To estimate the contribution of the fragmentation mechanism to the production of nonleading hadrons, we have carried out calculations for most of inclusive spectra $h_1 A \to h_2 X$ [1] ($h_1 \neq h_2$) by the same scheme as for the corresponding processes of the "leading" type. Here the characteristics of HN-interactions according to the essence of the model itself were chosen the same as in the description of spectra of the corresponding leading particles; the spectra [illegible] $\to h_1 X$ were parametrized according to the data and approximations of [14].

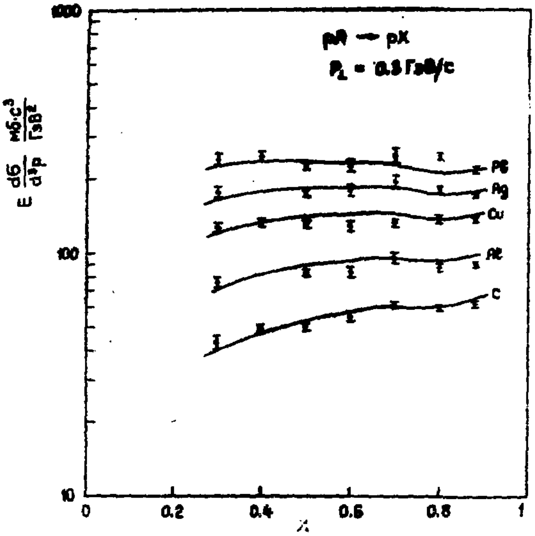
Fig. [illegible]a,b shows as an example the results of the calculations of inclusive spectra [illegible] $A \to$ [illegible] for three nuclei at $P_T = 0.3$ GeV/c (a) and $P_T = 0.5$ GeV/c (b).

On the whole, the situation with the description of data [1] on the nonleading hadrons looks contradictory. So, the agreement with the experiment for some processes ( $\pi^+ A \to pX$ , $\pi^+ A \to K^+ X$ , $pA \to \pi^- X$ ) turned out to be approximately at the same level as in Fig.4. At the same time in the description of spectra $pA \to \pi^+ X$ there was revealed an explicit underestimation of experimental data by theoretical ones practically for all nuclei in the whole range of variable $x$ .

We here refrain from making any definite conclusions on this point. Obviously they would have been premature before the appearance of new data on inclusive spectra of nonleading hadrons on nuclei, especially on the processes $pA \to \pi^+ X$ .

In conclusion we'd like to note that in the framework of a common approach the description of processes $hA \to hX$ both for small transverse transferred moments and for $P_\perp \simeq 1 - 7$ GeV/c [12] is to our mind a substantial argument in favour of the model proposed.

The author is thankful to S.R. Gevorkyan and H.R. Gulkanyan for the discussions.


pA → pX
$P_\perp$ = 0.3 ГэВ/с
E dσ/d³p мб·с³/ГэВ²
Pb
Ag
Cu
Al
C
1000
100
10
0
0.2
0.4
0.6
0.8
1
X

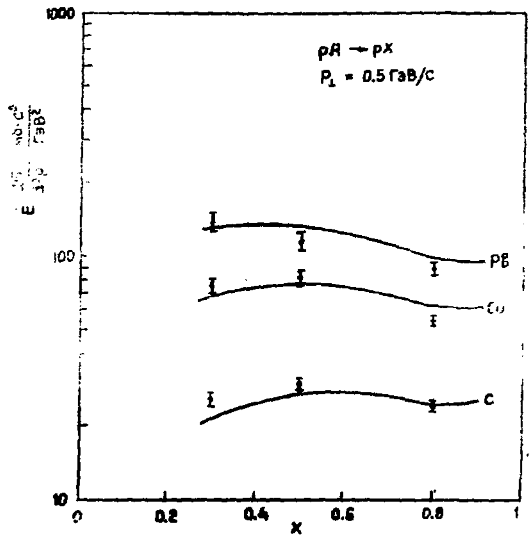
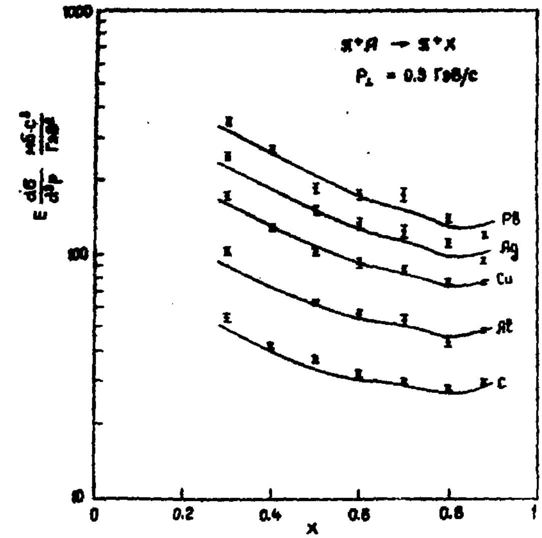

pA → pX
$P_\perp$ = 0.5 ГэВ/с
Pb
Cu
C
1000
100
10
0
0.2
0.4
0.6
0.8
1
X

Fig. 1


π⁺A → π⁺X
P⊥ = 0.3 ГэВ/c
E dσ/d³p мб·c³/ГэВ²
Pb
Ag
Cu
Al
C
X

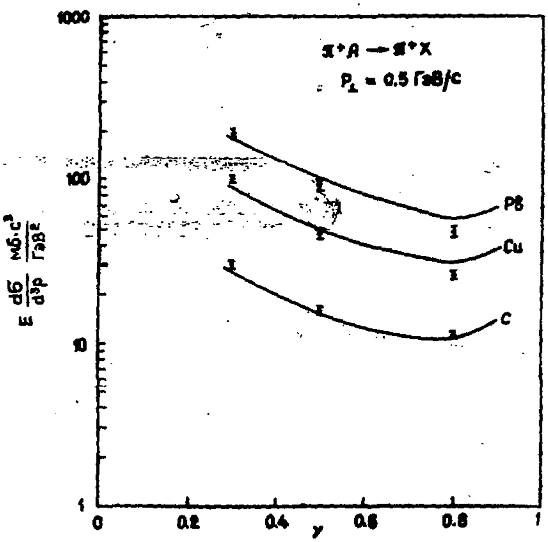
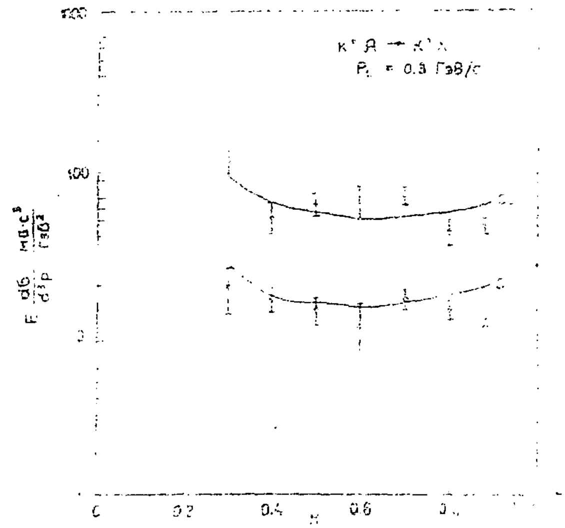

π⁺A → π⁺X
P⊥ = 0.5 ГэВ/c
E dσ/d³p мб·c³/ГэВ²
Pb
Cu
C
y

Fig.2


K⁺A → K⁺X
P⊥ = 0.3 ГэВ/c
100
Cu
C
0.4
0.6
x

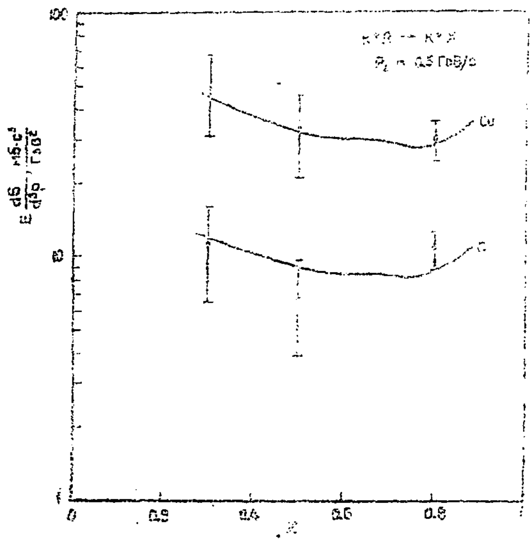

K⁺A → K⁺X
P⊥ = 0.5 ГэВ/c
100
10
1
Cu
C
0
0.2
0.4
0.6
0.8
x

Fig.

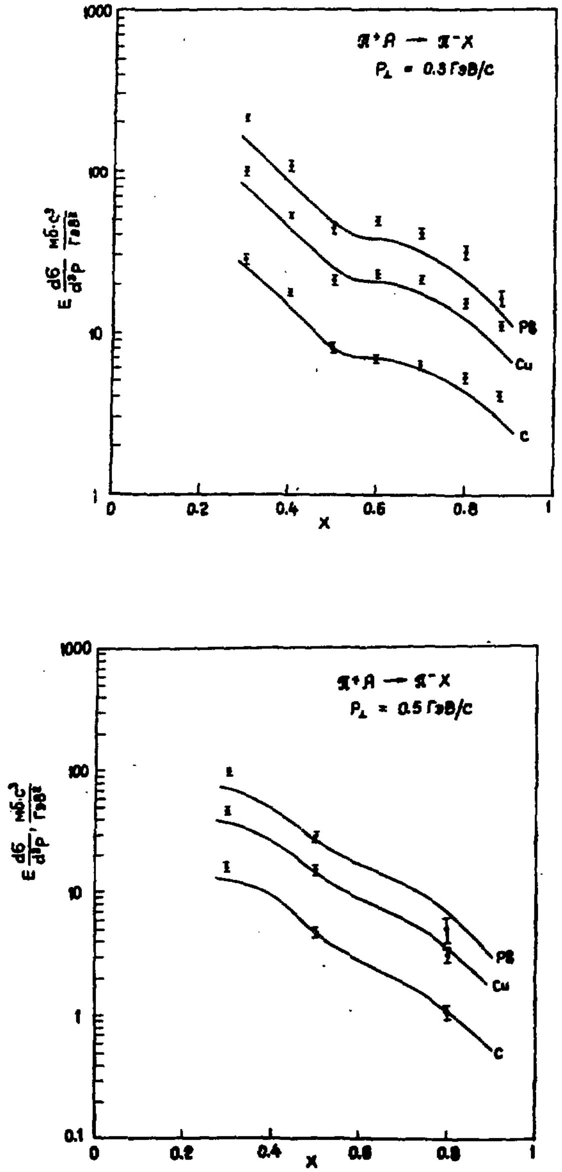



**fig.4**

## Figure Captions

Fig.1. Invariant cross sections of processes $pA \to pX$ as functions of $X$ at incident proton energy $E_o$ = 100 GeV. $P_\perp$ = 0.3 GeV/c (a), $P_\perp$ = 0.5 GeV/c (b).

Fig.2. Invariant cross sections of processes $\pi^+ A \to \pi^+ X$ as functions of $X$ at incident pion energy $E_o$ = 100 GeV. $P_\perp$ = 0.3 GeV/c (a), $P_\perp$ = 0.5 GeV/c (b).

Fig.3. Invariant cross sections of processes $K^+ A \to K^+ X$ as functions of $X$ at incident kaon energy $E_o$ = 100 GeV. $P_\perp$ = 0.3 GeV/c (a), $P_\perp$ = 0.5 GeV/c (b).

Fig.4. Invariant cross sections of processes $\pi^+ A \to \pi^- X$ as functions of $X$ at incident pion energy $E_o$ = 100 GeV. $P_\perp$ = 0.3 GeV/c (a), $P_\perp$ = 0.5 GeV/c (b).

## REFERENCES

1. Barton D.S., Brandenburg G.W., Busza W. et al. Phys.Rev., 1983, V.D27, P.2580-2599.
2. Bailey R., Blanar G., Bosman M. et al. Z. Phys., 1985, V.C29, P.1-8.
3. Gevorkyan S.R., Gulkanyan H.R., Kotzinian Ar.M., Zhamkochyan V.M. Preprint YERPHI-797(24)-85, Yerevan, 1985; Gevorkyan S.R., Gulkanyan H.R., Kotzinian Ar.M., Zhamkochyan V.M. Preprint YERPHI-843(70)-85, Yerevan, 1985.
4. Date S., Gyalassy M., Sumiyoshi H. Phys.Rev., 1985, V.D32, P.619-636.
5. Hwa R.C. Phys.Rev.Lett., 1984, V.52, P.492-495.
6. Csernai L.P., Kapusta J.I. Phys.Rev., 1984, V.D29, P.2664-2665.
7. Wong C.Y. Phys.Rev.Lett., 1984, V.52, P.1393.
8. Hufner J., Klar A. Phys.Lett., 1984, V.145B, P.167-170.
9. Noda H., Tashiro T. Z.Phys., 1989, V.C45, P.85-90.
10. Glauber R.J. Phys.Rev., 1957, V.105, P.1388-1398.
11. Жамкочян В.М. ЯФ, 1989, т.49, с.249.
12. Zhamkochyan V.M. Yad.Fiz., in print; preprint YERPHI-1237-90.
13. Antreasyan D., Cronin J.W., Frisch H.J. et al. Phys.Rev., 1979, V.D19, P.764-778.; Frisch H.J., Giokaris N.D., Green J.M. et al. Phys.Rev., 1983, V.D27, P.1001-1030.
14. Brenner A.E., Carey D.C., Elias J.E. et al. Phys.Rev., 1982, V.D26, P.1497-1533.
15. Murthy P.V., Ayre C.A., Gustafson H.R. et al. Nucl.Phys., 1975, V.B92, P.269-308.

16. Goulianos K. Phys.Rep., 1983, V.101, P. 171-219.

The manuscript was received 12 March 1990.

В.М.ЖАМКОЧЯН

О СПЕКТРАХ ЛИДИРУЮЩИХ АДРОНОВ В АДРОН-ЯДЕРНЫХ ВЗАИМОДЕЙСТВИЯХ

(на английском языке, перевод Асланян З.Н.)

Редактор Л.П.Мукаян

Технический редактор А.С.Абрамян

---

Подписано в печать 7/УШ-90г. ВФ-01460 Формат 60x84/16
Офсетная печать.Уч.изд.л.0,8 Тираж 299 экз. Ц.10 к.
Зак.тип.№ 193 Индекс 3649

---

Отпечатано в Ереванском физическом институте
Ереван, 36, ул.Братьев Алиханян,2

**The address for requests:**
**Information Department**
**Yerevan Physics Institute**
Alikhanian Brothers 2,
Yrevan, 375036
Armenia, USSR

ИНДЕКС 3649

ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ