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YEREVAN PHYSICS INSTITUTE

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ON THE A-DEPENDENCE OF CHARMED HADRON INCLUSIVE SPECTRA IN π-A COLLISIONS

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ՀՄԱՅՎԱԾ ՀԱԴՐՈՆՆԵՐԻ ԻՆԿԼՅՈՒԶԻՎ ՍՊԵԿՏՐԵՐԻ Ա-ԿԱԽՎԱԾՈՒԹՅՈՒՆՆԵՐԻ ՄԱՍԻՆ՝ πA-ՓՈԽԱԶԴԵՑՈՒԹՅՈՒՆՆԵՐՈՒՄ

Նախկինում առաջարկված մոդելի [1] շրջանակներում՝ բազմակի ցրման տեսության տարրերի կիրառմամբ, քննված է պիոն-միջուկային փոխազդեցություններում հմայված հադրոնների ծնման գործընթացը: Ձեռք բերվածը, ինչպես նաև [1] համաձայնությունը փորձարարական տվյալների հետ, ցույց է տալիս մոդելների [3] օրինաչափությունը, որոնցում ծնված c-քվարկը տանում է „ծնողական" հադրոնի իմպուլսի մեծ մասը:

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Г.Л.БАЛАЯН,С.Р.ГЕВОРКЯН,В.М.ЖАМКОЧЯН

ОБ А-ЗАВИСИМОСТИ ИНКЛЮЗИВНЫХ СПЕКТРОВ ОЧАРОВАННЫХ АДРОНОВ В πA- ВЗАИМОДЕЙСТВИЯХ

В рамках предложенной ранее модели [I] с использованием элементов теории многократного рассеяния рассмотрен процесс рождения очарованных адронов в пион-ядерных соударениях. Достигнутое, как и в [I] согласие с экспериментальными данными указывает на правомерность моделей [3] , в которых рожденный с - кварк уносит большую долю импульса "родительского" адрона.

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ON THE A-DEPENDENCE OF CHARMED HADRON INCLUSIVE SPECTRA IN π-A COLLISIONS

The process of charmed hadron production in pion-nuclei collisions is considered within the earlier suggested model [1] using elements of multiple scattering theory. The achieved (as in [1]) agreement with experimental data points out the validity of the models [3] where the produced c-quark carries away a larger portion of the "parent" hadron momentum.

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The study of processes of charmed hadron production on nuclei seems to be highly urgent for the analysis of possible models of charm production in elementary collisions. It is essential that the use of a nucleus as a target makes it possible to investigate both quantitative characteristics and space-time picture of processes at high energies.

Ref. [1] suggested a model which describes processes $hA \to hc(h\bar{c})X$ on the basis of methods of multiple scattering theory.

Its basic assumptions were as follows:

1) The incident hadron h already in the first inelastic interaction with the nucleus nucleon turns into excited hadronic state H which then interacts with nucleons with a cross section equal to the cross section of the "parent" hadron. The characteristic time of inelastic interactions is sufficiently small, which supports the assumption about a successive nature of the interactions.

2) The time of final state formation is so large that the observed hadrons are produced beyond the nucleus.

3) The charmed quarks produced in the elementary act $HN \to c\bar{c}X$ carry the major portions of momenta of final charmed hadrons h_c and $h_{\bar{c}}$. The interaction of $c\bar{c}$ pair with moving partons and nucleons of a nucleus is negligible.

Such assumptions seem to be quite justified at high energies considered; this is referred to in the conclusions of Refs. [2,3] .

It should be noted that in the leading hadron model [4] based on assumptions 1) and 2) there was achieved an agreement with a large set of experimental data on inclusive spectra of ordinary hadrons on nuclei in the incident particle fragmentation region.

The generalization of the model [4] with account of assumption 3) allowed us to describe [1] experimental data on the A-dependence in processes $NA \to h_c(h_{\bar{c}})X$.

Below, within the similar approach we considered processes $\pi A \to h_c(h_{\bar{c}})X$ and carried out a comparison with experimental data [5] .

Following [1] we write out the expression for inclusive cross section of the considered process as

$$\frac{d\sigma}{dx}^{\pi A \to h_c(h_{\bar{c}})X}(x,E) = \sum_{n=1}^{\infty} \frac{N_n^*(\sigma)}{\sigma^{n-1}} \Phi_n^{\pi h_c(h_{\bar{c}})}(x,E) ;$$

$$\Phi_n^{\pi h_c(h_{\bar{c}})}(x,E) = \int \frac{d\sigma}{dx_1}^{\pi N \to HX}(x_1) \frac{d\sigma}{dx_2}^{HN \to HX}(x_2) \cdots \times \qquad (1)$$

$$\times \frac{d\sigma}{dx_n}^{HN \to h_c(h_{\bar{c}})X}(x_n; x_1 \cdots x_{n-1} E)\, \delta(x - x_1 \cdots x_n)\, dx_1 \cdots dx_n ,$$

where

$$N_n^*(\sigma) = N(0,\sigma) - \sum_{i=1}^{n-1} N_i(\sigma) ;$$

$$N_n(\sigma) = \frac{1}{\sigma n!} \int (\sigma T(b))^n e^{-\sigma T(b)} d^2 b ;$$

$$N(0,\sigma) = \frac{1}{\sigma} \int (1 - e^{-\sigma T(b)}) d^2 b ;$$

$T(b) = \int \rho(\vec{b}, z)\, dz$ is a projection of one-particle nuclear density on the impact parameter plane; E is the incident pion energy.

The quantity σ in (1) represents an inelastic pion-nucleon cross section minus the cross sections of diffractive processes; here

$$\sigma = \sigma^{in}(\pi N) - \sigma_{diff}(\pi N) = \int_{x_{min}}^{x_{max}} \frac{d\sigma}{dx}(\pi N \to HX)\, dx \qquad (2)$$

where $x_{min} = \frac{m}{\sqrt{s}}$ is a minimum value of variable x in the lab system; x_{max} is a maximum value of variable x at which nondiffractive inelastic processes take place.

It is essential that in the considered model, as it follows from assumptions 1)-3), the following equalities hold:

$$\frac{d\sigma}{dx}(\pi N \to HX) = \frac{d\sigma}{dx}(HN \to HX) ,$$

$$\frac{d\sigma}{dx}(HN \to h_c(h_{\bar{c}})X) = \frac{d\sigma}{dx}(\pi N \to h_c(h_{\bar{c}})X) . \qquad (3)$$

The bottom equality reflects the fact that process $HN \to c(\bar{c})X$ is the last act of interaction in a nucleus, and the formation of the registered hadron $h_c(h_{\bar{c}})$ occurs outside the nucleus.

In the present work we have calculated inclusive spectra for processes $\pi^- A \to \mathcal{D} X$ at incident pion momentum 320 GeV/c.

Just like in [1,4], for simplicity we took

$$\frac{d\sigma}{dx}(HN \to HX) \equiv \text{const.}$$

Under the considered energy E=320 GeV the mentioned cross section was normalized to the value $\sigma \simeq 18$ mb.

Parametrizations for spectra $\frac{d\sigma^{\pi^- N \to h_c(h_{\bar{c}})X}}{dx}(x, E)$ were chosen in the form [6] :

$$\frac{d\sigma^{L}}{dx} \sim (1-x)^{1.8} \quad ; \qquad \frac{d\sigma^{NL}}{dx} \sim (1-x)^{7.9} \qquad (4)$$

respectively for registered $\mathcal{D}$ -mesons containing a valence quark of initial π^--mesons ($\mathcal{D}^-$ and $\mathcal{D}^0$), and for $\mathcal{D}$ -mesons having no such quark ($\mathcal{D}^+$ and $\bar{\mathcal{D}}^0$). The dependence of spectra on the incident pion energy was determined according to [7] .

We used in calculations the Fermi distribution for one-particle nuclear density,

$$\rho(r) = \rho_0 \Big/ 1 + \exp\left\{\frac{r-R}{c}\right\} \qquad (5)$$

with parameters taken from [8] .

In Figs 1 and 2 we give curves which describe quantities $\alpha(x)$ and $\beta(x)$ corresponding to approximation $\beta(x) A^{\alpha(x)}$

for effective nucleon numbers:

$$N_{eff}(x) = \frac{d\sigma^{\pi^- A \to \mathcal{D}X}}{dx} \Big/ \frac{d\sigma^{\pi^- N \to \mathcal{D}X}}{dx} \qquad (6)$$

Evidently, the difference in shapes of the curves for the two types of $\mathcal{D}$ -mesons is due only to the different dependences (4).

To carry out a comparison with experimental data [5] on the A-dependence in processes $pA \to h_c(h_{\bar{c}})X$ ($\llcorner\!\to \mu^+(\mu^-)$), a corresponding recalculation of inclusive spectra $\frac{d\sigma}{dx}(\pi^- A \to h_c(h_{\bar{c}})X$ is necessary, which was done according to the method [9] using normalizations [6,10] for cross sections $\sigma(\pi^- A \to \mathcal{D}X)$.

Figs 3 and 4 present the obtained values for indices α_{μ^+} and α_{μ^-} versus the lower threshold of muon registration.

The curve in Fig.5 presents the ratio $\sigma(\pi^- A \to \underset{\llcorner\to\mu^-}{\mathcal{D}}X) / \sigma(\pi^- A \to \underset{\llcorner\to\mu^+}{\mathcal{D}}X)$ for different nuclei at $P_\mu > 20$ GeV/c. All the cases demonstrate a perfect agreement with experimental data [8] .

The performed study of the A-dependence in processes $\pi^- A \to h_c(h_{\bar{c}})X$ just like the earlier accomplished [1] calculations on processes $NA \to h_c(h_{\bar{c}})X$ serve as a crucial argument in favour of the models [3] which assume the presence of states with fast charmed quarks in the incident hadron wave function.

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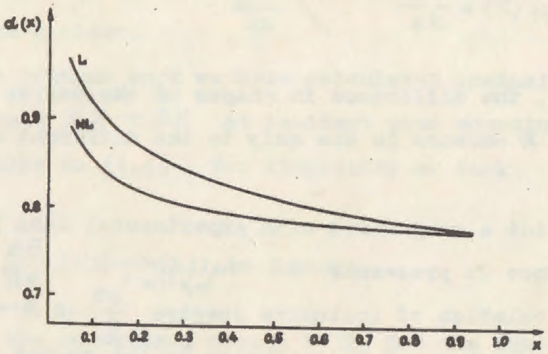

Fig.1

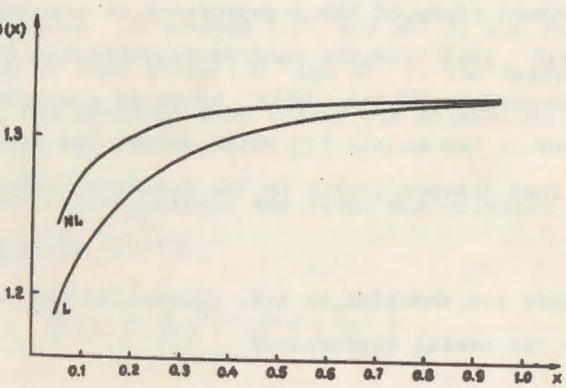

Fig.2

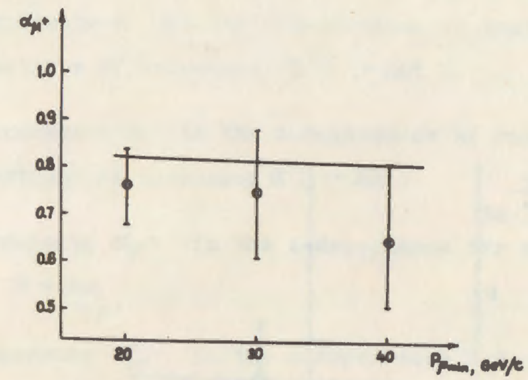

Fig.3

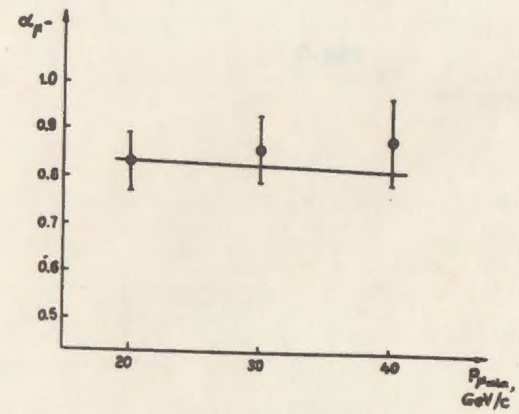

Fig.4

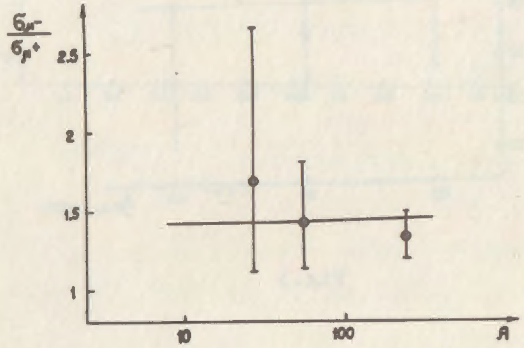

Fig.5

Figure Captions

Fig.1. Exponents α in the A-dependence of inclusive cross sections of processes $\pi^- A \to \mathcal{D} X$.

Fig.2. Parameters β in the A-dependence of inclusive cross sections of processes $\pi^- A \to \mathcal{D} X$.

Fig.3. Exponents α_{μ^+} in the A-dependence for processes $\pi^- A \to \mathcal{D} X$, $\mathcal{D} \to \mu^+$

Fig.4. Exponents α_{μ^-} in the A-dependence for processes $\pi^- A \to \mathcal{D} X$, $\mathcal{D} \to \mu^-$

Fig.5. The ratio $\sigma(\pi^- A \to \mathcal{D} X)_{\mu^-} / \sigma(\pi^- A \to \mathcal{D} X)_{\mu^+}$ for different nuclei at $P_\mu > 20$ GeV/c.

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