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ON THE DIFFERENCE OF SPECTRA AND STRUCTURE FUNCTIONS OF NUCLEI OBTAINED IN INCLUSIVE AND FORWARD-BACKWARD CORRELATION PRODUCTION OF CUMULATIVE PHOTOPROTONS

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ՄԻԱՄԱՍՆԻԿ ԵՎ ՀԱՄԱՏԵՂ ԾՆՎԱԾ ԵՏ-ԱՌԱՋ ԿՈՒՄՈՒԼՅԱՏԻՎ ՖՈՏՈՊՐՈՏՈՆՆԵՐԻ ԵՐԱՆԳԱՆԻՆԵՐԻ ԵՎ ՄԻՋՈՒԿՆԵՐԻ ԿԱՌՈՒՑՎԱԾՔԱՅԻՆ ԱՌՈՒՅԹՆԵՐԻ ՏԱՐԲԵՐՈՒԹՅԱՆ ՄԱՍԻՆ

Ցույց է տրված, որ եթե կումուլյատիվ ֆոտոպրոտոնները /ԿՖՊ/ գրանցվում են առաջ թռչող հադրոնների հետ /կումուլյատիվ պրոտոններ և π -մեզոններ/ և առանձին /միամասնիկ/, ապա ԿՖՊ երանգանիները տարբերվում են. ընդ որում, երկրորդ դեպքում այն ավելի կտրուկ է ընկնում։ Նաև ցույց է տրված, որ առաջին դեպքում տրոհվող համակարգի կառուցվածքային առույթը հարստացված է տրոհվող համակարգը կազմող բարձրիմպուլսային բաղադրիչներով։

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ON THE DIFFERENCE OF SPECTRA AND STRUCTURE FUNCTIONS OF NUCLEI OBTAINED IN INCLUSIVE AND FORWARD-BACKWARD CORRELATION PRODUCTION OF CUMULATIVE PHOTOPROTONS

It is shown that if the cumulative photoprotons (CPP) are registered in coincidence with the forward hadrons (noncumulative protons and π-mesons) and without coincidence (i.e. inclusive), then the CPP spectra are different, and in the latter process they are harder. It is also shown that in the former case the structure function of the fragmentation system (FS) in the CPP is enriched with high-momentum component of the FS constituents.

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Yerevan 1987

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О РАЗЛИЧИИ СПЕКТРОВ И СТРУКТУРНЫХ ФУНКЦИЙ ЯДЕР, ПОЛУЧЕННЫХ В ИНКЛЮЗИВНОМ И В ВПЕРЕД-НАЗАД КОРРЕЛЯЦИОННОМ РОЖДЕНИИ КУМУЛЯТИВНЫХ ФОТОПРОТОНОВ

Показано, что если кумулятивные фотопротоны (КФП) регистрируются в совпадении с вперед летящими адронами (некумулятивными протонами и π -мезонами) и без такого совпадения (т.е. инклюзивно), то спектры КФП различны, во втором случае спектры КФП более жесткие. Показано также, что в первом случае структурная функция фрагментирующей системы (ФС) в КФП обогащена высокоимпульсной компонентой составляющих ФС конституентов.

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Ереван 1987

1. Introduction.

In Ref. [1] we have presented results of the measurement of correlations between the cumulative protons (CP) and the forward protons and π-mesons produced by the bremsstrahlung γ-quanta with $E_{\gamma}^{max} = 4.5$ GeV from a ^{12}C target in the reaction:

$$\gamma + {}^{12}C \to \overleftarrow{P} + \overrightarrow{P}(\overrightarrow{\pi}) + X \qquad (1)$$

where "$\leftarrow$" and "$\rightarrow$" denote the backward (cumulative) and forward (noncumulative) particles, respectively. Such correlations are shown to be present. In the (pp) coincidence the presence of correlation is expressed through the dependence of the correlation function:

$$K_{pi} = \sigma_{tot}^{\gamma ^{12}C} \frac{f_{pi}}{f_p \cdot f_i} \qquad (2)$$

on angle and momentum, whereas in the ($p\pi$) coincidence - through the dependence on the CP momentum only (Fig. 1a,b). In the (1) f_{pi} is the two-

-particle invariant yield, f_p and f_i are the corresponding inclusive yields ($i = p, \pi$).

Following the above-cited results, in the present work we are making an attempt as to obtain information about the similarity of the CP energy spectra and the energy dependence of FS structure functions obtained in the CP inclusive production and in the coincidence with the forward hadrons.

2. Spectra.

The variation of the correlation function (2) with the CP energy (or momentum) (Fig. 1a,b) points out the alteration of the energy dependence of the two-particle spectra $f_{pi}(T, \Theta)$ as compared to the inclusive $f_p(T, \Theta)$. Note that the character of this variation (K_{pi} grows with increasing the CP energy) testifies that the kinematic restrictions are not important here. Indeed, with increasing the CP energy, the energy for the forward hadron becomes less and less. If there had acted the kinematic restrictions only, then at f_i = const the K_{pi} would have been a decreasing function with increasing T_p . The experiment shows a contrary situation; therefore, the variation of energy spectrum is connected rather to the mechanism of the CP production. There are similar experimental data on the correlation between the CP and the forward hadrons, obtained with the hadronic beams.

In Ref. [2] performed on the π^- beam with P = 3.7 GeV/c, there were studied correlations between the CP emitted in the angular range of 160^0 - 180^0 and the forward positive-charged hadrons ($P_{\bar{h}} \geqslant 0.8$ GeV/c). It was found that the correlation function " K^h_{ph} " is CP-energy-independent, i.e. the CP energy spectra are the same in correlation and without it (they are described well by the exponents with the same slopes). The difference between the cases with primary hadrons and γ -quanta, apparently, can be explained by the difference in the nature of interactions of γ -quanta and hadrons with the nucleus, which consists in the fact that the high-energy γ -quantum interacts with the nucleus once, whereas the hadron - $\nu \sim A^{1/3}$ times. Therefore, it is natural to expect in the hadronic data a considerable admixture in correlations, which is due to the coincidence of particles from different collisions. This in turn will result in the weakening of the dependence of the CP spectrum shape on the correlation. It follows from stated above, that if for the hadronic processes one chooses conditions when $\nu = 1$, then the variation of the spectrum in the case of correlated protons should be expected. Such conditions can be provided when studying the process (1) on the lightest nuclei (D, He) or by decreasing the incident hadron energy. Unfortunately, up to the present time, the correlation measurements on the lightest nuclei are performed neither for the low-energy photon beams nor for the high-energy (> 1 GeV) ones. However, there are results [3] obtained with 1 GeV proton on ^{12}C, when the number of interactions for the CP production cannot be more than unity. In Ref. [3] the CP spectra were measured at 109^0, in coincidence with the charged particles in the forward semisphere at -41^0. Fig. 2 shows the dependence of K_{pi} (or rather of the ratio $\frac{f_{pi}}{f_p}$) on the CP momentum. One can see the increase in K_{pi} with increasing the CP momentum. Fig. 2 also shows two our points at p = 0.4 GeV/c and p = 0.57 GeV/c. A good agreement can be observed here.

3. Structure Functions.

Consider the correlation function (2) versus the variable α which is a fraction of the fragmentation system momentum carried away by CP in the frame where the FS is fast. In this case $f_p(\alpha)|_{P_\perp} = \text{const}$ and $f_{pi}(\alpha)|_{P_\perp} = \text{const}$ are the momentum distribution of constituents in the fragmentator in the inclusive and the correlation cases, respectively.

Unfortunately, the present number of measured points is insufficient to study in detail the structure function $f_{pi}(\alpha, P_\perp)$, as it was done with the case of $f_p(\alpha, P_\perp)$ in [4,5] ; nevertheless, we can draw some conclusions as to the behaviour of $f_{pi}(\alpha)_{P_\perp=const}$ relative to $f_p(\alpha)_{P_\perp=const}$ versus α .

Fig. 3a,b presents K_{pp} and $K_{p\pi}$ as functions of α at three fixed values: $P_\perp$ = 0.2, 0.3 and 0.4 GeV/c. One can see that K_{pp} and $K_{p\pi}$ increase with α at fixed $P_\perp$. From (2) there follows:

$$f_{pi}(P_\perp,\alpha) = f_p(P_\perp,\alpha)\,\sigma_{tot}^{\gamma^{12}C}\cdot K_{pi}(P_\perp,\alpha) \qquad (3)$$

The increase of K_{pi} with α implies that the structure functions $f_{pi}(P_\perp,\alpha)$ differ from the same functions for the inclusive CP. To be more concrete, if $f_p(\alpha)_{P_\perp=const}$ is a decreasing function with α [4,5] , then $f_{pi}(\alpha)_{P_\perp=const}$ decreases relatively slow with α .

Thus, FS fragmentizing to CP and the forward hadrons are enriched with high-momentum constituents as against the FS fragmentizing to inclusive CP.

For the (pp) coincidences, in some cases one can even estimate quantitatively the variations of the structure function slope. Indeed, as can be seen from Fig. 3a, the α -dependence for all the $P_\perp$ is well-approximated by the exponent $K_{pp}(\alpha,P_\perp)=const\cdot\exp(\alpha/\alpha_{oK})$, where α_{oK} = 0.726±0.05. According to [4,5] , $f_p(\alpha, P_\perp)$ in the region $P_\perp$ = 0.2 ÷ 0.5 and at $\alpha \geqslant 1.5$ is well-factorized: $f_p(\alpha,P_\perp) = f_p(\alpha)\cdot f_p(P_\perp)$; here $f_p(\alpha)_{P_\perp=const} \simeq \exp(-\alpha/\alpha_{op})$ with α_{op} = 0.134. Taking account of the latter circumstance for $f_{pp}(\alpha)_{P_\perp=const}$, we obtain $f_{pp}(\alpha)_{P_\perp=const} \simeq \exp\left(-\frac{\alpha}{\alpha_{opp}}\right)$ where α_{opp} = 0.165 ± 0.06 , which differs substantially from α_{op} = 0.134.

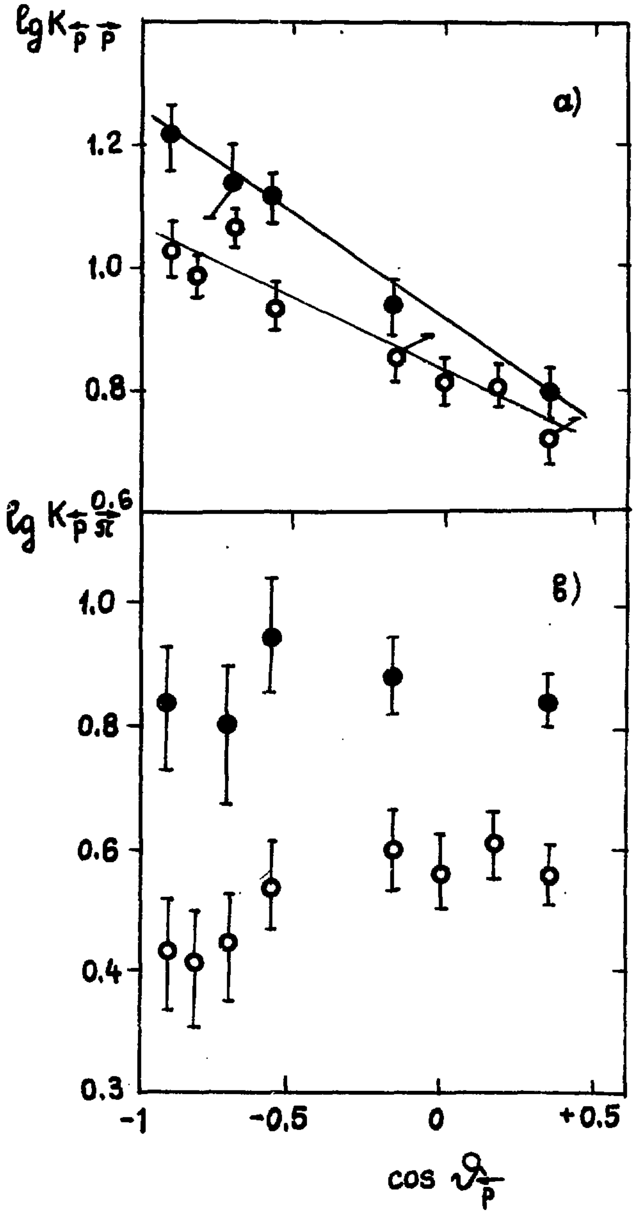

Fig.1

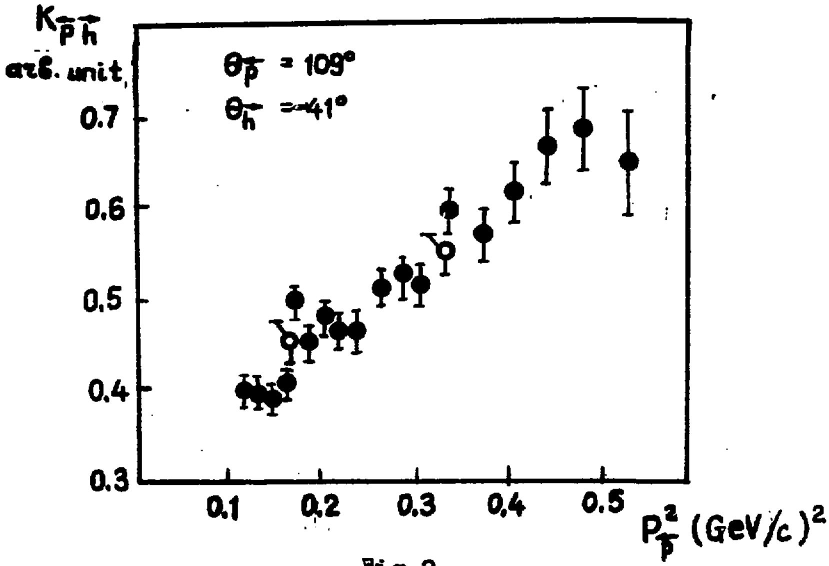

Fig.2

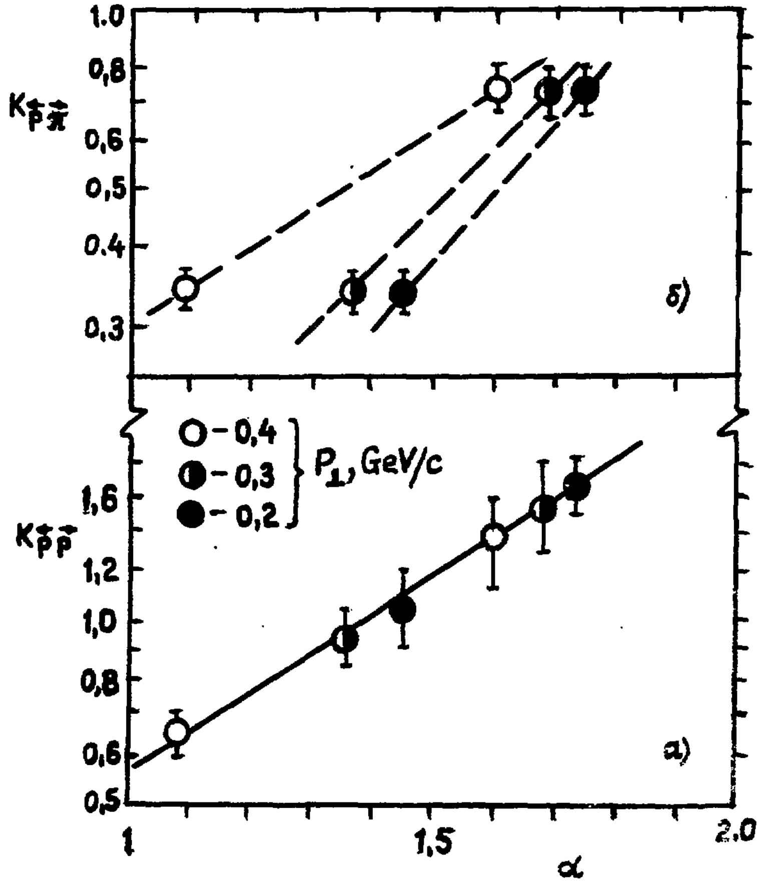

Fig.3

Figure Captions

Fig.1. The correlation functions $K_{\bar{p}\vec{p}}$ (a) and $K_{\bar{p}\vec{\pi}}$ (b) versus the emission angle of cumulative proton, $\theta_{\bar{p}}$, at two momenta: P_p = 0.4 (○) and 0.57 (●) GeV/c. The lines are drawn through experimental points for illustration only.

Fig.2. The ratio $\frac{f_{pp}}{f_p}$ (●) as a function of $p_{\bar{p}}^2$ of CP emitted at $\theta_{\bar{p}}$= 109^0; the forward hadrons emitted at -41^0 (○) - this work.

Fig.3. $K_{\bar{p}\vec{p}}$ ($P_\perp$, α) (a) and $K_{\bar{p}\vec{\pi}}$ ($P_\perp$, α) (b) as functions of α for three values of $P_\perp$ = 0.2 (●); 0.3 (◐) and 0.4 (○) GeV/c. For (a) the line is drawn through the points by the least-square method according to the relation $K_{\bar{p}\vec{p}}(\alpha) \sim \exp(\alpha/\alpha_{0K})$ with α_{0K} = 0,726 ± 0.06. For (b) the lines through the points for the given $P_\perp$ are drawn by eye.

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