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INCLUSIVE GAMMA PRODUCTION IN π-p INTERACTIONS AT 5 GEV/C

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The extensive amount of data on the multiparticle production in hadron-hadron collisions have been collected recently. It should be noted that the inclusive spectra of secondary particles show the scaling properties at not very high energies.

For the inclusive reaction

$$\pi^- p \to \gamma + \ldots \qquad (1)$$

the first indication for scaling behaviour of the invariant cross section has been made in ref. [1]. This conclusion was based on the comparison of normalized inclusive spectra for reaction (1) at 40 *GeV* with those for $pp \to \gamma + \ldots$ at 1500 *GeV* [19]. There exist data for reaction (1) at 18.5 *GeV* [2], 100 *GeV* [3] and 205 *GeV* [4] too. In these investigations, however, the analysis of the structure function energy dependence has not been performed.

This paper presents the results of an experimental study of reaction (1) at 5 *GeV*. The inclusive spectra are compared with the experimental results at higher energies.

Experimental Data

The data for this study were obtained from the analysis of 230000 pictures taken with the one-meter JINR propane bubble chamber exposed to the 5 *GeV/c* π^- beam [5] at the JINR synchrophasotron.

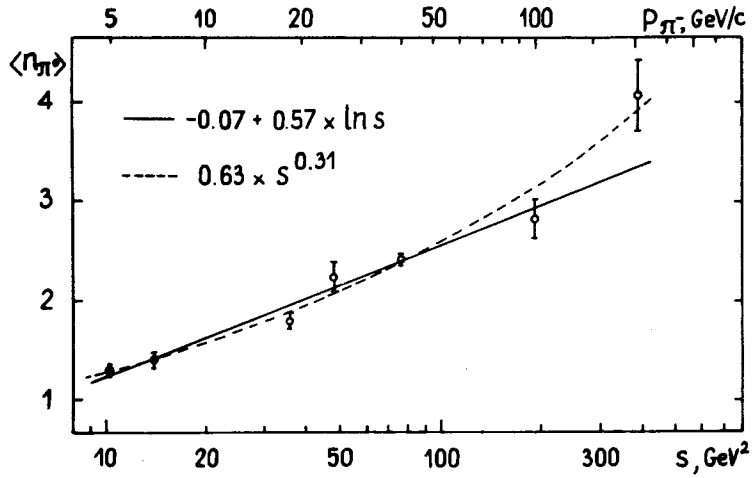

Fig. 1.

The processing of gamma-quanta events has been described elsewhere /6/. After the analysis of measured events 7940 gamma-quanta were selected for the purpose of the experiment. For this sample the average relative error of the gamma momentum measurement is equal to 11.3%, the average errors of the azimuthal and dip angle determination are 3 and 7 mrad, respectively. The average weight of the gamma-quantum (the quantity inverse to the detection probability) is equal to 6.21± ±0.06. It was ascertained in the result of the methodical investigations that no significant systematic losses of gamma-quanta were observed.

The average number of gamma-quanta per inelastic collision is determined under the assumption that the only source of gammas are π° -decays*.

The extensive experimental information on the reaction channel cross sections (including multiple neutral

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* Part of gammas from the other sources ($\eta \to \gamma\gamma$, $\Sigma^\circ \to \Lambda^\circ \gamma$,...) is estimated to be smaller than 1%.

particle production) for $\pi^- p$ interactions at 5 *GeV* have been published /7-14/. Using these data we determined the average number of neutral pions $\langle n_{\pi^\circ} \rangle$ per inelastic collision to be equal to 1.29 ± 0.04. Data on average π° multiplicity for $\pi^- p$ interactions in the energy range 7-205 *GeV* /1-4,15,16/, together with the value obtained at 5 *GeV*, are shown in fig. 1 as a function of the center of mass squared energy s. The curves show the results of fitting the experimental data by logarithmical ($P(\chi^2)=0.04$) and power ($P(\chi^2)=0.22$) average multiplicity dependence on the energy.

The average gamma multiplicity related to the given $\langle n_{\pi^\circ} \rangle$ value is equal to $\langle n_\gamma \rangle = 2.58 \pm 0.07$, and the inclusive cross section for gamma production is equal to 61.4 ± ±2.1 *mb*.

The average transversal momentum of gamma-quanta $\langle p_T \rangle$ is equal to 0.172 ± 0.002 *GeV/c*. Note that the $\langle p_T \rangle$ value at 5 *GeV* coincides, within error limits, with the data at 18.5 and 40 *GeV* (0.172 ± 0.002 *GeV/c* and 0.179 ± ±0.007 *GeV/c*, respectively).

Inclusive Distributions

The distribution of $\frac{d\sigma}{dy} = \pi \int E \frac{d^3\sigma}{d^3p} dp_T^2$ as a function of the center-of-mass rapidity y is shown in fig. 2 in comparison with data at 40 *GeV** and 100 *GeV*. One can see, that at 5 *GeV* in the $0 < y < 0.6$ interval the value of $\frac{d\sigma}{dy}$ reaches the maximum and, within the error limits, coincides with the data at higher energies. The region of maximal values of $\frac{d\sigma}{dy}$ becomes wider with increasing energy.

Fig. 3 shows the center-of-mass angular distribution of gammas $\frac{d\sigma}{d\Omega}$ as a function of the emission angle θ.

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* In order to plot unnormalized distributions at 40 *GeV*, the value of the inelastic cross section from ref. /17/ has been used.

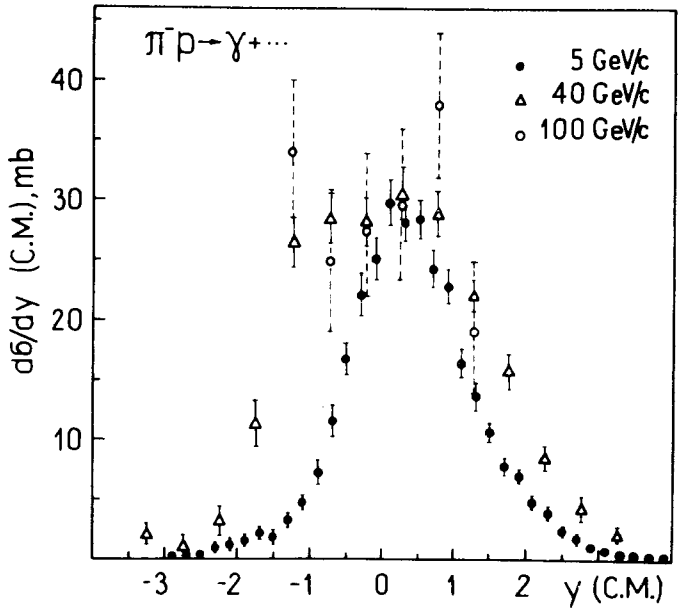

Fig. 2

In the interval of $60° < \theta < 90°$ both distributions coincide within the error limits. Moreover, they are in agreement with the value of $\frac{d\sigma}{d\Omega}\Big|_{\theta \simeq 90°} = 4.75 \pm$ ± 0.65 *mb/sr* obtained from $\frac{2E}{\pi\sqrt{s}} \frac{d\sigma}{dx}$ distribution at 100 *GeV*.

Let us consider the inclusive distribution behaviour in the fragmentation regions of the target (small longitudinal momenta in the lab. frame) and the incident pion (small longitudinal momenta in the projectile rest frame).

Fig. 4 shows the differential cross sections

$$E\frac{d\sigma}{dp_L} = \int E\frac{d^3\sigma}{d^3p}\,dp_T^2$$

at 5 *GeV* and 40 *GeV*[18] as a function of the longitudinal momentum p_L in the lab. frame. The same figure shows the ratio R of these quantities. One can see, that in the

region $p_L < 0.5$ *GeV/c* these two distributions practically coincide (average value of R in this region is equal to 0.98 ± 0.05).

Similar distributions for the projectile frame are shown in Fig. 5. In this case the region of the coincidence is wider - $p_L < 2$ *GeV/c*, the average value of R is 1.00 ± 0.05.

The experimental data quoted above could be considered as a reason for the following conclusion.

Integrated over p_T^2, the single particle inclusive distribution for reaction (1) does not depend on the energy:

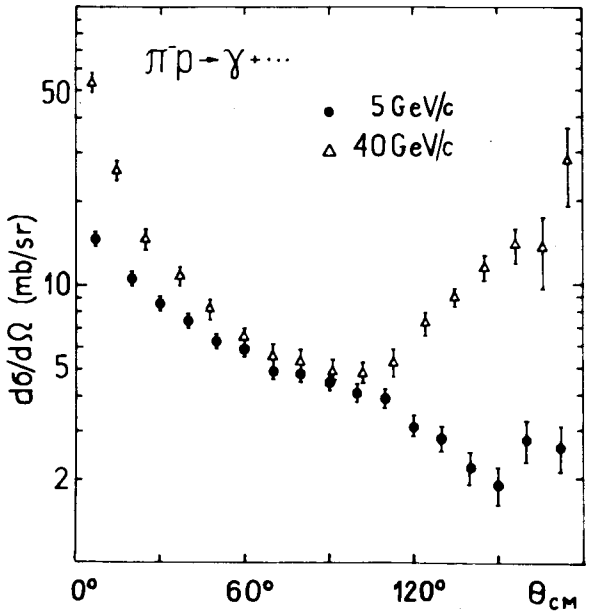

Fig. 3

- in the central region within the interval of 5-100 *GeV*,

- in the fragmentation regions within the interval of 5-40 *GeV* (no data exist for fragmentation regions at higher energies).

This result may indicate that the production of gamma-quanta in π^-p -interactions shows scaling behaviour already at the energy of 5 *GeV*.

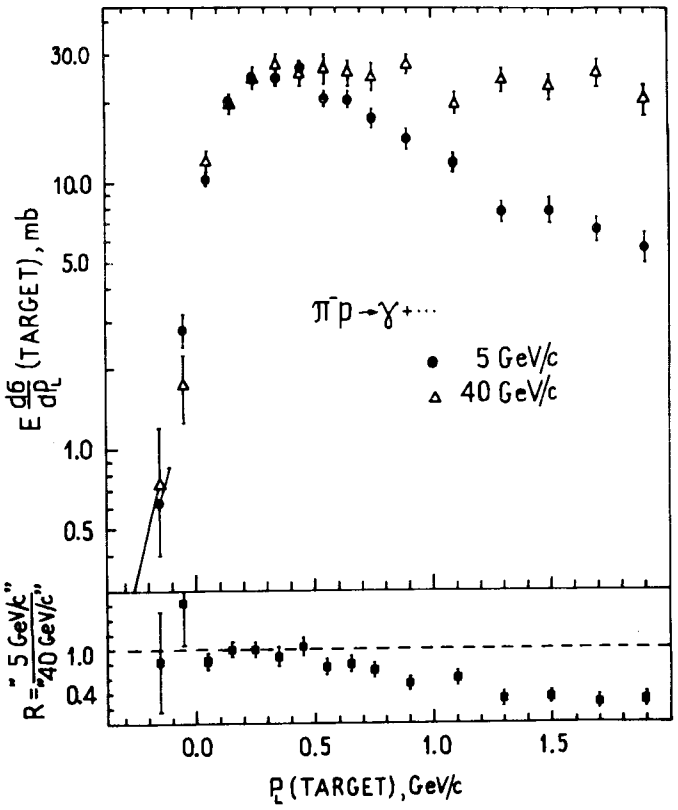

Fig. 4

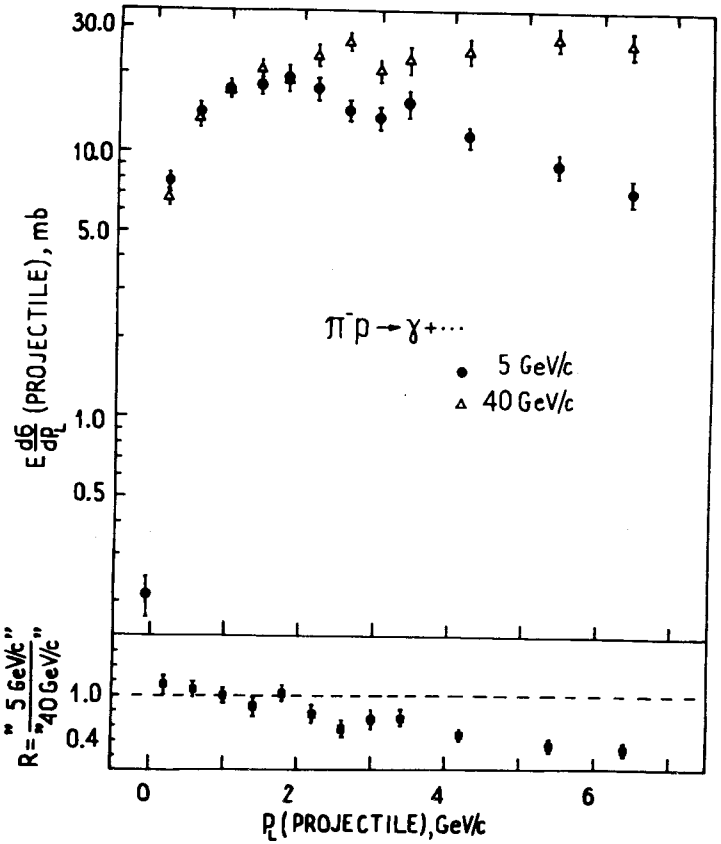

Fig. 5

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