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ЛАБОРАТОРИЯ ВЫСОКИХ ЭНЕРГИЙ

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# ON THE MEAN NUMBER OF $\pi^0$ MESONS PRODUCED IN INELASTIC $\pi^-$ PROTON COLLISIONS AT 6-8 GeV/c

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# Среднее число $\pi^0$-мезонов, образованных в неупругих $\pi^-$-протон столкновениях при 6-8 Бэв/с

По электронно-позитронным парам определено среднее число $\pi^0$-мезонов, образованных в неупругих двухлучевых $\pi^- p$ -взаимодействиях при 6,8 и 7,5 Гэв/с, сопровождающихся испусканием медленного протона с импульсом от 180 до 500 Мэв/с. Число $\pi^0$-мезонов оказалось равным $0,6 \pm 0,2$. В то же время из распределения событий по недостающим массам следует, что это число не должно быть меньше двух. С этим, возможно, связано наблюдаемое низкое значение среднего продольного импульса всех вторичных частиц. Полученные результаты скорее всего относятся к группе взаимодействий, в которых импульс вторичного $\pi^-$-мезона больше 1,5 Гэв/с.

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Kopylova D.K., Ljubimov V.B., Spirchez M.

# On the Mean Number of $\pi^0$ Mesons Produced in Inelastic $\pi^-$ Proton Collisions at 6-8 GeV/c

The mean number of $\pi^0$ mesons produced in inelastic $\pi^- p$ two prong collisions at 6.8 and 7.5 GeV/c has been studied by means of converted electron-positron pairs. A rather small value equal to $0.6 \pm 0.2$ has been found. At the same time the missing mass distribution for these events is peaked approximately at a value corresponding to $2\,\pi^0$. The low value of the total longitudinal momentum of secondary particles ($450 \pm 46$) MeV/c might be connected with the above mentioned results. It is very probable that a great contribution to these results is due to those collisions in which the momentum of the secondary $\pi^-$ is greater than 1.5 GeV/c.

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**Dubna. 1964.**

This paper is concerned with the study of the multiplicity of $\pi^0$ mesons produced in $\pi^-$ - proton ( $\pi p$ ) two prong inelastic interactions at 6.8 and 7.5 GeV/ c incident pion energy. The experiment was performed in the propane bubble chamber ( 24 litre) exposed at the synchrophasotron in Dubna.

The set of data consists of two samples. The first one was obtained with incident $\pi^-$ - mesons of momentum ( $6.8 \pm 0.6$) GeV/ c. It constituted also a part of the material analysed in [1,2]. The other sample was obtained with incident $\pi^-$ - mesons of momentum ( $7.5 \pm 0.6$) Gev/ c.

The main purpose of this work was to continue the investigation performed in [2] and to check on an enlarged statistics the validity of some results found there.

## 1. Selection Criteria

During the scanning the two prong $\pi p$ interactions were visually selected by the well known criteria described in [3]. The scanning efficiency was 98%. Only those events having a black prong among secondaries were taken for the further analysis. All black prongs of positively charged secondaries were considered protons and negatively ones $\pi^-$ - mesons.

The events in the first sample were measured and momenta and angles of the outgoing particles were calculated. Further we chose only those events in which the secondary proton had a momentum $P$ ( $180 < P < 500$) MeV/ c.

For each event we calculated the value

$$M_t = \Sigma ( E_i - P_i \cos \theta_i )$$

where $E_i$ , $P_i$ , $\theta_i$ means respectively the energy, momentum and emission angle of the i-th secondary particle, in the laboratory system. The $M_t$ value should not be greater than 1.1 GeV/ $c^2$.

From all two prong events selected by these criteria we excluded the elastic and quasielastic ones imposing kinematical conditions ( complanarity, angle-angle relation).

At last the missing mass criterium [1] was applied in order to eliminate quasielastic and pion-carbon collisions. So, as it follows from [1,4] quasielastic events in any case are not altering our sample.

For the first sample, ~ 3000 pictures were scanned. From the total of 279 two prong stars with one black track, only 52 satisfied all the above mentioned criteria and they constituted the first part of our material.

For the second sample, ~ 6000 pictures were scanned and 601 two prong events were selected by the same visual criteria as for the first one. Since we were interested only in the total number of inelastic $\pi p$ events and not in the kinematical characteristics of the tracks, we considered that it is not necessary to perform complete measurements.. However we tried to eliminate more carefully the events which did not fulfil the condition ( $180 < P < 500$ ) MeV/ c. In order to do this, we measured all doubtful events. Then, by mere comparison of the ratio of inelastic $\pi p$ to the total number of two prong events, we evaluated the number of inelastic $\pi p$ events in the second sample. Because of the nearly equal incoming energy and the equal number of primary tracks which led to an interaction in both samples, we considered that by these means at any rate we do not overestimate the number of inelastic $\pi p$ collisions. In this way we found it to be 112.

2. Analysis of Electron-Positron Pairs.

All electron-positron pairs which visually emerged from the point of interaction were registered. The events for which at least one pair has been found were completely measured in both samples. The number of $\pi p$ interactions among them was established by applying all criteria described for the first sample. After calculations it was finally settled which pairs producing gammas really originated in the primary observed star. Altogether we found 6 photons in the first sample and 19 in the second one.

For each photon a correction $W$ ("statistical weight"), which takes into account the dependence of registration effectiveness on geometric conditions and energy, was introduced. We got the total number of photons produced in our set and we calculated the mean number of photons for one interaction ( Table I). One must not forget that the main assumption underlying our investigation was that at least one neutral particle is produced in every selected event. In this respect, if we consider that all $\gamma$ quanta originate from meson decay we see that the average number of these $\pi^0$'s within limits of 3 standard errors is smaller than one. The same result is obtained in each sample and in their sum. We thought it interesting too, to plot the missing mass ( $M_x$ ) distribution ( Fig.1) . From the already mentioned result of low number of produced $\pi^0$ mesons one should expect the maximum to lie approximately at one pion rest mass. The experimental distribution ( Fig.1).( missing mass for the first sample) contradicts this fact.

As in the second sample we had at our disposal only the $M_x$ values for events with registered $\gamma$ ( let us call them, hereafter $\pi p \gamma$ ) we plotted them together with the same kind of events from the first sample ( Fig.2). The evaluated mean number of $\pi^0$ mesons for $\pi p \gamma$ events is $1.2 \pm 0.4$.

It seems that a large contribution to all these results is due to events with $P_{\pi^-} > 1.5$ GeV/c.

We should like to express our gratitude to M.I.Podgoretsky for many useful discussions and valuable advices, to Prof. V.I.Veksler, for his permanent interest in this work, and to A.C.Mihul for interesting discussions.

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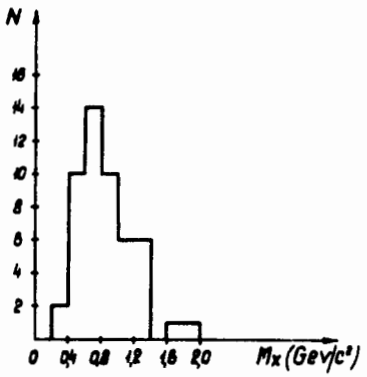


Fig. 1. Distribution of $M_x$ values ( first sample).

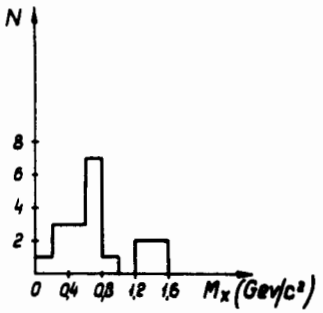


Fig. 2. Distribution of $M_x$ values ( $\pi p \gamma$ events from both samples).

Table I

| Energy | Number of two prong events | Number of inelastic events | Observed number of photons | Calculated total number of photons | Number of photons per interaction |
|---|---|---|---|---|---|
| 6.8 | 279 | 52 | 6 | $49 \pm 20$ | $0.9 \pm 0.4$ |
| 7.5 | 601 | 112 | 19 | $143 \pm 33$ | $1.3 \pm 0.3$ |
| $6.8 \pm 7.5$ | 880 | 164 | 25 | $192 \pm 38$ | $1.1 \pm 0.3$ |

Table II

| Momentum of secondary $\pi^-$ (GeV/c) | Number of inelastic events | Observed number of photons | Calculated total number of photons | Number of photons per interaction |
|---|---|---|---|---|
| $P_{\pi^-} < 1.5$ (A) | 44 | 14 | $120 \pm 32$ | $2.9 \pm 1.1$ |
| $P_{\pi^-} > 1.5$ (B) | 120 | 11 | $72 \pm 22$ | $0.6 \pm 0.2$ |

Table III

| | A | B | A+B |
|---|---|---|---|
| $\bar{P}_{\parallel}\ \pi^-$ | $787 \pm 20$ | $3690 \pm 221$ | $2908 \pm 243$ |
| $\bar{P}_{\parallel}\ p$ | $252 \pm 38$ | $213 \pm 11$ | $225 \pm 14$ |
| $\bar{P}_{\parallel}\ \gamma$ | $3065 \pm 1375$ | $562 \pm 219$ | $1204 \pm 336$ |
| $\bar{P}_{\parallel}\ K^\circ$ | — | $164 \pm 164$ | $164 \pm 164$ |
| $\Sigma \bar{P}_{\parallel}$ | $4396 \pm 1380$ | $4629 \pm 351$ | $4501 \pm 446$ |
| $M_t$ | $906 \pm 42$ | $804 \pm 18$ | $830 \pm 17$ |