

## Estimate of the contribution of diffraction dissociation and inelastic recharge in generation of leading neutral pions

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The experimental data about the contribution of processes of an inelastic recharge incident of a hadron in derivation of leading of neutral pions at the energy  $E > 10^{13} eV$ , obtained on complex installation Physics Technology Institute (Tjan-Shan H=3340) are presented. The events occurred in a target and registered in rentgen-emulsive chamber and ionization calorimeter were studied. It is shown, that the defining role in generation leading  $\pi^0$  - of mesons with  $U > 0, 2$  is brought in by an inelastic recharge of a primary hadron.

### 1. Introduction

For a long time on Tjan-Shan station of cosmic ray IPT MES RK, located on height 3340 above a sea level, the experiment on investigation hadrons of cosmic radiation will be carried out in the region of energy  $\geq 10^{13}$ . The given researches were carried out on complex installations "Hadron - 9" and "Hadron - 44" consisting of ionization calorimeters, x-rays chambers both targets from carbon and iron. There is an opinion, that during generation of families of  $\gamma$ -quantums the main role is played by interactions of primary pions with atomic nucleus of a target [1,2]. Really, already long time is known that of energy transmitted in the neutral component -  $K_{\pi^0}$  at collisions of pions higher, than at interaction of nucleons. Besides the experiments on accelerators testify that in  $p - p$  interactions as against  $\pi - p$  of interactions  $\gamma$ -quantums with energy  $U = \frac{E_{\gamma}}{E_0} \geq 0, 2$  practically are not observed. On the data of Neihoffer [3], obtained on colliding beams at =1500 GeV, the energy distribution of  $\gamma$ -quantums impinges up to zero at  $U \approx 0, 15$ . At the same time, according to results [4] a spectrum of  $\gamma$ -quantums from  $p -$  of interactions at = 205 GeV before values  $U = 0, 7-0, 8$  reach. It is known, that at a level of mountains the flux of hadrons consists of nucleons and pions, and the part of pions makes on different estimates from 30 up to 50 per cent. Taking into account that, it is possible to assume, that the formation leading  $\pi^0$  - of mesons at a level of mountains generating families of  $\gamma$ -quantums, happens, in main, in interactions initial of pions to atomic nucleus of substance. On our sight, main mechanisms responsible for generation leading  $\pi^0$  - of mesons, is, the inelastic recharge and diffraction dissociation of pions [5]. This point of view on formation leading  $\pi^0$  - of mesons is grounded on results of experiment [6]. We analysed 1508 interactions in a carbon target ( $x \approx 0, 15$ ) and 1057 interactions occurred in a target from iron ( $x \approx 0, 18$ ), registered on complex installations "Hadron - 9" and "Hadron - 44". As show outcomes of the analysis, a long of interactions, in which the leading neutral pions with relative energy  $U_{\pi^0} = \frac{E_{\pi^0}}{E_0}$  in collisions of hadrons with nucleus both carbon, and iron does not depend on primary energy and atomic number of a nucleus of a target (tab. 1,2).

### 2. Experimental data

From given reduced in the tables 1 and 2 it is visible, what both in a case with carbon, and in a case from an iron target of a part of interactions with formation leading  $\pi^0$  - of mesons with various  $U_{\pi^0}$  does not vary in limits of errors with growth  $U_{\pi^0}$  and for values  $U_{\pi^0} \geq 0, 2$  make  $\approx 0, 22 - 0, 25$ .

**Table 1.** Dependence of probability of generation leading  $\pi^0$  - of mesons from their energy and from a total energy interaction for a target from carbon.

$U_{\pi^0}$	$E_0, TeV$				
	3-5	5-10	10-15	15-30	30-50
$\geq 0,2$	-	-	$0,22 \pm 0,04$	$0,20 \pm 0,05$	$0,20 \pm 0,06$
$\geq 0,3$	-	$0,13 \pm 0,02$	$0,14 \pm 0,03$	$0,09 \pm 0,05$	$0,11 \pm 0,07$
$\geq 0,4$	-	$0,11 \pm 0,02$	$0,09 \pm 0,03$	$0,10 \pm 0,05$	$0,08 \pm 0,06$
$\geq 0,5$	$0,07 \pm 0,01$	$0,08 \pm 0,02$	$0,06 \pm 0,02$	$0,06 \pm 0,03$	*
$\geq 0,6$	$0,04 \pm 0,01$	$0,05 \pm 0,02$	$0,04 \pm 0,03$	*	*
$\geq 0,7$	$0,020 \pm 0,00060$	$0,02 \pm 0,01$	$0,03 \pm 0,02$	*	*

**Table 2.** Dependence of probability of generation leading  $\pi^0$  - of mesons from their energy and from  $E_0$  at interaction with nuclei of iron.

$U_{\pi^0}$	$E_0, TeV$		
	10-15	15-30	30-50
$\geq 0,2$	$0,27 \pm 0,04$	$0,23 \pm 0,04$	$0,27 \pm 0,05$
$\geq 0,3$	$0,17 \pm 0,03$	$0,17 \pm 0,03$	$0,14 \pm 0,04$
$\geq 0,4$	$0,13 \pm 0,03$	$0,10 \pm 0,03$	$0,13 \pm 0,04$
$\geq 0,5$	$0,07 \pm 0,03$	$0,13 \pm 0,04$	$0,08 \pm 0,04$

Note. The crossed out sections mean, that the energies of a primary particle not have enough for observation  $\pi^0$ - of a meson with a given data  $U_{\pi^0}$  and given threshold of registration, \* - insufficiency of a statistical material.

In article [7] cross section of birth  $\pi^0$ - of mesons with  $U_{\pi^0} \geq 0,7$  at 40 GeV for p- of interactions is bring. This value is equal 0,96 mbn, that corresponds  $\approx 4,4$  per cent of all interactions. If to accept, that the part of pions in hadron flux at height of mountains makes 40 per cent, what is represented quite reasonable [8], our data give a part of interactions with generation  $\pi^0$  of mesons with  $U_{\pi^0} \geq 0,7$ , equal 5 per cent. The estimate of the contribution of diffraction dissociation of protons and pions with formations of  $\gamma$  - *quantums* ( $\pi^0$ - of mesons) was carried out by us [9] earlier. Was shown, what the contribution of diffraction dissociation of hadrons is swept up up to relative energies  $\pi^0$ - of mesons  $U_{\pi^0} = 0,3$ , even  $U_{\pi^0} \geq 0,2$  the given process provides appearance only 4 per cent of interactions with birth leading  $\pi^0$  - of mesons of such energy. At the same time, agrees by the data of our experiment is observed  $\approx 23$  per cent of events with  $U_{\pi^0} \geq 0,2$  (tab. 1,2) Therefore, it is logical to explain an overwhelming part leading  $\pi^0$ - mesons by processes of an inelastic recharge of a charged pion in neutral. According to calculations of work [10] probability of the process of a recharge  $\pi^\pm - \pi^0$  with formation of a leading neutral pion ( $x \geq 0,5$ ) makes  $\approx 20$  per cent and feebly depends on primary energy. The theoretical estimate of probability of an inelastic recharge within the framework of model of additive quarks is reduced Yu.M. Shabelski [11]. For interactions  $\pi^0$  - of mesons with nuclei of atoms of iron the probability of a recharge in  $\pi^0$  - mesons makes  $\approx 0,40$ . Before analyze our results reduced in the tables 1,2 is possible to estimate probability of an inelastic recharge, setting a part of pions in flux of

hadrons at a level of mountains. If to put, that this part makes 40 per cent, the probabilities of a recharge in  $\pi^0$ -mesons with  $U_{\pi^0} = E_{\pi^0}/E_0$  are equal:

$$W(U \geq 0, 2) = 0,45 \pm 0,10; \quad W(U \geq 0, 3) = 0,32 \pm 0,05;$$

$$W(U \geq 0, 4) = 0,25 \pm 0,05; \quad W(U \geq 0, 5) = 0,17 \pm 0,03;$$

### **3. Conclusions**

Experimental data is received on our installation let us confirm about predominate contribution inelastic recharge in generation of leading neutral pions.

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