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COHERENT PRODUCTION OF CHARGED PARTICLES ON NUCLEI BY 400 GEV/C PROTONS.

ALMA-ATA - GATCHINA - MOSCOW - TASHKENT COLLABORATION.

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ABSTRACT

Topological cross sections $\sigma^{(n)}_{coh}$ (n = 1, 3, 5 and 7) of coherent diffractive dissociation of 400 Gev/c protons on nuclei of photoemulsion elements have been measured. Topological cross sections increase in the energy range from 20 to 400 Gev/c. This growth is the most noticeable for multiprong topologies. The total cross section of diffractive coherent production also increases from 8 to 25 mb/nucleus in this energy range. The increasing of the average multiplicity of charged particles in reaction of coherent proton dissociation is consistent with the logarthmic law $\langle n \rangle_{coh} = (0.25 \pm 0.05) \ln P_0 + (1.3 \pm 0.25)$.

Coherent particle generation reactions on nuclei are observed among reactions of inelastic hadron-nucleus interaction.

Processes are called coherent[1] if the recoil nucleus after interaction with the primary hadron remains in its basic state. In common idea the coherent diffractive dissociation of the primary hadron on target-nucleus takes place in coherent processes. The study of topological channels in reactions of coherent diffractive dissociation of protons have been made by nuclear emulsion method in the energy range up to 200 Gev.[2,3]

In the present paper the measurement of topological cross sections of the coherent proton diffractive dissociation

$$P \xrightarrow{A} n \text{ prongs} \qquad (1)$$

on emulsion nuclei at 400 Gev/c and analysis of their energy dependences are described.

Events of coherent particle generation on nuclei we must look for among the "clear" stars (i.e. without any visible indications of excitation or breakdown of the target-nucleus) having the odd number of the relativistic particle tracks. Thus, the coherent interactions must be selected from inelastic events in which the most are the inelastic quasifree proton-nucleon interactions of primary proton with nuclei. This stars have been recorded and measured in a systematical way on the effective length of 766 m of the scanned primary track in nuclear photoemulsions exposed to 400 Gev/c proton beam at FERMILAB accelerator (Batavia, USA).

For diffraction dissociation events the angles $_i$ of the secondary charge particles must satisfy

$$\sum_{i=1}^{n} \sin\theta_i \leq A^{-1/3} \qquad (2)$$

where A is a nucleus mass number. This condition is necessary but not sufficient because some part of quasifree proton nucleon interactions are satisfied to the condition (2). Below we described the selecting method of coherent dissociation reactions which is exactly the same method as we used at 67 Gev /2/ and 200 Gev /3/.

Fig.1. shows for example distributions of a quality $\Sigma = \sum_i^n \sin\theta_i$ in "clear" and background 3- and 5-prong events of the type 0 + 0 + 3 and 0 + 0 + 5. The background sample contains events with the β-electrons and events which have been "prepared" from stars of type 1 + 0 + n_g, 0 + 1 + n_g and 0 + 0 + (n_g+ 1) (n_g= 3 or 5) by subtracting the track of a recoil proton.

The subtraction of background distributions by a method with the free parameter Σ^{max} /1,2/ leads to the following results for reactions (1) with n_g = 3 or 5

n_g	$N^{(n)}_{coh}$	$\lambda^{(n)}_{coh}$, m	$\sigma^{(n)}_{coh}$, mb/nucleus
3	35 ± 10	22 ± 8	9.4 ± 2.7
5	19 ± 6	40 $^{+19}_{-9}$	5.1 ± 1.6

The difference between angular distributions for "clean" and background events, analogical to that shown in Fig.1., is seen for n = 1 and 7 as well. An analysis (at n = 1 we have introduce the 15% correction due the loss of one-prong coherent reactions at the scanning and in the "elastic" region (θ<0.001-) gives the values: $\sigma^{(1)}_{coh}$ = 8.6 (± 30%) mb/nucleus and $\sigma^{(7)}_{coh}$ = 1.6 (± 70%) mb/nucleus.

The contribution of coherent reactions (1) to the multiplicity distribution of quasifree proton-nucleon events in emulsion is shown in Fig.2.

Fig.3 shows the energy dependences of topological cross sections in coherent reactions (1). The data at 20 - 200 Gev are taken from the review article /4/.

One can conclude:

1. The total and topological cross sections of coherent diffractive dissociation off nuclei increase in the range 20 - 400 Gev; the total cross section in particular increases from 8 up to ~ 25 mb/nucleus.

2. This growth is the most fast for multiprong channels. Taking into account the fact that the cross sections for exclusive channels in inelastic diffraction (for the channel $p \xrightarrow{A} p\pi^+\pi^-$, for example) does not increase with the energy /2,3,4/, we conclude that the increase of topological cross sections is connected mainly with the opening channels of higher multiplicity of neutral secondary particles. In other words, we can say that the increase of cross sections happens due to the

growth of the mass of diffractively produced system. The last statement is confirmed also by the following point.

3. The average multiplicity of charged particles in reactions of coherent dissociation increases with P_0 (Fig.4.). This increase is consistent with the logarithmic one, so the data from the Fig.4. could be described by dependence

$$\langle n_{ch} \rangle_{coh} = (0.25 \pm 0.05) \ln P_0 + (1.3 \pm 0.25) \quad (3)$$

that qualitatively analogical to the law for multiplicity of charged particles in multiple production. Thus, the data indicate the similarity of energy dependences of the mean multiplicity of charged particles in diffractive and nondiffractive components of multiple production.

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4. S.A.Azimov et al. in "Elastic and inelastic interactions of high energy particles with nucleons and nuclei", ed. S.A.Azimov, Tashkent, 1975, pp 82 - 113.

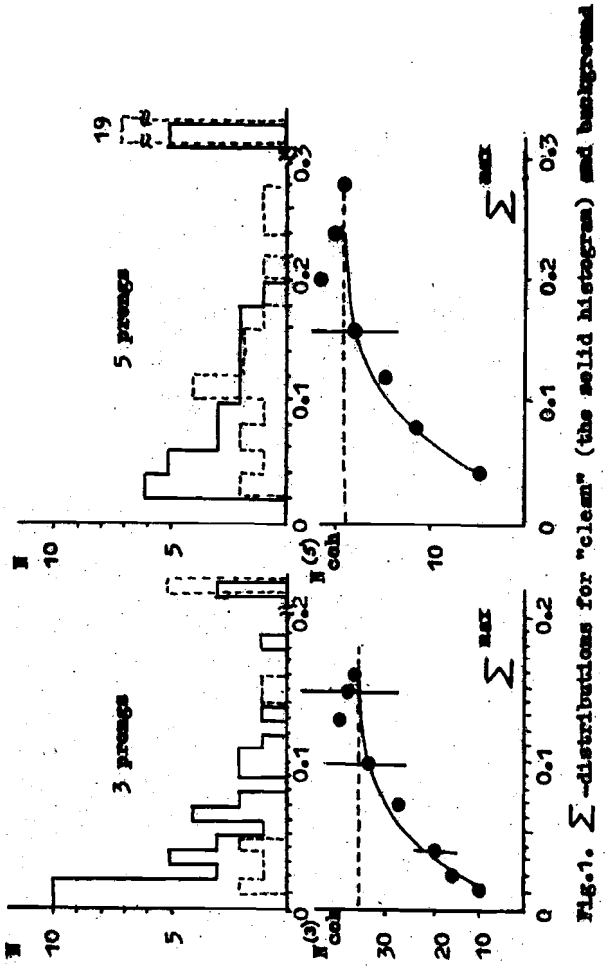

Fig.1. Σ-distributions for "clean" (the solid histogram) and background (the dashed histogram) 3- and 5-prong events and dependence of $N^{(n)}_{coh}$ at n = 3, 5 on the parameter Σ^{max} /2,3/.

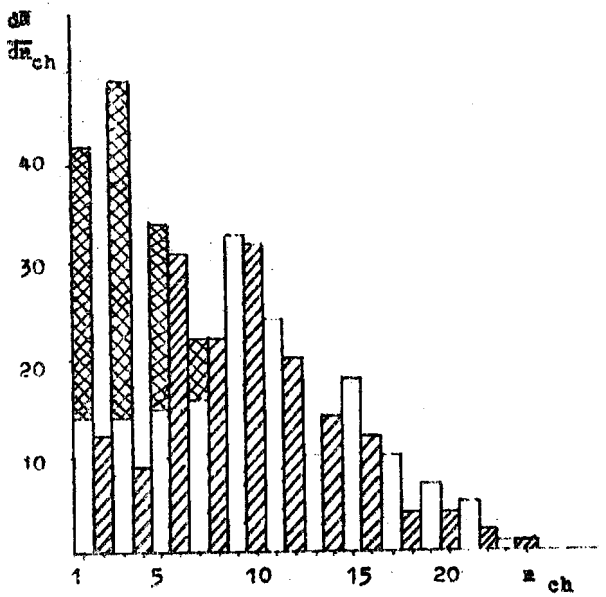

Fig.2. Multiplicity distribution of charged particles in quasifree proton-nucleon interactions at 400 Gev/c. Doubly stroked events show contributions of reactions (1).

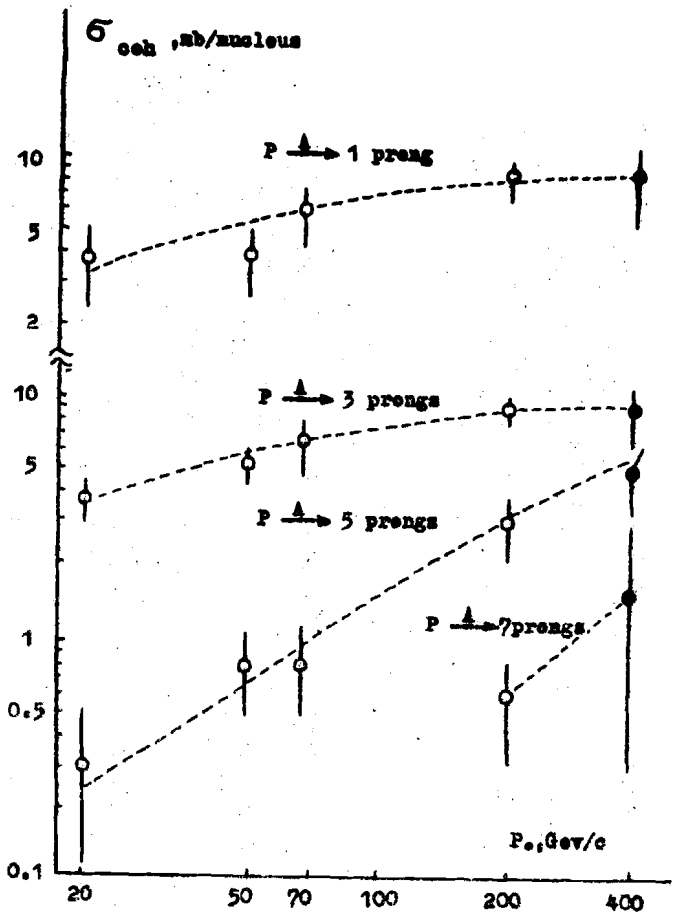

Fig.3.Energy dependences of topological cross sections in reactions (1).

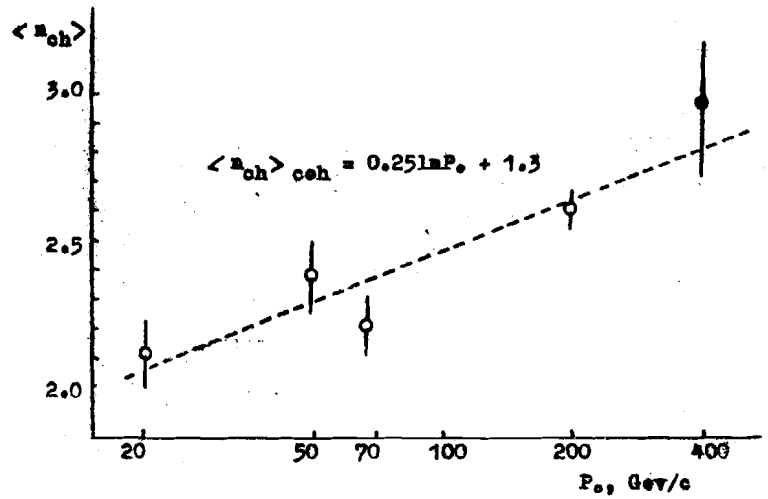

Fig.4. The energy dependence of the mean multiplicity of charged particles in reactions (1). The data at P_0= 20 - 200 Gev/c from the review [4].