CROSS-SECTION FOR THE CHARGE EXCHANGE REACTION $\pi^+ + d \rightarrow p + p + \pi^0$ AT 6 GeV/c PION MOMENTUM

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(Presented by P. FLEURY)

Recently (reference *) we published a study of two-prong stars from interactions of 6 GeV/c mesons in deuterium. The analysis was based on 388 events of the type $\pi^+ + d \rightarrow p + p +$ neutrals, observed in the 81 cm Saclay Bubble Chamber exposed at the CERN-PS. Protons were identified by ionisation up to momentum of 1.3 GeV/c.

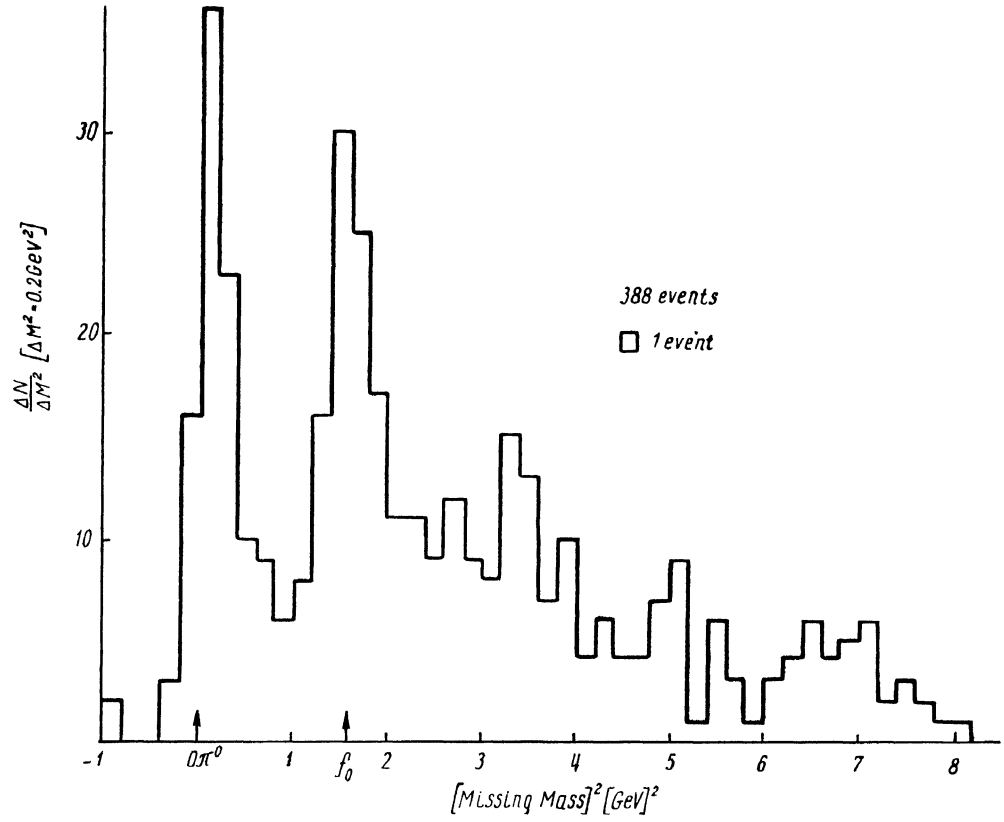

Fig. 1. Frequency distribution of missing masses or the two prong events.

The frequency distribution of the events as function of the square of the missing (neutral) masses displays two clear accumulations, certainly not due to phase space (Fig. 1, see also reference*): one is at the very beginning of the spectrum, the second one is centered at about 1.55 GeV. The latter has been discussed in detail in reference * and was interpreted as mainly due to f^0 production with the f^0 decaying into neutrals pions. In the present letter we want to comment the first peak and derive from it an estimate for the cross-section of the charge

* In contrast to measurement of elastic scattering, there is in this case no detection cut-off at small t values. Ref. I Bruyant et al., P. L., **10**, 232 (1964).

exchange process:

$$\pi^+ + n \to p + \pi^0.$$

The individual identification of single π^0 events is not feasible at our energy in the 80 cm chamber (i. e. one cannot rely on the answer of programm of fits). The proof that we deal single π^0 emission will be a statistical one. For this one needs carefull error considerations.

From the analysis of 4-prong events fitting the reaction

$$\pi^+ + d \to p + p + \omega^0 \quad \omega^0 \to \pi^+ + \pi^- + \pi^0$$

(the errors of the squares of the p-p missing masses were calibrated and estimated to be $\approx$ $\approx$ 0.1 GeV^2). Furthermore, in order to improve the resolution we retained a limited sample of best measured events, i. e. events with a calculated individual error <0.1 GeV^2. This cut-off while improving the resolution between mass peaks, does not introduce a distortion of the missing mass-spectrum, since no significant correlation between M_0^2 and ΔM_0^2 was observed all over the spectrum of M_0^2.

The ideogramm as function of M_0^2 for the restricted sample is shown in Fig. 2. The Figure shows also the expected ideogram for a zero-width accumulation (feeding into the calculation the experimental distribution of errors). Agreement between both curves is very good. A best fit of the experimental ideogram and the expected one gives $M_0^2 = 0.03 \pm 0.01$ GeV^2. This result leads to the conclusion that we deal here essentially with charge exchange events. In addition, we may notice a bump in the η^0 mass region.

Further proof for this conclusion is coming from the analysis of a sample of 800 4-prong events of the type

$$\pi^+ + d \to p + p + \pi^+ + \pi^- + n\pi^0; \quad n \geqslant 0$$

from a similar total path scanned. No accumulation at low p-p missing mass have been found.

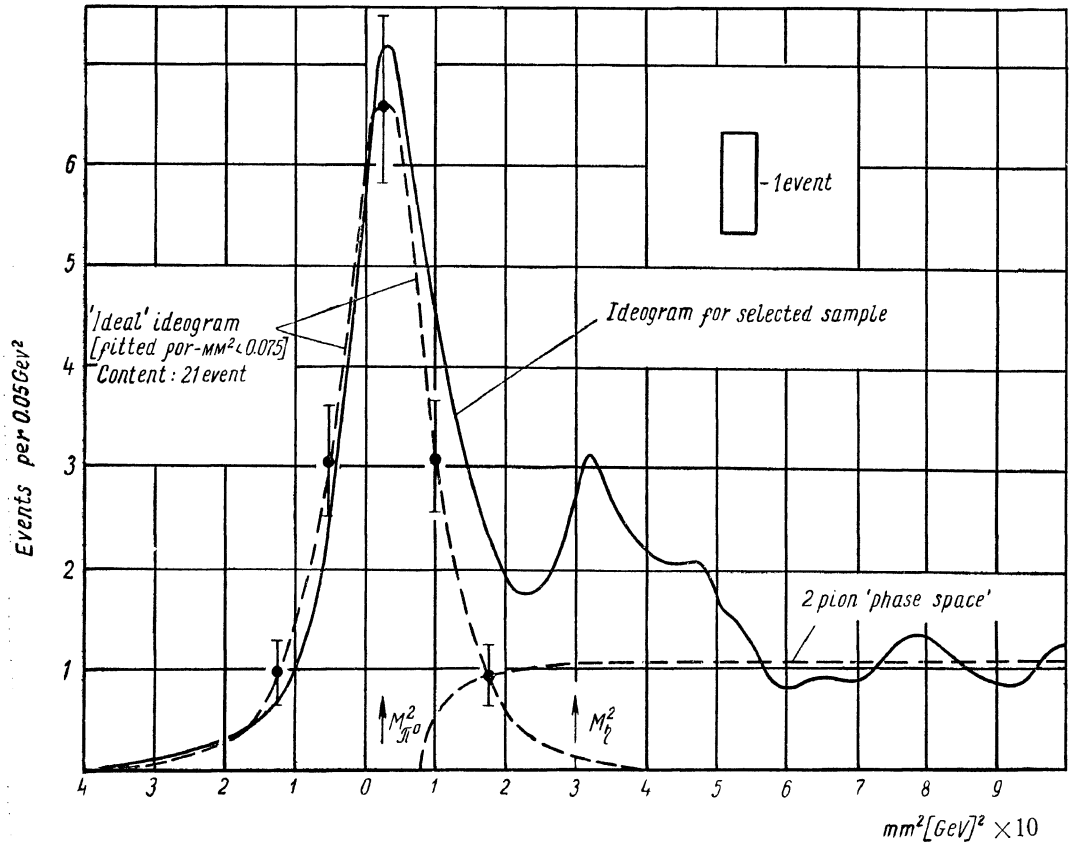

Fig. 2. Ideogram for selected sample.

Furthermore, among the fitted 5-body reactions $\pi^+ + d \to p + p + \pi^+ + \pi^- + n\pi^0$; $n \geqslant 0$, one single event was in the mass region. Thus, only an (unknown) particle of mass 0.36 GeV with the majority of its decays via neutral electromagnetical channels might mislead us (and could still simulate a π^0-peak). We are

thus led to conclude that the events in the zero-mass peak are due to π^0 production via the mechanism

$$\pi^+ + d \rightarrow p + p + \pi^0.$$

Tentatively we assume that the observed process is therefore reducible to the elementary charge exchange interaction

$$\pi^+ + n \rightarrow p + \pi^0$$

with a C. M. energy spead (due to the Fermi-motion of the neutron) as shown in Fig. 3*).

After correction for cut-off in the spectator protons range (see reference *) and account for scanning loss the cross-section becomes $\sigma_{\text{ch. ex.}} = 127 \pm 25$ μ barn (statistisal errors).

Furthermore we can give an estimate for η^0-production (decaying via neutrals)

$$\sigma_\eta \rightarrow \text{neuttals} \approx 46 \ \mu \text{ barn}.$$

For the derivation of the angular distribution all events in the zero-mass peak, defined by $M_0^2 < 0.2$ GeV^2 were taken. The everage value of the square of the for-momentum transfer is $\langle t \rangle = 0.16$ GeV ^{2} *.

* We have checked that the «spectator proton» has a momentum distribution in approximate agreement with the Hulthen spectrum and that no accumulation is occuring in the 2 proton mass spectrum.

This value is in good agreement with the one obtained by Whalig et al. and by

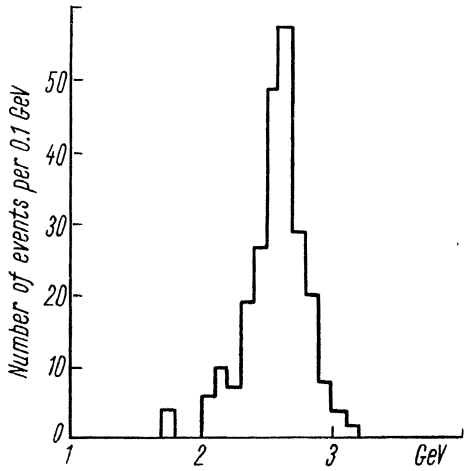

Fig. 3. Distribution of Q-values in the π-nucleon system.

Falk-Vairant et al.* in the charge conjugated charge exchange reaction ($\pi p \rightarrow \pi^0 n$). On the other hand our cross-section is larger by 2 standard deviations. This may be just a statistical fluctication; it may also be due at least partly to the fact that the neutron is off its mass-shell, we are now investigating this possible effects.

* Reported at this Conference.