

PRODUCTION OF NEUTRAL PARTICLES IN INTERACTIONS  
 AT 6 GeV/c —  $L$ -SPIN OF  $f^0$  —  $A_1$  AND  $A_2$  PRODUCTION

*F. Bruyant, M. Goldberg, C. Vegni, S. H. Winzeler*

CERN, Geneva, Switzerland

*P. Fleury, J. Hunc, R. Lestienne, G. de Rosny, R. Vanderhaghen*

Ecole Polytechnique, Paris, France

(Presented by P. FLEURY)

About 70,000 pictures from the Saclay 81 CM bubble chamber filled with deuterium and exposed with 6.07 GeV/c  $\pi^+$  mesons have been examined. In a previous publication [1]

with a very good resolution. If we admit that there is no asymmetry in the  $f^0$  desintegration, then the  $f^0$  production must be twice as large as it appears in the lower histogram. In this

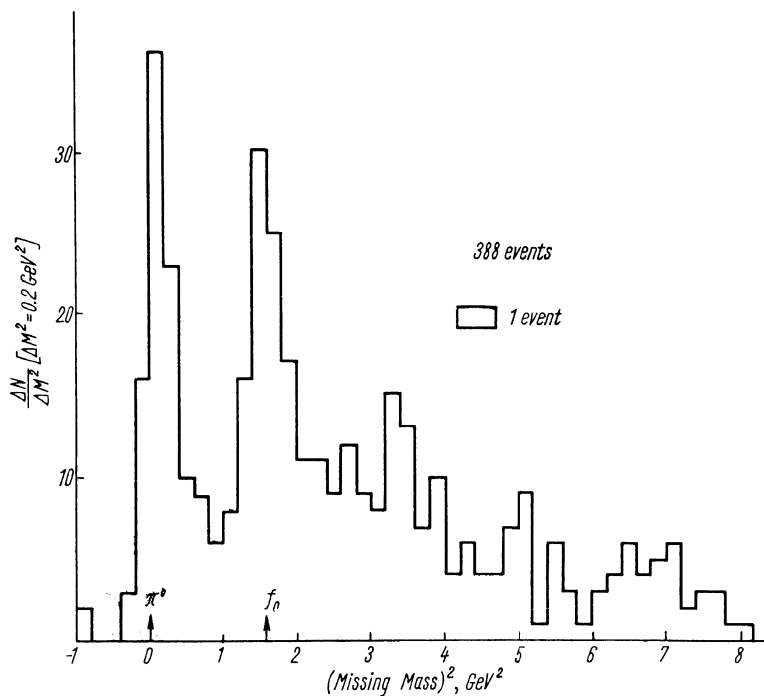


Fig. 1. Frequency distribution of missing masses for the two-prong events.

we have shown that two-prong and four-prong events indicate evidence of  $f^0$  production; i. e. the  $f^0$  meson has a neutral decay mode (Fig. 1) as well as the charged decay mode, from which it was found.

An increased statistics on 4-prong events fitting the reaction  $\pi^+d \rightarrow pp\pi^+\pi^-$  (424 events) allows us to give a better description of the charged mode and an estimation of the charge to neutral ratio. Fig. 2 shows the 2 pion invariant mass distribution. The lower histogram on the same figure concerns those events for which the  $\pi^-$  is going forward in the  $\pi^+\pi^-$ -system. In this selected sample the  $f^0$  peak appears

way we obtain  $\sigma_{f^0 \rightarrow \pi^+\pi^-}$  ( $277 \pm \pm 30$ )  $\mu\text{b}$  (statistical errors) after subtraction of an estimated background of 2 events per 0.05 GeV interval (i. e.  $\approx 15\%$ )

From the study of 2-prong events we had obtained a cross section for  $f^0$  production (subsequently decaying into neutrals) of  $\sigma_{f^0 \rightarrow \text{neutrals}} \approx (156 \pm 20)$   $\mu\text{b}$  (statistical errors)\*.

The value of the charged to neutral ratio is then  $R = 0.56 \pm 0.10$ . This value is in very good agreement with the expected one for zero  $I$ -Spin (i. e.  $1/2$ ). However a bias in the estimation of  $R$  could come from a possible over-estimation of the background under the  $f^0$  peak in the neutral mode (Fig. 1).

If the hypothesis of symmetry in the  $f^0$  desintegration is valid we can reach an estimate of the background in the  $f^0$  mass region for the complete sample; in this

mass region there is no more events with  $\pi^+$  forward then with  $\pi^-$  forward; so we are justified to admit that in the total sample the background contamination is of the same order of magnitude as in the forward sample, i. e. 15%. We refer to the events of the peak of the total histogram as the  $f^0$  events.

The 4-momentum transfer distribution is shown in Fig. 3, the average value  $\langle t \rangle =$

\* This number is somewhat higher than the value (130  $\mu\text{b}$ ) given previously [1], the difference comes from new corrections in the normalisation procedure and will be discussed elsewhere.

$= 10.5 m_{\pi}^2$ . For the two prong events ( $f^0$  in the neutral mode) the 4-momentum transfer distribution is somewhat broader:  $\langle t \rangle = 14. m_{\pi}^2$ ,

first been made by Veillat et al. [2]. Odd values of the spin are excluded by parity conservation if we admit that  $I$ -spin is zero, in fact the

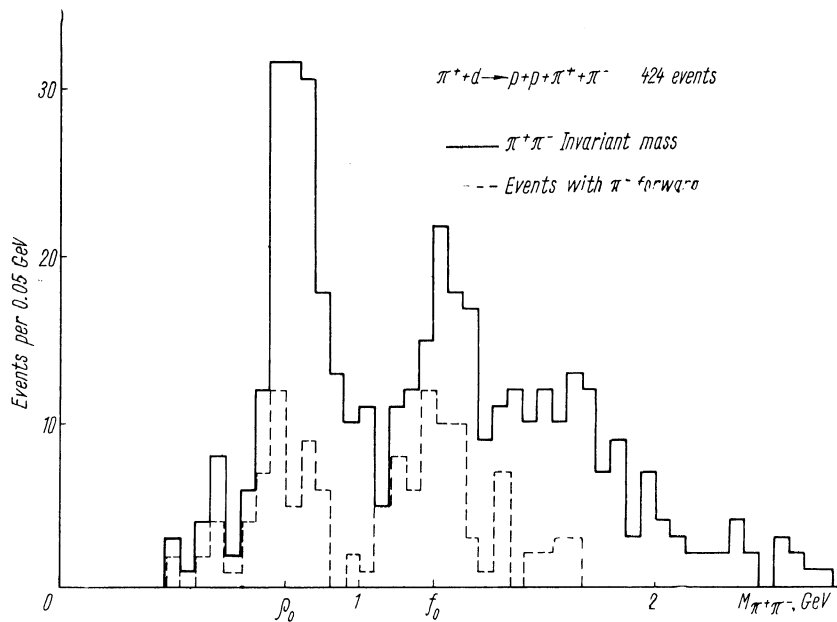


Fig. 2.

this effect is most probably due to the presence of more background events in this case. The angle between the primary  $\pi^+$  and the out-go-

ward and backward peaks of our distribution are too steep to be accounted for by a  $P$  wave.

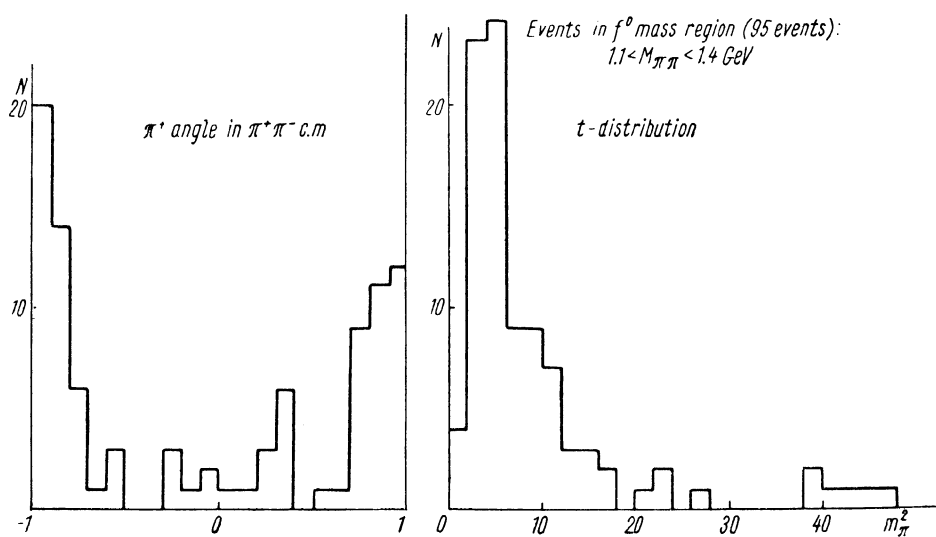


Fig. 3.

ing  $\pi^+$  in the  $f^0$  c. of m. has been calculated. The corresponding distribution (Fig. 3) is symmetric but anisotropic. This fact strongly favours spin 2 over spin 0; a similar observation had

Although most probably predominant, the  $D$  wave seems not pure from interference: the observed population at the center of the distributions ( $90^\circ$  in the  $f^0$  c. of m.) is too

low for a  $(\cos^2\theta - 1)^2$  law. In fact a coherent mixture of  $S$  and  $D$  waves gives a rather good fits; with lower  $S$  than  $D$  wave contribution. On the other hand we have observed that the continuum in the  $f^0$  mass region is of the order of 15%. Thus it seems that is this picture of  $S$  and  $D$  mixing the  $S$  wave must be attributed to the continuum and  $D$  wave to the  $f^0$  production.

groups according to the fits;

$$\pi^+d \rightarrow pp\pi^+\pi^- \quad 424 \text{ events;}$$

$$\pi^+d \rightarrow pp\pi^+\pi^-\pi^0 \quad 557 \text{ events;}$$

$$\pi^+d \rightarrow pp\pi^+\pi^-\pi^0 \quad (n > 1) \quad 553 \text{ events.}$$

The first group is very clean from contamination from the other two.

The separation between the two last ones is more difficult.

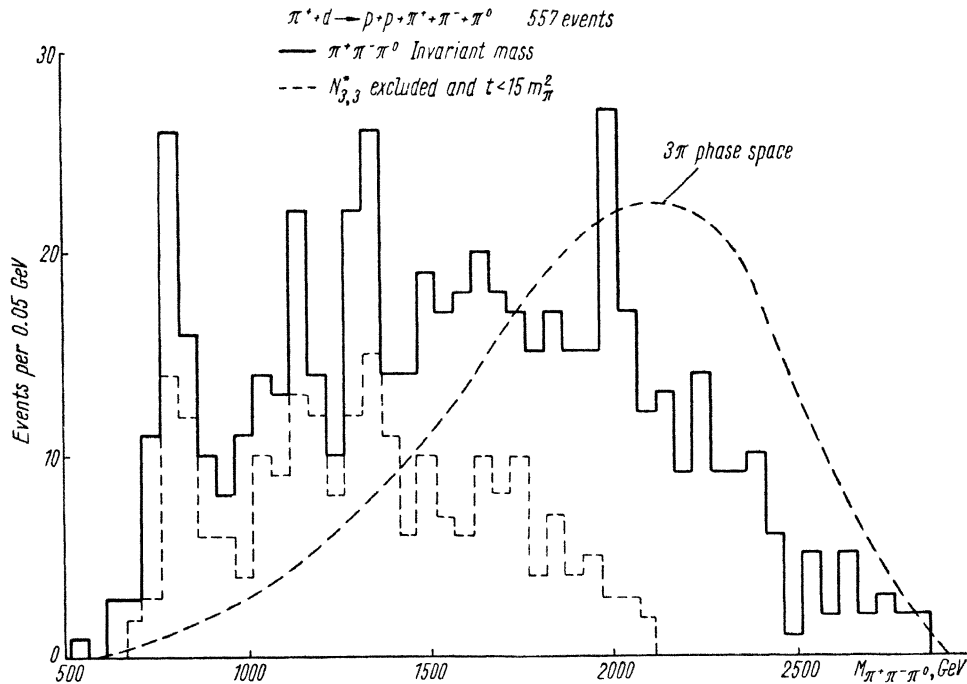


Fig. 4.

More detailed investigations of this point will be soon carried on, with an increased set of events: we are now measuring 3-prong events i. e. those for which the «spectator proton» has a very short range and escapes observation; we hope in this way to increase the statistics by a factor 3, without significant loss of the  $f^0$  peak resolution.

#### $A_1$ AND $A_2$ PRODUCTION

Our complete set of 4-prong events with two identified protons contains 1534 events which correspond to a cross section of 5.4 mb (scanning losses, as well as losses due to no visible short range protons are taken into account). These events are classed in three

No significant bump has been observed in the last group. As for the events fitting  $\pi^+ + d \rightarrow pp\pi^+\pi^-\pi^0$  the 3 pion mass spectrum Fig. 4 shows a peak at the  $\omega$ -mass.

The cross section is

$$\sigma_{\omega} \simeq (180 + 30) \mu b.$$

Besides these peaks there is some evidences for  $A_1$  and  $A_2$  production. Tentative estimates of the cross section give:

$$A_1 \simeq (65 \pm 30) \mu b;$$

$$A_2 \simeq (76 \pm 25) \mu b.$$

#### REFERENCES

1. Bruyant et al. Phys. Lett., **10**, 232 (1964).
2. Voillet et al. PRL, **10**, 29 (1963).