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THE REACTIONS  $K^+ p \rightarrow K^0 p \pi^+$  ABOVE 3 GEV/C

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The reaction  $K^+ p \rightarrow K^0 p \pi^+$  has been studied at various energies below and up to 2.97 GeV/c<sup>(1,2,3,4,5,6)</sup>. It was shown to proceed mainly through either of the channels :

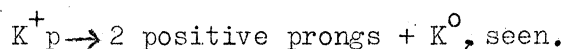


both reactions being of a peripheral nature.

At all energies, reaction (b) seems to be consistent with the Sakurai model of exchange of a  $\rho$ -meson via a magnetic dipole transition. For reaction (a) at 2.97 GeV/c, the angular distribution of the  $K^*$ -decay can be explained only by an exchange of a  $\rho$ -meson, or more generally<sup>(7)</sup>, of a system of spin  $J$  and parity  $(-1)^J, J \neq 0$ ; any appreciable proportion of  $\pi$ -exchange is completely ruled out. At lower  $K^+$  momenta<sup>(3,4)</sup>, this mechanism, which we shall call for short  $\rho$ -exchange, seems to be also present, but not to dominate the reaction so completely.

It seemed worthwhile to study the same reaction at higher energies. We present here preliminary results from a sample at 3.5 GeV/c, and expect to be able to report on bigger samples at both 3.5 and 5 GeV/c. Both sets of pictures come from runs of the Saclay 80cm HBC, exposed to separated  $K^+$  beams, in CERN.

The present analysis lies on 354 events of the topological type



These 354 events represent about 93% of the total number of events in the sample of film studied. Thus the possible effect of measurement biases should be small. These events could be unambiguously identified as follows :

Type	Number of events	Cross-section corrected for $K^0$ loss	Cross-section at 3 GeV/c <sup>(5,6)</sup>
$K^0 p \pi^+$	128	$2.2 \pm .3$	$2.1 \pm .3$
$K^0 p \pi^+ \pi^0$	157	$2.5 \pm .3$	$2.6 \pm .3$
$K^0 n \pi^+ \pi^+$	33	$.5 \pm .1$	$.5 \pm .1$
5-body or more	36	$.6 \pm .1$	$.7 \pm .1$

The 3-body events are displayed on a Dalitz plot (Fig.1) which clearly shows the predominance of  $K^*$  and  $N^*$  formation. Quantitatively, fitting the distributions of  $K\pi$  and  $N\pi$  masses to the sum of the  $K^*$  and  $N^*$  Breit-Wigner distributions and of phase-space, all assumed to be non-interfering, we find the following proportions :

	Percentage	For reference, percentage at 3 GeV
$\frac{K^* p}{\text{all } K^0 p \pi^+}$	$34 \pm 7$	$38 \pm 3$
$\frac{N^* K^0}{\text{all } K^0 p \pi^+}$	$54 \pm 8$	$38 \pm 3$

To study the mechanism of production of  $K^*$  and  $N^*$ , we select the 27 " $K^*$ -events" that lie in band  $.86 < M_{K\pi} < .94$ , but not in the band  $1.15 < M_{p\pi} < 1.33$  and, in the reverse way, 44 " $N^*$  events". These samples consist of about 60% of the total  $K^*$  and  $N^*$  events, and contain at most 5% background contamination.

Figs. 2a and 2b show the momentum-transfer distribution for, respectively, the  $K^*$  and  $N^*$  events, thus selected. Clearly, both phenomena are peripheral; no attempt has been made to fit theoretical distributions but, for comparison, the distributions deduced from the formfactors found at 3 GeV/c<sup>(5,6,8)</sup> are given.

To investigate the nature of the exchanged particles, we turn to the study of the angular distribution of the  $K^*$  and  $N^*$  decays.

Figs. 3a and 3b illustrate the  $K^{\mp}$ -decay in the  $K^{\mp}$  rest-frame;  $\theta$  and  $\varphi$  are respectively the polar and azimuthal angles of the  $K_0$ , relative to a system of axis such that the  $z$  axis is along the incoming  $K^+$  and the  $x$  axis lies in the production plane. These distributions can be written for a particle of spin 1, parity -1 :

$$W(\cos \theta) \, d(\cos \theta) = \frac{3}{4} \left[ (1 - \rho_{0,0}) + (3\rho_{0,0} - 1) \cos^2 \theta \right] d(\cos \theta)$$

$$W(\varphi) \, d\varphi = \frac{1}{2\pi} \left[ 1 - 2\rho_{1,-1} + 4\rho_{1,-1} \sin^2 \varphi \right] d\varphi$$

Maximum likelihood fits to the theoretical distribution yield for the unknown parameters  $\rho_{0,0}$  and  $\rho_{1,-1}$  the following values, to be compared with the corresponding values at 3 GeV/c :

	3.5 GeV/c	3 GeV/c <sup>(5)</sup>
$\rho_{0,0}$	$0.33 \pm .12$	$0.11 \pm .05$
$\rho_{1,-1}$	$0.10 \pm .09$	$0.34 \pm .04$

The only possible conclusion at that stage is that  $\pi$ -exchange (the possible amount of which is given by  $\rho_{0,0}$ ) can still account for only a fraction of the data, though the fraction, as well as the other parameter  $\rho_{1,-1}$ , may differ at 3 GeV/c and 3.5 GeV/c.

Fig. 3c shows the angular distribution in the  $N^{\mp}$  rest-frame of the proton from the  $N^{\mp}$  decay with respect to the normal to the production plane. According to the Sakurai-Stodolsky model<sup>(9)</sup>, the distribution of the cosine of that angle  $\Theta$  should be of the form  $1 + 3 \cos^2 \Theta$ . The agreement is seen to be as good as at lower energies.

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