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

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

$$K^+p \rightarrow K^{*}p \qquad (a)$$

$$K^+p \rightarrow K^o N^{*++} \qquad (b)$$

both reactions being of a peripheral nature.

At all energies, reaction (b) seems to be consistent with the Sakurai model of exchange of a ρ-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 ρ-meson, or more generally(7), of a a system of spin J and parity $(-1)^J, J\neq 0$; any appreciable proportion of π-exchange is completely ruled out. At lower $K^+$ momenta(3,4), this mechanism, which we shall call for short ρ-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 topogical type

$$K^+p \rightarrow 2 \text{ positive prongs} + K^o \text{, seen.}$$

These 354 events represent about 93°/o 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 $K^o$ loss | Cross-section at 3 GeV/c [5,6] |
|---|---|---|---|
| $K^o p\pi^+$ | 128 | 2.2 ± .3 | 2.1 ± .3 |
| $K^o p\pi^+\pi^o$ | 157 | 2.5 ± .3 | 2.6 ± .3 |
| $K^o n\pi^+\pi^+$ | 33 | .5 ± .1 | .5 ± .1 |
| 5-body or more | 36 | .6 ± .1 | .7 ± .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-interferring, we find the following proportions :

| | Percentage | For reference, percentage at 3 GeV |
|---|---|---|
| $\frac{K^* p}{\text{all } K^o p\pi^+}$ | 34 ± 7 | 38 ± 3 |
| $\frac{N^* K^o}{\text{all } K^o p\pi^+}$ | 54 ± 8 | 38 ± 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°/o of the total $K^*$ and $N^*$ events, and contain at most 5°/o 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 [5,6,8] 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 $K^*$-decay in the $K^*$ rest-frame; $\theta$ and $\varphi$ are respectively the polar and azimutal angles of the $K_o$, 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 $\rho_{00}$ 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[5] |
|---|---|---|
| $\rho_{0,0}$ | 0.33 ± .12 | 0.11 ± .05 |
| $\rho_{1,-1}$ | 0.10 ± .09 | 0.34 ± .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 $N^*$ rest-frame of the proton from the $N^*$ decay with respect to the normal to the production plane. According to the Sakurai-Stodolsky model[9], 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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