K$^+$n CHARGE EXCHANGE SCATTERING IN DEUTERIUM BETWEEN 0.72 AND 1.51 GeV/c FROM TWO-PRONG EVENTS

BGRT Collaboration

P. Lugaresi-Serra, G. Mandrioli and A. Minguzzi-Ranzi
Università di Bologna and INFN, Sezione di Bologna.

F. Griffiths, A. A. Hirata[x], R. Jennings and B. C. Wilson[o]
University of Glasgow, Scotland.

G. Bressi and A. Nappi
Università di Roma and INFN, Sezione di Roma.

E. Castelli, M. Furlan, P. Poropat and M. Sessa
Università di Trieste and INFN, Sottosezione di Trieste.

ABSTRACT. -

We present experimental results on k$^+$n → k^{o}p charge exchange scattering from two-prong events measured in a deuterium bubble chamber at 12 momenta between 0.72 and 1.51 GeV/c.

(x) - Now at Physics Dept., University of Purdue (USA).
(o) - Now at Physics Dept., Royal Marsden Hospital, Sutton (England).

2.

In this note we report experimental results on the reaction

(1) $$k^+d \rightarrow k^0p\,(p)$$

measured in the 81 cm Saclay bubble chamber at 12 laboratory momenta between 0.72 and 1.51 GeV/c. In (1) the proton in parenthesis denotes the spectator proton. For this investigation we have used events of the two-prong topology where the spectator proton in reaction (1) has a momentum between 100 and 250 MeV/c and thus stopped inside the chamber.

For this study the Saclay 81 cm bubble chamber filled with deuterium was exposed to low-energy electrostatically separated kaon beams from the CERN-PS. About 40.000 pictures were taken at 13 laboratory momenta between 0.64 and 1.51 GeV/c. Details of the experiment were given in previous publications of the BGRT collaboration[1-3].

Most of the film was scanned twice for two-prong events in which one particle stopped in the chamber. The scanning efficiency was about 0.96 for a single scan and 0.99 for a double scan. Measurements were made on Mangiaspago machines in Bologna, Rome and Trieste and on S.M.P. machines in Glasgow. Measured events were processed through either the CERN or Rutherford Laboratory chain of programs. The number of events ambiguous between reaction (1) and the reaction

(2) $$k^+d \rightarrow k^+n\,(p)$$

was about 2% for k^+ laboratory momenta below 1 GeV/c, reached 20% at 1.2 GeV/c and was almost 50% at 1.5 GeV/c. These ambiguities unresolved by ionization inspection, occurred when there was a fast forward-going particle. Hence the ambiguous events fall in the forward region of the cm angular distribution in the $k^+n(p)$ hypothesis and in the backward region for the $k^0p(p)$ hypothesis. As stated in Ref. (3), all these ambiguous events were assigned to reaction (2). The various tests described in Ref. (3) indicated that this was a reasonable assignment as far as reaction (2) was concerned. As far as reaction (1) the above criterium removes only a negligible number of events. The comparison with events of reaction (1) obtained from the measurements of two-prong-plus-V^0 category[2] showed that the cross section in the angular region $-1 < \cos \theta^* < -0.8$ obtained from two-prong events was considerably larger that that obtained from observed V^0. Since it is difficult to estimate the correction in the backward point we have eliminated this bin from our distributions. On the other hand the backward point ($-1 < \cos \theta^* < -0.9$) obtained

from the two-prong-plus-V^O events (2) may have some losses, arising from badly visible or poorly fittable V^O's.

In order to extract the $k^+n \to k^Op$ differential cross sections from the $k^+d \to k^Op(p)$ data we followed the same procedure of Ref. (2), that is:

a) The spectator proton is that proton with the lower momentum.
b) We considered only those events with $p_{spectator} < 250$ MeV/c.
c) The integrated cross sections were normalized to those in the $-0.8 < \cos \theta^* < 1$ angular range measured in the two-prongs-plus-V^O events.
d) The cm scattering angle θ^* is the angle between the outgoing k^O and the incoming k^+ in the cm frame of the outgoing k^Op system.

Table I and Fig. 1 show the differential cross sections for $k^+n \to k^Op$ charge exchange scattering at 12 energies. These cross sections are not those which one would obtain on free neutrons. In fact in the impulse approximation we have:

(3)
$$\frac{d\sigma}{d\Omega^*}\left[k^+d \to k^Op(p)\right] =$$

$$= \left\{ \left| g_{ce} \right|^2 + \frac{2}{3}\left| h_{ce} \right|^2 \right\} (I_o - J_o) + \frac{1}{3}\left| h_{ce} \right|^2 (I_o + J_o)$$

where g_{ce} and h_{ce} are the non-spin-flip and spin-flip amplitudes for scattering on free neutrons; $I_o(\theta^*)$ and $J_o(\theta^*)$ are deuteron weight factors.

Following Ref. (2) we have fitted the differential charge exchange cross sections to a sum of Legendre polynomials

(4)
$$\frac{d\sigma}{d\Omega^*} = \sum_{l=0}^{N} A_e P_1 (\cos \theta^*)$$

The fit was carried out in the angular region $-0.8 < \cos \theta^* < 0.8$, where the importance of the I_o and J_o terms is minimal. The results of the fits with $N = 4$ are in good agreement with those obtained in Ref. (2).

4.

REFERENCES: -

(1) - G. Giacomelli, P. Lugaresi-Serra, F. Mercatali, A. Minguzzi-Ranzi, A. M. Rossi, F. Griffiths, A. A. Hirata, I. S. Hughes, R. Jennings, B. C. Wilson, G. Ciapetti, P. Guidoni, G. Martellotti, A. Nappi, D. Zanello, E. Castelli, P. Poropat and M. Sessa, k^+d interactions between 0.6 and 1.5 GeV/c, Nuclear Phys. B37, 577 (1972).

(2) - G. Giacomelli, P. Lugaresi-Serra, A. Minguzzi-Ranzi, A. M. Rossi, F. Griffiths, A. A. Hirata, I. S. Hughes, R. Jennings, B. C. Wilson, G. Ciapetti, P. Guidoni, G. Martellotti, A. Nappi, D. Zanello, E. Castelli, P. Poropat and M. Sessa, Differential cross sections for k^+n charge exchange scattering in deuterium between 0.64 and 1.51 GeV/c, Nuclear Phys. B42, 437 (1972).

(3) - G. Giacomelli, P. Lugaresi-Serra, G. Mandrioli, A. Minguzzi-Ranzi, A. M. Rossi, F. Griffiths, A. A. Hirata, R. Jennings, B. C. Wilson, G. Ciapetti, P. Guidoni, G. Mastrantonio, A. Nappi, D. Zanello, G. Alberi, E. Castelli, P. Poropat and M. Sessa, Differential cross sections for k^+n elastic scattering between 0.64 and 1.51 GeV/c, Nuclear Phys. B56, 346 (1973).

TABLE I

Center of mass differential cross sections (in mb/sr) for the process $k^+d \to k^0p(p)$. The differential cross sections were normalized via the integral of the cross section between $-0.8 < \cos\theta^\pm < 1$ to the data of Ref. (2). The errors quoted are statistical. A systematic scale error, estimated at $\pm 5\%$ is not included.

| cos θ± / Lab momentum	-0.70	-0.50	-0.30	-0.10	0.10	0.30	0.50	0.70	0.85	0.95
0.72	0.57±0.12	0.44±0.10	0.63±0.13	0.50±0.12	0.57±0.12	0.71±0.13	0.85±0.14	0.55±0.12	0.22±0.06	
0.78	0.47±0.09	0.43±0.09	0.50±0.09	0.80±0.12	0.68±0.11	0.71±0.11	0.70±0.11	0.70±0.11	0.38±0.10	
0.85	0.55±0.14	0.24±0.10	0.43±0.13	0.65±0.15	0.49±0.13	0.68±0.15	0.83±0.17	0.63±0.15	0.34±0.10	
0.90	0.33±0.06	0.48±0.07	0.46±0.07	0.50±0.07	0.65±0.08	0.85±0.10	0.76±0.09	0.74±0.09	0.34±0.06	
0.98	0.32±0.07	0.20±0.07	0.42±0.09	0.55±0.10	0.57±0.10	0.71±0.11	0.68±0.10	0.81±0.11	0.71±0.14	0.32±0.10
1.06	0.31±0.06	0.39±0.06	0.38±0.06	0.47±0.06	0.56±0.06	0.58±0.06	0.69±0.07	0.92±0.09	0.84±0.12	0.37±0.07
1.13	0.16±0.04	0.13±0.04	0.23±0.05	0.29±0.05	0.47±0.07	0.51±0.07	0.83±0.09	0.84±0.09	0.68±0.11	0.33±0.07
1.21	0.19±0.04	0.30±0.04	0.29±0.04	0.36±0.05	0.33±0.05	0.51±0.06	0.68±0.07	0.79±0.07	0.77±0.11	0.39±0.09
1.29	0.05±0.02	0.11±0.04	0.21±0.05	0.15±0.04	0.22±0.05	0.37±0.07	0.58±0.09	0.80±0.11	0.72±0.14	0.37±0.08
1.35	0.09±0.03	0.15±0.03	0.14±0.03	0.18±0.04	0.18±0.04	0.26±0.05	0.56±0.08	0.73±0.09	0.84±0.11	0.48±0.10
1.42	0.13±0.03	0.17±0.04	0.14±0.04	0.18±0.04	0.21±0.05	0.25±0.05	0.48±0.07	0.74±0.10	0.76±0.13	0.55±0.10
1.51	0.09±0.03	0.09±0.03	0.11±0.04	0.07±0.03	0.11±0.04	0.20±0.05	0.41±0.06	0.69±0.08	0.80±0.13	0.54±0.11

236
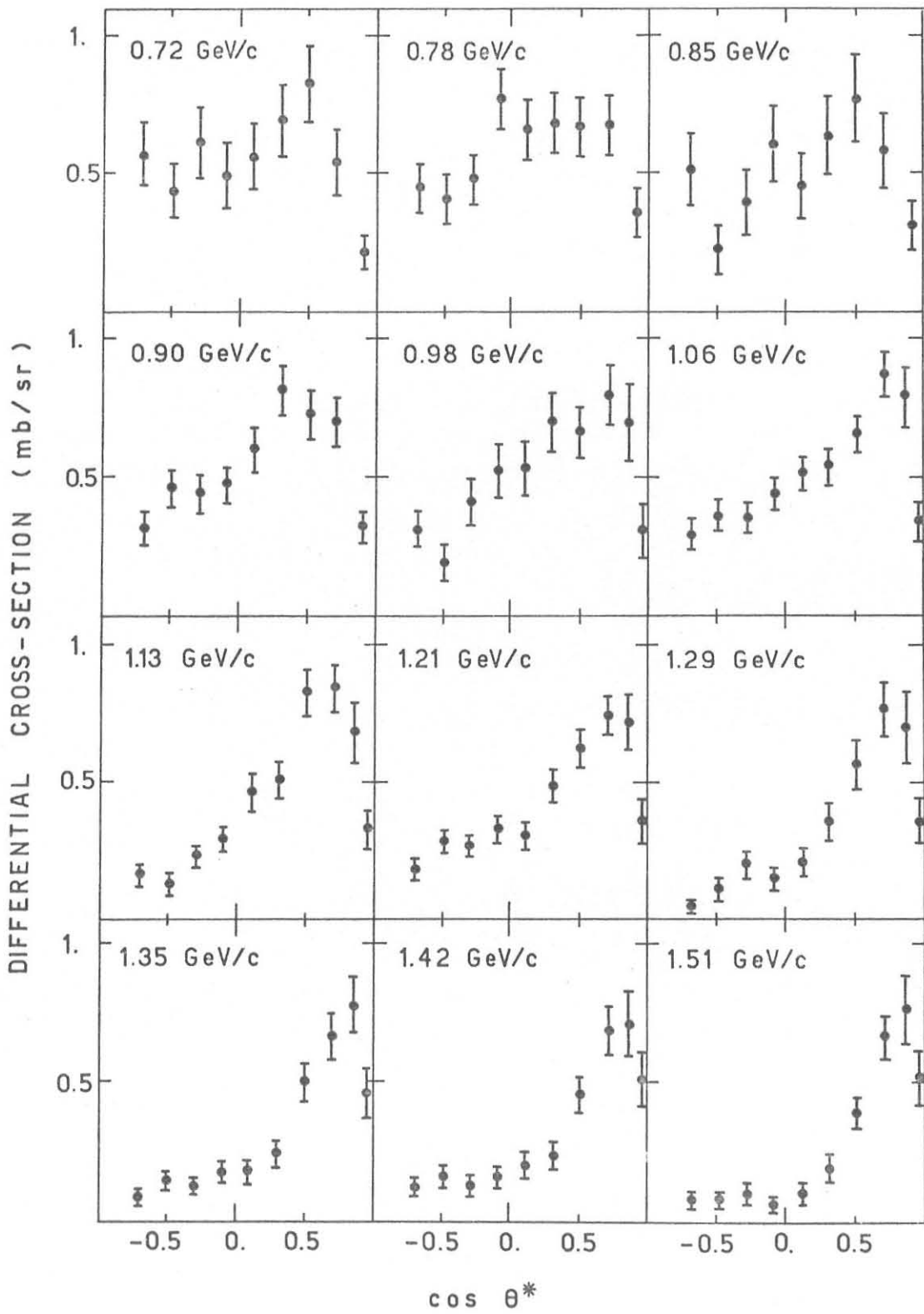
FIG. 1 - $k^+d \to k^0p(p)$ charge exchange differential cross sections at 12 momenta between 0.72 and 1.51 GeV/c.