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(BGRT Collaboration)

ABSTRACT.

We present experimental results on the $K^+n \rightarrow K^+n$ differential cross-sections obtained from one-prong events measured in deuterium at five momenta between 0.72 and 1.42 GeV/c.

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In this note we report experimental results on the reaction

$$K^+d \rightarrow K^+n(p) \qquad (1)$$

measured in a deuterium bubble chamber at five laboratory momenta between 0.72 and 1.42 GeV/c. For this investigation we have used one-prong events[1]; that is, events for which the proton in the final state left a track too short to be visible in the chamber; this ensured that the proton was really a spectator proton. This investigation was a part of a systematic study of the K^+N interaction in the low-energy region. For this purpose the Saclay 81 cm deuterium bubble chamber was exposed to low-energy, electrostatically separated kaon beams from the CERN Proton Synchrotron. About 40,000 pictures were taken at each of 13 momenta between 0.64 and 1.51 GeV/c, corresponding to about one event per microbarn at each momentum. Details of the experiment are given in previous publications of the BGRT Collaboration[1,2].

Only part of the film at the five momenta of 0.72, 0.85, 1.06, 1.13, and 1.42 GeV/c was scanned and measured for one-prong events. For events whose scattering angle corresponds to a cosine in the c.m. frame smaller than 0.5, the scanning efficiency was about 0.9 for a single scan. Measurements were done on Mangiaspago machines in Bologna and S.M.P. in Glasgow.

Measured events were processed through either the CERN or Rutherford Laboratory chain of programs. All the possible hypotheses were tried; only those events which fitted at least one of the following hypotheses were considered:

$$K^+d \rightarrow K^+pn \qquad (2)$$

$$K^+d \rightarrow K^+d \qquad (3)$$

$$K^+d \rightarrow K^0pp\ . \qquad (4)$$

Ambiguities existed among these channels and with K^+ decays.

In order to be free of the decay ambiguity, we have cut the angular distributions at forward angles ($\cos\theta_{cm} < 0.5$); this cut also eliminated completely the ambiguities with $K^+d \rightarrow K^+d$ events, and reduced to negligible values the ambiguities with $K^+d \rightarrow K^0pp$. Ionization inspection and checks of the same type as those made for the two-prong events[1] ensured that we have a good sample of events of reaction (1).

The fact that the spectator proton is unseen means that its momentum is smaller than 100 MeV/c, and thus that the impulse approximation is a very good approximation, better than in the case of our previous publications where the $K^+n \to K^+n$ cross-section was obtained for two-prong events (where $100 < p_{spectator} < 250$ MeV/c). This was the reason for measuring a sample of one-prong events.

The data were normalized to the integral of the differential cross-section between $-1 < \cos\theta_{cm} < 0.5$ previously measured with two-prong events[1].

In Table 1 and Fig. 1 we present the K^+n elastic differential cross-sections at five momenta. These differential cross-sections are not those one would obtain on free neutrons. In fact, we may write[1]:

$$\left[\frac{d\sigma}{d\Omega}(K^+n \to K^+n)\right]_{meas} = \left[\frac{d\sigma}{d\Omega}(K^+n \to K^+n)\right] I_0 \ , \qquad (5)$$

where $(d\sigma/d\Omega)(K^+n \to K^+n)$ is the differential cross-section on free neutrons; $I_0(\theta^*)$ is one of the two deuteron form factors which appear in the impulse approximation. The $I_0(\theta^*)$ term distorts the angular distribution as shown in Fig. 2 [3]. The I_0 factor for $p_{spectator} < 100$ MeV/c has a slightly different angular dependence from that of the I_0 factor for the case $100 < p_{spectator} < 250$ MeV/c (see Fig. 2 and Fig. 3 of Ref. 1).

In order to compare experimental results at different energies and to obtain preliminary information on the behaviour of the scattering amplitudes with energy, we have fitted the measured differential cross-sections, divided by the weight factor I_0 normalized to take into account the cuts in the spectator momentum, to a sum of Legendre polynomials:

$$\frac{\left[\frac{d\sigma}{d\Omega}(K^+n \to K^+n)\right]_{meas}}{I_0} = \sum_{\ell=0}^{N} A_\ell P_\ell(\cos\theta^*) \ , \qquad (6)$$

where A_ℓ are coefficients to be determined by the fit, and the maximum number of the polynomial N is found empirically. The results of such an analysis, for N = 4, are given in Table 1. The errors on the coefficients are larger than those in Ref. 1, mainly because of the missing forward points.

Table 1

$K^+n \rightarrow K^+n$ differential elastic cross-sections (in mb/sr) obtained from the one-prong events. The differential cross-sections were normalized to those obtained from two-prong events (Ref. 1). Also shown are the coefficients of the Legendre polynomial expansion. The errors quoted are statistical only. A systematic scale error estimated at ±15% is not included.

p_{lab} (GeV/c) / $\cos\theta^*$	0.72	0.85	1.06	1.35	1.42
−0.95	0.61 ± 0.11	0.37 ± 0.12	0.37 ± 0.09	0.20 ± 0.05	0.22 ± 0.04
−0.85	0.61 ± 0.11	0.58 ± 0.14	0.37 ± 0.09	0.19 ± 0.05	0.17 ± 0.03
−0.75	0.56 ± 0.10	0.37 ± 0.12	0.25 ± 0.07	0.07 ± 0.03	0.11 ± 0.03
−0.65	0.41 ± 0.09	0.53 ± 0.14	0.35 ± 0.09	0.07 ± 0.03	0.17 ± 0.03
−0.55	0.66 ± 0.11	0.68 ± 0.16	0.25 ± 0.07	0.12 ± 0.04	0.08 ± 0.02
−0.45	0.68 ± 0.11	0.37 ± 0.12	0.23 ± 0.07	0.15 ± 0.04	0.05 ± 0.02
−0.35	0.66 ± 0.11	0.31 ± 0.11	0.33 ± 0.08	0.07 ± 0.03	0.07 ± 0.02
−0.25	0.52 ± 0.10	0.47 ± 0.13	0.27 ± 0.08	0.09 ± 0.04	0.08 ± 0.02
−0.15	0.60 ± 0.11	0.61 ± 0.14	0.39 ± 0.09	0.20 ± 0.05	0.15 ± 0.03
−0.05	0.61 ± 0.11	0.81 ± 0.17	0.37 ± 0.09	0.15 ± 0.04	0.23 ± 0.04
0.05	0.43 ± 0.09	0.53 ± 0.13	0.49 ± 0.10	0.26 ± 0.06	0.23 ± 0.04
0.15	0.64 ± 0.11	0.95 ± 0.19	0.37 ± 0.09	0.42 ± 0.08	0.22 ± 0.04
0.25	0.49 ± 0.10	0.77 ± 0.16	0.52 ± 0.10	0.36 ± 0.07	0.37 ± 0.05
0.35	0.43 ± 0.09	0.74 ± 0.16	0.73 ± 0.12	0.45 ± 0.08	0.52 ± 0.06
0.45	0.49 ± 0.10	0.81 ± 0.17	0.97 ± 0.15	0.81 ± 0.12	0.59 ± 0.06
A_0	0.73 ± 0.22	0.23 ± 0.33	0.98 ± 0.24	0.68 ± 0.16	0.42 ± 0.10
A_1	0.73 ± 0.54	−0.80 ± 0.85	1.50 ± 0.60	1.22 ± 0.39	0.59 ± 0.25
A_2	0.56 ± 0.64	−1.27 ± 0.99	1.45 ± 0.69	1.10 ± 0.45	0.44 ± 0.28
A_3	0.50 ± 0.50	−1.16 ± 0.76	0.76 ± 0.51	0.50 ± 0.32	0.00 ± 0.21

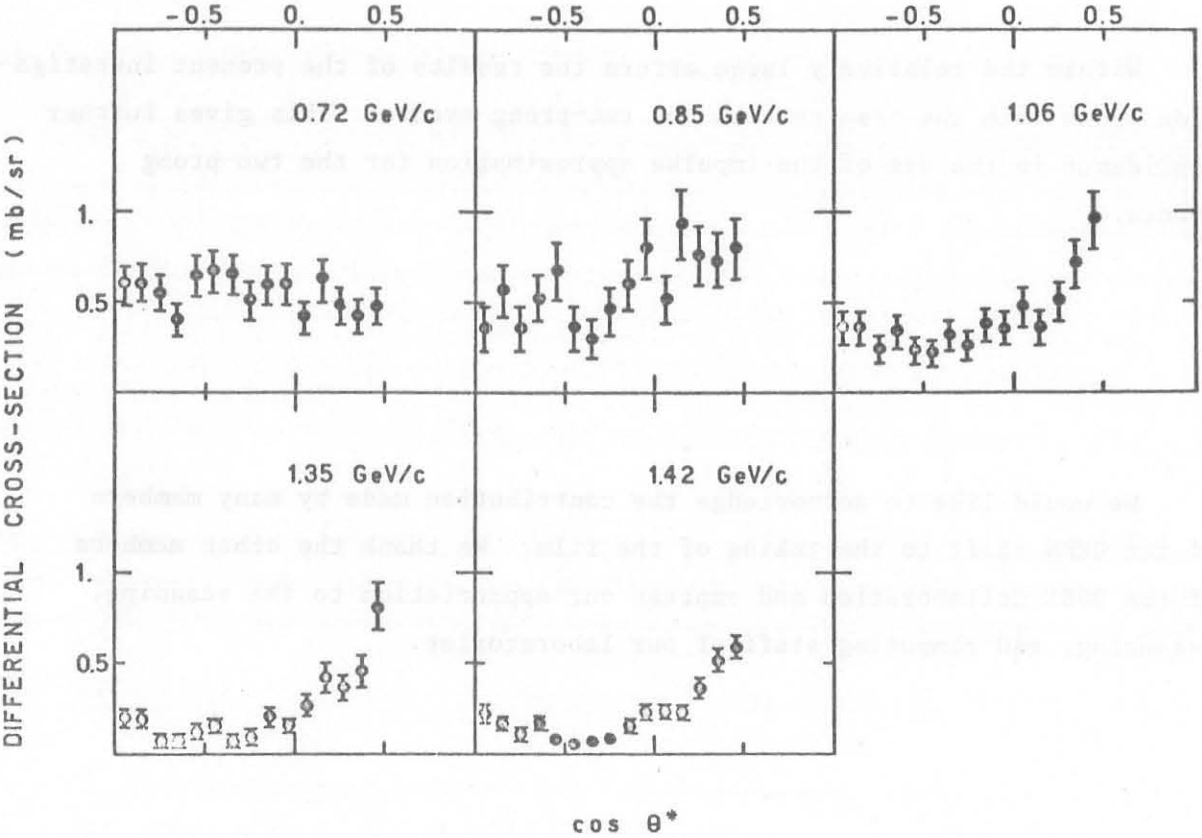

Fig. 1 : K^+n elastic differential cross-sections at the five momenta measured. These cross-sections have not been divided by I_0.

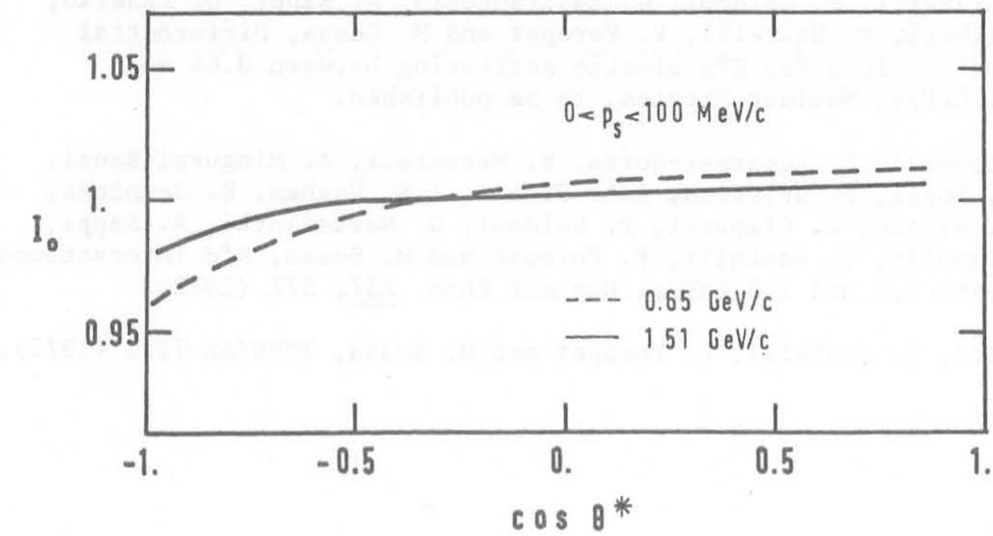

Fig. 2 : The I_0 weight factor at two laboratory momenta for $0 < p_{spectator} < 100$ MeV/c. I_0 is normalized such that the average value is equal to 1.

Within the relatively large errors the results of the present investigation agree with the results from the two-prong events. This gives further confidence in the use of the impulse approximation for the two-prong events.

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