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3.33 Measurement of the Transverse Polarization Transfer in $^{2}H(p,n)2p$ at 0° at 54 MeV

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We have performed a new, high accuracy measurement (see ref. 1 for previous data) of the transverse polarization transfer coefficient $K_{y}^{y'}(0^{\circ})$ in $^{2}H(p,n)2p$ at a mean proton energy of 54 MeV. This reaction is being used as a source of quasi-monoenergetic polarized neutrons with energies up to ~70 MeV at the SIN injector cyclotron [2]. Besides a high precision calibration of the neutron polarization we were especially interested in its dependence on excitation energy.

The experimental setup was as follows: neutrons produced in a 4.4MeV thick liquid D_2 target were collimated under 0° onto an "active" liquid ^{4}He target [3]. Neutrons scattered from this target were detected by 2 pairs of plastic scintillation counters (10 cm wide, 50 cm high and 8.4 cm thick) at 1 m distance. The proton polarization P^{p} was measured periodically in a polarimeter upstream via $p-^{12}C$ elastic scattering.

The data were written on tape in event mode. An event consisted of 4 parameters: 1) the TOF between a recoil α signal in the ^{4}He target and the cyclotron RF signal, (t_{α}). From this we determined the neutron energy. 2) the recoil α pulse height. 3) the TOF between the target and the plastic detectors, (t_{n}). 4) the pulse height in the plastic detectors. In the off-line analysis rather tight cuts were set on parameters 2, 3 and 4. As a result the peak to background ratio in the t_{n} spectra improved from 2:1 to 100:1. For a first analysis the cut on the neutron energy was such as to accept all neutrons in the peak region (see fig. 1).

For each scattering angle a number of separate runs was performed, from which the normalized asymmetry $\varepsilon_{N} = \varepsilon/P^{p}$ was derived using the super ratio method. The variance of these measurements is consistent with the expected statistical errors. In table I we have listed ε_{N} and its statistical uncertainty for all 5 angles, as well as the quantities discussed below.

Table I. For explanation of the quantities see text

Θ_{lab}	ε_{N}	$\Delta\varepsilon_{N}$	FG corrections [%]	MS1 corrections [%]	MS2 corrections [%]	A_{y}	$K_{y}^{y'}$	ΔK_{y}^{y}
118.4	-0.10	.02	3.9	1.3	1.2	0.563	-0.19	0.03
126.7	-0.28	.01	2.6	1.4	2.1	0.880	-0.34	0.01
135.0	- .30	.01	1.5	1.2	1.6	0.890	-0.36	0.01
143.3	- .27	.01	0.8	1.0	1.5	0.740	-0.37	0.01
151.6	- .18	.01	0.4	1.0	1.1	0.558	-0.34	0.02

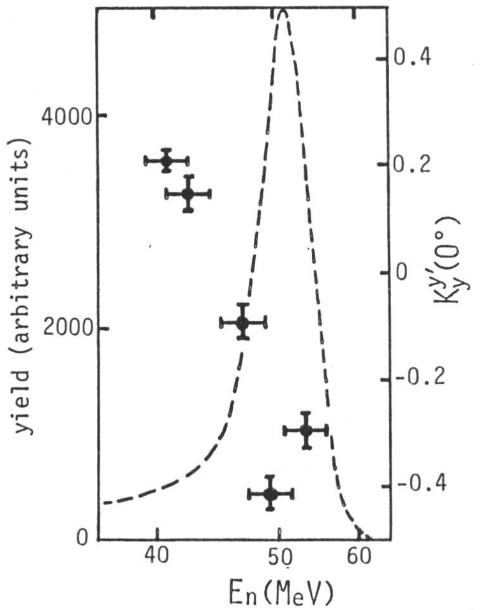

Fig. 1 Neutron yield (dashed curve, left-hand scale) and polarization transfer $K_y{}^{y'}(0^o)$ (crosses, right-hand scale) as a function of neutron energy E_n for 56.3 MeV incident protons.

In the next step ε_N was corrected for finite geometry (FG) and multiple scattering (MS) effects. Using a new Monte-Carlo code MS effects in the liquid itself (called MS1) as well as in combination with the target vessel, cold shield and vacuum tank (called MS2) were calculated [3]. It was found that the MS2 corrections are by no means negligible; they are in fact in our case larger than the MS1 corrections.

The corrected asymmetries were then divided by the pα analyzing power A_y, obtained from the phase shift solution 2 of ref. 4 (in principle one should use pα phases which have been properly corrected for Coulomb effects. However in the back-angle maximum these corrections are almost zero [5]). Since any possible discrepancies in A_y would be smallest in the vicinity of the maximum, we used for the final extraction of $K_y{}^{y'}=\varepsilon_N(\Theta)/A_y(\Theta)$ only the 3 central angle measurements. We obtained $K_y{}^{y'}(0^o) = -0.36 \pm 0.009$ where the uncertainty contains the statistical uncertainties of the measured quantities ε, p^p and the uncertainties of the corrections [3]. If we use the nα phase shifts of ref. 6 (which shift the angle of the A_y maximum by 3^o!) $K_y{}^{y'}(0^o)$ changes by 0.6%. Altogether we estimate the uncertainty due to the normalization of p^p and A_y to be < 3%. Our result for $K_y{}^{y'}(0^o)$ is larger than the value obtained by ref. 1 at ~50 MeV, however it seems compatible if one bears in mind its strong dependence on excitation energy.

In order to study the dependence of $K_y{}^{y'}(0^o)$ as a function of excitation energy, the t_α spectrum was divided into 5 bins and $K_y{}^{y'}$ extracted as described above. Fig. 1 shows the results of a preliminary analysis which was done only for the measurements at 126.7^o and 143.3^o. The horizontal error bars reflect the uncertainty in the TOF determination, mainly due to the ~1.9 ns time resolution of the proton beam.

Also indicated (dashed line) is the corresponding neutron yield as measured in the ^{4}He target. Again the TOF uncertainty has increased the FWHM from a real ~4.8 MeV to ~7.0 MeV.

The dependence on excitation energy shown here clearly contradicts an impulse approximation prediction [7], but is very similar to measurements and a Faddeev type prediction at energies around ~13 MeV [8].

References

1) L.P. Robertson et al., Nucl. Phys. A134 (1965) 545
2) S. Burzynski et al., SIN Newsletter 16, NL 126
3) S. Burzynski and R. Henneck, contribution to this conference
4) T. Saito, Nucl. Phys. A331 (1979) 477
5) J. Fröhlich et al., Nucl. Phys. A384 (1982)97;H. Zankel:priv. comm.
6) H. Krupp et al., Phys. Rev. C30 (1984)1810
7) G.V. Dass, N.M. Queen, J. Phys. A (Proc.Phys.Soc.) 2, (1968) 259
8) P.W. Lisowski et al., Nucl. Phys. A334 (1980) 45