Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 870-871

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Analyzing Power of the $^2H(\vec{p},\gamma)^3He$-Reaction below 2 MeV+

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Analyzing power measurements of the $^2H(\vec{p},\gamma)^3He$ capture reaction have been performed within our studies of the A=3 system. A precise determination of the M1-strength is important, because M1-transitions are only possible with D- and S'-states admixtures in the symmetric ground state of ^3He.[1,2].

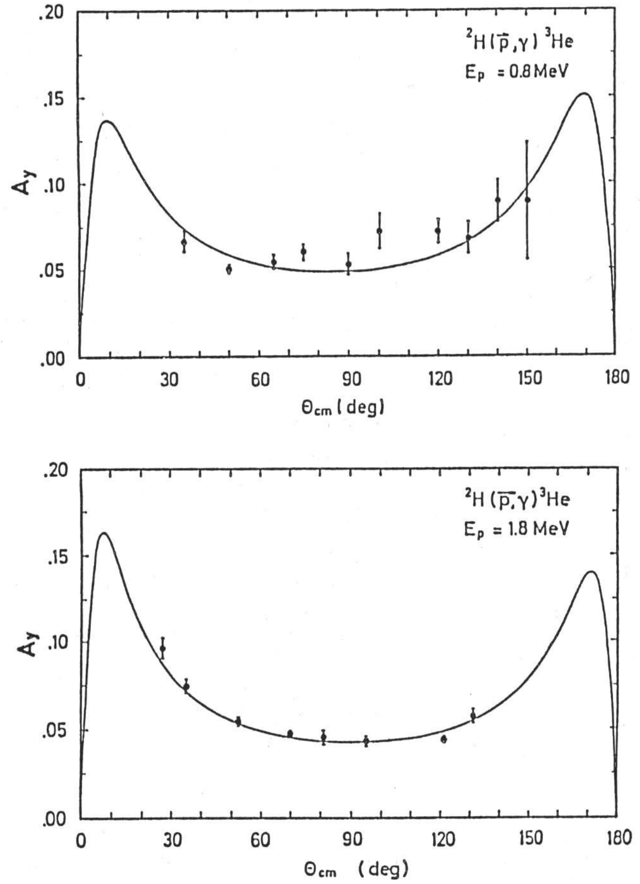

Fig. 1: Analyzing power of the $^2H(\vec{p},\gamma)^3He$-reaction at 0.5 MeV and 1.8 MeV. The solid line represents the best fit to the data.

Analyzing powers of the $^2H(\vec{p},\gamma)^3He$-reactions were measured at the energies E_p=0.5 MeV and 1.8 MeV in the angular range from 20° to 130° with a mean statistical error of $\Delta A_y \cong 5\cdot 10^{-3}$. The target consisted of a gas cell (pressure: 400 Torr deuterium; effective length: 43 mm), with an entrance foil of 0.5 µm rolled Ni. The energy loss was 40 and 80 keV in the foil and about 80 and 130 keV in the gas. The gamma rays were measured with four 100 cm³ GeLi-detectors and two 5"x5" NaJ-detectors. The scattering chamber and all apertures were made of tantal in order to reduce the ion beam induced background, which ranged from 1 to 15 % at E_p = 0.5 MeV and 40 to 70% at 1.8 MeV.

The corrected analyzing power values are shown in Fig. 1. The errors include the statistical errors of the counting rates, the errors of target current ($\Delta A/A \sim 10^{-4}$), scattering angle ($\Delta\Theta = \pm 2°$) and pile up ($\Delta A/A < 10^{-4}$) and all errors of the corrections (background, geometry and deadtime). The beam polarization was P = 0.72 ± 0.007.

+ Work supported by the Deutsche Forschungsgemeinschaft

For data analysis the product of differential cross section and analyzing power was expanded into associated Legendre polynomials.

$$\frac{\sigma A_y}{\sigma_o} = \sum_l b_l P_l^1 (\Theta) \qquad (1)$$

The differential cross section can be written as

$$\sigma(\Theta) = \sigma_o \left(a/b + \sin^2\Theta(1+\beta \cos \beta)\right). \qquad (2)$$

The values a/b and β, which represent the $M_1(E_2)/E1$-strength ratio and the E1-E2 interference, respectively, were taken from ref. 3 and 4.

The results of the least-squares fit are presented in table 1, together with our reanalysed measurements at E_p = 0.8 MeV[5].

E_p (MeV)	a/b	β	b_1	b_2
0.5	0.04	0.0	0.046±0.0015	-
0.8	0.03	0.1	0.049±0.0016	-
1.8	0.02	0.1	0.042±0.0010	0.003±0.0006

Table I: The fit parameter b_i for the Legendre polynom expansion and the coefficients a/b and β of the differential cross section

One can conclude from our data that the analyzing power at low energies is mainly caused by E1-M1 interferences represented by the b_1-coefficient and the strength is essentially constant in the measured energy range. Only a small b_2-coefficient is necessary for E_p= 1.8 MeV.

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