Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 880-881

3.39

$^4He(\vec{p},p)^4He$ Analyzing Powers, Phaseshift Analysis and Determination of the $A_y = 1$ Point below 2.15 MeV

S. Tharraketta, W. Arnold, H. Baumgart, J. Günzl, A. Hofmann, E. Huttel, N. Kniest and G. Clausnitzer

Institut für Kernphysik, Strahlenzentrum der Universität Giessen, D-6300 Giessen, West Germany

Polarized $^4He+\vec{p}$ elastic scattering is of special interest for the calibration of high efficiency polarimeters due to its analyzing power maxima $A_y=1$[1], which can be used as a primary standard for polarization measurements.

The analyzing power has been measured in the energy range 1.1 MeV $\leq E_p \leq$ 2.15 MeV in steps of 150 keV and 25 keV around the $A_y=1$ maximum, respectively. 14 surface barrier detectors have been installed in left-right position within the angular range of $37° \leq \Theta_{CM} \leq 165°$. The ^4He-gas target (40 Torr) was isolated from the beam tube by an Al entrance foil with a measured energy loss of 17 keV for 1.5 MeV protons ($\approx$ 130 $\mu g/cm^2$).

The asymmetry has been obtained from equation (1)

$$\varepsilon = P \cdot A_y = \frac{N_L^{\uparrow}/N_L^{\circ} - N_R^{\uparrow}/N_R^{\circ}}{N_L^{\uparrow}/N_L^{\circ} + N_R^{\uparrow}/N_R^{\circ}} \qquad (1)$$

where $N^{\uparrow}(N^{\circ})$ represents the integral of the proton peak in the spectrum recorded with proton polarization on (off). Using the new 1 MV tandem accelerator before installation of a foil stripper the polarization was determined to be 0.37 with an error of $\Delta P/P = \pm 0.3$ % and has been fixed in a normalization procedure from intermediate measurements at E_p=1.9 MeV.

Afer corrections for dead time (0.1%), angular range ($\leq$ 0.4%) and apparative effects ($\leq$ 0.01%) a statistical accuracy for the analyzing power of $\Delta A_y = \pm 0.003$ has been achieved. For $\Theta_L \leq 60°$ the ^4He recoil peak has been analysed additionally. Fig. 1 shows the analyzing powers below E_p = 2.15 MeV as a function of proton energy and scattering angle.

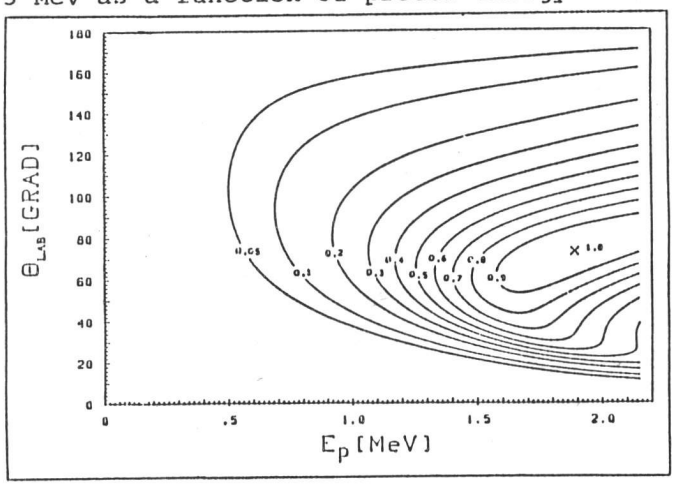

Fig. 1: Analyzing powers for $^4He + \vec{p}$ elastic scattering in a E_{LAB}-Θ_{LAB} contour plot.

A phaseshift analysis for $l \leq 1$ has been performed for the present data together with σ- and A_y-data from earlier measurements in the energy range 0.35 MeV $\leq E_p \leq$ 1.1 MeV. In order to present the values for energy and scattering angle of the lowest $A_y = 1$ point an 'effective range' parametrization[2,3] has been performed to describe the phases. Table I shows the results for the scattering length and effective range; the consideration of additional terms gave no significant change in χ^2.

Table I. Effective range parameters from the phaseshift analysis of the present data. For comparison the values of Ref. 4 are shown in brackets.

	a_s(fm)	a_r(fm)
$S_{1/2}$	4.701 ± .014 (4.970)	1.729 ± .035 (1.295)
$P_{3/2}$	-49.843 ± .087 (-44.830)	-.214 ± .001 (-.365)
$P_{1/2}$	-15.278 ± .179 (-19.360)	.019 ± .028 (.349)

For the determination of the A_y=1 point the ratio of the scattering amplitudes g/f and the analyzing power around the maximum have been calculated from the phases[5]. The A_y=1 point which is related to g=if[1] is given by the values E_p = 1.89 MeV and Θ_{CM}=87.04°. The error interval is given by the area 0.999 $\leq A_y \leq$ 1.0. Fig. 2 shows the corresponding contour plot.

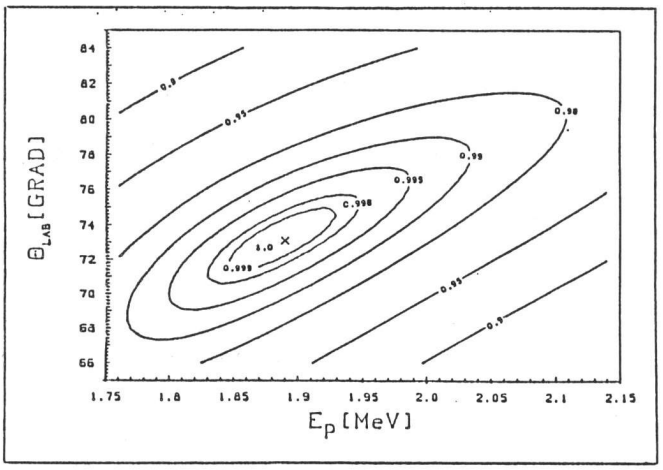

Fig. 2: Analyzing powers from the present analysis as a function of E_{LAB} and Θ_{LAB} around the A_y =1 maximum.

References

1) G.R.Plattner and A.D.Bacher, Phys. Lett. 36B (1971) 211.
2) J.D.Jackson and J.M.Blatt, Rev.Mod.Phys. 22 (1950) 77.
3) T.Teichmann, Phys. Rev. 83 (1951) 141.
4) R.A.Arndt, D.D.Long and L.D.Roper, Nucl. Phys. A209 (1973) 429.
5) S.J.Moss and W.Haeberli, Nucl.Phys. 72 (1965) 417.