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Break Up of ^{4}He with Polarized Proton at 65 MeV

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A break up reaction of ^{4}He with proton is studied measuring analyzing powers for the inelastic scattering ^{4}He(p,p')^{4}He* and for the three body break up reaction ^{4}He(p,p^{3}H)^{1}H. A polarized proton beam from the AVF cyclotron at RCNP bombarded a gas ^{4}He target. The inelastically scattered protons and the emitted tritons were detected with two counter telescopes of Si SSD and NaI(Tl) which were set at the opposite side with respect to the beam.

Fig. 1 shows the angular dependence of the analyzing powers for the elastic scattering and for the inelastic scatterings. The latter are not so similer to the former and qualitatively resemble to the analyzing powers for the p-^{3}He elastic scattering at 50 MeV[1] which is shown by the dotted curve in the figure. Fig. 2 shows the projected energy spectra on the triton energy axis and the analyzing power of the coincidence measurement for the ^{4}He(p,p^{3}H)^{1}H reaction. The peaks for the FSI cross sections are seen in the data at the angle set $(\theta_T-\theta_p)=(25°-95°)$ and (30°-95°). The large analyzing powers are obtained at the energies corresponding to these FSI peaks.

The three body break up cross section and the analyzing powers are calculated on the basis of the Faddeev theory assuming a three body model as two protons and one triton. The transition matrix is approximated as a sum of the single and double scatterings neglecting higher multiple scattering. The two body matrix is calculated using a separable potential with a form factor in momentum space as,

$$g_L(p) = N_L p^L(1+\gamma p^2) \Big/ \prod_{j=1}^{L+1}(1+\beta_j p^2). \qquad (1)$$

The parameters are determined to reproduce the energy dependence of the phase shifts of L=0 and 1 for the p-^{3}H scattering data[2] and the values are given in Table I.

Calculated curves for the break up cross sections are shown in Fig. 2 and are normalized to the experimental cross section with a factor 0.25. The calculations at (25°-95°) and (30°-95°) well reproduce the cross sections and

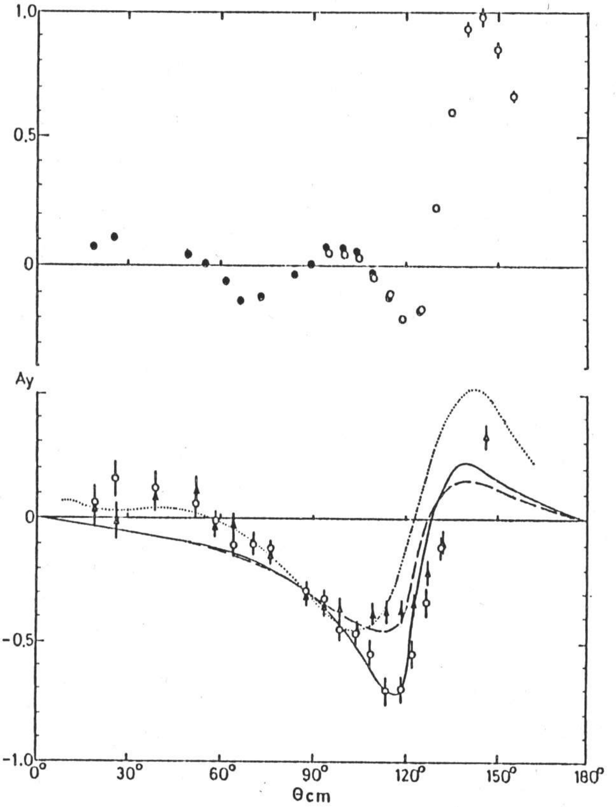

Fig. 1. Angular dependence of analyzing powers for the elastic (up) and inelastic scatterings (down). The circles and the triangles for the inelastic scatterings show the data corresponding to the excited states of ^{4}He at 20.3 MeV(0^+) and 21.5 MeV (0^- and 2^-), respectively.

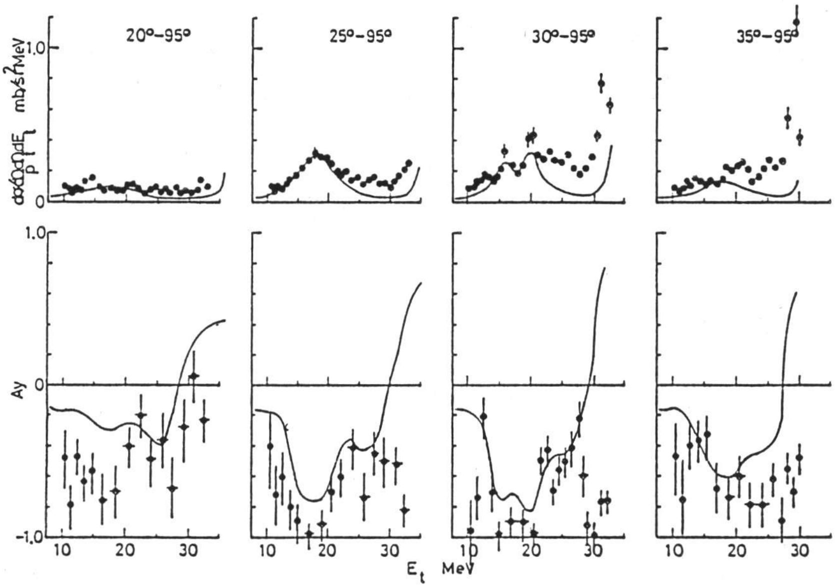

Fig. 2. Coincidence energy spectra and analyzing power distributions projected on the triton energy axis.

the large analyzing powers in the FSI regions. The large analyzing power mainly comes from the interference between the single and double scattering. The calculated analyzing powers at the FSI peaks are compared with the experimental analyzing powers for the inelastic scatterings in Fig. 1. The solid and dashed curves correspond to the analyzing powers for the excited state of ^{4}He at 20.3 MeV(0^+) and 21.5 MeV(0^- and 2^-), respectively. The curves reproduced well the experimental data.

Table I. Parameters of the form factor for p-^{3}H interaction. The strength N^2 is in MeV$^{-(0.5+L)}$, λ in MeV$^{1.5}$, γ and β_j in MeV^{-1}. Parameters with * is used for the ground state of ^{4}He.

	J	L	S	N	λ	γ	β_1	β_2	β_3
	0	0	0	0.1669	-1	1.114	0.4548	0.01093	
	1	0	1	0.1292	-1	2.575	0.7232	0.01078	
	0	1	1	0.2070	-1	0.007999	0.06010	0.04340	0.00000075
	1	1	0	0.2452	-1	1.365	0.9818	0.04927	0.0003199
	1	1	1	0.2798	-1	0.1956	0.2048	0.1873	0.007865
	2	1	1	0.2455	-1	0.1473	0.1554	0.1400	0.003034
*	0	0	0	3.439	-0.02124	1.041	0.5767	0.3246	

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