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1.85 Analyzing Power and Cross Section of $^{40}Ca(d,\alpha)^{38}K$ Reaction at E_d=22 MeV

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As a series of (d,α) reaction study, experiment of $^{40}Ca(d,\alpha)^{38}K$ reaction was made by using 22 MeV polarized deuterons. Measurement was made for differential cross section and vector and tensor analyzing powers of deuteron elastic scattering and cross sections, iT_{11} and A_{yy} for three low-lying levels in ^{38}K; $J^{\pi}=3^+$ ground state and two 1^+ states located at E_x=0.459 MeV and at E_x=1.698 MeV.

Experiment was made by using a self-supporting metallic foil. The thickness of the target was weighed to be 720 $\mu g/cm^2$. Ejectiles are momentum analyzed by a magnetic spectrograph and detected by a single wire position sensitive proportional counter[1]. Typical beam intensity and polarization were 30 nA and 70 percent on the target. Separate experiment was made by using two pairs of ΔE-E solid-state detector telescopes. The counter data was normalized to those of the magnetic spectrograph by using elastic cross section peak at around 50 degrees.

Optical model analysis was made for deuteron elastic scattering[2].

Behavior of $\sigma(\theta)$ and iT_{11} around 40 to 60 degrees in ground state transition can hardly be reproduced in zero-range DWBA analysis. While patterns of $\sigma(\theta)$ and iT_{11} for the two 1^+ transition are much the same, those of A_{yy} are not alike. Classical interpretation for J=L±1 transition predicts large positive A_{yy}, which is the case for the ground and 1_1^+ transitions. This is not true for 1_2^+ transition.

One- and (d,t)(t,α) and (d,h)(h,α) two-step analysis was tried for (d,α) reaction. Nuclear structure is assumed that the ground state of ^{40}Ca is a doubly closed shell nucleus and ^{38}K is described by two-hole states of $s_{1/2}$, $d_{3/2}$ and $d_{5/2}$ orbitals. Shell model parameters are taken from the work by Wildenthal[3]. Wave functions of the three ^{38}K levels are given in table 1. The table tells that the ground state transition is almost pure L=4 transition, i.e., product of Moshinsky bracket and 9-j coefficient for $(d_{3/2})^{-2}$, is very large for (L,S,J)=(4,1,3) compared to those for (2,1,3). L=0 transition is very important both in 1_1^+ and 1_2^+ transitions, while L=2 transition with $(d_{3/2}^{\,2})$ and $(s_{1/2}d_{3/2})$ configurations interfere constructively and destructively for 1_1^+ and 1_2^+ transitions, respectively. These points can easily be confirmed by DWBA analysis with microscopic two-nucleon transfer form-factor option. Fig. 1 compares the experimental data with zero-range DWBA predictions. Parameters of the DWBA calculation are taken from the work by Bhat et al.[4]. No finite-range correction, however, was introduced in the present analysis. Differences of A_{yy} in the two 1^+ transition is acounted for with the present nuclear structure. Distorting potentials, both in incident and exit channels, from many sources were tried, but better fit was not obtained. Two-step contribution of (d,t)(t,α) and (d,h)(h,α) process was also evaluated to find that their peak cross section lies around 50 to 100 μb/sr irrespective of the potentials used if we use the zero-range normalization constants D_0^2 of 3 and 25×10^4 MeV^2fm^3 for (d,t) and (t,α) reactions, respectively.

Table I. Nuclear Structure of ^{38}K.

states	D3D3	S1D3	S1S1	D5D3	D5S1	D5D5
3^+_1	-0.986			0.151	-0.008	0.075
1^+_1	0.448	0.741	0.293	-0.405		0.121
1^+_2	-0.892	0.373	0.189	-0.164		0.481

S1, D3 and D5 stand for $s_{1/2}$, $d_{3/2}$ and $d_{5/2}$, respectively.

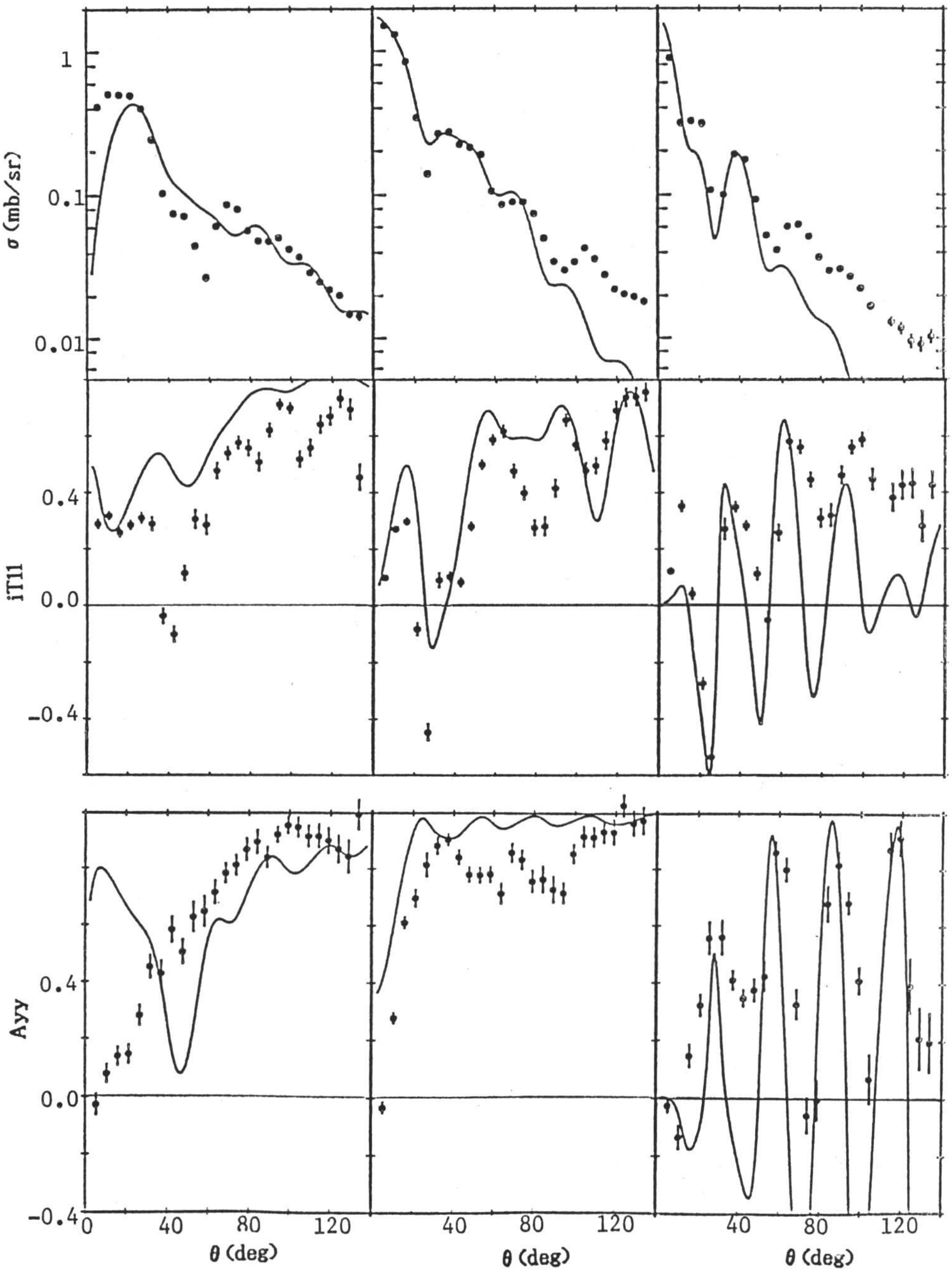

Fig. 1. Comparison of experiment and theory. Columns from left to right correspond to 3^+, 1_1^+ and 1_2^+ transitions and the rows from upper to lower correspond to cross sections, iT_{11} and A_{yy}.

References

1) H. Iida, Y. Aoki, K. Yagi and M. Matoba: Nucl. Instrum. & Methods 169 (1984) 432.
2) M. Takei et al.: Contribution to this conference.
3) B. H. Wildenthal: Progress in Particle and Nuclear Physics 11 (1983) 5.
4) C. M. Bhat, N. G. Puttaswamy, H. T. Fortune and J. L. Yntema: Phys. Rev. C28 (1983) 141.