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The D-state Effects of Deuterons, Tritons and the Transfer Interaction in the Reaction $^{208}Pb(d,t)^{207}Pb$ Investigated by using Polarized Deuteron Beam

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Vector- and tensor-analyzing powers together with differential cross section of $^{208}Pb(d,t)^{207}Pb$ reaction were measured at E_d=17 MeV for low-lying strong transitions. The role of D-state effect is emphasized by fitting the tensor analyzing power data with finite-range DWBA predictions. The experiment was designed to set a restriction on or to give foundation for the parameters in the detailed analysis of $^{208}Pb(p,t)$ $^{206}Pb(3_1+$, E_x=1.34 MeV) reaction at E_p=22 MeV[1].

Polarized deuterons produced by a Lamb-shift type polarized ion-source were accelerated to 17 MeV by 12UD PELLETRON of Tandem Accelerator Center, University of Tsukuba and hit a self-supporting ^{208}Pb target of thickness 2.6 mg/cm^2. The ejected tritons were momentum analyzed by a magnetic spectrograph and detected by a position-sensitive proportional counter. Separate experiment was carried out by using two-pairs of ΔE-E solid state detector telescopes. Vector analyzing power iT_{11} and tensor analyzing powers A_{yy}, T_{21} and T_{22} were measured by directing the deuteron spin along y-axis or 54.7 deg. from the z-axis in the x-z plane and counting the tritons for each m_d=1, 0 and -1 polarized beam. Typical beam intensity and polarization on the target was 30 nA and 75 percent, respectively. Beam polarization was measured by quench-ratio method. Experimental result is shown in Fig. 1. Error bars are due to counting statistics and 2 percent of beam polarization.

One-step distorted wave Born(DWB) analysis was made by using a finite-range option of the program TWOFNR[2]. Optical potential parameters in the present analysis are given in table 1. Neutrons are assumed to be picked up from the single particle orbitals of $2p_{1/2}$, $2p_{3/2}$, $1f_{5/2}$, $1f_{7/2}$ and $0i_{13/2}$. They are bound in the Woods-Saxon potential with experimental binding energies. Deuteron and triton wave functions are generated by Reid soft-core potential[3]. Transfer reaction was also initiated by this potential. Inherent in the potential is a tensor interaction, which is a source of D-state in deuteron and triton wave functions. Figure 2 shows the light particle form-factor;

$$\langle\phi_t(r,\rho)|V_{pn}+V_{nn}|\phi_d(\rho)\rangle_\rho$$

used in the present analysis. Dip in the ℓ=0 curve is due to coupling to D-state and to tensor interaction. DWBA curves are also shown in fig. 1. Roughly 10 percent of one-step scattering amplitude is predicted by the D-state. It is very hard to see D-state contribution in cross sections and in iT_{11}'s. D-state effect, however, is predominant in tensor analyzing powers. A factor of 10 increase in T_{21} amplitude was observed in every transition if we include D-state contributions. Dependence of T_{2q} on light particle form factor was studied to find to be very small. Large real diffuseness in deuteron channel is important to reproducing oscillatory pattern in angular distributions. It may reflect deuteron break-up effect in the nuclear field.

Table I. Optical potential parameters (in units of MeV or fm)

	V	r	a	r_c	W_v	W_s	r_i	a_i	V_{so}	r_{so}	a_{so}
d	109.9	1.063	1.038	1.2		9.8	1.501	0.728	5.25	0.9	0.6
t	161.7	1.2	0.72	1.3	19.6		1.4	0.86	2.0	1.2	0.72
n		1.225	0.7						6.5	1.225	0.7

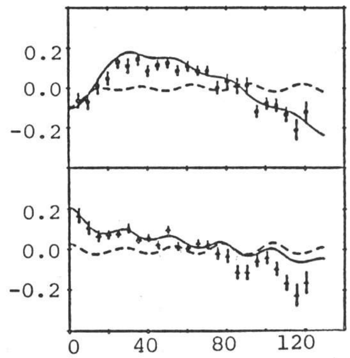

Fig. 1a

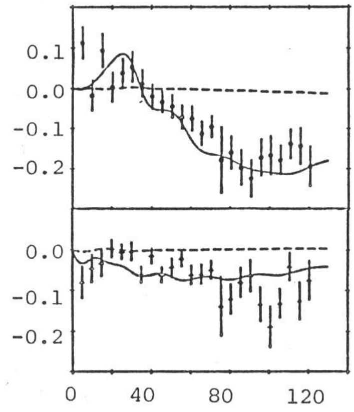

Fig. 1b

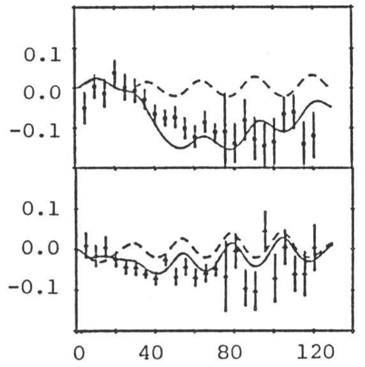

Fig. 1c

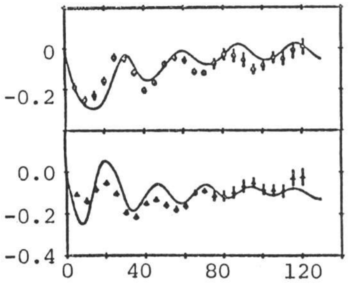

Fig. 1d

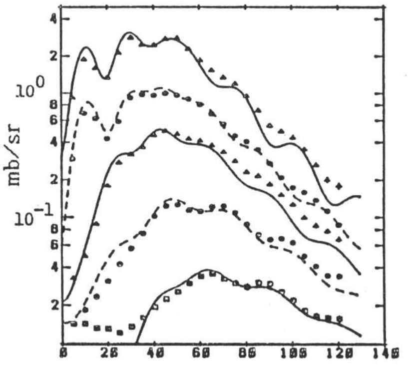

Fig. 1e

Fig. 1. Comparison of theory and experiment for $f_{7/2}$ (upper figure) and $f_{5/2}$ (lower ones) transitions. 1a for T_{20} 1b for T_{21} 1c for T_{22}, 1d for iT_{11} and 1e for cross sections. Dashed lines in 1a to 1c are due to S-state, while solid lines are to S- and D-states. Curves in 1e, from upper to lower are for $p_{1/2}$, $p_{3/2}$, $f_{5/2}$, $f_{7/2}$ and $i_{13/2}$ transitions and are scaled by 1, 1/4, 1/4, 1/8 and 1/8, respectively.

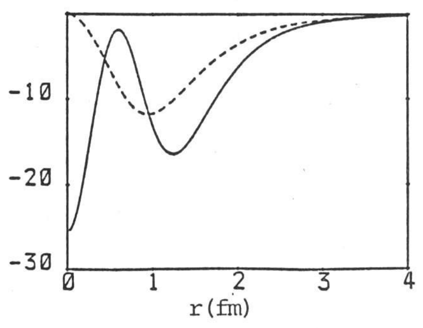

Fig. 2

Fig. 2. S-state (solid line) and D-state (dashed line) light particle form factor in units of $MeV \cdot fm^{3/2}$.

References

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