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Two-Step and D-state Contributions in the Reaction $^{90}Zr(d,\alpha)^{88}Y$ Studied by Vector- and Tensor-Polarized Deuteron Beam

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We measured the cross sections and analyzing powers, iT_{11}, T_{20}, T_{21} and T_{22} for the reaction $^{90}Zr(d,\alpha)^{88}Y(4^-_{gs},5^-_1)$ at E_d = 22 MeV. The nuclear structure of $^{88}Y(4^-_{gs}, 5^-_1)$ can be considered to be a ground-state doublet arising from the two-hole configuration of $(\pi 1p_{1/2})^{-1}(\nu 0g_{9/2})^{-1}$. Sequential transfer (d,t)(t,α) and (d,^{3}He)(^{3}He,α) two-step processes in addition to a (d,α) one-step process were calculated in terms of the DWBA by taking into account the effect of α particle D-state. For the direct one-step process, deuteron cluster pick up is assumed. The D-state admixture is chosen as the parameter ρ to be -0.38[1]. The contributions of the two-step processes are calculated so that the strength of each of the one-nucleon transfer reactions involved in the two-step processes [2,3] was determined to reproduce the corresponding experimental cross section (Fig. 1). The intensity of the one-step process is obtained so that the coherent sum of the one- and the two-step reaction amplitudes reproduce the experimental (d,α) cross sections (Fig. 2).

The two-step (d,t)(t,α) and (d,^{3}He)(^{3}He,α) processes have the same order of cross sections for both 4^-_{gs} and 5^-_1 transitions. The two-step contributions are about one order of magnitude less than the experimental (d,α) cross sections. The D-state contribution of the 4^-_{gs} transition has the the same intensity as that of the two-step processes, while that of the 5_1 transition has only about one tenths of the two-step intensity. In conclusion, the experimental cross sections for the three (d,α) transitions, which vary over a wide range in absolute magnitudes such as ∿15μb/sr for $^{208}Pb(d,\alpha)^{206}Tl(0^-_{gs})$ (Ref. 4), ∿50μb/sr for $^{90}Zr(d,\alpha)^{88}Y(5^-_1)$, and ∿200μb/sr for $^{90}Zr(d,\alpha)^{88}Y(4^-_{gs})$ can be reproduced systematically by taking account of the one- and two-step processes using the same normalizing factors in the one-step processes, i.e., 7.7, 10.0, 10.0.

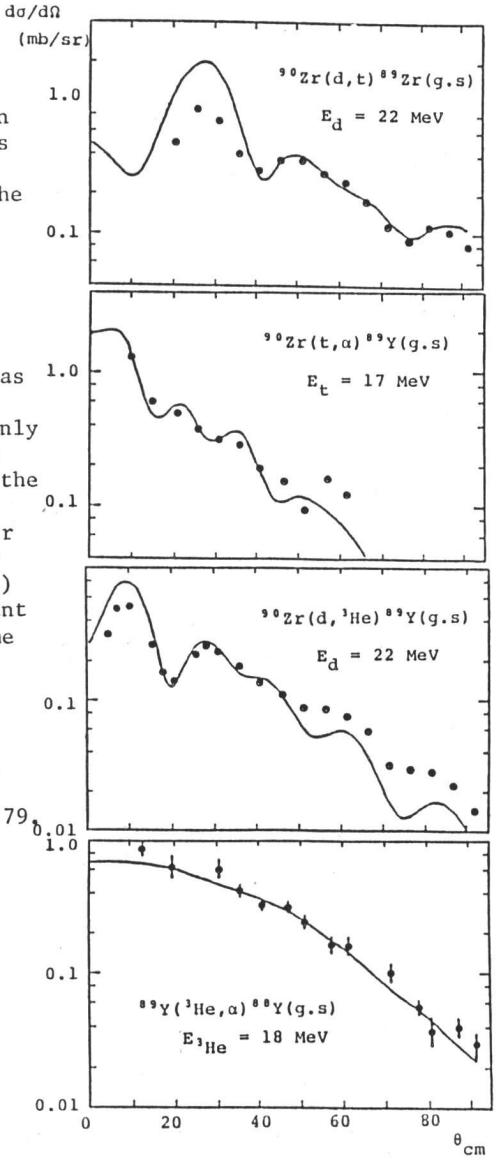

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Fig. 1 Experimental and calculated results of one-nucleon transfer reactions.

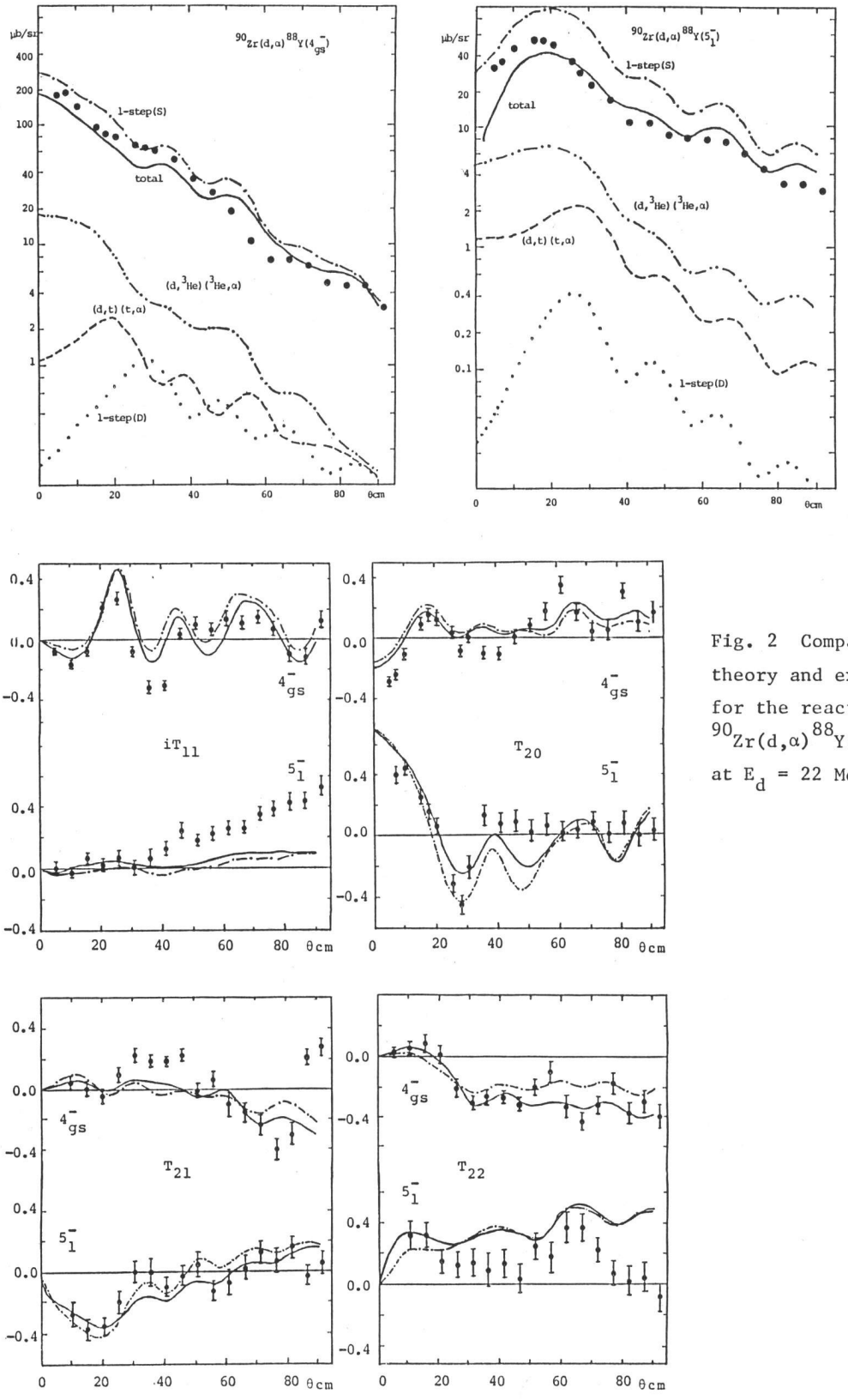

Fig. 2 Comparison of theory and experiment for the reaction $^{90}Zr(d,\alpha)^{88}Y(4^-_{gs},5^-_1)$ at E_d = 22 MeV.