Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 718-719

1.83 L-Mixing and D-state Effects in the $^{40}Ca(\vec{d},\alpha)$ Reaction at E_d = 20 MeV+)

F. Merz, H. Clement, G. und F.J. Eckle, G. Graw, H. Kader, P. Schiemenz, A.M. Eiró*

Sektion Physik der Universität München, 8046 Garching, Germany
* Universidade Lisboa

Evidence for a D-state component in the α-particle wave function has been reported for the $d(\vec{d},\gamma)\alpha$[1] and (d,α) reactions at lower energy[2-4]. The quantitative determination of the D-state amplitude depends very much on details of the reaction mechanism and is not yet settled.

We studied the $^{40}Ca(\vec{d},\alpha)$ reaction at 20 MeV, using the polarized beam from the new source operated in the spin filter mode. We have chosen this reaction because of the large cross section at energies well above the compound nuclear resonance region.

The figures show the data of differential cross-section, vector- and the three tensor analyzing powers for the excitation of the $J^\pi = 3^+$ ground state in ^{38}K together with finite range DWBA calculations (code PTOLEMY). The optical potentials have been taken from literature[5,6] with slight modification for the imaginary part. The α-particle is treated as a two deuteron-cluster bound in a Woods-Saxon potential with a geometry (r_o = 1.5 fm, a = .5 fm) chosen to reproduce the binding energy and finite range parameter β^{-1} = 1.5 fm[4].

The calculations shown in Fig. 1 are without D-state and compare the influence of L-mixing in the heavy nucleus, assuming transfer of a deuteron cluster. Starting from shell-model wave functions, the amplitudes G(L;J) are obtained using 9-j and Talmi-Moshinsky coefficients.

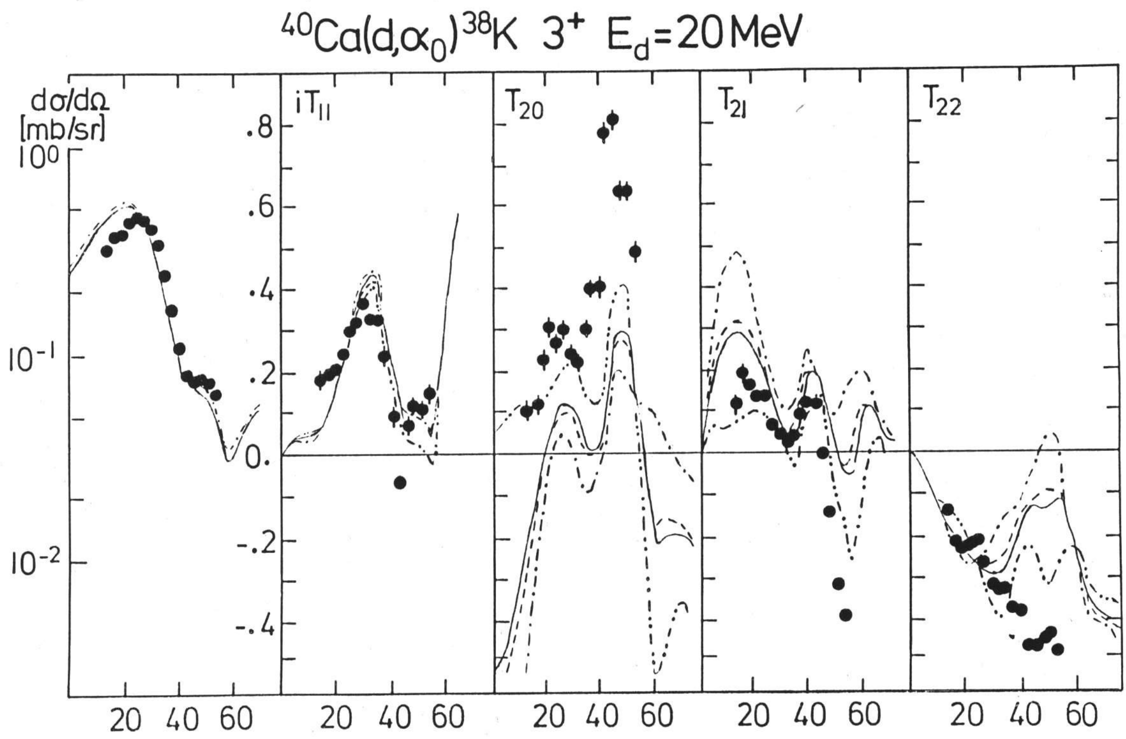

Fig. 1. DWBA-calculations for various L-mixing amplitudes G(L,J)

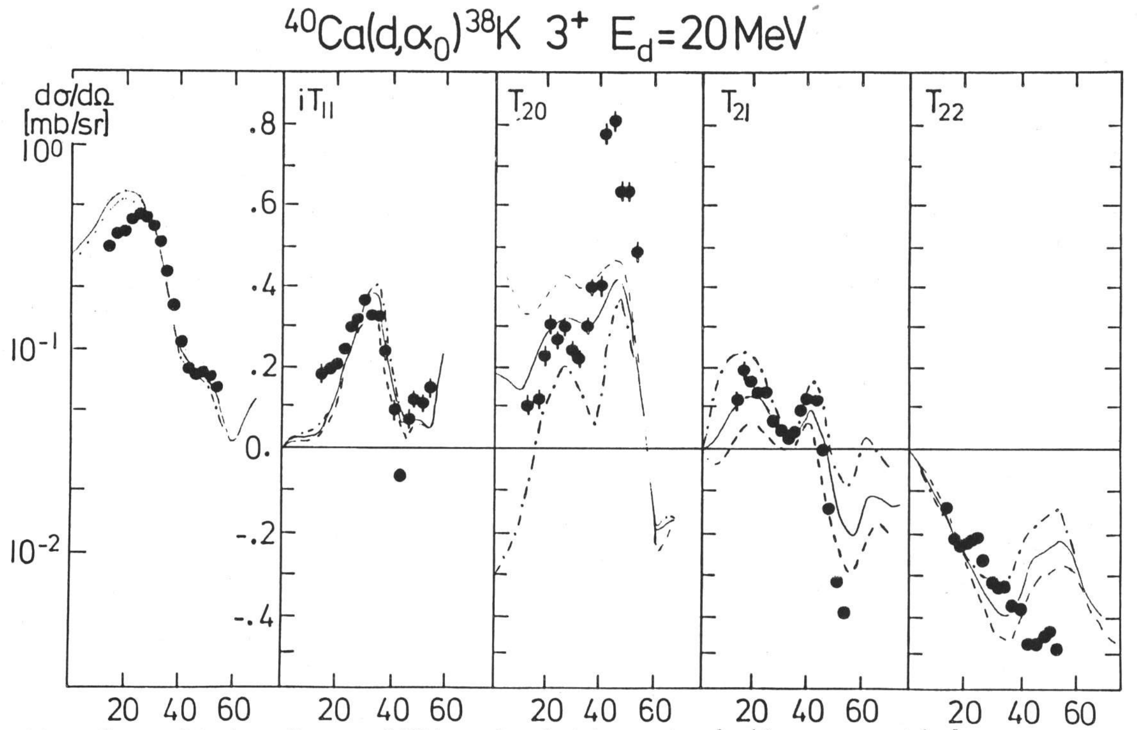

Fig. 2. Finite Range DWBA calculations including α-particle D-state: -.- D_2=-.05 fm²; - D_2=-.14 fm²; --- D_2=-.22 fm²

Cross-section and vector analyzing power are rather insensitive to weak L=2 admixtures to the dominating L=4 amplitude, in contrast to the tensor analyzing powers, especially T_{20} and T_{21} . The full curve (-) is for pure L=4 transfer (G(4;3)=1, G(2;3)=0). Shell model calculations give a pure (d3/2)-two-hole configuration (Ref. 7), corresponding to G(2;3)=-.068 (dash-dotted curve, -.-), a more recent one (Ref. 8) proposes a rather pure L=4 configuration: G(2;3)=-0.010 (dashed curve ---). A better reproduction of the tensor analyzing powers is obtained with positive signs of G(2;3), a calculation with G(2;3)=+.068 is shown as dash-dot-dotted curve (-..-).

Fig. 2 shows calculations including D-state amplitudes. As discussed in Ref. 3, L-mixing in the α-particle (D-state) and L-mixing in the heavy nucleus are hardly to distinguish. Assuming for the latter one the pure L=4 cluster configuration (in agreement with Ref. 8) we obtain a reasonable reproduction of the data with a comparatively[2] small value of D_2 = -.14 fm² (solid curve), (corresponding to P_D = 4,9% in the Woods-Saxon parametrization). For a pure d3/2 configuration[7] best reproduction is obtained for D_2 =-.22 fm².

+) supported in part by the BMFT

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