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6.12 An explanation of the apparent charge symmetry violation in the $^3H(^3He,d)^4He$ reaction

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The Conzett model[1] predicts antisymmetric analysing powers for the $^3H(^3He,d)^4He$ reaction provided the underlying assumption regarding charge symmetry is satisfied. Haglund et al.[2] have reported analysing power measurements for the $^3He(^3H,d)^4He$ reaction at bombarding energies of up to 17 MeV. However, they noted pronounced deviations from antisymmetry which steadily increased with increasing incident beam energy. In order to gain valuable insight into the trends at higher energies we have recently completed a series of analysing power measurements for the $^3H(^3He,d)^4He$ reaction over the incident energy range 18 to 33 MeV (24 to 32 MeV excitation in ^6Li) using the Radial Ridge cyclotron facility at Birmingham[3]. In this paper the measurements at 33 and 18 MeV and some of the results of the DWBA analysis of the data are presented.

The results of the measurements at 33 and 18 MeV are displayed in Figs.1 and 2 respectively. The expected agreement at 18 MeV between our data and those of Hagland et al. is satisfactory and thus confirms their observations. However, the angular distribution of analysing powers at 33 MeV is almost antisymmetric which suggests that a Conzett type model could predict these results, particularly if treated in the distorted wave Born approximation which has the advantage of including the effects of reaction dynamics.

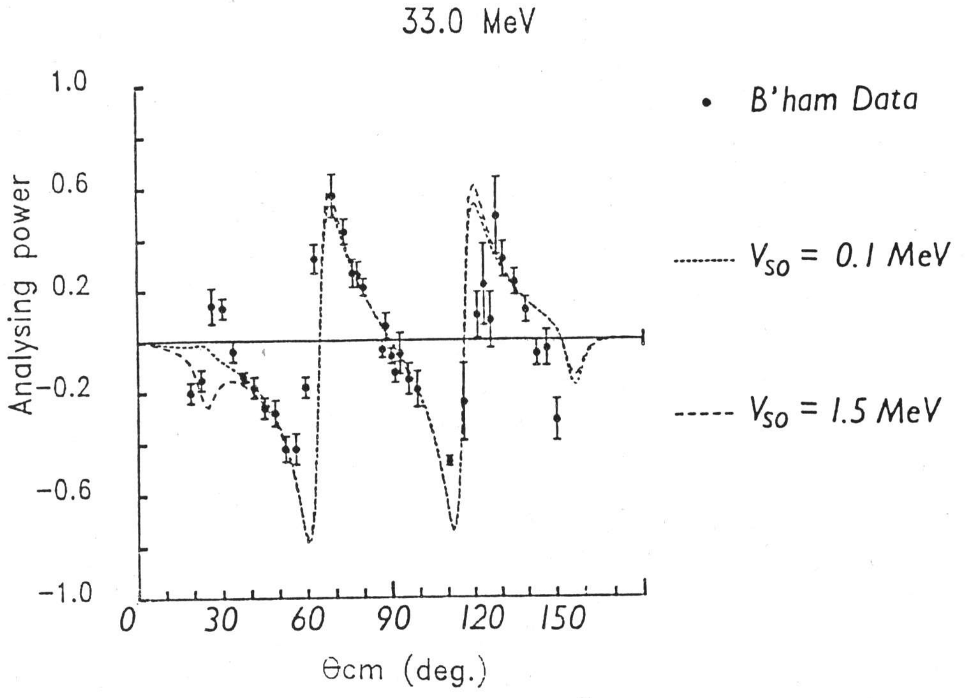

Fig.1 Fits to the reaction analysing powers at 33 MeV.

The exact finite range DWBA programme FRUCK2[4] was modified to calculate and coherently sum the direct and exchange, reduced transition amplitudes[5]. The 33 MeV angular distribution is well represented by the DWBA prediction, but the most interesting result of our investigation is the variation of the 90° analysing power with the strength of the spin orbit interaction in the entrance channel. This is illustrated in Fig.2 and a general feature of all the calculations done so far, is that, except for ^{3}He energies near 18 MeV, the 90° analysing power is sensibly zero and insensitive to the spin orbit potential in either the entrance or exit channel.

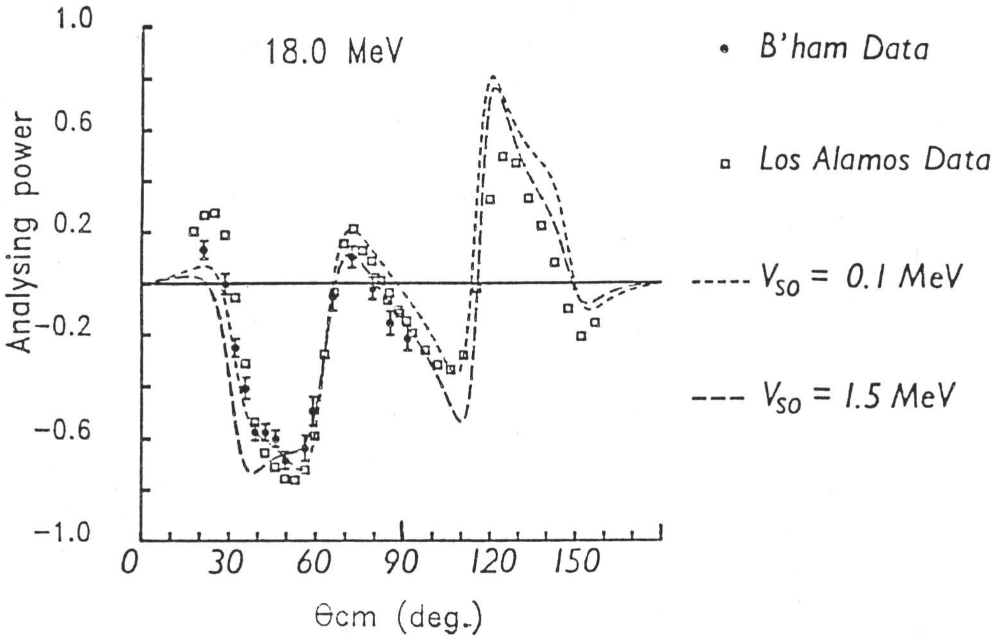

Fig.2 Fits to the reaction analysing powers at 18 MeV. The Los Alamos data were taken from ref.2.

The sensitivity at 18 MeV was found to be due to a $F_{7/2}$ resonance in the ^{3}He+^{3}H optical potential. This leads to an enlarged internal wavefunction and this highlights the short range differences between the ^{3}He and ^{3}H nuclei. The calculation did not fully include the effects of the target spin so that the J^π of the entrance channel resonance is not completely determined. However, it seems likely that it corresponds to the 3^-, T=0 level at 24 MeV excitation in ^{6}Li seen in both elastic channels[6,7] and in capture gamma ray[8] studies.

In summary the experimental data are adequately described by the DWBA approach provided the direct and exchange amplitudes are coherently summed and the spin-orbit force is included. Consequently there is no evidence for supposing that charge symmetry is violated in this reaction.

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