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1.97 # Analysing powers of the $^{12}C(^{3}\vec{He},^{2}He)$ reaction

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The breakup of ^{3}He particles was a subject of several recent studies[1-3] with an emphasis on understanding various mechanisms contributing to the breakup process. The availability of a polarised ^{3}He beam offers an independent and potentially more sensitive method to investigate the breakup phenomena. The aim of the present experiment was to study the polarisation effects in the (^{3}He,pp) channel at small relative proton energies where the sequential breakup is expected to be the dominant process[2]. The ^{12}C target was chosen from experimental considerations and because large effects were already observed in the $^{12}C(^{3}He,dp)$ reaction[4].

The experimental arrangement consisted of 4 telescopes situated symmetrically in pairs around the plane perpendicular to the ^{3}He spin symmetry axis $\underline{s}$ at the same reaction angle θ in a vertical configuration. The minimum relative energy ϵ of the protons coincident within a detector pair was 0.7 MeV, increasing to ~3 MeV at the extreme points of the yield along the locus. The event-by-event data were taken with a 33 MeV polarised ^{3}He beam from the University of Birmingham Radial Ridge cyclotron incident on a 10 mg/cm^2 ^{12}C target in alternating spin states of ±0.6 polarisation values over an angular range 17.5° and 65°. About 90% of the events in the total energy spectra were due to a breakup with a constant Q-value corresponding to the ground, 3.85 and ~8.0 MeV states in the residual ^{13}C nucleus.

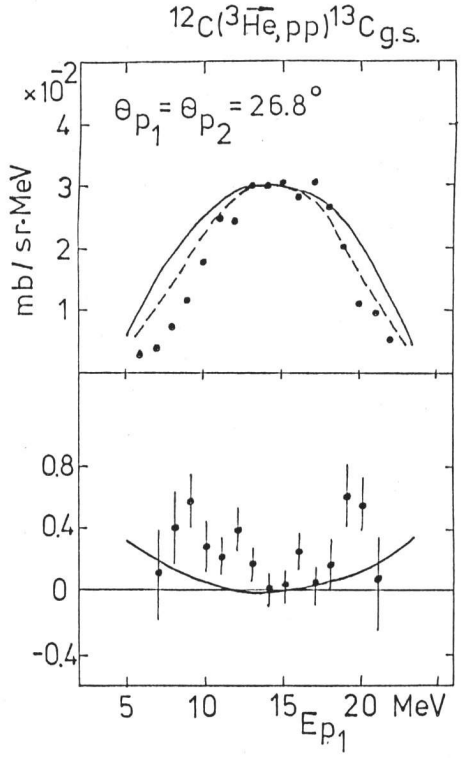

Fig.1 Double differential cross section and analysing power of the $^{12}C(^{3}He,pp)^{13}C_{g.s.}$ reaction at $\theta_1=\theta_2=26.8°$.

An example of the ground state locus projected on the E_{p1} axis is shown in Fig.1. The double differential cross section in the upper part of Fig.1 was obtained by integrating over the solid angle of the relative motion of the two protons and, as expected, is symmetric around the $E_1=E_2\cong14.5$ MeV point. In spite of the large statistical errors it is evident that the analysing powers vary significantly along the locus, therefore they depend on the ϵ-value.

In the next step of the analysis the peaks corresponding to the above three states were integrated and the results are presented in Fig.2 for the ground state and in Fig.3 for the 3.85 and 8.0 MeV states. Such a procedure implies a direct neutron stripping followed by an emission of the ^{2}He cluster. The differential cross section shows a typical direct reaction behaviour while the three analysing powers are completely different, and clearly dependent on the properties of the residual nucleus state.

In the sequential breakup model of the (^{3}He,pp) reaction it is assumed that a direct neutron stripping takes place at the first step of the reaction followed by a final-state interaction between the two protons at an energy ϵ. Therefore it is possible to apply a standard DWBA approach in a theoretical analysis of the data. Such

calculations were performed using the ^{3}He potential of ref.[5] and a deuteron potential[6] for the ^{2}He cluster[2]. In an attempt to describe the data in fig.1 the calculations were made ϵ-dependent by varying correspondingly the Q-value and the energy dependent deuteron potential. The solid lines in fig.2 show that this model can reasonably account for the shape of the double differential cross section but fails to reproduce the strong ϵ-dependence of the analysing power. Further improvement is achieved by taking into account the ϵ-dependence of the final-state proton-proton potential (dashed curve), which however does not affect the analysing power (s=0).

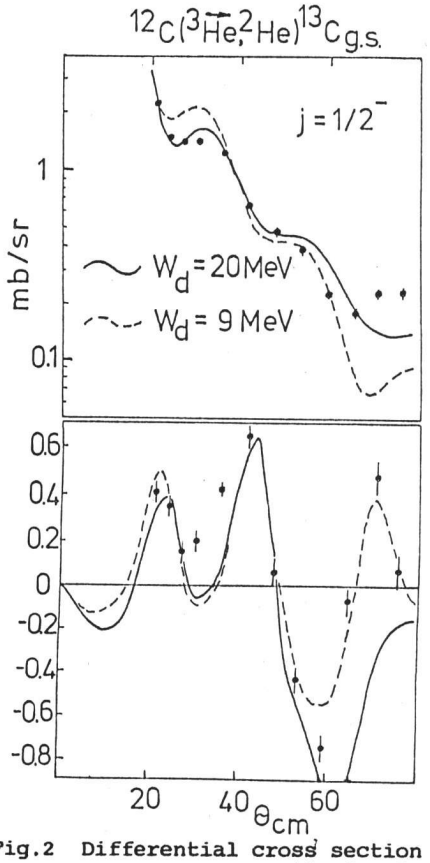

Fig.2 Differential cross section and analysing power of the $^{12}C(^3He,^2He)^{13}C_{g.s.}$ reaction compared with DWBA predictions.

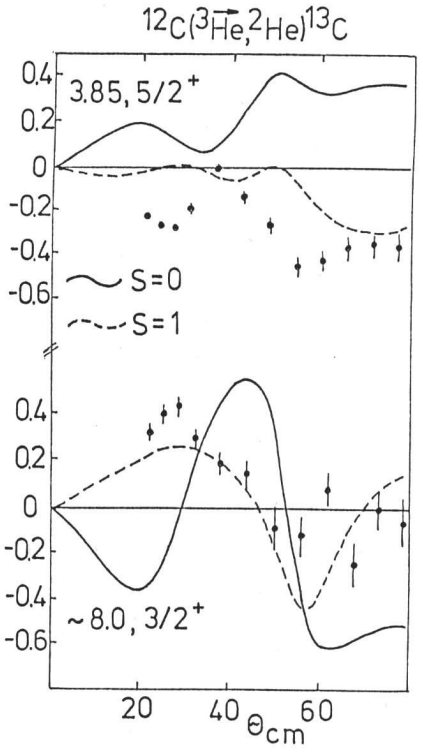

Fig.3 Analysing powers of the $^{12}C(^3He,^2He)^{13}C$ reaction to the 3.85 and 8.0 MeV states compared with DWBA predictions.

The ground state angular distributions (fig.2) are in a good agreement with the sequential model predictions, the analysing power fit could be further improved by reducing the deuteron potential imaginary strength (dashed lines). However, these calculations fail to predict the experimental analysing powers and their apparent j-dependence for the $5/2^+$ and $3/2^+$ transitions (solid lines in Fig.3). The agreement is improved when assuming s=1 for the ^{2}He cluster and switching on the spin-orbit potential (dashed lines). On the other hand, replacing the unknown ^2He-^{13}C potential by a d-^{12}C potential is a rather crude approximation and a folding procedure suggested in ref.[2] might be more appropriate in this case.

References

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