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1.101 Analysing powers of the ^{89}Y($^3\vec{\rm He}$,α) and ^{142}Nd($^3\vec{\rm He}$,α) reactions

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Polarisation effects in one-nucleon transfer reactions induced by 33 MeV ^{3}He particles have been studied on a number of nuclei up to A=58, establishing a systematic j-dependence of the analysing powers (AP). The present experiment was undertaken to investigate the AP behaviour in the (^{3}He,α) reactions involving a neutron pickup from higher shell-model orbits.

A standard experimental technique described e.g. in ref.1 allowed to obtain the reaction data simultaneously with the elastic scattering using the 33 MeV polarised ^{3}He beam. An optical model analysis of the elastic scattering cross sections and analysing powers provided several sets of potentials belonging to different families which were used in a DWBA analysis of the reaction data. As in previous studies the analysing powers were best reproduced by a spin-orbit term characterised by a small diffuseness parameter $a_{so} \simeq 0.2$ fm.

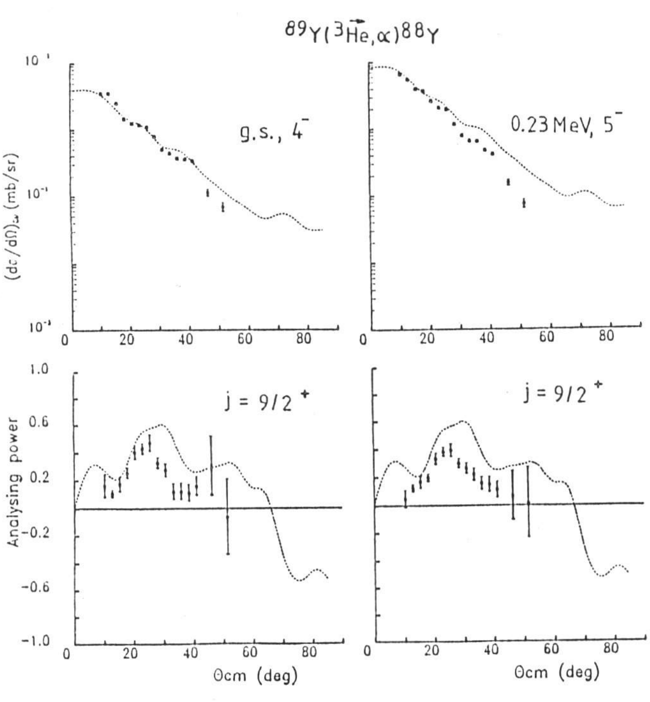

Fig.1 Differential cross sections and analysing powers of the ^{89}Y(^{3}He,α)^{88}Y reaction leading to the ground and 0.23 MeV states.

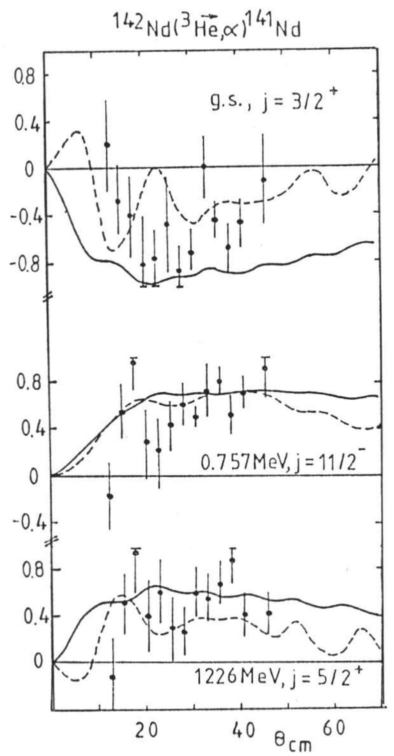

Fig.2 Analysing powers of the ^{142}Nd(^{3}He,α)^{141}Nd reaction from the ground, 0.757 and 1.226 MeV states.

In the ^{89}Y(^{3}He,α) reaction, AP were measured for the ground and first excited states and the results are shown in Fig.1. The corresponding AP reaching ~0.4

around θ=30° are almost identical implying a $j=9/2^+$ value for both ℓ=4 transitions, as expected from simple shell model arguments. The DWBA theory predicts correctly the experimental results (dashed lines in Fig.1). It is interesting to point out that the sign and magnitude of the AP involving a $1g_{9/2}$ neutron in the ($^3\vec{He}$,α) reaction at 33 MeV is identical to that involving a $1g_{9/2}$ proton in the ($\vec{t}$,α) at 17 MeV.

Analysing powers in the ^{142}Nd($^3\vec{He}$,α)^{141}Nd reaction were obtained for three prominent transitions[3] to the ground, 0.757 and 1.226 MeV states (Fig.2). In spite of the poor statistics it is clear that the polarisation effects are large, approaching the maximum possible value. The strong j-dependence of AP in the 2d shell is seen when comparing the ground and 1.226 MeV state data: for $j=\ell+1/2$ the effect is positive and for $j=\ell-1/2$ negative. The AP data for the $j=11/2^-$ and the above $j=9/2^+$ transitions also agree with this rule. It should be mentioned that this behaviour is opposite to that observed in the 1p and 1d shells[4,5]. In the semi-classical model[5] the sign of the analysing power in the (^{3}He,α) reactions for A$\leqslant$40 was interpreted as an evidence for a dominant (attractive) nuclear force during the interaction. With the increasing charge of the target the Coulomb barrier increases and in the forward angular region the replusive force becomes dominant which would lead, under the assumption of this model, to a sign reversal of the j-dependence. The DWBA calculations shown in Fig.2 as solid (deep ^{3}He potential) and broken lines (shallow ^{3}He potential) fully reproduce the observed sign and magnitude of the analysing powers. As in the case of ^{89}Y, the experimental behaviour of the analysing powers for the $j=3/2^+$,$5/2^+$ and $11/2^-$ transitions in the ($^3\vec{He}$,α) and ($\vec{t}$,α) reactions is the same[6].

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