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1.87 Mechanism of the $^{209}Bi(\vec{d},\alpha)^{207}Pb$ reaction at E_d = 23MeV[+)]

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To study the mechanism of (d,α) reactions[1)], we have chosen the $^{209}Bi(d,\alpha)^{207}Pb$ reaction because of the uniquely simple structure of both target and residual nucleus. Angular distributions of the differential cross-section and analyzing power A_y have been obtained in magnetic spectrograph measurements for the transitions leading to the low-lying one-neutron hole states in ^{207}Pb (see fig. 1). Because of the spin of the target ($J^\pi = 9/2^-$) and residual nucleus, several angular momenta L, J will contribute, the code CHUCK 3[2)] was used for the coherent superposition of DWBA amplitudes.

The two-nucleon formfactor was calculated either from single nucleon orbitals bound in a Woods-Saxon potential using the Bayman-Kallio-method[3)] (microscopic form-factor) or assuming transfer of a deuteron cluster. In the latter case the "deuteron" is bound in a Woods-Saxon well, with a depth given by the deuteron separation energy.

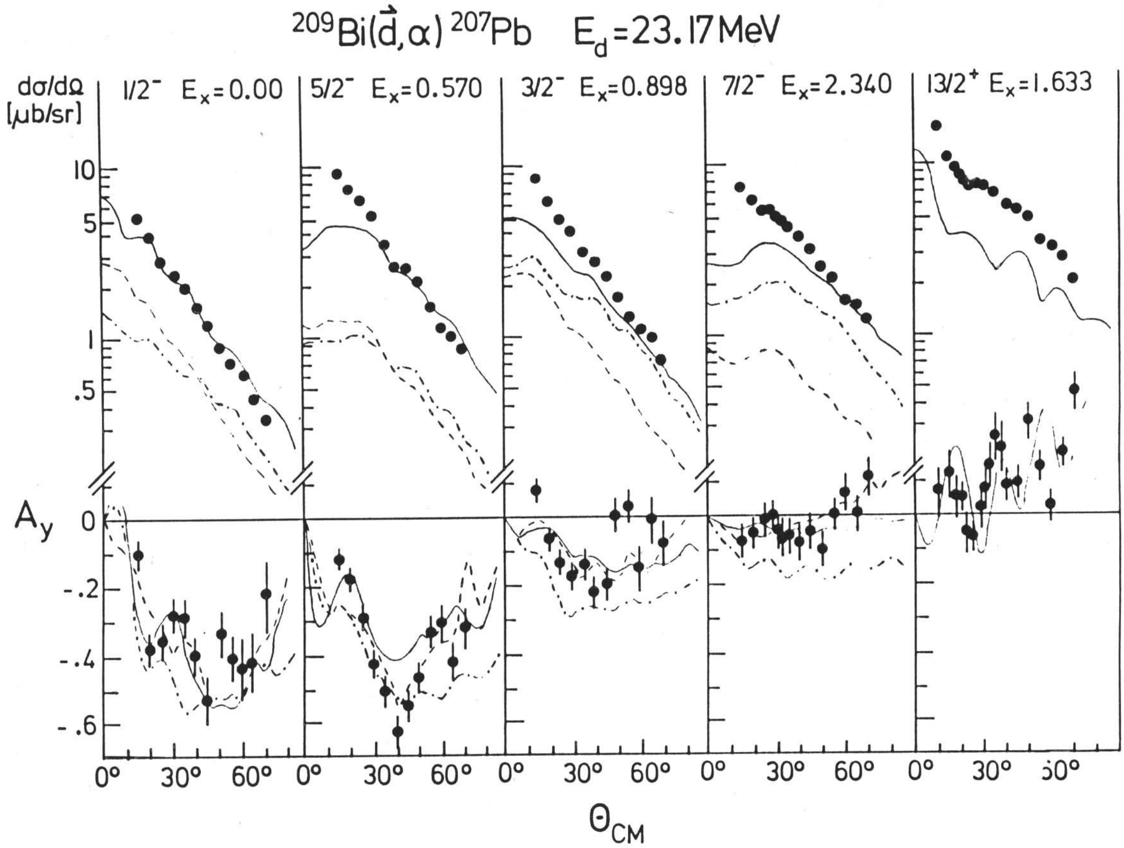

Fig. 1. Angular distributions of differential cross-section and vector analysing power for the five lower-lying neutron-hole states in ^{207}Pb. The DWBA curves are explained in the text

The radial quantum numbers for the cluster are given in terms of the single nucleon quantum numbers[4]: $2N+L = 2(n_p+n_n)+l_p+l_n$; to determine the L,J - strength for cluster-transfer 9-j and Talmi-Moshinsky[5] coefficients were used.

Optical potentials[6,7] and absolute normalisation for the microscopic calculations[7] (D_o = 4800 MeV/fm$^{3/2}$) have been taken from the literature, for cluster-transfer an adjusted value D_o(Cluster) = 2200 MeV fm$^{3/2}$ was used throughout. The calculations using cluster-transfer (dash-dotted curve in Fig. 1) proved to be superior to the microscopic ones especially in the reproduction of the analyzing powers.

This reaction is badly mismatched: the reaction kinematics favour transfer of rather small orbital angular momenta $L \approx 2$, whereas the coupling of the g9/2-proton with the neutron hole prefers large angular momenta; therefore higher order processes may be important. (The importance of multistep processes in (α,d)-reactions has been pointed out in Ref. 7).

We have encluded the two-step processes d-^{3}He-α via the 0^+ groundstate in ^{208}Pb - which is strongly suppressed due to coulomb-effects - and d-t-α via ^{208}Bi. In the latter case all states of the $(g9/2)_p \times (J^\pi(^{207}Pb))_n^{-1}$ multiplets have to be taken into account.

The dashed curve results from the coherent sum of the sequential transfer processes. For part of the transitions they are as strong as the one step processes. Their angular distributions of the analyzing power are nearly identical to the one step ones.

The coherent sum of direct and sequential transfer (full curve) accounts quite well for the experimental data for the p- and f-hole states of ^{207}Pb.

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