STRIPPING AND ELASTIC SCATTERING OF DEUTERONS BY C^{12}

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The angular distributions of elastically scattered deuterons and protons from the $C^{12}(d,p)C^{13}$ reaction leaving C^{13} in the ground or first excited state are measured simultaneously with a multiangle magnetic analyzer. The experimental results are compared with the theory, taking strong spin-orbit interaction between the incident and emitted particles into account.

THE discrepancy between experiment and the theory of stripping, both in its simple form [1] and when modified to account for distortion of incoming and outgoing waves, [2] is reduced considerably by introducing strong spin-orbit interaction between the incident and emitted particles. [3] However, Robson's [3] comparison of the theory with experiment is not entirely convincing, because theoretical cross sections for the reaction and for elastic scattering from a single target-nucleus are compared with experimental results for different deuteron energies and for different nuclei, since no better experimental data are to be found in the literature. Our experiment is a simultaneous study of angular distributions in elastic (d, d) scattering and (d, p) stripping by C^{12}.

Our experimental apparatus, which was described in [4,5], consisted of a cyclotron producing monoenergetic (~ 1%) deuterons in conjunction with a multiangle magnetic analyzer of the reaction products. The latter is a multispectrograph obtaining simultaneously the energy spectra of reaction products ejected at different angles. The energy of the bombarding deuterons was 6.60 MeV; the target was an unbacked carbon film ~ 2 mg/cm^2 thick. For the purpose of obtaining accurate elastic scattering cross sections it was important to check the purity of the target. The impurity content was measured in two ways: 1) by spectrographic analysis of a batch of identical films, one of which was used as the target, and 2) from the shape of the energy spectrum of particles scattered elastically at the largest angles in the main experiment. The energy resolution of the apparatus enabled us to distinguish groups of deuterons scattered elastically by oxygen and heavier nuclei as well as by boron and lighter nuclei.

The absence of appreciable target impurity was confirmed; the possible contribution from scattering by impurities was estimated at 8% of the total intensity of elastically scattered deuterons. The energy spectrum in each channel of the multispectrograph was registered in a nuclear emulsion. Because of the broad energy range of the reaction products registered in each channel simultaneously, each film in a single run detected both (d, p) protons and elastically scattered deuterons.

Figure 1 shows the experimental angular distribution of 6.60-MeV deuterons scattered elastically by C^{12}. A comparison is shown with theoretical curves calculated for 8.9-MeV deuterons [3] both with (1) and without (2) account of spin-orbit interaction.

Figure 2 shows the experimental angular distributions of protons from the reaction $C^{12}(d,p)C^{13}$, where C^{13} was formed in (a) the ground state and (b) the first excited state.

When a strong spin-orbit interaction is introduced into the theoretical calculation [3] somewhat better agreement is obtained with our ex-

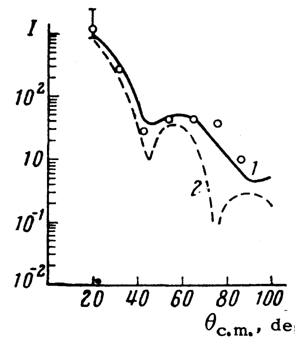

FIG. 1. Angular distribution of deuterons scattered elastically by C^{12}. $\theta_{c.m.}$ is the center-of-mass scattering angle; I is the differential scattering cross section in relative units. Our experimental results are represented by small circles, with statistical errors indicated whenever they exceed the diameter of the circles. The theoretical curve 1 was calculated with account of a strong spin-orbit interaction between the deuteron and the nucleus; [3] curve 2 was calculated neglecting the spin-orbit interaction.

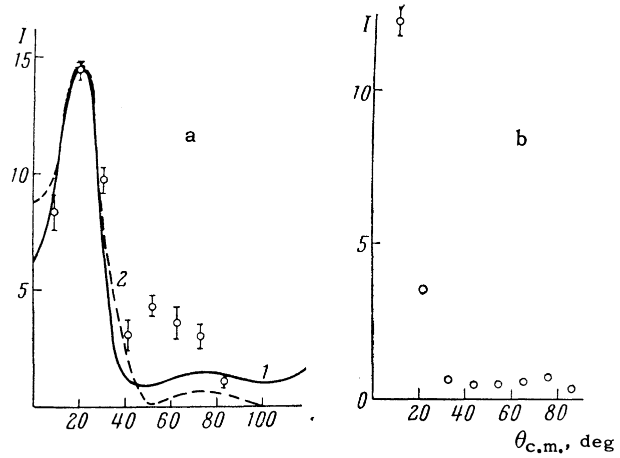

FIG. 2. Angular distribution of protons from the reaction $C^{12}(d,p)C^{13}$. a represents the proton group associated with the formation of ground-state C^{13}. The small circles indicate our data. The continuous theoretical curve was calculated with account of strong spin-orbit coupling between the incident and the emitted particle, while the dashed curve was calculated neglecting spin-orbit coupling. b represents protons associated with the formation of C^{13} having 3.09-MeV excitation energy.

perimental results. However, our data do not enable us to exclude a contribution from compound-nucleus formation in accounting for the cross section at large angles.

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