teractions with different nuclei. Calculations largely confirm this supposition.

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Translated by C. S. Robinson
218

SOVIET PHYSICS JETP VOLUME 20, NUMBER 4 APRIL, 1965

ELASTIC SCATTERING OF 13.6 MeV DEUTERONS BY GOLD AND BISMUTH NUCLEI

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SOKOLOV and Lebkova [1] have studied the possibility of describing the elastic scattering of 13.6-MeV deuterons on various nuclei by the optical model and have shown that scattering by heavy nuclei is explained rather well by this model. However, while the theoretical differential cross sections for elastic scattering show striking oscillations as large as 8% in the region of small scattering angles (15-45°), the experimental cross sections [2,3] do not show regular variations. For medium and large scattering angles the data of Gofman and Nemets on the elastic scattering of 13.6 MeV deuterons by gold [2] differ considerably from the data of Cindro and Wall [3] obtained at a deuteron energy of 13.5 MeV. The present work was undertaken to provide better data on the elastic scattering cross sections for deuterons by gold and bismuth at all angles.

The measurements were carried out at the cyclotron of the Scientific Research Institute of Nuclear Physics, Electronics, and Automation at the Tomsk Polytechnic Institute. The deuteron energy was 13.6 MeV. The external deuteron beam was focused by a pair of quadrupole lenses, deflected 30° by a bending magnet, and after passing through an iron shield in a beam pipe was incident on a target located at the center of a 1.5 m diameter scattering chamber. Collimation of the beam was achieved by two pairs of remotely controlled vanes located in the horizontal and vertical planes, and by tantalum diaphragms of diameter 6 mm (defining) and 8 mm (antiscattering).

The beam current was recorded by four monitors consisting of thin crystal scintillation counters located at angles of 15, 30, 60, and 90°. During the measurements three monitors were used simultaneously.

The scattered deuterons were detected by a telescope of two scintillation counters in which the particle identification was made from the values of dE/dx and E (the specific ionization loss and the total energy). The construction of the telescope is similar to that described by Nemets et al. [4]

A 70 mg/cm^2 crystal was used in the scintillation counters to obtain the pulse proportional to dE/dx, and a 700 mg/cm^2 crystal for the pulse proportional to E. The pulse height resolution was 7-8% for the dE/dx counter and 4-5% for the E counter. The dE/dx and E pulses were fed to an electronic multiplier circuit[5] whose output was used to control a proportional gating circuit. The gated pulses were fed to a 100-channel type AI-100 pulse height analyzer.

The counter telescope and multiplier circuit provided reliable identification of the particles. The spectrum of the product E(dE/dx) is shown in Fig. 1 for the reaction products from a gold target at 90°. The lower energy limit for the deuterons and protons recorded was 5 MeV. The targets were prepared by vacuum evaporation of gold and bismuth to a thickness of 2.1 and 2.7 mg/cm^2, respectively. Measurements were made over the angular range 10-165°. The zero angle was determined from the symmetry of the angular distributions with respect to the incident beam direction. The accuracy of the angle determinations was 0.15° or better; the statistical error of the measurements was less than 3% from 40-165° and less than 2% from 10-40°. Thus, the relative error of the measurements was not more than 3% from 10-40° and not more than 4% from 40-165°.

Figure 2 shows our experimental data together with those of Cindro and Wall [3] and of Gofman and Nemets [2], and also the theoretical curve obtained by Sokolov and Lebkova.[1] It can be seen from this figure that the differential cross sections in the region 20-40°, in contrast to the cross sections measured by the authors cited, [2,3] are pure Rutherford cross sections within the errors of ± 3%, and that the optical model of the nuclear interactions requires further refinement in its application to deuterons. At medium and large scattering angles our measured cross sections are different from those of Gofman and Nemets and of Cindro and Wall by 20-50%.

The authors are grateful to V. M. Galitskiĭ for discussion of the work of Sokolov and Lebkova,[1] to I. N. Serikov and V. V. Tokarevskiĭ for advice on experimental technique, to V. Vlasov for preparation of the targets, and to the cyclotron crew for assistance in performance of the measurements.

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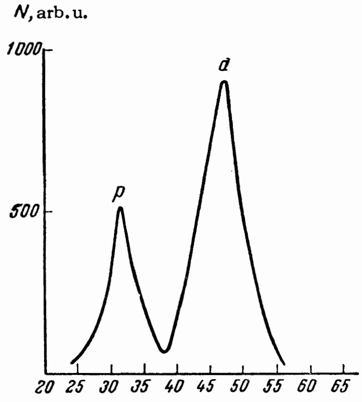

FIG. 1. Pulse height spectrum after the multiplier circuit; target – Au^{197}, $\theta = 90°$.

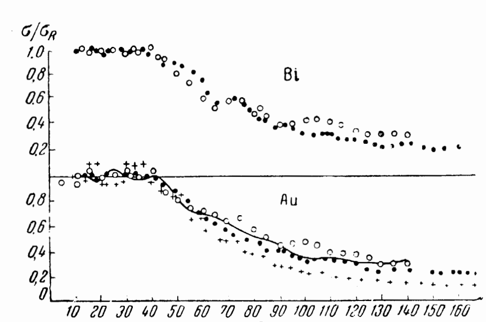

FIG. 2. Differential scattering cross sections for deuterons, relative to the Rutherford cross sections, as a function of the center-of-mass scattering angle: solid circles – data of the present experiment, open circles – data of Gofman and Nemets [2], crosses – data of Cindro and Wall [3]; the solid line in the plot for Au represents the calculations of Sokolov and Lebkova [1] on the basis of the optical model.

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219

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STUDY OF THE (p, p′) REACTION WITH EXCITATION OF 1.65 AND 1.83 MeV LEVELS IN Al^{27}

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CIUFFOLOTTI and Demichelis [1] in studying the β^- decay of Mg^{27} observed three new partial β^- spectra with end point energies of 0.750, 0.950, and 2.6 MeV, in addition to the previously found values of 1.59 and 1.75 MeV.[2] On this basis Ciuffolotti and Demichelis proposed a decay scheme for Mg^{27} from which it follows that there are two new levels in Al^{27} at 1.65 and 1.83 MeV. In an attempt to determine the quantum numbers of these levels, Ciuffolotti and Demichelis proceeded on the erroneous assumption that the spin of the 2.2 MeV level in Al^{27} was $3/2$ as determined by Van der Leun et al.,[3] instead of $7/2$ as determined subsequently by Towle and Gilboy [4] and Alkhazov et al.[5] Considering that the 1.65 and 1.83 MeV levels may belong to rotational bands, they proposed a spin of $1/2$ for the 1.83 MeV level and $7/2$ for the 1.65 MeV level. Val'ter et al.[6] attempted to confirm the existence of the 1.65 and 1.83 MeV levels in Al^{27} by studying the radiative capture of protons by Mg^{26}, but were unable to detect γ lines in the proper energy region. Proceeding from the spin value $7/2$ for the 2.2 MeV level, Val'ter et al.[6] concluded that the spin values of these levels must be less than $7/2$, possibly $1/2$ and $3/2$.

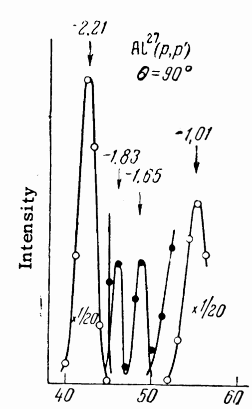

FIG. 1. Section of the spectrum of protons inelastically scattered by aluminum at 90°. The numbers give the excitation energy of Al^{27} in MeV.

In the present work we studied the reaction Al^{27}(p, p′) with excitation of the 1.65 and 1.83 MeV levels. The protons were accelerated in the 120 cm cyclotron of the Scientific Research Institute of Nuclear Physics at Moscow State University. The measurements were made in the apparatus described by us earlier;[7] the method of analyzing the experimental data was also de-