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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 $3/2$.

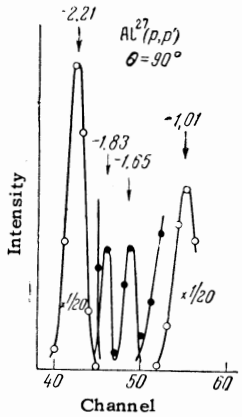

FIG. 1. Section of the spectrum of protons inelastically scattered by aluminum at 90°. The numbers give the excitation energy of Al^{27} in MeV.

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-

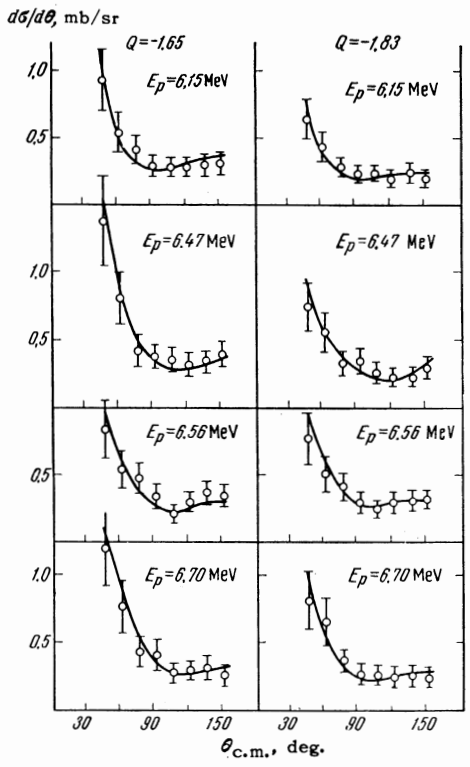

FIG. 2. Angular distribution of protons measured in the reaction Al^{27} (p,p') going to the 1.65 and 1.83 MeV levels. The energy of the proton incident on the target is indicated for each curve. The solid curves represent $|j_l(kR)|^2$ for $l = 0$ and R as given in the text.

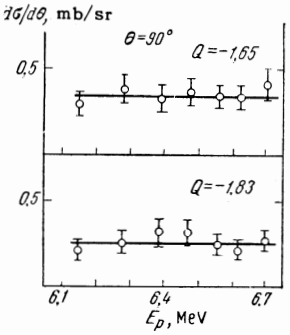

FIG. 3. Excitation curves for Al^{27} (p,p') for the levels 1.65 and 1.83 MeV. The scattering angle is 90°.

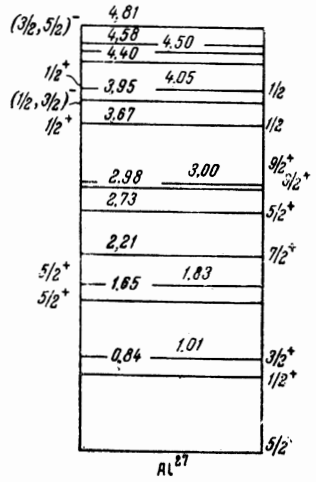

FIG. 4. Excited level scheme for Al^{27}. The quantum numbers at the right are based on [2,4,5], and those at the left on [7] and the present work.

scribed in the same article. A target of thickness 0.988 mg/cm^2 was prepared from an aluminum foil rolled from a crystal of purity 99.9% or better. The protons scattered by the target were recorded by a multichannel scintillation spectrometer.

Figure 1 shows a typical section of the spectrum of protons inelastically scattered by Al^{27}, for an angle of 90° and an incident proton energy of 6.47 MeV. In this figure, between the large peaks corresponding to protons inelastically scattered with excitation of the second and third known levels with E_{exc} = 1.01 and 2.21 MeV, two small peaks are distinctly visible which are due to protons scattered with excitation of the 1.65 and 1.83 MeV levels observed in Al^{27}.[1] For these two groups of inelastically scattered protons, which we designate as p'(1.6) and p'(1.8), we measured the angular distributions for several values of incident proton energy between 6.15 and 6.70 MeV. The results of the measurements are shown in Fig. 2. The angular distributions for p'(1.6) and p'(1.8) are sharply asymmetrical about 90° in the c.m.s. and preserve their shape with change of the incident proton energy. All of the angular distributions are well described by the square of the spherical Bessel function of zero order (the curves in Fig. 2) with $l = 0$ and R varying from 4.8-3.8 F as the incident proton energy changes from 6.15-6.70 MeV.

The excitation function of the levels studied, measured at a scattering angle of 90° in the indicated range of incident proton energy, has a flat behavior (see Fig. 3). The value of the excitation cross section for these levels is substantially less than for the neighboring levels, which indicates that the 1.65 and 1.83 MeV levels differ in nature from the others.

The experimental data obtained and the analysis carried out indicate a direct mechanism for the Al^{27} (p, p') reaction with excitation of the 1.65 and 1.83 MeV levels in Al^{27}, and give quantum numbers of $5/2^+$ for these levels; consequently the Al^{27} level diagram should have the form given in Fig. 4.

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