THE β^+ SPECTRUM OF Si^{27}

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The β^+ spectrum of Si^{27} was investigated with a magnetic-lens β spectrometer. End points were observed at 3.65 and 1.45 Mev with intensities 90% and 10%, respectively.

THE β^+ end-point energy of Si^{27} has been given as 3.48 ± 0.1 Mev by Boley and Zaffarano,[1] whose work was done with a scintillation spectrometer. On the basis of several investigations,[1-3] the most reliable value of the corresponding half-life appears to be 4.14 ± 0.03 sec.

We have used a magnetic-lens β spectrometer to investigate the β^+ spectrum of Si^{27} produced in the reaction $Al^{27}(p, n)Si^{27}$, with 6.7-Mev protons from the 120-cm cyclotron of the Institute of Nuclear Physics, Moscow State University. Figure 1 is a schematic diagram of the experimental apparatus. The extracted proton beam was focused by quadrupole lenses on a rotating target positioned 9 m from the cyclotron behind a concrete shield; this differs from the setup used in our earlier work.[4] Before reaching the target the protons passed through a grid coupled to an integrator, which registered the relative beam intensity. The target, which was subjected to continuous proton bombardment, consisted of a rotating aluminum ring 2.7 mg/cm^2 thick. Each bombarded area of the target reached the focus of the β spectrometer in a period of time which was variable, from a few hundredths of a second to one second, by changing the speed of rotation in accordance with the radioactive half-life under investigation; reduced target activity was compensated by intensifying the proton beam. The troublesome background was reduced by an additional shield. In addition, the materials used for parts of the apparatus subject to proton bombardment were selected with a view to reducing the gamma-ray and neutron backgrounds.

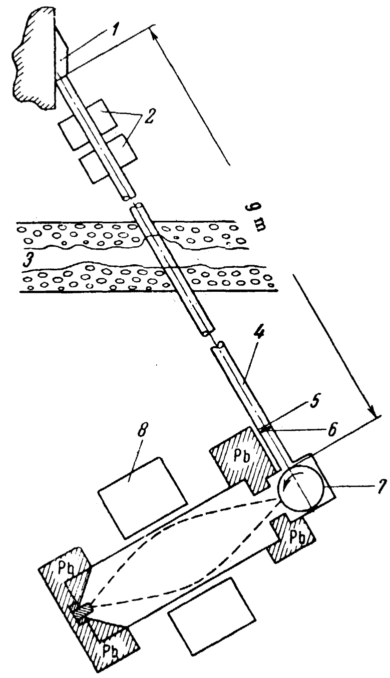

FIG. 1. Schematic diagram of experiment: 1 – exit window of cyclotron, 2 – quadrupole lenses, 3 – concrete wall, 4 – proton beam, 5 – to integrator, 6 – grid, 7 – rotating target, 8 – β spectrometer.

Figure 2 shows the Fermi plot for the complex β^+ spectrum of Si^{27}, consisting of two partial spectra. The principal end point, corresponding to ~ 90% of the intensity, is located at 3.65 ± 0.05 Mev, while not more than 10% of the intensity is represented by the partial β^+ spectrum having its end point at 1.45 ± 0.1 Mev. The decay scheme of Si^{27} given in the book by Dzhelepov and Peker[5] must therefore be amended by introducing the latter partial spectrum and end point, representing the transition to the 2270-kev level of Al^{27} (Fig. 3), which is observed in connection with inelastic scattering.[5,6]

FIG. 2

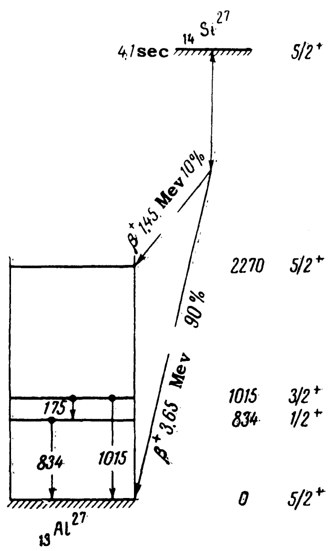

FIG. 3

According to reference 5, the given level has positive parity and spin $5/2$, like the ground state of Si^{27}. Therefore there is greater probability of a β transition to this level than to other Al^{27} levels having different spins.

The observed half-life of Si^{27} was 4.1 ± 0.4 sec, agreeing with the previously known value within experimental error. The given value was determined as follows. The current in the magnetic lenses of the β spectrometer was adjusted to focus 1650-kev electrons. The proton beam was then switched off, and pulses in the counter of the spectrometer were recorded magnetically. By means of a timing device, the magnetic record was read out so that pulses recorded within 2-second intervals were registered successively by a 100-channel pulse-height analyzer.

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