INVESTIGATION OF THE ALPHA DECAY OF U^{236}

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The α spectrum of U^{236} has been studied with the aid of an ionization chamber containing a grid. The energy of the fundamental group of α particles, after corrections for ionization, imperfect grid shielding, and pulse rise time have been applied, is equal to 4.488 ± 0.003 Mev. The energies and intensities of the transitions to the 2^+ and 4^+ levels of the daughter nucleus were also determined.

INFORMATION about the excited levels of Th^{232} has been obtained chiefly from Coulomb excitation experiments; the excitation of levels with energies of 50 and 790 kev has been observed.[1,2] The existence of the 50-kev level, which appears to be the first level of the fundamental rotation band, has also been confirmed by measurements of the conversion electron spectrum in photo-emulsions.[3] The 790-kev level is de-excited by the emission of γ quanta with energies of 790, 740, and 613 kev, which apparently correspond to transitions to the 0^+, 2^+, and 4^+ levels of the fundamental rotation band. It is known that the 0^+, 2^+, and 4^+ levels in even-even nuclei are also excited during α decay. Hence the study of the fine structure of the U^{236} α spectrum is of considerable interest.

We have carried out a study of the U^{236} α spectrum in an ionization α spectrometer of high resolution.

An ionization chamber permits one to determine the number of ion pairs produced by an α particle within the active volume of the chamber. The number of ion pairs N and the energy E of the α particle are connected by the relation $E = Nw$, where w is the mean energy required for the formation of a single ion pair. w depends on the working gas in the chamber and also, generally speaking, on the α-particle energy. In the case of argon there are contradictory opinions in the literature about the dependence of w on the α-particle energy. However, for α-particle energies above 4 Mev, w can be assumed, on the basis of experimental results, to be independent of the energy. Under these conditions the relation of α-particle energy to the total number of pairs is given by the formula $E = Nw_0 + \epsilon_0$, where w_0 is the mean energy going into the formation of a single ion pair when $E > 4$ Mev, and ϵ_0 is a parameter depending on the nature of the gas. For a mixture of argon and methane, $\epsilon_0 = 83$ kev.[4]

The U^{236} α-particle energies were measured by a comparison of the pulse amplitudes from U^{236} α particles with the pulse amplitudes from a reference α source, U^{234}, whose energy was taken equal to 4.768 Mev.[5] The amplitude comparison was accomplished with the aid of a precision generator, whose pulses were applied to the input of the preamplifier. The pulse amplitudes were measured by a method described previously.[6] The energy of the U^{236} α particles was determined from the relationship

$$E_{236} = aE_{234} + \varepsilon_0(1 - a),$$

where a is the ratio of the pulse amplitudes of the α particles from U^{236} and U^{234}.

After correcting for imperfect screening by the grid and for the pulse rise time, the energy of the U^{236} α particles was found to be $E = 4.488 \pm 0.003$ Mev. No correction was applied for the source thickness, since the α-particle energies of U^{236} and U^{234} are close together, and the source was one and the same. Previously measured values for the energy have been 4.5 Mev[7] and 4.499 ± 0.004 Mev.[8] It should be observed that reference 8 gives not the measurement error, but the deviation from the mean of 9 measurements. The error of these measurements must have been high (about 10 kev), judging from the large half-width of the α lines, the considerable "tail" of U^{234} α particles, and the inaccurate values of energies for the reference standards used. The U^{236} α-particle energy measured in reference 8 is high because corrections were not applied for imperfect grid screening and for pulse rise time. When these corrections are taken into

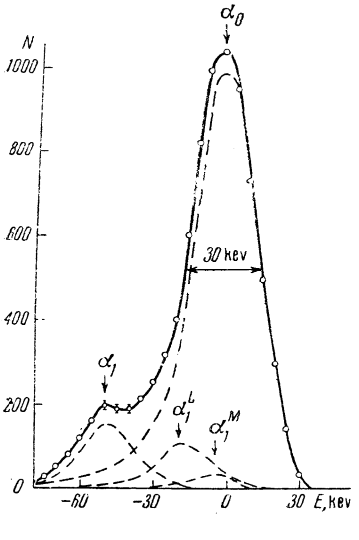

FIG. 1

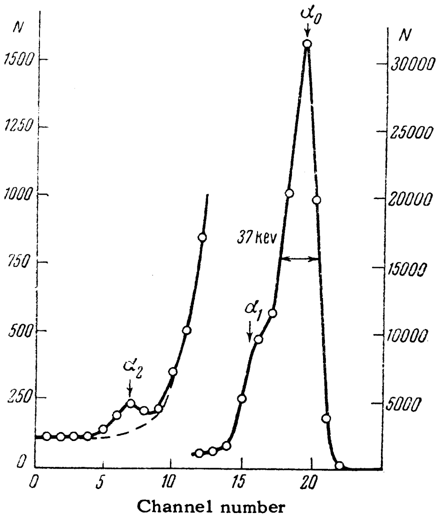

FIG. 2

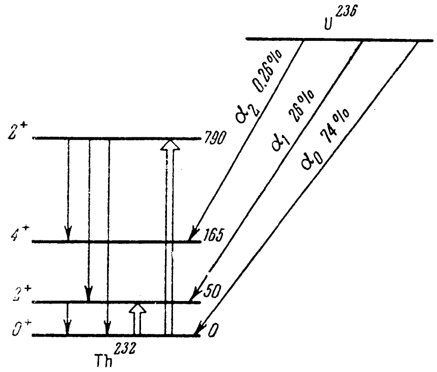

FIG. 3

FIG. 1. Spectrum of U^{236} α particles. Channel width 5 kev. The resolution of the curve is shown by dashed lines. α_0 is the group of α particles corresponding to a transition to the 0^+ level of the daughter nucleus, and α_1 to the 2^+ level. The groups α_1^L and α_1^M correspond to the cases in which the α particles of group α_1 are accompanied by conversion electrons from the L and M shells, which introduce an additional ionization; in half the cases the electrons do not traverse the active volume of the chamber (group α_1^0).

FIG. 2. Energy spectrum of U^{236} α particles, taken with a channel width of 13.9 kev. The groups α_0, α_1, and α_2 correspond to transitions to the 0^+, 2^+, and 4^+ levels of the Th^{232} nucleus.

FIG. 3. Decay scheme of U^{236}.

account, the value of energy measured in reference 8 does not disagree with our result, within the errors of measurement.

In Fig. 1 is shown the α spectrum of U^{236}, obtained with the use of electrical collimation. In carrying out the resolution of the curve, the distortion of the spectrum due to the conversion electrons was taken into account. The intensity of the α_1 line was $26 \pm 4\%$. The separation between the α_0 and α_1 lines is 50 ± 5 kev.

Figure 2 represents the α spectrum of U^{236} taken with a greater channel width. A group of α_2 particles can be seen at a separation of 160 kev from the main line, with an intensity of $0.26 \pm 0.1\%$. In determining the intensities of the α lines, account has been taken of the intensity distortions introduced by the electrical collimation. The α_2 group apparently corresponds to the transition to the excited state 4^+ of the Th^{232} nucleus.

The decay scheme for U^{236} is shown in Fig. 3.

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278