# MEASUREMENT OF THE ENERGY OF ALPHA PARTICLES FROM SOME EMITTERS

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Precise measurements of the energies of $\alpha$ particles from $At^{217}$, $Fr^{221}$, $Po^{213}$, $U^{235}$, and $U^{238}$ have been performed with an ionization $\alpha$ spectrometer.

By means of an ionization $\alpha$ spectrometer we measured the energy of the $\alpha$ particles from some emitters. The measurement of the value of the ionization was carried out by the method of comparison of the pulse amplitudes from the $\alpha$ particles with generator pulses, whose amplitude was measured with great precision ($\sim 0.01\%$). In order to completely exclude the effect of positive ions, we used two screening grids. The chamber was filled with a mixture of argon and methane (97% Ar, 3% $CH_4$). Here, the correction for the pulse rise time was negligibly small. The half-width of the $\alpha$ lines was 35 kev. The required stability of the gain of the amplifier channel was provided by a forced-stabilization circuit. In determining the energy of the $\alpha$ particles it is necessary to know the relation between the ionization and energy. The calibration measurements shown in Table I indicated that the relation between the ionization and energy can be represented by a straight line intersecting the energy axis at $E_\alpha = 84$ kev, which coincides with the results of reference 1. Therefore the energy of the $\alpha$ particles was calculated from the formula

$$(E_e - 84)/(E_\alpha - 84) = I_e/I_\alpha, \qquad (1)$$

where $E_e$ and $E_\alpha$ are the energies (in kev) of the $\alpha$ particles from the standard and the investigated emitters; $I_e$ and $I_\alpha$ are the values of the produced ionization.

In Table I are shown the results of the measurement of the energies of some emitters used for calibration. We took the $Th^{228}$ line as a standard.

**TABLE I**

| Element | $E_{mag}$ (Mev) | I | $E_{ioniz}$ (Mev) |
|---|---|---|---|
| $Th^{228}$ | 5.421 | 1.0000 | 5.421 |
| $Ra^{224}$ | 5.681 | 1.0485 | 5.680 |
| $Rn^{220}$ | 6.278 | 1.1602 | 6.276 |
| $Po^{216}$ | 6.775 | 1.2533 | 6.773 |
| $Po^{212}$ | 8.780 | 1.6306 | 8.786 |

In the first column are shown the results of the energy measurements known from magnetic analysis,[2] in the second column is shown the value of ionization in relative units, and in the third column is shown the $\alpha$-particle energy determined from (1). The measured values of the energies are in good agreement with the known values, which indicates the reliability of the $\alpha$-particle energy measurements by means of the ionization $\alpha$ spectrometer.

Table II lists the results of the measurements of the $\alpha$-particle energy of some emitters.

The measurement of the $At^{217}$, $Fr^{221}$, and $Po^{213}$ spectra were made simultaneously with the measurement of the energy-ionization relation. Therefore the check points shown in Table I serve as standards in the given case.

$At^{217}$. The measured energy values sharply differ from the results of references 3 and 5, and exceed by 14 kev the energy values obtained by Stephens.[4] In the first two experiments an ionization chamber was used. The results of the energy measurement in reference 3 should be considered only as an estimate. As regards Cranshaw and Harvey,[5] their method of energy measurement is highly inaccurate. Moreover, errors due to the poor screening of the grid and the low resolving power of the spectrometer are possible. It is characteristic that the energy values of other $\alpha$ emitters ($U^{233}$, $Pu^{239}$) obtained in this work differ from subsequent measurements by 10 — 15 kev, although the error of measurement indicated by the authors is 3 and 5 kev. Thus, there are grounds for considering the results of the energy measurements in reference 5 to be in error. The difference between the energy value measured by us and that measured on the magnetic spectrometer[4] lies within the limits of experimental error.

$Fr^{221}$. The measured energy value is in good agreement with the results of Stephens,[4] but, as in the case of $At^{217}$, it sharply differs from the energy

**TABLE II**

| Element | $E_{\alpha}$, (Mev) | |
|---|---|---|
| | our data | data of other authors |
| $At^{217}$ | 7,064±0.005 | 7.00±0,05 [3]; 7.05 ±0.01 [4]; 7,023±0.01 [5] |
| $Fr^{221}$ | 6,336±0.005 | 6.30±0.05 [3]; 6.332±0.01 [4]; 6,298±0.01 [5] |
| $Po^{213}$ | 8,368±0.010 | 8.34±0.01 [3]; 8.35 ±0.01 [4]; 8,336±0.005 [5] |
| $U_I^{235}$ | 4,396±0,003 | 4.354 [6]; 4.40 [7] |
| $U_{II}^{235}$ | 4,211±0.003 | 4.117 [6]; 4.20 [7] |
| $U^{238}$ | 4,190±0.005 | 4.195 [1]; 4.18 [9] |

values obtained in references 3 and 5.

$Po^{213}$. In this case the basic line broadens out towards the higher energies, owing to the ionization produced by the $\beta$ particles preceding $\alpha$ decay, which decreases the accuracy of the energy measurement. The value obtained is 18 kev greater than the result of the energy measurement by the magnetic spectrometer. The results differ from those of references 3 and 5 by approximately 30 kev.

$U^{235}$. For the energy measurement the basic line from $U^{234}$ present in the same source ($E_\alpha$ = 4.768 Mev) was used as a standard. In Table II are shown the energy values for the two largest intensities of the lines of $U_I^{235}$ and $U_{II}^{235}$. These values are in sharp disagreement with the results of the energy measurements of Pilger et al. on the magnetic spectrometer.[6] Better agreement was observed with the results of Ghiorso,[7] although these measurements bore only a qualitative character. Recently, an investigation of the $\alpha$ spectra of $U^{235}$ was made on a new magnetic spectrometer of greater luminosity (Baranov, Zelenkov, et al.[8]); the following energy values of the line spectra we are considering were obtained:

$$E_{\mathrm{I}} = 4.394 \pm 0.002, \qquad E_{\mathrm{II}} = (4.213 \pm 0.002)\ \mathrm{Mev}.$$

These values are in excellent agreement with our results. The obtained agreement is also evidence of the fact that the ionization — energy relation remains linear, at least up to the energies of $E_\alpha$ = 4 Mev.

$U^{238}$. The measurement of the energy of the ground line of $U^{238}$ was carried out with a source containing a natural mixture of uranium isotopes. The $U^{238}$ ground line served as the standard. The obtained energy value coincides with the results of reference 1.

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