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ABSOLUTE ENERGY MEASUREMENT OF THE ALPHA PARTICLES EMITTED BY ^{232}U AND ^{240}Pu*

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As part of a continuing cooperative program with the International Bureau of Weights and Measures the absolute alpha particle energies of the α_o and α_{58} groups of ^{232}U and the α_o and α_{45} groups of ^{240}Pu have been measured. The absolute energy magnetic spectrograph of the I. B. W. M. which has been described previously,[1,2,3] was used in the determinations.

The ^{232}U was separated from ^{228}Th and its daughters by adsorbing it on an anion column from 6M HCl (with a few drops of HNO_3 added). The Th was washed off with more 6M HCl and then the U was eluted off with 0.1 M HCl. The Fe was separated from the U by adsorbing the U on another anion column in 8M HNO_3. The Fe was washed off with more 8M HNO_3 and the U eluted off with 0.2M HNO_3.

A mass analysis of the ^{232}U sample gave upper limits of 1% and 1.5% for the mass of ^{238}U and ^{233}U respectively and 0.3% for all other masses in this region. A mass analysis of the Pu shows the following composition: 11% ^{239}Pu, 88% ^{240}Pu, 0.6% ^{241}Pu, and 0.03% ^{242}Pu.

Five sources of ^{232}U and three sources of ^{240}Pu prepared by vacuum evaporation were exposed for several different time intervals. The low activity of all the sources, except one, necessitated exposures from 6-12 days spanning a period of several months. The most intense (~ 30μ curie) ^{232}U source was used for 2 exposures of 12 hours each immediately after vaporization. The other four ^{232}U sources were stored in air. If one compares the energy measurement obtained using a freshly prepared source to that obtained using a source several weeks old, a difference in energy of 0.5 to 2 keV can be seen, the lower energy corresponding to the older source. The 30μ curie ^{232}U source was re-analyzed several weeks after the first measurement and the resulting energy was several hundred electron volts lower. The energy measured several months later was lower by 1 to 2 keV. The three weakest ^{232}U sources were dissolved and re-vaporized making one new very weak source. The results were much less precise but agreed with the first measurement. We attribute the difference in energy to an aging effect of the source. Therefore, we have only used the results obtained from freshly prepared sources.

Because the half life of ^{240}Pu corresponds to 1/6 of the maximum half life for which self absorption effects are seen, we have placed a slit 75 mm in front of the photographic plate in order to accept only a very limited energy region and thereby reduce the background on the plate. This slit was also used for certain exposures of ^{232}U which showed increasing background due to the growth of the ^{228}Th daughter.

The method employed in evaluating the data has been described in previous publications[1,2] in which one shows that the intensity of the alphas on the high energy side of the peak is proportional to $X^{3/2}$, where X is the distance between the point under consideration and the point which corresponds to the maximum energy. Figure 1 shows the ^{232}U α_o group plotted as $N^{2/3}$ _vs._ distance where N is the number of α particles. The best straight line has been calculated using the least squares method.

Table I gives a comparison of our results with the relative measurements of Asaro,[4,5] Baranov[6] and Leang.[7] The relative measurements have been normalized to the new absolute values of Greenberg and Rytz[1] and A. Rytz.[8]

It is evident that our results are in good agreement with the previously published work after normalization and they are much more precise.

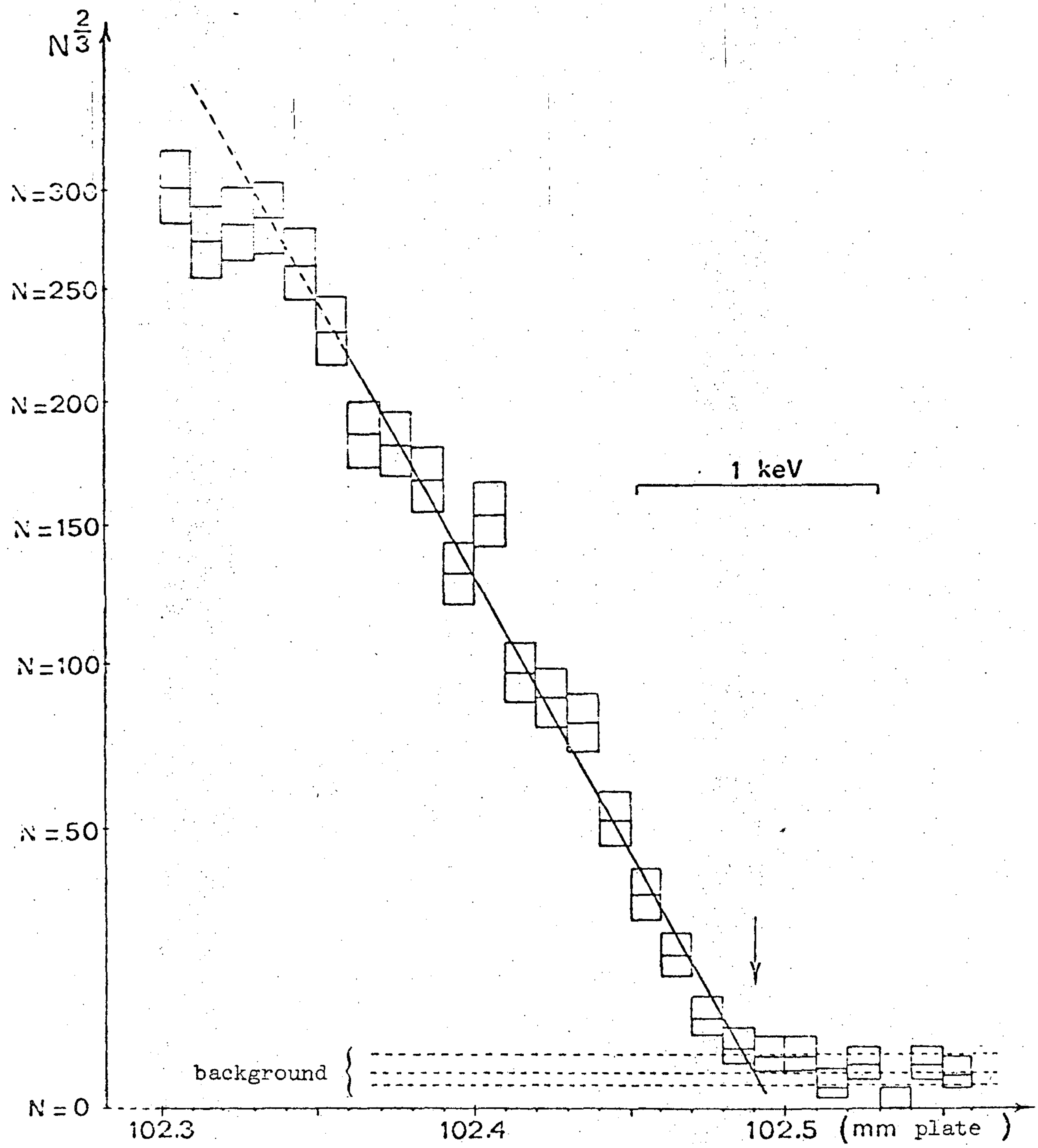

Fig. 1. One section of the main ^{232}U α group. The ordinate is $N^{2/3}$ where N is the number of alpha particles counted in a band width of 10 microns; the abscissa is the position along the plate with increasing energy to the right. The extrapolated value is shown by the arrow.

Table I.

Nuclide	Published values (normalized) (keV)			Present Work		
	Asaro[4,5]	Baranov[6]	Leang[7]	Average energy and estimated standard deviation.* (keV)	Number of exposures	Number of the Sources
^{232}U (α_o)	5 320±2	5 320.9±1.0		5 320.36±0.09	2	1
^{232}U (α_{58})	5 263±2	5 264.0±1.0		5 263.56±0.13	2	1
Standard used by the authors	^{228}Th(5 421)	^{240}Pu(5 167.7)				
^{240}Pu (α_o)	5 169±4		5 168.0±0.7	5 168.38±0.09	4	3
^{240}Pu (α_{45})	5 125±4		5 123.6±0.7	5 123.45±0.20	2	2
Standard	^{210}Po(5 298)		^{212}Bi(6 089.8)			

*To the listed standard deviation a systematic error should be added whose upper limit is about 0.1 keV.

FOOTNOTES AND REFERENCES

*Work performed under the auspices of the U. S. Atomic Energy Commission.

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