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In the course of the measurement of the alpha particle spectra of a considerable number of artificial alpha emitters using a magnetic spectrograph, some secondary standards for energy calibration have been adopted in relation to the primary standard RaA whose alpha particle energy was determined accurately as 5.9981 ± 0.0008 by Briggs.[1] Among these standards is Ra^{226} which has been used primarily to determine the dispersion of the instrument by measuring the displacement between the two well known peaks separated by 185 kev. The abundances of the alpha groups are used in testing agreement between measured data and alpha decay theory and since there have been some minor differences between published values of the abundances, a new determination has been made.

That Ra^{226} has complex structure could be inferred from the early measurement of an 188 kev gamma ray by Hahn and Meitner.[2] This gamma ray was shown to be partially converted[3] and the gamma ray energy determined as 186 kev by spectrographic measurement of the conversion electrons.[4]

The alpha particle group for the transition to this excited state was observed with an alpha ray spectrograph by Rosenblum and co-workers[5] who reported its abundance as ~6.5 percent. The abundance was confirmed as 6.5 percent in another measurement by Bastin-Scoffier.[6] Using an ionization

chamber coupled to a pulse height analyzer, members of this laboratory[7] reported a lower value (4.8 percent) for the abundance of the low energy group. In addition to this well defined group Rosenblum and co-workers[5,6] found some evidence for a weak group of 600 kev lower energy than the main group. In referring to alpha groups of a particular nuclide we shall designate by α_o that group believed to be the ground state transition and for other groups the energy levels in kev above the ground state to which the groups lead will be entered as subscripts.[8] The three groups mentioned would be accordingly, α_o, α_{188}, α_{600}.

The source employed in the present measurement consisted of 14 micrograms of Ra^{226} as radium chloride sublimed in vaccuum onto a 1/8 x 1 inch band on a platinum plate by a technique described elsewhere.[8] The magnetic alpha particle spectrograph and its operation have also been described.[8,9]

The solid curve of Figure 1 shows the results of 21 hour exposure for the alpha particle spectrum in the range ~4.5 - 4.8 Mev with the ordinate showing the number of alpha tracks in each 1/4 mm wide (one field of view of the microscope) scan across the receiver photographic plate. Because of the disparity in track counts for the two peaks, the ordinate scales have been made ten-fold different. Because of source thickness, the half-width of the peaks are about 28 kev as compared with 5 - 8 kev obtained with other sources in this instrument under best conditions. Nevertheless, the resolution of the two peaks in Figure 1 is complete and the abundances of the alpha groups [5.5 percent ($\pm$0.2) for the low energy group] should be reliable within the indicated limits of error.

The abundances (Figure 1) were determined by counting all of the tracks in the low energy peak (almost 26,000) and those in every fourth 1/4 mm scan for the principal peak (109,000). The measured abundance of the low energy group was 5.6 percent but this was revised downward to 5.5 percent because of the different geometry factor applicable to the two groups. This difference is a consequence of the longer path followed by the high energy particles because the photographic plate is not normal to the trajectory of the alpha particles but 60° to the normal.

In order to illustrate the resolution attainable with thinner sources an analysis of the main peak was made with a source consisting of only 0.3 micrograms Ra^{226}. The peak is shown with a broken line in Figure 1 and the width at half maximum is only 6 kev as compared with 26 kev for the thicker source. In this particular measurement the magnetic field was such that the low energy group did not register on the photographic plate.

As mentioned, a weak group of about 600 kev lower energy than the ground state transition has been reported[5,6] and its abundance was given in the second publication as 0.17 percent. This group would be placed at 4.20 Mev and in the present experiments the region from 4.0 to 4.5 Mev was examined. The results are shown in Figure 2 from which it is deduced that no peak of greater than 0.1 percent abundance could be present.

As seen in Figure 2 the inability to distinguish groups in lower abundance than 0.1 percent so distant from the main groups is due to an extensive and nearly constant tailing on the low energy side of the peaks. This phenomenon is as yet unexplained. Incidentally, the integrated number of alpha tracks over this wide range is considerable but by the same token they

must come proportionally from both alpha groups so that the ratio of abundances of the two groups would not be affected. Since the limitation of discrimination of an alpha group in this region is not a great deal lower than the reported[5,6] intensity of the peak α_{600}, a definite disagreement cannot be suggested. However, A. Ghiorso in this laboratory has made a careful examination of Ra^{226} with an alpha particle pulse analyzer over the energy range 3.6 - 4.4 Mev and set a limit of 0.02 percent for the abundance of any group in this interval.

We wish to acknowledge the assistance of Miss Beverly Turner in counting the alpha tracks. This work was performed under the auspices of the U.S. Atomic Energy Commission.

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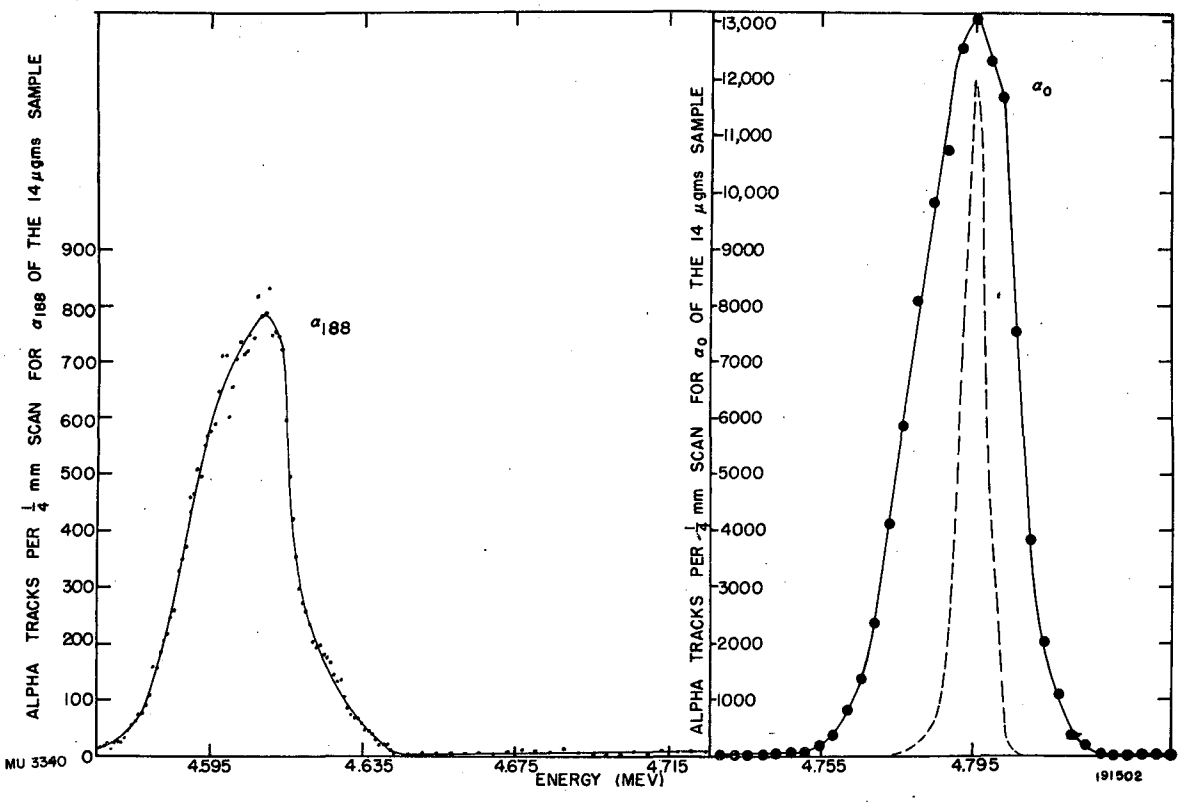

Figure 1

- Alpha tracks per 1/4 mm scan for α_{188} of the 14 microgram sample.

- Alpha tracks per 1/4 mm scan for α_0 of the 14 microgram sample. The ordinate scale is that shown on the center of the figure.

– – – Curve showing the shape of the α_0 peak obtained with the 0.3 microgram sample. The ordinate scale is 1/20 that shown in the center of the figure.

The abscissa scale is the same for all three alpha groups.

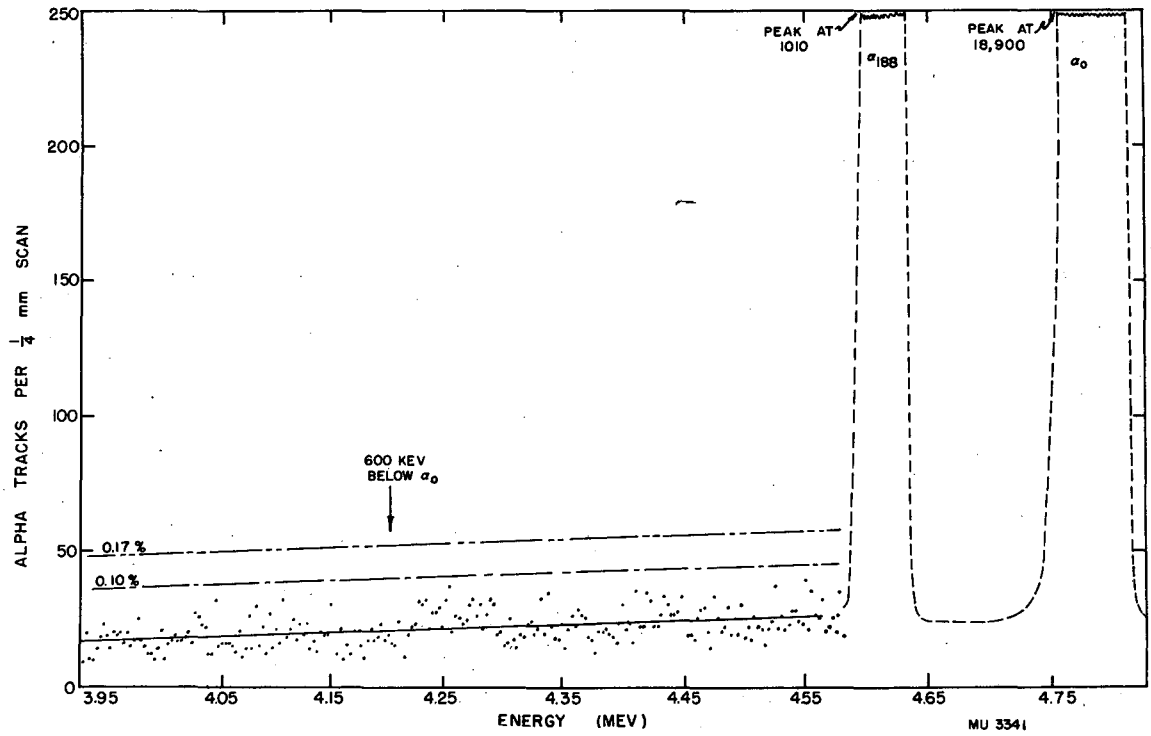

Figure 2

• Alpha tracks per 1/4 mm scan.

– – – Curve indicating the position and the abundances calculated for α_0 and α_{188} from a short exposure.

——— Average background below α_{188}.

——— – – ——— A straight line parallel to the average background and 0.17 percent of the α_0 peak height above the average background.

——— – – ——— A straight line parallel to the average background and 0.10 percent of the α_0 peak height above the average background.