MEAN ENERGY OF THE Y^{90} BETA SPECTRUM

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The mean energy of the Y^{90} beta-ray spectrum was measured calorimetrically and the value 933 ± 18 kev obtained.

VARIOUS methods may be employed for an experimental determination of the average energy of the beta spectrum, $\overline{E}_\beta$. The calorimetric method, however, is at the present time the simplest and the most accurate. We measured calorimetrically the mean energy of the beta spectrum of Y^{90}, which is one of the isotopes most frequently used in radiometry and biology. The procedure was similar to that employed previously.[1]

The Y^{90} source was obtained by irradiating in a reactor 1 — 1.5 g of yttrium oxide. The initial activity was usually on the order of 300 — 500 mC. The heating effect was measured using a double static calorimeter with a sensitivity of $\sim 2.5 \times 10^{-5}$ watt/mm. Measurements were made with four different Y^{90} sources. For each of these, calorimetric measurements lasted from three to seven days. The individual experimental points fell properly on straight lines which correspond to a decay with a 64.9 hour period. This is consistent with recent data on the half-life of Y^{90} (64.8 ± 0.2 hours)[2] and is evidence of the purity of the sources; this was also controlled by measurements on a scintillation gamma spectrometer. Corrections were introduced into the calorimetric measurement results for the energy of internal bremsstrahlung of the Y^{90} absorbed in the calorimeter, and for the thermal inertia of the latter.[3]

After the calorimetric measurements, all of the active yttrium was dissolved in weak nitric acid and the absolute activity of a known aliquot of the solution was measured by a 4π counter.

The mean energy of the Y^{90} beta-ray spectrum obtained when the results for all four sources were averaged was 933 ± 18 kev. The noticeable discrepancy between this value and the quantity $\overline{E}_\beta(Y^{90})$ = 895 ± 35 kev obtained by Caswell[4] using an extrapolation chamber may, it seems, be explained by the reduced value of ionization energy ϵ (ϵ = 32.5 ev) adopted by that author. If we recompute Caswell's results using the value of ϵ currently applied (ϵ = 34.0 ev),[5] we obtain the value 936 ± 35 kev, which agrees well with our measurements. Values of $\overline{E}_\beta$ which we calculated on the basis of the shape of Y^{90} beta spectra measured on the magnetic spectrograph by Yuasa[6] and Braden[7] equal, respectively, 900 and 925 kev with an error of about 5%.

The mean energy of the Y^{90} beta spectrum can also be compared with theoretical values of $\overline{E}_\beta$ for the unique, first-forbidden beta-transition ($n = 1$, $\Delta J = 2$, the wave function changes sign) with an energy of 2275 kev. Our experimental value is closest to the value of $\overline{E}_\beta$ computed using the form factors $S = (W_0 - W)^2 L_0 + 9L_1$[8] ($\overline{E}_\beta$ = 928.8 kev) and $S = (W^2 - 1) + \lambda(p) \times (W_0 - W)^2$[9] ($\overline{E}_\beta$ = 929.2 kev). The form factor $S = (W^2 - 1) + (W_0 - W)^2$,[10] which does not take into account the influence of the Coulomb field of the nucleus on the emitted electron, yields a somewhat higher value: $\overline{E}_\beta$ = 942.6 kev.

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