Half-Life of Cs^{137}†

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The half-life of Cs^{137} was found to be 26.6±0.4 years by observing the disintegration rate of a known number of atoms. The disintegration rate was measured with a 4π proportional counter and the number of atoms was determined from isotope dilution data obtained with a mass spectrometer.

A SOLUTION of carrier-free Cs^{137} was prepared from fission products by ion exchange techniques. The disintegration rate per unit volume of this solution was determined with a 4π proportional counter and the number of atoms of Cs^{137} by means of isotope dilution with a mass spectrometer; a description of the counter and the mass spectrometer has been reported previously.[1] The observed counting rate required small corrections for background and coincidence loss but other standard corrections such as self-absorption and absorption in the source mount were found to be negligible for the conditions of this experiment. A detailed discussion of these corrections has been given in an earlier paper[1] on the half-life of Sr^{90}.

Additional corrections to the measured counting rates were necessary in the case of Cs^{137}. In its decay scheme the gamma radiation from the isomeric state of Ba^{137} (2.6-min half-life) is not in coincidence with the beta emission. Hence the observed counting rates were corrected for the contribution of conversion electrons and for secondary electrons produced by the gamma radiation. The correction for the conversion electrons was made assuming 92 percent decay to metastable Ba^{137} [2] and an internal conversion coefficient of 0.118.[3] In order to correct for secondary electrons the gamma-radiation efficiency of the brass proportional counter was estimated using aluminum sandwich techniques and found to be less than 0.27 percent. This compares reasonably well with the 0.15 percent value obtained from the data of Bradt *et al.*[4] A value of a 0.2 percent has been used to correct the observed counting rate and, since the correction is itself small, an uncertainty in its value has little influence on the probable error of the calculated half-life.

TABLE I. Concentration and counting rate values for Cs^{137} solution.

Concentration in μg per ml	Counts per sec per ml $\times 10^{-5}$ [a]
0.0310	1.298
0.0315	1.305
0.0320	1.307
0.0311	1.297
0.0314	1.303
av 0.0314±0.0004	1.300
	1.308
	av 1.303±0.004
Corrected for internal conversion electrons and for secondary electrons	1.174±0.004
Corrected for Cs^{134} contribution	1.139±0.004

[a] Corrected for coincidence loss and background.

A further correction to the counting rate was made to allow for the contribution of 2.3-year Cs^{134} formed in fission products by an (n,γ) reaction with Cs^{133}. Two sodium iodide scintillation spectrometers were used in coincidence to determine this contamination of the sample. With these spectrometers, the coincidence rate due to the 0.605- and 0.796-Mev cascade gamma rays of Cs^{134} was compared under conditions of known geometry with the single-channel counting rate due to the 0.661-Mev gamma ray of Cs^{137}. The ratio of these rates, together with the latest decay schemes,[2,5] gives a correction of 3.0±0.5 percent to the observed beta activity.

From the data in Table I a value of 26.6±0.4 years is obtained for the half-life of Cs^{137}, where the limits of precision include only the uncertainties in the counting rate and concentration determinations. This is considerably lower than the currently accepted value of 33±2 years[6] calculated from comparison of the mass spectrometric ratios of Cs^{133}/Cs^{137} in fission products differing up to 5.4 years in age. More recent studies of similar ratios have been made in this laboratory with fission products up to 8 years old and these results give a half-life of 26±1 years.[7] Any variation in the relative yields of the samples compared by this method would materially affect the calculated half-life. Both the 26- and 33-year values were obtained by comparison of different fission-product samples and hence depend on the assumption that changes in the relative fission yields due to different irradiation conditions are small. Nevertheless it is felt that the 26-year value based on completely independent measurements does support the 26.6-year half-life found in this investigation.

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