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LETTER TO THE EDITOR

Radioative decay of ^{57}Co

The nuclide ^{57}Co has been reported to decay by emission of positrons with a half-life of 270 days. For the endpoint energy, values are given of 0.26 MeV [1]) (measurement by aluminium absorption), and 0.320 $\pm$ 0.015 MeV [2]) (lens spectrometer). It seems probable that all transitions lead to a 137 keV level in ^{57}Fe, which is deexcited both by a 137 keV gamma ray and by a cascade of 123 keV and 14 keV gamma rays [2]) [3]). The mass difference of ^{57}Co and ^{57}Fe would then be 1.47 MeV. It is also possible, however, to compute this mass difference from a chain of seven nuclear reactions [4]) [5]), which yields only 0.45 $\pm$ 0.30 MeV. If the latter figure is correct, ^{57}Co could not decay by positron emission at all, but only by electron capture.

To solve this discrepancy a search was made for the 0.51 MeV annihilation gamma ray with the use of a NaI scintillation spectrometer. The ^{57}Co source had grown from ^{57}Ni (36 hours), obtained from deuteron bombardment of a nickel target in the Philips cyclotron in Amsterdam. By the time of these experiments the ^{57}Ni mother activity had died out completely. The source contained also a very small amount of ^{56}Co (77 days) grown from ^{56}Ni (6.2 days). The former decays by positron emission and electron capture followed by several gamma rays, amongst which a 0.845 MeV gamma ray is the most prominent.

This gamma ray was used to estimate the amount of ^{56}Co present in the ^{57}Co source. The intensity ratio of the 0.845 keV gamma ray and the annihilation radiation in the ^{56}Co decay was not known accurately enough from the literature, but it was determined from a ^{56}Co source, kindly supplied by the Kamerlingh Onnes Laboratory in Leiden. It could be shown that the weak annihilation radiation observed from the ^{57}Co source could be accounted for wholly from the presence of the ^{56}Co contamination. An upper limit of 0.1% per disintegration can be set for the occurrence of positrons in the ^{57}Co decay. This is in agreement with three other recent investigations. Weak annihilation radiation corresponding to 0.4% positron per disintegration is observed by Madansky and Rasetti [6]), but they are inclined to ascribe it to an impurity. An upper limit of 0.08% is given by Lemmer, Segaert and Grace [7]), and an upper limit of 0.002% by Crasemann and Manley [8]).

Another point which had to be settled was the order of the 123 and 14 keV gamma rays. It has been shown by Deutsch and Wright [9]) that the 14 keV gamma ray is delayed by $(1.1 \pm 0.1) \times 10^{-7}$ sec relative to the iron K X-rays resulting from ^{57}Co electron capture. In the present investigation it could be shown that the 14 keV gamma ray is also delayed relative to the 123 keV gamma ray. Pulses from two scintillation spectrometers were fed to a fast-slow coincidence arrangement [10]). The resolving time of the fast coincidence circuit amounted to 3×10^{-8} sec.

The spectrometer detecting the 14 keV gamma ray was equipped with a thin NaI crystal with the ^{57}Co source mounted inside the aluminium cover. The pulse from the 123 keV gamma ray could be delayed in steps of 8.8×10^{-8} sec from 8.8×10^{-8} sec to 4.4×10^{-7} sec. The coincidence rate plotted logarithmically as a function of the delay is beautifully straight yielding a half life of $(1.01 \pm 0.05) \times 10^{-7}$ sec. This is in agreement with the recent result of Lemmer, Segaert and Grace[7]) of $(1.0 \pm 0.1) \times 10^{-7}$ sec. The present coincidence measurements show conclusively that the 123 keV – 14 keV cascade proceeds through a 14 keV level.

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