Disintegration Scheme of the Yttrium Activity of 100-Day Half-Period

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THE gamma-radiation from the 100-day activity of yttrium,[1] produced by deuteron bombardment of strontium,[2] has recently been investigated by means of recoil electrons in a cloud chamber[3] and by the photo-disintegration of beryllium.[4]

We have investigated these gamma-rays in a magnetic lens spectrometer, by a method previously described.[5] The yttrium source, kindly loaned to the authors by Dr. Francis Moore of Huntington Memorial Hospital, had a gamma-ray intensity equivalent to about 10 micrograms of radium (both radiations filtered by 1 mm of lead). Photoelectrons from lead and tin radiators and Compton recoil electrons from a thick aluminum radiator were investigated (Fig. 1). The observed gamma-ray energies of 0.908 ± 0.02 Mev and 1.89 ± 0.05 Mev are in good agreement with those reported by other workers. Considering the variation of the photoelectric cross section with energy, it is estimated that any gamma-rays between 0.2 and 0.5 Mev which may have escaped detection could not be more than about 1/20 as abundant as the 0.9-Mev gamma-ray, (about 1/10 for gamma-rays outside this energy range, down to about 0.12 Mev).

We have further investigated the disintegration scheme of this activity by observing coincidences between gamma-rays recorded in G-M counters of known efficiency. (Details of the calibration for various energies will be published shortly.) The source used in these measurements was prepared in the M.I.T. cyclotron. The observed number of coincidences was $(1.91 \pm 0.10) \times 10^{-3}$ per recorded gamma-ray. The number to be expected if the two gamma-rays follow each other in cascade, (Fig. 1, insert) is $(1.97 \pm 0.10) \times 10^{-3}$. If the successive emission of two gamma-rays of about 0.95 Mev were alternative to the emission of a single gamma-ray of 1.9 Mev, the intensities about equal as observed by Richardson,[3] the expected coincidence rate would be only 0.54×10^{-3}. Absorption measurements on the coincident gamma-rays also gave results consistent with the disintegration scheme shown in Fig. 1.

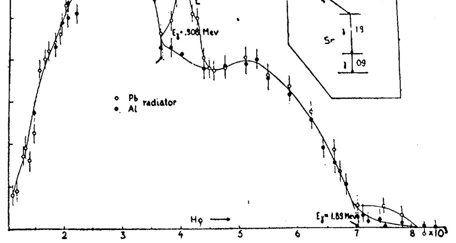

FIG. 1. Energies given are weighted averages of photoelectron and Compton end-point determinations.

These data, together with Richardson's[3] estimate of the relative intensities of the two gamma-rays, also indicate that no more than about one fifth of the disintegrations lead directly to the intermediate level in the Sr nucleus (the neutrino carrying away the excess energy).

Each electron capture process in Y is followed by the emission of a Sr x-ray (or Auger electron). We have measured the number of coincidences between these x-rays and the gamma-rays and found $(3.3 \pm 0.5) \times 10^{-3}$ coincidence per recorded x-ray (measured with a less efficient gamma-ray counter than the gamma-gamma coincidences reported above). The number predicted if each disintegration follows the scheme shown in Fig. 1 is $(3.3 \pm 0.2) \times 10^{-3}$. It appears from this that no more than about one fifth of the disintegrations can lead directly to the ground state of the product nucleus.

It may therefore be concluded that most of the disintegrations of the 100-day yttrium isotope follow the scheme shown in Fig. 1 (except for the unknown *order* of emission of the gamma-rays). The small number (or absence) of direct transitions to the ground state or intermediate level and the absence of positron emission probably indicate a large spin change between initial and final nuclei.

It is a pleasure to acknowledge the friendly interest of Professor Robley D. Evans in this investigation.

[1] L. A. DuBridge and J. Marshall, Phys. Rev. **58**, 7 (1940).
[2] C. Pecher, Phys. Rev. **58**, 843 (1940).
[3] J. R. Richardson, Phys. Rev. **60**, 188 (1941).
[4] G. Scharff-Goldhaber, Phys. Rev. **59**, 937A (1941).
[5] M. Deutsch and A. Roberts, Phys. Rev. **60**, 362 (1941).

The Cosmic-Ray Latitude Effect and the Single Primary Component Hypothesis*

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ON the assumption that a single primary component produces mesotrons at a definite altitude in the stratosphere, the writer finds that, if $F(E)dE$ represents the energy distribution of the vertically directed mesotrons at the point of production, then the number of mesotrons at a distance x below this point, and remaining from the group $F(E)dE$ at $x=0$ is Δn_x, where

$$\Delta n_x = [(1+A/(\gamma+1))e^{-\lambda x} - A/(\gamma+1)]^{[\lambda c\tau_0(\gamma+1)+A]^{-1}} F(E)dE, \quad (1)$$

with $A \equiv \alpha\rho_0/\lambda m_0 c^2$, and $\gamma \equiv E/m_0 c^2$; m_0, τ_0, ρ_0, α being, respectively, the rest mass of the mesotron, its mean life at rest, the atmospheric density at $x=0$, the ionization energy loss per unit of mass (per unit area) traversed, and where λ is the constant in the expression $\rho = \rho_0 \exp[\lambda x]$ for the atmospheric density at the depth x.

If we regard the mesotron intensity as responsible for the sea-level latitude effect, we must suppose that the minimum energy of the mesotrons at magnetic latitude