Gamma-Ray Energies in the Decay of Cs^{134}

M. C. Joshi and B. V. Thosar
Tata Institute of Fundamental Research, Bombay, India

(Received April 12, 1954; revised manuscript received August 23, 1954)

The photoelectric conversion spectrum of gamma rays in the decay of Cs^{134} was studied with a newly installed Siegbahn-Slätis beta-ray spectrometer, using a strong source and thick lead and uranium radiators to bring out weak lines. Lines corresponding to the following gamma rays were found (expressed in kev) 467; 553; 571; 607; 794; 1027; 1164; 1368; 1401.

THE gamma rays emitted in the decay of Cs^{134} of 2.3-year half-life have been studied by recording the photoelectron spectrum, both lead and uranium radiators being used. The instrument used was a Siegbahn-Slätis type intermediate image beta-ray spectrometer which has recently been installed at this Institute. This had a high transmission for a resolution of 1.5 percent used in these experiments. The source, 1.5 mC, was covered with aluminum sufficient in thickness to absorb all beta particles. Figure 1 shows the spectrum of the photoelectric conversion electrons of the gamma rays in lead of thickness 110 mg/cm^2. Photoelectron lines were observed corresponding to the following gamma-ray energies, expressed in kev: 467±15, 553±7, 571±7, 607±5, 794±3, 1027±15, 1164±10, 1368±5, and 1401±15. The observed relative intensities are $\gamma_1:\gamma_3:\gamma_4:\gamma_5:\gamma_7:\gamma_8::0.035:0.21:1:1:0.04:0.053$.

This confirms the gamma-ray energies reported by Schmidt and Keister[1] and by Waggoner *et al.*,[2] who studied the electron spectrum caused by internal conversion, and gives, in addition, two gamma rays, one at 0.47 Mev and the other at 1.40 Mev. A fairly consistent level scheme for Ba^{134} can be drawn to explain most of the gamma-ray transitions, though the gamma ray of energy 1.036 Mev has been attributed by some observers to an alternative K-capture decay branch. Another suggestion[3] for explaining this gamma ray has been to postulate an excited level at 1.831 Mev below the highest level at 1.956 Mev in Ba^{134}. This level scheme, shown in Fig. 2, also explains the gamma ray of 0.47 Mev, this transition being indicated by a dotted arrow. The line corresponding to the 1401-kev gamma ray is very weak and it is difficult to estimate its relative intensity. From the energy level schemes for Ba^{134}, suggested by previous workers, a gamma ray of this energy could be caused by a cross-over transition from the 1.395-Mev level to the ground state. On the other hand, the spin assignment to this excited level from angular correlation experimental data is 4^+. The intensity of a crossover transition to the ground state 0^+, relative to that of the 0.607-Mev gamma ray which is a transition from the same 4^+ level to an intermediate level 2^+ (0.794 Mev) would be of the order of 10^{-7}. The observed relative intensity is

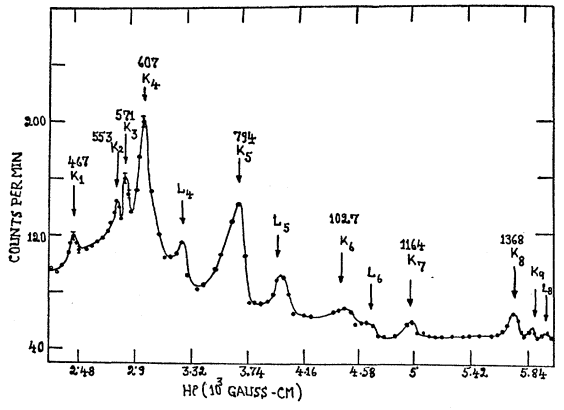

FIG. 1. Spectrum of the photoelectric conversion electrons of the γ rays emitted in the decay of Cs^{134}. Thickness of lead radiator is 110 mg/cm^2.

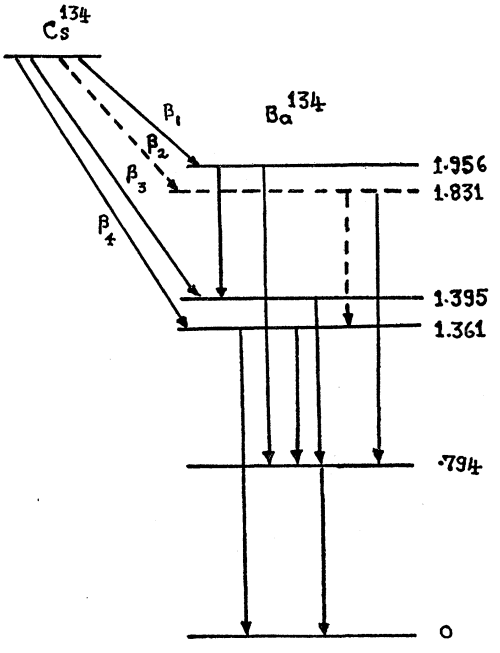

FIG. 2. Proposed decay scheme of Cs^{134}.

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[2] Waggoner, Moon, and Roberts, Phys. Rev. **80**, 420 (1950).
[3] Hollander, Perlman, and Seaborg, Revs. Modern Phys. **25**, 552 (1953).

of the order of 10^{-3}. It is not possible, therefore, to fit this gamma-ray transition into the decay scheme with any certainty at this stage.

Most of the previous work on gamma rays from this isotope has been concerned with internal conversion lines when thin sources of presumably low total strength are used. The study of the photoelectron spectrum has a greater chance of bringing out weaker gamma rays, as stronger and thicker sources may be used.

The Radiochemical Center, Amersham, England, which supplied the active cesium bromide, gave us the quantitative spectrographic analysis of the material. Consideration of these data and the relevant capture cross sections for neutrons shows that no appreciable radioactive impurity can be present in the sample.

Further work on the details of the decay scheme of Cs^{134} is in progress.

Our thanks are due Dr. H. J. Bhabha, F.R.S. for his keen interest in the work of installation of the new spectrometer and also in the work here described.

PHYSICAL REVIEW VOLUME 96, NUMBER 4 NOVEMBER 15, 1954

Radiative Capture of Deuterons by He^3†

J. M. Blair, N. M. Hintz, and D. M. Van Patter*
Department of Physics, University of Minnesota, Minneapolis, Minnesota
(Received August 9, 1954)

The excitation function of $He^3(d,\gamma)$ capture radiation, measured from E_d=0.2 to 2.85 Mev, exhibits a broad resonance at 0.45±0.04 Mev, with a total cross section of 0.05±0.01 mb. Above this energy, the presence of nonresonant capture is observed. At E_d=0.58 Mev, the radiation is isotropic from 0° to 90° within ±10 percent. The measured gamma-ray energy of 16.6±0.2 Mev at resonance corresponds to a Q value for the $He^3(d,\gamma)Li^5$ reaction of 16.36±0.2 Mev. The experimental radiation width at resonance is calculated to be 11±2 ev, which is compared to the Weisskopf estimate for $E1$ transitions.

I. INTRODUCTION

THE ground states of each member of the mirror pair, He^5 and Li^5 are unstable against nucleon decay to He^4 by about 1.0 and 1.9 Mev, respectively, with a lifetime $\sim 10^{-21}$ sec (Fig. 1). These states have been observed chiefly as resonances in the elastic scattering of neutrons and protons[1,2] by He^4, although there has been some indication from other experiments.[3–5] The results of the experiment reported here give independent evidence for the existence of a virtual ground state of Li^5 together with a measurement of its energy.

For the case of Li^5, a phase shift analysis of the p-He^4 scattering data,[6] together with a measurement of the polarization of the scattered protons,[7] fixes the character of the ground state as $P_{\frac{3}{2}}$, as expected from an independent particle model with spin-orbit coupling.[8] Aside from the rather uncertain $P_{\frac{1}{2}}$ level in the vicinity of 2.5 Mev, the only other known state of Li^5 is the comparatively narrow level at 16.7±0.2 Mev, observed as a resonance in the $He^3(d,p)He^4$ reaction.[9–11] This has been assigned $J=\frac{3}{2}+$ on the basis of the (d,p) cross section at resonance and the observed isotropy of the protons. It occurred to one of us (N.M.H.) that if these assignments are correct, it should be possible to observe radiative capture of deuterons from the state at 16.7 Mev to the virtual ground state by electric dipole transition. This is indicated by a dotted line in Fig. 1. Such a transition would be interesting to detect as it would provide an independent measurement of the ground-state energy and give some information on the character of the states involved. Radiative capture of deuterons has not been reported previously except in the case of the $D(p,\gamma)He^3$ reaction.[12]

With these considerations in mind it was decided to search for a gamma ray of energy ~17 Mev from the deuteron bombardment of a He^3 gas sample.

II. EXPERIMENTAL PROCEDURE

The Minnesota electrostatic generator was used to provide a beam of deuterons or protons up to 2.8 Mev. As indicated in Fig. 2, the beam was defined by tantalum diaphragms, then passed through a thin nickel foil into the target chamber containing the enriched He^3 gas. The stainless steel target chamber was normally 6.17

† Assisted by the joint program of the Office of Naval Research and the U. S. Atomic Energy Commission.
* Present address: Bartol Research Foundation, Swathmore, Pennsylvania.
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