viously used for the mass determination of active isotopes.[4] The instrument and techniques employed in this mass analysis were the same as those used in the measurement of the isotopic constitution of lanthanum and cerium.[5] Two different samples of Yb_2O_3 were analyzed. The first was secured from Adam Hilger, Ltd. (laboratory number 1071), while the second was an exchange column purified sample obtained from Dr. D. H. Harris of the Clinton Laboratories. There was no detectable difference in the isotopic constitution of the two samples. The values quoted in the third row of Table I are the averages of thirty separate determinations on each sample. The mean deviation of each percentage was about 1 percent of that percentage. Because of the large number of readings the precision should be better than this by a factor of one over the square root of the number of determinations. However, since we have not as yet been able to rule out systematic mass discriminations because of selective emission from the surface ionization source, or because of non-linearity of the 10^{10}-ohm resistor over the wide current range used, to better than 1 percent we do not wish to quote any limits closer than this.

The following upper limits for the natural occurrence of other isotopes of ytterbium were set: $Yb^{166}<0.002$ percent, $Yb^{167}<0.002$ percent, $Yb^{169}<0.01$ percent, $Yb^{175}<0.02$ percent, $Yb^{177}<0.01$ percent, $Yb^{178}<0.002$ percent.

With the assumption of zero packing fraction for the ytterbium isotopes the chemical atomic weight of ytterbium calculated from the new abundances is 173.046 $\pm$0.006. The international value, chemically determined, is 173.04.

[1] F. W. Aston, Nature **133**, 327 (1934); Proc. Roy. Soc. **A146**, 46 (1934).
[2] A. J. Dempster, Phys. Rev. **53**, 727 (1938).
[3] W. Wahl, Naturwiss. **29**, 536 (1941).
[4] R. J. Hayden, Phys. Rev. **74**, 650 (1948).
[5] M. G. Inghram, R. J. Hayden, and D. C. Hess, Jr., Phys. Rev. **72**, 967 (1947).

A Measurement of the Half-Life of Double Beta-Decay from $_{50}Sn^{124}$ *

E. L. FIREMAN
Department of Physics, Princeton University, Princeton, New Jersey
November 29, 1948

IF two isobars differ by two units in atomic number, the heavier may decay into the lighter by double beta-decay.[1,2] This is the simultaneous emission of two negatrons if the heavier has lower atomic number or the simultaneous emission of two positons, 1 positon+1K capture, or 2K captures if the heavier has higher atomic number. The half-life depends markedly upon whether or not two neutrinos are emitted in the process. If no neutrinos are emitted, the half-life is of the order of 10^{10} times shorter than if two neutrinos are emitted (see Table I). The reason for this large difference in half-life arises from the number of cells in phase space available for the transition.

TABLE I. Theoretical half-life for allowed double negaton emission.

Atomic mass difference	0	0.52 Mev	1.04 Mev	1.56 Mev	2.08 Mev	2.60 Mev
2 neutrinos	∞	$2.6\cdot10^{27}$ yr.	$2.4\cdot10^{26}$ yr.	$1.3\cdot10^{24}$ yr.	$2.1\cdot10^{23}$ yr.	$4.3\cdot10^{22}$ yr.
No neutrinos	∞	$2.1\cdot10^{16}$ yr.	$2.7\cdot10^{15}$ yr.	$6.5\cdot10^{14}$ yr.	$2.2\cdot10^{14}$ yr.	$8.3\cdot10^{13}$ yr.

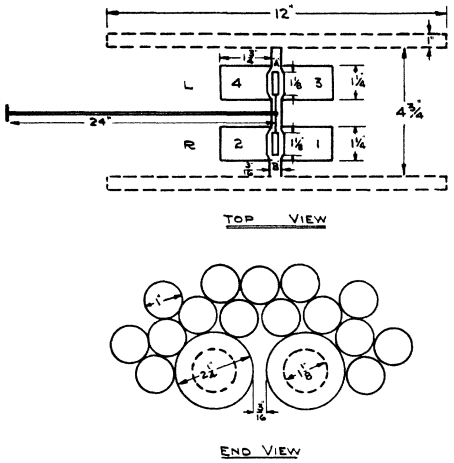

FIG. 1. Experimental arrangement.

In the present work an experimental investigation of $_{50}Sn^{124}$ which belongs to isobaric triplet $_{50}Sn^{124}-{}_{52}Te^{124}-{}_{54}Xe^{124}$ has been carried out. The experimental arrangement consists of four thin window counters (3 mg/cm^2 mica) connected in pairs to coincidence circuits L and R. These counters are shielded by anticoincidence counters and by an Fe and Pb box. Two specimens** of Sn (25 g) identical in all respects except for isotopic constitution are placed between the thin window counters. These specimens are called A and B. Specimen A contains 54 percent of Sn^{124}; specimen B contains 0.4 percent of Sn^{124}. The position of the specimens between the counters is interchanged by rotating the specimen holder through 180° (see Fig. 1).

Coincidences and single counts from both specimens are recorded simultaneously. The specimen holder is rotated through 180° every other hour and the positions of the specimens in the holder are interchanged every 20 hours. These data are summarized in Table II.

In all situations specimen A gives 2 coincidence counts/hr. more than specimen B. By repeating this type of measurement with Al absorbers over one side of each specimen an absorption curve is obtained. This absorption curve is similar to that of electrons from a spectrum with an energy end point between 1.0 Mev and 1.5 Mev. The single counts from specimens A and B both give 6.5$\pm$0.3 counts/min. If one interprets this effect as double beta-decay from Sn^{124}, one obtains a half-life between $0.4\cdot10^{16}$ yr. and $0.9\cdot10^{16}$ yr. Other alternative explanations for these observations have been considered but none have been found to be plausible. This result would indicate that double beta-decay is unaccompanied by neutrinos. A further consequence of these results pointed out to the author by Professor J. R. Oppenheimer is that the neutron-proton charge difference is exactly equal to the electron charge.

TABLE II. $L(A)$ gives the coincidences from specimen A between counters L, and $R(B)$ gives the coincidences from B between counters R. Holder 0° and 180° are the two holder positions. Positions 1 and 2 are positions for the specimens in the holder.

Pos. 1	Holder 0° Coin. counts/hr.	$L(A)$ 16.4±0.3	$R(B)$ 14.3±0.3
	Holder 180° Coin. counts/hr.	$L(B)$ 14.4±0.3	$R(A)$ 15.9±0.3
Pos. 2	Holder 0° Coin. counts/hr.	$L(B)$ 14.6±0.3	$R(A)$ 16.4±0.3
	Holder 180° Coin. counts/hr.	$L(A)$ 16.4±0.3	$R(B)$ 13.9±0.3

A detailed report of this work is being prepared for publication in the Physical Review.

The author is grateful to Professor R. Sherr for accepting the supervision of this research and to Professor E. P. Wigner for many profitable discussions.

* This work is assisted by the Office of Naval Research.
** These isotopes were obtained from Oak Ridge.
[1] Maria Goeppert-Mayer, Phys. Rev. **48**, 512 (1935).
[2] W. H. Furry, Phys. Rev. **56**, 1184 (1939).

Internal Conversion Electrons from Metastable Te^{125}

R. D. HILL AND G. SCHARFF-GOLDHABER
Department of Physics, University of Illinois, Urbana, Illinois*
AND
G. FRIEDLANDER
*Brookhaven National Laboratory,** Upton, New York*
December 6, 1948

RECENTLY, it has been found[1] that an isomer of the stable isotope Te^{125} with a half-life of two months

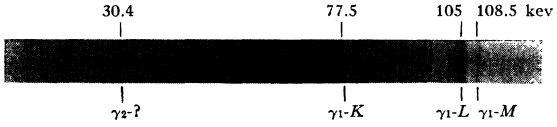

FIG. 1. Internal conversion spectrum of Te^{125}*, $\gamma_1 = 109.3$ kev.

grows out of Sb^{125} (2.7 yr.). Absorption measurements of its radiations showed that it decays through a highly converted isomeric transition of approximately 120-kev energy.

TABLE I. Average relative intensities in lines.

$B\rho$ gauss-cm	Line energy kev	Assignment	Gamma-ray energy kev	Relative intensity
975.2	77.5	$\gamma_1 - K$	77.5 + 31.8 = 109.3	100
1147	105.1	$\gamma_1 - L$	105.1 + 4.35 = 109.45	67
1169	108.6	$\gamma_1 - M$	108.6 + 0.58 = 109.18	19
598.6	30.4	$\gamma_2 - ?$		6

The decay of Te^{125} has now been followed for a longer period and the half-life was found to be 58±4 days. For a more accurate measurement of the energy of the isomeric transition, a source of a few microcuries of Te^{125} was separated from Sn irradiated with slow neutrons at Oak Ridge. It was subjected to an analysis in a 180° magnetic beta-ray spectrograph previously described.[2] Three lines corresponding to the K, L, and M conversion electrons of a 109.3-kev gamma-ray were obtained after a 36-hr. exposure. A longer exposure of about one week yielded, in addition, a weak line produced by conversion electrons of 30.4 kev, for which we cannot state the gamma-ray energy since we do not know in which shell the conversion took place. Figure 1 shows the spectrum of the conversion lines. A part of a microphotometer trace of the film is reproduced in Fig. 2. Using the density-intensity calibration recently described,[3] we obtained the relative intensities of the lines from a number of microphotometer traces. The average relative intensities are given in Table I. It follows that the K/L intensity ratio is ~1.5, the L/M ratio ~3.5. From the half-life and energy, and from the lower limit of 0.99 for the total internal conversion coefficient, it was previously concluded[1] that the effective $\Delta l = 5$ for this transition. According to Drell's[4] recent calculations, the K/L ratio obtained by us is compatible with an effective $\Delta l = 5$, if one assumes that this transition is "parity forbidden," and that 95 percent is 2^4-pole magnetic while the rest is 2^5-pole electric. The spin change between the metastable state and ground state would then be 4. The role of the very weak transition is at present in doubt. Further experiments are needed to decide whether it has to be ascribed to Te^{125}*.

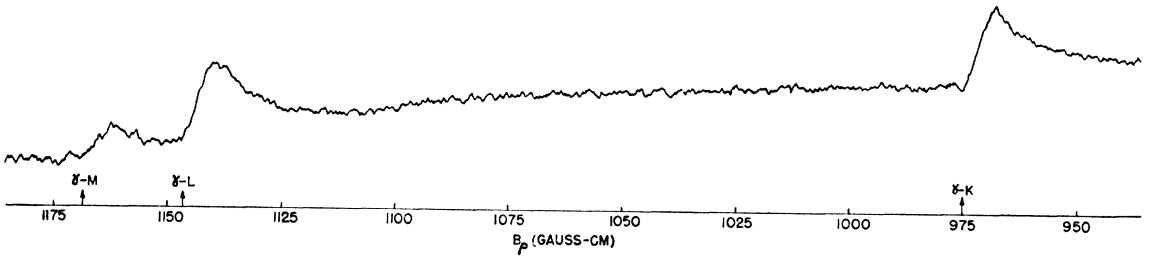

FIG. 2. Microphotometer trace of the internal conversion electron lines from the 109.3-kev gamma-ray of Te^{125}*.

* Assisted by the joint program of the Office of Naval Research and the Atomic Energy Commission.
** Research work carried out under the auspices of the Atomic Energy Commission.
[1] G. Friedlander, M. Goldhaber, and G. Scharff-Goldhaber, Phys. Rev. **74**, 981 (1948).
[2] R. D. Hill, Phys. Rev. **74**, 78 (1948).
[3] R. D. Hill and J. W. Mihelich, Phys. Rev. **74**, 1874 (1948).
[4] S. D. Drell, Phys. Rev. in press.