The Disintegration of Rh^{102}

LUIS MARQUEZ*
Institute for Nuclear Studies, University of Chicago, Chicago, Illinois
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The disintegration of Rh^{102} has been investigated using a beta-ray spectrometer. It was found that it decays by the emission of a negatron of end-point energy of 1150 kev and three positrons of end-point energies of 400 kev, 760 kev, and 1240 kev. Five gamma rays were also found in its disintegration of 86 kev, 124 kev, 195 kev, 353 kev, and 475 kev.

THE disintegration of Rh^{102} has been investigated using the double magnetic lens nuclear spectrometer of Agnew and Anderson.[1] The Rh^{102} was prepared by irradiation of 20 g of Ag for three hours with full intensity and 420 Mev in the University of Chicago synchrocyclotron. The target was dissolved in HNO_3 and 2-mg carriers of Sr, Y, Zr, Nb, Mo, Ru, Rh, Pd, and Cd added. After long boiling the solution was diluted with H_2O, the Ag precipitated with HCl and filtered. The Pd was precipitated with dimethylglyoxime and centrifuged. More Pd was added, reprecipitated, and centrifuged. The supernatant was evaporated to near dryness and strongly fumed with a mixture of $HClO_4$, $NaBiO_3$, and H_3PO_4 to evaporate the Ru. The Rh was finally purified by pyridine extraction as described by Meinke.[2]

The samples for the beta-ray spectrometer were prepared three months later to allow the shorter-lived activities to decay. They were prepared as the finely divided metal by precipitation with $TiCl_3$ and when mounted had a thickness of about 0.3 mg/cm². They were mounted on a thin Zapon film, placed in the beta-ray spectrometer, and counted with a Geiger counter having a mica window of 1.5 mg/cm² as described in a previous work.[3]

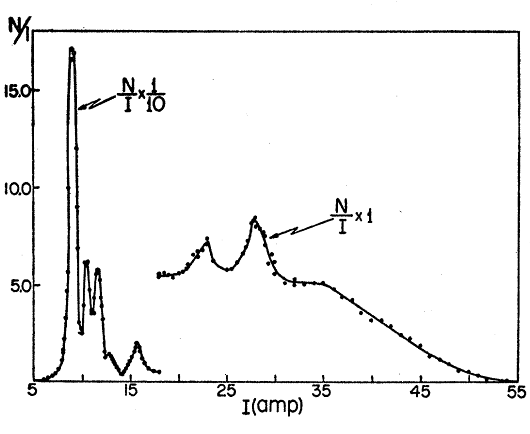

FIG. 1. The spectrum of the negatrons from Rh^{102}.

The beta-ray spectrometer was operated with a resolution of 3.5 percent and was calibrated with the conversion line of Ba^{137m} in equilibrium with Cs^{137}. The relationship between the momentum of the electrons and the current was $\eta=5.695\times10^{-2}I$, where η is the momentum in units of mc and I is the current in amperes. The measurements were taken during one week and no appreciable decay occurred during the measurements. We assume that all the activity measured corresponds to Rh^{102}.

The spectrum of the negatrons is shown in Fig. 1. It is formed by seven conversion electron lines and a negatron spectrum. The conversion electrons are due to five gamma rays, the two hardest ones come from Ru^{102} and the three softest could come from either Ru^{102} or Pd^{102}, but more likely from the first one for reasons that will be seen later. So, to calculate the energies of the gamma rays we used for all of them the corresponding x-ray energies of Ru. The relevant data about the conversion electrons and the gamma rays are shown in Table I. The errors in the energies of the gamma rays are of the order of one percent. It is possible that there are more gamma rays than those listed and they were not detected due to their small conversion coefficient, particularly if they are harder than those detected. The K/L ratio for γ_1 is greater than 2.5 which places it as $M1$, $M2$, or $M3$ transition,[4] we can only place a lower limit to this ratio because below 100 kev the

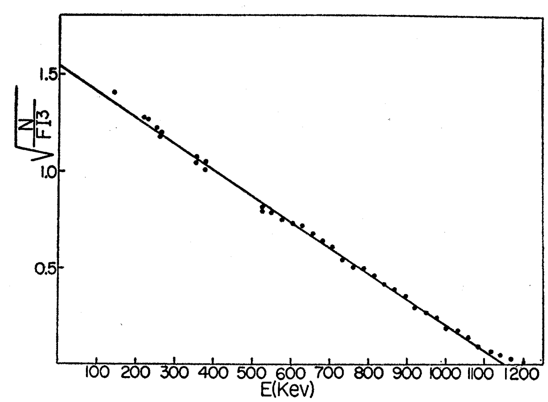

FIG. 2. The Fermi plot of the negatron spectrum of Rh^{102}, leaving out the conversion electrons.

* Now at the Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil.
[1] H. L. Anderson and H. M. Agnew, Rev. Sci. Instr. **20**, 869 (1949).
[2] W. W. Meinke, University of California Radiation Laboratory Report UCRL-432, 1949 (unpublished).
[3] Luis Marquez, Phys. Rev. **92**, 1511 (1953).
[4] M. Goldhaber and A. W. Sunyar, Phys. Rev. **83**, 906 (1951).

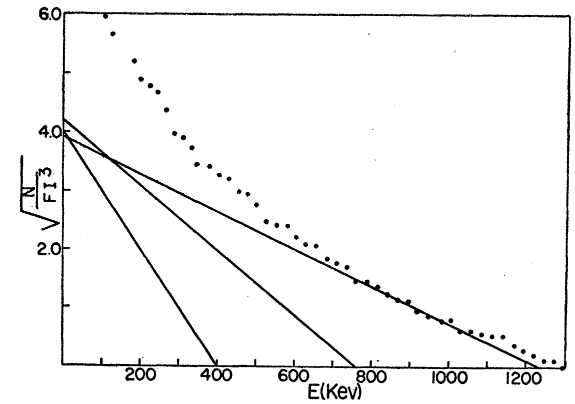

FIG. 3. The Fermi plot of the positron spectrum of Rh^{102}.

transmission decreases. The K/L ratio of γ_2 is about 7.5 which places it as $M1$ or $M2$.

The Fermi plot of the negatron spectrum, leaving out the conversion electrons, is shown in Fig. 2. There seems to be only one negatron group and to have an allowed shape. In view of the expectations that there were about it having an "unique" first forbidden shape, the spectrum was plotted using the corresponding correction factor and it was found that it gave a much worse straight line than the allowed shape. Therefore we conclude that within our experimental errors there is only one negatron group and it has an allowed shape.

The Fermi plot of the positron spectrum is shown in Fig. 3. It is complex and we were able to resolve it in the three groups shown in the figure. The hardest group was explored from the end point to the point where the second group begins to show, that is, a region of about 450 kev, and in this region the Fermi plot is compatible with an allowed shape, although a categoric statement cannot be made because the spectrum was examined without interference only in this small region. All the relevant information about the positron groups and the negatron group are given in Table II. The log ft values given were calculated using the data in the article of Feenberg and Trigg[5] to correct for the K capture.

TABLE I. The energy and the intensity of the conversion electrons from the gamma rays following the decay of Rh^{102}.

Current (amp)	Energy of conversion electron (kev)	Origin of conversion electron	Energy of gamma ray (kev)	Intensity of conversion electron ($\beta^-=100$)	Name of gamma ray
9.07	64.1	K	86.3	>66	γ_1
10.44	83.4	L	86.6	26	γ_1
11.61	101.6	K	123.7	28	γ_2
12.90	123.0	L	126.4	3.8	γ_2
15.62	172.9	$K+L$	195	10.0	γ_3
23.0	331.1	$K+L$	353	1.5	γ_4
28.1	452.7	$K+L$	475	3.0	γ_5

TABLE II. The end-point energy, intensity, and log ft of each positron and negatron group from Rh^{102}.

Group	End-point energy (kev)	Intensity ($\beta^-=100$)	Log ft
β^-	1150 ± 20	100.0	9.8
β_1^+	400 ± 30	3.9	8.0
β_2^+	760 ± 30	21.3	8.7
β_3^+	1240 ± 20	58.8	9.1

These log ft values are really lower limits, but we think that they are close to the true ones, since the K captures which were not detected are probably not a large fraction of the total number of disintegrations.

The decay scheme derived for Rh^{102} from this work is shown in Fig. 4. The decay scheme is incomplete since the softer gamma rays have not been placed definitely. We think that they are associated with K captures to higher levels in Ru^{102}. It seems to us that this decay scheme is complete in regard to the positrons and the negatron, as is shown in the decay scheme.

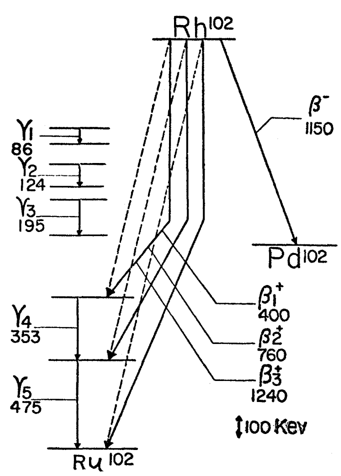

FIG. 4. The incomplete decay scheme of Rh^{102}.

I am indebted to H. L. Anderson for the use of the University of Chicago synchrocyclotron and the beta-ray spectrometer.

[5] E. Feenberg and G. Trigg, Revs. Modern Phys. 22, 406 (1950).