Reprinted from THE PHYSICAL REVIEW, Vol. 111, No. 4, 1140–1141, August 15, 1958
Printed in U. S. A.

Gamma Rays of Rh^{106}(130±2 min)

S. MAYO* AND S. J. NASSIFF†
Comision Nacional de Energia Atomica, Buenos Aires, Argentina
(Received May 3, 1956; revised manuscript received November 21, 1957)

The gamma-ray spectrum of Rh^{106} (130 min) was studied with a NaI(Tl) crystal scintillation spectrometer of 9% resolution for the 662-kev gamma line of Cs^{137}. The following gamma rays were obtained: 220±5 kev (18%), 435±5 kev (43%), 515±5 kev (100%), 610±5 kev (26%), 735±5 kev (36%), 820±5 kev (45%), 940±10 kev (?), 1070±5 kev (40%), 1225±5 kev (23%), 1380±10 kev (?), 1555±5 kev (23%), 1760±10 kev (7%), 1860±10 kev (8%), 2090±10 kev (1%), 2260±10 kev (1%). The measured half-life was 130±2 min.

INTRODUCTION

IN 1955[1] a beta activity of 117-minute disintegration period with 700-kev maximum energy measured by absorption was found in the $Pd^{108}(d,\alpha)Rh^{106}$, $Pd^{106}(n,p)Rh^{106}$, and $Ag^{109}(n,\alpha)Rh^{106}$ reactions and was attributed to Rh^{106m}.

Independently, Nervik and Seaborg[2] obtained, by bombardment of tantalum and uranium with 340-Mev protons, a rhodium of 136-minute disintegration period, to which the (uncertain) mass number 107 was assigned.

In order to study the gamma radiation of this nuclide we utilized the reactions indicated in reference 1. Some of the gamma rays observed lead to the assumption that in the disintegration of this nuclide there are levels common to those found[3–6] in the Rh^{106} and Ag^{106} disintegrations to Pd^{106}; accordingly the mass number 106 is more likely to be the correct one for this nuclide.

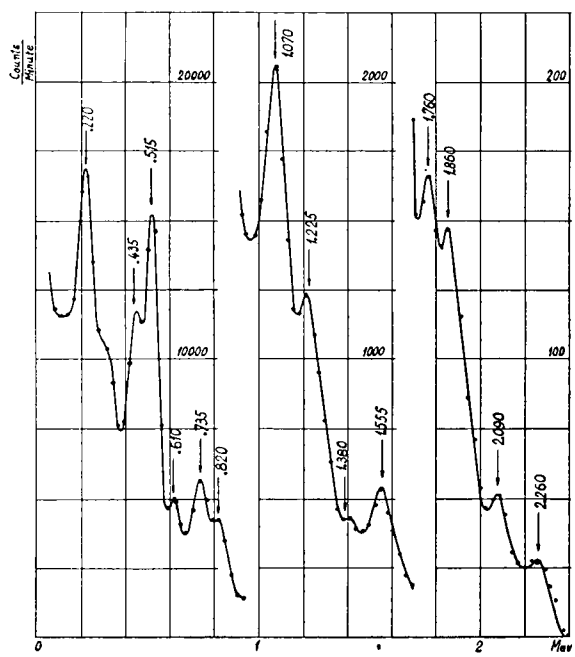

FIG. 1. Rh^{106} (130-min) gamma spectrum with 2-mm Al and with 1.5-in. crystal.

EXPERIMENTAL PART

By irradiation of palladium with 28-Mev deuterons and of silver with fast neutrons, Rh^{106} (130 min) was obtained. The rhodium was separated by precipitating it as $[Rh(NO_2)_6]K_3$.

Purification was carried out by successive precipitations, using appropriate hold-back carriers; silver was always eliminated as AgCl.

The gamma rays were measured in a single-channel scintillation spectrometer, with one Harshaw NaI(Tl)

TABLE I. Comparison of the gamma-ray energies from decay of Rh^{106} (30 sec), Ag^{106} (8.3 day), and Rh^{106} (130 min).

$Rh^{(107)}$ [a] $T_{\frac{1}{2}}$=136 min E_γ (kev)	Rh^{106} [b,c,d,e] $T_{\frac{1}{2}}$=30 sec E_γ (kev)	Ag^{106} [e,f] $T_{\frac{1}{2}}$=8.3 day E_γ (kev)	Rh^{106} $T_{\frac{1}{2}}$=(130±2) min Present results E_γ (kev)	Intensity (%)
195				
225		222	220±5	18
		409	435±5	43
510	513	511–513	515±3	100
630	619–624	620–624	610±5	26
715		717–720	735±5	36
	870–880	815–820	820±5	45
			940±10?	?
1060	1040–1045	1040–1045	1070±5	40
	1131–1140	1131		
1200	1205	1205	1225±5	23
		1390	1380±10?	?
1500	1540–1555	1550–1555	1555±5	23
	1760–1770	1770	1760±10	7
		1850	1860±10	8
	1960			
			2090±10	1
	2100	2100		
	2280		2260±10	1
	2410–2420			
	2660	2660		

[a] See reference 2.
[b] See reference 3.
[c] See reference 4.
[d] See reference 5.
[e] See reference 6.
[f] See reference 7.

* Guest at Brookhaven National Laboratory, Upton, New York.
† Guest at Columbia University, New York City, New York.
[1] Baró, Seelmann-Eggebert, and Zabala, Z. Naturforsch. **10a**, 80 (1955).
[2] W. E. Nervik and G. T. Seaborg, Phys. Rev. **97**, 1092 (1955).
[3] D. E. Alburger, Phys. Rev. **88**, 338 (1952).
[4] B. Kahn and W. S. Lyon, Phys. Rev. **92**, 902 (1953).
[5] D. E. Alburger and B. J. Toppel, Phys. Rev. **100**, 1357 (1955).
[6] M. Goldhaber and R. D. Hill, Revs. Modern Phys. **24**, 179 (1952).

crystal of 1-inch diameter and 1-inch thickness and with another of 1.5-inch diameter and 1.5-inch thickness, and an EMI-6262 photomultiplier. The source-to-crystal distance was 7 mm.

The device was calibrated in relative energies and efficiencies with the Hg^{203}, Na^{22}, Cs^{137}, Zn^{65}, Y^{88}, and Na^{24} gamma rays.

The width at half-height of the 662-kev line from Cs^{137} was 9%.

In Table I the results of references and the present results are compared.

The disintegration period of all the gamma rays has been studied and the value $T_{\frac{1}{2}}=130\pm2$ min has been found. In Fig. 1, the Rh^{106} (130 min) gamma spectrum obtained with the 1.5-inch crystal, and corrected for decay, is shown.

The method followed in order to subtract the Compton background and the annihilation radiation for high-energy gamma rays consisted of the study of standard substances with simple spectra and gamma-ray energies comparable to those of the substance to be studied, in the same geometry to be used with the Rh^{106} (130 min).

Using these standards, the ratios of heights and energies for the Compton background and the photopeaks were plotted against the photopeak energies. We proceeded in the same manner with one-pair production and annihilation radiation from high-energy gamma rays. We thus obtained curves permitting interpolation for intermediate energies. By subtracting these backgrounds it was possible to distinguish between true peaks and those due to secondary processes, and thus to obtain gamma-ray intensities of Rh^{106}. We measured gamma rays having an energy less than 1555 kev with the 1-inch crystal and those with higher energies with the 1.5-inch crystal.

DISCUSSION

Some of the gamma rays of energies above 1800 kev were perhaps due to a pileup effect in the crystal since the source-to-crystal distance was rather small. The 1380- and 940-kev gamma rays appear only after the subtraction of the Compton background, and their existence is therefore uncertain. Because of the presence of annihilation radiation in this region, the intensities of the 735-kev and 610-kev gamma rays are not determined exactly.

At an energy corresponding to 315 kev a peak can be observed which, because of its 36.5-hr disintegration period, we attribute to Rh^{105}. The 220-kev, 435-kev, 610-kev, 1070-kev, 1225-kev, and 1555-kev gamma rays have been observed[6] in the disintegration of Ag^{106} (8.3 day) by electron capture and the 511-kev gamma ray has been observed by emission from Ag^{106} (24 min).[6]

The 735-kev and 820-kev gamma rays may be compared to the 717-kev and 815-kev gamma rays of the Ag^{106} (8.3 day)[7] disintegration.

The 515-kev, 610-kev, 820-kev, 1070-kev, 1555-kev, and 2090-kev gamma rays have been observed in the disintegration by negative beta emission of Rh^{106} (30 sec).[3–5] This leads to the assumption that the disintegration scheme of Rh^{106} (130 min) shows levels in common with those of the Rh^{106} (30 sec) and Ag^{106} (8.3 day).

Probably the 515-kev, 1130-kev, and 1555-kev levels of the Rh^{106} and Ag^{106} disintegration can also be found in the disintegration scheme of Rh^{106} (130 min).

ACKNOWLEDGMENTS

We are indebted to the staff of the Laboratory of Nuclear Spectroscopy for its collaboration in this study and to the Synchrocyclotron Laboratory for the irradiations.

[7] R. W. Hayward, Phys. Rev. 85, 760(A) (1952).