



## XI. The rate of decay of thorium emanation

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this conclusion still remains undisturbed, even though the shape be not one of revolution.

Whether the conditions of the limit can be sufficiently attained in experiment is a question upon which I am not prepared to express a decided opinion. From the logarithmic character of the infinity upon which the argument is founded, one would suppose that there might be practical difficulty in reducing the section sufficiently. Even if an adequate reduction were possible mechanically, the conductivity of actual materials might fail. We must remember that in the theory the conductivity is supposed to be *perfect*.

Terling Place, Witham,  
June 12, 1904.

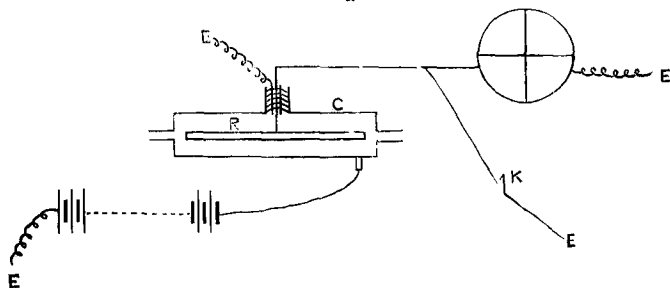
XI. *The Rate of Decay of Thorium Emanation.*  
*By C. LE ROSSIGNOL and C. T. GIMINGHAM\*.*

**D**URING the investigation of a substance, giving an emanation which was suspected to be that of thorium, we had occasion to determine the time taken for known thorium emanation to decay to half-value, and finding that the value obtained was rather less than Prof. Rutherford's (*Phil. Mag.* 1900, xlix. p. 1), we carried out a series of experiments, which go to prove that the true value is 51 seconds, and not 60, as found by him.

Before going on to describe our method of measurement, it might be advantageous to give a short account of the apparatus employed (fig. 1).

The electrometer was of the Thomson-White pattern, with the bifilar suspension removed and replaced by a quartz fibre; the electrodes were insulated by means of ebonite coated

Fig. 1.



with shellac, and the instrument was practically dead-beat. A transparent celluloid scale was used, divided in millimetres;

\* Communicated by Prof. F. T. Trouton, F.R.S.

and for a difference of potential of 1 volt between the quadrants, the spot of light travelled through 120 mms.

The apparatus was almost identical with that described by Prof. Rutherford; one pair of quadrants was permanently earthed while the other pair was connected to the central rod R of the emanation cylinder C, and so arranged that the quadrants could be earthed at will by means of the key K recommended by Rutherford. The rod was insulated from the external cylinder by a plug of shellac, into which a guard-ring connected to "earth" was inserted. After considerable trouble the apparatus was brought into such a condition that no sensible leak could be detected in five minutes, and consequently no correction was necessary for it in the present experiments.

The charge was proved to be proportional to the deflexion throughout the scale by placing some uranium oxide (giving a constant current) inside the cylinder and reading the deflexion at intervals of five seconds. On plotting these values against the time, a straight line was obtained.

A battery of test-tube accumulators was used to create a difference of potential of 300 volts between the central rod and the emanation cylinder.

Time in secs.	Scale- readings.	Time in secs.	Scale- readings.	Time in secs.	Scale- readings.	Time in secs.	Scale- readings.
	cms.		cms.		cms.		cms.
0	0	100	13.85	200	17.77	300	18.96
5	1.15	105	14.2	205	17.89	305	19.0
10	2.2	110	14.5	210	17.99	310	19.1
15	3.22	115	14.8	215	18.09	315	19.17
20	4.22	120	15.07	220	18.14	320	19.2
25	5.2	125	15.3	225	18.22	325	19.22
30	6.04	130	15.56	230	18.3	330	19.26
35	6.8	135	15.8	235	18.35	335	19.28
40	7.64	140	16.02	240	18.41	340	19.30
45	8.35	145	16.18	245	18.5	345	19.32
50	9.08	150	16.4	250	18.53	350	19.33
55	9.78	155	16.6	255	18.6	355	19.37
60	10.37	160	16.78	260	18.65	360	19.37
65	11.0	165	16.88	265	18.60	365	19.39
70	11.5	170	17.0	270	18.68	370	19.4
75	12.02	175	17.17	275	18.7	375	19.45
80	12.5	180	17.3	280	18.76	380	19.5
85	12.88	185	17.44	285	18.84	385	19.5
90	13.27	190	17.56	290	18.91	390	19.54
95	13.64	195	17.68	295	18.9	395	19.58
						400	19.6

Each experiment was carried out as follows:—A definite quantity of emanation was blown into the cylinder as quickly

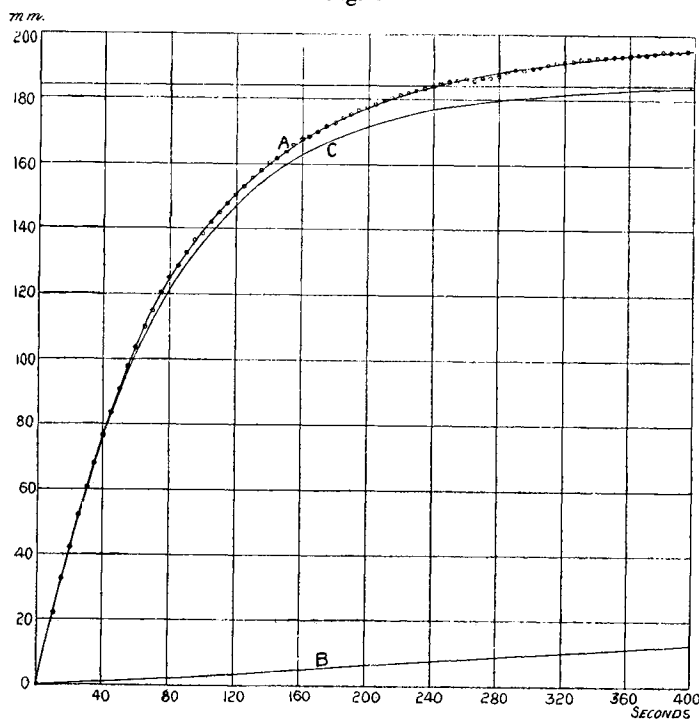
as possible through a calcium-chloride drying-tube and the time noted. The cylinder was then closed, the earth connexion broken, and readings taken every 5 seconds over a period of 400 seconds; any residual emanation was immediately blown out, and the rate of charge due to the excited activity taken as quickly as possible. It was unnecessary to apply any correction for the lag of the needle, as it did not require more than 5 seconds to become steady.

An example will make the method clear.

After introducing the emanation, an operation which lasted 10 seconds, readings were begun 30 seconds later (see table, p. 108).

The emanation was then blown out, and the subsequent rate of charge, which was due solely to the induced activity developed during the experiment, was found to be .65 cm. in 200 seconds.

Fig. 2



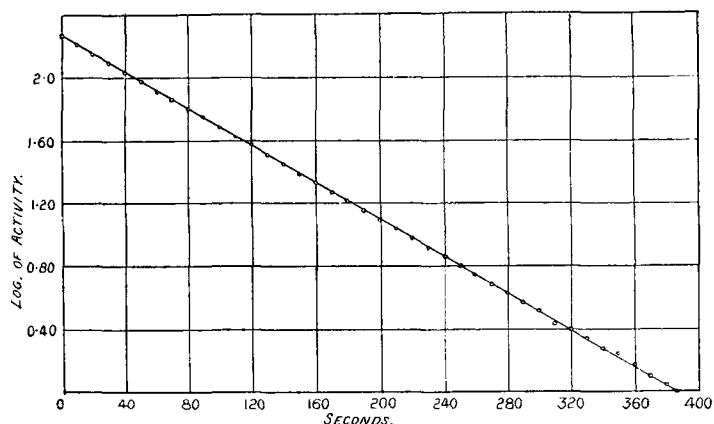
In the annexed diagram (fig. 2) the values given above are plotted against time and a smooth curve A drawn through the points, from which it will be seen that they are nearly all on the

curve. This gives the charge at any time due to the emanation together with the excited activity.

Now, knowing the time when the emanation was blown in, the excited activity at any time can be calculated, assuming an approximate rate of decay for the emanation, and from these values the curve B showing the charge due to the excited activity can be drawn.

If the ordinates of this curve be subtracted from the ordinates of the former, then the curve C drawn through the resulting points will show the charge due to the emanation alone. An asymptote was then drawn, and the logarithms of the ordinates measured from this to the curve were plotted and, from fig. 3, it will be seen that the points thus obtained lie on a straight line.

Fig. 3.



This proves the curve to be a true exponential. From this the time taken by the emanation to decay to half value was found to be 51.2 seconds. Other experiments gave very similar values, *e.g.* 50.8 and 51.5 seconds. The mean of these numbers gives 51.2 seconds as the time taken to decay to half value.

In conclusion we wish to express our thanks to Sir William Ramsay and Prof. Trouton for the kind interest they have taken in the work, and especially are we indebted to Mr. A. W. Porter for his valuable advice and assistance which were always at our disposal.

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