XCV. The heterogeneity of the β rays from a thick layer of radium E

J.A. Gray B.Sc. & W. Wilson M.Sc.

To cite this article: J.A. Gray B.Sc. & W. Wilson M.Sc. (1910) XCV. The heterogeneity of the β rays from a thick layer of radium E , Philosophical Magazine Series 6, 20:119, 870-875, DOI: [10.1080/14786441008636975](https://doi.org/10.1080/14786441008636975)

To link to this article: <http://dx.doi.org/10.1080/14786441008636975>

Published online: 21 Apr 2009.

Submit your article to this journal [↗](#)

Article views: 4

View related articles [↗](#)

ionization did not change materially with the velocity, then the rise and fall in the curve would have to be explained by supposing the number of β -particles reflected to increase with the velocity up to a certain value and then decrease again. Since, however, the ionization produced by β -particles of different velocities may play an important part in the results obtained, a satisfactory explanation of this phenomenon cannot be arrived at until we know definitely the variation of the ionization due to β -particles moving with different velocities.

In conclusion we wish to express our best thanks to Prof. Rutherford for suggesting this research.

Physical Laboratory,
Victoria University of Manchester.
July 25, 1910.

XCV. *The Heterogeneity of the β Rays from a Thick Layer of Radium E.* By J. A. GRAY, B.Sc., 1851 Exhibition Scholar, Melbourne University, and W. WILSON, M.Sc., Hon. Research Fellow, Manchester University*.

THE law of absorption of β rays by matter has lately been the cause of some discussion. Until the experiments of W. Wilson†, it had generally been assumed that β rays absorbed exponentially by aluminium were homogeneous. It was shown, however, that the coefficient of absorption of approximately homogeneous β rays rapidly increased with the thickness of matter traversed, which suggests that the rays experience a diminution in velocity as they pass through the aluminium. Crowther‡ obtained a similar result by the same method.

The decrease in velocity indicated by these experiments has been determined directly§. It follows as a necessary consequence of these results that β rays which are absorbed exponentially by aluminium are not homogeneous.

Recently, however, v. Baeyer and Hahn||, using a photographic method, have shown that the β rays from several radioactive products initially possess a considerable degree of homogeneity. We have no definite evidence so far that the

* Communicated by Prof. E. Rutherford, F.R.S.

† Wilson, Proc. Roy. Soc., A. lxxxii. 1909, p. 612.]

‡ Crowther, Proc. Camb. Phil. Soc. xv. pt. v. p. 442.

§ Wilson, Proc. Roy. Soc., A. lxxxiv. 1910, p. 141.

|| v. Baeyer & Hahn, *Phys. Zeit.* xi. 1910, p. 488.

rays from such thin layers as they used are absorbed according to an exponential law.

Gray* by the same method showed that the β rays from a thick layer of radium E are distinctly heterogeneous, although they are absorbed according to an exponential law by aluminium. In view of the experiments of v. Baeyer and Hahn the following experiments were performed.

The apparatus is shown in fig. 1 and is similar to that used by Wilson (*loc. cit.*).

Fig. 1.

The rays from the radium E which was placed at B could pass through a hole in a lead block A and into a magnetic field perpendicular to the plane of the diagram. They were bent round in circular paths and passed through holes O and P in lead screens into an electroscope E. The mean radius of the path of the rays was 4 cm. and the diameters of the holes O and P $\cdot 8$ cm. The ionization in the electroscope was determined for several strengths of the magnetic field, and the results obtained are shown in fig. 2 *a*, where the ionization in the electroscope is plotted against the product of the field strength and the radius of curvature of the path of the rays. If the rays were homogeneous and the holes O and P and the source infinitely small, we should only get ionization in the electroscope for one definite strength of field. Experimentally however, even if the

* Gray, Proc. Roy. Soc., A. lxxxiv. 1910, p. 136.

rays were homogeneous we should get a curve somewhat similar to that shown, on account of the necessarily finite size of the holes O and P. The following test of the

Fig. 2.

homogeneity of the rays was therefore applied. A sheet of aluminium of known thickness was placed in the path of the rays just underneath the electroscope, which was about 2 mm. above the hole P, and the experiment repeated. Now if the rays are heterogeneous, those which enter the electroscope with the higher magnetic fields should be less easily absorbed than those which enter with the lower. The maximum point should therefore move to the higher fields when sheets of aluminium are placed under the electroscope. That this is the case is shown unmistakably by the curves of fig. 2, *a*, *b*, *c*, *d*, *e*, which are plotted from the results obtained with 0, .067, .245, .489, .731 mm. of aluminium respectively under the electroscope. If, on the other hand,

the rays were homogeneous there would be no such change, since for any strength of field the percentage change in ionization would be the same for the same absorbing screen.

The change in the position of the maximum is quite marked, being at $H\rho = 2,400$ in curve *a*, and at $H\rho = 3,650$ in curve *e*.

It will be noticed that the rays which produced the maximum ionization when no aluminium was placed under the electroscope are practically all absorbed by a thickness of $\cdot 73$ mm. Al, while for rays corresponding to the higher fields appreciable quantities are still transmitted.

In these experiments the bottom of the electroscope was closed by a sheet of tinfoil so that the maximum point even with no aluminium under the electroscope occurs at a rather higher field than it would if no matter whatever were placed in the path of the rays. An experiment was therefore made with a dutch-metal leaf closing the bottom of the electroscope, and the maximum point, which was carefully determined, was found to occur for a value of $H\rho$ 2,200 gauss cm.

This value is in very good agreement with those obtained by Schmidt* 2,200 and Gray 2,300. Experiments made with tin as absorbing medium gave the same type of result.

Absorption curves were taken for rays corresponding to various field strengths and are shown in fig. 3, curves *a*, *b* and *d*, in which the log of the ionization in arbitrary units is plotted against the thickness of absorbing material. The curves are for rays corresponding to $H\rho = 3,200$, 2,400, and 1620 gauss cm. respectively. It will be seen that the different pencils of rays have very different penetrating powers, the initial absorption coefficients being 13.0, 22.2, and 62.5 cm.^{-1} for curves *a*, *b*, and *d* respectively.

It is especially significant that bundles of rays forming a large percentage of the whole can be separated out which have initial absorption coefficients much less than that of the whole beam. If homogeneous rays were absorbed according to an exponential law the absorption coefficient of the whole beam would continually decrease, which is not found to be the case.

The source of radium E was a thick layer of radium D, so that any soft rays are practically all absorbed in the material. As a further precaution the active material was covered with $\cdot 1$ mm. of aluminium.

* Schmidt, *Phys. Zeit.* viii. 1907, p. 361.

874 *Heterogeneity of β Rays from Thick Layer of Radium E.*

That the type of absorption curve obtained for homogeneous rays was not due to the arrangement of apparatus was shown as follows. The radium E was placed 6 cms. below the hole P and an absorption curve of the whole bundle of rays taken. The result obtained is shown in fig. 3 curve *c*. The curve is exponential, showing that the

Fig. 3.

apparatus used has no effect on the absorption curves and the absorption coefficient found 42.8 cm.^{-1} is in very good agreement with the results obtained by other observers. The initial drop is due to scattering of the rays and not to the presence of any soft radiation, since the same percentage drop is obtained if various thicknesses of aluminium are placed directly over the radium E and the absorption curve again taken.

Conclusion.

It has been shown above that from a pencil of β rays which is absorbed by aluminium according to an exponential law, rays of widely different penetrating powers can be separated out. It follows, therefore, that absorption of β rays according to an exponential law is no criterion of homogeneity. The experiments confirm the results obtained by Gray by the photographic method.

We wish to express our best thanks to Prof. Rutherford for the kind interest he has taken in this research.

Physical Laboratories,
The University, Manchester.
Aug. 19th, 1910.

XCVI. *The Deflexion by an Electrostatic Field of Radium B on Recoil from Radium A.* By SIDNEY RUSS, D.Sc., and WALTER MAKOWER, M.A., D.Sc.*

Introduction.

IN a previous paper † an account was given of some attempts made to determine whether radium C is electrically charged when it recoils from radium B; but the experiments made for this purpose failed to reveal any such charge. The formation of radium C from radium B is accompanied only by the emission of β -particles, and it was thought that a transformation involving the expulsion of an α -particle might afford a more satisfactory case for investigation. Experiments were therefore undertaken on the recoil of radium B from radium A. In this transformation the atom of radium B should be negatively charged after recoil, if the process is accompanied simply by the expulsion of an α -particle, as is usually supposed. If, however, there is a simultaneous evolution of β -particles, the recoiling atom might be electrically neutral or even positively charged. It will be remembered that radium A on formation from the emanation in air at atmospheric pressure does in fact acquire a positive charge, so that it is concentrated on the negative electrode when the emanation is subjected to an electric field ‡. The following experiments were made with the object of determining whether the radium B is charged when

* Communicated by the Authors.

† Makower and Russ, Phil. Mag. Jan. 1910.

‡ Rutherford, Phil. Mag. Feb. 1900.