

could be obtained with 400 volts between the plates, without any danger of a discharge, even if the vacuum were not very good.

From the distance between the outside edges of the two bands, the value of mv^2/e could be calculated. The value of mv/e was determined in the magnetic experiment by measuring the curvature of the path of the rays after passing through the same thickness of mica as in the electric experiment.

The determinations of e/m and v for different strengths of electric and magnetic fields were very concordant. The values of e/m in the different experiments lay between 5.0×10^8 and 5.2×10^8 . A separate experiment showed that the value of e/m was unaltered by passing the rays through the mica screen.

The initial velocity of projection of the rays from radium *C* is very nearly 2×10^9 cm. per second.

The writer originally obtained by the electric method a value of e/m for radium rays of 6.5×10^8 ; Des Coudres by the photographic method found a value 6.3×10^8 , while Mackenzie recently obtained a value of 4.7×10^8 . These experimenters all used radium in radioactive equilibrium as a source of α rays. The rays were non-homogeneous, and it was consequently not easy to obtain an accurate value of e/m .

Since the value of e/m for the hydrogen atom in the electrolysis of water is about 10^4 , the present results show that, within the limit of experimental error, the apparent mass of the α particle from radium *c* is twice that of the hydrogen atom.

The question whether the α particle is a molecule of hydrogen, an atom of helium, or a helium molecule carrying twice the ionic charge, was discussed. It is not at present possible to decide definitely between these possibilities. Further experiments are in progress to determine the value of e/m for the α particles from the other radium products and from thorium and actinium.

SOME PROPERTIES OF THE α RAYS FROM RADIUM. II.¹

BY E. RUTHERFORD.

IN the Philosophical Magazine (July, 1905), the author showed that the α particles emitted from a thin film of radium *C*, obtained on a wire by exposure to the radium emanation, decreased in velocity in their passage through matter. When the α particles from radium *C* had been reduced to a velocity of about 60 per cent. of their initial velocity, the photographic effect produced by them was relatively very small.

The velocity was deduced from measurements of the deflection of a

¹ Communicated to the American Physical Society, December 29, 1905.

pencil of the α rays in a strong magnetic field, using the photographic method. The results confirmed the essential points of the theory of Bragg and Kleeman of the nature of the absorption of the α rays by matter. The rays from radium are complex and consist of four sets of α rays from the four α ray products, each set of rays being initially projected with a definite but different velocity.

In a recent paper, Becquerel (*Comptes Rendus*, Sept., 1905), has taken exception to these views. He states that the α rays from radium are homogeneous, and that their velocity is not reduced by their passage through matter, and concludes that the theory of Bragg and Kleeman is incorrect.

In support of his views, Becquerel describes an experiment in which the trace of the α rays from a thick layer of radium was not altered by placing absorbing screens over the radium.

The author showed that the result obtained by Becquerel is a necessary consequence of the view that the rays are complex, and does not in any way invalidate the conclusions of Bragg and Kleeman and Rutherford. The outside edge of the trace of the pencil of rays on a photographic plate, when exposed in a magnetic field, is due to the α particles which are just able to produce an appreciable effect on a photographic plate. When a screen is placed over the radium, the velocity of all the particles is reduced, but, as before, the outside edge of the trace will be produced by rays which, after emerging from the screen, have the same velocity as in the first case. The deflection in a magnetic field will consequently be unaltered, and there will be no apparent displacement of the trace of the rays, although the velocities of the α particles as a whole are reduced in their passage through matter.

The inside edge of the trace should be slightly altered but this effect would be too small to detect experimentally under the conditions of the experiment of Becquerel.

It was also shown that the α rays from a thick layer of radium are deflected to unequal extents by a magnetic field. This dispersion of the rays in a magnetic field shows that the α particles are expelled from radium over a wide range of velocity. The position taken by Becquerel, viz., that the α rays are all projected at the same speed, is untenable.

Becquerel observed that the radius of curvature of a pencil of rays emitted from radium was not constant but increased with distance from the source. The explanation of this effect has been given previously by Bragg, and has been shown to be a necessary consequence of the complexity of the α rays. The assumption made by Becquerel that the ratio e/m decreases with distance from the source of rays is unnecessary. In addition, the author showed that the magnetic deflexion of the α rays from radium *C* increased when the rays passed through air instead of a

vacuum. According to the views of Becquerel, the amount of deflexion of the α rays under such conditions should be reduced by their passage through air.

The results in general completely support the theory of Bragg and Kleeman that the α rays from radium decrease in velocity in their passage through matter, and disprove in every particular the theories proposed by Becquerel.

ON THE USE OF CENTRIFUGAL FORCE IN SOIL INVESTIGATIONS.¹

BY LYMAN J. BRIGGS.

CENTRIFUGAL force can be employed with advantage in the following laboratory investigations of soils:

1. The study of the retentive power of different soil types for moisture. The moist soil is placed in a perforated cup and subjected to a known centrifugal force, by which the moisture content is reduced until it is in equilibrium with the force employed. It logically follows that two soils whose moisture contents have thus been brought into equilibrium with the same force should, when placed in contact, be in capillary equilibrium. The method thus enables us to determine the moisture equivalents of different soil types, which it is essential to know before the moisture contents of two soils under field or laboratory conditions can be rationally compared.

2. The study of the rate of movement and the final distribution of moisture in a column of soil when acted upon by a known force. In this case the tube containing the moist soil is mounted radially on a shaft revolving at a known rate. The method gives a means of determining the moisture gradient necessary to maintain equilibrium against a uniform force gradient. By the arrangement of the apparatus so that water can be supplied at a definite rate, the moisture gradient necessary to maintain a steady flow of known amount under the influence of a given force gradient can be determined. The direction and rate of movement of soil moisture under field conditions can then be determined from a study of the moisture distribution in the field. These methods have not yet been tried experimentally.

3. The study of the composition and concentration of the soil solution. A part of the soil moisture with the substances it holds in solution can be removed by centrifugal force without changing, so far as we have been able to determine, the composition or concentration of the soil solution. This method possesses obvious advantages over the excess-solvent

¹ Abstract of a paper presented at the New York meeting of the Physical Society, December 29-30, 1905.