On the Scattering of the α-Particles by Matter.

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In the course of the experiments undertaken by Professor Rutherford and myself to determine accurately the number of α-particles expelled from 1 gramme of radium, our attention was directed to a notable scattering of the α-particles in passing through matter. The effect of scattering is well known in the case of β-particles. A narrow pencil of β-rays emerges after passing through a metal plate as an ill-defined beam. A similar effect, but to a much smaller extent, was known to exist also for the α-particles. Professor Rutherford* showed that the image of a narrow slit produced by the α-rays on a photographic plate broadens out when the slit was covered with a thin sheet of mica, while a well-defined image was obtained in vacuum with the uncovered slit. The question of the actual existence of the scattering effect of the α-particles has been discussed further by Kucera and Masek,† by W. H. Bragg,‡ L. Meitner,§ and E. Meyer.||

Some experiments have been made, using the scintillation method to determine the magnitude of the scattering of the α-particles in passing through matter. The apparatus used is shown in fig. 1. The main part consists of

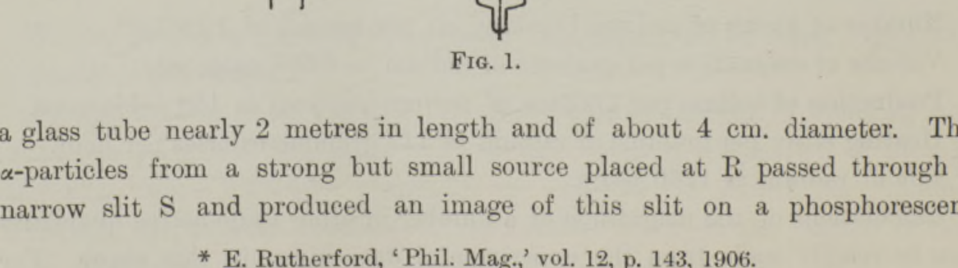

Fig. 1.

a glass tube nearly 2 metres in length and of about 4 cm. diameter. The α-particles from a strong but small source placed at R passed through a narrow slit S and produced an image of this slit on a phosphorescent

* E. Rutherford, 'Phil. Mag.,' vol. 12, p. 143, 1906.

† Kucera and Masek, 'Phys. Z. S.,' vol. 7, p. 650, 1906.

‡ W. H. Bragg, 'Phil. Mag.,' vol. 13, p. 507, 1907.

§ L. Meitner, 'Phys. Z. S.,' vol. 8, p. 489, 1907.

|| E. Meyer, 'Phys. Z. S.,' vol. 8, p. 425, 1907.

screen Z, which was cemented to the end of the glass tube. The breadth of the slit was 0·9 mm., and the breadth of the geometrical image on the screen was about 2 mm., depending upon the dimensions and the distance of the source. The numbers of scintillations at different points of the screen were counted directly by means of a suitable microscope M, of 50 times magnification. The area of the screen which could be seen through the microscope was about 1 $mm.^2$ The number of scintillations counted varied between two or three a minute and about 80 per minute. As regards the microscope and the most convenient method to count the scintillations, the hints given by E. Regener* in his recent paper proved very useful. The microscope was mounted on a slide PP so that the scintillations produced at varying distances from the centre of the beam could be observed. The actual position of the microscope was read on a millimetre scale fixed to the slide.

The first experiments were made with radium C, which had been deposited on a small piece of metal, as a source of α-rays; but it soon became obvious that, owing to its comparatively quick rate of decay, it was impossible to get any definite results. To avoid this difficulty, the emanation from several milligrammes $RaBr_2$ was enclosed under a low pressure in a sloping glass tube R, as seen in the figure. One end of this tube, which was of less than 2 mm. internal diameter, was closed airtight by a thin sheet of mica through which the α-particles could freely escape. In this way an intense source of small cross-sectional area was obtained, and the scintillations on the screen could easily be counted at different points without any corrections for the decay.

In a good vacuum, hardly any scintillations were observed outside of the geometrical image of the slit. But on allowing a little air into the tube, the area where scintillations were observed greatly increased. By moving the microscope along the whole screen and counting the number of scintillations at definite intervals, usually every second millimetre, a curve of the distribution of the α-particles was obtained. The number of scintillations was small at the extreme boundary of the screen but rapidly increased towards the centre of the beam.

Similar results were obtained in a vacuum, if the slit were covered with leaves of gold or aluminium. The leaves were attached to small frames and were put into a slide AA connected with the slit S. The distribution of the particles hitting the screen was measured in the same way as before. The figure 2 shows some typical examples of the curves which were obtained. The curve A shows the distribution of the scintillations in a charcoal vacuum. A slight scattering was also observed in this case, which was probably due to

* E. Regener, 'Verhdlg. d. D. phys. Ges.,' vol. 10, p. 78, 1908.

the last traces of air in the tube. The second curve B shows the effect if the slit is covered with one gold leaf. The area over which the scintillations were observed was much broader and the difference in the distribution could easily be noticed with the naked eye. The actual measurements are given in the curve B. The third curve C shows the effect of two gold leaves together.

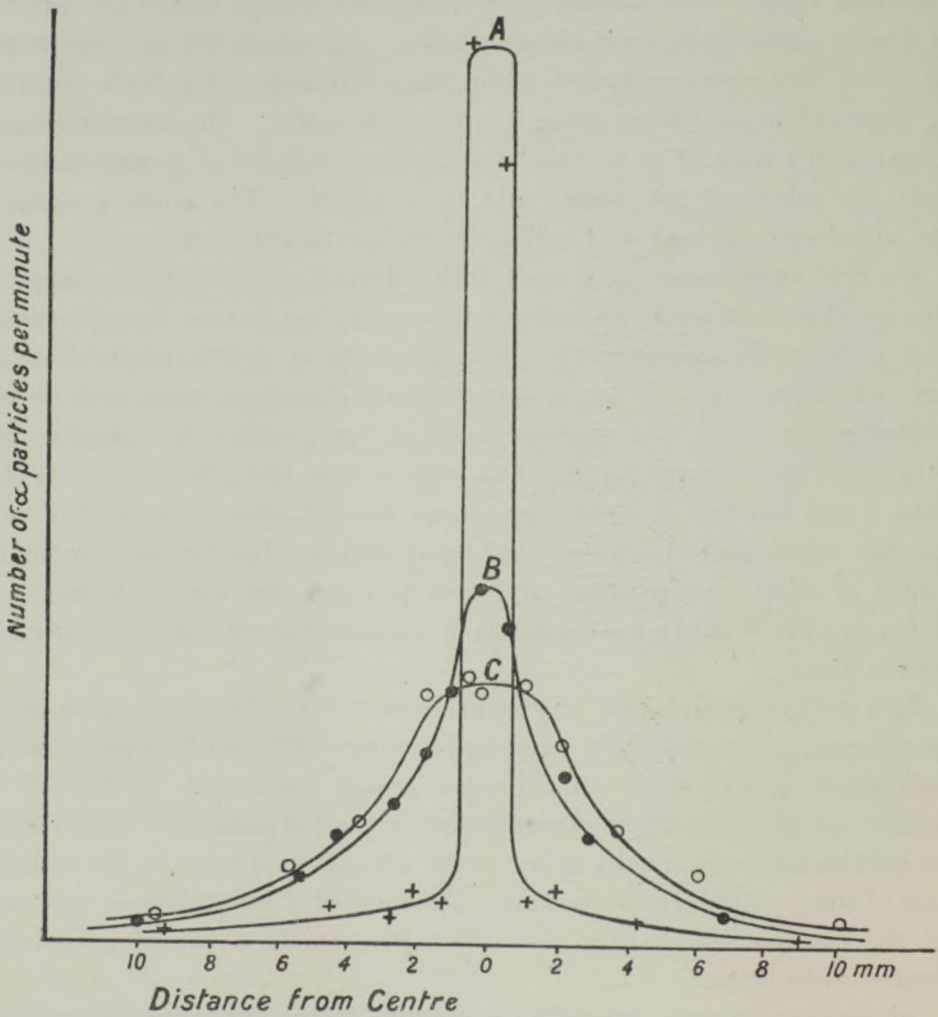

FIG. 2.

The curves as given in fig. 2 are corrected for the absorption in the metal foils. Some absorption took place, since α-particles of different velocity were present.

Some experiments were also made, using aluminium foil. The aluminium foil showed the scattering effect clearly, but to a much smaller extent than gold leaf, if equivalent thicknesses were used.

The observations just described give direct evidence that there is a very marked scattering of the α-rays in passing through matter, whether gaseous or solid. It will be noticed that some of the α-particles after passing through the very thin leaves—the stopping power of one leaf corresponded to about 1 mm. of air—were deflected through quite an appreciable angle. The experiments are being continued with all substances for which it is possible to get thin samples in the hope of establishing some connection between the scattering power and the stopping power of these materials. A fuller investigation will also enable us to treat the matter from a theoretical point of view.

In conclusion, I desire to express my thanks to Professor Rutherford for the kind interest he has taken in these experiments.