The β-ray spectrum of Ra E. By E. MADGWICK, M.C., Ph.D., Emmanuel College. (Communicated by Prof. Sir ERNEST RUTHERFORD.)

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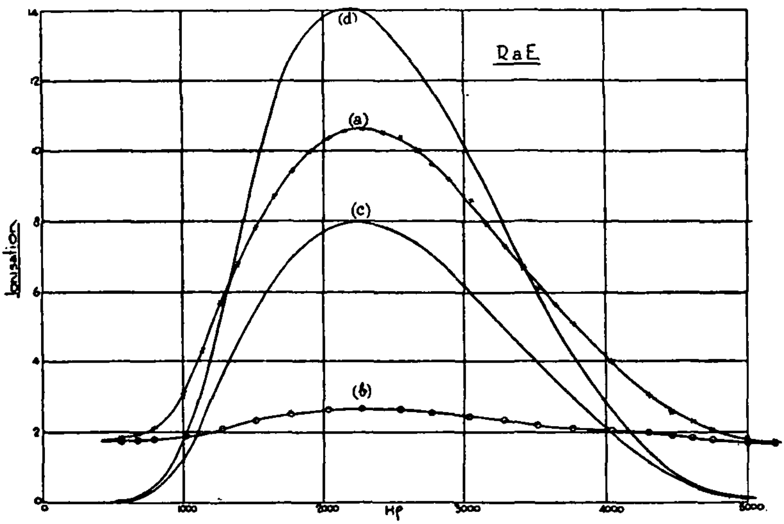
Introduction.

In the course of an investigation of the β-ray spectrum of Ra $(B + C)$ by the ionisation method, Chadwick (1) concluded that the line spectrum is superimposed on a strong continuous background. The ionisation method, however, is not one which admits of high resolving power, and doubts have been entertained whether the continuous spectrum has in fact any real existence. In this connection the case of Ra E is one of special importance, since no line spectrum from this body has been detected by the more sensitive photographic method. Experiments have therefore been undertaken with the object of determining the distribution with velocity of the numbers of particles in the β-ray spectrum of Ra E.

Experimental. The source of radiation is contained in a brass box which is situated between the pole pieces of an electromagnet and evacuated to a pressure of a fraction of a millimetre. A limited beam of the rays of radius of curvature $\rho = 6$ cms. is focussed on to a mica window where it passes out of the box and enters an ionisation chamber, the ionisation current being measured by means of a Wilson tilted electroscope working at a sensitivity of 200 divisions per volt. By adjusting the current through the electromagnet the ionisation currents corresponding to successive values of $H\rho$ are determined. To eliminate the effect of scattered radiation a small lead screen, sufficiently thick to stop the β-rays, is arranged so that it can be turned into or out of the path of the direct beam so that the effects of the scattered and of the direct + scattered radiation can be determined separately, the difference representing the effect of the direct rays. The source was obtained by rotating a small nickel plate in a solution of Ra D. The plate was 5 mms. long and 3 mms. wide and was arranged so that the beam to be measured left the plate at a very small angle.

Experimental results are shown in the diagram. The curve (a) represents the effect of the direct + scattered radiation, (b) that of the scattered radiation alone, and (c), the difference between the two, that of the direct beam. To estimate the distribution of the numbers of particles with $H\rho$ the curve (c) must be corrected in two respects. The beam contains particles of radii of curvature between ρ and $\rho + \delta\rho$. Therefore for any field H the rays have values of $H\rho$ between $H\rho$ and $H(\rho + \delta\rho)$, that is a range of $H\delta\rho$. In order that each reading shall correspond to a constant increment of $H\rho$ it is thus necessary to divide it by H. Also, the numbers of pairs of ions produced by an electron per cm. of path varies with the velocity, and for fairly low velocities the variation is very considerable. Block (2) has collected data from all available sources and gives a curve showing the number of ions produced per centimetre path in air by particles of velocities up to $2\cdot9 \times 10^{10}$ cms. per sec. This is employed to estimate from the ionisation currents the relative numbers of particles entering the ionisation chamber. Corrected in these respects the results are represented by the curve (*d*).

Discussion. The curve starts at about 600 $H\rho$, rises to a maximum at about 2200 $H\rho$, and ends at about 5000 $H\rho$. The



beginning will be affected to some extent by absorption of the rays in the mica window (of 1·8 cms. stopping power for α-particles) and the 2 mms. of air space between the window and the ionisation chamber. It is to be noted also that the rays which are measured include those reflected from the nickel plate, which would tend to move the maximum in the direction of lower velocity. There is no reason to doubt the accuracy of the end point.

Ellis (3) considers that the particles comprising the continuous spectrum are ejected from the nucleus through a wide range of velocities. Meitner (4), on the other hand, supposes them to be ejected with constant velocity. If Meitner's supposition is correct it is clear that varying amounts of energy are lost by the particles during their passage out of the atoms; the energies represented by the end point and by the maximum of the spectrum differ by roughly 7×10^5 volts. If this loss is to be attributed to collisions with extranuclear electrons the number of particles ejected must be substantially greater than one per disintegrating atom, which is in conflict with the results of Emeléus's experiments (5); and there ought to be present κ-radiation, which, however, is not found in any quantity. Rosseland (6) suggests that the continuous spectrum may be due to the radiation of energy as the β-ray passes through the intense fields within the atom, but Ra *E* emits practically no γ-radiation. The phenomena attaching to the disintegration of Ra *E* are relatively simple, yet by virtue of their simplicity they impose restrictions on the way of explaining the continuous β-ray spectrum; and at present there appears to be no alternative but to follow Ellis and postulate that the particles are ejected from the nucleus with velocities which vary continuously.

The continuous spectra of Ra *C* and Th $(B+C)$ have also been investigated. The values for the maxima and end points are set out below.

	Maxima		End points	
	$H\rho$	volts	$H\rho$	volts
Ra *C*	2500	4×10^5	12,000	30×10^5
Ra *E*	2200	$3{\cdot}26 \times 10^5$	5,000	$10{\cdot}7 \times 10^5$
Th $(B+C)$	1400	$1{\cdot}52 \times 10^5$	8,800	22×10^5

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