The conception of an electron as a particle moving with a high velocity in fields of force of such magnitudes is not a possible one according to the condition we have introduced.

The principle of minimum proper time may thus be regarded as setting a boundary to the region to which such a conception may be applied and to the domain where the quantum equation is valid.

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Positron Emission accompanying β-Ray Activity

ACCORDING to the theory of β-decay proposed by Fermi, a neutron can be transformed spontaneously into a proton with simultaneous creation of an electron and a neutrino. The probability of this process occurring is to a first approximation proportional to g^2, where g is the universal constant introduced by Fermi. Since the β-particle has an electric charge, there will be an electromagnetic interaction between the β-particle and the virtual electrons which, according to Dirac's theory of the positron, occupy the states of negative energy. As a result of this interaction, it may happen that an electron in a negative energy state during the creation of the β-particle makes a transition to a state of positive energy, so that we have a process in which a neutron is transformed into a proton by simultaneous creation of two electrons, a positron and a neutrino. Since the interaction energy between two electrons is to a first approximation proportional to the square of the charge e of an electron, the probability of this process will be proportional to $(g\,e^2)^2$ or (for dimensional reasons) proportional to $(g\,\alpha)^2$, where $\alpha = 2\pi\,e^2/hc = 1/137$ is the fine structure constant.

We get, therefore, for the ratio $N+/N-$ ($N+$ = number of positrons emitted, $N-$ = number of β-particles) the following expression

$$N+/N- = k\,\alpha^2,$$

where k is a dimensionless constant independent of the atomic number Z (Z will be involved only in terms of higher order in e). The constant k depends to some extent on the energy distribution of the β-rays and is generally larger the larger the upper limit of the β-spectrum. A preliminary estimate showed that in actual cases k has a value of a few units, so that $N+/N-$ is of the order of 10^{-4}. This is in agreement with the experiments of Alichanow, Alichanian and Kosodaew[1], who have measured $N+/N-$ for thorium C+C″ and for radium C.

Further, it is a simple consequence of the theory that the upper limit of the positron energy spectrum is smaller than the upper limit of the β-ray spectrum by an amount $2mc^2 \sim 10^6$ e.v. Now the end-points of the β-spectra of thorium C+C″ and radium C correspond to energies of $2{\cdot}2 \times 10^6$ e.v. and $2{\cdot}9 \times 10^6$ e.v. respectively[2]. This is in good agreement with the measurements of Alichanow, Alichanian and Kosodaew (loc. cit.). After subtracting the positrons originating from the internal conversion of γ-rays, these authors find in the case of thorium C+C″ a continuous positron spectrum with the end-point at an energy of about $1{\cdot}2 \times 10^6$ e.v. In the case of radium C they find in the same way a positron spectrum extending at least as far as an energy of $1{\cdot}7 \times 10^6$ e.v. In the latter case the end-point is not very well defined, since the distribution curve has a tail.

The details of the theory together with a detailed calculation of the positron distribution curve will be given later.

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Jan. 10.

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The Continuous Spectra of RaE and RaP^{30}

THE purpose of this investigation was to study the continuous spectra of RaE and RaP^{30}, especially in their low energy regions.

The spectrum of RaE was investigated by focusing the electrons in a uniform magnetic field, the radius of the circles being 10 cm. The angular divergence of the beam was about 11°. The electrons were counted with a small Geiger-Müller counter, separated from the apparatus by a nitrocellulose film only $4{\cdot}5 \times 10^{-4}$ gm./cm.² thick, the apparatus itself being evacuated to a pressure of 10^{-4} mm. Hg. Eleven aluminium screens were mounted inside the deflecting chamber to exclude completely the possibility of electrons scattered by the walls reaching the counter; furthermore, in designing the apparatus, a large distance from the source to the walls and the first defining slit was provided for.

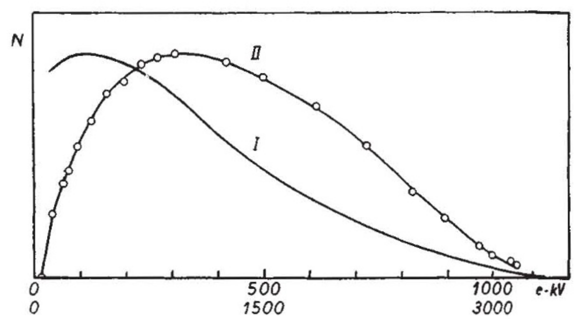

FIG. 1.

The source was an aluminium strip 3 mm. wide and $0{\cdot}5\,\mu$ thick ($0{\cdot}13 \times 10^{-3}$ gm./cm.²), on which pure RaE was deposited electrolytically. Having investigated the energy distribution curve of β-particles from this RaE source under the conditions described above, we discovered the presence of a great number of electrons with low energies. The energy distribution curve obtained, beginning from 30 kv., is given in Fig. 1 (I). There is no pronounced maximum, and the curve seems, when extrapolated, to intersect the axis of ordinates. At energies less than 60 e.kv. the absorption of electrons in the film separating the counter from the deflecting chamber becomes noticeable. Using data on absorption of cathode rays[1], the weakening of the β-ray beam in passing through the film can be taken into account, and the curve corrected for this absorption effect. In the curve given in Fig. 1, this correction has been