Heavy Particles and the Neutrino

In a previous letter the writer[1] has suggested that the x particle may be produced by the absorption of a photon by an ordinary electron. Corson and Brode[2] give the rest mass of a heavy particle as 350 m_0, while Street and Stevenson[3] give 130 m_0. (m_0 is the rest mass of the ordinary electron. See previous letter for definitions.) To produce a rest mass of p_2m_0 a photon of energy $(p_2^2-1)m_0c^2/2$ is needed. When $p_2=350$, this energy is 31,000 Mev. The values 130 and 350 for p_2 and still other values are consistent with the writer's idea.

If a photon of α_1 greater than $(p_2^2-1)/2$ strikes an ordinary electron ($p_1=1$) at rest ($\beta_1=0$), an energy $\alpha' m_0c^2$, where $\alpha'=(p_2^2-1)/2$, is absorbed from the photon, giving rise to a particle of mass p_2m_0 with a velocity $\beta' c=c(p_2^2-1)/(p_2^2+1)$ in the direction of the photon. The remaining energy $(\alpha_1-\alpha')m_0c^2$ is treated as that of a primary photon which is to be scattered in the direction θ according to the principles of the Compton effect by an electron of rest mass p_2m_0 traveling with an original speed $\beta' c$ in the direction of the primary photon.

Perhaps heavy particles other than the heavy electron may be produced according to Eqs. (1) and (2) of the previous letter. To produce a heavy particle of mass p_2m_0 from a particle of mass p_1m_0 which is at rest a photon

$$h\nu_1=m_0c^2(p_2^2-p_1^2)/2p_1 \tag{1}$$

is needed. The kinetic energy produced by complete absorption of this photon is

$$T_2=m_0c^2(p_2-p_1)^2/2p_1. \tag{2}$$

So, to produce a heavy proton with kinetic energy 940 Mev, a photon of energy 2260 Mev is needed. From (2), $p_2=2.414p_1$.

In a β-ray radioactive transformation the β-rays are found to have a continuous spectrum of speeds up to a certain maximum speed β_0c, such that the energy relation

$$M_1c^2=M_2c^2/(1-\beta_2^2)^{\frac{1}{2}}+m_0c^2/(1-\beta_0^2)^{\frac{1}{2}} \tag{3}$$

holds, where M_1 and M_2 are the rest masses of the parent and product atoms, respectively, and β_2c is the recoil velocity of M_2. The writer suggests that the energies of all β-rays in the spectrum are the same but that different β-rays have different rest masses pm_0 and different velocities βc, such that

$$m_0c^2/(1-\beta_0^2)^{\frac{1}{2}}=pm_0c^2/(1-\beta^2)^{\frac{1}{2}}. \tag{4}$$

From (4), it is seen that, as p increases from unity to $1/(1-\beta_0^2)^{\frac{1}{2}}$, β decreases from β_0 to zero. Allowing the expelled β-particle to have a variable rest mass thus removes the need for postulating the neutrino. The kinetic energy distribution curves for β-rays have been calculated on the basis of the rest mass always being m_0. According to the writer's suggestion, variation of $H\rho$ implies variation of p. From the distribution curve with respect to $H\rho$ for the β-particles from RaE, it is estimated that more than 90 percent of the electrons have a rest mass greater than $2m_0$ and a kinetic energy less than half the maximum kinetic energy, 2.06 m_0c^2. The average kinetic energy for all the electrons is less than one-third of the maximum. This is in agreement with Meitner and Ortheim's calorimetric experiment[4] on RaE, provided that the life of the heavy electron is long compared with the duration of the experiment, or that the γ-radiation which the heavy electron ultimately emits in returning to m_0 was not recorded in Meitner and Ortheim's experiments.

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December 15, 1937.

[1] Jauncey, Phys. Rev. **52**, 1256(L) (1937).
[2] Corson and Brode, Bull. Am. Phys. Soc., December 2 (1937).
[3] Street and Stevenson, Phys. Rev. **52**, 1004 (1937).
[4] Meitner and Ortheim, Zeits. f. Physik **60**, 143 (1930).