Suppose that occasionally an electron of suitable speed is able to interact with an atomic nucleus near which it passes in such way that its relativity mass increase is retained in a quasi-stable form provided that the de Broglie wave-length of the electron is equal to $2\pi a$, where $a=e^2/m_0c^2$ is a length representing the range of nuclear forces. This is analogous to the result that the de Broglie wave-length of an electron in the lowest Bohr orbit of an atom is equal to the circumference of the orbit. Substituting $\lambda=2\pi e^2/m_0c^2$ in (3) and calling $m/m_0=R$,

$$R=\frac{1}{[1-(hc/2\pi e^2R)^2]^{\frac{1}{2}}}, \tag{4}$$

or with $hc/2\pi e^2=137$, this becomes

$$R=[1+(137)^2]^{\frac{1}{2}}. \tag{5}$$

Thus the "new" particle should have a mass of about $137m_0$. In view of the fact that $a=e^2/m_0c^2$ is determined only approximately, the result is in accord with experimental values of m so far reported.

The speed of an electron having the apparent mass required by the above relations is given by

$$v/c=137/[1+(137)^2]^{\frac{1}{2}}=0.99997. \tag{6}$$

It is likely that a heavy electron of this kind would ultimately revert to its ordinary state by emission of radiation or by conversion of its excess mass into kinetic energy or both. The behavior of reflected electrons cited by Zwicky[3] may find a ready explanation in terms of such processes.

The total energy given off when a heavy electron of mass $137m_0$ returns to its normal state would be $136m_0c^2$ or about 69 Mev.

IRA M. FREEMAN

Central College,
Chicago, Illinois,
February 28, 1938.

[1] Neddermeyer and Anderson, Phys. Rev. **51**, 884 (1937); Street and Stevenson, Phys. Rev. **52**, 1003 (1937); Corson and Brode, Bull. Am. Phys. Soc., Dec. 2 (1937).
[2] Jauncey, Phys. Rev. **52**, 1256 (1937).
[3] Zwicky, Phys. Rev. **53**, 315 (1938).

On the Latitude Effect of the Soft Component of Cosmic Rays

The measurements of Korff, Curtiss, and Astin[1] afford the possibility of evaluating completely the latitude effect of the high altitude part of the absorption curve. The most striking features of this important research are: (a) Almost all ionization measured in the stratosphere is produced by secondary radiation; (b) The shape of the absorption curve does not undergo any considerable change with latitude; (c) The peak of the curve does not shift considerably; (d) The latitude effect, between Washington and Peru, as measured by the heights of the peaks, amounts to 50 percent of the Washington intensity.

We may therefore write for the intensity $I(x)$ measured at a depth X and latitude λ, as a first approximation

$$I(x)=S(x)=S_\lambda\varphi(x) \tag{1}$$

where $S(x)$ is the intensity of the secondary radiation and S_λ a factor only dependent on latitude.

Concerning the energy spectrum of the soft component, different methods of analysis give in the energy range considered here an expression[2]

$$f(\epsilon)d\epsilon=\epsilon^{-n}d\epsilon \tag{2}$$

where n varies between 2.4 and 3 approximately. We may put

$$n=2.5. \tag{3}$$

The number of primaries arriving in a given latitude λ is

$$N_\lambda=c\int_{\epsilon_\lambda}^{\infty}f(\epsilon)d\epsilon=[c/(1-n)]\epsilon_\lambda^{1-n} \tag{4}$$

where ϵ_λ is the threshold energy imposed by the earth's magnetic field. If the intensity of secondaries were directly proportional to the number of primaries, i.e., if $S_\lambda\sim N_\lambda$, an excessively high latitude effect would result. S_λ would be proportional to $\epsilon_\lambda^{-1.5}$. At the latitude of Peru where the threshold energy is as great as three times the corresponding value at Washington (1.2×10^{10} ev against 4×10^9 ev), only 19 percent of the Washington intensity should be observed. In order to obtain a better fit of calculated and observed values a much slower fall of the energy distribution with energy than that given by (2) and (3) would be necessary.

This difficulty may be solved by admitting proportionality between the number of secondaries and the total energy of the incoming rays. This point of view emanates from a general theory based on Swann's formula[3] for the energy loss of corpuscular rays which has already provided an interpretation[4] of a large number of cosmic-ray phenomena. The mathematical deduction will be treated in a subsequent paper. Here let us examine only qualitatively the consequences of this assumption resulting from the behavior of the latitude effect at high altitudes.

With decreasing latitude there is a cut-off of a greater and greater number of soft primaries, but as only small energy is carried by these rays, their efficiency as producers of secondaries is less than that of the remaining rays. Therefore we put

$$S_\lambda\sim E_\lambda=c\int_{\epsilon_\lambda}^{\infty}\epsilon f(\epsilon)d\epsilon=[c/(2-n)]\epsilon_\lambda^{2-n}. \tag{5}$$

The rise of the energy and consequently the rise of the measured intensity, differs from that for the number of primaries by a factor ϵ_λ. There results

$$S_\lambda\sim\lambda^{-0.5}. \tag{6}$$

The intensity at Peru is calculated as 58 percent of that at Washington.

BERNHARD GROSS

Instituto Nacional de Technologia,
do Ministerio do Trabalho,
Rio de Janeiro, Brazil,
February 7, 1938.

[1] S. A. Korff, L. F. Curtiss, A. V. Astin, Phys. Rev. **53**, 14 (1938); L. F. Curtiss, A. V. Astin, L. L. Stockmann, B. W. Brown, Phys. Rev. **53**, 23 (1938).
[2] G. Pfotzer, Zeits. f. Physik **102**, 41 (1936); W. F. G. Swann, Phys. Rev. **50**, 1103 (1936); J. F. Carlson, J. R. Oppenheimer, Phys. Rev. **51**, 220 (1937); W. Heitler, Proc. Roy. Soc. London **A159**, 432 (1937).
[3] W. F. G. Swann, Phys. Rev. **46**, 432 (1934); **46**, 828 (1934); **47**, 575 (1935).
[4] B. Gross, Physik. Zeits. **37**, 11 (1936); **37**, 409 (1936); **38**, 201 (1937); G. Pfotzer, reference 2; W. F. G. Swann, Phys. Rev. **48**, 641 (1935); **50**, 1103 (1936).