of a crystal, with the characteristic temperature

$$\Theta_0 = 1.63 \times 10^{11} \text{ degree.}$$

These deviations are connected with the fact that the pressure of radiation is not equal to $\frac{1}{3}$ of the energy density; Maxwell's equations do not hold in these domains.

The laws of the kinetic theory of gases undergo also an alteration, which for a gas of molecular weight μ begins at a characteristic temperature

$$\Theta = \frac{137}{1845} \frac{\Theta_0}{\mu} = \frac{1.21 \times 10^{11}}{\mu} \text{ degree.}$$

The equation of state is unchanged, but the specific heat goes to zero for $T \rightarrow \infty$.

The application of the new principle to the structure of nuclei leads to interesting results. A nucleus of mass number A is considered as the densest packing of A particles of mass number 1 (protons, neutrons). Then the radius R of the nucleus is connected with the electronic radius r_0 by

$$R = r_0 \sqrt[3]{\frac{A}{2}} = 2.02 \times 10^{-13} \sqrt[3]{A} \text{ cm.,}$$

in excellent agreement with Bethe's⁴ estimate (2.05×10^{-13}). The mean kinetic energy $\bar{\epsilon}$ per nuclear particle (proton or neutron) and the maximum energy ϵ_0 are given by

$$\epsilon_0 = \frac{4}{3} \bar{\epsilon} = 10.4 \text{ M.e.v.}$$

The application of the Fermi distribution law together with Bethe's empirical value for the radius leads to $\epsilon_0 = 10 \text{ M.e.v.}$

These confirmations show that we have to do with more than a mere formalism. Though we are at present far from having a consistent theory, the new principle provides an attractive programme of investigation.

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¹ Eddington, A. S., "Relativity theory of Protons and Electrons". (Camb. Univ. Press, 1936.)

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⁴ Bethe, H. A., "Nuclear Physics". *Rev. Mod. Phys.* Part A (with R. F. Bacher), **8**, 82; Part B, **9**, 71; Part C (with M. S. Livingston), **9**, 245. See especially Part B, formula (598), p. 166.

Wilson Chamber Photograph of the Neutro-Electric Effect

AMONG the possible interpretations of the neutro-electric effect, recently discovered by Kikuchi, Aoki and Husimi¹, the disintegration of the neutron into an electron and a proton must be discarded, since Gilbert, Smith and Fremlin² could find no corresponding track in the Wilson chamber. (Their estimation that about thirty proton-electron pairs should appear per expansion is no doubt too large; but our present result is also in contradiction to the view of disintegration.) The most reasonable explanation would be to assume the expulsion of the orbital electron or the electron in a negative state due to some still unknown interaction between the electron and heavy particles. In this process, as the neutron loses its energy, the atom with which collision has occurred should gain the corresponding

momentum. Therefore, the electron track starting in the Wilson chamber should always be accompanied by a track of a heavy particle.

We searched for such kind of tracks in a Wilson chamber placed near the D-D neutron source filled with methane mixed with alcohol vapour. According to our previous result, the cross-section of the proton for the process is $0.6 \times 10^{-26} \text{ cm.}^2$. Assuming the cross-section for the elastic scattering to be $2.0 \times 10^{-24} \text{ cm.}^2$, 1 in 300 recoil proton tracks should appear in pair with an electron track. From the atomic concentration of the carbon atoms in the chamber and the known cross-section, the ratio of the number of carbon-electron pairs to that of single proton tracks in the same photographs should be about 1 in 200.

WILSON CHAMBER PHOTOGRAPH OF THE NEUTRO-ELECTRIC EFFECT. THE NEUTRON TRAVELS UPWARDS.

We examined about 900 pairs of photographs and obtained 3,060 proton tracks starting from the illuminated portion of the chamber. Of these, six appeared with the electron track. The accompanying illustration shows one of the photographs obtained. The number of the tracks which should be attributed to the carbon-electron pair was 12. These figures are in good agreement with our expectation. For various reasons it is impossible to consider that all the pairs we have observed are due to accidental coincidence of two independent tracks.

There now seems to be no doubt about the reality of the new effect. Its importance in connexion with the theory of the elementary particles can scarcely be over-estimated.

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² *NATURE*, **139**, 796 (1937).

A Non-radiating Motion of a Spinning Electron

MATHISSON¹ recently deduced the equations of motion of a spinning electron from the General Theory of Relativity. According to those equations such a particle, when free, instead of following a geodesic, performs some sort of screw motion around it. In the special case when the 'gravitational background' is the space time of the Special Theory of Relativity and the velocity is small compared to the velocity of light, this movement consists of a uniform translation in any direction and a uniform circular motion in a plane perpendicular to the angular momentum J of the particle, the frequency ν being proportional to J . The radius remains indeterminate. Assuming $J = \hbar/4\pi$ we get $\nu = 2m_0c^2/\hbar$.