Possible Origin of the *X* Particle

Anderson, Neddermeyer, Street and Stevenson have recently reported evidence for the existence of an X particle of mass between the proton and the electron. In 1925 Bothe[1] considered the possibility of the Compton effect taking place in two stages. In the first stage the photon was absorbed by the electron and then later emitted in a direction different from the original direction. In both stages energy and momentum were conserved. The conservation principles required that at the end of the first stage the rest mass of the electron must be greater than its normal rest mass.

Taking a hint from the first stage of Bothe's process we consider the following process: A particle of rest mass m_1, traveling with velocity $\beta_1 c$ is struck by a photon $h\nu_1$. Part of the photon is absorbed so that the rest mass of the particle is changed to m_2 and its velocity to $\beta_2 c$ and a photon $h\nu_2$ is left over. For simplicity we suppose the photons $h\nu_1$ and $h\nu_2$ and the particle before and after the collision to be traveling in the same direction. Conservation of energy gives

$$h\nu_1+m_1c^2/(1-\beta_1{}^2)^{\frac{1}{2}}=h\nu_2+m_2c^2/(1-\beta_2{}^2)^{\frac{1}{2}} \quad (1)$$

and conservation of momentum gives

$$h\nu_1/c+m_1\beta_1c/(1-\beta_1{}^2)^{\frac{1}{2}}=h\nu_2/c+m_2\beta_2c/(1-\beta_2{}^2)^{\frac{1}{2}}. \quad (2)$$

We introduce $\alpha_1=h\nu_1/m_0c^2$, $\alpha_2=h\nu_2/m_0c^2$, $p_1=m_1/m_0$ and $p_2=m_2/m_0$, where m_0 is the rest mass of the ordinary electron. From (1) and (2) we obtain

$$p_1[(1-\beta_1)/(1+\beta_1)]^{\frac{1}{2}}=p_2[(1-\beta_2)/(1+\beta_2)]^{\frac{1}{2}}. \quad (3)$$

This relation means that the process we have supposed cannot occur unless there is a change of rest mass of the particle.

For brevity and simplicity we shall assume that an ordinary electron at rest partially absorbs the photon so that $p_1=1$ and $\beta_1=0$. We then obtain

$$p_2=[1+2(\alpha_1-\alpha_2)]^{\frac{1}{2}} \text{ and } \beta_2=(\alpha_1-\alpha_2)/(1+\alpha_1-\alpha_2). \quad (4)$$

When Street and Stevenson's recent value[2] of 130 for p_2 is put into (4), we obtain $\alpha_1-\alpha_2=8450$ and $\beta_2=1-1.18\times10^{-4}$. The loss of energy of the original photon was 4306 Mev. A photon with at least this energy was necessary to produce Street and Stevenson's particle from an ordinary electron at rest. On absorbing an energy of 4306 Mev from the photon the particle had a kinetic energy of 4240.5 Mev and a mass energy of 66 Mev. The mass energy of the original electron was 0.5 Mev. The kinetic energy of the particle was gradually lost by ionization along the path through the counter tubes, lead filter and intermediate air in the experiment. By the time the particle had reached the cloud chamber it had a kinetic energy of about 6 Mev and had preserved its rest mass of 130 m_0. It is conceivable that the particle may lose mass energy while producing ions. Also it may lose mass by emitting radiation. In this case the process of (1) and (2) is reversed. On this theory there is no special reason why the particle should have the mass 130 m_0 since the mass of the particle depends upon the energy of the original photon.

It has probably occurred to various physicists that Street and Stevenson's value of 130 for p_2 is not far from Eddington's mysterious 137. One is tempted to postulate that after the absorption of energy from the photon the particle which was originally an ordinary electron at rest develops a fixed mass of 137 m_0. Then, in virtue of (3), β_2 and the total energy of the particle is also fixed. A photon with energy of at least 4790 Mev is necessary.

G. E. M. Jauncey

Wayman Crow Hall of Physics,
Washington University,
St. Louis, Missouri,
December 1, 1937.

[1] Bothe, Zeits. f. Physik **34**, 819 (1925).
[2] Street and Stevenson, Phys. Rev. **52**, 1004 (1937).

The Band Spectrum of Antimony Chloride

The band spectrum attributed to the molecule SbCl, in the region λλ4200–5600, has been excited by means of active nitrogen. The spectrum consists of two (sub) systems of bands (designated A_1 and A_2) degraded toward the red end of the spectrum. The wave numbers of the heads of 28 bands are tentatively represented by the formulas:

$$A_1:\ \nu_1=19{,}146.1+367.7u'-2.61u'^2-483.3u''+1.43u''^2,$$
$$A_2:\ \nu_2=21{,}896.6+364.2u'-2.19u'^2-492.7u''+4.46u''^2.$$

The electronic separation, $\delta\nu_e$, the system origin, ν_e, and the vibrational coefficients, ω_e and $\chi_e\omega_e$, for these two systems are compared with the corresponding values for the band systems of other monohalides of group $V(b)$ elements. With increasing number of electrons and mass of a molecule the expected trend is observed; namely, a decrease in the values of ν_e, ω_e, and $\chi_e\omega_e$, and an increase in the value of $\delta\nu_e$.

I. Hudes

New York University,
Washington Square College,
New York, N. Y.,
November 29, 1937.

On Supraconductivity

In answer to a letter[1] by Wick about the diamagnetism of supraconductive bodies, F. London tries to show that the parallelism, claimed by Wick to exist between a metal which can be supraconductive and the system liquid gas (as described according to van der Waals) is misleading.[2] In his argument he points out that on the basis of Wick's suggestion above the transition line the neighborhood of the other (supraconductive) phase ought to make itself perceptible, as in the case of a nearly saturated vapor.

When, some time ago, I elaborated Langevin's old viewpoint of the existence of a separate supraconductive phase,[3] I had in mind experimental evidence suggesting an intimate connection between the two phases. For simplicity of argument I did not then stress this evidence. But as the matter is being discussed again, it might be useful to point out that measurements on thermoelectricity as well as on heat conductivity seem to indicate supraconductivity several degrees above the transition line.

When the temperature is lowered the thermoelectric force per degree decreases approximately linearly to the