A MOMENTUM ANALYSIS OF PROTON AND ELECTRON MASSES

E A. SMITH and J. A. VOGELMANN, Secaucus, New Jersey

The asymmetry in the masses of the electron and the proton is one of the most provoking in the sphere of physical science. It is not necessary to treat in detail in this case the process of the union of an electron and proton to form radiation. We are at present only taking into account the whole mass concerned and whereever it may be distributed.

The new quantum theory in its present development indicates that relations exist between certain physical quantities which have previously been observed as independent. This has certain physical aspects which have led us to weigh these relations and as an example we mention Eddington's attempt to express the fundamental charge e in terms of h and c. We will now consider another relation.

Recently[1] the world line of an electron was assumed as composed of fundamental units of length of magnitude h/m_0c where m_0 is the electronic mass similarly the world line of the proton is made up of units of length h/M_0c and that is the study of these fundamental masses no shorter length associated with their world line will ever be revealed.

The most convenient expression of this theory is by consideration of a principle of the least proper time which shows in association with the electron or proton no proper time less than h/m_0c^2 or (h/M_0c^2) will be observed. This appears different from the Bohr-Heisenberg uncertainty principle which admits that the position of an electron can be determined as accurately as possible but the momentum can be estimated to an order given by the equation $\triangle q \triangle p \sim h$ where $\triangle q$ denotes the error in the determination of the position, and $\triangle p$ that in momentum. It is understood that in atomic dimensions the general application of the principle leads to no opposition to the uncertainty principle.

Recently Furth[2] arrived at the principle by using the uncertainty relation and modifying it on a basis of conjecture that the electron cannot be located exactly as desired. By following despotic assumptions he arrived at a value of the ratio M_0/m_0. It is the determination of this ratio that we make the subject of this paper and our effort shall be to approach it in view of the principle of proper time.

According to Furth the value h/m_0c is assumed to be the radius of the electron, but as the estimated figure is 2,000 times the accepted value, he is inclined to believe that the principle can be applied to the neutral masses. There is no reason to consider h/m_0c as the fixed electronic radius nor to limit it to neutral masses. The established principle of minimum proper time, however, shows that it appears true for charged or uncharged masses and there is no possibility that the fundamental length signifies more than a length along the world line. Under the circumstances Dr. Furth's results are nevertheless very interesting and furthermore we can easily remove his hypothesis.

For example let τ_0 be the minimum proper time h/m_0c^2. Now if it were possible for the mass m_0 to be converted into radiation we could estimate the frequency of that radiation by the equation $m_0c^2 = h\nu_0$ and if the proper time is

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not less than τ_0 the radiation from this conversion of matter will have V_c as maximum frequency. The proper time of course is the standard time in the system in which the electron is at rest, so that the frequency is capable of being mathematically estimated in the system.

It may not be possible to consider this transformation in the case of one electron, alone, since this would require the diminishing of the charge, but it may be assumed to occur in the case of an electron and a proton. We can consider the two bodies as a single one of mass (M_0-m_0). The new quantum theory shows that it is necessary to consider phenomena possessing a double sided character. One side being that in which we mention particles and in the other we mention waves. So that we can consider the phenomena as that of a particle of mass (M_0-m_0) and that of radiation of a certain wave-length. The principle of minimum proper time applied to this combination of electron and proton shows that the maximum frequency is V_0 where, $V_0=(M_0+m_0)c^2/h$ or minimum wave-length is λ_0 where $\lambda_0=h/(M_0+m_0)c$. Now the wave-length unit in radiation corresponds to the unit along the world line of the particle. If we ascertain what this unit could correspond to in the case just considered the supposition once arises that it must correspond to the distance between the centers of the electron and proton. Our method approaching this relative point is different from that of which Furth describes whereby this suggestion is due to him. In the theories of past decades the value of the radius of the electron $r_0=ke^2/m_0c^2$ and for the proton $R_0=ke^2/M_0c^2$. The value of k depends mostly upon the distribution of the charge where $k=\frac{1}{2}$ and $k=\frac{2}{3}$ as given in the classical theory. If the charge is taken in the light of the new quantum theory it immediately becomes very difficult to consider any electron or proton as a sharply defined structure, therefore, we can only mention a radius as an equivalent radius. This of course Furth mentions with an arbitrary selection of equivalent radius where he finds $k={}^{15}/_{13}$. Fortunately we can still speak of a distance between the centers of the two bodies and show for its value $d_0=k\dfrac{e^2}{c^2}\left(\dfrac{I}{m_0}+\dfrac{I}{M_0}\right)$ as the dimensions of the charges are proportional to $e^2/c^2\times$mass. Then we have $\left(\dfrac{h}{M_0+m_0}\right)c = \dfrac{ke^2}{c^2}\left(\dfrac{I}{m_0}+\dfrac{I}{M_0}\right)$ or

$\mu=M_0/m_0$ $\qquad$ $\mu+(I/\mu)+2=hc/ke^2$. The appearance of hc/e^2 is important.

In Eddington's calculation of e, the determination of the number of chemical elements by the application of the principle proper time we observe that it is a pure number having no dimensions.

From the foregoing we cannot proceed further to examine whether the equation discloses the experimental value for μ unless we know k accurately. Now if we follow the classical procedure and write $k=\frac{2}{3}$ or $\frac{1}{4}$, μ is taken of the right order but the value is extremely small. The result appears interesting for we have an equation in μ which reduces the quantity of fundamental constants by one and the failure to obtain the true value is explained by k. By accepting Furth's supposition the equivalent radius must be estimated on a basis that it is the radius of the sphere within which all the charge must be enclosed so that it produces the same moment as the charge in the actual distribution believed in the new quantum theory, where $k = {}^{15}/_{32}$ and the value obtained for μ (1838.2) is then in complete agreement with the experimental value (1838.3).

We know that one of the most peculiar problems in atomic physical science is the asymmetry with reference to mass in the case of electron and proton. As a matter of opinion among physicists a question arises as to the reason that the positive charge is associated with a mass extremely different from that associated with the negative charge. Theoretically the assumption of asymmetry appears very interesting to study. In attacking one side of the five-dimensional hypothesis we find a constant a which has the value $\pm e/m_0c$. This theory seems to account for the occurrence of positive and negative charges, yet there is no way of suggesting that m_0 has more than one value. It would nevertheless be a major procedure in physics if we could possibly relate m_0 and M_0 in order to consider further attempts in this direction similar to that described above.

Let us consider the problem from another view point, though the asymmetry is replaced by another and this change may offer a better point to study the subject by a special kind of metric preferred in nature. In this procedure we shall follow the method adopted by Doctors Weyl and Eddington in their inclusion of electromagnetism and gravitation into a space-metric system. Our view in attacking this method is that it is not in electromagnetic phenomena that the metric is found but really in the quantum phenomena. However, if we assume that there is only one standard of measurement for the proton and another for the electron, we can readily perform without the introduction of a second mass, and retain one mass for both electron and proton. By doing this we introduce two scales of measurement and so unalter the number of constants. Evidently physicists prefer to introduce different masses directly instead of different scales, yet there is more in the change than this, because the metrical method has other advantages. The best method to adopt can be decided when we discover which is the most nearest to accuracy. It appears certain according to Einstein's theory of relativity that the space near a proton must be much more strongly curved than that near an electron and the metric of space may also be notably different in the two cases.

The particular point may be clearly explained by a study of the world lines of the proton and electron. These may be accepted as made of the elements of lengths h/M_0c and h/m_0c. We are basing this on two scales, one more finely divided than the other. From our conclusion the view point under consideration is that this difference in magnitude is merely apparent. The length h/M_0c in the proton space appears to be equivalent physically to h/m_0c in the electron space. This then resembles a sort of compressed state of space in the proton relatively to that in the electron. The reason for the equivalence of these two lengths is that in a parallel displacement in the region of the proton from one end of the element h/M_0c to the other we have the same change in length per unit length as in the electron space from one end of the element h/m_0c to the other.

If we render decision on the phenomena concerning electrons and protons from the same point of view and apply the same metrical considerations to each, we observe that a proton moves more slowly than an electron under similar conditions, and thereby estimate its acceleration at too low a value and at the same time attribute it to higher inertia. We therefore should consider the unit in the proton space not as of length h/M_0c but as h/m_0c because the unit of length signifies physically so much more in that space. While the constant a is $\pm e/m_0c$, with the change of sign we must change the metric. Another point is, if this view or method be correct, the proton space is a miniature of the electron space. We would very likely anticipate the radii of the two bodies to appear in the ratio of the units of the scales, that is inversely as their masses. From the foregoing it has been pointed out what is assumed about these bodies, for we have,

$$r_0 = k\frac{e^2}{m_0c^2} \text{ and } R_0 = k\frac{e^2}{M_0^2}.$$

The above is offered as a suggestion of a new method in looking at one of the problems confronting us at present in our daily routines.

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