A Theory of Neutron Lifetime.

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In an earlier letter (1) presenting a derivation of the fine-structure constant it was suggested that space may have properties associated with a characteristic cubic-cell volume of lattice dimension $d = 72\pi e^2/m_e c^2$, a characteristic frequency $\nu = m_e c^2/h$ and a characteristic threshold energy quantum (here denoted $Tm_e c^2$) which analysis gave as the combined energy of 1843 electrons. This led to a value of α^{-1} of

$$108\pi(8/1843)^{\frac{1}{6}} = 137.035915\,. \tag{1}$$

Above, e is the electron charge, m_e the electron mass, c the speed of light *in vacuo* and h is Planck's constant. α is the fine-structure constant $2\pi e^2/hc$.

The theory also indicated that space may well be populated by energy quanta, equivalent to having a muon pair in each cell. In 1975 this model, based on a theoretical evaluation of this double-muon energy quantum, was applied to the exact derivation of the proton/electron mass ratio (2). Recently, in 1980, by regarding these muon energy quanta as a pair of point charges migrating within a cell at random at the frequency ν, the model has found further application in explaining and evaluating the muon lifetime, also in very good accord with observation (3).

In this letter it is shown how these basic ideas may also have relevance to the decay processes of the neutron.

We regard the neutron as having two quarklike constituents, of charges $-e$ and $+e$, respectively. The negative charge is deemed to be an electron and the positive-charge component, denoted N^+, is taken to contain the residue of the neutron energy, denoted $Nm_e c^2$, where N is of the order of 1838.

Our object is simply to determine the probability that the migrant point charge muon pair will come close enough to these neutron constituents to satisfy the following two conditions simultaneously. Let μ denote the muon energy in terms of electron mass energy units and μ^+, μ^- denote the positive and negative members of the muon pair, respectively.

Then firstly, μ^+ must be close enough to the electron to create an unstable situation. As we may see from ref. (2), the electron has, according to the Thomson formula, a

(1) H. Aspden and D. M. Eagles: *Phys. Lett. A*, **41**, 423 (1972).
(2) H. Aspden and D. M. Eagles: *Nuovo Cimento A*, **30**, 235 (1975).
(3) H. Aspden: *Physics Unified* (Southampton, 1980), p. 146.

radius given by $\frac{2}{3}e^2/m_e c^2$ and we can suppose that the charge μ^+ will, on entering the spherical volume associated with the electron charge, put the electron in a state conducive to escape from the neutron complex and therefore conducive to decay.

Secondly, simultaneously with the above condition, μ^- must come close enough to N^+, with total energy conserved, to trigger an increase of the energy of μ^- to the threshold level $Tm_e c^2$. Thus, at a separation distance x, we have

$$(\mu + N)m_e c^2 = (T + N)m_e c^2 - e^2/x \,. \tag{2}$$

Here the negative Coulomb interaction energy component has been deployed to augment the energy of point charge. Alternatively, we could consider the situation where both the point charge and N^+ are driven to the threshold limit

$$(\mu + N)m_e c^2 = (T + T)m_e c^2 - e^2/y \,, \tag{3}$$

where y is the critical separation distance.

To find the neutron lifetime, we now calculate the frequency at which these two conditions are met simultaneously, bearing in mind that μ^- and μ^+ occupy new random positions within a cell of volume d^3, ν times per second. Evidently, the lifetime τ of the neutron for condition (2) is

$$\tau = \frac{1}{\nu}\left(\frac{3d^3}{4\pi x^3}\right)\left(\frac{3d^3}{4\pi z^3}\right), \tag{4}$$

where z is the electron radius $\frac{2}{3}e^2/m_e c^2$. From (2) x is $e^2/(T-\mu)m_e c^2$. Also, $d = 72\pi e^2/m_e c^2$ and $\nu = m_e c^2/h$. Thus τ becomes

$$\tau = (9/16\pi^2)(1.5)^3(72\pi)^6(T-\mu)^3 h/m_e c^2 \,. \tag{5}$$

Upon evaluation ν^{-1} is $8.09\cdot 10^{-21}$ s and we have seen that T is 1843. μ is 207. These data give

$$\tau = 913 \text{ s} \,. \tag{6}$$

Had we used alternative condition (3), then the $T-\mu$ term in (5) would be replaced by $2T-N-\mu$, with N as 1838. This gives a value

$$\tau = 921 \text{ s} \,. \tag{7}$$

These alternative values compare with the observed neutron lifetime of (918 ± 14) s.

Further research is now needed in order to develop this approach to neutron decay. We need, for example, to explain why, in (2), it is the muon point charge energy that adjusts with the interaction to the exclusion of N^+, or why, in (3), its the muon point charge energy that adjusts first to the T threshold before N^+ also adjusts to this same threshold. In choosing between (2) and (3) we must favour (3) because it is N^+ that is to decay into a proton and this is more likely to occur if N^+ is excited beyond a critical threshold. Also, there is need for more understanding of the process governing the other condition and the electron role in decay. These are matters which can perhaps be explored with some confidence in the light of the very close theoretical values of neutron decay time available from the technique presented.