charge at the position of the proton. The total charge is zero (omitting the charge $+e$ of the proton). The charge contained in any small volume is finite but may be negative or larger than 1. Lamb's argument now runs as follows: Since the proton is capable of emitting only *one* positive meson at a time the charge contained in any volume of space must always be positive and smaller than 1.

This, however, appears to be quite false in a field theory describing Bose-Einstein particles. It is well known that in such a theory the *charge density is not positive definite.* This may even be the case if we have in *momentum space* a single free positive meson. Let its wave function be

$$\psi=\sum_i c_i\varphi_i, \qquad \sum_i |c_i|^2=1,$$

where $\varphi_i(\cdots n_j^+\cdots n_j^-\cdots)$ depends on the number of positive and negative mesons with wave numbers k_j. Let $\varphi_i=1$ if $n_i^+=1$ and all other $n=0$, and $\varphi_i=0$ for all other states. From the formulae of Pauli and Weisskopf the expectation value of the charge density at the point $\mathbf{r}$ becomes (ϵ_i = energy in state k_i)

$$\bar{\rho}=\frac{e}{V}\left[1+\frac{1}{2}\sum_{i\neq j}\left(\left(\frac{\epsilon_i}{\epsilon_j}\right)^{\frac{1}{2}}+\left(\frac{\epsilon_j}{\epsilon_i}\right)^{\frac{1}{2}}\right)c_ic_j^*\exp\left(i(\mathbf{k}_i-\mathbf{k}_j,\mathbf{r})\right)\right]. \qquad (3)$$

(V = volume in ordinary space.) The total charge is $+e$. Yet $\bar{\rho}$ is negative in some points if at least one ϵ_i is large compared with another ϵ_j. The regions of volume in which this is the case are always smaller than $h/\mu c$. Thus there are small regions of volume in which the charge is negative or larger than 1. The result is connected with pair creation taking place if one tries to localize the meson in a volume smaller than $h/\mu c$. It is clear that in such a small volume the position of the meson (and therefore the "dissociation time") has no longer any physical meaning.

Since even for a free positive meson the charge density may be negative in some points there is certainly *no legitimate reason for expecting that the charge density surrounding a proton according to the meson theory should not be negative in some points.*

It is true that for our result kinetic meson energies higher than μc^2 are required. It is doubtful whether the present meson theory can still be applied in this region. This was clearly emphasized in our paper. The fact, however, that some quantities diverge if kinetic energies $>\mu c^2$ are used is, in our opinion, not sufficient to postulate that the same "cutting off" rule should be applied for convergent effects. The purpose of our paper was to find convergent effects by which the limits of the theory can be checked experimentally.

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Coincidences Between Beta- and Gamma-Rays in Na^{24}

Using a method previously described,[1] we have investigated the coincidences between beta- and gamma-rays in Na^{24}.

The beta-ray spectrum of Na^{24} has been studied by several investigators, the most recent of which are Feather and Dunworth;[2] Kikuchi, Watase, Itoh, Takeda and Yamaguchi;[3] and Lawson.[4] Feather and Dunworth, measuring the range of the beta-particles in aluminum, concluded that the end point was 1.40±0.05 Mev and that the spectrum was simple. Both Lawson and the Japanese investigators used a beta-ray spectrograph for analysis. The former, using very thin sources, concluded that the spectrum was simple and that the end point was at 1.40 Mev. The Japanese investigators, on the other hand, believe the spectrum to be complex and analyzable into three groups.

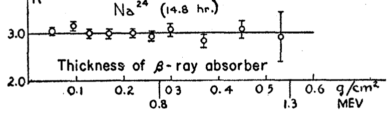

FIG. 1. Ratio R of beta-gamma coincidences to beta-rays recorded ($\times 10^3$) as a function of the beta-ray energy.

The gamma-radiation has been found to consist of three lines at 1.01, 2.04 and 3.00 Mev by Richardson and Kurie,[5] and Richardson.[6] On the other hand, the Japanese investigators suggest that there are gamma-rays of 2.97, 1.55, 0.8 Mev and possibly some of still lower energy.

In the present investigation, preliminary experiments were performed with a source of sodium fluoride bombarded by neutrons from a radium-beryllium neutron source but final results were obtained with the help of a strongly activated source of Na^{24} from the Berkeley cyclotron. The end point of the beta-ray spectrum was obtained by measuring the range in aluminum. The results give an end point of 1.43±0.05 Mev.

To measure beta-gamma and gamma-gamma coincidences, the source was mounted midway between two counters. Aluminum of 0.60 cm thickness, sufficient to stop completely all beta-particles, was placed between the source and one of the counters. Between the source and the other counter there was placed either 0.6 cm of aluminum for measuring gamma-gamma coincidences, or smaller thicknesses of aluminum for measuring beta-gamma coincidences as a function of the energy of the beta-rays. The resolving time of the coincidence circuit was 0.56×10^{-7} min.

The number of gamma-gamma coincidences per thousand gamma-ray counts was found to be 1.72±0.05. The beta-gamma coincidences were measured as a function of the energy and are shown in Fig. 1. As ordinate is plotted the number of beta-gamma coincidences per thousand beta-counts (the appropriate number of gamma-gamma coincidences subtracted) against the thickness of the beta-absorber, and therefore as a function of the beta-ray energy. It will be seen from the graph, that the number of beta-gamma coincidences per thousand beta-rays remains constant at 3.0 throughout the whole range of the spectrum. This means that *the beta-ray spectrum of* Na^{24} *consists of a* *single group*. Furthermore, it follows at once from the data that Mg^{24} is formed in an excited state.

The existence of gamma-gamma coincidences means that in at least some cases there are two or more gamma-rays emitted per disintegration in dropping from the excited state of Mg^{24} to the ground state. If one assumes that the sensitivities of the counter to the different gamma-rays emitted by the source is not very different from an average sensitivity S_γ, one may get an estimate of K, the average number of gamma-rays per disintegration. We have, from the beta-gamma coincidences data,

$$N_{\beta\gamma}/N_\beta S_\beta = S_\gamma K = 3.0\times 10^{-3}, \tag{1}$$

where $N_{\beta\gamma}$ is the beta-gamma coincidence rate, $N_\beta S_\beta$ the number of beta-rays recorded.

From the gamma-gamma coincidence data we have[7]

$$N_{\gamma\gamma}/N_\gamma S_\gamma = (K-1)S_\gamma = 1.72\times 10^{-3}. \tag{2}$$

Therefore,

$$K = 2.36.$$

The level scheme proposed by Richardson and Kurie permits the transition to the ground level to take place either in one jump by a 3-Mev gamma-ray or in two steps of 2 Mev and 1 Mev. This should result in an average value of K less than 2. The scheme of Feather and Dunworth, on the other hand, calls for a 1-Mev gamma-ray followed by one of 3 Mev or alternatively a 2-Mev gamma-ray followed by another of 2 Mev. This should give $K = 2$. Our value of $K = 2.36$ suggests that in some cases the transition to the ground level may take place in even more than two steps.

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The Use of Radioactive Forms of the Common Elements in Physiology

The use of radioactive forms of the elements as "tracers" for studying cell-wall permeability and metabolic processes is becoming increasingly common in physiology. For example, Cohn and Cohn,[1] using radioactive sodium, have recently reported that this form of the element readily traverses the wall of the red blood cell. They conclude, therefore, that ordinary nonradioactive sodium, contrary to what had generally been thought, passes as readily through the red cell membrane.

Since the red cell is known to have a charged surface[2] composed of a polar lipoidal substance probably of monomolecular thickness,[3] it is fair to raise the question as to whether (1) the charge on the limiting membrane of a red blood cell and (2) the polar properties of the lipoid molecules of which it is composed, might not be modified by the radiations (electrons and gamma-rays) emanating from the radioactive ion being studied. One would not expect electrically asymmetrical polar molecules in a monolayer to remain indifferent to bombardment by electrons and gamma-rays at short range and any change in the polar properties of the membrane would, according to Wilbrandt,[4] alter its permeability. Fricke[5] has shown that beta- and gamma-rays are capable of denaturing proteins. Radioactive sodium, once it has traversed the cell membrane, might, therefore, also denature the proteins in the vicinity of the cell surface and grossly modify surface conditions. Since the cell membrane is assumed to have a thickness of the order of one molecule, the radioactive sodium might even modify intracellular proteins while outside the cell, its radiations traversing the cell wall before the ion itself has penetrated. Any conclusions as to the permeability of the walls of a red cell for radioactive sodium ion cannot, therefore, be properly extended to embrace the behavior of the nonradioactive forms of the same element, until or unless it is first shown that the radioactivity is without effect on the membrane and on the proteins with which the latter is in contact.

The question raised here is, of course, broader than the illustrative case given. It applies to the general body of work now currently appearing in many journals and involving the use of radioactive forms of the common elements as tracers. Until it is answered, it will be fair to doubt the validity of conclusions drawn as to the corresponding behavior of nonradioactive forms of the same elements.

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The Nature of Visual Observations at Low Light Intensities

We were led to conclude from visual observations that the minima reported by Allison in his magneto-optic method were reproducible. Our conclusions[1] are certainly wrong as we have not been able by any purely objective method to check these results. In order to clear up the record we wish to make this retraction.

There have been so many cases of erroneous deduction resulting from visual observations at very low light in-