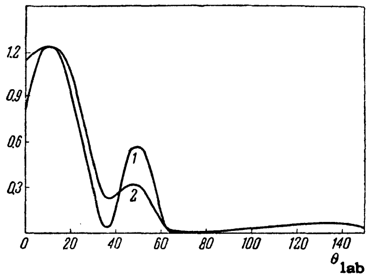

FIG. 1

Be^8 from 0.5 to 2 Mev. The calculated curves of the angular distribution k_{2n} for $\rho = 1 \times 10^{-13}$ cm (curve 1) and $\rho = 2.8 \times 10^{-13}$ cm (curve 2) are shown in Fig. 1. The histogram of the angular distribution of the vector k_{2n} obtained experimentally by using nuclear emulsions,[7] where the reaction was identified by the particle tracks produced as a result of the decay of the Ne^8 nucleon, is shown in Fig. 2. The peak for small angles was not found in the experiment. This may possibly be explained by the fact that we probably omitted those stars, in which k_{2n} is directed forward with respect to the direction of the incident neutrons and the kinetic energy of the Be^8 nucleus is smaller than 1 Mev, i.e., when the tracks of α particles produced in the decay of Be^8 are difficult to observe in the emulsion. If one constructs the theoretical curve of the angular distribution of the vector k_{2n} for the variation of the kinetical energy of Be^8 in the range 1 to 2 Mev, then the peak for small angles disappears (see Fig. 2, solid curve) and an approximate agreement between the experimental histogram and the calculated curve can be seen (curve for $\rho_0 = 2.8 \times 10^{-13}$ cm).

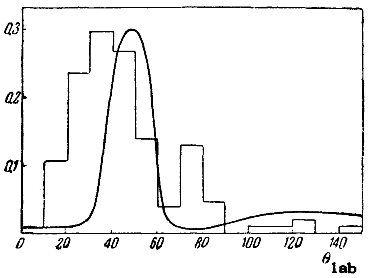

FIG. 2

Numerical calculations of the angular distribution of an event in which a bound bi-neutron is emitted yield the usual Butler-type curve with a sharp maximum at 0°, and with first minimum at 30°. Evidently, this curve cannot be compared with the histogram since, as has been shown above, it is difficult to observe in the emulsion events with emission of two neutrons in the forward direction.

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ON THE INFLUENCE OF THE ISOBARIC STATE OF A NUCLEON ON THE ELECTRON-NEUTRON INTERACTION

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It is well known that the experimentally-found large value of the electromagnetic radius of the proton on one hand, and the very small depth of the well of the electrostatic electron-neutron interaction on the other, lead to considerable difficulties in interpretation of these data.

Since it would have been very undesirable to abandon the idea of charge independence of strong interactions, the assumption has been proposed that the usual electrodynamics ceases to be correct at distances of the order of 10^{-14} cm. It could then be understood why large electromagnetic dimensions are observed for a proton for a small depth of the well $V_0^{(S)}$ of the electrostatic e-n interaction without abandoning the charge independence of meson-nucleon interactions.

However, the theoretical explanation of the observed value of $V_0^{(S)}$ is, in itself, rather difficult. It is known that the relativistic pseudo-scalar theory in the lower order cannot give a reasonable value of $V_0^{(S)}$ from the constant of the N-π interaction. This result is obviously not unexpected since perturbation-theory calculations are simply not applicable in this region. In connection with the above, one has to bear in mind that in this order of perturbation theory one obtains a wrong value of the ratio of the magnetic moments of the neutron and the proton. It is true that the relativistic theory with cut-off[3] enables us to attain a certain improvement in the value of the ratio $\mu^{(n)}/\mu^{(p)}$, but in that case, $V_0^{(S)}(N\pi) = (f^2/4\pi)\,46.3$ kev, and for $f^2/4\pi = 0.08$ the depth of the well is found to be equal to 3.7 kev, which is even worse than the result obtained in the relativistic theory without cut-off.

The success of the semi-phenomenological isobaric theory[4-6] is well known. This theory describes sufficiently accurately a rather wide range of effects connected with meson-nucleon interactions. This can be explained by the fact that the isobaric theory is based on the certainly correct assumption of a very strong interaction of the meson-nucleon system in the state $T = J = 3/2$. It should be noted that with the isobaric theory one can obtain satisfactory values of the anomalous magnetic moments of the nucleons.[7] An attempt has been made[8,9] to take the influence of multimeson states on the electron-neutron interaction into account, and it was found that the effect is qualitatively favorable. The authors made an essentially similar attempt of a fuller explanation of the characteristic features of meson-nucleon interactions, and in particular of the resonance character of the interaction in the state with $T = J = 3/2$.

In view of the above, one can expect that, in calculations using a Hamiltonian containing a term corresponding to the excitation of the nucleon isobar with $T = J = 3/2$, one can reduce the present discrepancy between the observed and theoretical values of $V_0^{(S)}$.

To estimate the influence of isobaric states on the electro-magnetic radius of the nucleon, the triangular diagrams without fermionic pairs were considered, and the motion of the isobar was neglected in the operator of the spin projection. It was assumed that the nucleon and the isobar have opposite internal parities, i.e., the Hamiltonian describing the excitation of the isobaric state is given by the formula

$$H'_{I\pi} = (F/\mu)\,[\overline{\Psi}_\nu T_\alpha \psi \partial\varphi_\alpha/\partial x_\nu + \overline{\psi} T_\alpha^{+} \Psi_\nu \partial\varphi_\alpha/\partial x_\nu], \qquad (1)$$

where Ψ_ν is the spin vector corresponding to the particle with spin $3/2$, and the four-row matrices T_α take care of the isotopic invariance of the interaction.

As a result of the calculations of the above diagrams, one obtains the following expression for the mean-square electric radius of the nucleon, resulting from the presence of isobaric states:

$$\langle r^2\rangle_{I\pi}^{(N)} = (F^2/4\pi M_N^2)\,[0.8 - 12.2\tau_z], \qquad (2)$$

where the momenta of virtual particles are cut off at a value of the order of the nucleonic mass. The depth of the electrostatic e-n well is

$$V_0^{(s)}(I\pi) = -1.42 M_N^2 \langle r^2\rangle_{I\pi}^{(n)} \text{ kev}.$$

Comparing this with the result obtained in the usual pseudo-scalar theory with cut-off and putting $F^2/4\pi = 0.15$, we have for the resulting well depth

$$V_0^{(s)} \approx 1 \text{ kev},$$

which is much better than the former value. For the same selection of free parameters, one obviously cannot expect very good values of magnetic moments. Keeping in mind the approximate nature of the calculation, the numerical results given are only to be considered as qualitative.

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