than that of 1/A in the region of large A (A >> 2T').

The intersection of curves 1 and 4 in the figure would correspond not only to the possible existence of multineutrons in the mass-number region to the right of this intersection, but to the appearance of a second region of stability of atomic nuclei against prompt decay with emission of nucleons (of course, in the presence of radioactive decay). Owing to the rapid decrease of a(A) with increasing A, the replacement of neutrons by protons in this region would result in only a relatively small gain in the isospin component of the binding energy, or even a loss in this component if the sign of the differences of $\Delta_{T'+1,T'}$ is reversed. It follows therefore that even if the second region of the nuclear stability does exist, it cannot be adjacent to the presently known region in any case, and it can form only a larger or smaller "island" of superheavy isotopes of light elements.

It is also of interest to analyze the influence of any specified character of the decrease of the function $(1/A)\Delta_{TT'}(A)$ at large differences $(T - T') \approx A/2$ on the boundary of the hypothetical second region of nuclear stability and on the expected properties of the nuclei in this region.

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REMARKS ON UNIFIED GAUGE THEORIES OF WEAK AND ELECTROMAGNETIC INTERACTION1)

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Theories of weak and electromagnetic interactions with spontaneously violated gauge invariance have been extensively discussed of late [1 - 7]. In particular, Glashow and Georgi (G-G) [3] proposed a very interesting model without neutral currents and without anomalies connected with the axial current [8, 9].

We show in the present article that the G-G model is unequivocally refuted by the experimental data on $K_L \to 2\mu$ decay. In addition, we discuss a number of problems connected with the duplication of the experimentally observed SU(3) symmetry of strong interactions, which are common to the G-G model as well as to the models of [1, 4 - 6].

In the G-G model, in the most interesting case of decays with $\Delta S = 1$ and with an axial lepton current, only diagrams with exchange of two W bosons contribute to the amplitude (Figs. 1, 2). It turns out that by using current algebra we can calculate exactly the effective neutral-current interaction constant G_0 with strong interactions taken into account

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$$G_0 = \frac{G}{\sqrt{2}} \frac{3\alpha}{2\pi} \sin\theta \cos\theta. \tag{1}$$

Neglecting the fermion masses and the external momenta, we obtain for the amplitude of the $A \to B\ell^+\ell^-$ decay

$$T = g_W^2 e^2 \sin\theta \cos\theta \int \frac{d^4k}{(2\pi)^4} \frac{\epsilon_{\mu\nu\delta\sigma} k_\delta \bar{\ell}_2 \gamma_\sigma \gamma_5 \ell_1}{k^2(k^2 - m_W^2)^2} H_{\mu\nu}(k). \tag{2}$$

Here

$$H_{\mu\nu}(k) = i \int d^4x \, e^{ikx} < B | T \{ l^1_{2\mu}(x) l^3_{1\nu}(0) + l^5_{2\mu}(x) l^3_{5\nu}(0) \} | A > \tag{3}$$

$$l^i_{k\mu}(x) = \bar{q}_i(x) \gamma_\mu (1 + \gamma_5) q_k(x) \tag{4}$$

are the weak V - A currents ($q_1 = p$, $q_2 = n$, $q_3 = \lambda$, $q_4 = q^0$, $q_5 = q^-$) and θ is the Cabbibo angle. Allowance is made in (2) for the fact that the longitudinal parts of the W-boson Green's function make no contribution to the amplitude sought by us. This can be easily verified by recognizing that

$$\delta(x_0)[l^1_{2 0}(x), l^3_{1\nu}(0)] = \delta(x_0)[l^5_{2 0}(x), l^3_{5\nu}(0)], \tag{5}$$

$$\delta(x_0)[\partial_\mu l^1_{2\mu}(x), l^3_{1 0}(0)] = \delta(x_0)[\partial_\mu l^5_{2\mu}(x), l^3_{5 0}(0)]. \tag{6}$$

It is important in the derivation of (6) that in the G-G model the SU(5) × SU(5) symmetry of the strong interactions is broken only by an interaction belonging to the $(5, \bar{5}) + (\bar{5}, 5)$ representation of the SU(5) × SU(5) symmetry.

Using the Bjorken expansion [10], which we assume to be valid also for the spatial current components [11], and calculating the resultant equal-time weak-current commutator, we obtain for $|k^2| >> m^2$ (m is the characteristic hadron mass):

$$\epsilon_{\mu\nu\delta\sigma} H_{\mu\nu}(k) = i \frac{4k_\beta}{k^2} \epsilon_{\mu\nu\delta\sigma} \epsilon_{\mu\nu\alpha\beta} < B | l^3_{2\alpha}(0) | A > . \tag{7}$$

Substituting (7) in (2), we obtain the value (1) for G_0:

$$G_0 = -6 g_W^2 e^2 \sin\Theta \cos\Theta \int \frac{d^4k}{(2\pi)^4} \frac{i}{k^2(k^2 - m_W^2)^2} = \frac{G}{\sqrt{2}} \frac{3\alpha}{2\pi} \sin\Theta \cos\Theta. \tag{8}$$

In the integral of (8), only $|k^2| \sim m_W^2$ are significant, and this justifies the neglect of the external momenta and the fermion masses.

The value (1) for G_0 coincides with that calculated in [12] when strong quark interactions were neglected and only the single-particle p and q^- intermediate states were taken into account. There is a simple physical reason for this agreement in our case. In fact, according to [7], the behavior of $H_{\mu\nu}(k)$ at $|k^2| >> m^2$ is determined by the equal-time commutator of the weak currents, which have the same form in current algebra as for the free fields.

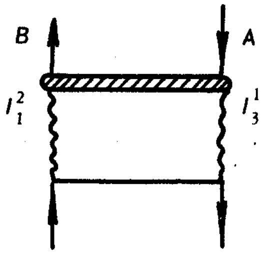

Fig. 1

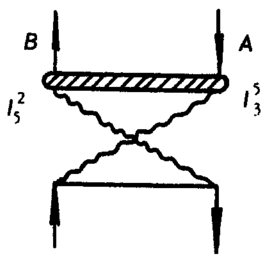

Fig. 2

For the $K_L \to 2\mu$ decay we have in accordance with (1) $\Gamma_L(2\mu) \approx 2.3 \times 10^{-4}\Gamma_L$, which differs greatly from the experimental $\Gamma_L(2\mu) \leq 1.8 \times 10^{-9}\Gamma_L$ [13]. Thus, the experimental data on the $K_L \to 2\mu$ decay unequivocally refute the G-G model.

It is easily seen that the result $G_0 \sim G\alpha$ is in fact general and pertains also to other models, where the well-known Glashow-Iliopoulos-Maiani procedure [14] for the compensation of transitions with $\Delta S = 1$ is not used, when $G_0 \sim G(G\Delta m^2)$ and can be made sufficiently small if the splitting of the squared quark masses Δm^2 is not too large.

We discuss now problems connected with the reproduction of the SU(3) symmetry of strong interactions in models of the G-G type, where quarks with whole-number charges are used [1, 4 - 6].

Thus, to construct the baryon octet in such schemes it is necessary to have, in addition to the Sakata quark triplet $t = (p, n, \lambda)$, also an SU(3) singlet quark q^0 with $S = -1$ and $Y = 0$ (see, e.g., [15, 16]). This definitely contradicts the mass ratio of the q^0 quark and the triplet t. In fact, since no quasistable [15, 16] triplet mesons tq_0 and q^0t were observed in experiment, the q^0 quark should be heavier than the triplet t, and the estimate $m_{q0} - m_t \geq 1$ GeV seems reasonable. On the other hand, it is precisely the states $\bar{t}tq^0$ and $\bar{t}\bar{t}ttq^0$, which contain the heavy q^0 quart, which yield a physic 1 $1/2^+$ octet and a $3/2^+$ decuplet, with the minimal baryon mass; this could occur in turn only if the q^0 quart, to the contrary, were lighter than the triplet ($m_t - m_{q0} \gtrsim 1$ GeV).

A more reliable argument, which is not only qualitative but also quantitative, against the discussed schemes is [14] the fact that no SU(3)-singlet component of the electromagnetic current has been observed experimentally. Thus, experiment confirms well a relation that follows from the octet character of the electromagnetic current [17]:

$$m_\rho \Gamma_\rho(e^+e^-) = 3(m_\omega \Gamma_\omega(e^+e^-) + m_\phi \Gamma_\phi(e^+e^-)). \tag{9}$$

Experiment agrees also, not only in sign, but also in the numerical values, with the relation for the magnetic moments of the baryons:

$$\mu_\Lambda = \frac{1}{2}\mu_n \quad (\mu_\Lambda = -0{,}73 \pm 0{,}06\,\mu_{\text{nuc}},\ \mu_n = -1{,}91\mu_{\text{nuc}}) \tag{10}$$

which is valid only if there is no singlet component of the electromagnetic current (see [15, 16]). The discrepancy on the order of 30% in (10) can be attributed to the fact that (10) can be violated already in first order in moderately strong interaction [15].

It would also be of great interest to analyze other electromagnetic phenomena in which an SU(3)-singlet component of the electromagnetic hadron current can appear. In particular, it would be interesting to verify experimentally the analogs of relation (9) for the decays A_2, f^0, $f^{0\prime} \to X^0(960)\gamma$:

$$\tilde{\Gamma}_{A_2}(X^\circ\gamma) = 3[\tilde{\Gamma}_{f^\circ}(X^\circ\gamma) + \tilde{\Gamma}_{f^{\circ\prime}}(X^\circ\gamma)], \tag{11}$$

where

$$\tilde{\Gamma}_i(X^\circ\gamma) = m_i^4 / q_\gamma^n \Gamma_i(X^\circ\gamma) \tag{12}$$

q_γ is the photon momentum in the corresponding decay and n is determined by the spin of X^0 (960): $n = 5$ for $I^P = 0^-$ and $n = 3$ for $I^P = 2^-$.

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ERRATUM

Article by Ya. Smorodinskii, "Muon Decay and Equivalence Principle, Vol. 16, No. 8, p. 356.

The assumption that the proper time is proportional to the action leads to a contradiction. The effect indicated in the article does not exist.