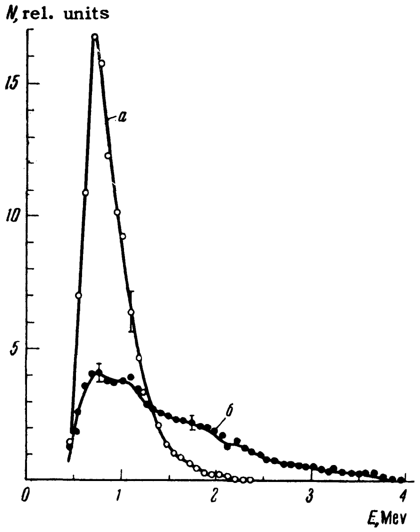

FIG. 2

This normalization takes account of the change in the registration efficiency of the radiation with a change in the distance between the target and the crystal. From a comparison of the spectra it can be seen that with the decreasing target-to-crystal distance the relative number of pulses corresponding to 1.5- to 4-Mev gamma quanta increases. It must be assumed that this is caused by the presence of cascades consisting of relatively soft gamma rays which, being simultaneously registered, simulate gamma quanta of higher energy. The mean number of simultaneously registered gamma quanta for $R = 0.2$ cm, found from the ratio of the areas under curves (a) and (b) (Fig. 2), is ~ 1.8.

To determine the mean number of gamma quanta in a cascade, it is essential to know not only the counting efficiency of the spectrometer, but also the angular distribution of the gamma quanta. At present, there are no data on the angular distribution of gamma quanta emitted by a compound nucleus with a large angular momentum, and therefore a sufficiently precise determination of this quantity is difficult. According to our rough estimates this number is apparently not less than 10.

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BETA DECAY OF P^{32}

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THE β transition in P^{32} appears to be an allowed $1^+ \rightarrow 0^+$ transition. Therefore the β spectrum of P^{32} must have a Fermi shape and a polarization equal to v/c. However experimental results[1-3] have indicated a small deviation from the Fermi shape for the spectrum and from the designated polarization value. The aim of the present paper is to offer a possible explanation of these experimental results.

Since $\log ft = 7.9$ for P^{32}, while for Gamow-Teller transitions $\log ft \sim 4$, this means that the matrix element $\int \boldsymbol{\sigma}$ in this case must be about 30 — 40 times smaller than its normal value. Therefore we must examine second-forbidden terms. The transition in question may have contributions from terms of the form $\int \boldsymbol{\sigma} \mathbf{r}^2$, $\int (\boldsymbol{\sigma}\mathbf{r})\mathbf{r}$, $\int [\boldsymbol{\alpha}\mathbf{r}]$ and $\int \gamma_5 \mathbf{r}$. The first two matrix elements are small in comparison to the last two. The matrix element $\int [\boldsymbol{\alpha}\mathbf{r}]$ introduces into the spectrum a term which is proportional to the β-electron energy, but since there is no such term experimentally observed in the P^{32} spectrum, we set this matrix element equal to zero. Therefore we shall consider further only the matrix element $\int \gamma_5 \mathbf{r}$.

Let us introduce the relation $x = \int \gamma_5 \mathbf{r} / \int \boldsymbol{\sigma}$. In β transitions having a normal value of $\log ft$ we have $x \sim (v/c)_{\text{nucl}}\, \rho_{\text{nucl}} / \lambda\!\!\!^{-}_{\text{Compton}} \sim 0.002$. (We use a system of units in which $\hbar = c = m_e = 1$.) Because of the smallness of $\int \boldsymbol{\sigma}$, the value of x for P^{32} must be about 30 — 40 times larger, i.e., $x \sim 0.06 - 0.08$. For these values of x it is necessary to take into account not only the terms proportional to x, but also terms of the order of x^2.

Assuming the correctness of the theory of weak interactions,[4,5] we obtain the following equations for the correction constant C and for the polarization $\langle\sigma\rangle$:

$$C = \left(1 - \tfrac{2}{3} qy + \tfrac{1}{3} q^2y^2\right)L_0 + 2\left(y - \tfrac{1}{3} qy^2\right)N_0 + y^2 (M_0 + 2L_1),$$
$$\langle\sigma\rangle = - D/C, \qquad (1)$$

whereupon D is obtained from C by substituting

$$L_0 \to L_0' = (L_0^2 - P_0^2) \sin(\delta_{-1} - \delta_1),$$
$$M_0 \to M_0' = (M_0^2 - Q_0^2) \sin(\delta_{-1} - \delta_1),$$
$$N_0 \to N_0' = \tfrac{1}{2} [(L_0 + P_0)^{1/2} (M_0 + Q_0)^{1/2} + (L_0 - P_0)^{1/2} (M_0 - Q_0)^{1/2}] \sin(\delta_{-1} - \delta_1),$$
$$L_1 \to L_1' = (L_1^2 - P_1^2)^{1/2} \sin(\delta_{-2} - \delta_2).$$

For determination of the functions L_0, M_0, N_0, etc. see references 6 and 7; δ_1, δ_{-1}, δ_2, δ_{-2} are Coulomb phases; q is the neutron momentum. If we use the relation $Ze^2 \ll 1$, and the explicit expressions for the functions L_0, M_0, . . . ,[6,8] we obtain the following simple equations for the β spectrum and for the longitudinal polarization of the β electrons in P^{32}:

$$C = 1 + a/\varepsilon, \qquad \langle\sigma\rangle = - v(1 - a/\varepsilon), \qquad (2)$$

where $a = \tfrac{2}{3} x [1 - (Ze^2/2\rho + \tfrac{2}{3}\epsilon_0) x]^{-1}$, ϵ_0 is the spectral end-point energy. In deriving Eq. (2) we neglected terms in x^2 if they were multipled by small quantities, i.e., a necessary condition for the validity of these equations is

$$x^2 \ll 1 - \left(Ze^2/2\rho + \tfrac{2}{3} \varepsilon_0\right) x.$$

Equations (1) and (2) convert into Morita's equation[9] if we drop the quadratic terms in x^2. For a value of $x = 0.08$ we obtain $a = 0.18$ which agrees with experimental data.[1-3] The deviation of the spectrum from a Fermi shape and of the polarization from v/c also occurs for In^{114} ($1^+ \to 0^+$ transition).[2,3] The formally required value $a \sim 0.3$ is obtained for a value of $x = 0.057$. Although such a large value of x seems improbable because the quantity log ft equals 4.4 for In^{114}, it cannot be strictly ruled out.

In conclusion I wish to express my thanks to Academician A. I. Alikhanov, Professor V. A. Berestetsko, B. L. Ioffe, and V. A. Lyubimov for their interest in and discussion of the work.

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ON THE DECAY OF Σ HYPERONS

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THE experimental data on the probabilities and asymmetry coefficients of the decays of Σ hyperons by various channels evidently satisfy the rule $|\Delta I| = \tfrac{1}{2}$. If the $|\Delta I| = \tfrac{1}{2}$ rule receives final experimental confirmation, it will be necessary to renounce the theory of the universal weak interaction between charged currents.[3] At present it is desirable to have more data to test this rule.

Let us denote the amplitudes for the processes $\Sigma^+ \to p + \pi^0$, $\Sigma^+ \to n + \pi^+$, and $\Sigma^- = n + \pi^-$ by A_+, A_0, and A_-, respectively, where $A = a + ib(\boldsymbol{\sigma}\mathbf{k})$; **k** is the unit vector in the direction of motion of the nucleon. The absence of asymmetry in the decays $\Sigma^\pm \to n + \pi^\pm$ means that for these processes

$$\mathrm{Re}(ab^*) = 0. \qquad (1)$$

There are three ways to satisfy the condition (1): 1) $a = 0$, 2) $b = 0$, 3) the phases of a and b differ by 90°. Since the interaction of pion and nucleon in the final state is small, the third possibility violates the conservation of time parity.