the electromagnetic corrections due to the finiteness of m_B, then the above-discussed nonlocal effect decreases the value $(2.33 \pm 0.05) \times 10^{-6}$ sec to $(2.27 \pm 0.049) \times 10^{-6}$ sec which is in the right direction to maintain the universality of the coupling constant. It is, however, necessary to treat the radiative corrections correctly (without assuming $m_B = \infty$) in order to get more precise information. This may be discussed elsewhere. We would like to thank Dr. J. Sucher for his interest in this work.

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[†] On leave of absence from the Institute of Theoretical Physics, Kanazawa University, Japan.

[1] R. P. Feynman and M. Gell-Mann, Phys. Rev. 109, 193 (1958).

[2] E. C. G. Sudarshan and R. E. Marshak, Proceedings of the Padua-Venice Conference, September, 1957 [Suppl. Nuovo cimento (to be published)], and Phys. Rev. 109, 1860 (1958).

[3] The existence of the B_α-meson will give severe restrictions on the mass spectra of observable particles.

[4] For instance, G. Feinberg, Phys. Rev. 110, 1482 (1958).

[5] J. Schwinger, Ann. Phys. 2, 407 (1957); K. Nishijima, Phys. Rev. 108, 907 (1958); M. Konuma, Nuclear Phys. 5, 504 (1958). It may be remarked that this procedure alone is not enough to forbid $K^+ \to \pi^+ + \nu + \bar{\nu}$ and $K^+ \to \pi^+ + e^+ + e^-$, etc.

[6] In the case $\omega \equiv \nu^C$ the neutrinos have four components rather than two. This is a modified form of the twin neutrino theory where one twin is associated with the e^- and the other twin with the μ^+. The complete Lagrangian is invariant under $\nu \to \gamma_5 \nu$, $e \to e$ and $\mu \to -\mu$ (Nishijima transformation[5]) which guarantees the strict vanishing of the neutrino rest mass.

[7] We could expand M into $a + b\, k \cdot p / m^2 + \ldots$, where m is a quantity of the order of baryon mass.

[8] S. Oneda, Nuclear Phys. 4, 21 (1957), Eq. (5); S. W. Macdowell, Nuovo cimento 6, 1445 (1957); S. Furuichi, Nuovo cimento 7, 269 (1958).

[9] Furuichi, Kodama, Ogawa, Sugawara, Wakasa, and Yonezawa, Progr. Theoret. Phys. (Japan) 17, 89 (1957).

[10] Bruin, Holthuizen, and Jongejans, Nuovo cimento 9, 422 (1958). Earlier references will be found there.

[11] However, if, for instance, the strangeness-nonconserving baryon current behaves as an isospinor ($|\Delta I| = 1/2$), these energy spectra should be the same irrespective of the dependence of M on E_π. Okubo, Marshak, Sudarshan, Teutsch, and Weinberg, Phys. Rev. 112, 665 (1958). If the current is a mixture of $|\Delta I| = 1/2$ and 3/2, this will in general not be the case.

[12] T. D. Lee and C. N. Yang, Phys. Rev. 108, 1611 (1957).

[13] R. J. Plano and A. Lecourtois, report at the Conference on Weak Interactions, Gatlinburg, Tennessee, October, 1958 [Bull. Am. Phys. Soc. 4, 82 (1959)].

[14] For instance, S. M. Berman, Phys. Rev. 112, 267 (1958); T. Kinoshita and A. Sirlin (to be published).

γ_5-SYMMETRIZATION

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By imposing the requirement that a Fermi interaction Lagrangian $(\bar{\psi}_1 \Omega \psi_2)(\bar{\psi}_3 \Omega \psi_4)$ remain invariant for the independent transformations $\psi_i \to \gamma_5 \psi_i$ ($m_i \to -m_i$,[1] $i = 1, 2, 3, 4$), Sakurai[2] was able to deduce that weak interactions must be of (V-A) type. Unfortunately (the parity-conserving) strong interactions are not invariant for this transformation. In this connection the following remarks may be made:

(1) The Yukawa interactions

$$\bar{\psi}\psi\phi, \quad \bar{\psi}\gamma_5\psi\phi, \quad \bar{\psi}\gamma_\mu\psi A_\mu, \quad \bar{\psi}\gamma_\mu\gamma_5\psi A_\mu \tag{1}$$

remain unchanged for the following substitutions: $\psi \to \gamma_5\psi$, $\phi \to -\phi$, $A_\mu \to A_\mu$, $m \to -m$. Alternatively stated, all Lagrangians of the above type involving one ψ field are γ_5-symmetrized in the following sense:

$$L = \tfrac{1}{2}[\mathcal{L}(\psi, A_\mu, \phi, m) + \mathcal{L}(\gamma_5\psi, A_\mu, -\phi, -m)]. \tag{2}$$

(2) If there are two independent Fermi fields ψ_1 and ψ_2 and all interactions are of Yukawa type, define a γ_5-symmetrized Lagrangian as

$$\begin{aligned} L = \tfrac{1}{4}[&\mathcal{L}(\psi_1, \psi_2, A_\mu, \phi, m) + \mathcal{L}(\gamma_5\psi_1, \psi_2, A_\mu, -\phi, -m) \\ &+ \mathcal{L}(\psi_1, \gamma_5\psi_2, A_\mu, -\phi, -m) \\ &+ \mathcal{L}(\gamma_5\psi_1, \gamma_5\psi_2, A_\mu, -\phi, -m)]; \end{aligned} \tag{3}$$

i.e., change every field ψ independently into $\gamma_5\psi$ and after making the appropriate changes of ϕ fields (and m) sum all possible terms. The generalization to the case of n different Fermi fields is immediate and involves symmetrization of 2^n terms.

It may easily be checked that the only γ_5-symmetrized interaction terms which conserve parity are

(a) nonderivative interactions of scalar bosons, and

(b) interactions of vector mesons when only one

Fermi field is involved (e.g. $\bar{\psi}\gamma_\mu\psi A_\mu$). γ_5-symmetrized vector meson interactions involving two different Fermi fields must exist in $V \pm A$ combinations. It may be noted that this symmetrization commutes with any isotopic symmetries Lagrangians may possess.

It has been suggested that weak[3] interactions are mediated by charged vector bosons. It is to be remarked that, if this hypothesis is accepted, the complete strong, electromagnetic, and weak interaction, which is believed to describe the actual physical world, is γ_5-symmetrized in the sense used above. Alternatively the prescription of γ_5-symmetrization with Yukawa interactions could have been used to predict almost uniquely the presently accepted physical Lagrangian.

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[1] $m_i \to -m_i$ is necessary for the invariance of the corresponding free Lagrangian.

[2] J. J. Sakurai, Nuovo cimento 7, 649 (1958). The formalism of R. P. Feynman and M. Gell-Mann [Phys. Rev. 109, 193 (1958)] and E. C. G. Sudarshan and R. E. Marshak [Phys. Rev. 109, 1860 (1958)] gives identical results. However there is one difference: in Sukarai's work there is no insistence on the projection operators $(1+\gamma_5)$ and $(1-\gamma_5)$ to start with. These particular combinations of operators arise naturally where required during the course of theoretical development.

[3] R. P. Feynman and M. Gell-Mann (reference 2).