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PROBLEMS WITH WEAK PARITY-VIOLATING POTENTIALS[1]

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Problems connected with parity-violating potentials in weak Hamiltonians are discussed and some general statements including recently obtained results are presented.

I. INTRODUCTION

In the first approximation, the weak Hamiltonian, corresponding to the so-called „conventional" or „Cabibbo" current-current model is

$$H_w = \frac{G}{2\sqrt{2}}(J_\lambda(x)J^*_\lambda(x) + J^*_\lambda(x)J_\lambda(x)), \quad (1)$$

$$J_\lambda(x) = l_\lambda(x) + \cos\Theta h_\lambda^{\Delta S=0} + \sin\Theta h_\lambda^{\Delta S=1}.$$

Here $l_\lambda(x)$ and $h_\lambda(x)$ refer to the leptonic and hadronic currents, respectively. The study of the nonleptonic decay reveals something about the strangeness-nonconserving ($\Delta S = 1$) product of hadronic currents. If the structure of the weak Hamiltonian, or better to say weak-interaction theory, is to be completely understood, one has to study in addition to many other problems also:

i)Strangeness-conserving nonleptonic processes.

ii) The isospin selection rule $|\Delta \boldsymbol{I}| = \frac{1}{2}$ for strangeness-violating nonleptonic decays.

iii) The consistency of the weak-interaction theory, i.e., its application to any order of weak interactions.

These three problems are singled out, as they can to some extent be understood by studying weak parity-violating nuclear potentials. The study of weak parity violation in nucleon forces has so far been the only way of gaining information about ***i***). Analyses indicate that ***ii***) is closely connected with ***i***), at least in many weak-interaction models. Detailed accounts of the above

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statements can be found in a recent review [1]. In this review one can also find a complete presentation and discussion of the whole chain of reasoning, the main links of which are:

Weak Hamiltonian → Parity-Violating Potential
→ Theoretical Predictions ⇄ Experiment. (2)

Question ***iii***) crops out in many studies of weak interactions. Here it is connected with the derivation of the parity-violating vector-meson-exchange potential, as explained in[2].

Our aim is to investigate some problems concerning the first link in the chain (2). The second link, leading to definite theoretical predictions, involves deep problems in theoretical nuclear physics. We just mention, in passing, that in the case of complex nuclei, such as ^{181}Ta, interesting advances are to be expected from the approximation based on the giant dipole resonance[3].

The first link, leading from the weak Hamiltonian to PV potentials, is mainly concerned with the evaluation of PV mesonic vertices appearing in meson-exchange contributions to the internucleon potential $V_{12'}$ as shown in Fig. 1.

Here we present schematically key experimental and theoretical results (Table 1); for details we refer the reader to review papers. Only those experiments that have already been performed are mentioned in the table. For our purpose it was enough to quote order-of-magnitude numbers, since they already indicate where the problems are. Useful additional information is to be found also in review [55].

In all experiments where photon emission is involved, there is a marked disagreement with theory in magnitude (up to two orders) and in sign. On the contrary, for parity-violating α decay, experiment and theory seem to be in an agreement that is almost too good. It is fair to mention that two very important processes, namely, $n + p \to d + \gamma$ and parity-violating α decay have been studied in no more than one independent experimental measurement. For α decay, all references but Ref. [6—8] give only an upper limit. The last row in Table 1 is included for the benefit of sceptics. In the case of the K-forbidden decay of ^{180}Hf the effect is so large that one cannot doubt experiments. Unfortunately, this transition is almost hopelessly difficult to analyze theoretically. Using the language of collective nuclear models, one can say that the Coriolis coupling is to be calculated to the eighth order ($\Delta K = 8$). This reduces all theoretical attempts to order-of-magnitude estimates.

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[2] Guberina B., Missimer J., Tabić D., Phys. Rev. *D9* (1973), 2456.
[3] Missimer J., private communication.

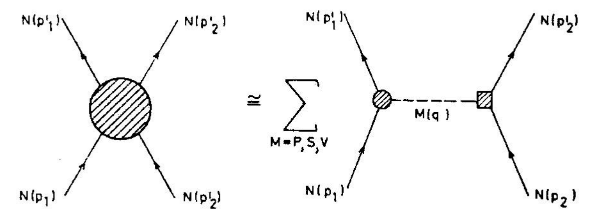


Fig. 1. One meson exchange contribution to the parity-violating internucleon potential. The shaded circles indicate a weak parity-violating interaction, while the shaded square denotes a purely strong vertex. The momenta of the various particles are given in parentheses.

Trying to speculate about disagreement between experiment and theory, we have to district ways of approach:

i) — The standard value [1] for the PV potential is correct.
— All experiments and all theoretical analyses stand.
— Everything works when no electromagnetic field is present.
— Theorefore, something strange is happening with electromagnetic interactions. One might speculate about intrinsic violation of parity.

If reasoning ***i***) is followed, the most urgent task would be to make all α-decay theoretical and experimental data maximally reliable. This would be valuable even if we applied an alternative reasoning, which is less revolutionary.

ii) — The derivation of the PV potential is suspect.
— Theoretical nuclear-physics calculations are suspect. It is a matter of taste to pick the most suspicious one. Obviously, α decay is the odd man out.
— Theoretical and/or experimental data should be checked, and their accuracy improved.

As the derivation of the PV potential belongs mainly to the domain of elementary particle physics, in the following we shall concentrate on the first of the possibilities in ***ii***).

II. PROBLEMS WITH WEAK PARITY-VIOLATING POTENTIALS

As weak PV potentials depend on the weak baryon-baryonmeson vertex, technical problems encountered by its derivation are closely related to the calculation of nonleptonic amplitudes. Two steps are essential:

i) Weak Hamiltonian and its internal symmetries are to be exploited, relating required PV vertices to measurable decay amplitudes whereever possible.

ii) The $\bar{N}NB$ vertex is to be deduced by all techniques devised so far to tackle (approximately) dynamical problems involving strong interactions:

Feynman diagrams, current algebra, $SU(3)$ symmetry, current-field identity, quark models, Bjorken-Johnson-Low limiting procedure, light-cone analysis, etc.

Steps ***i***) and ***ii***) are not comp letely independent as even the exploit of internal symmetries depends on the dynamics (see Subsecs. II.1 and II.2). It has long been established that the $PV\,\bar{N}N\pi$ vertex is especially sensitive to the nature of H_w. In some models it can be larger by a factor of 15 than for the standard H_w, thus improwing the agreement between experiment and theory in the case of ^{181}Ta, where $\Delta \boldsymbol{I} = 1$ potentials can contribute. The change of the $\bar{N}N\varrho$ vertex ($\Delta \boldsymbol{I} = 0{,}2$) can help in the case of ^{181}Ta, and it is the only change that helps in the $n + p \to d + \gamma$ experiment. However, any such change would upset good agremeent existing for α decay. A way out can be looked for in the effects involving photons.

In order to illustrate our statements, we consider the following particular examples:
1) Weinberg's unified-field-theory model. 2) Gronau's fit of nonleptonic decay amplitudes. 3) Off-mass shell PV nucleon-nucleon-pion amplitude. 4) Two-pion-exchange contributions. 5) Exchange contribution to γ decay. 6) New estimates of PV nucleon-nucleon-vector-meson amplitude.

II.1. $\bar{N}N\pi$ amplitude and Weinberg's model

The amplitude $a(n^0_-)$ for the $n \to p + \pi^-$ process can be found from the sum rule

$$a(\Xi^-_-) - 2a(\Lambda^0_-) - \frac{\sqrt{3}}{2A}\, a(n^0_-) = 0, \qquad (3)$$

deduced either by current algebra [56—58] or by $SU(3)$ symmetry and CP invariance (see [1], [24]). In Subsecs. II.2 and II.3 we comment on some dynamical assumptions underlying Eq. (3). The derivation of Eq. (3) is based on the structure of H_w, which has the following decomposition into isotensors T_I for the Cabbibo model, for example:

$$H_w \sim (\cos^2 \Theta(T_0 + T_2) + \sin^2 \Theta T_1 + \sin \Theta \cos \Theta(T_{1/2} + T_{3/2}) + \qquad (4)$$
$$+ \ldots + \ldots).$$

Tensors T_1 contributing to $a(n^0_-)$ and tensors $T_{1/2}$ contributing to $a(\Xi^-_-)$ and $a(\Lambda^0_-)$ belong to the same octet, thus leading to the result II.1. The constant A is a function of the Cabibbo angle Θ, and it may vary from one model of H_w to another.

In unified-field-theory models, which generally require introducing additional quark fields, we encounter a different situation. To avoid strangeness-changing neutral hadronic currents, Weinberg [59] had to introduce four quarks [60], and a new quantum number ,,charm". The effective contributions to the $\Delta S = 0$ and $\Delta S \neq 0$ nonleptonic amplitudes, respectively, are of the form[4]

$$H_{\Delta S \neq 0} \sim \sin \Theta \cos \Theta\, (T_{\Delta S} + T''_{\Delta S}), \qquad (5a)$$

$$H_{\Delta S = 0} \sim (\sin^2 \Theta + \alpha) T_1 + \sin^2 \Theta T''_1 + \beta \hat{T}_1. \qquad (5b)$$

Here Θ is the Cabibbo angle, while α and β depend on the model parameters. It is assumed that mass-term contributions are unimportant. The tensors appearing in Eq. (5) were found by reduction of the products of currents

$$T_{\Delta S} \sim \pi^- K^+; \quad T''_{\Delta S} \sim S^-_p D^+_p, \qquad (6)$$
$$T_1 \sim K^- K^+; \quad T''_1 \sim D^-_p D^+_p, \quad \hat{T}_1 \sim \pi^0 \chi.$$

The meson fields given above represent the $SU(3)$ properties of the corresponding currents. S_p is a charmed singlet, while D_p is a charmed doublet. As the tensors $(T_{\Delta S}, T_1)$, $(T''_{\Delta S}, T''_1)$ and $\hat{T}_1$ belong to different multiplets, $SU(3)$ symmetry can no more lead to the sum rule of the type (II.1). In Weinberg's model the prediction of $a(n^0_-)$ is wide open, requiring additional dynamical assumptions and/or symmetries (e.g., $SU(4)$). As there is a contribution proportional to one in Eq. (5), $a(n^0_-)$ could be appreciably larger than in the Cabibbo model.

We mention as a curiosity the combination [61] which contains Weinberg's $SU(2) + U(1)$ model plus the σ model [62, 63]. The model allows for parity and isospin breaking in such a way as to correlate the $PV\; NN\pi$ amplitude h with the mass difference $\Delta M = m_p - m_n$

$$h = \tfrac{1}{2}L + \delta G',$$

$$\Delta M = (M/G)L + (2M/G)\delta G' + C.$$

Here L is the divergent contribution which can be eliminated by renormalization. As the quantity

$$C = \frac{3\alpha}{8\pi} M(1 + 2 \ln m_Z^2/M^2)$$

[4] This result was found in cooperation with B. Guberina.

is known, one can easily express h in terms of ΔM. Insertion of the experimental ΔM leads to a very large result

$$h \approx -4 \times 10^{-2}$$

the model being obviously very unrealistic.

II.2. Gronau's fit of nonleptonic hyperon-decay amplitudes

The derivations of (II.1) based both on current algebra and on $SU(3)$ symmetry have (implicitly) assumed the following: ***i***) Soft-pion approximation meaning that the amplitude is a slowly varying function of the pion momenta q; $a(q^2 = m^2) \simeq a(q^2 = 0)$. In the derivation based on $SU(3)$ this is expressed by the fact that the masses of the initial and final baryon are assumed to be equal. ***ii***) Baryons are on the mass shell. The first statement can be challenged considering the vector-meson pole, which vanishes in the $q = 0$ limit, but can give considerable contributions to the physical pion. Inclusion of such a pole leads to a successful simultaneous fit [64] of both P- and S-wave decay amplitudes. The parity-violating strangeness-conserving amplitude belongs to the same $SU(3)$ multiplet as the strangeness-changing amplitude. One has, for example,

$$a(p_+^+) = \frac{-2\sqrt{2}\, ig\Theta}{f_\pi}(F + D) - \frac{c}{\sqrt{6}}\,\frac{2\cos^2\Theta - \sin^2\Theta}{\sin\Theta\cos\Theta}\,\cdot$$
$$\cdot\frac{M_k^2}{M_\varrho^2}\left(1 + \frac{\delta}{\Phi}\right)(m_p - m_n). \qquad (7)$$

The first term corresponds to the ,,old" result obtained by current algebra or $SU(3)$,while the second term is due to vector-meson exchange, leading to[5]

$$|a(p_+^+)| = 1.4 \times 10^{-8}.$$

The old result for the Cabibbo model [1] is almost three times larger

$$|a(p_+^+)| = 4.1 \times 10^{-8}.$$

The difference comes from the fact that the second term, being proportional to the hyperon mass difference, is quite significant in the strangeness-changing decay, while being negligible in the strangeness-conserving decay. In the ,,old" approach, the D/F value was relatively small (-0.3). In the new approach [64] the D/F value is ≈ -0.85, which agrees well with the conclusion following from the symmetric quark model, where $D/F = -1$. The quark-model calculation[6] yields even a smaller value

[5] This result was obtained in cooperation with A. Andrasi.

[6] Körner J. G., *Heidelberg University preprint.*

$$|a(N\pi)| \simeq 0.24 \times 10^{-8},$$

which is closer to the factorization approximation [66], where

$$|a(N\pi)| = 0.14 \times 10^{-8}.$$

The contribution from the factorization approximation is proportional to the proton-neutron mass difference, and comes from the first term in Eq. (4). The same holds for the quark-model approach[6] [65]. This way of reasoning shows how crucial the assumption ***i***) was in obtaining the old result for $a(N\pi)$. Naturally, in any approach the result will still vary from one model of H_w to the next. Let us now investigate the assumption ***ii***).

II.3. Off-mass-shell PV $\bar{N}N\pi$ amplitude

As long as nucleons are on the mass shell, the parity-violating $\bar{N}N\pi$ amplitude transforms as an isovector, i.e., T_1. In[7] this amplitude was calculated in the model [62, 63], including contributions of the diagrams in Fig. 2. The complete renormalizability of the model is by no means certain. In this respect one should study models of the type mentioned at the end of Subsec. II.1. The model was such that no isovector contribution was possible, as only two fermions p and n were included. As long as one of them was kept off the mass shell, there was a contribution transforming as a linear combination of T_0 and T_2:

$$M(\pi N) \sim (\alpha\boldsymbol{\tau} \cdot \boldsymbol{\Phi}_\pi + \beta\tau_Z\Phi_{\pi Z})\varepsilon', \qquad (8)$$

$$\alpha \simeq -2 \times 10^{-7} \qquad \beta = 12 \times 10^{-7}, \qquad \varepsilon' = p'^2/M^2 - 1.$$

Here ε' measures how much off-mass-shell one nucleon is. The estimate suggested by the authors was $p'^2 = (M_N + m_\pi)^2$, leading to the value $a(N\pi) \sim$ $\sim 10^{-6}$, which is rather large.

The amplitude (8) leads to the one-pion-exchange potential

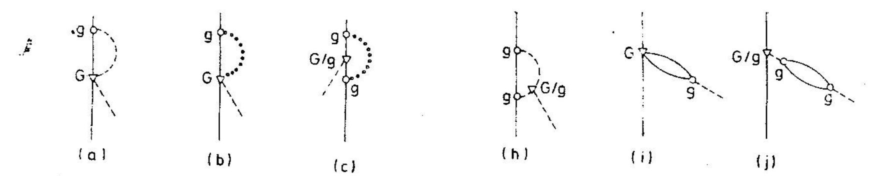
$$V_{off\pi} = \frac{q}{8M}(\boldsymbol{\sigma}_1 - \boldsymbol{\sigma}_2) \cdot \boldsymbol{r}\Phi(r)\varepsilon'(\alpha T_{12}^{(+)} + \beta\tau_{1z}\tau_{2z}), \qquad (9)$$

$$T_{12}^{(+)} + \tau_{1+}\tau_{2-} \pm \tau_{1-}\tau_{2+}.$$

When applied to complex nuclei such as ^{181}Ta, calculation[8] shows that the

[7] Henley E. M., Heliher T. E., Pardee W. J., Yu D. E. L., Seattle, Washington preprint 1973.

[8] This result was obtained in cooperation with B. Eman.



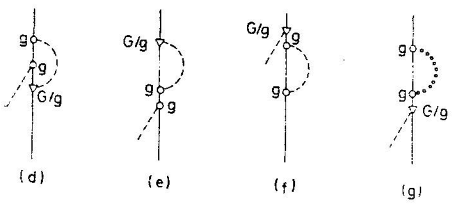


Fig. 2. Diagrams for the weak parity-violating pion-nucleon vertex. The triangle represents a weak vertex, while the circle denotes a purely strong vertex. The dashed lines indicate pions, the dotted lines σ particles, and the full lines nucleons. G is the Fermi coupling constant, while g is the strong pion-nucleon coupling constant.

contribution of the potential (9) is comparable with the contribution of the standard potential [1]

$$V_\pi = A\Gamma(\boldsymbol{\sigma}_1 + \boldsymbol{\sigma}_2)\boldsymbol{r}\Phi(r)T_{12}^{(-)} \tag{10}$$

If nuclear models are to be taken seriously, the estimate for ε' is more likely to be

$$\varepsilon' = E_B M_N^{-1} \text{ or } \varepsilon' = V_S M_N^{-1},$$

where E_B is the binding energy per nucleon and V_S is the shell-model potential. This estimate gives $\varepsilon' < 10^{-1}$.
When the contribution of the potential (9) is thus reduced by a factor of 10^{-2}, it becomes comparable with the contribution of the standard pion-exchange potential.

The potential (9) would also lead to two-pion-exchange contributions, which might easily be larger than the ones coming from the potential (10), to which we turn next.

II.4. Two-pion-exchange contributions

These contributions are illustrated by the diagrams *c*, *d*, and *e* in Fig. 4 and have been extensively studied recently [67—69]. The standard PV vertices [1] have been used in all calculations. There is good agreement between Refs. [68—69], the general conclusion being that the two-pion-exchange contribution is small, say $= 30\,\%$ of the one-pion-exchange (diagram *b* in Fig. 3).

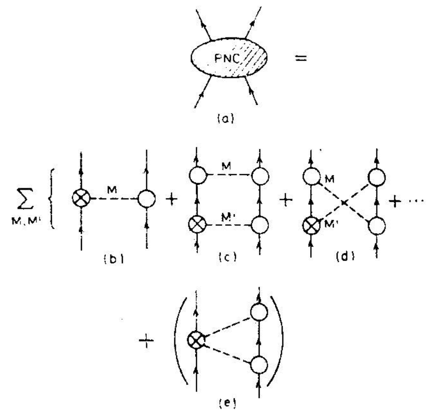


Fig. 3. Pion-exchange contributions to the parity-violating internucleon potential. The crossed circles indicate a weak parity-violating interaction. Diagrams *b*, *c*, and *d* have the isospin selection rule $\Delta I = 1$, while diagram *e* has $\Delta I = 0, 2$.

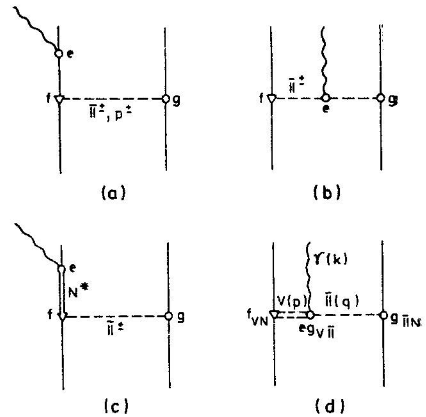


Fig. 4. Diagrams for parity-violating effects in photon emission. Diagram *c* shows a baryonic resonance effect and diagram *d* is an exchange diagram due to $V \to \pi + \gamma$, where V is a vector meson. Weak vertices are denoted by f and strong by g. The momenta are given in parentheses.

Recently, estimates have been made including contributions of baryonic N^* and mesonic resonances[9]. Results can be represented in the form of effective single-particle potentials corresponding to various isospin selection rules

$$V(\Delta I = 1) = K_1\boldsymbol{\sigma} \cdot \boldsymbol{p}\tau_3, \tag{11}$$
$$V(\Delta I = 0{,}2) = K_0\boldsymbol{\sigma} \cdot \boldsymbol{p}.$$

The values of K_1 and K_0 are given in Table 2. The influence of various corrections does not change earlier results very much. However, no studies with nonstandard potentials have been published so far. Exchange contributions to γ decay seem to be even more insignificant.

II.5. Exchange contributions to γ decay

Parity-violating γ emission is schematically described by the diagrams in Fig. 4. When transitions of the type $M1(\tilde{E}1)$ are concerned, diagrams *a*)

[9] Chemtob M., Desplanques B., (private communication by B. Desplanques).

and b) are automatically included in the formalism because of the Siegert theorem. A detailed discussion can be found in Refs. [1, 49]. Reference [70] is also instructive. Of the last two diagrams, c and d, which are not included in the standard formalism, the first one is very small. It has been argued [13, 14, 71, 72] that the parity-violating $\pi N\Delta(1236)$ vertex of Fig. 1c is negligible. Diagram d was evaluated[10] using the largest possible estimate (see Subsec. II.6) for the $PV\ \bar{N}N\varrho$ vertex f_{VN}. Its contribution to circular polarization in the $n + p \to d + \gamma$ process

$$p_\gamma(exchange) \lesssim 10^{-9}$$

is smaller than the result of standard calculations. Both are well below the experimental value, see Table 1. The exchange contribution to the asymmetry of photons emitted in the capture of polarized neutrons is more important, being comparable with the standard one.

However, the effects mentioned in Subsecs. II.4 and II.5 are completely irrelevant if the strength of the $PV\ \bar{N}N\varrho$ vertex is really very much larger than initially estimated.

II.6. *PV* nucleon-nucleon-vector-meson amplitude

By assuming the $SU(6)$ symmetry for nonleptonic amplitudes, McKellar and Pick [73] were able to show that in the Cabibbo model parity-violating

Table 1

Experiment	Exp. result	Change of isospin	Meson-exchange potential V_M	Theoretical predictions	References
O^{16} 8.82 MeV → → $C^{12} + \alpha$	$\Gamma_\alpha^{PNC} \lessapprox 10^{-10}$eV	$\Delta I = 0$	$V(vector)$	0.5×10^{-10}eV ≤ ≤ $\Gamma\alpha$ $\Gamma\alpha \leq 7 \times 10^{-10}$ eV	Exp [2–8] Theor [9–16]
$n + p \to d + \gamma$ circular polarization	$P_\gamma \cong (-)1.2 \times 10^{-6}$	$\Delta I = 0, 2$	$V(vector)$	$P_\gamma \approx +10^{-8}$; $+10^{-9}$	Exp ([17–20] Theor [21–28]
$Ta^{181*} \to Ta^{181} + \gamma$	$P_\gamma \cong (-)5 \times 10^{-6}$	$\Delta I = 0, 1, 2$	$V(vector)$, $V(pion)$	$P_\gamma \approx +2 \times 10^{-7}$	Exp [29–41] Theor [42–49]
$Hf^{180*} \to Hf^{180} + \gamma$	$P_\gamma = -2.5 \times 10^3$ $A_\gamma = -1.6 \times 10^{-2}$	$\Delta I = 0, 1, 2$	$V(vector)$, $V(pion)$		Exp [50–54]

[10] Henley E. M., Seattle, Washington 1972 preprint.

$\bar{N}N\varrho^0$ and $\bar{N}N\omega$ amplitudes cannot both vanish as follows from the factorization hypothesis. Various dynamic assumptions (e.g. meson-pole dominance, etc.) were then needed to find coupling constants which could be of opposite sign and larger up to a factor of 8 than the factorization results [1]. Danilov proposed[11] a large increase of the $\bar{N}NV$ amplitude coming from the divergencies inherent in weak interactions. His approach, which was based on a dubious shift of coordinates led to the same isospin structure as the factorization approximation (i.e., both $\bar{N}N\varrho^0$ and $\bar{N}N\omega$ amplitudes vanish). An alternative analysis of the divergences[2] was based on the *BJL* limiting procedure [74, 75] and/or on the light-cone (*LC* for abbreviation) structure of weak amplitudes [76]. Starting from the amplitude

$$T(N \to N' + V) = \varepsilon_\lambda A_\lambda, \tag{12}$$

one studies the derivative

$$q_\lambda A_\lambda^z = -g_w^2 f_\varrho \int d^4y \left(\delta_{\mu\nu} - \frac{\partial_\mu \partial_\nu}{m_W^2}\right) \Delta(y) \cdot \{e^{-iqy} \cdot M_{\mu\nu}^{zab}(y, 0) + + \tilde{M}_{\mu\nu}^{zba}(y, 0)\}, \tag{13}$$

$$M_{\mu\nu}^{zab}(y, 0) = f^{zac} \langle N'|T(A_\mu^c(y) V_\nu^b(0) + (V \leftrightarrow A))|N\rangle.$$

All notation has the usual meaning. ε_λ is the polarization vector, g_w is the weak coupling constant, m_w is the mass of the intermediate vector boson, A and V are the axial-vector and vector weak currents, respectively, while the Latin indices refer to the $SU(3)$ group. The most divergent contribution is of the form

$$q_\lambda A_\lambda^z \to -h^1 f_\varrho \frac{g_w^2}{m_w^2} f^{zac} i f^{acd} D_+^d(0), \tag{14}$$

Table 2

K_1	Contributions	K_0	Contributions
0 0210	N (old result)	−2.48	ϱ without width
0 0115	$N + N^*$	−2.15	ϱ with width
0 0158	$N + N^* + \varrho$	−2.58	ϱ with width $+ N$
		−2.64	ϱ with width $+ N + N^*$

Relative magnitudes are quoted.

[11] Danilov G. S., Leningrad Nuclear Physics Institute, preprint 1973.

$$D^d_+(0) = \frac{i}{2}\, q_\mu \langle N' | A^c_\mu(G) | N \rangle.$$

The same form persists in the so-called current-current limit, i.e., when $m_w^2 \to \infty$ and $g^2 m_w^{-2} \to$ Fermi constant.

The vector-boson exchange potential comes out in the form

$$V_{12} = -h_A^{S,D} f_\varrho / 8\pi \sqrt{2} M (i\, \boldsymbol{\sigma}_1 \times \boldsymbol{\sigma}_2) \Big| \boldsymbol{p}_{12'} \frac{e^{-m_\varrho r}}{r} \Big|_- \cdot \tag{15}$$

$$\cdot \{(1 + \mu_p - \mu_n) | \alpha T_{12}^{(+)} + \tfrac{1}{2}\beta \tau_{1z}\tau_{2z} + \tfrac{1}{4}\gamma\xi(\tau_{1z} + \tau_{2z}) | +$$

$$+ (1 + \mu_p + \mu_n) \tfrac{1}{8} \sqrt{3}\gamma'(\tau_{1z} + \tau_{z2}) + \ldots\}.$$

Here

$$h_A^S = -\frac{G m_\varrho^2}{8\sqrt{2\pi} M}; \quad G = g^2 m_w^{-2} \sqrt{2}$$

corresponds to the old separable approximation, while

$$o = h_A^D / h_A^S = -\frac{1}{4\pi} \frac{f_\varrho^2}{4\pi} \frac{\Lambda^2}{M^2}.$$

Depending on the cut-off λ, the ratio o is

$$o = -100 (\lambda = 15 \text{ GeV}),$$

$$= -7 (\lambda = 4 \text{ GeV}).$$

The constants α, β, γ, and γ' are shown in Table 3. All results hold for the Cabibbo model. The sign and the estimated magnitude of the divergent contribution would improve theoretical predictions for γ-decay processes. However, in the case of α decay, agreement would be completely lost.

It seems that the above analysis is in good qualitative agreement with the analysis based on $SU(6)_w$.

Table 3

	Separable approx	Divergent terms	Charge of the vector particle
α	$\cos^2\Theta$	$\cos^2\Theta + \frac{1}{2}\sin^2\Theta$	$\pm$
β	0	$4\cos^2\Theta + \sin^2\Theta$	0
γ	0	$\sqrt{3}\sin^2\Theta$	0
γ'	0	$\sqrt{3}\sin^2\Theta$	0

III. CONCLUSIONS

In the present contribution the first link of the chain: Weak Hamiltonian → → Parity-Violating (PV) Potential → Theoretical Predictions → Experiments has been investigated by means of the following particular approaches: Weinberg's unified-field theory model; Gronau's fit of nonleptonic decay amplitudes; off-mass-shell PV nucleon-nucleon-pion amplitude; two-pion-exchange contributions; exchange contributions to γ-decay; new estimates of PV nucleon-nucleon vector-meson amplitude.

General features have been outlined comparing theory with experiment.

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