aged cross sections.

[36]We do not give the l.m.t. analog of Eq. (27) because, as mentioned,[35] this equation is based on relation (8) between *single*-quark amplitudes, while in our l.m.t. treatment we add incoherently three-quark amplitudes. The neglect of interferences at single-quark amplitudes, which would read, in this case, $|y|^2=|x|^2+|r|^2$, is a different approximation.

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Sum Rules for *CP*-Nonconserving $BB\pi$ Amplitudes in Glashow's Model*

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Current algebra has been used to derive sum rules for the *CP*-nonconserving $\Delta S=1$ and $\Delta S=0$ nonleptonic transitions $B\to B'\pi$ in Glashow's model. Within the saturation scheme of Chiu, Schechter, and Ueda for the matrix elements of the weak current×current Hamiltonian between single baryon states, it is shown that the *CP*-nonconserving amplitudes do have octet dominance. The one-pion exchange contribution to the weak *P*- and *T*-violating nucleon-nucleon potential has been calculated by relating the weak $NN\pi$ vertex to hyperon decay amplitudes.

I. INTRODUCTION

A number of theories have been put forward to explain the experimental observation of *CP* nonconservation[1] in $K_L^0\to 2\pi$ decay. Among the models which embed the source of the *CP* nonconservation in the current × current form of the weak interactions,[2,3] Glashow's model[2] is unique in that it introduces no neutral currents and it predicts a violation of *CP* invariance in the $\Delta S=0$ nuclear interactions. In this paper the predictions based on Glashow's model for *CP*, or equivalently *T*, violations in the *s*-wave parity-violating nonleptonic transitions $B\to B'\pi$ are investigated[4] by using current algebra and the soft-pion technique.[5] Using the saturation scheme of Chiu, Schechter, and Ueda[6] for the matrix elements of the current×current Hamiltonian between single baryon states, we show that the *CP*-violating parts of the amplitudes also exhibit octet dominance. These predictions are used to evaluate the one-pion exchange contribution to the weak *P*- and *T*-violating nucleon-nucleon potential.

In Glashow's model[2] the weak-interaction Hamiltonian is given by

$$H_w=(G/2\sqrt{2})\{J_\mu,J_\mu^\dagger\}, \tag{1}$$

where $G=1.02\times10^{-5}/M_p{}^2$ is the Fermi coupling constant, and the Cabibbo currents, in the $SU(3)$ tensor notation, are given by

$$J_\mu=J_\mu(\text{leptonic})+\cos\theta(V_\mu+e^{i\rho}A_\mu)_1{}^2+\sin\theta(V_\mu+e^{i\psi}A_\mu)_1{}^3. \tag{2}$$

The model allows for *CP* nonconservation by the presence of the complex phases, with phase angles ρ and ψ, between the hadronic vector and axial-vector currents. Since *CP* violations have not been observed so far in nuclear β decay,[7] the angle ρ must be rather small. It has been shown by Pati[8] that the choice $\rho\cong\psi\le\frac{1}{600}$ ensures that the $\Delta T=\frac{1}{2}$ rule holds for the nonleptonic *CP*-conserving $K\to2\pi$ decays, and furthermore predicts an electric dipole moment for the neutron of the order of 10^{-23} e cm, which is nearly outside the present experimental upper limit.[9] In the following we shall assume that the phase angles are equal in magnitude and $|\rho| = |\psi| = 10^{-3}$. This simply ensures that the CP-violating effects have the appropriate order of magnitude.

II. THE S-WAVE PARITY-VIOLATING AMPLITUDES

The s-wave amplitudes for the weak process $B \to B'\pi_a^b$ are obtained in the soft-pion limit by the Sugawara-Suzuki[5] method and are given by

$$A(B \to B'\pi_a^b) = (1/f_\pi)\langle B' | [F_{5a}^b, H_w^{\text{p.v.}}(0)] | B\rangle = (1/f_\pi)\langle B' | \tilde{H}_w^{\text{p.c.}}(0) | B\rangle , \tag{3}$$

where F_{5a}^b are the axial charges.

The usual $SU(3)\otimes SU(3)$ current commutation relations are used to evaluate the commutator in Eq. (3). It should be noted that the usual chiral transformation property of the weak Hamiltonian does not hold in Glashow's model, and

$$[F_{5a}^b, H_w(0)] \neq [F_a^b, H_w(0)] . \tag{4}$$

Consider the s-wave amplitudes for the $\Delta S=1$ and the $\Delta S=0$ nonleptonic transitions. The amplitudes are given by

$$\begin{aligned} A = (G/2\sqrt{2} f_\pi)\{ & \sin\theta\cos\theta[\delta_1^a(e^{i\rho}V_{b3}^{21} + e^{i\psi}V_{b2}^{31} + e^{-i\rho}A_{2b}^{13} + e^{-i\psi}A_{3b}^{12}) + \delta_2^a(e^{i\psi}A_{1b}^{31} + e^{-i\rho}V_{b1}^{13}) \\ & -\delta_b^1(e^{i\rho}A_{13}^{2a} + e^{i\psi}A_{12}^{3a} + e^{-i\rho}V_{21}^{a3} + e^{-i\psi}V_{31}^{a2}) - \delta_b^2(e^{i\rho}V_{13}^{a1} + e^{-i\psi}A_{31}^{1a})] \\ & + \sin^2\theta[\delta_1^a(e^{i\psi}V_{b3}^{31} + e^{-i\psi}A_{b3}^{31}) - \delta_b^1(e^{i\psi}A_{13}^{3a} + e^{-i\psi}V_{13}^{3a})] \\ & + \cos^2\theta[\delta_1^a(e^{i\rho}V_{b2}^{21} + e^{-i\rho}A_{b2}^{21}) - \delta_b^1(e^{i\rho}A_{12}^{2a} + e^{-i\rho}V_{12}^{2a}) + \delta_2^a(e^{i\rho}A_{1b}^{21} + e^{-i\rho}V_{1b}^{21}) - \delta_b^2(e^{i\rho}V_{12}^{a1} + e^{-i\rho}V_{22}^{a1})]\} . \end{aligned} \tag{5}$$

Here V_{bd}^{ac} and A_{bd}^{ac} are defined by

$$V_{bd}^{ac} = \langle B' | \{V_{\mu b}^a, V_{\mu d}^c\} | B\rangle \tag{6}$$

and

$$A_{bd}^{ac} = \langle B' | \{A_{\mu b}^a, A_{\mu d}^c\} | B\rangle . \tag{7}$$

The vector and axial-vector "spurions" V_{bd}^{ac} and A_{bd}^{ac} have the $SU(3)$ tensorial characters

$$Q_{bd}^{ac} = \tau(Q)[\underline{27}] \oplus \delta(Q)[\underline{8}_D] \oplus \varphi(Q)[\underline{8}_F] \oplus \sigma(Q)[\underline{1}] , \tag{8}$$

where $Q \equiv V$ or A.

The matrix elements of Eqs. (6) and (7) can be evaluated by inserting a complete set of intermediate states; it is assumed that the matrix elements of the weak currents are known from data on the semileptonic decays of the hyperons. Following Chiu, Schechter, and Ueda[6] the sum over intermediate states is assumed to be saturated by octet and decuplet baryon states alone. Using available experimental information on the vector and axial-vector form factors, it is possible to make a numerical estimate of these matrix elements.[6,10] The parameters $\tau(Q)$, $\delta(Q)$, $\varphi(Q)$, and $\sigma(Q)$ of (8) are obtained[11] using such a procedure and are given in Table I.

On expanding $e^{\pm i\rho}$ and $e^{\pm i\psi}$, and retaining terms linear in the phase angles ρ and ψ ($\psi = \pm\rho$), the amplitudes can be expressed in terms of the sum and the difference of the vector and axial-vector spurions. From Table I it is evident that $\tau = \tau_V + \tau_A$ is much smaller than δ, φ, or σ, and hence the sum of the matrix elements V_{bd}^{ac} and A_{bd}^{ac} is dominated by the octet tensor contributions.[6] One may also observe from Table I that $\tau' = \tau_V - \tau_A$ is smaller than δ' and φ', and the difference of matrix elements V_{bd}^{ac} and A_{bd}^{ac} is also dominated by the octet tensor contributions. However, octet dominance in this case is not as pronounced as in the case of the sum of the matrix elements.

The amplitudes for the $\Delta S=1$ decays $B^i \to B'^j\pi^k$ are denoted by $A(B_k^i)$. Thus, for example, $A(\Lambda_-^0) = \Lambda^0 \to p\pi^-$ and $A(\Sigma_-^-) = \Sigma^- \to n\pi^-$. The ΔS = transitions are expressed in a similar notation,[12] and we

TABLE I. Numerical estimates for the parameters τ, δ, φ, and σ, in units of $(m_p{}^3 \times 10^{-4})$.

Parameter	V_{bd}^{ac}	A_{bd}^{ac}	Sum	Difference
$\tau(Q)$	-1.4	-31.0	$\tau = -32.4$	$\tau' = 29.6$
$\delta(Q)$	-239.0	-96.0	$\delta = -335.0$	$\delta' = -143.0$
$\varphi(Q)$	308.0	267.0	$\varphi = 575.0$	$\varphi' = 41.0$
$\sigma(Q)$	311.0	313.0	$\sigma = 624.0$	$\sigma' = -2.0$

write

$A(n^0_-)=n\to p\pi^-$, $A(\xi^-_-)=\Xi^-\to\Xi^0\pi^-$, $A(\sigma^-_-)=\Sigma^-\to\Sigma^0\pi^-$, and $A(\hat{\sigma}^-_-)=\Sigma^-\to\Lambda^0\pi^-$.

Glashow's model[2] allows for CP violation in the $\Delta S=0$ nonleptonic transitions, and hence neutral pseudoscalar π^0,η^0 meson transitions are not zero. The following are CP-violating amplitudes for the π^0 mode:

$$A(p_0^+)=p\to p\pi^0,\quad A(n_0^0)=n\to n\pi^0,\quad A(\xi_0^-)=\Xi^-\to\Xi^-\pi^0, \tag{9}$$

$$A(\xi_0^0)=\Xi^0\to\Xi^0\pi^0,\quad A(\sigma_0^+)=\Sigma^+\to\Sigma^+\pi^0,\quad A(\sigma_0^0)=\Sigma^0\to\Sigma^0\pi^0, \tag{10}$$

$$A(\sigma_0^-)=\Sigma^-\to\Sigma^-\pi^0,\quad A(\lambda_0^0)=\Lambda^0\to\Lambda^0\pi^0,\quad A(\hat{\sigma}_0^0)=\Sigma^0\to\Lambda^0\pi^0. \tag{11}$$

III. SUM RULES

It is now straightforward to derive the amplitudes of Eqs. (9)–(11) from the general expression of Eq. (5). There are two possible solutions and two sets of sum rules corresponding to the choice $\psi=\pm\rho$ for the phase angles. In the following, complete expressions are given only for a few amplitudes. The others are related to these amplitudes through the sum rules presented below. With

$$\mathcal{G}_1=(\tfrac{1}{8})^{1/2}G\sin\theta\cos\theta/f_\pi,\quad \mathcal{G}_2=(\tfrac{1}{8})^{1/2}G\sin^2\theta/f_\pi,\quad\text{and}\quad \mathcal{G}_3=(\tfrac{1}{8})^{1/2}G\cos^2\theta/f_\pi, \tag{12}$$

we have

$$A(\Lambda^0_-)=(\mathcal{G}_1/\sqrt{6})[(-\tfrac{6}{5}\tau+\delta+3\varphi)-i\xi(-\tfrac{6}{5}\tau_A+\delta_A+3\varphi_A)+i\rho(-\tfrac{6}{5}\tau_V+\delta_V+3\varphi_V)],$$

$$A(\Xi^-_-)=(\mathcal{G}_1/\sqrt{6})[(\tfrac{6}{5}\tau-\delta+3\varphi)-i\xi(\tfrac{6}{5}\tau_A-\delta_A+3\varphi_A)+i\rho(\tfrac{6}{5}\tau_V-\delta_V+3\varphi_V)],$$

$$A(\Sigma^+_+)=\mathcal{G}_1[(-2\tau)+i\xi 2\tau_A-i\rho 2\tau_V],$$

$$A(\Sigma^-_-)=\mathcal{G}_1[(\tfrac{6}{5}\tau-\delta+\varphi)-i\xi(\tfrac{6}{5}\tau_A-\delta_A+\varphi_A)+i\rho(\tfrac{6}{5}\tau_V-\delta_V+\varphi_V)],$$

$$A(\Sigma_0^+)=(\mathcal{G}_1/\sqrt{2})[(\tfrac{4}{5}\tau+\delta-\varphi)+i(2\rho+\xi)(\tfrac{4}{5}\tau_V+\delta_V-\varphi_V)-i(\rho+2\xi)(\tfrac{4}{5}\tau_A+\delta_A-\varphi_A)],$$

$$A(\Lambda_0^0)=(\mathcal{G}_1/2\sqrt{3})[(\tfrac{6}{5}\tau-\delta-3\varphi)+i(2\rho+\xi)(\tfrac{6}{5}\tau_V-\delta_V-3\varphi_V)-i(\rho+2\xi)(\tfrac{6}{5}\tau_A-\delta_A-3\varphi_A)],$$

$$A(\Xi_0^0)=(\mathcal{G}_1/2\sqrt{3})[(\tfrac{6}{5}\tau-\delta+3\varphi)+i(2\rho+\xi)(\tfrac{6}{5}\tau_V-\delta_V+3\varphi_V)-i(\rho+2\xi)(\tfrac{6}{5}\tau_A-\delta_A+3\varphi_A)],$$

$$A(n^0_-)=\mathcal{G}_2[(\tfrac{4}{5}\tau+\delta+\varphi)+i\xi(\tfrac{4}{5}\tau'+\delta'+\varphi')],$$

$$A(n_0^0)=i\xi\sqrt{2}\,\mathcal{G}_2(-\tfrac{1}{10}\tau'-\tfrac{1}{3}\delta'-\varphi'+\sigma')+i\rho 2\sqrt{2}\,\mathcal{G}_3(-\tfrac{1}{10}\tau'-\tfrac{1}{3}\delta'+\varphi'+\sigma'),$$

$$A(p_0^+)=i\xi\sqrt{2}\,\mathcal{G}_2(\tfrac{7}{10}\tau'+\tfrac{2}{3}\delta'+\sigma')+i\rho 2\sqrt{2}\,\mathcal{G}_3(-\tfrac{1}{10}\tau'-\tfrac{1}{3}\delta'+\varphi'+\sigma').$$

For $\psi=\rho$ the amplitudes satisfy the following sum rules:

$$2A(\Xi^-_-)-A(\Lambda^0_-)=(\tfrac{3}{2})^{1/2}A(\Sigma^-_-), \tag{13a}$$

$$A(\lambda^0_-)=A(\hat{\sigma}^-_-), \tag{13b}$$

$$A(n^0_-)+A(\xi^-_-)=(\tfrac{1}{2})^{1/2}[A(\sigma^-_-)-A(\sigma^0_-)], \tag{13c}$$

$$A(\sigma^0_-)+A(\sigma^-_-)=\cot^2\theta\{\sqrt{3}[A(\lambda^0_-)+A(\hat{\sigma}^-_-)]-\sqrt{2}[A(n^0_-)-A(\xi^-_-)]\}, \tag{13d}$$

$$A(\sigma^0_-)+A(\sigma^-_-)=2\sqrt{2}\cot\theta A(\Sigma^+_+), \tag{13e}$$

$$A(\Lambda^0_-)+A(\Xi^-_-)=(\tfrac{3}{2})^{1/2}\cot\theta[A(\sigma^-_-)-A(\sigma^0_-)], \tag{13f}$$

$$A(\Sigma^+_+)+A(\Sigma^-_-)=\cot\theta A(\xi^-_-). \tag{13g}$$

There are eight additional sum rules relating CP-violating parts of the amplitudes, which we denote by $\tilde{A}$. These sum rules are

$$\tilde{A}(p_0^+)-\tilde{A}(n_0^0)=\sqrt{2}\,\tilde{A}(n^0_-), \tag{14a}$$

$$[\tilde{A}(\xi_0^-)-\tilde{A}(\xi_0^0)]=-\sqrt{2}\tilde{A}(\xi^-_-), \tag{14b}$$

$$[\tilde{A}(\sigma_0^+)-\tilde{A}(\sigma_0^-)]=[\tilde{A}(\sigma^-_-)-\tilde{A}(\sigma^0_-)], \tag{14c}$$

$$\tilde{A}(\hat{\sigma}_0^0)=\tilde{A}(\lambda^0_-)=\tilde{A}(\hat{\sigma}^-_-), \tag{14d}$$

$$[\tilde{A}(p_0^+)-\tilde{A}(\xi^-_-)]=\tfrac{1}{2}\tan^2\theta[\tilde{A}(\sigma^-_-)-\tilde{A}(\sigma^0_-)], \tag{14e}$$

$$[\tilde{A}(\xi_0^0) - \tilde{A}(n_0^0)] = [\tilde{A}(\sigma_0^+) - \tilde{A}(\sigma_0^-)] + [\tilde{A}(\xi_-^-) - \tilde{A}(p_0^+)]\,, \tag{14f}$$

$$\tilde{A}(\lambda_0^0) - \tilde{A}(\sigma_0^0) = (\tfrac{4}{3})^{1/2}(1 - 4\cot^2\theta)\tilde{A}(\hat{\sigma}_0^0)\,, \tag{14g}$$

$$[\tilde{A}(\sigma_0^0) - \tilde{A}(\sigma_0^-)] = \tfrac{1}{2}[\tilde{A}(\sigma_-^-) - \tilde{A}(\sigma_-^0)] + 2\sqrt{2}\cot\theta\,\tilde{A}(\Sigma_+^+)\,. \tag{14h}$$

It should be noted that the $\Delta T = \frac{1}{2}$ relations in $\Delta S = 1$ decays are broken by the CP-violating parts of the amplitudes and

$$\begin{aligned} &A(\Lambda_-^0) \neq -\sqrt{2}A(\Lambda_0^0)\,, \\ &A(\Xi_-^-) \neq \sqrt{2}A(\Xi_0^0)\,, \\ &A(\Sigma_-^-) + A(\Sigma_+^+) \neq \sqrt{2}A(\Sigma_0^+)\,. \end{aligned} \tag{15}$$

Furthermore, not all the sum rules derived by Fischbach[12] for the $\Delta S = 0$ and $\Delta S = 1$ nonleptonic transitions remain valid in the Glashow model.

Similarly, for $\rho = -\psi$ the amplitudes satisfy the following sum rules:

$$A(\Lambda_-^0) = -\sqrt{2}A(\Lambda_0^0)\,, \tag{16a}$$

$$A(\Xi_-^-) = \sqrt{2}A(\Xi_0^0)\,, \tag{16b}$$

$$A(\Sigma_+^+) + A(\Sigma_-^-) = -\sqrt{2}A(\Sigma_0^+)\,, \tag{16c}$$

$$A(\Lambda_-^0) - 2A(\Xi_-^-) = (\tfrac{3}{2})^{1/2}A(\Sigma_+^+) + \sqrt{3}A(\Sigma_0^+)\,, \tag{16d}$$

$$A(\lambda_-^0) = A(\hat{\sigma}_-^-)\,, \tag{16e}$$

$$\sqrt{2}[A(n_-^0) + A(\xi_-^-)] = A(\sigma_-^-) - A(\sigma_-^0)\,, \tag{16f}$$

and

$$\sqrt{3}[A(\lambda_-^0) + A(\hat{\sigma}_-^-)] - \sqrt{2}[A(n_-^0) - A(\xi_-^-)] = \frac{4\sqrt{2}\tan\theta}{(1 - i\psi)}A(\Sigma_+^+) - \tan^2\theta[A(\sigma_-^-) + A(\sigma_-^0)]\,. \tag{16g}$$

As before, there are eight sum rules relating the CP-violating parts of the amplitudes. The six relations (14a)–(14f) remain unaffected. In addition, we have

$$[\tilde{A}(\lambda_0^0) - \tilde{A}(\sigma_0^0)] = (\tfrac{4}{3})^{1/2}(1 + 4\cot^2\theta)\tilde{A}(\hat{\sigma}_0^0) \tag{17a}$$

and

$$[\tilde{A}(\sigma_0^0) - \tilde{A}(\sigma_0^-)] = \tfrac{1}{2}[\tilde{A}(\sigma_-^-) - \tilde{A}(\sigma_-^0)] + [\tilde{A}(\sigma_-^-) + \tilde{A}(\sigma_-^0)]\,. \tag{17b}$$

It is possible to estimate the decay amplitudes using the values for the parameters given in Table I. For $\rho = \psi$ we have

$$\begin{aligned} &A(\Lambda_-^0) = (3.7 + i\psi\,0.14)\times 10^{-7},\quad A(\Xi_-^-) = (5.3 + i\psi 0.61)\times 10^{-7},\quad A(\Sigma_+^+) = (0.41 - i\psi 0.15)\times 10^{-7}, \\ &A(n_-^0) = (0.426 - i\psi 0.125)\times 10^{-7},\quad A(p_0^+) = i\psi 6.22\times 10^{-7},\quad A(n_0^0) = i\psi 6.054\times 10^{-7}. \end{aligned} \tag{18}$$

For $\rho = -\psi$ we have

$$\begin{aligned} &A(\Lambda_-^0) = (1 - i\psi)3.7\times 10^{-7},\quad A(\Xi_-^-) = (1 - i\psi)5.3\times 10^{-7},\quad A(\Sigma_+^+) = (1 - i\psi)0.41\times 10^{-7}, \\ &A(n_-^0) = (0.426 - i\psi 0.125)\times 10^{-7},\quad A(p_0^+) = -i\psi 5.878\times 10^{-7},\quad A(n_0^0) = -i\psi 6.046\times 10^{-7}. \end{aligned} \tag{19}$$

The CP-conserving parts of the $\Delta S = 1$ nonleptonic decay amplitudes of Eqs. (18) or (19) are in reasonable agreement with experimental values[13]

$$A_{\text{expt}}(\Lambda_-^0) = 3.3\times 10^{-7},\quad A_{\text{expt}}(\Xi_-^-) = 4.4\times 10^{-7},\quad \text{and}\quad A(\Sigma_+^+) = 0.001\times 10^{-7}.$$

Also, the numerical estimates for the amplitudes $A(n_-^0)$, $A(p_0^+)$, and $A(n_0^0)$ of Eqs. (18) and (19) are *predictions* based on the saturation scheme of Chiu, Schechter and Ueda.[6]

IV. THE P- AND T-VIOLATING PION-EXCHANGE N-N POTENTIAL

The Glashow model[2] predicts the existence of weak nuclear forces which simultaneously violate P and T invariance. At present there exists experimental evidence for parity mixing in the energy levels in nuclei, and it is of theoretical interest to estimate the effects of simultaneous breakdown of P and T invariance.[14]

The one-pion exchange contribution to the weak parity-violating nucleon-nucleon potential was derived by McKellar[15] by using current algebra and the soft-pion technique to relate the weak $NN\pi$ vertex to the $\Delta S=1$ hyperon decay amplitudes. Here we wish to obtain the P- and T-violating pion-exchange potential. Due to T violations, Barton's theorem[16] regarding the absence of neutral pseudoscalar particle exchanges is no longer valid. Therefore there will be contributions from the π^0- and η^0-exchange potentials.

For $\pi^\pm$ exchanges the weak $NN\pi$ vertex is given by

$$A(n\to p\pi^-)=A_R(n^0_-)+iA_I(n^0_-) \text{ and } A(p\to n\pi^+)=-A_R(n^0_-)+iA_I(n^0_-)\,, \tag{20}$$

where A_R and A_I are the P-violating and CP-violating parts of the amplitude. This leads to a real, Hermitian nucleon-nucleon potential of the form

$$V_{\pi^\pm}(x)=\frac{ig[A_R(n^0_-)]}{\sqrt{2}\,8\pi M_N}(\vec{\sigma}_1+\vec{\sigma}_2)\cdot\vec{\nabla}\frac{\bar{e}^{m_\pi x}}{x}(\tau_1^{(+)}\tau_2^{(-)}-\tau_1^{(-)}\tau_2^{(+)})-\frac{gA_I(n^0_-)}{\sqrt{2}\,8\pi M_N}(\vec{\sigma}_1-\vec{\sigma}_2)\cdot\vec{\nabla}\frac{\bar{e}^{m_\pi x}}{x}(\tau_1^{(+)}\tau_2^{(-)}+\tau_1^{(-)}\tau_2^{(+)})\,, \tag{21}$$

with g being the strong-interaction coupling constant ($g^2/4\pi=14.4$).

For the weak π^0-exchange potentials we have

$$V_{\pi^0}(x)=\frac{-gA_I(N)}{\sqrt{2}\,8\pi M_N}(\vec{\sigma}_1-\vec{\sigma}_2)\cdot\vec{\nabla}\frac{\bar{e}^{m_\pi x}}{x}(2\tau_1^{(3)}\tau_2^{(3)})\,. \tag{22}$$

where $A_1(N)$ denotes $A_1(p_0^+)$ or $A_1(n_0^0)$.

The P- and T-violating potential (the second term) of Eq. (21) can be expressed in terms of the PT-violating potentials of Eq. (22) on using the relation of Eq. (14a).

The η^0- exchange potential can also be obtained in an analogous manner. However, the extrapolation involved in the soft-η^0 calculation is much more than the extrapolation for the soft-pion calculations. For the sake of completeness, we note that

$$A(p\to p\eta^0)\simeq i\psi(2\sqrt{6}/3)\mathcal{G}_2(\tfrac{7}{10}\tau'+\tfrac{2}{3}\delta'+\sigma')=i\psi 0.2\times10^{-7}$$

and (23)

$$A(n\to n\eta^0)\simeq i\psi(2\sqrt{6}/3)\mathcal{G}_2(-\tfrac{1}{10}\tau'-\tfrac{1}{3}\delta'-\varphi'+\sigma')=i\psi 4.4\times10^{-10}\,.$$

The form of the η^0-exchange potential will be the same as π^0-exchange potential (22) except that m_π is now replaced by m_η, and the isospin operators are absent.

V. DISCUSSION

In the current×current model of weak interactions, Sugawara and Suzuki[5] showed that an application of current algebra and the soft-pion technique leads to an understanding of s-wave hyperon decays. The s-wave amplitudes are related to the matrix elements of the current×current Hamiltonian between single baryon states. This simplification allows an evaluation of the nonleptonic decay amplitudes using data on the semileptonic decays as input[6] and leads to (i) prediction for the amplitudes which are in reasonable agreement with experiment, (ii) octet dominance in nonleptonic decays, and (iii) the d/f ratio of the matrix elements which are in agreement with experiment.

The same technique is used in this paper to make predictions for the CP-violating effects. Glashow's model has been used to take into account CP violations while retaining the current ×current form of the weak Hamiltonian. Octet dominance of the sum and the difference of the vector and the axial-vector spurions of Eqs. (6) and (7) leads to the prediction that the CP-violating amplitudes also exhibit octet dominance.

For $\rho=\psi$ the CP-violating amplitude in $A(\Lambda^0_-)$ is much smaller than the CP-violating amplitudes in $A(\Xi^-_-)$ and $A(\Sigma^-_-)$ and may be difficult to detect experimentally. On the other hand, for $\rho=-\psi$ the s-wave $\Delta S=1$ decay amplitudes are given by the usual[5,6] expressions multiplied by a phase factor $(1-i\psi)$. For $\rho=\psi$ the weak hadronic currents can be obtained from the strangeness-conserving current by a rotation in $SU(3)$ space, just as in the Cabibbo hypothesis. Also, for $\rho=\psi$ there will be no CP-violating effects in the parity-conserving $\Delta S=1$ decays.[17] The sum rules in Sec. III for the $\Delta S=0$ and the $\Delta S=1$ amplitudes are of interest. Simple relations among amplitudes are obtained when we set $\rho=\pm\psi$. However, the phase angles need not, in general, be equal in magnitude.

In this paper it has been shown that specific predictions can be made regarding the weak pion-exchange potentials derivable from Glashow's model. An experimental detection of the simultaneous violation of P and T invariance in nuclear physics[14,18] is beyond the scope of the present-day technology, since PT violations are smaller than the P violations by a factor of 10^{-3}.

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Violation of the Pomeranchuk-Theorem Conditions and the Odd-Signature Amplitude

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We discuss the properties of the odd-signature amplitude in the case that the total cross sections of the particle and antiparticle tend to constant but different limits at high energy. The imaginary and real part of the odd-signature amplitude must be correlated by a simple relation and also be subjected to various stringent conditions. Sum rules are obtained that can be used as a test of the violation of the Pomeranchuk theorem. A specific model is proposed satisfying these conditions, and some consequences are discussed.

There have recently been wide theoretical investigations[1-9] motivated by the Serpukhov experiment.[10] In the case where the total cross sections of the particle σ^p and antiparticle σ^a tend to constant but different limits, it necessarily follows from analyticity, crossing, and polynomial boundedness that the real parts of both amplitudes $F^{p,a}(s,t=0)$ behave as $\pm s \ln s$ as $s\to\infty$.[11] In the original work of Pomeranchuk, this behavior was rejected on physical grounds, and $\lim \sigma^p = \lim \sigma^a$ followed. Although in some cases or by some assumptions this physical assumption can be replaced by unitarity,[12] we cannot reject the $\pm s \ln s$ behavior in general by the fundamental requirement of the field theory. Indeed, experimental confirmation of the high-energy behavior of the real part of the scattering amplitudes in the forward direction was urged in Refs. 1 and 2. We re-