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Charm-changing decays of $1/2^+$ and $3/2^+$ baryons in SU(3) dynamical scheme

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We discuss here the two-body weak decays of charmed baryons in a simple SU(3) dynamical scheme. Considering the decays $B \rightarrow B' + P$ in s, t, and u channels and assuming the dominance of nonexotic intermediate states, several decay amplitudes are obtained. We find that the the parity-violating decays in $B(3) \rightarrow B(8) + P(3^*)$, $B(3) \rightarrow D(10) + P(3^*)$, and $B(3^*) \rightarrow D(10) + P(8)$ channels are forbidden independent of the nature of the weak current. We obtain null asymmetries for the weak decays of singlet charmed isobar Ω_3^{*++}.

I. INTRODUCTION

Weak hadronic decays of charmed baryons have been studied in the framework of SU(4) and SU(8) symmetries.[1] Keeping in mind that SU(4) is badly broken, such studies have also been made in the framework of SU(3).[2] In the current⊗current picture of weak interactions, the SU(3) weak Hamiltonian can belong to the $\underline{3} + \underline{6}^* + \underline{15}$ representations, but no useful information can be obtained because of too many parameters. In the uncharmed sector, while leptonic and semileptonic decays are described successfully,[3] the weak nonleptonic decays are not well explained even at the phenomenological level. The lack of simple understanding of the $\Delta I = \frac{1}{2}$ enhancement has made its generalization unclear. Its simple extension to SU(4), i.e., to the $\underline{20}''$ dominance in the Glashow-Iliopoulos-Maiani (GIM) model leads to many unsatisfactory features.[4] Even at the SU(3) level, $\underline{6}^*$ dominance suppresses[5] $D^+ \rightarrow \bar{K}^0\pi^+$, while experimentally, its branching fraction is found to be comparable to $D^0 \rightarrow K^-\pi^+$, the GIM-allowed decay.[6] Therefore, substantial contributions from other parts of the SU(3) weak Hamiltonian, such as $\underline{3}$ and $\underline{15}$, seem to be present. But in the presence of these components, the predictive power of SU(3) is further decreased. Recently, we[7] have deduced most of the observed features of nonleptonic decays of ordinary hyperons in a simple dynamical consideration. Taking the decay $B \rightarrow B' + P$ as an $S + B \rightarrow B' + P$ scattering process, the decay amplitudes are expressed in terms of eigenamplitudes in different channels corresponding to each intermediate state.[8] By assuming that the nonexotic intermediate states[9] contribute dominantly, the hypothesis of octet dominance for the parity-violating (PV) weak Hamiltonian is obtained. Further, the assumption of the identity of s- and u-channel reduced matrix elements leads to well-satisfied relations such as $\Sigma_+^+ = 0$ for the PV mode and the Lee-Sugawara sum rule for the parity-conserving (PC) mode, etc. In the case of Ω^- decays, such considerations allow a $\Delta I = \frac{3}{2}$ contribution which was observed to be about 20–25% in a recent CERN experiment.[10] In this analysis, PV decays are found to arise mainly through the t channel and PC decays obtain dominant contributions from s and u channels. These results are in accordance with the results of current-algebra and duality arguments. Using duality arguments, Nussinov and Rosner[11] have shown that for s-wave decays, the low-energy pole contribution is relatively small and the Regge contribution dominates. In the current-algebra framework,[12] PV decays get a contribution through the equal-time commutator (ETC) term which in our analysis corresponds to t-channel contributions. For PC decays, small t-channel contributions are understandable since, here, unnatural-parity states appear which have low Regge intercepts. Similar structures for PV and PC decays have also been obtained in the constitutent-rearrangement quark model.[13]

In this paper, we employ similar dynamical assumptions in order to study the weak Hamiltonian structure for charm-changing decays in the SU(3)-symmetry framework, where the current ⊗current weak Hamiltonian transforms like $\underline{3} + \underline{6}^* + \underline{15}$ representations of SU(3). Constraints on the reduced matrix elements for the process $S + B \rightarrow B' + P$ are obtained by assuming the nonexoticity of the intermediate states. The identity of s- and u-channel reduced matrix elements cannot be applied here, since the initial and the final baryons belong to different representations. In the GIM model H_W^3 is suppressed as a result of the cancellation of the adjoint representation at the SU(4) level.

We discuss the weak hadronic decays of $\frac{1}{2}^+$ and $\frac{3}{2}^+$ baryons. Because of the heavy mass of the charm quark, new channels open up for the charm-changing decays of $\frac{1}{2}^+$ baryons. In addition to $B(\frac{1}{2}^+) \rightarrow B(\frac{1}{2}^+) + P(0^-)$ channels, $\frac{1}{2}^+$ baryons can decay like $B(\frac{1}{2}^+) \to D(\frac{3}{2}^+) + P(0^-)$, $B(\frac{1}{2}^+) \to B(\frac{1}{2}^+) + V(1^-)$, $B(\frac{1}{2}^+) \to D(\frac{3}{2}^+) + V(1^-)$ also. We obtain decay amplitudes for these channels for $\Delta C = \Delta S$ as well as the $\Delta C = -1$, $\Delta S = 0$ mode. Of the $\frac{3}{2}^+$ charmed isobars, Ω_3^{*++} $(C=3)$ is expected to decay through weak interactions only. Weak decays of Ω_3^{*++} are also discussed. Since recent data[14] on charm mesonic decays do not favor $\underline{6}^*$ dominance in the GIM weak Hamiltonian, this may indicate the presence of higher representations other than $\underline{20}''$ at the SU(4) level. Moreover, it has been argued by Ellis, Gaillard, and Nanopoulos[15] that short-distance enhancement for the sextet component is not as effective for charmed-particle decays as for ordinary decays due to the heavy charmed-quark mass. Therefore, we start with the general weak Hamiltonian $(\underline{6}^* + \underline{15})$. In our analysis, we do not get dominance of any of these representations. However, we discuss the implications of $\underline{6}^*$ dominance on weak decays.

In Sec. II, we discuss the details of the method and in Sec. III, the decay amplitudes are derived for $\Delta C = \Delta S$ as well as $\Delta C = -1$, $\Delta S = 0$ mode. In the last section, we discuss the results.

II. PRELIMINARIES

The GIM left-handed weak current[16] belongs to the $\underline{15}$ representation of SU(4) and has the following SU(3) components:

$$J_L^8 = \bar{u}\gamma_\mu(1+\gamma_5)d\cos\theta_C + \bar{u}\gamma_\mu(1+\gamma_5)s\sin\theta_C\,, \quad (2.1)$$

$$J_L^3 = -\bar{c}\gamma_\mu(1+\gamma_5)d\sin\theta_C + \bar{c}\gamma_\mu(1+\gamma_5)s\cos\theta_C\,. \quad (2.2)$$

The superscript denotes the SU(3) representation and θ_C is the Cabibbo angle. The weak Hamiltonian $H_W \sim \{J, J^\dagger\}$ then has the following SU(3) parts:

$$H_W \sim [\{\underline{8},\underline{8}\},\{\underline{3},\underline{3}^*\}]_{\Delta C=0} + \{\underline{3},\underline{8}\}_{\Delta C=-1} + \{\underline{8},\underline{3}^*\}_{\Delta C=+1}\,. \quad (2.3)$$

We are interested in the charm-changing $(\Delta C = -1)$ piece of the weak Hamiltonian belonging to the SU(3) representations present in the direct product

$$\underline{3} \otimes \underline{8} = \underline{3} \oplus \underline{6}^* \oplus \underline{15}\,. \quad (2.4)$$

H_W^3 is suppressed as a result of cancellation of H_W^{15} in SU(4).[17] Tensor structure of the Hamiltonian $(\underline{6}^* + \underline{15})$ corresponding to the three modes $(\Delta S = -1, 0, +1)$ of charm-changing decays is given by

$$H_W^{\Delta C=-1} \sim (T^2_{[13]} + T^2_{(13)})\cos^2\theta_C, \quad \text{for } \Delta S = -1\,,$$
$$\sim (T^3_{[12]} + T^3_{(12)})\sin^2\theta_C, \quad \text{for } \Delta S = +1\,, \quad (2.5)$$
$$\sim (T^2_{[12]} - T^3_{[13]} + T^2_{(12)} - T^3_{(13)})\cos\theta_C\sin\theta_C, \quad \text{for } \Delta S = 0\,,$$

where $T^a_{[bc]}$ and $T^a_{(bc)}$ are tensors representing $\underline{6}^*$ and $\underline{15}$ representations of SU(3), respectively. In order to obtain constraints on the reduced matrix elements, we consider the hyperon decay $A \to B + P$ as $S + A \to B + P$ scattering process[7] in all the three s, t, and u channels, where the weak spurion S has the same tensor structure as the weak Hamiltonian so that all the strong quantum numbers in the above reaction are conserved. The transition amplitudes are expressed in terms of reduced amplitudes

$$\langle B'\|P\|m\rangle\langle m\|S\|B\rangle \quad \text{for } s \text{ channel } (S+B \to m \to B' + P)\,, \quad (2.6)$$

$$\langle P\|\bar{S}\|m\rangle\langle m\|\bar{B}'\|B\rangle \quad \text{for } t \text{ channel } (B + \bar{B}' \to m \to P + \bar{S})\,, \quad (2.7)$$

$$\langle B'\|\bar{S}\|m\rangle\langle m\|\bar{P}\|B\rangle \quad \text{for } u \text{ channel } (B + \bar{P} \to m \to B' + \bar{S}) \quad (2.8)$$

The baryon intermediate states then appear in the s and u channels and meson states are exchanged in the t channel. We assume that the effective contribution to the decays comes mainly from the single-particle nonexotic intermediate states.[9] It has earlier been noticed[7] that this assumption leads to most of the observed features of the nonleptonic decays of ordinary baryons $B(8) \to B(8) + P(8)$ and those of Ω^-. Here, we consider the nonleptonic weak decays of $B(3^*)$ and $B(3)$ multiplets only since the present mass spectroscopy[18] of hadrons allows all the particles except Ω_1^0 of the $B(6)$ multiplet to decay to $B(3^*)$ baryons[19] through the strong and/or the electromagnetic interaction. Among $\frac{3}{2}^+$ charmed isobars, Ω_3^{*++} is stable against strong and electromagnetic interactions. In the next section, we consider the two-body weak hadronic decays of $B(3^*)$, $B(3)$ multiplets, and charmed isobar Ω_3^{*++}.

III. DECAY AMPLITUDES

Contributions in s, t, and u channels coming from different components of weak Hamiltonians for the various decay modes are given in the corresponding tables. In writing the amplitudes, we choose positive phases for all the $\frac{1}{2}^+$ baryons. It has been observed[7] that for the ordinary hadrons the PV weak decays arise through t channels only and PC weak decays acquire dominant contributions from s and u channels. Assuming that the same is true also for the charmed baryons[20] we obtain the following relations.

A. $\Delta C = \Delta S$ decay mode

(a) $B(\frac{1}{2}^+) \to B(\frac{1}{2}^+) + P(0^-)$. $H_W^{6^*+15}$ leads to

(i) $B(3^*) \to B(8) + P(8)$ *(Table I).*

TABLE I. $\Delta C = \Delta S$ decays of $B(3^*)$. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\cos^2\theta_C$.

	t channel		s channel					u channel			
	6*	15	6*		15			6*		15	
$B(3^*)\to B(8)+P(8)$	$a^t_{3^*}$	$A^t_{3^*}$	$a^s_{8_1}$	$a^s_{8_2}$	$A^s_{8_1}$	$A^s_{8_2}$	A^s_{10}	$a^u_{3^*}$	a^u_6	$A^u_{3^*}$	A^u_6
$\Lambda_1'^+\to p\bar{K}^0$	1	1	−1	−1	1	1	$-\frac{2}{3}$	0	0	0	0
$\Lambda\pi^+$	$2/\sqrt{6}$	$-2/\sqrt{6}$	$-2/\sqrt{6}$	0	$2/\sqrt{6}$	0	$2/\sqrt{6}$	0	$1/\sqrt{6}$	0	$1/\sqrt{6}$
$\Sigma^+\pi^0$	0	0	0	$-\sqrt{2}$	0	$-\sqrt{2}$	$-\sqrt{2}/3$	0	$1/\sqrt{2}$	0	$1/\sqrt{2}$
$\Sigma^+\eta$	0	0	$-2/\sqrt{6}$	0	$2/\sqrt{6}$	0	$-2/\sqrt{6}$	$-2/\sqrt{6}$	0	$-2/\sqrt{6}$	$2/\sqrt{6}$
$\Sigma^0\pi^+$	0	0	0	$-\sqrt{2}$	0	$\sqrt{2}$	$\sqrt{2}/3$	0	$-1/\sqrt{2}$	0	$-1/\sqrt{2}$
Ξ^0K^+	0	0	−1	1	1	−1	$\frac{2}{3}$	−1	$\frac{1}{2}$	1	$\frac{1}{2}$
$\Xi_1'^0\to\Lambda\bar{K}^0$	$1/\sqrt{6}$	$1/\sqrt{6}$	$-1/\sqrt{6}$	$-3/\sqrt{6}$	$-3/\sqrt{6}$	$-1/\sqrt{6}$	$-4/3\sqrt{6}$	0	$-1/\sqrt{6}$	0	$-1/\sqrt{6}$
Σ^+K^-	0	0	1	−1	1	1	$\frac{2}{3}$	1	$-\frac{1}{2}$	1	$\frac{1}{2}$
$\Sigma^0\bar{K}^0$	$1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$-\sqrt{2}/3$	0	$1/\sqrt{2}$	0	$-1/\sqrt{2}$
$\Xi^0\pi^0$	0	0	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$\sqrt{2}/3$	$-1/\sqrt{2}$	$-1/2\sqrt{2}$	$1/\sqrt{2}$	$-1/2\sqrt{2}$
$\Xi^0\eta$	0	0	$-1/\sqrt{6}$	$3/\sqrt{6}$	$-1/\sqrt{6}$	$3/\sqrt{6}$	$2/\sqrt{6}$	$-1/\sqrt{6}$	$-3/2\sqrt{6}$	$1/\sqrt{6}$	$-5/2\sqrt{6}$
$\Xi^-\pi^+$	1	−1	−1	−1	−1	−1	$\frac{2}{3}$	0	0	0	0
$\Xi_1'^+\to\Sigma^+\bar{K}^0$	1	1	0	0	0	0	0	1	$\frac{1}{2}$	1	$-\frac{1}{2}$
$\Xi^0\pi^+$	−1	1	0	0	0	0	0	−1	$-\frac{1}{2}$	1	$-\frac{1}{2}$

PV mode:

$$\langle\Sigma^+\pi^0|\Lambda_1'^+\rangle=\langle\Sigma^+\eta|\Lambda_1'^+\rangle=\langle\Sigma^0\pi^+|\Lambda_1'^+\rangle=\langle\Xi^0K^+|\Lambda_1'^+\rangle=\langle\Sigma^+K^-|\Xi_1'^0\rangle=\langle\Xi^0\eta|\Xi_1'^0\rangle=\langle\Xi^0\pi^0|\Xi_1'^0\rangle=0\,, \quad (3.1)$$

$$\langle p\bar{K}^0|\Lambda_1'^+\rangle=\langle\Sigma^+\bar{K}^0|\Xi_1'^+\rangle=\sqrt{2}\langle\Sigma^0\bar{K}^0|\Xi_1'^0\rangle=\sqrt{6}\langle\Lambda\bar{K}^0|\Xi_1'^0\rangle\,, \quad (3.2)$$

$$(\tfrac{3}{2})^{1/2}\langle\Lambda\pi^+|\Lambda_1'^+\rangle=-\langle\Xi^0\pi^+|\Xi_1'^+\rangle=\langle\Xi^-\pi^+|\Xi_1'^0\rangle\,, \quad (3.3)$$

PC mode:

$$\langle\Sigma^+\pi^0|\Lambda_1'^+\rangle=-\langle\Sigma^0\pi^+|\Lambda_1'^+\rangle\,, \quad (3.4)$$

$$\sqrt{2}\langle\Xi^0\pi^0|\Xi_1'^0\rangle-\langle\Xi^-\pi^+|\Xi_1'^0\rangle=\langle\Xi^0\pi^+|\Xi_1'^+\rangle\,, \quad (3.5)$$

$$\langle\Sigma^+\bar{K}^0|\Xi_1'^+\rangle-\langle\Xi^0\pi^+|\Xi_1'^+\rangle=2[\langle\Sigma^+K^-|\Xi_1'^0\rangle+\sqrt{2}\langle\Sigma^0\bar{K}^0|\Xi_1'^0\rangle]\,. \quad (3.6)$$

$\Xi_1'^+$ decays are forbidden in the s channel.

(ii) $B(3)\to B(8)+P(3^*)$ (Table II).

PV mode:

$$\langle\Sigma^+D^+|\Xi_2^{++}\rangle=\langle\Sigma^+D^0|\Xi_2^+\rangle=\langle\Lambda D^+|\Xi_2^+\rangle=\langle\Sigma^0D^+|\Xi_2^+\rangle=\langle\Xi^0F^+|\Xi_2^+\rangle=\langle\Xi^0D^+|\Omega_2^+\rangle=0\,, \quad (3.7)$$

PC mode:

$$\langle\Sigma^+D^+|\Xi_2^{++}\rangle+\langle\Sigma^+D^0|\Xi_2^+\rangle+\sqrt{2}\langle\Sigma^0D^+|\Xi_2^+\rangle=0\,. \quad (3.8)$$

Since all the decay amplitudes vanish in the PV mode, null asymmetries are indicated.[21] Notice also that Ξ_2^{++} and Ω_2^+ decay only through the u channel.

(iii) $B(3)\to B(3^*)+P(8)$ (Table II).

PV mode:

$$\langle\Xi_1'^+\pi^0|\Xi_2^+\rangle=\langle\Xi_1'^+\eta|\Xi_2^+\rangle=0\,, \quad (3.9)$$

$$\langle\Xi_1'^+\pi^+|\Xi_2^{++}\rangle=-\langle\Xi_1'^0\pi^+|\Xi_2^+\rangle\,, \quad (3.10)$$

$$\langle\Xi_1'^+\bar{K}^0|\Omega_2^+\rangle=-\langle\Lambda_1'^+\bar{K}^0|\Xi_2^+\rangle\,, \quad (3.11)$$

PC mode:

$$\langle\Xi_1'^0\pi^+|\Xi_2^+\rangle+\sqrt{2}\langle\Xi_1'^+\pi^0|\Xi_2^+\rangle=-\langle\Xi_1'^+\pi^+|\Xi_2^{++}\rangle\,, \quad (3.12)$$

$$\sqrt{6}\langle\Xi_1'^+\eta|\Xi_2^+\rangle+\langle\Xi_1'^0\pi^+|\Xi_2^+\rangle-2\langle\Lambda_1'^+\bar{K}^0|\Xi_2^+\rangle=\langle\Xi_1'^+\pi^+|\Xi_2^{++}\rangle\,. \quad (3.13)$$

Ξ_2^{++} and Ω_2^+ decays do not arise through the s channel.

(iv) $B(3)\to B(6)+P(8)$ (Table II).

PV mode:

$$\langle\Sigma_1^{++}K^-|\Xi_2^+\rangle=\langle\Xi_1^+\eta|\Xi_2^+\rangle=\langle\Xi_1^+\eta|\Xi_2^+\rangle=\langle\Xi_1^+\pi^0|\Xi_2^+\rangle=\langle\Omega_1^0K^+|\Xi_2^+\rangle=0\,, \quad (3.14)$$

$$\langle\Sigma_1^{++}\bar{K}^0|\Xi_2^{++}\rangle=\sqrt{2}\langle\Sigma_1^+\bar{K}^0|\Xi_2^+\rangle=\sqrt{2}\langle\Xi_1^+\bar{K}^0|\Omega_2^+\rangle\,, \quad (3.15)$$

$$\sqrt{2}\langle\Xi_1^+\pi^+|\Xi_2^{++}\rangle=\sqrt{2}\langle\Xi_1^0\pi^+|\Xi_2^+\rangle=\langle\Omega_1^0\pi^+|\Omega_2^+\rangle\,, \quad (3.16)$$

PC mode:

$$\langle\Sigma_1^{++}\bar{K}^0|\Xi_2^{++}\rangle=\langle\Omega_1^0\pi^+|\Omega_2^+\rangle=0\,, \quad (3.17)$$

$$\langle\Xi_1^+\pi^+|\Xi_2^{++}\rangle=\langle\Xi_1^0\pi^+|\Xi_2^+\rangle-\sqrt{2}\langle\Xi_1^+\pi^0|\Xi_2^+\rangle=\langle\Xi_1^+\bar{K}^0|\Omega_2^+\rangle\,, \quad (3.18)$$

$$\sqrt{2}\langle\Xi_1^0\pi^+|\Xi_2^+\rangle=\langle\Omega_1^0K^+|\Xi_2^+\rangle\,, \quad (3.19)$$

$$\langle\Sigma_1^{++}K^-|\Xi_2^+\rangle=\sqrt{2}\langle\Sigma_1^+\bar{K}^0|\Xi_2^+\rangle\,. \quad (3.20)$$

Here, also, there is null contribution to decays of Ξ_2^{++} and Ω_2^+ baryons in the s channel. $\underline{6}^*$ dominance of the weak Hamiltonian leads to the following addi-

TABLE II. $\Delta C = \Delta S$ decays of $B(3)$. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\cos^2\theta_C$.

	t channel 6* (no nonexotic state)	t channel 15	s channel 6*	s channel 15	u channel 6*	u channel 6*	u channel 15	u channel 15
$B(3) \to B(8) + P(3^*)$			$b^s_{3^*}$	B^s_6	$b^u_{3^*}$	b^u_6	B^u_3	B^u_6
$\Xi_2^{++} \to \Sigma^+ D^+$	0	0	0	0	-1	-1	1	-1
$\Xi_2^{+} \to \Lambda D^+$	0	0	$-2/\sqrt{6}$	$-3/\sqrt{6}$	0	$-2/\sqrt{6}$	0	$\sqrt{6}$
$\Sigma^+ D^0$	0	0	2	1	1	-1	-1	-1
$\Sigma^0 D^+$	0	0	$-\sqrt{2}$	$-1/\sqrt{2}$	0	$\sqrt{2}$	0	$\sqrt{2}$
$\Xi^0 F^+$	0	0	2	-1	0	-1	1	1
$\Omega_2^+ \to \Xi^0 D^+$	0	0	0	0	-1	-1	-1	1

$B(3) \to B(3^*) + P(8)$	$c^t_{3^*}$	$C^t_{3^*}$	$c^s_{3^*}$	C^s_6	c^u_3	(no nonexotic state)
$\Xi_2^{++} \to \Xi_1'^{+}\pi^+$	1	1	0	0	2	0
$\Xi_2^{+} \to \Lambda_1'^{+}\bar{K}^0$	-1	1	2	1	0	0
$\Xi_1'^{+}\pi^0$	0	0	$-\sqrt{2}$	$1/\sqrt{2}$	$-\sqrt{2}$	0
$\Xi'^{+}\eta$	0	0	$2/\sqrt{6}$	$3/\sqrt{6}$	$2/\sqrt{6}$	0
$\Xi'^{0}\pi^+$	-1	-1	2	-1	0	0
$\Omega_2^+ \to \Xi_1'^{+}\bar{K}^0$	1	-1	0	0	2	0

$B(3) \to B(6) + P(8)$	$d^t_{3^*}$	$D^t_{3^*}$	$d^s_{3^*}$	D^s_6	no nonexotic state	D^u_3
$\Xi_2^{++} \to \Sigma_1^{++}\bar{K}^0$	-1	1	0	0	0	0
$\Xi_1^{+}\pi^+$	$1/\sqrt{2}$	$1/\sqrt{2}$	0	0	0	$\sqrt{2}$
$\Xi_2^{++} \to \Sigma_1^{++}\bar{K}^0$	0	0	1	1	0	0
$\Sigma_1^{+}\bar{K}^0$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$1/\sqrt{2}$	$1/\sqrt{2}$	0	0
$\Xi_1^{+}\pi^0$	0	0	$-\frac{1}{2}$	$\frac{1}{2}$	0	-1
$\Xi_1^{+}\eta$	0	0	$-\sqrt{3}/2$	$-1/\sqrt{3}$	0	$1/\sqrt{3}$
$\Xi_1^{0}\pi^+$	$1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	0	0
$\Omega_1^{0}K^+$	0	0	-1	1	0	0
$\Omega_2^+ \to \Xi_1^{+}\bar{K}^0$	$-1/\sqrt{2}$	$1/\sqrt{2}$	0	0	0	$\sqrt{2}$
$\Omega_1^{0}\pi^+$	1	1	0	0	0	0

tional relations:

for the PV mode:

$$\sqrt{3}\langle \Lambda\pi^+ | \Lambda_1'^{+}\rangle = \sqrt{2}\langle p\bar{K}^0 | \Lambda_1'^{+}\rangle , \qquad (3.21)$$

$$\langle \Lambda_1'^{+}\bar{K}^0 | \Xi_2^{+}\rangle = \langle \Xi_1'^{0}\pi^+ | \Xi_2^{+}\rangle , \qquad (3.22)$$

$$\langle \Sigma_1^{+}\bar{K}^0 | \Xi_2^{+}\rangle = -\langle \Xi_1^{0}\pi^+ | \Xi_2^{+}\rangle ; \qquad (3.23)$$

for the PC mode:

$$\langle p\bar{K}^0 | \Lambda_1'^{+}\rangle = \langle \Xi^-\pi^+ | \Xi_1'^{0}\rangle , \qquad (3.24)$$

$$\langle \Xi^0 K^+ | \Lambda_1'^{+}\rangle = -\langle \Sigma^+ K^- | \Xi_1'^{0}\rangle , \qquad (3.25)$$

$$(\tfrac{2}{3})^{1/2}\langle \Sigma^+\bar{K}^0 | \Xi_1'^{+}\rangle = 2\langle \Lambda\bar{K}^0 | \Xi_1'^{0}\rangle + \sqrt{3}\langle \Sigma^+\pi^0 | \Lambda_1'^{+}\rangle - \langle \Sigma^+\eta | \Lambda_1'^{+}\rangle , \qquad (3.26)$$

$$\langle \Sigma^+ D^+ | \Xi_2^{++}\rangle = \langle \Xi^0 D^+ | \Omega_2^{+}\rangle , \qquad (3.27)$$

$$\sqrt{3}\langle \Lambda D^+ | \Xi_2^{+}\rangle + \langle \Sigma^0 D^+ | \Xi_2^{+}\rangle = 0 , \qquad (3.28)$$

$$\langle \Xi_1'^{+}\pi^0 | \Xi_2^{+}\rangle = -\sqrt{3}\langle \Xi_1'^{+}\eta | \Xi_2^{+}\rangle , \qquad (3.29)$$

$$\langle \Xi_1'^{0}\pi^+ | \Xi_2^{+}\rangle = \langle \Lambda_1'^{+}\bar{K}^0 | \Xi_2^{+}\rangle , \qquad (3.30)$$

$$\langle \Xi_1'^{+}\pi^+ | \Xi_2^{++}\rangle = \langle \Xi_1'^{+}\bar{K}^0 | \Omega_2^{+}\rangle , \qquad (3.31)$$

TABLE III. $\Delta C = \Delta S$ decays $(\frac{1}{2}^+ \to \frac{3}{2}^+ + 0^-)$. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\cos^2\theta_C$.

	t channel		s channel			u channel		
	6*	15	6*	15		6*	15	
$B(3^*) \to D(10) + P(8)$	no nonexotic state		e_8^s	E_8^s	E_{10}^s	no nonexotic state	$E_{3^*}^u$	E_6^u
$\Lambda_1'^+ \to \Delta^{++}K^-$	0	0	-1	1	$\frac{2}{3}$	0	0	0
$\Delta^+\bar{K}^0$	0	0	$-1/\sqrt{3}$	$1/\sqrt{3}$	$2/3\sqrt{3}$	0	0	0
$\Sigma^{*+}\pi^0$	0	0	$1/\sqrt{6}$	$-1/\sqrt{6}$	$4/3\sqrt{6}$	0	0	$2/\sqrt{6}$
$\Sigma^{*+}\eta$	0	0	$1/\sqrt{2}$	$-1/\sqrt{2}$	0	0	$-2\sqrt{2}/3$	$-\sqrt{2}/3$
$\Sigma^{*0}\pi^+$	0	0	$1/\sqrt{6}$	$-1/\sqrt{6}$	$4/3\sqrt{6}$	0	0	$2/\sqrt{6}$
$\Xi^{*0}K^+$	0	0	$1/\sqrt{3}$	$-1/\sqrt{3}$	$4/3\sqrt{3}$	0	$-2/\sqrt{3}$	0
$\Xi_1'^+ \to \Sigma^{*+}\bar{K}^0$	0	0	0	0	0	0	$2/\sqrt{3}$	$2/\sqrt{3}$
$\Xi^{*0}\pi^+$	0	0	0	0	0	0	$-2/\sqrt{3}$	$-2/\sqrt{3}$
$\Xi_1'^0 \to \Sigma^{*+}K^-$	0	0	$1/\sqrt{3}$	$1/\sqrt{3}$	$-4/3\sqrt{3}$	0	$2/\sqrt{3}$	0
$\Sigma^{*0}\bar{K}^0$	0	0	$1/\sqrt{6}$	$1/\sqrt{6}$	$-4/3\sqrt{6}$	0	0	$-2/\sqrt{6}$
$\Xi^{*0}\pi^0$	0	0	$-1/\sqrt{6}$	$-1/\sqrt{6}$	$-2/3\sqrt{6}$	0	$-2/\sqrt{6}$	$-2/\sqrt{6}$
$\Xi^{*0}\eta$	0	0	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$\sqrt{2}/3$	0	$-\sqrt{2}/3$	$\sqrt{2}/3$
$\Xi^{*-}\pi^+$	0	0	$-1/\sqrt{3}$	$-1/\sqrt{3}$	$-2/3\sqrt{3}$	0	0	0
Ω^-K^+	0	0	-1	-1	$-\frac{2}{3}$	0	0	0

$B(3) \to D(10) + P(3^*)$	not allowed	no nonexotic state	not allowed	F_6^s	not allowed	$F_{3^*}^u$	F_6^u
$\Xi_2^{++} \to \Sigma^{*+}D^+$	0	0	0	0	0	$2/\sqrt{3}$	$2/\sqrt{3}$
$\Xi_2^+ \to \Sigma^{*+}D^0$	0	0	0	$2/\sqrt{3}$	0	$-2/\sqrt{3}$	$2/\sqrt{3}$
$\Sigma^{*0}D^+$	0	0	0	$2/\sqrt{6}$	0	0	$4/\sqrt{6}$
$\Xi^{*0}F^+$	0	0	0	$2/\sqrt{3}$	0	$-2/\sqrt{3}$	$2/\sqrt{3}$
$\Omega_2^+ \to \Xi^{*0}D^+$	0	0	0	0	0	$2/\sqrt{3}$	$2/\sqrt{3}$

$$\langle \Sigma_1^{++}K^- \mid \Xi_2^+\rangle = -\langle \Omega_1^0 K^+ \mid \Xi_2^+\rangle = -2/\sqrt{3}\langle \Xi_1^+\eta \mid \Xi_2^+\rangle = -2\langle \Xi_1^+\pi^0 \mid \Xi_2^+\rangle \,. \quad (3.32)$$

$B(3) \to B(6) + P(8)$ decays are forbidden in the u channel.

(b) $B(\frac{1}{2}^+) \to D(\frac{3}{2}^+) + P(0^-)$ (Table III).

(i) $B(3^*) \to D(10) + P(8)$. Since the t-channel contributions vanish here, we expect the PV mode to be forbidden, indicating vanishing asymmetries. If $\underline{6}^*$ dominance is assumed, these decays occur

TABLE IV. $\Delta C = \Delta S$ decays of Ω_3^{*++}. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\cos^2\theta_C$.

	t channel		s channel		u channel	
	6*	15	6*	15	6*	15
$D(1) \to B(3^*) + P(3^*)$	no nonexotic state	not allowed	no nonexotic state	not allowed	h_3^u	not allowed
$\Omega_3^{*++} \to \Xi_1'^+D^+$	0	0	0	0	2	0
$D(1) \to B(6) + P(3^*)$	not allowed	no nonexotic state	not allowed	no nonexotic state	not allowed	I_3^u
$\Omega_3^{*++} \to \Xi_1^+D^+$	0	0	0	0	0	$\sqrt{2}$
$D(1) \to B(3) + P(8)$	$j_{3^*}^t$	$J_{3^*}^t$	no nonexotic state	no nonexotic state	no nonexotic state	no nonexotic state
$\Omega_3^{*++} \to \Xi_2^{++}K^0$	1	1	0	0	0	0
$\Omega_2^+\pi^+$	-1	1	0	0	0	0

through the s channel only.

(ii) $B(3)\to D(10)+P(3^*)$ *(Table III).* Due to the vanishing t-channel contributions, the PV mode is suppressed. Therefore, null asymmetries are indicated. Notice that these decays can occur through the H_W^{15} component only. Therefore, sextet dominance forbids these decays totally.[22]

(iii) $B(3)\to D(6)+P(8)$. These decays can be obtained from the corresponding decays $B(3)\to B(6)+P(8)$ in Table (II) simply by replacing d and D by g and G, respectively.

(c) $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$.

(i) $D(1)\to B(\frac{1}{2}^+)+P(0^-)$ *(Table IV).* Ω_3^{*++} can decay to $B(3^*)$ and $B(6)$ baryons through $\underline{6}^*$ and $\underline{15}$ spurions, respectively. Our analysis allows the only possible decays $\Omega_3^{*++}\to\Xi_1'^+D^+/\Xi_1^+D^+$ to occur through the u channel. The PV mode is suppressed. Sextet dominance forbids $\Omega_3^{*++}\to\Xi_1^+D^+$ decay in the PC mode too.

(ii) $D(1)\to B(3)+P(8)$ *(Table IV).* This mode is allowed in the t channel alone thus indicating vanishing asymmetries.

(d) $D(\frac{3}{2}^+)\to D(\frac{3}{2}^+)+P(0^-)$. The decay amplitudes for the channels $D(1)\to D(6)+P(3^*)$ and $D(1)\to D(3)+P(8)$ can be obtained from corresponding decay amplitudes in $D(1)\to B(6)+P(3^*)$ and $D(1)\to B(3)+P(8)$. Thus the results obtained for $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$ are regained.

B. $\Delta C=-1$, $\Delta S=0$ decay mode

(a) $B(\frac{1}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$.

(i) $B(3^*)\to B(8)+P(8)$ *(Table V).* Here the PV decays $\Lambda_1'^+\to\Sigma^+K^0\,|\,\Sigma^0K^+$, $\Xi_1'^+\to pK^0$, $\Xi_1'^0\to\Sigma^+\pi^-\,|\,pK^-\,|\,n\bar{K}^0\,|\,\Xi^0K^0$ are forbidden.

(ii) $B(3)\to B(8)+P(3^*)$ *(Table VI).* The t-channel contributions vanish and so the asymmetries are zero.

(iii) $B(3)\to B(3^*)/B(6)+P(8)$ *(Table VI).* Ξ_2^{++} decays are forbidden in the s channel. $\underline{6}^*$ dominance forbids PC decays of Ξ_2^{++} in the $B(3)\to B(6)+P(8)$ mode.

(b) $B(\frac{1}{2}^+)\to D(\frac{3}{2}^+)+P(0^-)$

(i) $B(3^*)\to D(10)+P(8)$ *(Table VII).* Similar to the $\Delta C=\Delta S$ mode, here also, vanishing t-channel contributions forbid the decays in the PV mode. Sextet dominance allows the decays to occur through the s channel only.

(ii) $B(3)\to D(10)+P(3^*)$ *(Table VIII).* PV decays do not occur due to null t-channel contribution. Sextet dominance forbids these decays totally.[21]

(iii) $B(3)\to D(6)+P(8)$. Decay amplitudes for this mode can be obtained from $B(3)\to B(6)+P(8)$ (Table II) by using appropriate reduced matrix elements and $\Sigma_1\to\Sigma_1^*$, $\Xi_1\to\Xi_1^*$, and $\Omega_1\to\Omega_1^*$.

(c) $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$.

(i) $D(1)\to B(3^*)/B(6)+P(3^*)$ *(Table IX).* Ω_3^{*++} decays arise only through the u channel. $\underline{6}^*$ dominance forbids all the decays in the $D(\bar{1})\to B(6)+P(3^*)$ mode.

(ii) $D(1)\to B(3)+P(8)$ *(Table IX).* PC decays of Ω_3^{*++} in this mode are suppressed as the decays in this mode are allowed only through the t channel.

(d) $D(\frac{3}{2}^+)\to D(\frac{3}{2}^+)+P(0^-)$. Decay amplitudes for this channel are obtainable from those in $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$ (Table IX) by using the appropriate reduced matrix elements. The results remain unchanged.

Finally, we summarize that all the PV decays of $B(3)$ and $B(3^*)$ multiplets in the modes $B(3)\to B(8)+P(3^*)$, $B(3)\to D(10)+P(3^*)$, and $B(3^*)\to D(10)+P(8)$ are forbidden in our considerations. We obtain null asymmetries for all the Ω_3^{*++} decays since $D(1)\to B(3^*)+P(3^*)$, $D(1)\to B(6)+P(3^*)$, and $D(1)\to D(6)+P(3^*)$ are forbidden in the PV mode and $D(1)\to B(3)+P(8)$ and $D(1)\to D(3)+P(8)$ are forbidden in the PC mode. We have not discussed the weak decays of $D(3)$ and $D(6)$ charmed multiplets as these are expected to be swamped by stronger interactions. However, decay amplitudes for the $D(3)$ multiplet can be obtained from those of $B(3)$ baryons straightforwardly. Similarly, vector-meson channels $B(\frac{1}{2}^+)\to B(\frac{1}{2}^+)+V(1^-)$, $B(\frac{1}{2}^+)\to D(\frac{3}{2}^+)+V(1^-)$, $D(\frac{3}{2}^+)\to D(\frac{3}{2}^+)+V(1^-)$, $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+V(1^-)$ can be obtained from the corresponding pseudoscalar-meson channels by following the replacement $P\to V$ as

$$\pi\to\rho,K\to K^*,\ D\to D^*,\ F\to F^*,\ \eta\to V_8,\text{ and }\eta'\to V_{15}\,.$$

IV. DISCUSSION

At present, the structure of the charm-changing weak Hamiltonian is not clear. The conventional GIM model fails to describe the weak hadronic decays successfully. Even at the SU(3) level, sextet dominance does not seem to be a good assumption. Since SU(4) is expected to be badly broken, we here employ SU(3) symmetry to study the weak nonleptonic decays of charmed baryons and isobars. In SU(3), the general Hamiltonian belonging to $\underline{6}^*+\underline{15}$ representations does not yield useful information, due to a large number of parameters. In order to obtain constraints on the reduced matrix elements, we work in a dynamical model where we consider the weak decay $B\to B'+P$ arising as an $S+B\to B'+P$ scattering process which is assumed to be dominated by the nonexotic single-particle intermediate states. The weak nonleptonic decays of baryons including Ω^- have been explained successfully in such considerations.[7] In particular, this model simultaneously explains octet dominance for $\frac{1}{2}^+\to\frac{1}{2}^++0^-$ and $\Delta I=\frac{1}{2}$ violation (25%) for $\Omega^-\to\Xi\pi$

TABLE V. $\Delta C=-1$ $\Delta S=0$ decays of $B(3^*)$. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\sin\theta_C\cos\theta_C$.

	t channel		s channel					u channel			
	6*	15	6*		15			6*		15	
$B(3^*)\to B(8)+P(8)$	$a^t_{3^*}$	$A^t_{3^*}$	$a^s_{8_1}$	$a^s_{8_2}$	$A^s_{8_1}$	$A^s_{8_2}$	A^s_{10}	$a^u_{3^*}$	a^u_6	$A^u_{3^*}$	A^u_6
$\Lambda_1'^+\to p\pi^0$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$4/3\sqrt{2}$	0	$-1/\sqrt{2}$	0	$-1/\sqrt{2}$
$p\eta$	$3/\sqrt{6}$	$3/\sqrt{6}$	$-1/\sqrt{6}$	$-3/\sqrt{6}$	$1/\sqrt{6}$	$3/\sqrt{6}$	0	$2/\sqrt{6}$	0	$2/\sqrt{6}$	$-2/\sqrt{6}$
$n\pi^+$	-1	1	1	-1	-1	1	$-\frac{2}{3}$	0	-1	0	-1
ΛK^+	$-2/\sqrt{6}$	$2/\sqrt{6}$	$-1/\sqrt{6}$	$3/\sqrt{6}$	$1/\sqrt{6}$	$-3/\sqrt{6}$	0	$-3/\sqrt{6}$	$1/2\sqrt{6}$	$3/\sqrt{6}$	$1/2\sqrt{6}$
Σ^+K^0	0	0	1	1	-1	-1	$\frac{2}{3}$	1	$\frac{1}{2}$	1	$-\frac{1}{2}$
Σ^0K^+	0	0	$1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-4/3\sqrt{2}$	$1/\sqrt{2}$	$1/2\sqrt{2}$	$-1/\sqrt{2}$	$1/2\sqrt{2}$
$\Xi_1'^+\to pK^0$	0	0	-1	-1	1	1	$-\frac{2}{3}$	-1	$-\frac{1}{2}$	-1	$\frac{1}{2}$
$\Lambda\pi^+$	$-1/\sqrt{6}$	$1/\sqrt{6}$	$-2/\sqrt{6}$	0	$2/\sqrt{6}$	0	$2/\sqrt{6}$	$-3/\sqrt{6}$	$-1/2\sqrt{6}$	$3/\sqrt{6}$	$-1/2\sqrt{6}$
$\Sigma^+\pi^0$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	0	$\sqrt{2}$	0	$-\sqrt{2}$	$-\sqrt{2}/3$	$-1/\sqrt{2}$	$1/2\sqrt{2}$	$-1/\sqrt{2}$	$3/2\sqrt{2}$
$\Sigma^+\eta$	$3/\sqrt{6}$	$3/\sqrt{6}$	$-2/\sqrt{6}$	0	$2/\sqrt{6}$	0	$-2/\sqrt{6}$	$1/\sqrt{6}$	$3/2\sqrt{6}$	$1/\sqrt{6}$	$1/2\sqrt{6}$
$\Sigma^0\pi^+$	$1/\sqrt{2}$	$-1/\sqrt{2}$	0	$-\sqrt{2}$	0	$\sqrt{2}$	$\sqrt{2}/3$	$1/\sqrt{2}$	$-1/2\sqrt{2}$	$-1/\sqrt{2}$	$-1/2\sqrt{2}$
Ξ^0K^+	1	-1	-1	1	1	-1	$\frac{2}{3}$	0	1	0	1
$\Xi_1'^0\to pK^-$	0	0	-1	1	-1	1	$-\frac{2}{3}$	-1	$\frac{1}{2}$	-1	$-\frac{1}{2}$
$n\bar{K}^0$	0	0	0	2	0	2	$\frac{2}{3}$	0	1	0	-1
$\Lambda\pi^0$	$-1/2\sqrt{3}$	$-1/2\sqrt{3}$	$-1/\sqrt{3}$	0	$-1/\sqrt{3}$	0	$2/\sqrt{3}$	$-\sqrt{3}/2$	$-1/4\sqrt{3}$	$\sqrt{3}/2$	$-5/4\sqrt{3}$
$\Lambda\eta$	$\frac{1}{2}$	$\frac{1}{2}$	-1	0	-1	0	0	$-\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{2}$	$-\frac{3}{4}$
$\Sigma^+\pi^-$	0	0	1	-1	1	-1	$2/\sqrt{3}$	1	$-\frac{1}{2}$	1	$\frac{1}{2}$
$\Sigma^0\pi^0$	$-\frac{1}{2}$	$-\frac{1}{2}$	1	0	1	0	0	$\frac{1}{2}$	$-\frac{1}{4}$	$-\frac{1}{2}$	$\frac{3}{4}$
$\Sigma^0\eta$	$\sqrt{3}/2$	$\sqrt{3}/2$	$-1/\sqrt{3}$	0	$-1/\sqrt{3}$	0	$-2/\sqrt{3}$	$1/2\sqrt{3}$	$\sqrt{3}/4$	$-1/2\sqrt{3}$	$-1/4\sqrt{3}$
$\Sigma^-\pi^+$	-1	1	1	1	1	1	$-\frac{2}{3}$	0	0	0	0
Ξ^0K^0	0	0	0	-2	0	-2	$-\frac{2}{3}$	0	-1	0	1
Ξ^-K^+	-1	1	1	1	1	1	$-\frac{2}{3}$	0	0	0	0

TABLE VI. $\Delta C=-1$, $\Delta S=0$ decays of $B(3)$. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\sin\theta_C \cos\theta_C$.

	t channel		s channel		u channel			
	6*	15	6*	15	6*		15	
$B(3)\to B(8)+P(3^*)$	no nonexotic state	no nonexotic state	$b^s_{3^*}$	B^s_6	$b^u_{3^*}$	b^u_6	B^u_3	B^u_6
$\Xi^{++}_2 \to pD^+$	0	0	0	0	1	1	-1	1
Σ^+F^+	0	0	0	0	1	1	-1	1
$\Xi^+_2 \to pD^0$	0	0	-2	-1	-1	1	1	1
nD^+	0	0	-2	1	0	2	0	-2
ΛF^+	0	0	$-4/\sqrt{6}$	0	$3/\sqrt{6}$	$-1/\sqrt{6}$	$3/\sqrt{6}$	$-3/\sqrt{6}$
Σ^0F^+	0	0	0	$\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-3/\sqrt{2}$
$\Omega^+_2 \to \Lambda D^+$	0	0	$-2/\sqrt{6}$	$3/\sqrt{6}$	$-3/\sqrt{6}$	$-1/\sqrt{6}$	$-3/\sqrt{6}$	$-3/\sqrt{6}$
Σ^+D^0	0	0	-2	-1	-1	1	1	1
Σ^0D^+	0	0	$\sqrt{2}$	$1/\sqrt{2}$	$+1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$-\sqrt{2}$
Ξ^0F^+	0	0	-2	1	0	2	0	-2

$B(3)\to B(3^*)+P(8)$	$c^t_{3^*}$	$C^t_{3^*}$	$c^s_{3^*}$	C^s_6	c^u_3	no nonexotic state
$\Xi^{++}_2 \to \Lambda'^+_1\pi^+$	-1	-1	0	0	-2	0
$\Xi'^+_1K^+$	-1	-1	0	0	-2	0
$\Xi^+_2 \to \Lambda'^+_1\pi^0$	$1/\sqrt{2}$	$-1/\sqrt{2}$	0	$-\sqrt{2}$	$\sqrt{2}$	0
$\Lambda'^+_1\eta$	$-3/\sqrt{6}$	$3/\sqrt{6}$	$4/\sqrt{6}$	0	$-2/\sqrt{6}$	0
$\Xi'^+_1K^0$	0	0	-2	-1	-2	0
$\Xi'^0_1K^+$	1	1	-2	1	0	0
$\Omega^+_2 \to \Lambda'^+_1\bar{K}^0$	0	0	-2	-1	-1	0
$\Xi'^+_1\pi^0$	$-1/\sqrt{2}$	$1/\sqrt{2}$	$\sqrt{2}$	$-1/\sqrt{2}$	0	0
$\Xi'^+_1\eta$	$3/\sqrt{6}$	$-3/\sqrt{6}$	$-2/\sqrt{6}$	$-3/\sqrt{6}$	$4/\sqrt{6}$	0
$\Xi'^0_1\pi^+$	1	1	-2	1	0	0

$B(3)\to B(6)+P(8)$	$d^t_{3^*}$	$D^t_{3^*}$	$d^s_{3^*}$	D^s_6	no nonexotic state	D^s_3
$\Xi^{++}_2 \to \Sigma^{++}\pi^0$	$1/\sqrt{2}$	$-1/\sqrt{2}$	0	0	0	0
$\Sigma^{++}\eta$	$-3/\sqrt{6}$	$3/\sqrt{6}$	0	0	0	0
$\Sigma^+_1\pi^+$	$1/\sqrt{2}$	$1/\sqrt{2}$	0	0	0	$\sqrt{2}$
$\Xi^+_1K^+$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	0	0	0	$-\sqrt{2}$
$\Xi^+_2 \to \Sigma^{++}_1\pi^-$	0	0	1	1	0	0
$\Sigma^+_1\pi^0$	$\frac{1}{2}$	$-\frac{1}{2}$	-1	0	0	-1
$\Sigma^+_1\eta$	$-\sqrt{3}/2$	$\sqrt{3}/2$	0	$1/\sqrt{3}$	0	$1/\sqrt{3}$
$\Sigma^0_1\pi^+$	1	1	-1	1	0	0
$\Xi^+_1K^0$	0	0	$1/\sqrt{2}$	$1/\sqrt{2}$	0	$-\sqrt{2}$
$\Xi^0_1K^+$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$1/\sqrt{2}$	0	0
$\Omega^+_2 \to \Sigma^{++}_1K^-$	0	0	-1	-1	0	0
$\Sigma^+_1\bar{K}^0$	0	0	$-1/\sqrt{2}$	$-1/\sqrt{2}$	0	$\sqrt{2}$
$\Xi^+_1\pi^0$	$\frac{1}{2}$	$-\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	0	0
$\Xi^+_1\eta$	$-\sqrt{3}/2$	$-\sqrt{3}/2$	$\sqrt{3}/2$	0	0	$2/\sqrt{3}$
$\Xi^0_1\pi^+$	$1/\sqrt{2}$	$1/\sqrt{2}$	$1/\sqrt{2}$	$-1/\sqrt{2}$	0	0
$\Omega^0_1K^+$	-1	-1	1	-1	0	0

decays. On extending these considerations to the charm sector, we notice that the sextet dominance of the weak Hamiltonian does not follow as might be expected in the GIM model. The most general Hamiltonian forbids $B(3)\to B(8)+P(3^*)$, $B(3)\to D(10)+P(3^*)$, and $B(3^*)\to D(10)+P(8)$ channels in the PV mode independent of the nature of the weak current. Corresponding channel emitting vector mesons are also forbidden. For Ω^{*++}_3 decays we obtain null asymmetry parameters for

TABLE VII. $\Delta C=-1$, $\Delta S=0$ decays ($\frac{1}{2}^+ \to \frac{3}{2}^+ + 0^-$). The contributions to the decay amplitudes are proportional to the tabulated numbers times $\sin\theta_C\cos\theta_C$.

	t channel		s channel			u channel		
	6*	15	6*	15		6*	15	
$B(3^*) \to D(10) + P(8)$	no nonexotic state	no nonexotic state	e_8^s	E_8^s	E_{10}^s	no nonexotic state	$E_{3^*}^u$	E_6^u
$\Lambda_1'^+ \to \Delta^{++}\pi^-$	0	0	-1	1	$\frac{2}{3}$	0	0	0
$\Delta^+\pi^0$	0	0	$2/\sqrt{6}$	$-2/\sqrt{6}$	$2/3\sqrt{6}$	0	0	$2/\sqrt{6}$
$\Delta^+\eta$	0	0	0	0	$2/3\sqrt{2}$	0	$-2\sqrt{2}/3$	$-\sqrt{2}/3$
$\Delta^0\pi^+$	0	0	$1/\sqrt{3}$	$-1/\sqrt{3}$	$4/3\sqrt{3}$	0	0	$2/\sqrt{3}$
$\Sigma^{*+}K^0$	0	0	$-1/\sqrt{3}$	$1/\sqrt{3}$	$2/3\sqrt{3}$	0	$2/\sqrt{3}$	$2/\sqrt{3}$
$\Sigma^{*0}K^+$	0	0	$1/\sqrt{6}$	$-1/\sqrt{6}$	$4/3\sqrt{6}$	0	$-4/\sqrt{6}$	$-2/\sqrt{6}$
$\Xi'^+ \to \Delta^{++}K^-$	0	0	-1	1	$\frac{2}{3}$	0	0	0
$\Delta^+\bar{K}^0$	0	0	$-1/\sqrt{3}$	$-1/\sqrt{3}$	$4/3\sqrt{3}$	0	$2/\sqrt{3}$	$2/\sqrt{3}$
$\Sigma^{*+}\pi^0$	0	0	$1/\sqrt{6}$	$-1/\sqrt{6}$	$4/3\sqrt{6}$	0	$-2/\sqrt{6}$	0
$\Sigma^{*+}\eta$	0	0	$1/\sqrt{2}$	$-1/3\sqrt{2}$	$-\sqrt{2}/9$	0	$\sqrt{2}/3$	$2\sqrt{2}/3$
$\Sigma^{*0}\pi^+$	0	0	$1/\sqrt{6}$	$-1/\sqrt{6}$	$4/3\sqrt{6}$	0	$-1/\sqrt{6}$	$-2/\sqrt{6}$
$\Xi^{*0}K^+$	0	0	$1/\sqrt{3}$	$-1/\sqrt{3}$	$4/3\sqrt{3}$	0	0	$2/\sqrt{3}$
$\Xi'^0 \to \Delta^+K^-$	0	0	$1/\sqrt{3}$	$1/\sqrt{3}$	$2/3\sqrt{3}$	0	$2/\sqrt{3}$	0
$\Delta^0\bar{K}^0$	0	0	$1/\sqrt{3}$	$1/\sqrt{3}$	$-4/3\sqrt{3}$	0	0	$-2/\sqrt{3}$
$\Sigma^{*+}\pi^-$	0	0	$1/\sqrt{3}$	$1/\sqrt{3}$	$-4/3\sqrt{3}$	0	$2/\sqrt{3}$	0
$\Sigma^{*0}\pi^0$	0	0	$-\sqrt{3}/2$	$-\sqrt{3}/2$	0	0	$-1/\sqrt{3}$	$-1/\sqrt{3}$
$\Sigma^{*0}\eta$	0	0	$-\frac{1}{2}$	$-\frac{1}{2}$	0	0	$\frac{2}{3}$	$\frac{1}{3}$
$\Sigma^{*-}\pi^+$	0	0	$-2/\sqrt{3}$	$-2/\sqrt{3}$	$-4/3\sqrt{3}$	0	0	0
$\Xi^{*0}K^0$	0	0	$1/\sqrt{3}$	$1/\sqrt{3}$	$-4/3\sqrt{3}$	0	0	$-2/\sqrt{3}$
$\Xi^{*-}K^+$	0	0	$-2/\sqrt{3}$	$-2/\sqrt{3}$	$-4/3\sqrt{3}$	0	0	0

TABLE VIII. $\Delta C=-1$, $\Delta S=0$ decays ($\frac{1}{2}^+ \to \frac{3}{2}^+ + 0^-$). The contributions to the decay amplitudes are proportional to the tabulated numbers times $\sin\theta_C \cos\theta_C$.

	t channel		s channel		u channel		
	6*	15	6*	15	6*	15	
$B(3) \to D(10)+P(3^*)$	not allowed	no nonexotic state	not allowed	F_6^s	not allowed	$F_{3^*}^u$	F_6^u
$\Xi_2^{++} \to \Delta^{++}D^0$	0	0	0	0	0	0	0
$\Delta^+ D^+$	0	0	0	0	0	$2/\sqrt{3}$	$-2/\sqrt{3}$
$\Sigma^{*+}F^+$	0	0	0	0	0	$-2/\sqrt{3}$	$-2/\sqrt{3}$
$\Xi_2^+ \to \Delta^+ D^0$	0	0	0	$2/\sqrt{3}$	0	$-2/\sqrt{3}$	$2/\sqrt{3}$
$\Delta^0 D^+$	0	0	0	$2/\sqrt{3}$	0	0	$4/\sqrt{3}$
$\Sigma^{*0}F^+$	0	0	0	$2/\sqrt{6}$	0	$-4/\sqrt{6}$	0
$\Omega^+ \to \Sigma^{*+}D^0$	0	0	0	$-2/\sqrt{3}$	0	$2/\sqrt{3}$	$-2/\sqrt{3}$
$\Sigma^{*0}D^+$	0	0	0	$-2/\sqrt{6}$	0	$4/\sqrt{6}$	0
$\Xi^{*0}F^+$	0	0	0	$-2/\sqrt{3}$	0	0	$-4/\sqrt{3}$

all the decays emitting pseudoscalar mesons or vector mesons.

In an earlier work,[23] two of us studied the structure of the SU(4) weak Hamiltonian. Using similar dynamical assumptions, GIM contributions are shown to vanish[24] for PV weak decays of baryons. These decays could occur through 15, 45, 45* representations.[25] At the SU(3) level, 45*, 45 reduce to 6* and 15 representations, respectively, but 15 gives rise to the H_W^3 piece of the weak Hamiltonian. In the presence of these admixtures, decay amplitudes acquire additional terms. We notice that the Cabibbo-enhanced mode ($\Delta C=\Delta S$) does not get disturbed except that in addition to $\cos^2\theta_C$, other factors will be present. Therefore, decay amplitude relations remain unaffected. For the $\Delta C=-1$, $\Delta S=0$ mode, the PV decays forbidden in the GIM model remain forbidden. (This is a consequence of the fact that these decays require exotic mesons to be exchanged in the t channel.) Parity-conserving decays of $\Omega_3^{*++} \to B(3) + P(8)$ and $\Omega_3^{*++} \to D(3) + P(8)$, forbidden in the GIM model, are allowed to appear in the s channel through the H_W^3 part of the weak Hamiltonian.

TABLE IX. $\Delta C=-1$, $\Delta S=0$ decays of Ω_3^{*++}. The contributions to the decay amplitudes are proportional to the tabulated numbers times $\sin\theta_C \cos\theta_C$.

	t channel		s channel		u channel	
	6*	15	6*	15	6*	15
$D(1) \to B(3^*)+P(3^*)$	no nonexotic state	not allowed	no nonexotic state	not allowed	h_3^u	not allowed
$\Omega_3^{*++} \to \Lambda_1'^+ D^+$	0	0	0	0	-2	0
$\Xi_1'^+ F^+$	0	0	0	0	-2	0
$D(1) \to B(6)+P(3)$	not allowed	no nonexotic state	not allowed	no nonexotic state	not allowed	I_3^u
$\Omega_3^{*++} \to \Sigma_1^{++}D^0$	0	0	0	0	0	0
$\Sigma_1^+ D^+$	0	0	0	0	0	$\sqrt{2}$
$\Xi_1^+ F^+$	0	0	0	0	0	$-\sqrt{2}$
$D(1) \to B(3)+P(8)$	$j_{3^*}^t$	$J_{3^*}^t$	no nonexotic state	no nonexotic state	no nonexotic state	no nonexotic state
$\Omega_3^{*++} \to \Xi_2^{++}\pi^0$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	0	0	0	0
$\Xi_2^{++}\eta$	$3/\sqrt{6}$	$3/\sqrt{6}$	0	0	0	0
$\Xi_2^+\pi^+$	-1	1	0	0	0	0
$\Omega_2^+ K^+$	1	-1	0	0	0	0

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APPENDIX

Reduced matrix elements for different modes are defined as

(a) $B(\frac{1}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$

(i) $B(3^*)\to B(8)+P(8)$

$a^s_m = \langle 8|8|m\rangle\langle m|6^*|3^*\rangle, \quad m = 8_1, 8_2, 10^*$

$A^s_m = \langle 8|8|m\rangle\langle m|15|3^*\rangle, \quad m = 8_1, 8_2, 10, 27$

$a^t_m = \langle 8|6|m\rangle\langle m|8|3^*\rangle, \quad m = 3^*, 6, 15^*$

$A^t_m = \langle 8|15^*|m\rangle\langle m|8|3^*\rangle, \quad m = 3^*, 6, 15^*_1, 15^*_2$

$a^u_m = \langle 8|6|m\rangle\langle m|8|3^*\rangle, \quad m = 3^*, 6, 15^*$

$A^u_m = \langle 8|15^*|m\rangle\langle m|8|3^*\rangle, \quad m = 3^*, 6, 15^*_1, 15^*_2.$

(ii) $B(3)\to B(8)+P(3^*)$

$b^s_m = \langle 8|3^*|m\rangle\langle m|6^*|3\rangle, \quad m = 3^*, 15^*$

$B^s_m = \langle 8|3^*|m\rangle\langle m|15|3\rangle, \quad m = 6, 15^*$

$b^t_m = \langle 3^*|6|m\rangle\langle m|8|3\rangle, \quad m = 3, 15$

$B^t_m = \langle 3^*|15^*|m\rangle\langle m|8|3\rangle, \quad m = 6^*, 15$

$b^u_m = \langle 8|6|m\rangle\langle m|3|3\rangle, \quad m = 3^*, 6$

$B^u_m = \langle 8|15^*|m\rangle\langle m|3|3\rangle, \quad m = 3^*, 6.$

(iii) $B(3)\to B(3^*)+P(8)$

$c^s_m = \langle 3^*|8|m\rangle\langle m|6^*|3\rangle, \quad m = 3^*, 15^*$

$C^s_m = \langle 3^*|8|m\rangle\langle m|15|3\rangle, \quad m = 6, 15^*$

$c^t_m = \langle 8|6|m\rangle\langle m|3|3\rangle, \quad m = 3^*, 6$

$C^t_m = \langle 8|15^*|m\rangle\langle m|3|3\rangle, \quad m = 3^*, 6$

$c^u_m = \langle 3^*|6|m\rangle\langle m|8|3\rangle, \quad m = 3, 15$

$C^u_m = \langle 3^*|15^*|m\rangle\langle m|8|3\rangle, \quad m = 6^*, 15.$

(iv) $B(3)\to B(6)+P(8)$

$d^s_m = \langle 6|8|m\rangle\langle m|6^*|3\rangle, \quad m = 3^*, 15^*$

$D^s_m = \langle 6|8|m\rangle\langle m|15|3\rangle, \quad m = 6, 15^*, 24$

$d^t_m = \langle 8|6|m\rangle\langle m|6^*|3\rangle, \quad m = 3^*, 15^*$

$D^t_m = \langle 8|15^*|m\rangle\langle m|6^*|3\rangle, \quad m = 3^*, 15^*_1, 15^*_2$

$d^u_m = \langle 6|6|m\rangle\langle m|8|3\rangle, \quad m = 6^*, 15$

$D^u_m = \langle 6|15^*|m\rangle\langle m|8|3\rangle, \quad m = 3, 6^*, 15.$

(b) $B(\frac{1}{2}^+)\to D(\frac{3}{2}^+)+P(0^-)$

(i) $B(3^*)\to D(10)+P(8)$

$e^s_m = \langle 10|8|m\rangle\langle m|6^*|3^*\rangle, \quad m = 8$

$E^s_m = \langle 10|8|m\rangle\langle m|15|3^*\rangle, \quad m = 8, 10, 27$

$e^t_m = \langle 8|6|m\rangle\langle m|10^*|3^*\rangle, \quad m = 15^*$

$E^t_m = \langle 8|15^*|m\rangle\langle m|10^*|3^*\rangle, \quad m = 15^*_1, 15^*_2, \overline{15}'$

$e^u_m = \langle 10|6|m\rangle\langle m|8|3^*\rangle, \quad m = 15^*$

$E^u_m = \langle 10|15^*|m\rangle\langle m|8|3^*\rangle, \quad m = 3^*, 6, 15^*.$

(ii) $B(3)\to D(10)+P(3^*)$

$f^s_m = \langle 10|3^*|m\rangle\langle m|6^*|3\rangle$, no intermediate state

$F^s_m = \langle 10|3^*|m\rangle\langle m|15|3\rangle, \quad m = 6, 24$

$f^t_m = \langle 3^*|6|m\rangle\langle m|10^*|3\rangle$, no intermediate state

$F^t_m = \langle 3^*|15^*|m\rangle\langle m|10^*|3\rangle, \quad m = 6^*, 24^*$

$f^u_m = \langle 10|6|m\rangle\langle m|3|3\rangle$, no intermediate state

$F^u_m = \langle 10|15^*|m\rangle\langle m|3|3\rangle, \quad m = 3^*, 6.$

(iii) $B(3)\to D(6)+P(8)$. Reduced amplitudes for this channel can be obtained from the corresponding channel $B(3)\to B(6)+P(8)$ by replacing d by g and D by G.

(c) $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$

(i) $D(1)\to B(3^*)+P(3^*)$

$h^s_m = \langle 3^*|3^*|m\rangle\langle m|6^*|1\rangle, \quad m = 6^*$

$H^s_m = \langle 3^*|3^*|m\rangle\langle m|15|1\rangle$, no intermediate state

$h^t_m = \langle 3^*|6|m\rangle\langle m|3|1\rangle, \quad m = 3$

$H^t_m = \langle 3^*|15^*|m\rangle\langle m|3|1\rangle$, no intermediate state

$h^u_m = \langle 3^*|6|m\rangle\langle m|3|1\rangle, \quad m = 3$

$H^u_m = \langle 3^*|15^*|m\rangle\langle m|3|1\rangle$, no intermediate state.

(ii) $D(1)\to B(6)+P(3^*)$

$i^s_m = \langle 6|3^*|m\rangle\langle m|6^*|1\rangle$, no intermediate state

$I^s_m = \langle 6|3^*|m\rangle\langle m|15|1\rangle, \quad m = 15$

$i^t_m = \langle 3^*|6|m\rangle\langle m|6^*|1\rangle$, no intermediate state

$I^t_m = \langle 3^*|15^*|m\rangle\langle m|6^*|1\rangle, \quad m = 6^*$

$i^u_m = \langle 6|6|m\rangle\langle m|3|1\rangle$, no intermediate state

$I^u_m = \langle 6|15^*|m\rangle\langle m|3|1\rangle, \quad m = 3.$

(iii) $D(1)\to B(3)+P(8)$

$j^s_m = \langle 3|8|m\rangle\langle m|6^*|1\rangle, \quad m = 6^*$

$J^s_m = \langle 3|8|m\rangle\langle m|15|1\rangle, \quad m = 15$

$j^t_m = \langle 8|6|m\rangle\langle m|3^*|1\rangle, \quad m = 3^*$

$J^t_m = \langle 8|15^*|m\rangle\langle m|3^*|1\rangle, \quad m = 3^*$

$j^u_m = \langle 3|6|m\rangle\langle m|8|1\rangle, \quad m = 8$

$J^u_m = \langle 3|15^*|m\rangle\langle m|8|1\rangle, \quad m = 8.$

(d) $D(\frac{3}{2}^+)\to D(\frac{3}{2}^+)+P(0^-)$. Reduced amplitudes for this mode can be obtained from the corresponding mode $D(\frac{3}{2}^+)\to B(\frac{1}{2}^+)+P(0^-)$ by the following replace-

ment:

(i) for $D(1) \to D(6) + P(3^*)$, $i \to k$, $I \to K$ and

(ii) for $D(1) \to D(3) + P(8)$, $j \to 1$, $J \to L$.

A superscript denotes the channel.

Nonexoticity of the intermediate states gives the following constraints on the reduced matrix elements.

(a) $\frac{1}{2}^+ \to \frac{1}{2}^+ + 0^-$

(i) $B(3^*) \to B(8) + P(8)$

$$a^s_{10^*} = a^t_6 = a^t_{15^*} = a^u_{15^*} = 0\,,$$

$$A^s_{27} = A^t_6 = A^t_{15^*_1} = A^t_{15^*_2} = A^u_{15^*_1} = A^u_{15^*_2} = 0\,.$$

(ii) $B(3) \to B(8) + P(3^*)$

$$b^s_{15^*} = b^t_3 = b^t_{15} = 0\,,$$

$$B^s_{15^*} = B^t_{6^*} = B^{t'}_{15} = 0\,.$$

(iii) $B(3) \to B(3^*) + P(8)$

$$c^s_{15^*} = c^t_6 = c^u_{15} = 0\,,$$

$$C^s_{15^*} = C^t_6 = C^u_{6^*} = C^u_{15} = 0\,.$$

(iv) $B(3) \to B(6) + P(8)$

$$d^s_{15^*} = d^t_{15^*} = d^u_{6^*} = d^u_{15} = 0\,,$$

$$D^s_{15^*} = D^s_{24} = D^t_{15^*_1} = D^t_{15^*_2} = D^u_{6^*} = D^u_{15} = 0\,.$$

(b) $\frac{1}{2}^+ \to \frac{3}{2}^+ + 0^+$

(i) $B(3^*) \to D(10) + P(8)$

$$e^t_{15^*} = e^u_{15} = 0\,, \quad E^s_{27} = E^t_{15^*_1} = E^t_{15^*_2} = E^t_{\overline{15}} = E^u_{15^*} = 0\,.$$

(ii) $B(3) \to D(10) + P(3^*)$

$$F^s_{24} = F^t_{6^*} = F^t_{24^*} = 0\,.$$

(iii) $B(3) \to D(6) + P(8)$

$$g^s_{15^*} = g^t_{15^*} = g^u_{6^*} = g^u_{15} = 0\,,$$

$$G^s_{15^*} = G^s_{24} = G^t_{15^*_1} = G^t_{15^*_2} = G^u_{6^*} = G^u_{15} = 0\,.$$

(c) $\frac{3}{2}^+ \to \frac{1}{2}^+ + 0^-$

(i) $D(1) \to B(3^*) + P(3^*)$

$$h^s_{6^*} = h^t_3 = 0\,.$$

(ii) $D(1) \to B(6) + P(3^*)$

$$I^s_{15} = I^t_{6^*} = 0\,.$$

(iii) $D(1) \to B(3) + P(8)$

$$j^s_{6^*} = j^u_8 = 0\,, \quad J^s_{15} = J^u_8 = 0\,.$$

(d) $\frac{3}{2}^+ \to \frac{3}{2}^+ + 0^-$

(i) $D(1) \to D(6) + P(3^*)$

$$K^s_{15} = K^t_{6^*} = 0\,.$$

(ii) $D(1) \to D(3) + P(8)$

$$l^s_{6^*} = l^u_8 = 0\,, \quad L^s_{15} = L^u_8 = 0\,.$$

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