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Radiative decays and the $SU(6)$ Lie algebra

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We present research on radiative decays of vector ($J^{PC} = 1^{--}$) to pseudoscalar ($J^{PC} = 0^{-+}$) particles (u, d, s, c, b, t quark system) using broken symmetry techniques in the infinite-momentum frame and equal-time commutation relations and the $SU(6)$ Lie algebra, and conducted without ascribing any specific form to meson quark structure or intra-quark interactions. We utilize the physical electromagnetic current $j^{\mu}_{\rm em}(0)$ including its singlet $U(1)$ term and focus on the $SU(6)$ 35-plet. We derive new relations involving the electromagnetic current (including its singlet — proportional to the $SU(6)$ singlet). Remarkably, we find that the electromagnetic current singlet plays an intrinsic role in understanding the physics of radiative decays and that the charged and neutral ρ meson radiative decays into $\pi\gamma$ are due entirely to the singlet term in $j^{\mu}_{\rm em}(0)$. Although there is insufficient radiative decay experimental data available at this time, parametrization of possible predicted values of $\Gamma(D^{*0} \to D^0\gamma)$ is made. For conciseness and self-containment, we compute all $SU(6)$ Lie algebra simple roots, positive roots, weights and fundamental weights which allow the construction of all $SU(6)$ representations. We also derive all nonzero $SU(6)$ generator commutators and anticommutators — useful for further research on grand unified theories.

Keywords: Radiative decays of mesons; broken symmetry; infinite-momentum frame; equal-time commutation relations; $SU(6)$ Lie algebra.

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1. Introduction

It is remarkable that in many cases observed particles appear to roughly fit into group-theoretical representation constructs which happen to be special unitary group representations. While these group-theoretical constructs obviously require that particles belonging to a particular representation all have the same mass, that is not what one observes in the real world — thus the need for *quark flavor broken symmetry group techniques.* To date, quantum chromodynamics (QCD) based on Lagrangians (involving the addition of the Higgs field and other terms) invoking spontaneous symmetry breaking is the best theory for describing the real world, although lattice gauge models are making headway. As is well known, no theory capable of predicting and accommodating physical observations has yet been developed which incorporates the gravitational force. Indeed, although glueballs are predicted to exist in QCD, no *uncontrovertible* candidates have been found.

In this paper, we present research on radiative decays of vector ($J^{PC} = 1^{--}$) to pseudoscalar ($J^{PC} = 0^{-+}$) particles[1] which appear to belong — at least in part — (especially after application of broken symmetry techniques — infinite-momentum frame and asymptotic symmetry is discussed in Sec. 2) to specific flavor $SU_F(6)$ *representations*. The representations of $SU(N)$ — [special (determinant = unity), unitary] — classical Lie[2] groups are associated with the $SU(N)$ classical, semisimple Lie algebras via linearly independent matrix operators V_a [the V_a are linear "charge" generators[3] — and ${V_a}^\mu(x) = \bar{q}^i(x)(\lambda_a/2)_{ij}\gamma^\mu q^j(x)$ are the corresponding charge density operators (q represents the u, d, s, c, b, t quark system)] which act on the relevant vector space where (bilinear) commutators of the V_a are Lie products acting over the real number field. Each V_a is a Hermitian 6×6 matrix for $N = 6$ and there are $6^2 - 1 = 35$ V_a, where $a = 1, \ldots, 35$.

In addition, we also introduce the singlet $U(1)$ matrix V_0 which is proportional to the identity matrix and commutes with all other generators and is *explicitly included in the physical electromagnetic current* $j^\mu_{\text{em}}(0)$. As we will discover in Sec. 3, *the singlet has an intrinsic role in understanding the physics of radiative decays*. Indeed, we introduce "generalized" Gell-Mann matrices (see Table 1) λ_a where $V_a = \lambda_a/2$. We will find that specific combinations of the V_a can be ultimately constructed which represent physical "raising" or "lowering" operators and we will label them using $J^{PC} = 0^{-+}$ 35-plet pseudoscalar particle names. Explicitly — *in the infinite-momentum frame* — (as we will demonstrate later in this paper) — for example, the *physical* vector charge V_{K^0} is $V_{K^0} = V_6 + iV_7$ and the *physical* vector charge $V_{\pi^\pm} = V_1 \pm iV_2$. The λ_a satisfy the commutation algebra $[(\lambda_a/2), (\lambda_b/2)] = i\sum_{c=1}^{N^2-1} f_{abc}(\lambda_c/2)$, where the f_{abc} are structure constants (see Table 2) (we choose f_{abc} to be real and totally antisymmetric under permutations of the indices abc — we note that this can be done for $SU(M)$ groups in general). For clarity and conciseness and self-containment, the $SU(6)$ Lie algebra simple roots, positive roots, weights, fundamental weights, nonzero commutators (see Table 3), and nonzero anticommutators (see Table 5) are also determined which allow construction of all $SU(6)$ representations. In Table 4, we also give all nonzero totally symmetric $SU(6)$ tensors d_{ijk} useful in studying quark–gluon scattering and other processes. The d_{ijk} satisfy $d_{ijk} = 2\,\text{Tr}(V_i\{V_j, V_k\})$.

Unless otherwise specified (or context specified), Lie algebras — (usually denoted by $\mathfrak{su}(\mathfrak{n})$) — corresponding to Lie groups $SU(N)$ — will just be denoted by $SU(N)$. Thus, $SU(6)$ refers to the compact, analytic, continuous, semisimple Lie algebra for the Lie group $SU(6)$. Cartan[4] denotes $SU(6)$ as A_5 and $SU(N)$

Table 1. "Generalized" Gell-Mann and flavor $U(1)$ singlet matrices.

$$\lambda_1 = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_2 = \begin{pmatrix} 0 & -i & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_3 = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_4 = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_5 = \begin{pmatrix} 0 & 0 & -i & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_6 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_7 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -i & 0 & 0 & 0 \\ 0 & i & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_8 = \begin{pmatrix} \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{2}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_9 = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{10} = \begin{pmatrix} 0 & 0 & 0 & -i & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{11} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{12} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -i & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & i & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{13} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{14} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -i & 0 & 0 \\ 0 & 0 & i & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{15} = \begin{pmatrix} \frac{1}{\sqrt{6}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{6}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & -\sqrt{\frac{3}{2}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{16} = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{17} = \begin{pmatrix} 0 & 0 & 0 & 0 & -i & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{18} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{19} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -i & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & i & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{20} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{21} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -i & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & i & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{22} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{23} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -i & 0 \\ 0 & 0 & 0 & i & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{24} = \begin{pmatrix} \frac{1}{\sqrt{10}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{10}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{10}} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{\sqrt{10}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{-4}{\sqrt{10}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{25} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{26} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & -i \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ i & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{27} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{28} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -i \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & i & 0 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{29} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix} \quad \lambda_{30} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -i \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & i & 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_{31} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \quad \lambda_{32} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -i \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & i & 0 & 0 \end{pmatrix} \quad \lambda_{33} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

$$\lambda_{34} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -i \\ 0 & 0 & 0 & 0 & i & 0 \end{pmatrix} \quad \lambda_{35} = \begin{pmatrix} \frac{1}{\sqrt{15}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{\sqrt{15}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{\sqrt{15}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{-5}{\sqrt{15}} \end{pmatrix} \quad \lambda_0 = \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

Table 2. Nonzero totally antisymmetric $SU(6)$ structure constants f_{ijk}.

i	j	k	f_{ijk}	i	j	k	f_{ijk}	i	j	k	f_{ijk}	i	j	k	f_{ijk}
1	2	3	1	1	4	7	$1/2$	1	5	6	$-1/2$	1	9	12	$1/2$
1	10	11	$-1/2$	1	16	19	$1/2$	1	17	18	$-1/2$	1	25	28	$1/2$
1	26	27	$-1/2$	2	4	6	$1/2$	2	5	7	$1/2$	2	9	11	$1/2$
2	10	12	$1/2$	2	16	18	$1/2$	2	17	19	$1/2$	2	25	27	$1/2$
2	26	28	$1/2$	3	4	5	$1/2$	3	6	7	$-1/2$	3	9	10	$1/2$
3	11	12	$-1/2$	3	16	17	$1/2$	3	18	19	$-1/2$	3	25	26	$1/2$
3	27	28	$-1/2$	4	5	8	$\sqrt{3}/2$	4	9	14	$1/2$	4	10	13	$-1/2$
4	16	21	$1/2$	4	17	20	$-1/2$	4	25	30	$1/2$	4	26	29	$-1/2$
5	9	13	$1/2$	5	10	14	$1/2$	5	16	20	$1/2$	5	17	21	$1/2$
5	25	29	$1/2$	5	26	30	$1/2$	6	7	8	$\sqrt{3}/2$	6	11	14	$1/2$
6	12	13	$-1/2$	6	18	21	$1/2$	6	19	20	$-1/2$	6	27	30	$1/2$
6	28	29	$-1/2$	7	11	13	$1/2$	7	12	14	$1/2$	7	18	20	$1/2$
7	19	21	$1/2$	7	27	29	$1/2$	7	28	30	$1/2$	8	9	10	$1/(2\sqrt{3})$
8	11	12	$1/(2\sqrt{3})$	8	13	14	$-(1/\sqrt{3})$	8	16	17	$1/(2\sqrt{3})$	8	18	19	$1/(2\sqrt{3})$
8	20	21	$-(1/\sqrt{3})$	8	25	26	$1/(2\sqrt{3})$	8	27	28	$1/(2\sqrt{3})$	8	29	30	$-(1/\sqrt{3})$
9	10	15	$\sqrt{6}/3$	9	16	23	$1/2$	9	17	22	$-1/2$	9	25	32	$1/2$
9	26	31	$-1/2$	10	16	22	$1/2$	10	17	23	$1/2$	10	25	31	$1/2$
10	26	32	$1/2$	11	12	15	$\sqrt{6}/3$	11	18	23	$1/2$	11	19	22	$-1/2$
11	27	32	$1/2$	11	28	31	$-1/2$	12	18	22	$1/2$	12	19	23	$1/2$
12	27	31	$1/2$	12	28	32	$1/2$	13	14	15	$\sqrt{6}/3$	13	20	23	$1/2$
13	21	22	$-1/2$	13	29	32	$1/2$	13	30	31	$-1/2$	14	20	22	$1/2$
14	21	23	$1/2$	14	29	31	$1/2$	14	30	32	$1/2$	15	16	17	$1/(2\sqrt{6})$
15	18	19	$1/(2\sqrt{6})$	15	20	21	$1/(2\sqrt{6})$	15	22	23	$-3/(2\sqrt{6})$	15	25	26	$1/(2\sqrt{6})$
15	27	28	$1/(2\sqrt{6})$	15	29	30	$1/(2\sqrt{6})$	15	31	32	$-3/(2\sqrt{6})$	16	17	24	$\sqrt{10}/4$
16	25	34	$1/2$	16	26	33	$-1/2$	17	25	33	$1/2$	17	26	34	$1/2$
18	19	24	$\sqrt{10}/4$	18	27	34	$1/2$	18	28	33	$-1/2$	19	27	33	$1/2$
19	28	34	$1/2$	20	21	24	$\sqrt{10}/4$	20	29	34	$1/2$	20	30	33	$-1/2$
21	29	33	$1/2$	21	30	34	$1/2$	22	23	24	$\sqrt{10}/4$	22	31	34	$1/2$
22	32	33	$-1/2$	23	31	33	$1/2$	23	32	34	$1/2$	24	25	26	$1/(2\sqrt{10})$
24	27	28	$1/(2\sqrt{10})$	24	29	30	$1/(2\sqrt{10})$	24	31	32	$1/(2\sqrt{10})$	24	33	34	$-\sqrt{10}/5$
25	26	35	$\sqrt{15}/5$	27	28	35	$\sqrt{15}/5$	29	30	35	$\sqrt{15}/5$	31	32	35	$\sqrt{15}/5$
33	34	35	$\sqrt{15}/5$												

as A_{N-1}. It is known that the *lowest-dimensional* $SU(N)$ representation is by $N \times N$, traceless matrix generators which we utilize in this paper. Data in this paper are taken from the Particle Data Group.[5,a]

[a]Particle charge conjugate states are utilized in this paper.

Table 3. Nonzero $SU(6)$ commutators.

1. $$\left[V_3, V_{\pi^+}\right] = \begin{pmatrix} 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

2. $$\left[V_3, V_{K^+}\right] = \begin{pmatrix} 0&0&\frac{1}{2}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^+}}{2}\right)$$

3. $$\left[V_3, V_{\bar{D}^0}\right] = \begin{pmatrix} 0&0&0&\frac{1}{2}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{D}^0}}{2}\right)$$

4. $$\left[V_3, V_{B^+}\right] = \begin{pmatrix} 0&0&0&0&\frac{1}{2}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^+}}{2}\right)$$

5. $$\left[V_3, V_{\bar{T}^0}\right] = \begin{pmatrix} 0&0&0&0&0&\frac{1}{2}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{T}^0}}{2}\right)$$

6. $$\left[V_3, V_{\pi^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\pi^-}\right)$$

7. $$\left[V_3, V_{K^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&-\frac{1}{2}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{K^0}}{2}\right)$$

8. $$\left[V_3, V_{D^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&-\frac{1}{2}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{D^-}}{2}\right)$$

9. $$\left[V_3, V_{B^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&-\frac{1}{2}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{B^0}}{2}\right)$$

10. $$\left[V_3, V_{T^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{1}{2}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{T^-}}{2}\right)$$

11. $$\left[V_3, V_{K^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{K^-}}{2}\right)$$

12. $$\left[V_3, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{K}^0}}{2}\right)$$

13. $$\left[V_3, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{D^0}}{2}\right)$$

14. $$\left[V_3, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D^+}}{2}\right)$$

15. $$\left[V_3, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2}&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{B^-}}{2}\right)$$

16. $$\left[V_3, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2}&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{B}^0}}{2}\right)$$

17. $$\left[V_3, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2}&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{T^0}}{2}\right)$$

18. $$\left[V_3, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2}&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^+}}{2}\right)$$

19. $$\left[V_{\pi^+}, V_{\pi^-}\right] = \begin{pmatrix} 1&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(2V_3\right)$$

20. $$\left[V_{\pi^+}, V_{K^0}\right] = \begin{pmatrix} 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^+}\right)$$

Table 3 (*Continued*)

21. $\left[V_{\pi^+}, V_{D^-}\right] = \begin{pmatrix} 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$

22. $\left[V_{\pi^+}, V_{B^0}\right] = \begin{pmatrix} 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^+}\right)$

23. $\left[V_{\pi^+}, V_{T^-}\right] = \begin{pmatrix} 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$

24. $\left[V_{\pi^+}, V_{K^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{K}^0}\right)$

25. $\left[V_{\pi^+}, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D^+}\right)$

26. $\left[V_{\pi^+}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{B}^0}\right)$

27. $\left[V_{\pi^+}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0 \end{pmatrix} = \left(-V_{T^+}\right)$

28. $\left[V_{K^+}, V_{\pi^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{K^0}\right)$

29. $\left[V_{K^+}, V_8\right] = \begin{pmatrix} 0&0&-\frac{\sqrt{3}}{2}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$
$= \left(-\frac{1}{2}\sqrt{3}V_{K^+}\right)$

30. $\left[V_{K^+}, V_{K^-}\right] = \begin{pmatrix} 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$
$= \left(V_3 + \sqrt{3}V_8\right)$

31. $\left[V_{K^+}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^+}\right)$

32. $\left[V_{K^+}, V_{D_s^-}\right] = \begin{pmatrix} 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$

33. $\left[V_{K^+}, V_{B_s^0}\right] = \begin{pmatrix} 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^+}\right)$

34. $\left[V_{K^+}, V_{T_s^-}\right] = \begin{pmatrix} 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$

35. $\left[V_{K^+}, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D_s^+}\right)$

36. $\left[V_{K^+}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{B}_s^0}\right)$

37. $\left[V_{K^+}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0 \end{pmatrix} = \left(-V_{T_s^+}\right)$

38. $\left[V_{\bar{D}^0}, V_{\pi^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&-1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D^-}\right)$

39. $\left[V_{\bar{D}^0}, V_8\right] = \begin{pmatrix} 0&0&0&-\frac{1}{2\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{\bar{D}^0}}{2\sqrt{3}}\right)$

40. $\left[V_{\bar{D}^0}, V_{K^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D_s^-}\right)$

Table 3 (*Continued*)

41. $$\left[V_{\bar{D}^0}, V_{15}\right] = \begin{pmatrix} 0 & 0 & 0 & -\sqrt{\frac{2}{3}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{2}{3}} V_{\bar{D}^0}\right)$$

42. $$\left[V_{\bar{D}^0}, V_{D^0}\right] = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_3 + \frac{V_8}{\sqrt{3}} + 2\sqrt{\tfrac{2}{3}} V_{15}\right)$$

43. $$\left[V_{\bar{D}^0}, V_{D^+}\right] = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

44. $$\left[V_{\bar{D}^0}, V_{D_s^+}\right] = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{K^+}\right)$$

45. $$\left[V_{\bar{D}^0}, V_{B_c^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B^+}\right)$$

46. $$\left[V_{\bar{D}^0}, V_{\bar{T}_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$$

47. $$\left[V_{\bar{D}^0}, V_{B^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B_c^-}\right)$$

48. $$\left[V_{\bar{D}^0}, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \end{pmatrix} = \left(-V_{T_c^0}\right)$$

49. $$\left[V_{B^+}, V_{\pi^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B^0}\right)$$

50. $$\left[V_{B^+}, V_8\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & -\frac{1}{2\sqrt{3}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{B^+}}{2\sqrt{3}}\right)$$

51. $$\left[V_{B^+}, V_{K^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B_s^0}\right)$$

52. $$\left[V_{B^+}, V_{15}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & -\frac{1}{2\sqrt{6}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{B^+}}{2\sqrt{6}}\right)$$

53. $$\left[V_{B^+}, V_{D^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B_c^+}\right)$$

54. $$\left[V_{B^+}, V_{24}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & -\frac{\sqrt{\frac{5}{2}}}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\tfrac{1}{2}\sqrt{\tfrac{5}{2}} V_{B^+}\right)$$

55. $$\left[V_{B^+}, V_{B^-}\right] = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \sqrt{\tfrac{5}{2}} V_{24}\right)$$

56. $$\left[V_{B^+}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

57. $$\left[V_{B^+}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{K^+}\right)$$

58. $$\left[V_{B^+}, V_{B_c^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$$

Table 3 (*Continued*)

59. $$\left[V_{B^+}, V_{T_b^-}\right] = \begin{pmatrix} 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$$

60. $$\left[V_{B^+}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0 \end{pmatrix} = \left(-V_{T_b^+}\right)$$

61. $$\left[V_{\bar{T}^0}, V_{\pi^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T^-}\right)$$

62. $$\left[V_{\bar{T}^0}, V_8\right] = \begin{pmatrix} 0&0&0&0&0&-\frac{1}{2\sqrt{3}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{\bar{T}^0}}{2\sqrt{3}}\right)$$

63. $$\left[V_{\bar{T}^0}, V_{K^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_s^-}\right)$$

64. $$\left[V_{\bar{T}^0}, V_{15}\right] = \begin{pmatrix} 0&0&0&0&0&-\frac{1}{2\sqrt{6}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{\bar{T}^0}}{2\sqrt{6}}\right)$$

65. $$\left[V_{\bar{T}^0}, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_c^0}\right)$$

66. $$\left[V_{\bar{T}^0}, V_{24}\right] = \begin{pmatrix} 0&0&0&0&0&-\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\frac{V_{\bar{T}^0}}{2\sqrt{10}}\right)$$

67. $$\left[V_{\bar{T}^0}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_b^-}\right)$$

68. $$\left[V_{\bar{T}^0}, V_{35}\right] = \begin{pmatrix} 0&0&0&0&0&-\sqrt{\frac{3}{5}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{3}{5}}V_{\bar{T}^0}\right)$$

69. $$\left[V_{\bar{T}^0}, V_{T^0}\right] = \begin{pmatrix} 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1 \end{pmatrix}$$
$$= \left(V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} + 2\sqrt{\tfrac{3}{5}}V_{35}\right)$$

70. $$\left[V_{\bar{T}^0}, V_{T^+}\right] = \begin{pmatrix} 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

71. $$\left[V_{\bar{T}^0}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^+}\right)$$

72. $$\left[V_{\bar{T}^0}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$$

73. $$\left[V_{\bar{T}^0}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^+}\right)$$

74. $$\left[V_{\pi^-}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{K^-}\right)$$

75. $$\left[V_{\pi^-}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D^0}\right)$$

76. $$\left[V_{\pi^-}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B^-}\right)$$

Table 3 (*Continued*)

77. $\left[V_{\pi^-}, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{T^0}\right)$

78. $\left[V_8, V_{K^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{\sqrt{3}V_{K^0}}{2}\right)$

79. $\left[V_8, V_{D^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2\sqrt{3}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^-}}{2\sqrt{3}}\right)$

80. $\left[V_8, V_{B^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{3}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B^0}}{2\sqrt{3}}\right)$

81. $\left[V_8, V_{T^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{T^-}}{2\sqrt{3}}\right)$

82. $\left[V_8, V_{K^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{\sqrt{3}}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$
$= \left(-\frac{1}{2}\sqrt{3}V_{K^-}\right)$

83. $\left[V_8, V_{\bar{K}^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{\sqrt{3}}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$
$= \left(-\frac{1}{2}\sqrt{3}V_{\bar{K}^0}\right)$

84. $\left[V_8, V_{D_s^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{1}{\sqrt{3}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D_s^-}}{\sqrt{3}}\right)$

85. $\left[V_8, V_{B_s^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{1}{\sqrt{3}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{B_s^0}}{\sqrt{3}}\right)$

86. $\left[V_8, V_{T_s^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -\frac{1}{\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_s^-}}{\sqrt{3}}\right)$

87. $\left[V_8, V_{D^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D^0}}{2\sqrt{3}}\right)$

88. $\left[V_8, V_{D^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D^+}}{2\sqrt{3}}\right)$

89. $\left[V_8, V_{D_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D_s^+}}{\sqrt{3}}\right)$

90. $\left[V_8, V_{B^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{B^-}}{2\sqrt{3}}\right)$

91. $\left[V_8, V_{\bar{B}^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{B}^0}}{2\sqrt{3}}\right)$

92. $\left[V_8, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{B}_s^0}}{\sqrt{3}}\right)$

93. $\left[V_8, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^0}}{2\sqrt{3}}\right)$

94. $\left[V_8, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^+}}{2\sqrt{3}}\right)$

Table 3 (*Continued*)

$$95.\ \left[V_8, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{3}}&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^+}}{\sqrt{3}}\right)$$

$$96.\ \left[V_{K^0}, V_{K^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$$

$$97.\ \left[V_{K^0}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_3 + \sqrt{3}V_8\right)$$

$$98.\ \left[V_{K^0}, V_{D_s^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$$

$$99.\ \left[V_{K^0}, V_{B_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$$

$$100.\ \left[V_{K^0}, V_{T_s^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$$

$$101.\ \left[V_{K^0}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D_s^+}\right)$$

$$102.\ \left[V_{K^0}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{B}_s^0}\right)$$

$$103.\ \left[V_{K^0}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0 \end{pmatrix} = \left(-V_{T_s^+}\right)$$

$$104.\ \left[V_{D^-}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D_s^-}\right)$$

$$105.\ \left[V_{D^-}, V_{15}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&-\sqrt{\frac{2}{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\sqrt{\frac{2}{3}}V_{D^-}\right)$$

$$106.\ \left[V_{D^-}, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$$

$$107.\ \left[V_{D^-}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_3 + \frac{V_8}{\sqrt{3}} + 2\sqrt{\frac{2}{3}}V_{15}\right)$$

$$108.\ \left[V_{D^-}, V_{D_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$$

$$109.\ \left[V_{D^-}, V_{B_c^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$$

$$110.\ \left[V_{D^-}, V_{\bar{T}_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$$

$$111.\ \left[V_{D^-}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B_c^-}\right)$$

$$112.\ \left[V_{D^-}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0 \end{pmatrix} = \left(-V_{T_c^0}\right)$$

$$113.\ \left[V_{B^0}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B_s^0}\right)$$

Table 3 (*Continued*)

114. $$\left[V_{B^0}, V_{15}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&-\frac{1}{2\sqrt{6}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{B^0}}{2\sqrt{6}}\right)$$

115. $$\left[V_{B^0}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B_c^+}\right)$$

116. $$\left[V_{B^0}, V_{24}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&-\frac{\sqrt{\frac{5}{2}}}{2}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{B^0}\right)$$

117. $$\left[V_{B^0}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$$

118. $$\left[V_{B^0}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \sqrt{\frac{5}{2}}V_{24}\right)$$

119. $$\left[V_{B^0}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$$

120. $$\left[V_{B^0}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$$

121. $$\left[V_{B^0}, V_{T_b^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$$

122. $$\left[V_{B^0}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0 \end{pmatrix} = \left(-V_{T_b^+}\right)$$

123. $$\left[V_{T^-}, V_{\bar{K}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_s^-}\right)$$

124. $$\left[V_{T^-}, V_{15}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{1}{2\sqrt{6}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{T^-}}{2\sqrt{6}}\right)$$

125. $$\left[V_{T^-}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{T}_c^0}\right)$$

126. $$\left[V_{T^-}, V_{24}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{T^-}}{2\sqrt{10}}\right)$$

127. $$\left[V_{T^-}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_b^-}\right)$$

128. $$\left[V_{T^-}, V_{35}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-\sqrt{\frac{3}{5}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\sqrt{\frac{3}{5}}V_{T^-}\right)$$

129. $$\left[V_{T^-}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$$

130. $$\left[V_{T^-}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1 \end{pmatrix} = \left(-V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} + 2\sqrt{\frac{3}{5}}V_{35}\right)$$

Table 3 (*Continued*)

131. $$\left[V_{T^-}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$$

132. $$\left[V_{T^-}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$$

133. $$\left[V_{T^-}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$$

134. $$\left[V_{K^-}, V_{D_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D^0}\right)$$

135. $$\left[V_{K^-}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B^-}\right)$$

136. $$\left[V_{K^-}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0 \end{pmatrix} = \left(-V_{T^0}\right)$$

137. $$\left[V_{\bar{K}^0}, V_{D_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{D^+}\right)$$

138. $$\left[V_{\bar{K}^0}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{B}^0}\right)$$

139. $$\left[V_{\bar{K}^0}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0 \end{pmatrix} = \left(-V_{T^+}\right)$$

140. $$\left[V_{15}, V_{D_s^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\sqrt{\frac{2}{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(\sqrt{\tfrac{2}{3}}V_{D_s^-}\right)$$

141. $$\left[V_{15}, V_{B_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{2\sqrt{6}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_s^0}}{2\sqrt{6}}\right)$$

142. $$\left[V_{15}, V_{T_s^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{6}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^-}}{2\sqrt{6}}\right)$$

143. $$\left[V_{15}, V_{D^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\sqrt{\frac{2}{3}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{2}{3}}V_{D^0}\right)$$

144. $$\left[V_{15}, V_{D^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-\sqrt{\frac{2}{3}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{2}{3}}V_{D^+}\right)$$

145. $$\left[V_{15}, V_{D_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-\sqrt{\frac{2}{3}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{2}{3}}V_{D_s^+}\right)$$

146. $$\left[V_{15}, V_{B_c^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-\frac{\sqrt{\frac{3}{2}}}{2}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\tfrac{1}{2}\sqrt{\tfrac{3}{2}}V_{B_c^+}\right)$$

147. $$\left[V_{15}, V_{\bar{T}_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{\sqrt{\frac{3}{2}}}{2}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\tfrac{1}{2}\sqrt{\tfrac{3}{2}}V_{\bar{T}_c^0}\right)$$

148. $$\left[V_{15}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2\sqrt{6}}&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\frac{V_{B^-}}{2\sqrt{6}}\right)$$

Table 3 (*Continued*)

149. $$\left[V_{15}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{B}^0}}{2\sqrt{6}}\right)$$

150. $$\left[V_{15}, V_{\bar{B}^0_s}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{B}^0_s}}{2\sqrt{6}}\right)$$

151. $$\left[V_{15}, V_{B_c^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{\frac{3}{2}}}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{1}{2}\sqrt{\frac{3}{2}}V_{B_c^-}\right)$$

152. $$\left[V_{15}, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^0}}{2\sqrt{6}}\right)$$

153. $$\left[V_{15}, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^+}}{2\sqrt{6}}\right)$$

154. $$\left[V_{15}, V_{T_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_s^+}}{2\sqrt{6}}\right)$$

155. $$\left[V_{15}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{\frac{3}{2}}}{2} & 0 & 0 \end{pmatrix} = \left(\frac{1}{2}\sqrt{\frac{3}{2}}V_{T_c^0}\right)$$

156. $$\left[V_{D_s^-}, V_{D^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{K^-}\right)$$

157. $$\left[V_{D_s^-}, V_{D^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

158. $$\left[V_{D_s^-}, V_{D_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{2V_8}{\sqrt{3}} + 2\sqrt{\frac{2}{3}}V_{15}\right)$$

159. $$\left[V_{D_s^-}, V_{B_c^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B_s^0}\right)$$

160. $$\left[V_{D_s^-}, V_{\bar{T}_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T_s^-}\right)$$

161. $$\left[V_{D_s^-}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B_c^-}\right)$$

162. $$\left[V_{D_s^-}, V_{T_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \end{pmatrix} = \left(-V_{T_c^0}\right)$$

163. $$\left[V_{B_s^0}, V_{D_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{B_c^+}\right)$$

164. $$\left[V_{B_s^0}, V_{24}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{\frac{5}{2}}}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{B_s^0}\right)$$

Table 3 (*Continued*)

165. $$\left[V_{B_s^0}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

166. $$\left[V_{B_s^0}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

167. $$\left[V_{B_s^0}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\frac{2V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \sqrt{\frac{5}{2}}V_{24}\right)$$

168. $$\left[V_{B_s^0}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^-}\right)$$

169. $$\left[V_{B_s^0}, V_{T_b^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_s^-}\right)$$

170. $$\left[V_{B_s^0}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0 \end{pmatrix} = \left(-V_{T_b^+}\right)$$

171. $$\left[V_{T_s^-}, V_{D_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{T}_c^0}\right)$$

172. $$\left[V_{T_s^-}, V_{24}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\frac{V_{T_s^-}}{2\sqrt{10}}\right)$$

173. $$\left[V_{T_s^-}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_b^-}\right)$$

174. $$\left[V_{T_s^-}, V_{35}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\sqrt{\frac{3}{5}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\frac{3}{5}}V_{T_s^-}\right)$$

175. $$\left[V_{T_s^-}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

176. $$\left[V_{T_s^-}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

177. $$\left[V_{T_s^-}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1 \end{pmatrix}$$
$$= \left(-\frac{2V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} + 2\sqrt{\frac{3}{5}}V_{35}\right)$$

178. $$\left[V_{T_s^-}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^-}\right)$$

179. $$\left[V_{T_s^-}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_s^0}\right)$$

180. $$\left[V_{D^0}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{B^-}\right)$$

181. $$\left[V_{D^0}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0 \end{pmatrix} = \left(-V_{T^0}\right)$$

182. $$\left[V_{D^+}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{\bar{B}^0}\right)$$

Table 3 (*Continued*)

183. $$\left[V_{D^+}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{T^+}\right)$$

184. $$\left[V_{D_s^+}, V_{B_c^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{\bar{B}_s^0}\right)$$

185. $$\left[V_{D_s^+}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \end{pmatrix} = \left(-V_{T_s^+}\right)$$

186. $$\left[V_{24}, V_{B_c^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{\frac{5}{2}}}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{1}{2}\sqrt{\frac{5}{2}}V_{B_c^+}\right)$$

187. $$\left[V_{24}, V_{\bar{T}_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{10}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}_c^0}}{2\sqrt{10}}\right)$$

188. $$\left[V_{24}, V_{B^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{\sqrt{\frac{5}{2}}}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{B^-}\right)$$

189. $$\left[V_{24}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{\sqrt{\frac{5}{2}}}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{\bar{B}^0}\right)$$

190. $$\left[V_{24}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{\frac{5}{2}}}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{\bar{B}_s^0}\right)$$

191. $$\left[V_{24}, V_{B_c^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{\sqrt{\frac{5}{2}}}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{5}{2}}V_{B_c^-}\right)$$

192. $$\left[V_{24}, V_{T_b^-}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -\sqrt{\frac{2}{5}} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\sqrt{\frac{2}{5}}V_{T_b^-}\right)$$

193. $$\left[V_{24}, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{2\sqrt{10}} & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^0}}{2\sqrt{10}}\right)$$

194. $$\left[V_{24}, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{10}} & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T^+}}{2\sqrt{10}}\right)$$

195. $$\left[V_{24}, V_{T_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2\sqrt{10}} & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_s^+}}{2\sqrt{10}}\right)$$

196. $$\left[V_{24}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{1}{2\sqrt{10}} & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_c^0}}{2\sqrt{10}}\right)$$

197. $$\left[V_{24}, V_{T_b^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sqrt{\frac{2}{5}} & 0 \end{pmatrix} = \left(\sqrt{\frac{2}{5}}V_{T_b^+}\right)$$

Table 3 (*Continued*)

198. $$\left[V_{B_c^+}, V_{B^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$$

199. $$\left[V_{B_c^+}, V_{\bar{B}^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$$

200. $$\left[V_{B_c^+}, V_{\bar{B}_s^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^+}\right)$$

201. $$\left[V_{B_c^+}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&-1&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{3}{2}}V_{15} + \sqrt{\tfrac{5}{2}}V_{24}\right)$$

202. $$\left[V_{B_c^+}, V_{T_b^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}_c^0}\right)$$

203. $$\left[V_{B_c^+}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-1&0 \end{pmatrix} = \left(-V_{T_b^+}\right)$$

204. $$\left[V_{\bar{T}_c^0}, V_{B_c^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-V_{T_b^-}\right)$$

205. $$\left[V_{\bar{T}_c^0}, V_{35}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\sqrt{\tfrac{3}{5}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{3}{5}}V_{\bar{T}_c^0}\right)$$

206. $$\left[V_{\bar{T}_c^0}, V_{T^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$$

207. $$\left[V_{\bar{T}_c^0}, V_{T^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$$

208. $$\left[V_{\bar{T}_c^0}, V_{T_s^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^+}\right)$$

209. $$\left[V_{\bar{T}_c^0}, V_{T_c^0}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-1 \end{pmatrix}$$
$$= \left(-\sqrt{\tfrac{3}{2}}V_{15} + \frac{V_{24}}{\sqrt{10}} + 2\sqrt{\tfrac{3}{5}}V_{35}\right)$$

210. $$\left[V_{\bar{T}_c^0}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^+}\right)$$

211. $$\left[V_{B^-}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -1&0&0&0&0&0 \end{pmatrix} = \left(-V_{T^0}\right)$$

212. $$\left[V_{\bar{B}^0}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-1&0&0&0&0 \end{pmatrix} = \left(-V_{T^+}\right)$$

213. $$\left[V_{\bar{B}_s^0}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-1&0&0&0 \end{pmatrix} = \left(-V_{T_s^+}\right)$$

214. $$\left[V_{B_c^-}, V_{T_b^+}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-1&0&0 \end{pmatrix} = \left(-V_{T_c^0}\right)$$

215. $$\left[V_{35}, V_{T_b^-}\right] = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\sqrt{\tfrac{3}{5}}\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(\sqrt{\tfrac{3}{5}}V_{T_b^-}\right)$$

Table 3 (*Continued*)

216. $$\left[V_{35}, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\sqrt{\frac{3}{5}} & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{3}{5}}V_{T^0}\right)$$

217. $$\left[V_{35}, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\sqrt{\frac{3}{5}} & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{3}{5}}V_{T^+}\right)$$

218. $$\left[V_{35}, V_{T_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\sqrt{\frac{3}{5}} & 0 & 0 & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{3}{5}}V_{T_s^+}\right)$$

219. $$\left[V_{35}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\sqrt{\frac{3}{5}} & 0 & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{3}{5}}V_{T_c^0}\right)$$

220. $$\left[V_{35}, V_{T_b^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\sqrt{\frac{3}{5}} & 0 \end{pmatrix} = \left(-\sqrt{\tfrac{3}{5}}V_{T_b^+}\right)$$

221. $$\left[V_{T_b^-}, V_{T^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B^-}\right)$$

222. $$\left[V_{T_b^-}, V_{T^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{B}^0}\right)$$

223. $$\left[V_{T_b^-}, V_{T_s^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{B}_s^0}\right)$$

224. $$\left[V_{T_b^-}, V_{T_c^0}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B_c^-}\right)$$

225. $$\left[V_{T_b^-}, V_{T_b^+}\right] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} = \left(-2\sqrt{\tfrac{2}{5}}V_{24} + 2\sqrt{\tfrac{3}{5}}V_{35}\right)$$

1.1. *More about the SU(6) Lie algebra*

The defining bilinear operation — the commutator [,] — involving the structure constants and which determines the Lie algebra and a generator scalar product is given by

$$[V_a, V_b] = i \sum_{c=1}^{N^2-1} f_{abc} V_c \,, \tag{1a}$$

where a, $b = 1, 2, \ldots, N^2 - 1$

$$\mathrm{Tr}[V_a V_b] = \frac{1}{2}\delta_{ab} \,, \tag{1b}$$

$$f_{abc} = -i2\,\mathrm{Tr}([V_a, V_b]V_c) \,. \tag{1c}$$

Table 4. Nonzero totally symmetric $SU(6)$ structure constant related tensors d_{ijk}.

i	j	k	d_{ijk}	i	j	k	d_{ijk}	i	j	k	d_{ijk}	i	j	k	d_{ijk}
0	j	k	$\delta_{jk}/\sqrt{3}$	1	1	8	$1/\sqrt{3}$	1	1	15	$1/\sqrt{6}$	1	1	24	$1/\sqrt{10}$
1	1	35	$1/\sqrt{15}$	1	4	6	$1/2$	1	5	7	$1/2$	1	9	11	$1/2$
1	10	12	$1/2$	1	16	18	$1/2$	1	17	19	$1/2$	1	25	27	$1/2$
1	26	28	$1/2$	2	2	8	$1/\sqrt{3}$	2	2	15	$1/\sqrt{6}$	2	2	24	$1/\sqrt{10}$
2	2	35	$1/\sqrt{15}$	2	4	7	$-1/2$	2	5	6	$1/2$	2	9	12	$-1/2$
2	10	11	$1/2$	2	16	19	$-1/2$	2	17	18	$1/2$	2	25	28	$-1/2$
2	26	27	$1/2$	3	3	8	$1/\sqrt{3}$	3	3	15	$1/\sqrt{6}$	3	3	24	$1/\sqrt{10}$
3	3	35	$1/\sqrt{15}$	3	4	4	$1/2$	3	5	5	$1/2$	3	6	6	$-1/2$
3	7	7	$-1/2$	3	9	9	$1/2$	3	10	10	$1/2$	3	11	11	$-1/2$
3	12	12	$-1/2$	3	16	16	$1/2$	3	17	17	$1/2$	3	18	18	$-1/2$
3	19	19	$-1/2$	3	25	25	$1/2$	3	26	26	$1/2$	3	27	27	$-1/2$
3	28	28	$-1/2$	4	4	8	$-1/(2\sqrt{3})$	4	4	15	$1/\sqrt{6}$	4	4	24	$1/\sqrt{10}$
4	4	35	$1/\sqrt{15}$	4	9	13	$1/2$	4	10	14	$1/2$	4	16	20	$1/2$
4	17	21	$1/2$	4	25	29	$1/2$	4	26	30	$1/2$	5	5	8	$-1/(2\sqrt{3})$
5	5	15	$1/\sqrt{6}$	5	5	24	$1/\sqrt{10}$	5	5	35	$1/\sqrt{15}$	5	9	14	$-1/2$
5	10	13	$1/2$	5	16	21	$-1/2$	5	17	20	$1/2$	5	25	30	$-1/2$
5	26	29	$1/2$	6	6	8	$-1/(2\sqrt{3})$	6	6	15	$1/\sqrt{6}$	6	6	24	$1/\sqrt{10}$
6	6	35	$1/\sqrt{15}$	6	11	13	$1/2$	6	12	14	$1/2$	6	18	20	$1/2$
6	19	21	$1/2$	6	27	29	$1/2$	6	28	30	$1/2$	7	7	8	$-1/(2\sqrt{3})$
7	7	15	$1/\sqrt{6}$	7	7	24	$1/\sqrt{10}$	7	7	35	$1/\sqrt{15}$	7	11	14	$-1/2$
7	12	13	$1/2$	7	18	21	$-1/2$	7	19	20	$1/2$	7	27	30	$-1/2$
7	28	29	$1/2$	8	8	8	$-(1/\sqrt{3})$	8	8	15	$1/\sqrt{6}$	8	8	24	$1/\sqrt{10}$
8	8	35	$1/\sqrt{15}$	8	9	9	$1/(2\sqrt{3})$	8	10	10	$1/(2\sqrt{3})$	8	11	11	$1/(2\sqrt{3})$
8	12	12	$1/(2\sqrt{3})$	8	13	13	$-(1/\sqrt{3})$	8	14	14	$-(1/\sqrt{3})$	8	16	16	$1/(2\sqrt{3})$
8	17	17	$1/(2\sqrt{3})$	8	18	18	$1/(2\sqrt{3})$	8	19	19	$1/(2\sqrt{3})$	8	20	20	$-(1/\sqrt{3})$
8	21	21	$-(1/\sqrt{3})$	8	25	25	$1/(2\sqrt{3})$	8	26	26	$1/(2\sqrt{3})$	8	27	27	$1/(2\sqrt{3})$
8	28	28	$1/(2\sqrt{3})$	8	29	29	$-(1/\sqrt{3})$	8	30	30	$-(1/\sqrt{3})$	9	9	15	$-(1/\sqrt{6})$
9	9	24	$1/\sqrt{10}$	9	9	35	$1/\sqrt{15}$	9	16	22	$1/2$	9	17	23	$1/2$
9	26	32	$1/2$	10	10	15	$-(1/\sqrt{6})$	10	10	24	$1/\sqrt{10}$	10	10	35	$1/\sqrt{15}$
10	16	23	$-1/2$	10	17	22	$1/2$	10	25	32	$-1/2$	10	26	31	$1/2$
11	11	15	$-(1/\sqrt{6})$	11	11	24	$1/\sqrt{10}$	11	11	35	$1/\sqrt{15}$	11	18	22	$1/2$
11	19	23	$1/2$	11	27	31	$1/2$	11	28	32	$1/2$	12	12	15	$-(1/\sqrt{6})$
12	12	24	$1/\sqrt{10}$	12	12	35	$1/\sqrt{15}$	12	18	23	$-1/2$	12	19	22	$1/2$
12	27	32	$-1/2$	12	28	31	$1/2$	13	13	15	$-(1/\sqrt{6})$	13	13	24	$1/\sqrt{10}$
13	13	35	$1/\sqrt{15}$	13	20	22	$1/2$	13	21	23	$1/2$	13	29	31	$1/2$
13	30	32	$1/2$	14	14	15	$-(1/\sqrt{6})$	14	14	24	$1/\sqrt{10}$	14	14	35	$1/\sqrt{15}$
14	20	23	$-1/2$	14	21	22	$1/2$	14	29	32	$-1/2$	14	30	31	$1/2$
15	15	15	$-2/\sqrt{6}$	15	15	24	$1/\sqrt{10}$	15	15	35	$1/\sqrt{15}$	15	16	16	$1/(2\sqrt{6})$
15	17	17	$1/(2\sqrt{6})$	15	18	18	$1/(2\sqrt{6})$	15	19	19	$1/(2\sqrt{6})$	15	20	20	$1/(2\sqrt{6})$
15	21	21	$1/(2\sqrt{6})$	15	22	22	$-3/(2\sqrt{6})$	15	23	23	$-3/(2\sqrt{6})$	15	25	25	$1/(2\sqrt{6})$
15	26	26	$1/(2\sqrt{6})$	15	27	27	$1/(2\sqrt{6})$	15	28	28	$1/(2\sqrt{6})$	15	29	29	$1/(2\sqrt{6})$
15	30	30	$1/(2\sqrt{6})$	15	31	31	$-3/(2\sqrt{6})$	15	32	32	$-3/(2\sqrt{6})$	16	16	24	$-3/(2\sqrt{10})$
16	16	35	$1/\sqrt{15}$	16	25	33	$1/2$	16	26	34	$1/2$	17	17	24	$-3/(2\sqrt{10})$
17	17	35	$1/\sqrt{15}$	17	25	34	$-1/2$	17	26	33	$1/2$	18	18	24	$-3/(2\sqrt{10})$
18	18	35	$1/\sqrt{15}$	18	27	33	$1/2$	18	28	34	$1/2$	19	19	24	$-3/(2\sqrt{10})$
19	19	35	$1/\sqrt{15}$	19	27	34	$-1/2$	19	28	33	$1/2$	20	20	24	$-3/(2\sqrt{10})$
20	20	35	$1/\sqrt{15}$	20	29	33	$1/2$	20	30	34	$1/2$	21	21	24	$-3/(2\sqrt{10})$
21	21	35	$1/\sqrt{15}$	21	29	34	$-1/2$	21	30	33	$1/2$	22	22	24	$-3/(2\sqrt{10})$
22	22	35	$1/\sqrt{15}$	22	31	33	$1/2$	22	32	34	$1/2$	23	23	24	$-3/(2\sqrt{10})$
23	23	35	$1/\sqrt{15}$	23	31	34	$-1/2$	23	32	33	$1/2$	24	24	24	$-3/\sqrt{10}$
24	24	35	$1/\sqrt{15}$	24	25	25	$1/(2\sqrt{10})$	24	26	26	$1/(2\sqrt{10})$	24	27	27	$1/(2\sqrt{10})$
24	28	28	$1/(2\sqrt{10})$	24	29	29	$1/(2\sqrt{10})$	24	30	30	$1/(2\sqrt{10})$	24	31	31	$1/(2\sqrt{10})$
24	32	32	$1/(2\sqrt{10})$	24	33	33	$-\sqrt{2/5}$	24	34	34	$-\sqrt{2/5}$	25	25	35	$-2/\sqrt{15}$
26	26	35	$-2/\sqrt{15}$	27	27	35	$-2/\sqrt{15}$	28	28	35	$-2/\sqrt{15}$	29	29	35	$-2/\sqrt{15}$
30	30	35	$-2/\sqrt{15}$	31	31	35	$-2/\sqrt{15}$	32	32	35	$-2/\sqrt{15}$	33	33	35	$-2/\sqrt{15}$
34	34	35	$-2/\sqrt{15}$	35	35	35	$-4/\sqrt{15}$								

Table 5. Nonzero $SU(6)$ anticommutators.

1. $\left\{V_3, V_{K+}\right\} = \begin{pmatrix} 0 & 0 & \frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K+}}{2}\right)$	10. $\left\{V_3, V_{K-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K-}}{2}\right)$
2. $\left\{V_3, V_{\bar{D}0}\right\} = \begin{pmatrix} 0 & 0 & 0 & \frac{1}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{D}0}}{2}\right)$	11. $\left\{V_3, V_{\bar{K}0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{K}0}}{2}\right)$
3. $\left\{V_3, V_{B+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B+}}{2}\right)$	12. $\{V_3, V_{15}\} = \begin{pmatrix} \frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_3}{\sqrt{6}}\right)$
4. $\left\{V_3, V_{\bar{T}0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}0}}{2}\right)$	13. $\left\{V_3, V_{D0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D0}}{2}\right)$
5. $\{V_3, V_8\} = \begin{pmatrix} \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_3}{\sqrt{3}}\right)$	14. $\left\{V_3, V_{D+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D+}}{2}\right)$
6. $\left\{V_3, V_{K0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{K0}}{2}\right)$	15. $\{V_3, V_{24}\} = \begin{pmatrix} \frac{1}{2\sqrt{10}} & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{10}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_3}{\sqrt{10}}\right)$
7. $\left\{V_3, V_{D-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{1}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D-}}{2}\right)$	16. $\left\{V_3, V_{B-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B-}}{2}\right)$
8. $\left\{V_3, V_{B0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{1}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{B0}}{2}\right)$	17. $\left\{V_3, V_{\bar{B}0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{B}0}}{2}\right)$
9. $\left\{V_3, V_{T-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -\frac{1}{2} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T-}}{2}\right)$	18. $\{V_3, V_{35}\} = \begin{pmatrix} \frac{1}{2\sqrt{15}} & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{2\sqrt{15}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_3}{\sqrt{15}}\right)$

Table 5 (*Continued*)

19. $$\left\{V_3, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{2}&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^0}}{2}\right)$$

20. $$\left\{V_3, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-\frac{1}{2}&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{T^+}}{2}\right)$$

21. $$\{V_3, V_0\} = \begin{pmatrix} \frac{1}{2\sqrt{3}}&0&0&0&0&0\\ 0&-\frac{1}{2\sqrt{3}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_3}{\sqrt{3}}\right)$$

22. $$\left\{V_{\pi^+}, V_{\pi^-}\right\} = \begin{pmatrix} 1&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$
$$= \left(\frac{2V_0}{\sqrt{3}} + \frac{2V_8}{\sqrt{3}} + \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$$

23. $$\left\{V_{\pi^+}, V_8\right\} = \begin{pmatrix} 0&\frac{1}{\sqrt{3}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^+}}{\sqrt{3}}\right)$$

24. $$\left\{V_{\pi^+}, V_{K^0}\right\} = \begin{pmatrix} 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^+}\right)$$

25. $$\left\{V_{\pi^+}, V_{D^-}\right\} = \begin{pmatrix} 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$$

26. $$\left\{V_{\pi^+}, V_{B^0}\right\} = \begin{pmatrix} 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^+}\right)$$

27. $$\left\{V_{\pi^+}, V_{T^-}\right\} = \begin{pmatrix} 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$$

28. $$\left\{V_{\pi^+}, V_{K^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

29. $$\left\{V_{\pi^+}, V_{15}\right\} = \begin{pmatrix} 0&\frac{1}{\sqrt{6}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^+}}{\sqrt{6}}\right)$$

30. $$\left\{V_{\pi^+}, V_{D^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$$

31. $$\left\{V_{\pi^+}, V_{24}\right\} = \begin{pmatrix} 0&\frac{1}{\sqrt{10}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^+}}{\sqrt{10}}\right)$$

32. $$\left\{V_{\pi^+}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{B}^0}\right)$$

33. $$\left\{V_{\pi^+}, V_{35}\right\} = \begin{pmatrix} 0&\frac{1}{\sqrt{15}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^+}}{\sqrt{15}}\right)$$

34. $$\left\{V_{\pi^+}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0 \end{pmatrix} = \left(V_{T^+}\right)$$

35. $$\left\{V_{\pi^+}, V_0\right\} = \begin{pmatrix} 0&\frac{1}{\sqrt{3}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^+}}{\sqrt{3}}\right)$$

36. $$\left\{V_{K^+}, V_{\pi^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$$

Table 5 (*Continued*)

37. $$\left\{V_{K^+}, V_8\right\} = \begin{pmatrix} 0 & 0 & -\frac{1}{2\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{K^+}}{2\sqrt{3}}\right)$$

38. $$\left\{V_{K^+}, V_{K^-}\right\} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} + V_3 - \frac{V_8}{\sqrt{3}} + \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$$

39. $$\left\{V_{K^+}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

40. $$\left\{V_{K^+}, V_{15}\right\} = \begin{pmatrix} 0 & 0 & \frac{1}{\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K^+}}{\sqrt{6}}\right)$$

41. $$\left\{V_{K^+}, V_{D_s^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$$

42. $$\left\{V_{K^+}, V_{B_s^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B^+}\right)$$

43. $$\left\{V_{K^+}, V_{T_s^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$$

44. $$\left\{V_{K^+}, V_{D^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{D_s^+}\right)$$

45. $$\left\{V_{K^+}, V_{24}\right\} = \begin{pmatrix} 0 & 0 & \frac{1}{\sqrt{10}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K^+}}{\sqrt{10}}\right)$$

46. $$\left\{V_{K^+}, V_{B^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{B}_s^0}\right)$$

47. $$\left\{V_{K^+}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K^+}}{\sqrt{15}}\right)$$

48. $$\left\{V_{K^+}, V_{T^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T_s^+}\right)$$

49. $$\left\{V_{K^+}, V_0\right\} = \begin{pmatrix} 0 & 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K^+}}{\sqrt{3}}\right)$$

50. $$\left\{V_{\bar{D}^0}, V_{\pi^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{D^-}\right)$$

51. $$\left\{V_{\bar{D}^0}, V_8\right\} = \begin{pmatrix} 0 & 0 & 0 & \frac{1}{2\sqrt{3}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{D}^0}}{2\sqrt{3}}\right)$$

52. $$\left\{V_{\bar{D}^0}, V_{K^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{D_s^-}\right)$$

53. $$\left\{V_{\bar{D}^0}, V_{15}\right\} = \begin{pmatrix} 0 & 0 & 0 & -\frac{1}{\sqrt{6}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{D}^0}}{\sqrt{6}}\right)$$

54. $$\left\{V_{\bar{D}^0}, V_{D^0}\right\} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} + V_3 + \frac{V_8}{\sqrt{3}} - \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$$

Table 5 (*Continued*)

55. $$\left\{V_{\bar{D}^0}, V_{D^+}\right\} = \begin{pmatrix} 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

56. $$\left\{V_{\bar{D}^0}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^+}\right)$$

57. $$\left\{V_{\bar{D}^0}, V_{24}\right\} = \begin{pmatrix} 0&0&0&\frac{1}{\sqrt{10}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{D}^0}}{\sqrt{10}}\right)$$

58. $$\left\{V_{\bar{D}^0}, V_{B_c^+}\right\} = \begin{pmatrix} 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^+}\right)$$

59. $$\left\{V_{\bar{D}^0}, V_{\bar{T}_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}^0}\right)$$

60. $$\left\{V_{\bar{D}^0}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^-}\right)$$

61. $$\left\{V_{\bar{D}^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&\frac{1}{\sqrt{15}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{D}^0}}{\sqrt{15}}\right)$$

62. $$\left\{V_{\bar{D}^0}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0 \end{pmatrix} = \left(V_{T_c^0}\right)$$

63. $$\left\{V_{\bar{D}^0}, V_0\right\} = \begin{pmatrix} 0&0&0&\frac{1}{\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{D}^0}}{\sqrt{3}}\right)$$

64. $$\left\{V_{B^+}, V_{\pi^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$$

65. $$\left\{V_{B^+}, V_8\right\} = \begin{pmatrix} 0&0&0&0&\frac{1}{2\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^+}}{2\sqrt{3}}\right)$$

66. $$\left\{V_{B^+}, V_{K^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_s^0}\right)$$

67. $$\left\{V_{B^+}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&\frac{1}{2\sqrt{6}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^+}}{2\sqrt{6}}\right)$$

68. $$\left\{V_{B^+}, V_{D^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^+}\right)$$

69. $$\left\{V_{B^+}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&-\frac{3}{2\sqrt{10}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{B^+}}{2\sqrt{10}}\right)$$

70. $$\left\{V_{B^+}, V_{B^-}\right\} = \begin{pmatrix} 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} + V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} - \frac{3V_{24}}{\sqrt{10}} + \frac{2V_{35}}{\sqrt{15}}\right)$$

71. $$\left\{V_{B^+}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^+}\right)$$

72. $$\left\{V_{B^+}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^+}\right)$$

73. $$\left\{V_{B^+}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{D}^0}\right)$$

Table 5 (*Continued*)

74. $$\left\{V_{B+}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & \frac{1}{\sqrt{15}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B+}}{\sqrt{15}}\right)$$

75. $$\left\{V_{B+}, V_{T_b^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{T}0}\right)$$

76. $$\left\{V_{B+}, V_{T0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} = \left(V_{T_b^+}\right)$$

77. $$\left\{V_{B+}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & \frac{1}{\sqrt{3}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B+}}{\sqrt{3}}\right)$$

78. $$\left\{V_{\bar{T}0}, V_{\pi-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T-}\right)$$

79. $$\left\{V_{\bar{T}0}, V_8\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}0}}{2\sqrt{3}}\right)$$

80. $$\left\{V_{\bar{T}0}, V_{K-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T_s^-}\right)$$

81. $$\left\{V_{\bar{T}0}, V_{15}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{6}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}0}}{2\sqrt{6}}\right)$$

82. $$\left\{V_{\bar{T}0}, V_{D0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{T}_c^0}\right)$$

83. $$\left\{V_{\bar{T}0}, V_{24}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{10}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}0}}{2\sqrt{10}}\right)$$

84. $$\left\{V_{\bar{T}0}, V_{B-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T_b^-}\right)$$

85. $$\left\{V_{\bar{T}0}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & -\frac{2}{\sqrt{15}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{2V_{\bar{T}0}}{\sqrt{15}}\right)$$

86. $$\left\{V_{\bar{T}0}, V_{T0}\right\} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} + V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} - \frac{4V_{35}}{\sqrt{15}}\right)$$

87. $$\left\{V_{\bar{T}0}, V_{T+}\right\} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\pi+}\right)$$

88. $$\left\{V_{\bar{T}0}, V_{T_s^+}\right\} = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{K+}\right)$$

89. $$\left\{V_{\bar{T}0}, V_{T_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{D}0}\right)$$

90. $$\left\{V_{\bar{T}0}, V_{T_b^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B+}\right)$$

91. $$\left\{V_{\bar{T}0}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & \frac{1}{\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{T}0}}{\sqrt{3}}\right)$$

92. $$\left\{V_{\pi-}, V_8\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\pi-}}{\sqrt{3}}\right)$$

Table 5 (*Continued*)

93. $$\left\{V_{\pi^-}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

94. $$\left\{V_{\pi^-}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ \frac{1}{\sqrt{6}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^-}}{\sqrt{6}}\right)$$

95. $$\left\{V_{\pi^-}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$$

96. $$\left\{V_{\pi^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ \frac{1}{\sqrt{10}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^-}}{\sqrt{10}}\right)$$

97. $$\left\{V_{\pi^-}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^-}\right)$$

98. $$\left\{V_{\pi^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ \frac{1}{\sqrt{15}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^-}}{\sqrt{15}}\right)$$

99. $$\left\{V_{\pi^-}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0 \end{pmatrix} = \left(V_{T^0}\right)$$

100. $$\left\{V_{\pi^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ \frac{1}{\sqrt{3}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\pi^-}}{\sqrt{3}}\right)$$

101. $$\left\{V_8, V_{K^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&-\frac{1}{2\sqrt{3}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{K^0}}{2\sqrt{3}}\right)$$

102. $$\left\{V_8, V_{D^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&\frac{1}{2\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D^-}}{2\sqrt{3}}\right)$$

103. $$\left\{V_8, V_{B^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{2\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^0}}{2\sqrt{3}}\right)$$

104. $$\left\{V_8, V_{T^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{3}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^-}}{2\sqrt{3}}\right)$$

105. $$\left\{V_8, V_{K^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{1}{2\sqrt{3}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{K^-}}{2\sqrt{3}}\right)$$

106. $$\left\{V_8, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-\frac{1}{2\sqrt{3}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{\bar{K}^0}}{2\sqrt{3}}\right)$$

107. $$\{V_8, V_{15}\} = \begin{pmatrix} \frac{1}{6\sqrt{2}}&0&0&0&0&0\\ 0&\frac{1}{6\sqrt{2}}&0&0&0&0\\ 0&0&-\frac{1}{3\sqrt{2}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_8}{\sqrt{6}}\right)$$

108. $$\left\{V_8, V_{D_s^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-\frac{1}{\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{D_s^-}}{\sqrt{3}}\right)$$

109. $$\left\{V_8, V_{B_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-\frac{1}{\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{V_{B_s^0}}{\sqrt{3}}\right)$$

Table 5 (*Continued*)

110. $$\left\{V_8, V_{T_s^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -\frac{1}{\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_s^-}}{\sqrt{3}}\right)$$

111. $$\left\{V_8, V_{D^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^0}}{2\sqrt{3}}\right)$$

112. $$\left\{V_8, V_{D^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^+}}{2\sqrt{3}}\right)$$

113. $$\left\{V_8, V_{D_s^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{D_s^+}}{\sqrt{3}}\right)$$

114. $$\{V_8, V_{24}\} = \begin{pmatrix} \frac{1}{2\sqrt{30}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{30}} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{30}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_8}{\sqrt{10}}\right)$$

115. $$\left\{V_8, V_{B^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B^-}}{2\sqrt{3}}\right)$$

116. $$\left\{V_8, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{B}^0}}{2\sqrt{3}}\right)$$

117. $$\left\{V_8, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{\bar{B}_s^0}}{\sqrt{3}}\right)$$

118. $$\{V_8, V_{35}\} = \begin{pmatrix} \frac{1}{6\sqrt{5}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{6\sqrt{5}} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{3\sqrt{5}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_8}{\sqrt{15}}\right)$$

119. $$\left\{V_8, V_{T^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{T^0}}{2\sqrt{3}}\right)$$

120. $$\left\{V_8, V_{T^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{3}} & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{T^+}}{2\sqrt{3}}\right)$$

121. $$\left\{V_8, V_{T_s^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{3}} & 0 & 0 & 0 \end{pmatrix} = \left(-\frac{V_{T_s^+}}{\sqrt{3}}\right)$$

122. $$\{V_8, V_0\} = \begin{pmatrix} \frac{1}{6} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{6} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{3} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_8}{\sqrt{3}}\right)$$

123. $$\left\{V_{K^0}, V_{K^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\pi^-}\right)$$

124. $$\left\{V_{K^0}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(\frac{2V_0}{\sqrt{3}} - V_3 - \frac{V_8}{\sqrt{3}} + \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$$

125. $$\left\{V_{K^0}, V_{15}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{K^0}}{\sqrt{6}}\right)$$

Table 5 (*Continued*)

126. $\left\{V_{K^0}, V_{D_s^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$

127. $\left\{V_{K^0}, V_{B_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$

128. $\left\{V_{K^0}, V_{T_s^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$

129. $\left\{V_{K^0}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^+}\right)$

130. $\left\{V_{K^0}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{10}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^0}}{\sqrt{10}}\right)$

131. $\left\{V_{K^0}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{B}_s^0}\right)$

132. $\left\{V_{K^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{15}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^0}}{\sqrt{15}}\right)$

133. $\left\{V_{K^0}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0 \end{pmatrix} = \left(V_{T_s^+}\right)$

134. $\left\{V_{K^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{3}}&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^0}}{\sqrt{3}}\right)$

135. $\left\{V_{D^-}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^-}\right)$

136. $\left\{V_{D^-}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&-\frac{1}{\sqrt{6}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(-\frac{V_{D^-}}{\sqrt{6}}\right)$

137. $\left\{V_{D^-}, V_{D^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$

138. $\left\{V_{D^-}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(\frac{2V_0}{\sqrt{3}} - V_3 + \frac{V_8}{\sqrt{3}} - \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$

139. $\left\{V_{D^-}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$

140. $\left\{V_{D^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{10}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D^-}}{\sqrt{10}}\right)$

141. $\left\{V_{D^-}, V_{B_c^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$

142. $\left\{V_{D^-}, V_{\bar{T}_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$

143. $\left\{V_{D^-}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^-}\right)$

144. $\left\{V_{D^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{15}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D^-}}{\sqrt{15}}\right)$

Table 5 (*Continued*)

145. $\left\{V_{D^-}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0 \end{pmatrix} = \left(V_{T_c^0}\right)$

146. $\left\{V_{D^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D^-}}{\sqrt{3}}\right)$

147. $\left\{V_{B^0}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_s^0}\right)$

148. $\left\{V_{B^0}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{2\sqrt{6}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^0}}{2\sqrt{6}}\right)$

149. $\left\{V_{B^0}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^+}\right)$

150. $\left\{V_{B^0}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&-\frac{3}{2\sqrt{10}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(-\frac{3V_{B^0}}{2\sqrt{10}}\right)$

151. $\left\{V_{B^0}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$

152. $\left\{V_{B^0}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(\frac{2V_0}{\sqrt{3}} - V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} - \frac{3V_{24}}{\sqrt{10}} + \frac{2V_{35}}{\sqrt{15}}\right)$

153. $\left\{V_{B^0}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$

154. $\left\{V_{B^0}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$

155. $\left\{V_{B^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{15}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^0}}{\sqrt{15}}\right)$

156. $\left\{V_{B^0}, V_{T_b^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T^-}\right)$

157. $\left\{V_{B^0}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0 \end{pmatrix} = \left(V_{T_b^+}\right)$

158. $\left\{V_{B^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^0}}{\sqrt{3}}\right)$

159. $\left\{V_{T^-}, V_{\bar{K}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_s^-}\right)$

160. $\left\{V_{T^-}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{6}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^-}}{2\sqrt{6}}\right)$

161. $\left\{V_{T^-}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V^0_{\bar{T}_c}\right)$

162. $\left\{V_{T^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(\frac{V_{T^-}}{2\sqrt{10}}\right)$

Table 5 (*Continued*)

163. $\left\{V_{T^-}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_b^-}\right)$

164. $\left\{V_{T^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{2}{\sqrt{15}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(-\frac{2V_{T^-}}{\sqrt{15}}\right)$

165. $\left\{V_{T^-}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\pi^-}\right)$

166. $\left\{V_{T^-}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1 \end{pmatrix}$

$= \left(\frac{2V_0}{\sqrt{3}} - V_3 + \frac{V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} - \frac{4V_{35}}{\sqrt{15}}\right)$

167. $\left\{V_{T^-}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^0}\right)$

168. $\left\{V_{T^-}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^-}\right)$

169. $\left\{V_{T^-}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^0}\right)$

170. $\left\{V_{T^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{\sqrt{3}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^-}}{\sqrt{3}}\right)$

171. $\left\{V_{K^-}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{6}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^-}}{\sqrt{6}}\right)$

172. $\left\{V_{K^-}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$

173. $\left\{V_{K^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{10}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^-}}{\sqrt{10}}\right)$

174. $\left\{V_{K^-}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^-}\right)$

175. $\left\{V_{K^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{15}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^-}}{\sqrt{15}}\right)$

176. $\left\{V_{K^-}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0 \end{pmatrix} = \left(V_{T^0}\right)$

177. $\left\{V_{K^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{3}}&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{K^-}}{\sqrt{3}}\right)$

178. $\left\{V_{\bar{K}^0}, V_{15}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{\sqrt{6}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{K}^0}}{\sqrt{6}}\right)$

179. $\left\{V_{\bar{K}^0}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$

180. $\left\{V_{\bar{K}^0}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{\sqrt{10}}&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{K}^0}}{\sqrt{10}}\right)$

181. $\left\{V_{\bar{K}^0}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{B}^0}\right)$

Table 5 (*Continued*)

182. $$\left\{V_{\bar{K}^0}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{K}^0}}{\sqrt{15}}\right)$$

183. $$\left\{V_{\bar{K}^0}, V_{T_s^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T^+}\right)$$

184. $$\left\{V_{\bar{K}^0}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{K}^0}}{\sqrt{3}}\right)$$

185. $$\left\{V_{15}, V_{D_s^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{1}{\sqrt{6}} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{V_{D_s^-}}{\sqrt{6}}\right)$$

186. $$\left\{V_{15}, V_{B_s^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{6}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B_s^0}}{2\sqrt{6}}\right)$$

187. $$\left\{V_{15}, V_{T_s^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2\sqrt{6}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{T_s^-}}{2\sqrt{6}}\right)$$

188. $$\left\{V_{15}, V_{D^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{\sqrt{6}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{V_{D^0}}{\sqrt{6}}\right)$$

189. $$\left\{V_{15}, V_{D^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{\sqrt{6}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{V_{D^+}}{\sqrt{6}}\right)$$

190. $$\left\{V_{15}, V_{D_s^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{V_{D_s^+}}{\sqrt{6}}\right)$$

191. $$\{V_{15}, V_{24}\} = \begin{pmatrix} \frac{1}{4\sqrt{15}} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{4\sqrt{15}} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{4\sqrt{15}} & 0 & 0 & 0 \\ 0 & 0 & 0 & -\frac{\sqrt{\frac{3}{5}}}{4} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(\frac{V_{15}}{\sqrt{10}}\right)$$

192. $$\left\{V_{15}, V_{B_c^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{\frac{3}{2}}}{2} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{1}{2}\sqrt{\frac{3}{2}}V_{B_c^+}\right)$$

193. $$\left\{V_{15}, V_{\bar{T}_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -\frac{\sqrt{\frac{3}{2}}}{2} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$
$$= \left(-\frac{1}{2}\sqrt{\frac{3}{2}}V_{\bar{T}_c^0}\right)$$

194. $$\left\{V_{15}, V_{B^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{B^-}}{2\sqrt{6}}\right)$$

195. $$\left\{V_{15}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2\sqrt{6}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{B}^0}}{2\sqrt{6}}\right)$$

196. $$\left\{V_{15}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{2\sqrt{6}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{\bar{B}_s^0}}{2\sqrt{6}}\right)$$

Table 5 (*Continued*)

197. $$\left\{V_{15}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-\frac{\sqrt{\frac{3}{2}}}{2}&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{3}{2}}V_{B_c^-}\right)$$

198. $$\{V_{15}, V_{35}\} = \begin{pmatrix} \frac{1}{6\sqrt{10}}&0&0&0&0&0\\ 0&\frac{1}{6\sqrt{10}}&0&0&0&0\\ 0&0&\frac{1}{6\sqrt{10}}&0&0&0\\ 0&0&0&-\frac{1}{2\sqrt{10}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{15}}{\sqrt{15}}\right)$$

199. $$\left\{V_{15}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{2\sqrt{6}}&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^0}}{2\sqrt{6}}\right)$$

200. $$\left\{V_{15}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2\sqrt{6}}&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^+}}{2\sqrt{6}}\right)$$

201. $$\left\{V_{15}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{2\sqrt{6}}&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^+}}{2\sqrt{6}}\right)$$

202. $$\left\{V_{15}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-\frac{\sqrt{\frac{3}{2}}}{2}&0&0 \end{pmatrix} = \left(-\frac{1}{2}\sqrt{\frac{3}{2}}V_{T_c^0}\right)$$

203. $$\{V_{15}, V_0\} = \begin{pmatrix} \frac{1}{6\sqrt{2}}&0&0&0&0&0\\ 0&\frac{1}{6\sqrt{2}}&0&0&0&0\\ 0&0&\frac{1}{6\sqrt{2}}&0&0&0\\ 0&0&0&-\frac{1}{2\sqrt{2}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{15}}{\sqrt{3}}\right)$$

204. $$\left\{V_{D_s^-}, V_{D^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

205. $$\left\{V_{D_s^-}, V_{D^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

206. $$\left\{V_{D_s^-}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$$

$$= \left(\frac{2V_0}{\sqrt{3}} - \frac{2V_8}{\sqrt{3}} - \sqrt{\frac{2}{3}}V_{15} + \sqrt{\frac{2}{5}}V_{24} + \frac{2V_{35}}{\sqrt{15}}\right)$$

207. $$\left\{V_{D_s^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{10}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D_s^-}}{\sqrt{10}}\right)$$

208. $$\left\{V_{D_s^-}, V_{B_c^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_s^0}\right)$$

209. $$\left\{V_{D_s^-}, V_{\bar{T}_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_s^-}\right)$$

210. $$\left\{V_{D_s^-}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^-}\right)$$

211. $$\left\{V_{D_s^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{15}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D_s^-}}{\sqrt{15}}\right)$$

212. $$\left\{V_{D_s^-}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0 \end{pmatrix} = \left(V_{T_c^0}\right)$$

213. $$\left\{V_{D_s^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{3}}&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{D_s^-}}{\sqrt{3}}\right)$$

Table 5 (*Continued*)

214. $$\left\{V_{B_s^0}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^+}\right)$$

215. $$\left\{V_{B_s^0}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-\frac{3}{2\sqrt{10}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{B_s^0}}{2\sqrt{10}}\right)$$

216. $$\left\{V_{B_s^0}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

217. $$\left\{V_{B_s^0}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

218. $$\left\{V_{B_s^0}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} - \frac{2V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} - \frac{3V_{24}}{\sqrt{10}} + \frac{2V_{35}}{\sqrt{15}}\right)$$

219. $$\left\{V_{B_s^0}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^-}\right)$$

220. $$\left\{V_{B_s^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{15}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_s^0}}{\sqrt{15}}\right)$$

221. $$\left\{V_{B_s^0}, V_{T_b^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left\{V_{T_s^-}\right\}$$

222. $$\left\{V_{B_s^0}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0 \end{pmatrix} = \left(V_{T_b^+}\right)$$

223. $$\left\{V_{B_s^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_s^0}}{\sqrt{3}}\right)$$

224. $$\left\{V_{T_s^-}, V_{D_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}_c^0}\right)$$

225. $$\left\{V_{T_s^-}, V_{24}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^-}}{2\sqrt{10}}\right)$$

226. $$\left\{V_{T_s^-}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_b^-}\right)$$

227. $$\left\{V_{T_s^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{2}{\sqrt{15}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{2V_{T_s^-}}{\sqrt{15}}\right)$$

228. $$\left\{V_{T_s^-}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{K^-}\right)$$

229. $$\left\{V_{T_s^-}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{K}^0}\right)$$

230. $$\left\{V_{T_s^-}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1 \end{pmatrix} = \left(\frac{2V_0}{\sqrt{3}} - \frac{2V_8}{\sqrt{3}} + \frac{V_{15}}{\sqrt{6}} + \frac{V_{24}}{\sqrt{10}} - \frac{4V_{35}}{\sqrt{15}}\right)$$

Table 5 (*Continued*)

231. $\left\{V_{T_s^-}, V_{T_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{D_s^-}\right)$

232. $\left\{V_{T_s^-}, V_{T_b^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B_s^0}\right)$

233. $\left\{V_{T_s^-}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{\sqrt{3}} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{T_s^-}}{\sqrt{3}}\right)$

234. $\left\{V_{D^0}, V_{24}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{10}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^0}}{\sqrt{10}}\right)$

235. $\left\{V_{D^0}, V_{B_c^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{B^-}\right)$

236. $\left\{V_{D^0}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{15}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^0}}{\sqrt{15}}\right)$

237. $\left\{V_{D^0}, V_{T_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T^0}\right)$

238. $\left\{V_{D^0}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^0}}{\sqrt{3}}\right)$

239. $\left\{V_{D^+}, V_{24}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{10}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^+}}{\sqrt{10}}\right)$

240. $\left\{V_{D^+}, V_{B_c^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{B}^0}\right)$

241. $\left\{V_{D^+}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^+}}{\sqrt{15}}\right)$

242. $\left\{V_{D^+}, V_{T_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T^+}\right)$

243. $\left\{V_{D^+}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D^+}}{\sqrt{3}}\right)$

244. $\left\{V_{D_s^+}, V_{24}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{10}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D_s^+}}{\sqrt{10}}\right)$

245. $\left\{V_{D_s^+}, V_{B_c^-}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(V_{\bar{B}_s^0}\right)$

246. $\left\{V_{D_s^+}, V_{35}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{15}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D_s^+}}{\sqrt{15}}\right)$

247. $\left\{V_{D_s^+}, V_{T_c^0}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix} = \left(V_{T_s^+}\right)$

248. $\left\{V_{D_s^+}, V_0\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{\sqrt{3}} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} = \left(\frac{V_{D_s^+}}{\sqrt{3}}\right)$

249. $\left\{V_{24}, V_{B_c^+}\right\} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{3}{2\sqrt{10}} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

$= \left(-\frac{3V_{B_c^+}}{2\sqrt{10}}\right)$

Table 5 (*Continued*)

250. $$\left\{V_{24}, V_{\bar{T}_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{2\sqrt{10}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{T}_c^0}}{2\sqrt{10}}\right)$$

251. $$\left\{V_{24}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{3}{2\sqrt{10}}&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{B^-}}{2\sqrt{10}}\right)$$

252. $$\left\{V_{24}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-\frac{3}{2\sqrt{10}}&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{\bar{B}^0}}{2\sqrt{10}}\right)$$

253. $$\left\{V_{24}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-\frac{3}{2\sqrt{10}}&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{\bar{B}_s^0}}{2\sqrt{10}}\right)$$

254. $$\left\{V_{24}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-\frac{3}{2\sqrt{10}}&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{3V_{B_c^-}}{2\sqrt{10}}\right)$$

255. $$\{V_{24}, V_{35}\} = \begin{pmatrix} \frac{1}{10\sqrt{6}}&0&0&0&0&0\\ 0&\frac{1}{10\sqrt{6}}&0&0&0&0\\ 0&0&\frac{1}{10\sqrt{6}}&0&0&0\\ 0&0&0&\frac{1}{10\sqrt{6}}&0&0\\ 0&0&0&0&-\frac{\sqrt{\frac{2}{3}}}{5}&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{24}}{\sqrt{15}}\right)$$

256. $$\left\{V_{24}, V_{T_b^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\sqrt{\frac{2}{5}}\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\sqrt{\tfrac{2}{5}}V_{T_b^-}\right)$$

257. $$\left\{V_{24}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{2\sqrt{10}}&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^0}}{2\sqrt{10}}\right)$$

258. $$\left\{V_{24}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{2\sqrt{10}}&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^+}}{2\sqrt{10}}\right)$$

259. $$\left\{V_{24}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{2\sqrt{10}}&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^+}}{2\sqrt{10}}\right)$$

260. $$\left\{V_{24}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{2\sqrt{10}}&0&0 \end{pmatrix} = \left(\frac{V_{T_c^0}}{2\sqrt{10}}\right)$$

261. $$\left\{V_{24}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-\sqrt{\frac{2}{5}}&0 \end{pmatrix} = \left(-\sqrt{\tfrac{2}{5}}V_{T_b^+}\right)$$

262. $$\{V_{24}, V_0\} = \begin{pmatrix} \frac{1}{2\sqrt{30}}&0&0&0&0&0\\ 0&\frac{1}{2\sqrt{30}}&0&0&0&0\\ 0&0&\frac{1}{2\sqrt{30}}&0&0&0\\ 0&0&0&\frac{1}{2\sqrt{30}}&0&0\\ 0&0&0&0&-\sqrt{\frac{2}{15}}&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{24}}{\sqrt{3}}\right)$$

263. $$\left\{V_{B_c^+}, V_{B^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$$

264. $$\left\{V_{B_c^+}, V_{\bar{B}^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$$

Table 5 (*Continued*)

265. $\left\{V_{B_c^+}, V_{\bar{B}_s^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^+}\right)$

266. $\left\{V_{B_c^+}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(\frac{2V_0}{\sqrt{3}} - \sqrt{\frac{3}{2}}V_{15} - \frac{3V_{24}}{\sqrt{10}} + \frac{2V_{35}}{\sqrt{15}}\right)$

267. $\left\{V_{B_c^+}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{15}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_c^+}}{\sqrt{15}}\right)$

268. $\left\{V_{B_c^+}, V_{T_b^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{T}_c^0}\right)$

269. $\left\{V_{B_c^+}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0 \end{pmatrix} = \left(V_{T_b^+}\right)$

270. $\left\{V_{B_c^+}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{3}}&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_c^+}}{\sqrt{3}}\right)$

271. $\left\{V_{\bar{T}_c^0}, V_{B_c^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{T_b^-}\right)$

272. $\left\{V_{\bar{T}_c^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{2}{\sqrt{15}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix}$

$= \left(-\frac{2V_{\bar{T}_c^0}}{\sqrt{15}}\right)$

273. $\left\{V_{\bar{T}_c^0}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^0}\right)$

274. $\left\{V_{\bar{T}_c^0}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D^+}\right)$

275. $\left\{V_{\bar{T}_c^0}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{D_s^+}\right)$

276. $\left\{V_{\bar{T}_c^0}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&1 \end{pmatrix}$

$= \left(\frac{2V_0}{\sqrt{3}} - \sqrt{\frac{3}{2}}V_{15} + \frac{V_{24}}{\sqrt{10}} - \frac{4V_{35}}{\sqrt{15}}\right)$

277. $\left\{V_{\bar{T}_c^0}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^+}\right)$

278. $\left\{V_{\bar{T}_c^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{\sqrt{3}}\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{T}_c^0}}{\sqrt{3}}\right)$

279. $\left\{V_{B^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{15}}&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^-}}{\sqrt{15}}\right)$

280. $\left\{V_{B^-}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0 \end{pmatrix} = \left(V_{T^0}\right)$

281. $\left\{V_{B^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{3}}&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B^-}}{\sqrt{3}}\right)$

282. $\left\{V_{\bar{B}^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{\sqrt{15}}&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{B}^0}}{\sqrt{15}}\right)$

Table 5 (*Continued*)

283. $$\left\{V_{\bar{B}^0}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0 \end{pmatrix} = \left(V_{T^+}\right)$$

284. $$\left\{V_{\bar{B}^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{\sqrt{3}}&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{B}^0}}{\sqrt{3}}\right)$$

285. $$\left\{V_{\bar{B}_s^0}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{15}}&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{B}_s^0}}{\sqrt{15}}\right)$$

286. $$\left\{V_{\bar{B}_s^0}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0 \end{pmatrix} = \left(V_{T_s^+}\right)$$

287. $$\left\{V_{\bar{B}_s^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{3}}&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{\bar{B}_s^0}}{\sqrt{3}}\right)$$

288. $$\left\{V_{B_c^-}, V_{35}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{15}}&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_c^-}}{\sqrt{15}}\right)$$

289. $$\left\{V_{B_c^-}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0 \end{pmatrix} = \left(V_{T_c^0}\right)$$

290. $$\left\{V_{B_c^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{3}}&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{B_c^-}}{\sqrt{3}}\right)$$

291. $$\left\{V_{35}, V_{T_b^-}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&-\frac{2}{\sqrt{15}}\\ 0&0&0&0&0&0 \end{pmatrix} = \left(-\frac{2V_{T_b^-}}{\sqrt{15}}\right)$$

292. $$\left\{V_{35}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ -\frac{2}{\sqrt{15}}&0&0&0&0&0 \end{pmatrix} = \left(-\frac{2V_{T^0}}{\sqrt{15}}\right)$$

293. $$\left\{V_{35}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&-\frac{2}{\sqrt{15}}&0&0&0&0 \end{pmatrix} = \left(-\frac{2V_{T^+}}{\sqrt{15}}\right)$$

294. $$\left\{V_{35}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&-\frac{2}{\sqrt{15}}&0&0&0 \end{pmatrix} = \left(-\frac{2V_{T_s^+}}{\sqrt{15}}\right)$$

295. $$\left\{V_{35}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&-\frac{2}{\sqrt{15}}&0&0 \end{pmatrix} = \left(-\frac{2V_{T_c^0}}{\sqrt{15}}\right)$$

296. $$\left\{V_{35}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&-\frac{2}{\sqrt{15}}&0 \end{pmatrix} = \left(-\frac{2V_{T_b^+}}{\sqrt{15}}\right)$$

297. $$\{V_{35}, V_0\} = \begin{pmatrix} \frac{1}{6\sqrt{5}}&0&0&0&0&0\\ 0&\frac{1}{6\sqrt{5}}&0&0&0&0\\ 0&0&\frac{1}{6\sqrt{5}}&0&0&0\\ 0&0&0&\frac{1}{6\sqrt{5}}&0&0\\ 0&0&0&0&\frac{1}{6\sqrt{5}}&0\\ 0&0&0&0&0&-\frac{\sqrt{5}}{6} \end{pmatrix} = \left(\frac{V_{35}}{\sqrt{3}}\right)$$

298. $$\left\{V_{T_b^-}, V_{T^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 1&0&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B^-}\right)$$

Table 5 (*Continued*)

299. $$\left\{V_{T_b^-}, V_{T^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&1&0&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{B}^0}\right)$$

300. $$\left\{V_{T_b^-}, V_{T_s^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&1&0&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{\bar{B}_s^0}\right)$$

301. $$\left\{V_{T_b^-}, V_{T_c^0}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&1&0&0\\ 0&0&0&0&0&0 \end{pmatrix} = \left(V_{B_c^-}\right)$$

302. $$\left\{V_{T_b^-}, V_{T_b^+}\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&1&0\\ 0&0&0&0&0&1 \end{pmatrix}$$
$$= \left(\frac{2V_0}{\sqrt{3}} - 2\sqrt{\frac{2}{5}}V_{24} - \frac{4V_{35}}{\sqrt{15}}\right)$$

303. $$\left\{V_{T_b^-}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&\frac{1}{\sqrt{3}}\\ 0&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T_b^-}}{\sqrt{3}}\right)$$

304. $$\left\{V_{T^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ \frac{1}{\sqrt{3}}&0&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^0}}{\sqrt{3}}\right)$$

305. $$\left\{V_{T^+}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&\frac{1}{\sqrt{3}}&0&0&0&0 \end{pmatrix} = \left(\frac{V_{T^+}}{\sqrt{3}}\right)$$

306. $$\left\{V_{T_s^+}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&\frac{1}{\sqrt{3}}&0&0&0 \end{pmatrix} = \left(\frac{V_{T_s^+}}{\sqrt{3}}\right)$$

307. $$\left\{V_{T_c^0}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&\frac{1}{\sqrt{3}}&0&0 \end{pmatrix} = \left(\frac{V_{T_c^0}}{\sqrt{3}}\right)$$

308. $$\left\{V_{T_b^+}, V_0\right\} = \begin{pmatrix} 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&0&0\\ 0&0&0&0&\frac{1}{\sqrt{3}}&0 \end{pmatrix} = \left(\frac{V_{T_b^+}}{\sqrt{3}}\right)$$

The structure constants and Lie generators have been constructed so that *they remain the same for* $SU(n-m)$, where $n > m$ (n, m are positive integers). In general, commutators of Lie group generators (see Table 3) are themselves linear combinations of these same generators and the generator algebra is called a Lie algebra.[6–14] If the group has r (group order) $\equiv N^2 - 1$ generators, then there are $(1/2)(r-1)r = (1/2)(N^2-2)(N^2-1)$ possible generator commutation relations. The rank l of a Lie group is equal to the *maximum* number of generators (linear) which *mutually commute*. There also exist l *non-linear* Casimir operators $C_i = \sum_{j=1}^{r} a_{ji} V_j^{i+1}$, $i = 1, 2, \ldots, l$, which commute with *all* of the algebra generators. Following primarily the notation of Lichtenberg[9] but also others:[10–20] — the *mutually commuting* generators are conventionally denoted by H_i $(i = 1, 2, \ldots, l)$, where $H_i = {H_i}^\dagger$, and $[H_i, H_j] = 0$ $(i, j = 1, 2, \ldots, l)$. So $H_1 = V_3 = \frac{\lambda_3}{2}$, $H_2 = V_8 = \frac{\lambda_8}{2}$, $H_3 = V_{15} = \frac{\lambda_{15}}{2}$, $H_4 = V_{24} = \frac{\lambda_{24}}{2}$, $H_5 = V_{35} = \frac{\lambda_{35}}{2}$ and $\mathbf{H} \equiv (H_1, H_2, H_3, H_4, H_5)$. The l (maximal number of *mutually commuting*

Hermitian generators) and H_i (*Cartan generators*) are the basis for what is called the *Cartan subalgebra* and constitute a linear space. The H_i are Cartan (A_5) generators and the rank of the traceless, semisimple, compact Lie algebra of the *classical* group $SU(6)$ is $(6-1) = 5 =$ number of H_i's.

1.2. *Roots and weights*

Given the generators V_a, one can construct $A = \sum_{j=1}^{r} a_j V_j$ and the eigenvalue equation $[A, X] = \rho X$, where X is some linear combination of the V_j, then one can derive the secular equation (polynomial of degree r) for the $(r-l)$ eigenvalues called *roots* ρ, namely $\det(\sum_{i=1}^{r} a_i f_{ijk} - \rho\delta_{jk}) = 0$. For semisimple Lie groups (which includes $SU(N)$), Cartan has shown that there are r independent eigenvectors (even if there exist degenerate roots for $\rho = 0$) and the multiplicity of these degenerate roots is equal to the rank l.

We define (Cartan–Weyl formalism) $l = 5$ generators (the H_i mentioned above), $(r-l) = 30$ remaining generators, $E_\alpha \equiv V_\alpha$, where $\alpha = (\pi^\pm, K^\pm, K^0, \bar{K}^0, \bar{D}^0, D^0, D^\pm, D_s^\pm, B^0, \bar{B}^0, B^\pm, B_s^0, \bar{B}_s^0, B_c^\pm, T^\pm, T^0, \bar{T}^0, T_s^\pm, T_c^0, \bar{T}_c^0, T_b^\pm)$, six-dimensional basis states (vectors u_i), the diagonal vector operator $\mathbf{H}$, and six five-dimensional *weights* (*convention dependent*) $\mathbf{m}(i)$ of $SU(6)$:

$$
\begin{gathered}
H_i = H_i{}^\dagger\,, \quad [H_i, H_j] = 0\,, \\
\mathrm{Tr}[H_i, H_j] = \frac{1}{2}\delta_{ij}\,, \quad \mathbf{H} \equiv (H_1, H_2, H_3, H_4, H_5)\,,
\end{gathered}
\tag{2a}
$$

$$
\begin{gathered}
u_i = \begin{pmatrix} \delta_i^1 \\ \delta_i^2 \\ \delta_i^3 \\ \delta_i^4 \\ \delta_i^5 \\ \delta_i^6 \end{pmatrix} \Rightarrow u_1 = |u\rangle = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \\
u_2 = |d\rangle = \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \ldots, u_6 = |t\rangle = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{pmatrix},
\end{gathered}
\tag{2b}
$$

$$
\mathbf{H}u_i = \mathbf{m}(i)u_i\,, \quad \mathbf{m}(i) = (m_1, m_2, m_3, m_4, m_5, m_6)\,,
\tag{2c}
$$

$$
\begin{gathered}
\mathbf{m}(1) = (H_1 u, H_2 u, H_3 u, H_4 u, H_5 u)\,, \\
\mathbf{m}(2) = (H_1 d, H_2 d, H_3 d, H_4 d, H_5 d)\,,
\end{gathered}
\tag{2d}
$$

$$\mathbf{m}(3) = (H_1 s, H_2 s, H_3 s, H_4 s, H_5 s)\,, \quad \mathbf{m}(4) = (H_1 c, H_2 c, H_3 c, H_4 c, H_5 c)\,, \tag{2e}$$

$$\mathbf{m}(5) = (H_1 b, H_2 b, H_3 b, H_4 b, H_5 b)\,, \quad \mathbf{m}(6) = (H_1 t, H_2 t, H_3 t, H_4 t, H_5 t)\,. \tag{2f}$$

Using Eqs. (2), Tables 1 and 3, we obtain

$$\mathbf{m}(1) = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{1}{2\sqrt{15}}\right), \quad \mathbf{m}(2) = \left(-\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{1}{2\sqrt{15}}\right), \tag{3a}$$

$$\mathbf{m}(3) = \left(0, -\frac{1}{\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{1}{2\sqrt{15}}\right), \quad \mathbf{m}(4) = \left(0, 0, -\frac{3}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{1}{2\sqrt{15}}\right), \tag{3b}$$

$$\mathbf{m}(5) = \left(0, 0, 0, -\frac{2}{\sqrt{10}}, \frac{1}{2\sqrt{15}}\right), \quad \mathbf{m}(6) = \left(0, 0, 0, 0, -\frac{5}{2\sqrt{15}}\right), \tag{3c}$$

$$\mathbf{m}(i) \cdot \mathbf{m}(j) = -\frac{1}{2*6} + \frac{1}{2}\delta_{ij}\,, \tag{3d}$$

$$\sum_{i=1}^{i=6} \mathbf{m}(i) = 0\,. \tag{3e}$$

So the jth component of $\mathbf{m}(k)$ is given by

$$m_j(k) = \begin{cases} [2j(j+1)]^{-1/2} & k < j+1\,, \\ -j[2j(j+1)]^{-1/2} & k = j+1\,, \\ 0 & k > j+1\,. \end{cases} \tag{4}$$

The eigenvalues $\mathbf{m}(i)$ form a 5-simplex hexateron[11,21] and are the *weights of the first fundamental representation* of $SU(6)$ spanning a l-dimensional vector *weight-space*. We use the convention that $\mathbf{m}$ is higher than $\mathbf{m}'$ if the last component of the vector $\mathbf{m} - \mathbf{m}'$ is positive — if that is zero, one moves to the next component and so on. Thus, the (eigenvalues) $\mathbf{m}(i)$ in Eq. (3) are already ordered. There exist four other fundamental representations of $SU(6)$, however one can construct the entire Lie algebra from the first fundamental representation. The positive roots α_i are

$$\mathbf{m}(i) - \mathbf{m}(j) \quad \text{for} \quad i < j \quad (i,j) = 1, \ldots, 6\,. \tag{5}$$

There are 15 positive roots. We now introduce some helpful new notation:

$SU(6)$ 6×6 Lie algebra generator matrix where each element is also a 6×6 matrix

$$
\left\{
\begin{aligned}
&\begin{pmatrix}
V_3 & V_1^2 & V_1^3 & V_1^4 & V_1^5 & V_1^6 \\
V_2^1 & V_8 & V_2^3 & V_2^4 & V_2^5 & V_2^6 \\
V_3^1 & V_3^2 & V_{15} & V_3^4 & V_3^5 & V_3^6 \\
V_4^1 & V_4^2 & V_4^3 & V_{24} & V_4^5 & V_4^6 \\
V_5^1 & V_5^2 & V_5^3 & V_5^4 & V_{35} & V_5^6 \\
V_6^1 & V_6^2 & V_6^3 & V_6^4 & V_6^5 & V_0
\end{pmatrix} \\
&\equiv \begin{pmatrix}
V_3 & V_{\pi^+} & V_{K^+} & V_{\bar{D}^0} & V_{B^+} & V_{\bar{T}^0} \\
V_{\pi^-} & V_8 & V_{K^0} & V_{D^-} & V_{B^0} & V_{T^-} \\
V_{K^-} & V_{\bar{K}^0} & V_{15} & V_{D_s^-} & V_{B_s^0} & V_{T_s^-} \\
V_{D^0} & V_{D^+} & V_{D_s^+} & V_{24} & V_{B_c^+} & V_{\bar{T}_c^0} \\
V_{B^-} & V_{\bar{B}^0} & V_{\bar{B}_s^0} & V_{B_c^-} & V_{35} & V_{T_b^-} \\
V_{T^0} & V_{T^+} & V_{T_s^+} & V_{T_c^0} & V_{T_b^+} & V_0
\end{pmatrix} \\
&= \begin{pmatrix}
V_3 & V_1 + iV_2 & V_4 + iV_5 & V_9 + iV_{10} & V_{16} + iV_{17} & V_{25} + iV_{26} \\
V_1 - iV_2 & V_8 & V_6 + iV_7 & V_{11} + iV_{12} & V_{18} + iV_{19} & V_{27} + iV_{28} \\
V_4 - iV_5 & V_6 - iV_7 & V_{15} & V_{13} + iV_{14} & V_{20} + iV_{21} & V_{29} + iV_{30} \\
V_9 - iV_{10} & V_{11} - iV_{12} & V_{13} - iV_{14} & V_{24} & V_{22} + iV_{23} & V_{31} + iV_{32} \\
V_{16} - iV_{17} & V_{18} - iV_{19} & V_{20} - iV_{21} & V_{22} - iV_{23} & V_{35} & V_{33} + iV_{34} \\
V_{25} - iV_{26} & V_{27} - iV_{28} & V_{29} - iV_{30} & V_{31} - iV_{32} & V_{33} - iV_{34} & V_0
\end{pmatrix} \overset{(i\neq j)}{\equiv} V_i^j \\
&[i = \text{row index},\ j = \text{column index}]\,, \\
&V_1^1 \equiv V_3 + \frac{1}{\sqrt{3}}V_8 + \frac{1}{\sqrt{6}}V_{15} + \frac{1}{\sqrt{10}}V_{24} + \frac{1}{\sqrt{15}}V_{35}\,, \\
&V_2^2 \equiv -V_3 + \frac{1}{\sqrt{3}}V_8 + \frac{1}{\sqrt{6}}V_{15} + \frac{1}{\sqrt{10}}V_{24} + \frac{1}{\sqrt{15}}V_{35}\,, \\
&V_3^3 \equiv -\frac{2}{\sqrt{3}}V_8 + \frac{1}{\sqrt{6}}V_{15} + \frac{1}{\sqrt{10}}V_{24} + \frac{1}{\sqrt{15}}V_{35}\,, \\
&V_4^4 \equiv \frac{3}{\sqrt{6}}V_{15} + \frac{1}{\sqrt{10}}V_{24} + \frac{1}{\sqrt{15}}V_{35}\,, \\
&V_5^5 \equiv -\frac{4}{\sqrt{10}}V_{24} + \frac{1}{\sqrt{15}}V_{35}\,, \quad V_6^6 \equiv \frac{5}{\sqrt{15}}V_{35}\,, \\
&\text{and} \\
&V_3 = \frac{1}{2}\left(V_1^1 - V_2^2\right)\,, \quad V_8 = \frac{1}{2\sqrt{3}}\left(V_1^1 + V_2^2 - 2V_3^3\right)\,, \\
&V_{15} = \frac{1}{2\sqrt{6}}\left(V_1^1 + V_2^2 + V_3^3 - 3V_4^4\right)\,, \\
&V_{24} = \frac{1}{2\sqrt{10}}\left(V_1^1 + V_2^2 + V_3^3 + V_4^4 - 4V_5^5\right)\,, \\
&V_{35} = \frac{1}{2\sqrt{15}}\left(V_1^1 + V_2^2 + V_3^3 + V_4^4 + V_5^5 - 5V_6^6\right)\,.
\end{aligned}
\right. \tag{6}
$$

We also have

$$[\mathbf{H}, E_\alpha] = [\mathbf{H}, V_\alpha] = \boldsymbol{\rho}(\alpha) V_\alpha\,, \tag{7}$$

where the $\boldsymbol{\rho}(\alpha)$ are l-dimensional *root vectors* spanning a $(r-l) = 30$-dimensional root-space.

We can extract all roots $\boldsymbol{\rho}(\alpha)$ from the nonzero commutation relations given in Table 3 and using Eq. (7). *We define a root as positive if its last component is positive* — otherwise it is negative. In addition, it can be shown that $\boldsymbol{\rho}(\alpha^\dagger) = -\boldsymbol{\rho}(\alpha)$ so that for instance $\boldsymbol{\rho}(\pi^-) = -\boldsymbol{\rho}(\pi^+) = (-1, 0, 0, 0, 0)$. Thus, for V_α where $(\alpha = \pi^-,\ \pi^+,\ K^+,\ K^0,\ K^-,\ \bar{K}^0,\ \bar{D}^0, \ldots, B^+, \ldots, \bar{T}^0, \ldots, T_b^+)$, utilizing Eq. (2), Table 1 (defines the V_α in terms of the λ matrices), and Table 3 (which lists all nonzero commutators), one can extract the positive root vectors $\boldsymbol{\rho}(\alpha)$. One can also obtain the positive roots by using:

$$\text{positive roots are given by} \quad \mathbf{m}(i) - \mathbf{m}(j) \quad \text{for } i < j\,. \tag{8}$$

Either way, we obtain the following positive root listing — note that the positive roots lie to the right of the diagonal of the 6×6 Lie algebra generator matrix in Eq. (6) and have length 1:

List of positive root vectors		
$\boldsymbol{\rho}(\pi^+) = (1, 0, 0, 0, 0)$	$\boldsymbol{\rho}(K^+) = \left(\frac{1}{2}, \frac{3}{2\sqrt{3}}, 0, 0, 0\right)$	$\boldsymbol{\rho}(\bar{D}^0) = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{2}{\sqrt{6}}, 0, 0\right)$
$\boldsymbol{\rho}(B^+) = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{5}{2\sqrt{10}}, 0\right)$	$\boldsymbol{\rho}(\bar{T}^0) = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$	$\boldsymbol{\rho}(K^0) = \left(-\frac{1}{2}, \frac{3}{2\sqrt{3}}, 0, 0, 0\right)$
$\boldsymbol{\rho}(D^-) = \left(-\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{2}{\sqrt{6}}, 0, 0\right)$	$\boldsymbol{\rho}(B^0) = \left(-\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{5}{2\sqrt{10}}, 0\right)$	$\boldsymbol{\rho}(T^-) = \left(-\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$
$\boldsymbol{\rho}(D_s^-) = \left(0, -\frac{1}{\sqrt{3}}, \frac{2}{\sqrt{6}}, 0, 0\right)$	$\boldsymbol{\rho}(B_s^0) = \left(0, -\frac{1}{\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{5}{2\sqrt{10}}, 0\right)$	$\boldsymbol{\rho}(T_s^-) = \left(0, -\frac{1}{\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$
$\boldsymbol{\rho}(B_c^+) = \left(0, 0, -\frac{3}{2\sqrt{6}}, \frac{5}{2\sqrt{10}}, 0\right)$	$\boldsymbol{\rho}(\bar{T}_c^0) = \left(0, 0, -\frac{3}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$	$\boldsymbol{\rho}(T_b^-) = \left(0, 0, 0, -\frac{2}{\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$

Of the 15 positive roots, only $l = 5$ are linearly independent and complete and are called the simple roots. The number of simple roots is equal to the rank of the algebra, the number of Cartan generators. The simple roots are

$$\boldsymbol{\rho}(\alpha_i) = \mathbf{m}(i) - \mathbf{m}(i+1) \quad \text{for } i = 1, \ldots, (6-1) = 5\,. \tag{9}$$

List of simple root vectors		
$\boldsymbol{\rho}(\pi^+) = (1, 0, 0, 0, 0)$	$\boldsymbol{\rho}(K^0) = \left(-\frac{1}{2}, \frac{3}{2\sqrt{3}}, 0, 0, 0\right)$	$\boldsymbol{\rho}(D_s^-) = \left(0, -\frac{1}{\sqrt{3}}, \frac{2}{\sqrt{6}}, 0, 0\right)$
$\boldsymbol{\rho}(B_c^+) = \left(0, 0, -\frac{3}{2\sqrt{6}}, \frac{5}{2\sqrt{10}}, 0\right)$	$\boldsymbol{\rho}(T_b^-) = \left(0, 0, 0, -\frac{2}{\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$	

1.3. *Fundamental weights*

The fundamental representation weights $\boldsymbol{\mu}_j$ of $SU(6)$ are given by

$$\frac{2\boldsymbol{\rho}(\alpha_i) \cdot \boldsymbol{\mu}_j}{{\alpha_i}^2} = \delta_{ij}\,, \tag{10}$$

$$\boldsymbol{\mu}_j = \sum_{k=1}^{j} \mathbf{m}(k)\,. \tag{11}$$

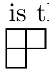
List of $SU(6)$ fundamental weights

$\boldsymbol{\mu}_1 = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{1}{2\sqrt{15}}\right)$	$\boldsymbol{\mu}_2 = \left(0, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{6}}, \frac{1}{\sqrt{10}}, \frac{1}{\sqrt{15}}\right)$	$\boldsymbol{\mu}_3 = \left(0, 0, \frac{3}{2\sqrt{6}}, \frac{3}{2\sqrt{10}}, \frac{3}{2\sqrt{15}}\right)$
$\boldsymbol{\mu}_4 = \left(0, 0, 0, \frac{2}{\sqrt{10}}, \frac{2}{\sqrt{15}}\right)$	$\boldsymbol{\mu}_5 = \left(0, 0, 0, 0, \frac{5}{2\sqrt{15}}\right)$	

The rank l $\boldsymbol{\mu}_j$ are the highest (dominant) weights of the rank l fundamental representations and are complete. Thus, the highest weight $\boldsymbol{\mu}$ of *any* irreducible $SU(6)$ representation can be written in terms of these $\boldsymbol{\mu}_j$. Indeed, we have

$$\frac{2\boldsymbol{\rho}(\alpha_j) \cdot \boldsymbol{\mu}}{{\alpha_j}^2} = l_j \,, \tag{12}$$

$$\boldsymbol{\mu} = \sum_{j=1}^{l} l_j \boldsymbol{\mu}_j \,, \tag{13}$$

where the l_j are Dynkin coefficients and are non-negative integers. The $SU(6)$ 35-plet is denoted by $(1, 0, 0, 0, 1)$. The *standard* Young tableau can be constructed by noting that the kth Dynkin label is the number of tableau columns with k boxes. Thus, for instance, $(1, 1, 0, 0, 0) \sim$ . In general (see Ref. 9), a tableau is specified by $\mathbf{p} = (p_1, p_2, p_3, p_4, p_5)$ (here the p_j = positive integers = l_j ($j = 1, \ldots, l$) in Eq. (13)) and the ith *fundamental representation* is given by

$$p_i = 1 \,, \quad p_j = 0 \,, \quad \text{where } i \neq j \quad \text{for } i, j = 1, \ldots (6-1) = 5 \,. \tag{14}$$

Thus, $(1, 0, 0, 0, 0) \sim$  $\sim$ first fundamental representation of $SU(6)$. We also note that for an irreducible representation (irrep.) with $\mathbf{p} = (p_1, p_2, p_3, p_4, p_5)$, the highest weight is given by

$$\boldsymbol{\mu}_{\text{dominant weight}} = \sum_{i=1}^{l} p_i \boldsymbol{\mu}_i \,. \tag{15}$$

So the highest weight for the irrep. $(1, 1, 0, 0, 0)$ is $\left(\frac{1}{2}, \frac{3}{2\sqrt{3}}, \frac{3}{2\sqrt{6}}, \frac{3}{2\sqrt{10}}, \frac{3}{2\sqrt{15}}\right)$, whereas the highest weight for the irrep. $(1, 0, 0, 0, 1)$ is $\left(\frac{1}{2}, \frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{6}}, \frac{1}{2\sqrt{10}}, \frac{3}{\sqrt{15}}\right)$.

The dimension D_6 of a particular representation with $\mathbf{p} = (p_1, p_2, p_3, p_4, p_5)$ is given by the following equation (see Ref. 9):

$$\begin{aligned}
&D_6(p_1, p_2, p_3, p_4, p_5) \\
&= \frac{1}{2!3!4!5!}(p_1 + 1)(p_1 + p_2 + 2)(p_1 + p_2 + p_3 + 3) \\
&\quad \times (p_2 + 1)(p_2 + p_3 + 2)(p_3 + 1)(p_4 + 1)(p_4 + p_3 + 2) \\
&\quad \times (p_4 + p_3 + p_2 + 3)(p_4 + p_3 + p_2 + p_1 + 4)(p_5 + 1)(p_5 + p_4 + 2) \\
&\quad \times (p_5 + p_4 + p_3 + 3)(p_5 + p_4 + p_3 + p_2 + 4)(p_5 + p_4 + p_3 + p_2 + p_1 + 5) \,.
\end{aligned} \tag{16}$$

2. Equal-Time Commutation and Anticommutation Relations and Infinite-Momentum Frame Asymptotic Symmetry

$SU(6)$ 35-plet $q\bar{q}$ representation matrix

$$\begin{array}{c} \\ u \\ d \\ s \\ c \\ b \\ t \end{array}\begin{array}{c} \begin{array}{cccccc} \bar{u} & \bar{d} & \bar{s} & \bar{c} & \bar{b} & \bar{t} \end{array} \\ \begin{pmatrix} u\bar{u} & u\bar{d} & u\bar{s} & u\bar{c} & u\bar{b} & u\bar{t} \\ d\bar{u} & d\bar{d} & d\bar{s} & d\bar{c} & d\bar{b} & d\bar{t} \\ s\bar{u} & s\bar{d} & s\bar{s} & s\bar{c} & s\bar{b} & s\bar{t} \\ c\bar{u} & c\bar{d} & c\bar{s} & c\bar{c} & c\bar{b} & c\bar{t} \\ b\bar{u} & b\bar{d} & b\bar{s} & b\bar{c} & b\bar{b} & b\bar{t} \\ t\bar{u} & t\bar{d} & t\bar{s} & t\bar{c} & t\bar{b} & t\bar{t} \end{pmatrix} \end{array}. \tag{17}$$

$SU(6)$ normalized, orthogonal, and traditional zero weight particle representation states constructed using diagonal $SU(6)$ group quark matrix elements

$$\begin{aligned} |\eta_3\rangle &= \left|\frac{u\bar{u} - d\bar{d}}{\sqrt{2}}\right\rangle = |\pi^0\rangle\,, \\ |\eta_8\rangle &= \left|\frac{u\bar{u} + d\bar{d} - 2s\bar{s}}{\sqrt{6}}\right\rangle \sim |\eta\rangle\,, \\ |\eta_{15}\rangle &= \left|\frac{u\bar{u} + d\bar{d} + s\bar{s} - 3c\bar{c}}{2\sqrt{3}}\right\rangle, \\ |\eta_{24}\rangle &= \left|\frac{u\bar{u} + d\bar{d} + s\bar{s} + c\bar{c} - 4b\bar{b}}{2\sqrt{5}}\right\rangle, \\ |\eta_{35}\rangle &= \left|\frac{u\bar{u} + d\bar{d} + s\bar{s} + c\bar{c} + b\bar{b} - 5t\bar{t}}{\sqrt{30}}\right\rangle, \\ |\eta_0\rangle &= \left|\frac{u\bar{u} + d\bar{d} + s\bar{s} + c\bar{c} + b\bar{b} + t\bar{t}}{\sqrt{6}}\right\rangle. \end{aligned} \tag{18}$$

In Ref. 22, using infinite-momentum frame broken asymptotic symmetry, we calculated the magnetic moments of the *physical* on-mass shell $J^P = 3/2^+$ ground-state decuplet baryons without ascribing any specific form to their quark structure or intra-quark interactions by using *equal-time commutation relations* (ETCRs) which involve at most one current density, thus, avoiding problems associated with Schwinger terms. Here, the ETCRs involve the vector charge generators (the V_α) of the symmetry groups of QCD. They are valid even though these symmetries are broken[3,14,15,22–27,33–35] and even when the Lagrangian is not known or cannot be constructed.

As shown in Ref. 22 and references therein, infinite-momentum frame broken asymptotic symmetry is characterized by the existence of physical on-mass-shell hadron annihilation operators $a_\alpha(\mathbf{k}, \lambda)$ (momentum $\mathbf{k}$ ($|\mathbf{k}| \to \infty$), helicity λ, and $SU_F(N)$ flavor index α) and their creation operator counterparts which produce physical states when acting on the vacuum. Indeed, the *physical* on-mass-shell hadron annihilation operator $a_\alpha(\mathbf{k},\lambda)$ is related linearly under flavor transformations to the *representation* annihilation operator $a_j(\mathbf{k},\lambda)$. Thus, in the infinite-momentum frame, physical states denoted by $|\alpha,\mathbf{k},\lambda\rangle$ (which do not belong to irreducible representations) are linear combinations of representation states denoted by $|j,\mathbf{k},\lambda\rangle$ (which do belong to irrep.) plus nonlinear corrective terms that are best calculated in a frame where mass differences are deemphasized such as in the infinite-momentum frame. Mathematically,[14,15,22,23,27–30] this is expressed by $|\alpha,\mathbf{k},\lambda\rangle = \sum_j C_{\alpha j}|j,\mathbf{k},\lambda\rangle$, $|\mathbf{k}| \to \infty$, where the orthogonal matrix $C_{\alpha j}$ depends on *physical* $SU_F(N)$ mixing parameters, is defined *only* in the ∞-momentum frame, and can be constrained directly by ETCRs.

It cannot be overemphasized that the particular Lorentz frame that one utilizes when analyzing current-algebraic sum rules does not matter when flavor symmetry is exact and is strictly a matter of taste and calculational convenience, whereas when one uses current-algebraic sum rules in broken symmetry, the choice of frame is *paramount* since one wishes to emphasize the calculation of leading order contributions while simultaneously simplifying the calculation of symmetry breaking corrections.[14,15,22–27,31–33]

While we will only discuss the $J^{PC} = 0^{-+}$ 35-plet representation in this paper, nevertheless, it is instructive to outline our normalization conventions including fermionic representation states. In Table 5, we give all nonzero anticommutation relations, where the singlet $U(1)$ matrix V_0 is explicitly present. We have particle four-momentum $p = \big(p^0,\mathbf{p}\big)$, with

$$\big[a^{(r)}(p), a^{\dagger(s)}(p')\big]_+ = \big[b^{(r)}(p), b^{\dagger(s)}(p')\big]_+ = N_a \delta_{rs}\delta^3(\mathbf{p}-\mathbf{p}')\,,$$

$$u^{\dagger(r)}(p)u^{(s)}(p) = N_D\delta_{rs}\,,$$

$$\psi(x) = \sum_r \int \mathrm{d}^3p\, N_\psi \big[a^{(r)}(p)u^{(r)}(p)e^{-ip\cdot x} + b^{\dagger(r)}(p)v^{(r)}(p)e^{+ip\cdot x}\big]\,,$$

$$a^{(r)}(p) = \big((2\pi)^3 N_\psi N_D\big)^{-1}\int \mathrm{d}^3x\, e^{+ip\cdot x}\bar{u}^r(p)\gamma_0\psi(x)\,,$$

$$b^{(r)}(p) = \big((2\pi)^3 N_\psi N_D\big)^{-1}\int \mathrm{d}^3x\, e^{+ip\cdot x}\bar{\psi}(x)\gamma_0 v^{(r)}(p)\,,$$

$$\langle s',\mathbf{p}',\lambda'|s,\mathbf{p},\lambda\rangle = \delta_{ss'}\delta_{\lambda\lambda'}(2\pi)^3 2p^0\delta^3(\mathbf{p}'-\mathbf{p})\,,$$

where $a^{(r)}(p)$ and $b^{(r)}(p)$ are creation operators, $u^{(s)}(p)$, $v^{(r)}(p)$ are Dirac spinors, $\psi(x)$ is a spin 1/2 Dirac field operator (s, λ denote particle spin and helicity, respectively), $|\psi\rangle = \sum_{s,\lambda}\int N_a^{-1}\mathrm{d}^3p\,|s,p,\lambda\rangle\langle s,p,\lambda|\psi\rangle$, $(2\pi)^6 N_\psi^2 N_D^2\langle N|\Omega^{\mu\cdots}|N\rangle$ is covariant (transforms like $\Omega^{\mu\cdots}$), and $(2\pi)^3 N_\psi^2 N_D N_a = 1$.

3. The Physical Electromagnetic Current

We now discuss the vector charges and two-particle basis states after imposing a unitary homogeneous pure Lorentz transformation $-\hat{z}$ boost such that the three-momentum $\mathbf{k}$ of all states has $|\mathbf{k}| \to \infty$, and all creation operators produce *physical* states when acting on the physical vacuum (see Refs. 22 and 23 for more details).

First, we note that the charges operating on states (see Eqs. (6), (17) and (18)) transform according to

$$V_i^j|q_k\bar{q}_l\rangle = \delta_k^j|q_i\bar{q}_l\rangle - \delta_i^l|q_k\bar{q}_j\rangle\,. \tag{19}$$

Bras and kets are given by

$$\begin{aligned}|D^+,p'\rangle\big(J^{PC}=0^{-+}\big) &= |c\bar{d}\rangle = |u_4\bar{u}_2\rangle\,,\\ \langle D^{*+},p'|\big(J^{PC}=1^{--}\big) &\equiv \langle{}^*c\bar{d}| = \langle{}^*u_4\bar{u}_2|,\ \text{etc.}\,,\end{aligned} \tag{20}$$

where the spacelike four-momentum transfer q^2 is given by

$$q^2 = (p'-p)^2 = m^{*2} + m^2 - 2p'\cdot p\,, \tag{21}$$

$$p' = (E',\mathbf{s}) = \left(\sqrt{m^{*2}+s_x^2+s_z^2}, s_x, 0, s_z\right), \tag{22}$$

$$p = (E,\mathbf{t}) = \left(\sqrt{m^2+t_z^2}, 0, 0, t_z\right), \tag{23}$$

$$\text{Set } s_z = rt_z \quad \text{and} \quad 0 < r = \text{const}\,, \tag{24}$$

$$p'\cdot p = \sqrt{m^{*2}+s_x^2+r^2t_z^2}\,\sqrt{m^2+t_z^2} - rt_z^2\,, \tag{25}$$

$$p'\cdot p = rt_z^2\sqrt{1+\frac{m^{*2}+s_x^2}{r^2t_z^2}}\sqrt{1+\frac{m^2+t_z^2}{t_z^2}} - rt_z^2\,, \tag{26}$$

$$\overbrace{p'\cdot p}^{t_z\to\infty} = \frac{1}{2}\left(\frac{m^{*2}+s_x^2+r^2m^2}{r}\right), \tag{27}$$

$$q^2 = m^{*2} + m^2 - \left(\frac{m^{*2}+s_x^2+r^2m^2}{r}\right), \tag{28}$$

$$q^2 = \frac{-(1-r)}{r}\,m^{*2}\left[1-\left(\frac{m^2}{m^{*2}}\right)r\right] - \frac{s_x^2}{r}\,. \tag{29}$$

The physical vector charge V_{K^0} is $V_{K^0} = V_6 + iV_7$, the physical vector charge $V_{\pi^\pm} = V_1 \pm iV_2$, etc. The λ_a, $a = 1, 2, \ldots, 35$ satisfy the Lie algebra $[(\lambda_a/2),(\lambda_b/2)] = i\sum_c f_{abc}(\lambda_c/2)$, where the f_{abc} are structure constants of the flavor group $SU_F(6)$ and $V_a{}^\mu(x) = \bar{q}^i(x)(\lambda_a/2)_{ij}\gamma^\mu q^j(x)$.

The *physical electromagnetic current* $j^\mu_{\text{em}}(0)$ (u, d, s, c, b, t quark system) is

$$\begin{aligned} j^\mu_{\text{em}}(0) &= V_3^\mu(0) + \left(\frac{1}{3}\right)^{1/2} V_8^\mu(0) - \left(\frac{2}{3}\right)^{1/2} V_{15}^\mu(0)\\ &\quad + \left(\frac{2}{5}\right)^{1/2} V_{24}^\mu(0) - \left(\frac{3}{5}\right)^{1/2} V_{35}^\mu(0) + \left(\frac{1}{3}\right)^{1/2} \times V_0{}^\mu(0) \qquad (30)\\ &= j_V^\mu(0) + j_S^\mu(0)\,, \qquad (31)\end{aligned}$$

where $j_V^\mu(0) \equiv j_{\text{em}\,3}^\mu(0)$ = the iso-vector part of the electromagnetic current, $j_S^\mu(0) \equiv$ the isoscalar part of the electromagnetic current. The flavor $U(1)$ singlet current ${V_0}^\mu(x) = \bar{q}^i(x)(\lambda_0/2)_{ij}\gamma^\mu q^j(x)$ where $\lambda_0 \equiv \sqrt{1/3}I$, I is the identity, so that $\text{Tr}(\lambda_a\lambda_b) = 2\delta_{ab}$ holds for all $\lambda_{a'}$ $(a' = 0, 1, 2, \ldots, 35)$, and $j_0^\mu = V_0^\mu/\sqrt{3}$. The $U(1)$ singlet charge V_0 commutes with all of the V_a.

From the commutation relations in Table 3, we obtain the fascinating equation (it contains only ETCRs and explicitly the electromagnetic current singlet j_0^μ) — in broken symmetry $j^\mu \equiv j_{\text{em}}^\mu(0)$ (momentum $\mathbf{k}$ with $|\mathbf{k}| \to \infty$):

$$[[j^\mu, V_{\pi^+}], V_{\pi^-}] + \left[\left[j^\mu, V_{D_s^-}\right], V_{D_s^+}\right] + \left[\left[j^\mu, V_{T_b^-}\right], V_{T_b^+}\right]$$
$$= 2j^\mu - 2\left(\frac{V_0^\mu}{\sqrt{3}}\right) = 2j^\mu - 2j_0^\mu\,. \tag{32}$$

The angles between the simple roots appearing in Eq. (32) are: $\theta_{\boldsymbol{\rho}(\pi^+),\boldsymbol{\rho}(D_s^-)} = \theta_{\boldsymbol{\rho}(D_s^-),\boldsymbol{\rho}(T_b^-)} = 90°$. These angles correspond to the (u,d), (c,s), and (t,b) doublet "sectors."

For vector $(V) \to$ pseudoscalar (P) radiative decays, we have (in the infinite-momentum frame $[t_z \to \infty$, see Eq. (29)], $\lambda = 1$ = vector meson polarization index, $\mu = 0$, $r = 1$, and $s_x^2 = 0 \Rightarrow q^2 = 0$ in the following matrix element):

$$\langle V|j^\mu|P\rangle = \langle V\rangle\epsilon^{\mu\nu\rho\sigma}\epsilon_\nu(\mathbf{p},\lambda)p'_\rho p_\sigma\,, \tag{33a}$$

$$\Gamma(V(p',\lambda=1) \to P(p) + \gamma(q^2=0)) = \frac{\langle V\rangle^2}{96\pi}\left(\frac{m_V^2 - m_P^2}{m_V}\right)^3, \tag{33b}$$

$$|\langle V\rangle| = \left[96\pi\left(\frac{m_V}{m_V^2 - m_P^2}\right)^3 \Gamma(V \to P + \gamma)\right]^{\frac{1}{2}}. \tag{33c}$$

So for instance, if we evaluate Eq. (32) between the states $\langle D^{*+}|$ and $|D^+\rangle$ using Eqs. (17), (19) and (20) we obtain

$$\left\langle D^{*0}\right\rangle + \left\langle \bar{K}^{*0}\right\rangle = 2\left\langle D^{*+}\right\rangle_0\,, \tag{34}$$

where

$$\langle D^{*0}\rangle \equiv \left\langle D^{*0}|j^\mu|D^0\right\rangle,$$
$$\left\langle \bar{K}^{*0}\right\rangle \equiv \left\langle \bar{K}^{*0}\middle|j^\mu|K^0\right\rangle,$$
$$\langle\rho^+\rangle_0 \equiv \langle\rho^+|\frac{1}{\sqrt{3}}V_0^\mu|\pi^+\rangle\,,$$
$$\langle D^{*0}\rangle_0 \equiv \langle D^{*0}\rangle\frac{1}{\sqrt{3}}V_0^\mu|D^0\rangle\,,\ \text{etc.}$$

We define

$$X_{1--} \equiv \begin{pmatrix} \rho^0 \\ \omega \\ \phi \\ \psi \\ \Upsilon \\ t\bar{t} \end{pmatrix}, \tag{35}$$

$$X_{0-+} \equiv \begin{pmatrix} \pi^0 \\ \eta \\ \eta' \\ \eta_c \\ \eta_b \\ \eta_t \end{pmatrix}. \tag{36}$$

Evaluating Eq. (32) between the 16 bra–ket state pairs with bras yields

$$\langle\rho^0|\,,\ \langle\rho^+|\,,\ \langle K^{*+}|\,,\ \langle\bar{D}^{*0}|\,,\ \langle B^{*+}|\,,\ \langle\bar{T}^{*0}|\,,\ \langle K^{*0}|\,,\ \langle D^{*-}|\,,$$

$$\langle B^{*0}|\,,\ \langle T^{*-}|\,,\ \langle D_s^{*-}|\,,\ \langle B_s^{*0}|\,,\ \langle T_s^{*-}|\,,\ \langle B_c^{*+}|\,,\ \langle\bar{T}_c^{*0}| \quad \text{and} \quad \langle\bar{T}_b^{*-}|\,,$$

then we find that

$$\langle\rho^+\rangle = \langle\rho^-\rangle = \langle\rho^0\rangle_0\,, \tag{37}$$

$$\langle\rho^0\rangle = \langle\rho^+\rangle_0\,, \tag{38}$$

$$\langle K^{*0}\rangle + \langle\bar{D}^{*0}\rangle = 2\langle K^{*+}\rangle_0\,, \tag{39}$$

$$\langle K^{*+}\rangle + \langle D^{*-}\rangle = 2\langle\bar{D}^{*0}\rangle_0\,, \tag{40}$$

$$\langle B^{*0}\rangle + \langle\bar{T}^{*0}\rangle = 2\langle B^{*+}\rangle_0\,, \tag{41}$$

$$\langle B^{*+}\rangle + \langle T^{*-}\rangle = 2\langle\bar{T}^{*0}\rangle_0\,, \tag{42}$$

$$\langle K^{*+}\rangle + \langle D^{*-}\rangle = 2\langle K^{*0}\rangle_0\,, \tag{43}$$

$$\langle K^{*0}\rangle + \langle\bar{D}^{*0}\rangle = 2\langle D^{*-}\rangle_0\,, \tag{44}$$

$$\langle B^{*+}\rangle + \langle T^{*-}\rangle = 2\langle B^{*0}\rangle_0\,, \tag{45}$$

$$\langle B^{*0}\rangle + \langle\bar{T}^{*0}\rangle = 2\langle T^{*-}\rangle_0\,, \tag{46}$$

$$\begin{aligned} &\langle D_s^{*-}\rangle\langle D_s{}^-|V_{D_s^-}|[X_{0-+}\rangle\langle X_{0-+}]|V_{D_s}^+|D_s{}^-\rangle \\ &\quad - \langle D_s^{*-}|V_{D_s^-}|[X_{1--}\rangle\langle X_{1--}]|j^\mu|[X_{0-+}\rangle\langle X_{0-+}]|V_{D_s}^+|D_s{}^-\rangle \\ &= 2\langle D_s^{*-}\rangle - 2\langle D_s^{*-}\rangle_0\,, \end{aligned} \tag{47}$$

$$\langle B_c^{*+}\rangle + \langle T_s^{*-}\rangle = 2\langle B_s^{*0}\rangle_0\,, \tag{48}$$

$$\langle B_s^{*0}\rangle + \langle \bar{T}_c^{*0}\rangle = 2\langle T_s^{*-}\rangle_0\,, \tag{49}$$

$$\langle B_s^{*0}\rangle + \langle \bar{T}_c^{*0}\rangle = 2\langle B_c^{*+}\rangle_0\,, \tag{50}$$

$$\langle B_c^{*+}\rangle + \langle \bar{T}_s^{*-}\rangle = 2\langle \bar{T}_c^{*0}\rangle_0\,, \tag{51}$$

$$\begin{aligned}\langle T_b^{*-}\rangle\langle T_b{}^-|V_{T_b^-}|\big[X_{0-+}\rangle\langle X_{0-+}\big]|V_{T_b^+}|T_b{}^-\rangle \\ -\langle T_b^{*-}|V_{T_b^-}|\big[X_{1--}\rangle\langle X_{1--}\big]|j^\mu|\big[X_{0-+}\rangle\langle X_{0-+}\big]|V_{T_b^+}|T_b{}^-\rangle \\ = 2\langle T_b^{*-}\rangle - 2\langle T_b^{*-}\rangle_0\,.\end{aligned} \tag{52}$$

Equations (37)–(52) *explicitly demonstrate in broken symmetry* the importance of the electromagnetic current singlet $U(1)$ matrix V_0 contribution to radiative decays. Indeed, one finds that $\Gamma(\rho^\pm \to \pi^\pm\gamma)$ and $\Gamma(\rho^0 \to \pi^0\gamma)$ are *entirely due to the electromagnetic current singlet contribution.* At present, insufficient data are available for most of the decay matrix elements in Eqs. (37)–(52). Even where there are data, the signs of the matrix elements are not yet experimentally available, although there exist theoretical models which predict matrix element signs.[1] From Eqs. (39) and (44), we find that $\langle D^{*-}\rangle_0 = \langle K^{*+}\rangle_0$. Similarly, we find from Eqs. (40) and (43), we find that $\langle \bar{D}^{*0}\rangle_0 = \langle K^{*0}\rangle_0$. Very little is known about the behavior of the singlet generator in broken symmetry, other than that given by Eqs. (37)–(52) — to partially remedy that situation let the right-hand sides of Eqs. (39) and (43) be proportional, i.e. $\langle K^{*0}\rangle_0 = \beta\langle K^{*+}\rangle_0$. We then obtain[5]

$$\frac{\langle D^{*0}\rangle}{\langle K^{*+}\rangle} = \frac{1}{\beta} * \left[1 + \frac{\langle D^{*-}\rangle}{\langle K^{*+}\rangle} - \beta * \frac{\langle K^{*0}\rangle}{\langle K^{*+}\rangle}\right], \quad \text{where} \quad \beta \neq 0\,. \tag{53}$$

From data in Ref. 5, we get ($\pm$ signs are not correlated and β is assumed to be 1) (an assumption suggested only by Eqs. (37) and (38) ρ triplet charged and neutral singlet results and perhaps holding for doublets as well):

$$\begin{aligned}\frac{\langle D^{*0}\rangle}{\langle K^{*+}\rangle} &= 1 + (\pm(0.56 \pm 0.08)) - (\pm(1.52 \pm 0.10)) \\ &= \begin{cases} +0.05 \pm 0.13 & \text{for } ++\,, \\ +3.06 \pm 0.13 & \text{for } +-\,, \\ -1.06 \pm 0.13 & \text{for } -+\,, \\ +1.95 \pm 0.13 & \text{for } --\,. \end{cases}\end{aligned} \tag{54}$$

This implies that (statistical propagation of errors — quadrature calculated):

$$\Gamma(D^{*0} \to D^0\gamma)_{\beta=1} = \begin{cases} 0.13^{+0.65}_{-0.13}\ \text{keV} & \text{for } ++\,, \\ 468.0 \pm 61.0\ \text{keV} & \text{for } +-\,, \\ 56.0 \pm 15.0\ \text{keV} & \text{for } -+\,, \\ 189.0 \pm 31.0\ \text{keV} & \text{for } --\,. \end{cases} \tag{55}$$

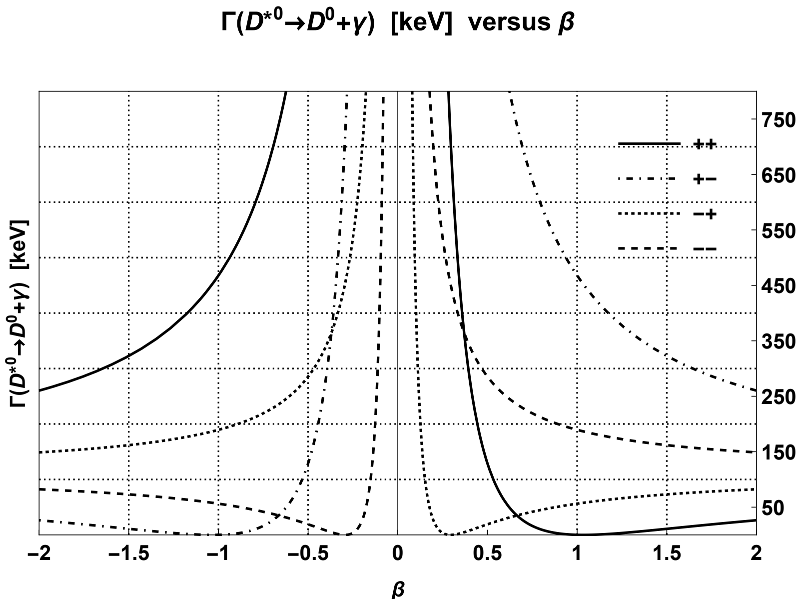


Fig. 1. $\Gamma(D^{*0} \to D^0 + \gamma)$ versus β.

In Fig. 1, we graphically show $\Gamma(D^{*0} \to D^0 + \gamma)$ versus β as β is allowed to vary from -2 to 2.

From Fig. 1, we see that $\Gamma(D^{*0} \to D^0\gamma)$ is dependent upon the signs of $\frac{\langle D^{*-}\rangle}{\langle K^{*+}\rangle}$ and $\frac{\langle K^{*0}\rangle}{\langle K^{*+}\rangle}$. However, in unbroken $SU(3)$ $\frac{\langle K^{*0}\rangle}{\langle K^{*+}\rangle}$ is negative and $= -2$.[1,15,26] From experiment we therefore choose $\frac{\langle K^{*0}\rangle}{\langle K^{*+}\rangle} = -1.51 \pm 0.10$, so we expect the $+-$ or $--$ curves in Fig. 1 to be more physically predictive. From Table 3, we have at our disposal

$$\left[V_{K^0}, j^\mu\right] = 0\,, \tag{56a}$$

$$\left[V_{D^0}, j^\mu\right] = 0\,. \tag{56b}$$

Evaluating (we neglect intermultiplet mixing with the $K^*(1410)$) Eq. (56a) between the physical asymptotic states $\langle K^+|$ and $|\rho^+\rangle$ and Eq. (56b) between the physical asymptotic states $\langle D^+|$ and $|\rho^+\rangle$, one obtains

$$\langle D^{*+}\rangle = \langle K^{*+}\rangle = \langle \rho^+\rangle\,. \tag{57}$$

Thus, we expect (conjugate states used) that $\frac{\langle D^{*-}\rangle}{\langle K^{*+}\rangle}$ is positive and the $+-$ curve in Fig. 1, to be that which is operative. An experimental determination of $\Gamma(D^{*0} \to D^0\gamma)$ would then provide a value for β which may be useful in further research — especially where higher rank special unitary groups and Lie algebras play a role. Unfortunately, current experimental data from Ref. 5 yields only that $\Gamma(D^{*0} \to D^0\gamma) \leq 741.3$ keV, CL $= 90\%$.

At present, quantum field theories (including SUSY theories) have not been successful in replacing the standard model (QCD... which does not include gravity) with a grand unified theory without hierarchical or other problems. Generally speaking, most theories are perturbative and renormalizable with local gauge fields strongly related to Lie algebras and utilize spontaneous symmetry breaking. In Lie algebraic representations of interest, anomalies (for instance, see Refs. 11, 36, 37, especially Chap. 22) and, Refs. 38 and 39 must vanish for physical representations — a severe constrain on those theories. On the other hand, Eqs. (37)–(52) are *nonperturbative*.

4. Summary and Conclusions

We presented research on radiative decays of vector ($J^{PC} = 1^{--}$) to pseudoscalar ($J^{PC} = 0^{-+}$) particles (u, d, s, c, b, t quark system) using broken symmetry techniques in the infinite-momentum frame and equal-time commutation relations. The research utilized the $SU(6)$ Lie algebra characterization of flavor $SU_F(6)$ *representations* and the *physical electromagnetic current* $j^{\mu}_{\text{em}}(0)$ including its singlet $U(1)$ term and focused on the 35-plet. The research was conducted without ascribing any specific form to meson quark structure or intra-quark interactions by using ETCRs which involve at most one current density, thus, *avoiding problems associated with Schwinger terms*. We found that *the electromagnetic current singlet plays an intrinsic role in understanding the physics of radiative decays* where (bilinear) commutators of the $SU(6)$ Lie algebra generators are Lie products acting over the real number field. Indeed, in broken symmetry and the infinite-momentum frame, we developed a new and fascinating equation involving the electromagnetic current (including its singlet–proportional to the $SU(6)$ singlet), three $SU(6)$ simple roots, and double commutators using ETCRs.

For notational conciseness and self-containment and use by other researchers, $SU(6)$ Lie algebra simple roots, positive roots, weights, fundamental weights, nonzero commutators, and nonzero anticommutators were also determined which allow construction of all $SU(6)$ representations. Surprisingly — after symmetry breaking — we discovered that charged and neutral ρ meson radiative decays into $\pi\gamma$ were due entirely to the singlet term in $j^{\mu}_{\text{em}}(0)$. Although there is insufficient experimental data on the radiative decay $\Gamma(D^{*0} \to D^0\gamma)$ available at this time, we derived equations involving *physical* matrix elements of the $SU(6)$ singlet generator which allowed parametrization of possible predicted values of $\Gamma(D^{*0} \to D^0\gamma)$ versus β.

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