DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY

DESY 83-078
August 1983

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ISSN 0418-9833

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DESY 83-078
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ISSN 0418-9833

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Abstract

Decays of charmed meson into one vector meson and one pseudoscalar meson $P_c \rightarrow VP$ in both the group theoretical and quark diagrammatic approaches are considered. A complete decay amplitude analysis is given. The present available experimental data can be accommodated if the contributions from exotic final states and exotic piece of weak Hamiltonian are also taken into account.

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I. Introduction

Recent lifetime and branching ratio measurements (1) of nonleptonic decays of charmed particles have attracted much attention because of their apparent disagreements with previous naive calculations (2,3). A number of proposals (4-7) have been made to account for these observed discrepancies. Since there is complicated interplay between the weak current-current interaction and strong interaction in the nonleptonic decays of charmed particles there is no really reliable method which can be used to calculate precisely the contributions to nonleptonic decays from many different contending mechanisms. Therefore all of these suggestions, in fact, just proposed some kind of selection rules for nonleptonic decays of charmed particles (8).

Of course, the existence of more available experimental data is very important for the test of these selection rules. At the same time it is clearly necessary to work out some appropriate theoretical frameworks in which the selection rules can be imposed on the decays of charmed particles in a straight-forward way. For this purpose the group theoretical approach for studying the decays of charmed mesons into two pseudoscalars $P_c \rightarrow PP$ has been extended to the case of the six-quark model (12) by some authors (7), while a quark diagrammatic approach for the decays $P_c \rightarrow PP$ and for the decays of strange and charmed baryons into a baryon and a pseudoscalar meson $B_c \rightarrow BP$ has also been suggested (9).

Recently the decays of charmed particles into one vector meson and one pseudoscalar meson $P_c \rightarrow VP$ became available. The preliminary experimental data suggest a seemingly large $D^+ \rightarrow \bar{K}^0 \rho^+$ rate (and the near absence of $D^0 \rightarrow \bar{K}^0 \rho^0$),(10) and it probably creates a difficulty for practically all models in which only a few decay amplitudes are assumed to dominate the weak decays of charmed particles (for example, sextet dominance [3,4], no exotic decay final states [5] and W-exchange diagram dominance [6] etc.) even though these models can explain the lifetime measurement of charmed particles [11]. Therefore a more complete analysis for decays $P_c \longrightarrow VP$ is necessary.

The purpose of this paper is to discuss the decays $P_c \longrightarrow VP$. A complete decay amplitude analysis in the six-quark model [12] is considered in both the group theoretical approach and quark diagrammatic approach. It is found that additional decay amplitudes which are via the "exotic" piece of the weak Hamiltonian and lead to "exotic" decay final states may also have to be taken into account in order to accommodate the present experimental results for decays $P_c \longrightarrow VP$ [10].

The paper is organized as follows. Section II is devoted to the presentation of decay amplitudes for decays $P_c \longrightarrow VP$ in the group theoretical approach. For completeness, the decay amplitudes of charmed baryons Λ_c^+ (cud), Ξ_c^0(cds), Ξ_c^+ (csu) and Ω_c^0 (css) into a baryon and a pseudoscalar meson are also given. In section III the decays $P_c \longrightarrow VP$ are considered in the quark diagrammatic approach. Finally in section IV we give some discussions and comments.

II. The decays $P_c \longrightarrow VP$ in the group theoretical approach

The group theoretical approach has extensively been applied to the charmed meson decays into two pseudoscalars $P_c \longrightarrow PP$ in the four quark model by many authors [3], and the analysis in the six-quark model has also been done recently [7]. But so far as the decays of charmed mesons into a vector

meson and a pseudoscalar meson $P_c \longrightarrow VP$, these are discussed only in the context of the sextet dominance of the charm-changing weak Hamiltonian and in the four-quark model [13]. In this section we would like to describe the decays $P_c \longrightarrow VP$ in the six-quark model by assuming the validity of SU(3) symmetry only but without any assumed enhancement mechanism.

The analysis is quite straight-forward. According to the Wigner theorem decay amplitudes can be expanded in terms of the reduced matrix elements when the properties of the weak Hamiltonian and initial and final states of the decays under SU(3) transformations are given. The Clebsch-Gordan coefficients can be calculated by using the tensor method. Compared with the decays $P_c \longrightarrow PP$ in which there exist only five reduced matrix elements, there are now in general ten reduced matrix elements for the decays $P_c \longrightarrow VP$ since the decay final states do not involve identical particles. These ten reduced matrix elements are denoted by

$$\begin{aligned}
\bar{D}_{6^*} &= \langle 3 \,|\, 6^* \,|\, 10^* \rangle \\
S_{6^*} &= \langle 3 \,|\, 6^* \,|\, 8_S \rangle \\
A_{6^*} &= \langle 3 \,|\, 6^* \,|\, 8_A \rangle \\
S_{15} &= \langle 3 \,|\, 15 \,|\, 8_S \rangle \\
A_{15} &= \langle 3 \,|\, 15 \,|\, 8_A \rangle \\
D_{15} &= \langle 3 \,|\, 15 \,|\, 10 \rangle \\
G_{15} &= \langle 3 \,|\, 15 \,|\, 27 \rangle \\
A_3 &= \langle 3 \,|\, 3 \,|\, 8_A \rangle \\
S_3 &= \langle 3 \,|\, 3 \,|\, 8_S \rangle \\
U_3 &= \langle 3 \,|\, 3 \,|\, 1 \rangle
\end{aligned}$$

where D, $\bar{D}$; A, S, G, U denote the SU(3) decuplet and its complex conjugation, antisymmetric and symmetric octet, 27-plet and singlet decay final states, respectively. The sub-indices indicate that the decays proceed via the 6^*, 15 and 3-plet piece of the weak Hamiltonian. The results for decays $P_c \longrightarrow VP$ are summarized in Tables 1-3. We neglect the η-η' mixing and take the mixing as ideal, that is

$$\eta = \tfrac{1}{\sqrt{6}}\,(u\bar{u} + d\bar{d} - 2s\bar{s})$$
$$\eta' = \tfrac{1}{\sqrt{3}}\,(u\bar{u} + d\bar{d} + s\bar{s})$$
$$\omega = \tfrac{1}{\sqrt{2}}\,(u\bar{u} + d\bar{d})$$
$$\varphi = s\bar{s}.$$

The V_{11}, V_{12}, V_{21}, V_{22} are Kobayashi-Maskawa parameters [12,14]

$$V_{11} = \cos\theta_1$$
$$V_{12} = \sin\theta_1 \cos\theta_3$$
$$V_{21} = -\sin\theta_1 \cos\theta_2$$
$$V_{22} = \cos\theta_1 \cos\theta_2 \cos\theta_3 - \sin\theta_2 \sin\theta_3\, e^{i\delta}$$

and

$$\Sigma = 1/2\,[V_{12}V_{22} - V_{11}V_{21}]$$
$$\Delta = 1/2\,[V_{12}V_{22} + V_{11}V_{21}]$$

For completeness the results for decays $B_c \longrightarrow BP$ are also given in Tables 4-7, where only the decay amplitudes of the four weakly decaying charmed baryons Λ_c^+, Ξ_c^0, Ξ_c^+ and Ω_c^0 (Λ_c^+, Ξ_c^0, Ξ_c^+ belong to a 3^*-plet of SU(3) group while Ω_c^0 is in the SU(3) sextet) are presented since the remaining five spin 1/2 charmed baryons are expected to decay strongly via

single pion emission or electromagnetically. The reduced matrix elements are of course different from those in the charmed meson decays even though the same notations are used here. There should be no confusion.

III. The decays $P_c \longrightarrow VP$ in the quark diagrammatic approach

The group theoretical approach is more convenient for the consideration of the selection rules which are imposed on the effective weak Hamiltonian and on the final states of charmed particles decays. But there are other kinds of selection rules which are imposed on the set of quark diagrams. For analysis of the effects of this kind of selection rules the quark diagrammatic approach is more useful. Ling-Lie Chau and Rizzo [9] have outlined in detail the basic assumptions and procedures of the quark diagrammatic approach for the decays $P_c \longrightarrow PP$ and $B_c \longrightarrow BP$. As pointed out by these authors, a $q\bar{q}$ pair in the final states may just as well be identified with a vector meson as a pseudoscalar meson with equal probability since no mention is made of spin and hadronic wave functions. Thus if this quark diagrammatic approach is simply used to describe the decays $P_c \longrightarrow VP$, then the absence of $F^+ \longrightarrow \pi^+\pi^0$ would imply no $F^+ \longrightarrow \rho^+\pi^0$ and $F^+ \longrightarrow \rho^0\pi^+$ because the decays $F^+ \longrightarrow \rho^+\pi^0$ and $F^+ \longrightarrow \rho^0\pi^+$ have exactly the same quark diagrams as decay $F^+ \longrightarrow \pi^+\pi^0$. Therefore some new factor related to the spin of final state must be taken into consideration. The simplest way out of this problem is to assume that for each given quark diagram a $q\bar{q}$ pair in the final state can be identified as a vector meson or a pseudoscalar meson but with different probability. Although this is a very "naive" approach, nevertheless it predicts that

$$A(F^+ \to \rho^0\pi^+) = -A(F^+ \to \rho^+\pi^0)$$

which is consistent with the group theoretical approach. Furthermore, the generality of the approach is retained since it does not resort to any special dynamics.

With this extension in mind the decays $P_c \longrightarrow VP$ in the quark diagrammatic approach can be considered easily. The results are summarized in Tables 8-10, in which the so-called hairpin diagram [(9)] (that is, the produced $q\bar{q}$ pair fragment together to form a color and flavor singlet hadron) contributions to various decay modes are also included.

IV. Discussions and comments

1) In general several sum rules can be obtained since the number of independent decay amplitudes is limited amongst many different decay modes. For our present purpose only the Cabibbo-favored decays are considered. In this case 7 independent sum rules in the quark diagrammatic approach can be derived if the contributions to decays from the "hairpin" diagrams are taken into account. They are

$$A(D^+ \to \bar{K}^{*0}\pi^+) = A(D^0 \to K^{*-}\pi^+) + \sqrt{2}\,A(D^0 \to \bar{K}^{*0}\pi^0)$$

$$A(D^+ \to \rho^+\bar{K}^0) = A(D^0 \to \rho^+K^-) + \sqrt{2}\,A(D^0 \to \rho^0\bar{K}^0)$$

$$A(D^0 \to \rho^0\bar{K}^0) + A(D^0 \to \bar{K}^{*0}\pi^0) = \sqrt{3}\,A(D^0 \to \bar{K}^{*0}\eta^0) - \sqrt{2}\,A(D^0 \to \varphi\bar{K}^0) + A(D^0 \to \omega\bar{K}^0)$$

$$A(F^+ \to \rho^+\pi^0) = -A(F^+ \to \rho^0\pi^+)$$

$$\begin{aligned} &A(D^+ \to \rho^+\bar{K}^0) + A(D^+ \to \bar{K}^{*0}\pi^+) \\ &= A(F^+ \to \varphi\pi^+) - \tfrac{1}{\sqrt{2}}A(F^+ \to \omega\pi^+) - \tfrac{\sqrt{6}}{2}A(F^+ \to \rho^+\eta^0) + A(F^+ \to K^{*+}\bar{K}^0) + A(F^+ \to \bar{K}^{*0}K^+) \end{aligned}$$

$$\begin{aligned} &A(D^+ \to \rho^+\bar{K}^0) - A(D^+ \to \bar{K}^{*0}\pi^+) \\ &= -A(F^+ \to \varphi\pi^+) + \tfrac{1}{\sqrt{2}}A(F^+ \to \omega\pi^+) - \tfrac{\sqrt{6}}{2}A(F^+ \to \rho^+\eta^0) + A(F^+ \to K^{*+}\bar{K}^0) - A(F^+ \to \bar{K}^{*0}K^+) - \sqrt{2}A(F^+ \to \rho^0\pi^+) \end{aligned}$$

and

$$\begin{aligned} &A(D^0 \to \rho^+K^-) + 2A(D^0 \to \varphi\bar{K}^0) - \sqrt{2}\,A(D^0 \to \omega\bar{K}^0) - A(D^0 \to K^{*-}\pi^+) + \sqrt{2}\,A(D^0 \to \bar{K}^{*0}\pi^0) \\ &= -A(F^+ \to \varphi\pi^+) + \tfrac{1}{\sqrt{2}}A(F^+ \to \omega\pi^+) - \tfrac{\sqrt{6}}{2}A(F^+ \to \rho^+\eta^0) - A(F^+ \to K^{*+}\bar{K}^0) + A(F^+ \to \bar{K}^{*0}K^+) + \sqrt{2}\,A(F^+ \to \rho^0\pi^+) \end{aligned}$$

In the group theoretical approach the number of independent decay amplitudes is less than those in the quark diagrammatic approach (since no special dynamics is assumed in the former). We therefore obtain four extra independent sum rules, they are

$$\sqrt{3}\,A(D^0 \to \bar{K}^{*0}\eta') = \tfrac{3}{5}\left[A(D^0 \to K^{*-}\pi^+) + A(D^0 \to \rho^+K^-)\right] - \tfrac{2\sqrt{5}}{5}\left[A(D^0 \to \rho^0\bar{K}^0) + A(D^0 \to \bar{K}^{*0}\pi^0)\right]$$

$$A(D^0 \to \varphi\bar{K}^0) + \sqrt{2}\,A(D^0 \to \omega\bar{K}^0) = \tfrac{3}{5}\left[A(D^0 \to K^{*-}\pi^+) + A(D^0 \to \rho^+K^-)\right] - \tfrac{2\sqrt{5}}{5}\left[A(D^0 \to \rho^0\bar{K}^0) + A(D^0 \to \bar{K}^{*0}\pi^0)\right]$$

$$\begin{aligned} \sqrt{3}\,A(F^+ \to \rho^+\eta') = &\tfrac{3}{5}\left[A(F^+ \to K^{*+}\bar{K}^0) + A(F^+ \to \bar{K}^{*0}K^+)\right] \\ &- \tfrac{1}{5}\left[2A(F^+ \to \varphi\pi^+) - \sqrt{2}\,A(F^+ \to \omega\pi^+) - \sqrt{6}\,A(F^+ \to \rho^+\eta^0)\right] \end{aligned}$$

and

$$7A(F^+ \to \varphi\pi^+) + 4\sqrt{2}\,A(F^+ \to \omega\pi^+) = \sqrt{6}\,A(F^+ \to \rho^+\eta^0) + 3\left[A(F^+ \to K^{*+}\bar{K}^0) + A(F^+ \to \bar{K}^{*0}K^+)\right]$$

If SU(3) symmetry is assumed all these sum rules are true independent of any enhancement mechanism. Unfortunately at present there are not enough available experimental data which can be used to test the above sum rules. However, the first two sum rules give two triangle relations which can be used to estimate the magnitude of $A(D^+ \to \bar{K}^{*0}\pi^+)$ and $A(D^+ \to \rho^+\bar{K}^0)$. Using the central value of the present available experimental data [(10)]

$$B(D^0 \to \bar{K}^{*0}\pi^0) = 1.4\,^{+2.3}_{-1.4}\ \%$$

$$B(D^0 \to K^{*-}\pi^+) = 3.6 \pm 1.3\ \%$$

$$B(D^0 \to \rho^+K^-) = 7.2 \pm 3.0\ \%$$

$$B(D^0 \to \rho^0\bar{K}^0) = 0.1\,^{+0.6}_{-0.1}\ \%$$

and [11]

$$\tau_{D^+}/\tau_{D^0} = 2.2 \begin{smallmatrix} +0.9 \\ -0.6 \end{smallmatrix}$$

it is found that

$$1\% \leq B(D^+ \to \bar{K}^{*0}\pi^+) \leq 29\%$$
$$11\% \leq B(D^+ \to \rho^+\bar{K}^0) \leq 23\%$$

Therefore, it seems to predict a quite large value for $|A(D^+ \to \rho^+\bar{K}^0)|$.

2) No exotic decay final state or $\Delta \mathcal{H}_k = 0$ rule [5,13] is one of the proposals which are recently made to explain the lifetime measurement of charmed particles. In the present case, this implies that the reduced matrix elements $\bar{D}_6^*$, D_{15} and G_{15} can be neglected. This rule predicts

$$A(D^+ \to \bar{K}^{*0}\pi^+) = 0$$
$$A(D^+ \to \rho^+\bar{K}^0) = 0$$

and

$$A(D^0 \to K^{*-}\pi^+) = -\sqrt{2}\,A(D^0 \to \bar{K}^{*0}\pi^0)$$
$$A(D^0 \to \rho^+K^-) = -\sqrt{2}\,A(D^0 \to \rho^0\bar{K}^0)$$

The present experimental data seems to create a difficulty for this proposal because of the nearly absence of the decay $D^0 \to \rho^0\bar{K}^0$ and possible large value for $|A(D^+ \to \rho^+\bar{K}^0)|$.

3) W-exchange or annihilation diagram dominance [6] is another suggestion for explaining recent experimental lifetime measurements of charmed particles. This can be easily considered in the quark diagrammatic approach just by

neglecting the contributions a, a', b, b' from c-quark decay diagrams. It gives exactly the same predictions for these decay channels as those of the no exotic decay final state assumption. Therefore the present available experimental data seem to be also difficult for this model to account.

4) The predictions of sextet dominance [3,4] can be easily worked out in the group theoretical approach by taking the reduced matrix elements S_{15}, A_{15}, D_{15} and G_{15} to be zero. In this case two extra and independent sum rules relating the D^0 decay to the F^+ decay can be obtained. They are

$$3[A(D^0 \to K^{*-}\pi^+) + A(D^0 \to \rho^+K^-)] - 2\sqrt{2}\,[A(D^0 \to \rho^0\bar{K}^0) + A(D^0 \to \bar{K}^{*0}\pi^0)]$$
$$= [2A(F^+ \to \varphi\pi^+) - \sqrt{2}\,A(F^+ \to \omega\pi^+) - \sqrt{6}\,A(F^+ \to \rho^+\eta^0)] - 3[A(F^+ \to K^{*+}\bar{K}^0) + A(F^+ \to \bar{K}^{*0}K^+)]$$

and

$$[A(D^0 \to K^{*-}\pi^+) - A(D^0 \to \rho^+K^-)] + \sqrt{2}\,A(D^0 \to \rho^0\bar{K}^0) + [2A(D^0 \to \varphi\bar{K}^0) - \sqrt{2}\,A(D^0 \to \omega\bar{K}^0)]$$
$$= A(F^+ \to \bar{K}^{*0}K^+) - A(F^+ \to K^{*+}\bar{K}^0) - 2\sqrt{2}\,A(F^+ \to \rho^0\pi^+)$$

It also predicts that

$$A(D^+ \to \bar{K}^{*0}\pi^+) = -A(D^+ \to \rho^+\bar{K}^0)$$

and

$$A(D^0 \to K^{*-}\pi^+) + A(D^0 \to \rho^+K^-) + \sqrt{2}\,A(D^0 \to \bar{K}^{*0}\pi^0) + \sqrt{2}\,A(D^0 \to \rho^0\bar{K}^0) = 0$$

It seems unlikely that sextet dominance can explain the seemingly large value for $|A(D^+ \to \rho^+\bar{K}^0)|$.

5) How can we accommodate the present experimental data? It is interesting to observe that $A(D^0 \to \bar{K}^{*0}\pi^0)$ and $A(D^0 \to \rho^0\bar{K}^0)$ are also consistent with

zero. If so, these facts can be accommodated by assuming

$$b = c \text{ and } b' = c'$$

in the quark diagrammatic approach, or

$$G_{15} = S_6^* + S_{15}$$

and $$-2\bar{D}_6^* + D_{15} = A_6^* + A_{15}$$

in the group theoretical approach. This means that for decays of charmed mesons into one vector meson and one pseudoscalar meson $P_c \longrightarrow VP$, the contributions to decays from the exotic piece (15-plet) of weak Hamiltonian and free c quark decay diagrams are also important, and the decay amplitudes which involve the exotic final states should also be taken into account.

Acknowledgements

One of us (X. Li) would like to thank Professor H. Joos and the Theory Group at DESY for hospitality.

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Table Caption

Table 1: Decay amplitudes for $D^0 \longrightarrow VP$ in group theoretical approach

Table 2: Same as Table 1, but for $D^+ \longrightarrow VP$

Table 3: Same as Table 1, but for $F^+ \longrightarrow VP$

Table 4: Same as Table 1, but for $\Lambda_c^+ \rightarrow BP$

Table 5: Same as Table 1, but for $\Xi_c^0 \rightarrow BP$

Table 6: Same as Table 1, but for $\Xi_c^+ \rightarrow BP$

Table 7: Same as Table 1, but for $\Omega_c^0 \rightarrow BP$

Table 8: Decay amplitudes for $D^0 \longrightarrow VP$ in quark diagrammatic approach in terms of quark diagrams a, a'; b, b'; c, c'; d, d'; e, e'; f, f'; h_c, h_c'; h_d, h_d'; h_e, h_e'; h_f, h_f' as shown in Fig. 1.

Table 9: Same as Table 8, but for $D^+ \rightarrow VP$

Table 10: Same as Table 8, but for $F^+ \rightarrow VP$

Figure Caption

Fig. 1 Quark diagrams for decays of charmed particles into one vector meson and one pseudoscalar meson.

<u>Table 1</u>

<u>D° decays</u>

$\rho^{\circ}\bar{K}^{\circ}$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[-2\bar{D}_{6^*}-(S_{6^*}+S_{15})-(A_{6^*}+A_{15})+D_{15}+3G_{15}\right]$
$\bar{K}^{*\circ}\pi^{\circ}$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[2\bar{D}_{6^*}-(S_{6^*}+S_{15})+(A_{6^*}+A_{15})-D_{15}+3G_{15}\right]$
$K^{*-}\pi^{+}$	$V_{11}V_{22}\left[\bar{D}_{6^*}+(S_{6^*}+S_{15})-(A_{6^*}+A_{15})+D_{15}+2G_{15}\right]$
$\rho^{+}K^{-}$	$V_{11}V_{22}\left[-\bar{D}_{6^*}+(S_{6^*}+S_{15})+(A_{6^*}+A_{15})-D_{15}+2G_{15}\right]$
$\bar{K}^{*\circ}\eta^{\circ}$	$V_{11}V_{22}\left(\frac{1}{\sqrt{6}}\right)\left[-(S_{6^*}+S_{15})-3(A_{6^*}+A_{15})-3D_{15}+3G_{15}\right]$
$\varphi\bar{K}^{\circ}$	$V_{11}V_{22}\left[(S_{6^*}+S_{15})-(A_{6^*}+A_{15})-D_{15}-G_{15}\right]$
$\omega\bar{K}^{\circ}$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[(S_{6^*}+S_{15})+(A_{6^*}+A_{15})+D_{15}+G_{15}\right]$
$\bar{K}^{*\circ}\eta'$	$V_{11}V_{22}\left(\frac{2}{\sqrt{3}}\right)(S_{6^*}+S_{15})$
$K^{*-}K^{+}$	$\Sigma\left[\bar{D}_{6^*}+(S_{6^*}+S_{15})-(A_{6^*}+A_{15})+D_{15}+2G_{15}\right]$
	$+\frac{\Delta}{2}\left[-(S_{15}-S_{3})-3(A_{15}-A_{3})+3G_{15}+2U_{3}\right]$
$K^{*+}K^{-}$	$\Sigma\left[-\bar{D}_{6^*}+(S_{6^*}+S_{15})+(A_{6^*}+A_{15})-D_{15}+2G_{15}\right]$
	$+\frac{\Delta}{2}\left[-(S_{15}-S_{3})+3(A_{15}-A_{3})+3G_{15}+2U_{3}\right]$
$\rho^{-}\pi^{+}$	$\Sigma\left[-\bar{D}_{6^*}-(S_{6^*}+S_{15})+(A_{6^*}+A_{15})-D_{15}-2G_{15}\right]$
	$+\frac{\Delta}{2}\left[-(S_{15}-S_{3})-3(A_{15}-A_{3})+3G_{15}+2U_{3}\right]$
$\rho^{+}\pi^{-}$	$\Sigma\left[\bar{D}_{6^*}-(S_{6^*}+S_{15})-(A_{6^*}+A_{15})+D_{15}-2G_{15}\right]$
	$+\frac{\Delta}{2}\left[-(S_{15}-S_{3})+3(A_{15}-A_{3})+3G_{15}+2U_{3}\right]$
$\bar{K}^{*\circ}K^{\circ}$	$\Sigma\left[-\bar{D}_{6^*}-2(A_{6^*}+A_{15})-D_{15}\right]+\frac{\Delta}{2}\left[2(S_{15}-S_{3})-G_{15}+2U_{3}\right]$
$K^{*\circ}\bar{K}^{\circ}$	$\Sigma\left[\bar{D}_{6^*}+2(A_{6^*}+A_{15})+D_{15}\right]+\frac{\Delta}{2}\left[2(S_{15}-S_{3})-G_{15}+2U_{3}\right]$
$\rho^{\circ}\pi^{\circ}$	$\Sigma\left[-(S_{6^*}+S_{15})+3G_{15}\right]+\frac{\Delta}{2}\left[-(S_{15}-S_{3})-7G_{15}+2U_{3}\right]$
$\rho^{\circ}\eta^{\circ}$	$\Sigma\left(\frac{1}{\sqrt{3}}\right)\left[3\bar{D}_{6^*}+(S_{6^*}+S_{15})-3D_{15}-3G_{15}\right]+\frac{\Delta}{2}(\sqrt{3})\left[-(S_{15}-S_{3})-2G_{15}\right]$
$\rho^{\circ}\eta'$	$\Sigma\left(\frac{\sqrt{6}}{3}\right)\left[(S_{6^*}+S_{15})\right]+\frac{\Delta}{2}(\sqrt{6})\left[-(S_{15}-S_{3})\right]$
$\varphi\pi^{\circ}$	$\Sigma(\sqrt{2})\left[\bar{D}_{6^*}-D_{15}+G_{15}\right]+\frac{\Delta}{2}(2\sqrt{2})\,G_{15}$
$\varphi\eta^{\circ}$	$\Sigma\left(\frac{2\sqrt{6}}{3}\right)\left[-(S_{6^*}+S_{15})+\frac{3}{2}G_{15}\right]+\frac{\Delta}{2}\left(\frac{\sqrt{6}}{3}\right)\left[-2(S_{15}-S_{3})+3G_{15}-2U_{3}\right]$

<u>Table 1</u> (continued)

<u>D° decays</u>

$\varphi\eta'$	$\Sigma\left(\frac{2\sqrt{3}}{3}\right)(S_{6^*}+S_{15})+\frac{\Delta}{2}\left(\frac{2\sqrt{3}}{9}\right)\left[3(S_{15}-S_{3})+U_{3}\right]$
$\omega\pi^{\circ}$	$\Sigma\left[-\bar{D}_{6^*}+(S_{6^*}+S_{15})+D_{15}-G_{15}\right]+\frac{\Delta}{2}\left[-3(S_{15}-S_{3})-2G_{15}\right]$
$\omega\eta^{\circ}$	$\Sigma\left(\frac{1}{\sqrt{3}}\right)\left[-(S_{6^*}+S_{15})-3G_{15}\right]+\frac{\Delta}{2}\left(\frac{1}{\sqrt{3}}\right)\left[-(S_{15}-S_{3})-3G_{15}+2U_{3}\right]$
$\omega\eta'$	$\Sigma\left(\frac{\sqrt{6}}{3}\right)\left[-(S_{6^*}+S_{15})\right]+\frac{\Delta}{2}\left(\frac{\sqrt{6}}{3}\right)\left[-(S_{15}-S_{3})+\frac{2}{3}U_{3}\right]$
$K^{*\circ}\eta^{\circ}$	$V_{12}V_{21}\left[\frac{3}{\sqrt{6}}\bar{D}_{6^*}-\frac{1}{\sqrt{6}}(S_{6^*}+S_{15})+\frac{3}{\sqrt{6}}(A_{6^*}+A_{15})+\frac{3}{\sqrt{6}}G_{15}\right]$
φK°	$V_{12}V_{21}\left[\bar{D}_{6^*}+(S_{6^*}+S_{15})+(A_{6^*}+A_{15})-G_{15}\right]$
ωK°	$V_{12}V_{21}\left(\frac{1}{\sqrt{2}}\right)\left[-\bar{D}_{6^*}+(S_{6^*}+S_{15})-(A_{6^*}+A_{15})+G_{15}\right]$
$\rho^{-}K^{+}$	$V_{12}V_{21}\left[\bar{D}_{6^*}+(S_{6^*}+S_{15})-(A_{6^*}+A_{15})-D_{15}+2G_{15}\right]$
$K^{*+}\pi^{-}$	$V_{12}V_{21}\left[-\bar{D}_{6^*}+(S_{6^*}+S_{15})+(A_{6^*}+A_{15})+D_{15}+2G_{15}\right]$
$\rho^{\circ}K^{\circ}$	$V_{12}V_{21}\left(\frac{1}{\sqrt{2}}\right)\left[-\bar{D}_{6^*}-(S_{6^*}+S_{15})+(A_{6^*}+A_{15})+2D_{15}+3G_{15}\right]$
$K^{*\circ}\pi^{\circ}$	$V_{12}V_{21}\left(\frac{1}{\sqrt{2}}\right)\left[\bar{D}_{6^*}-(S_{6^*}+S_{15})-(A_{6^*}+A_{15})-2D_{15}+3G_{15}\right]$
$K^{*\circ}\eta'$	$V_{12}V_{21}\left(\frac{2}{\sqrt{3}}\right)(S_{6^*}+S_{15})$

Table 2

D^+ decays

$\bar{K}^{*0}\pi^+$	$V_{11}V_{22}\ [\,3\bar{D}_{6^*} + 5G_{15}\,]$
$\rho^+\bar{K}^0$	$V_{11}V_{22}\ [\,-3\bar{D}_{6^*} + 5G_{15}\,]$
$\varphi\pi^+$	$\Sigma\ [\,2\bar{D}_{6^*} - D_{15} + 3G_{15}\,] + \Delta\ [\,-D_{15} + G_{15}\,]$
$\omega\pi^+$	$\Sigma\ (1/\sqrt{2})[\,-2\bar{D}_{6^*} + 2(S_{6^*} - S_{15}) + D_{15} - 3G_{15}\,] + \Delta/\sqrt{2}\,[\,(S_{15}+3S_3) + D_{15} - 3G_{15}\,]$
$\rho^+\eta^0$	$\Sigma\ (1/\sqrt{6})[\,6\bar{D}_{6^*} + 2(S_{6^*} - S_{15}) - 3D_{15} - 9G_{15}\,] + \Delta/\sqrt{6}\,[\,(S_{15}+3S_3) - 3D_{15} - 3G_{15}\,]$
$\bar{K}^{*0}K^+$	$\Sigma\ [\,2\bar{D}_{6^*} + (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) + D_{15} + 3G_{15}\,]$
	$+\Delta/2\ [\,(S_{15} + 3S_3) + (A_{15} + 3A_3) + 2D_{15} + 2G_{15}\,]$
$K^{*+}\bar{K}^0$	$\Sigma\ [\,-2\bar{D}_{6^*} + (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) - D_{15} + 3G_{15}\,]$
	$+\Delta/2\ [\,(S_{15} + 3S_3) - (A_{15} + 3A_3) - 2D_{15} + 2G_{15}\,]$
$\rho^+\pi^0$	$\Sigma\ (1/\sqrt{2})[\,-2\bar{D}_{6^*} + 2(A_{6^*} - A_{15}) - D_{15} + 5G_{15}\,] + \Delta/\sqrt{2}\,[\,(A_{15}+3A_3) - D_{15} - 5G_{15}\,]$
$\rho^0\pi^+$	$\Sigma\ (1/\sqrt{2})[\,2\bar{D}_{6^*} - 2(A_{6^*} - A_{15}) - D_{15} + 5G_{15}\,] + \Delta/\sqrt{2}\,[\,-(A_{15}+3A_3) + D_{15} - 5G_{15}\,]$
$\rho^+\eta'$	$\Sigma\ (2/\sqrt{3})\ (S_{6^*} - S_{15}) + \Delta/\sqrt{3}\ (S_{15} + 3S_3)$
φK^+	$V_{12}V_{21}\ [\,-\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) - G_{15}\,]$
ωK^+	$V_{12}V_{21}\ (1/\sqrt{2})\ [\,\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) + G_{15}\,]$
$K^{*+}\eta^0$	$V_{12}V_{21}\ (1/\sqrt{6})\ [\,-3\bar{D}_{6^*} + (S_{6^*} - S_{15}) - 3(A_{6^*} - A_{15}) + 3G_{15}\,]$
ρ^+K^0	$V_{12}V_{21}\ [\,-\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) + D_{15} + 2G_{15}\,]$
$K^{*0}\pi^+$	$V_{12}V_{21}\ [\,\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) - D_{15} + 2G_{15}\,]$
ρ^0K^+	$V_{12}V_{21}\ (1/\sqrt{2})\ [\,-\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) - 2D_{15} - 3G_{15}\,]$
$K^{*+}\pi^0$	$V_{12}V_{21}\ (1/\sqrt{2})\ [\,\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) + 2D_{15} - 3G_{15}\,]$
$K^{*+}\eta'$	$V_{12}V_{21}\ (2/\sqrt{3})\ [\,-(S_{6^*} - S_{15})\,]$

Table 3

F^+ Decays

$\rho^+\pi^0$	$V_{11}V_{22}\ (1/\sqrt{2})\ [\,-\bar{D}_{6^*} - 2(A_{6^*} - A_{15}) + D_{15}\,]$
$\rho^0\pi^+$	$V_{11}V_{22}\ (1/\sqrt{2})\ [\,\bar{D}_{6^*} + 2(A_{6^*} - A_{15}) - D_{15}\,]$
$K^{*+}\bar{K}^0$	$V_{11}V_{22}\ [\,-\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) + D_{15} + 2G_{15}\,]$
$\bar{K}^{*0}K^+$	$V_{11}V_{22}\ [\,\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) - D_{15} + 2G_{15}\,]$
$\rho^+\eta^0$	$V_{11}V_{22}\ (1/\sqrt{6})\ [\,3\bar{D}_{6^*} - 2(S_{6^*} - S_{15}) + 3D_{15} - 6G_{15}\,]$
$\varphi\pi^+$	$V_{11}V_{22}\ [\,\bar{D}_{6^*} + D_{15} + 2G_{15}\,]$
$\omega\pi^+$	$V_{11}V_{22}\ (1/\sqrt{2})\ [\,-\bar{D}_{6^*} - 2(S_{6^*} - S_{15}) - D_{15} + 2G_{15}\,]$
$\rho^+\eta'$	$V_{11}V_{22}\ (2/\sqrt{3})\ [\,-(S_{6^*} - S_{15})\,]$
φK^+	$\Sigma\ [\,2\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) + 4G_{15}\,] + \Delta/2\,[\,(S_{15}+3S_3) + (A_{15}+3A_3) + 4G_{15}\,]$
ωK^+	$\Sigma/\sqrt{2}\ [\,-2\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) - 4G_{15}\,] + \Delta/2\sqrt{2}\,[\,(S_{15}+3S_3) - (A_{15}+3A_3) - 4G_{15}\,]$
$K^{*+}\eta^0$	$\Sigma/\sqrt{6}\ [\,6\bar{D}_{6^*} + (S_{6^*} - S_{15}) - 3(A_{6^*} - A_{15}) - 12G_{15}\,] + \Delta/2\sqrt{6}\,[\,-(S_{15}+3S_3) + 3(A_{15}+3A_3) - 12G_{15}\,]$
ρ^+K^0	$\Sigma\ [\,2\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) + D_{15} - 3G_{15}\,]$
	$+\Delta/2\ [\,(S_{15} + 3S_3) - (A_{15} + 3A_3) - 2D_{15} + 2G_{15}\,]$
$K^{*0}\pi^+$	$\Sigma\ [\,-2\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) - D_{15} - 3G_{15}\,]$
	$+\Delta/2\ [\,(S_{15} + 3S_3) + (A_{15} + 3A_3) + 2D_{15} + 2G_{15}\,]$
ρ^0K^+	$\Sigma/\sqrt{2}\ [\,2\bar{D}_{6^*} - (S_{6^*} - S_{15}) + (A_{6^*} - A_{15}) - 2D_{15} + 2G_{15}\,]$
	$+\Delta/2\sqrt{2}\ [\,(S_{15} + 3S_3) - (A_{15} + 3A_3) + 4D_{15} - 8G_{15}\,]$
$K^{*+}\pi^0$	$\Sigma/\sqrt{2}\ [\,-2\bar{D}_{6^*} - (S_{6^*} - S_{15}) - (A_{6^*} - A_{15}) + 2D_{15} + 2G_{15}\,]$
	$+\Delta/2\sqrt{2}\ [\,(S_{15} + 3S_3) + (A_{15} + 3A_3) - 4D_{15} - 8G_{15}\,]$
$K^{*+}\eta'$	$\Sigma\ (2/\sqrt{3})\ [\,-(S_{6^*} - S_{15})\,] + \Delta/\sqrt{3}\ (S_{15} + 3S_3)$
$K^{*+}K^0$	$V_{12}V_{21}\ [\,-3\bar{D}_{6^*} + 5G_{15}\,]$
$K^{*0}K^+$	$V_{12}V_{21}\ [\,3\bar{D}_{6^*} + 5G_{15}\,]$

Table 4

Λ_c^+ decays

$\Sigma^+\pi^+$	$V_{11}V_{22}\cdot\left(\frac{1}{\sqrt{2}}\right)\left[-\bar{D}_{6^*}-2\left(A_{6^*}-A_{15}\right)+D_{15}\right]$
$\Lambda^0\pi^+$	$V_{11}V_{22}\left(\frac{1}{\sqrt{6}}\right)\left[3\bar{D}_{6^*}-2\left(S_{6^*}-S_{15}\right)+3D_{15}-6G_{15}\right]$
$\Sigma^+\pi^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[\bar{D}_{6^*}+2\left(A_{6^*}-A_{15}\right)-D_{15}\right]$
$\Sigma^+\eta^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{6}}\right)\left[-3\bar{D}_{6^*}-2\left(S_{6^*}-S_{15}\right)-3D_{15}-6G_{15}\right]$
Ξ^0K^+	$V_{11}V_{22}\left[-\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)+\left(A_{6^*}-A_{15}\right)+D_{15}+2G_{15}\right]$
$p\bar{K}^0$	$V_{11}V_{22}\left[\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)-\left(A_{6^*}-A_{15}\right)-D_{15}+2G_{15}\right]$
$\Sigma^+\eta'$	$V_{11}V_{22}\left(\frac{2}{\sqrt{3}}\right)\left[-\left(S_{6^*}-S_{15}\right)\right]$
$p\eta^0$	$\frac{\Sigma}{\sqrt{6}}\left[-6\bar{D}_{6^*}+\left(S_{6^*}-S_{15}\right)+3\left(A_{6^*}-A_{15}\right)-12G_{15}\right]$ $+\frac{\Delta}{2}\left(\frac{1}{\sqrt{6}}\right)\left[-\left(S_{15}+3S_3\right)-3\left(A_{15}+3A_3\right)-12G_{15}\right]$
Λ^0K^+	$\frac{\Sigma}{\sqrt{6}}\left[6\bar{D}_{6^*}+\left(S_{6^*}-S_{15}\right)-3\left(A_{6^*}-A_{15}\right)-12G_{15}\right]$ $+\frac{\Delta}{2}\left(\frac{1}{\sqrt{6}}\right)\left[-\left(S_{15}+3S_3\right)+3\left(A_{15}+3A_3\right)-12G_{15}\right]$
$n\pi^+$	$\Sigma\left[2\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)+\left(A_{6^*}-A_{15}\right)+D_{15}-3G_{15}\right]$ $+\frac{\Delta}{2}\left[\left(S_{15}+3S_3\right)-\left(A_{15}+3A_3\right)-D_{15}+G_{15}\right]$
Σ^+K^0	$\Sigma\left[-2\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)-\left(A_{6^*}-A_{15}\right)-D_{15}-3G_{15}\right]$ $+\frac{\Delta}{2}\left[\left(S_{15}+3S_3\right)+\left(A_{15}+3A_3\right)+D_{15}+G_{15}\right]$
$p\pi^0$	$\frac{\Sigma}{\sqrt{2}}\left[2\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)+\left(A_{6^*}-A_{15}\right)-2D_{15}+2G_{15}\right]$ $+\frac{\Delta}{2}\left(\frac{1}{\sqrt{2}}\right)\left[\left(S_{15}+3S_3\right)-\left(A_{15}+3A_3\right)+4D_{15}-8G_{15}\right]$
Σ^0K^+	$\frac{\Sigma}{\sqrt{2}}\left[-2\bar{D}_{6^*}-\left(S_{6^*}-S_{15}\right)-\left(A_{6^*}-A_{15}\right)+2D_{15}+2G_{15}\right]$ $+\frac{\Delta}{2}\left(\frac{1}{\sqrt{2}}\right)\left[\left(S_{15}+3S_3\right)+\left(A_{15}+3A_3\right)-4D_{15}-8G_{15}\right]$
$p\eta'$	$\Sigma\left(\frac{2}{\sqrt{3}}\right)\left[-\left(S_{6^*}-S_{15}\right)\right]+\frac{\Delta}{2}\left(\frac{2}{\sqrt{3}}\right)\left(S_{15}+3S_3\right)$
nK^+	$V_{12}V_{21}\left[-3\bar{D}_{6^*}+5G_{15}\right]$
pK^0	$V_{12}V_{21}\left[3\bar{D}_{6^*}+5G_{15}\right]$

Table 5

Ξ_c^0 decays

$\Xi^0\pi^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[-2\bar{D}_{6^*}-\left(S_{6^*}+S_{15}\right)-\left(A_{6^*}+A_{15}\right)+D_{15}+3G_{15}\right]$
$\Sigma^0\bar{K}^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{2}}\right)\left[2\bar{D}_{6^*}-\left(S_{6^*}+S_{15}\right)+\left(A_{6^*}+A_{15}\right)-D_{15}+3G_{15}\right]$
Σ^+K^-	$V_{11}V_{22}\left[\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)-\left(A_{6^*}+A_{15}\right)+D_{15}+2G_{15}\right]$
$\Xi^-\pi^+$	$V_{11}V_{22}\left[-\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)+\left(A_{6^*}+A_{15}\right)-D_{15}+2G_{15}\right]$
$\Lambda^0\bar{K}^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{6}}\right)\left[-\left(S_{6^*}+S_{15}\right)-3\left(A_{6^*}+A_{15}\right)-3D_{15}+3G_{15}\right]$
$\Xi^0\eta^0$	$V_{11}V_{22}\left(\frac{1}{\sqrt{6}}\right)\left[-\left(S_{6^*}+S_{15}\right)+3\left(A_{6^*}+A_{15}\right)+3D_{15}+3G_{15}\right]$
$\Xi^0\eta'$	$V_{11}V_{22}\left(\frac{2}{\sqrt{3}}\right)\left(S_{6^*}+S_{15}\right)$
pK^-	$\Sigma\left[\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)-\left(A_{6^*}+A_{15}\right)+D_{15}+2G_{15}\right]$ $+\frac{\Delta}{2}\left[-\left(S_{15}-S_3\right)-3\left(A_{15}-A_3\right)+3G_{15}+2U_3\right]$
Ξ^-K^+	$\Sigma\left[-\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)+\left(A_{6^*}+A_{15}\right)-D_{15}+2G_{15}\right]$ $+\frac{\Delta}{2}\left[-\left(S_{15}-S_3\right)+3\left(A_{15}-A_3\right)+3G_{15}+2U_3\right]$
$\Sigma^+\pi^-$	$\Sigma\left[-\bar{D}_{6^*}-\left(S_{6^*}+S_{15}\right)+\left(A_{6^*}+A_{15}\right)-D_{15}-2G_{15}\right]$ $+\frac{\Delta}{2}\left[-\left(S_{15}-S_3\right)-3\left(A_{15}-A_3\right)+3G_{15}+2U_3\right]$
$\Sigma^-\pi^+$	$\Sigma\left[\bar{D}_{6^*}-\left(S_{6^*}+S_{15}\right)-\left(A_{6^*}+A_{15}\right)+D_{15}-2G_{15}\right]$ $+\frac{\Delta}{2}\left[-\left(S_{15}-S_3\right)+3\left(A_{15}-A_3\right)+3G_{15}+2U_3\right]$
$n\bar{K}^0$	$\Sigma\left[-\bar{D}_{6^*}-2\left(A_{6^*}+A_{15}\right)-D_{15}\right]+\frac{\Delta}{2}\left[2\left(S_{15}-S_3\right)-G_{15}+2U_3\right]$
Ξ^0K^0	$\Sigma\left[\bar{D}_{6^*}+2\left(A_{6^*}+A_{15}\right)+D_{15}\right]+\frac{\Delta}{2}\left[2\left(S_{15}-S_3\right)-G_{15}+2U_3\right]$
$\Sigma^0\pi^0$	$\Sigma\left[-\left(S_{6^*}+S_{15}\right)+3G_{15}\right]+\frac{\Delta}{2}\left[-\left(S_{15}-S_3\right)-7G_{15}+2U_3\right]$
$\Lambda^0\pi^0$	$\frac{\Sigma}{\sqrt{3}}\left[3\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)-3D_{15}-3G_{15}\right]+\frac{\Delta}{2}\left(\sqrt{3}\right)\left[-\left(S_{15}-S_3\right)-2G_{15}\right]$
$\Sigma^0\eta^0$	$\frac{\Sigma}{\sqrt{3}}\left[-3\bar{D}_{6^*}+\left(S_{6^*}+S_{15}\right)+3D_{15}-3G_{15}\right]+\frac{\Delta}{2}\left(\sqrt{3}\right)\left[-\left(S_{15}-S_3\right)-2G_{15}\right]$
$\Lambda^0\eta^0$	$\Sigma\left[\left(S_{6^*}+S_{15}\right)-3G_{15}\right]+\frac{\Delta}{2}\left[\left(S_{15}-S_3\right)-3G_{15}+2U_3\right]$
$\Sigma^0\eta'$	$\Sigma\left(\frac{\sqrt{6}}{3}\right)\left(S_{6^*}+S_{15}\right)-\frac{\Delta}{2}\left(\sqrt{6}\right)\left(S_{15}-S_3\right)$
$\Lambda^0\eta'$	$\Sigma\left(\sqrt{2}\right)\left[-\left(S_{6^*}+S_{15}\right)\right]-\frac{\Delta}{2}\left(S_{15}-S_3\right)$

Table 5 (continued)

Ξ_c^0 decays

$\Lambda^0 K^0$	$V_{12}V_{21}\left(\frac{1}{\sqrt{6}}\right)\left[3\bar{D}_{6^*} - (S_{6^*}+S_{15}) + 3(A_{6^*}+A_{15}) + 3G_{15}\right]$
$n\eta^0$	$V_{12}V_{21}\left(\frac{1}{\sqrt{6}}\right)\left[-3\bar{D}_{6^*} - (S_{6^*}+S_{15}) - 3(A_{6^*}+A_{15}) + 3G_{15}\right]$
$p\pi^-$	$V_{12}V_{21}\left[\bar{D}_{6^*} + (S_{6^*}+S_{15}) - (A_{6^*}+A_{15}) + D_{15} + 2G_{15}\right]$
$\Sigma^- K^+$	$V_{12}V_{21}\left[-\bar{D}_{6^*} + (S_{6^*}+S_{15}) + (A_{6^*}+A_{15}) - D_{15} + 2G_{15}\right]$
$n\pi^0$	$V_{12}V_{21}\left[-\bar{D}_{6^*} - (S_{6^*}+S_{15}) + (A_{6^*}+A_{15}) + 2D_{15} + 3G_{15}\right]\left(\frac{1}{\sqrt{2}}\right)$
$\Sigma^0 K^0$	$V_{12}V_{21}\left[\bar{D}_{6^*} - (S_{6^*}+S_{15}) - (A_{6^*}+A_{15}) - 2D_{15} + 3G_{15}\right]\left(\frac{1}{\sqrt{2}}\right)$
$n\eta'$	$V_{12}V_{21}\left(\frac{2}{\sqrt{3}}\right)(S_{6^*}+S_{15})$

Table 6

Ξ_c^+ decays

$\Sigma^+\bar{K}^0$	$V_{11}V_{22}\left[3\bar{D}_{6^*} + 5G_{15}\right]$
$\Xi^0\pi^+$	$V_{11}V_{22}\left[-3\bar{D}_{6^*} + 5G_{15}\right]$
$\Sigma^+\eta^0$	$\frac{\Sigma}{\sqrt{6}}\left[-6\bar{D}_{6^*} + 2(S_{6^*}-S_{15}) + 3D_{15} - 9G_{15}\right] + \frac{\Delta}{\sqrt{6}}\left[(S_{15}+3S_3) + 3D_{15} - 3G_{15}\right]$
$\Lambda^0\pi^+$	$\frac{\Sigma}{\sqrt{6}}\left[6\bar{D}_{6^*} + 2(S_{6^*}-S_{15}) - 3D_{15} - 9G_{15}\right] + \frac{\Delta}{\sqrt{6}}\left[(S_{15}+3S_3) - 3D_{15} - 3G_{15}\right]$
$p\bar{K}^0$	$\Sigma\left[2\bar{D}_{6^*} + (S_{6^*}-S_{15}) + (A_{6^*}-A_{15}) + D_{15} + 3G_{15}\right]$
	$+\frac{\Delta}{2}\left[(S_{15}+3S_3) + (A_{15}+3A_3) + 2D_{15} + 2G_{15}\right]$
$\Xi^0 K^+$	$\Sigma\left[-2\bar{D}_{6^*} + (S_{6^*}-S_{15}) - (A_{6^*}-A_{15}) - D_{15} + 3G_{15}\right]$
	$+\frac{\Delta}{2}\left[(S_{15}+3S_3) - (A_{15}+3A_3) - 2D_{15} + 2G_{15}\right]$
$\Sigma^0\pi^+$	$\frac{\Sigma}{\sqrt{2}}\left[-2\bar{D}_{6^*} + 2(A_6^*-A_{15}) - D_{15} + 5G_{15}\right] + \frac{\Delta}{\sqrt{2}}\left[(A_{15}+3A_3) - D_{15} - 5G_{15}\right]$
$\Sigma^+\pi^0$	$\frac{\Sigma}{\sqrt{2}}\left[2\bar{D}_{6^*} - 2(A_6^*-A_{15}) + D_{15} + 5G_{15}\right] + \frac{\Delta}{\sqrt{2}}\left[-(A_{15}+3A_3) + D_{15} - 5G_{15}\right]$
$\Sigma^+\eta'$	$\Sigma\left(\frac{2}{\sqrt{3}}\right)(S_{6^*}-S_{15}) + \frac{\Delta}{\sqrt{3}}(S_{15}+3S_3)$
$p\eta^0$	$V_{12}V_{21}\left(\frac{1}{\sqrt{6}}\right)\left[3\bar{D}_{6^*} + (S_{6^*}-S_{15}) + 3(A_{6^*}-A_{15}) + 3G_{15}\right]$
$\Lambda^0 K^+$	$V_{12}V_{21}\left(\frac{1}{\sqrt{6}}\right)\left[-3\bar{D}_{6^*} + (S_{6^*}-S_{15}) - 3(A_{6^*}-A_{15}) + 3G_{15}\right]$
$n\pi^+$	$V_{12}V_{21}\left[-\bar{D}_{6^*} - (S_{6^*}-S_{15}) + (A_{6^*}-A_{15}) + D_{15} + 2G_{15}\right]$
$\Sigma^+ K^0$	$V_{12}V_{21}\left[\bar{D}_{6^*} - (S_{6^*}-S_{15}) - (A_{6^*}-A_{15}) - D_{15} + 2G_{15}\right]$
$p\pi^0$	$V_{12}V_{21}\left(\frac{1}{\sqrt{2}}\right)\left[-\bar{D}_{6^*} - (S_{6^*}-S_{15}) + (A_{6^*}-A_{15}) - 2D_{15} - 3G_{15}\right]$
$\Sigma^0 K^+$	$V_{12}V_{21}\left(\frac{1}{\sqrt{2}}\right)\left[\bar{D}_{6^*} - (S_{6^*}-S_{15}) - (A_{6^*}-A_{15}) + 2D_{15} - 3G_{15}\right]$
$p\eta'$	$V_{12}V_{21}\left(\frac{2}{\sqrt{3}}\right)\left[-(S_{6^*}-S_{15})\right]$

Table 7

Ω_c^0 decays

$\Xi^0 \bar{K}^0$	$V_{11} V_{22} [\, 10\, G_{6^*} + 10\, G_{15} \,]$
$\Xi^0 \pi^0$	$\Sigma/\sqrt{2}\, [\, 2G_{6^*} + 8G_{15} - 2(S_{6^*} + S_{15}) - 2(A_{6^*} + A_{15}) + 2D_{15} - 4\bar{D}_{15} \,]$
	$+ \Delta/\sqrt{2}\, [\, -6G_{15} - (S_{15} + 2S_3) - (A_{15} + 2A_3) + (D_{15} + D_3) + 4\bar{D}_{15} \,]$
$\Sigma^0 \bar{K}^0$	$\Sigma/\sqrt{2}\, [\, 2G_{6^*} + 8G_{15} - 2(S_{6^*} + S_{15}) + 2(A_{6^*} + A_{15}) - 2D_{15} + 4\bar{D}_{15} \,]$
	$+ \Delta/\sqrt{2}\, [\, -6G_{15} - (S_{15} + 2S_3) + (A_{15} + 2A_3) - (D_{15} + D_3) - 4\bar{D}_{15} \,]$
$\Sigma^+ K^-$	$2\Sigma\, [\, -G_{6^*} + G_{15} + (S_{6^*} + S_{15}) - (A_{6^*} + A_{15}) + D_{15} + \bar{D}_{15} \,]$
	$+ \Delta\, [\, -4G_{15} + (S_{15} + 2S_3) - (A_{15} + 2A_3) + D_{15} + D_3 - 2\bar{D}_{15} \,]$
$\Xi^- \pi^+$	$2\Sigma\, [\, -G_{6^*} + G_{15} + (S_{6^*} + S_{15}) + (A_{6^*} + A_{15}) - D_{15} - \bar{D}_{15} \,]$
	$+ \Delta\, [\, -4G_{15} + (S_{15} + 2S_3) + (A_{15} + 2A_3) - D_{15} - D_3 + 2\bar{D}_{15} \,]$
$\Lambda^0 \bar{K}^0$	$\Sigma/\sqrt{6}\, [\, -6(3G_{6^*} + 2G_{15}) - 2(S_{6^*} + S_{15}) - 6(A_{6^*} + A_{15}) - 6D_{15} \,]$
	$+ \Delta/\sqrt{6}\, [\, -6G_{15} - (S_{15} + 2S_3) - 3(A_{15} + 2A_3) - 3(D_{15} + D_3) \,]$
$\Xi^0 \eta^0$	$\Sigma/\sqrt{6}\, [\, -6(3G_{6^*} + 2G_{15}) - 2(S_{6^*} + S_{15}) + 6(A_{6^*} + A_{15}) + 6D_{15} \,]$
	$+ \Delta/\sqrt{6}\, [\, -6G_{15} - (S_{15} + 2S_3) + 3(A_{15} + 2A_3) + 3(D_{15} + D_3) \,]$
$\Xi^0 \eta'$	$\Sigma\, (4/\sqrt{3})\, (S_{6^*} + S_{15}) + \Delta\, (2/\sqrt{3})\, (S_{15} + 2S_3)$
$p K^-$	$V_{12} V_{21}\, [\, \tfrac{3}{2} G_{6^*} - \tfrac{2}{3} S_{6^*} + 2A_{6^*} + U_{6^*} - 2G_{15} - D_{15} - \bar{D}_{15} - 2S_{15} - 2A_{15} \,]$
$n \bar{K}^0$	$V_{12} V_{21}\, [\, \tfrac{3}{2} G_{6^*} - \tfrac{2}{3} S_{6^*} + 2A_{6^*} + U_{6^*} + 2G_{15} + D_{15} + \bar{D}_{15} + 2S_{15} + 2A_{15} \,]$
$\Sigma^+ \pi^-$	$V_{12} V_{21}\, [\, -\tfrac{1}{2} G_{6^*} + \tfrac{4}{3} S_{6^*} + U_{6^*} + D_{15} + \bar{D}_{15} - 4A_{15} \,]$
$\Sigma^- \pi^+$	$V_{12} V_{21}\, [\, -\tfrac{1}{2} G_{6^*} + \tfrac{4}{3} S_{6^*} + U_{6^*} - D_{15} - \bar{D}_{15} + 4A_{15} \,]$
$\Xi^0 K^0$	$V_{12} V_{21}\, [\, \tfrac{3}{2} G_{6^*} - \tfrac{2}{3} S_{6^*} - 2A_{6^*} + U_{6^*} + 2G_{15} - D_{15} - \bar{D}_{15} + 2S_{15} - 2A_{15} \,]$
$\Xi^- K^+$	$V_{12} V_{21}\, [\, \tfrac{3}{2} G_{6^*} - \tfrac{2}{3} S_{6^*} - 2A_{6^*} + U_{6^*} - 2G_{15} + D_{15} + \bar{D}_{15} - 2S_{15} + 2A_{15} \,]$
$\Sigma^0 \pi^0$	$V_{12} V_{21}\, [\, -\tfrac{1}{2} G_{6^*} + \tfrac{4}{3} S_{6^*} + U_{6^*} \,]$
$\Sigma^0 \eta^0$	$V_{12} V_{21}\, [\, 2\sqrt{3}\, G_{15} - \sqrt{3}\, D_{15} + \sqrt{3}\, \bar{D}_{15} - 4/\sqrt{3}\, S_{15} \,]$

Table 7 (continued)

Ω_c^0 decays

$\Lambda^0 \pi^0$	$V_{12} V_{21}\, (1/\sqrt{15})\, [\, 6G_{15} + 3D_{15} - 3\bar{D}_{15} - 4S_{15} \,]$
$\Lambda^0 \eta^0$	$V_{12} V_{21}\, (1/6)\, [\, -27G_{6^*} - 8S_{6^*} + 6U_{6^*} \,]$
$\Sigma^0 \eta'$	$V_{12} V_{21}\, (1/\sqrt{6})\, [\, -8S_{15} \,]$
$\Lambda^0 \eta'$	$V_{12} V_{21}\, (\sqrt{2}/3)\, [\, 4S_{6^*} \,]$

Table 8

D^0 decays

$\rho^0\bar{K}^0$	$V_{11}V_{22}\,(1/\sqrt{2})\,(b-c)$
$\bar{K}^{*0}\pi^0$	$V_{11}V_{22}\,(1/\sqrt{2})\,(b'-c')$
$K^{*-}\pi^+$	$V_{11}V_{22}\,(a'+c')$
ρ^+K^-	$V_{11}V_{22}\,(a+c)$
$\bar{K}^{*0}\eta^0$	$V_{11}V_{22}\,(1/\sqrt{6})\,(b'+c'-2c)$
$\varphi\bar{K}^0$	$V_{11}V_{22}\,(c'+\tfrac{1}{2}h_c)$
$\omega\bar{K}^0$	$V_{11}V_{22}\,(1/\sqrt{2})\,(b+c+h_c)$
$\bar{K}^{*0}\eta'$	$V_{11}V_{22}\,(1/\sqrt{3})\,(b'+c+c'+h_c')$
$K^{*-}K^+$	$\Sigma\,(a'+c')+\Delta\,(a'+c'+2e+2f+2f')$
$\bar{K}^{*0}K^0$	$\Sigma\,(-c+c')+\Delta\,(c+c'+2f+2f')$
$\rho^-\pi^+$	$\Sigma\,(-a'-c')+\Delta\,(a'+c'+2e+2f+2f')$
$\rho^+\pi^-$	$\Sigma\,(-a-c)+\Delta\,(a+c+2e'+2f+2f')$
$K^{*0}\bar{K}^0$	$\Sigma\,(c-c')+\Delta\,(c+c'+2f+2f')$
$K^{*+}K^-$	$\Sigma\,(a+c)+\Delta\,(a+c+2e'+2f+2f')$
$\rho^0\pi^0$	$\Sigma/2\,(b+b'-c-c')+\Delta/2\,(-b-b'+c+c'+2e+2e'+4f+4f')$
$\rho^0\eta^0$	$\Sigma(\sqrt{3}/6)(-3b+b'+c+c')+\Delta(\sqrt{3}/6)(-b-b'-c-c'+2e+2e')$
$\rho^0\eta'$	$\Sigma/\sqrt{6}\,(b'+c+c'+h_c')+\Delta/\sqrt{6}\,(2b-b'-c-c'-h_c'+2e+2e'+2h_e')$
$\varphi\pi^0$	$\Sigma/\sqrt{2}\,(b'+\tfrac{1}{2}h_c)+\Delta/\sqrt{2}\,(b'-\tfrac{1}{2}h_c+h_e)$
$\varphi\eta^0$	$\Sigma/\sqrt{6}\,(b'-2c-2c'-\tfrac{3}{2}h_c)+\Delta/\sqrt{6}\,(b'-2c-2c'-\tfrac{1}{2}h_c+h_e-4f-4f')$
$\varphi\eta'$	$\Sigma/\sqrt{3}\,(b'+c+c'+h_c')+\Delta/\sqrt{3}\,(b'+c+c'+h_c+h_c'+h_e+2f+2f'+2h_f+2h_f')$
$\omega\pi^0$	$\Sigma/2\,(b-b'+c+c'+h_c)+\Delta/2\,(-b+b'-c-c'-h_c+2e+2e'+2h_e)$
$\omega\eta^0$	$\sqrt{3}/6\,\Sigma\,(-3b-b'-c-c'-3h_c)$
	$+\sqrt{3}/6\,\Delta\,(b+b'+c+c'-h_c+2e+2e'+2h_e+4f+4f')$

Table 8 (continued)

D^0 decays

$\omega\eta'$	$\Sigma(-1/\sqrt{6})\,(b+c+c'+h_c)+\Delta/\sqrt{6}\,(4f+4f'+4h_f+4h_f')$
	$+\Delta/\sqrt{6}\,(2b+b'+c+c'+2h_c+h_c'+2e+2e'+2h_e+2h_e')$
$K^{*0}\eta^0$	$V_{12}V_{21}\,(1/\sqrt{6})\,(b'+c-2c')$
φK^0	$V_{12}V_{21}\,(c+\tfrac{1}{2}h_c)$
ωK^0	$V_{12}V_{21}\,(1/\sqrt{2})\,(b+c'+h_c)$
ρ^-K^+	$V_{12}V_{21}\,(a'+c')$
$K^{*+}\pi^-$	$V_{12}V_{21}\,(a+c)$
ρ^0K^0	$V_{12}V_{21}\,(1/\sqrt{2})\,(b-c')$
$K^{*0}\pi^0$	$V_{12}V_{21}\,(1/\sqrt{2})\,(b'-c)$
$K^{*0}\eta'$	$V_{12}V_{21}\,(1/\sqrt{3})\,(b'+c+c'+h_c')$

Table 9

D^+ decays

$\bar{K}^{*0}\pi^+$	$V_{11}V_{22}\ (a'+b')$
$\rho^+\bar{K}^0$	$V_{11}V_{22}\ (a+b)$
$\varphi\pi^+$	$\Sigma\,(b'-\tfrac{1}{2}h_d)+\Delta\,(b'+\tfrac{1}{2}h_d+h_e)$
$\omega\pi^+$	$\Sigma(-\tfrac{1}{\sqrt{2}})(a'+b'+d+d'+h_d')+\tfrac{\Delta}{\sqrt{2}}(a'+b'+d+d'+h_d'+2e+2e'+2h_e)$
$\rho^+\eta^0$	$-\tfrac{\Sigma}{\sqrt{6}}\,(a+3b+d+d')+\tfrac{\Delta}{\sqrt{6}}\,(a-b+d+d'+2e+2e')$
$\bar{K}^{*0}K^+$	$\Sigma\,(a'-d)+\Delta\,(a'+d+2e)$
$K^{*+}\bar{K}^0$	$\Sigma\,(a-d')+\Delta\,(a+d'+2e')$
$\rho^+\pi^0$	$\tfrac{\Sigma}{\sqrt{2}}\,(a+b-d+d')+\tfrac{\Delta}{\sqrt{2}}\,(-a-b+d-d'+2e-2e')$
$\rho^0\pi^+$	$\tfrac{\Sigma}{\sqrt{2}}\,(a'+b'-d'+d)+\tfrac{\Delta}{\sqrt{2}}\,(-a'-b'+d'-d+2e'-2e)$
$\rho^+\eta'$	$-\tfrac{\Sigma}{\sqrt{3}}\,(a+d+d'+h_d')+\tfrac{\Delta}{\sqrt{3}}\,(a+2b+d+d'+h_d'+2e+2e'+2h_e')$
φK^+	$V_{12}V_{21}\ (d+\tfrac{1}{2}h_d)$
ωK^+	$V_{12}V_{21}\ (\tfrac{1}{\sqrt{2}})\,(a'+d'+h_d)$
$K^{*+}\eta^0$	$V_{12}V_{21}\ (\tfrac{1}{\sqrt{6}})\,(a+d-2d')$
ρ^+K^0	$V_{12}V_{21}\ (b+d')$
$K^{*0}\pi^+$	$V_{12}V_{21}\ (b'+d)$
ρ^0K^+	$V_{12}V_{21}\ (\tfrac{1}{\sqrt{2}})\,(d'-a')$
$K^{*+}\pi^0$	$V_{12}V_{21}\ (\tfrac{1}{\sqrt{2}})\,(d-a)$
$K^{*+}\eta'$	$V_{12}V_{21}\ (\tfrac{1}{\sqrt{3}})\,(a+d+d'+h_d')$

Table 10

F^+ decays

$\rho^+\pi^0$	$V_{11}V_{22}\ (\tfrac{1}{\sqrt{2}})\,(d-d')$
$\rho^0\pi^+$	$V_{11}V_{22}\ (\tfrac{1}{\sqrt{2}})\,(d'-d)$
$K^{*+}\bar{K}^0$	$V_{11}V_{22}\ (b+d')$
$\bar{K}^{*0}K^+$	$V_{11}V_{22}\ (b'+d)$
$\rho^+\eta^0$	$V_{11}V_{22}\ (\tfrac{1}{\sqrt{6}})\,(-2a+d+d')$
$\varphi\pi^+$	$V_{11}V_{22}\ (a'+\tfrac{1}{2}h_d)$
$\omega\pi^+$	$V_{11}V_{22}\ (\tfrac{1}{\sqrt{2}})\,(d+d'+h_d)$
$\rho^+\eta'$	$V_{11}V_{22}\ (\tfrac{1}{\sqrt{3}})\,(a+d+d'+h_d')$
ρ^+K^0	$\Sigma\,(-a+d')+\Delta\,(a+d'+2e')$
$K^{*0}\pi^+$	$\Sigma\,(-a'+d)+\Delta\,(a'+d+2e)$
ρ^0K^+	$\tfrac{\Sigma}{\sqrt{2}}\,(b'+d')+\tfrac{\Delta}{\sqrt{2}}\,(-b'+d'+2e')$
$K^{*+}\pi^0$	$\tfrac{\Sigma}{\sqrt{2}}\,(b+d)+\tfrac{\Delta}{\sqrt{2}}\,(-b+d+2e)$
$K^{*+}\eta^0$	$\tfrac{\Sigma}{\sqrt{6}}\,(-2a+3b+d-2d')+\tfrac{\Delta}{\sqrt{6}}\,(-2a-b+d-2d'+2e-4e')$
ωK^+	$\tfrac{\Sigma}{\sqrt{2}}\,(-b'+d'+h_d)+\tfrac{\Delta}{\sqrt{2}}\,(b'+d'+h_d+2e'+2h_e)$
φK^+	$\Sigma\,(a'+b'+d+\tfrac{h_d}{2})+\Delta\,(a'+b'+d+\tfrac{1}{2}h_d+2e+h_e)$
$K^{*+}\eta'$	$\tfrac{\Sigma}{\sqrt{3}}\,(a+d+d'+h_d')+\tfrac{\Delta}{\sqrt{3}}\,(a+2b+d+d'+h_d'+2e+2e'+2h_e')$
$K^{*+}K^0$	$V_{12}V_{21}\,(a+b)$
$K^{*0}K^+$	$V_{12}V_{21}\,(a'+b')$

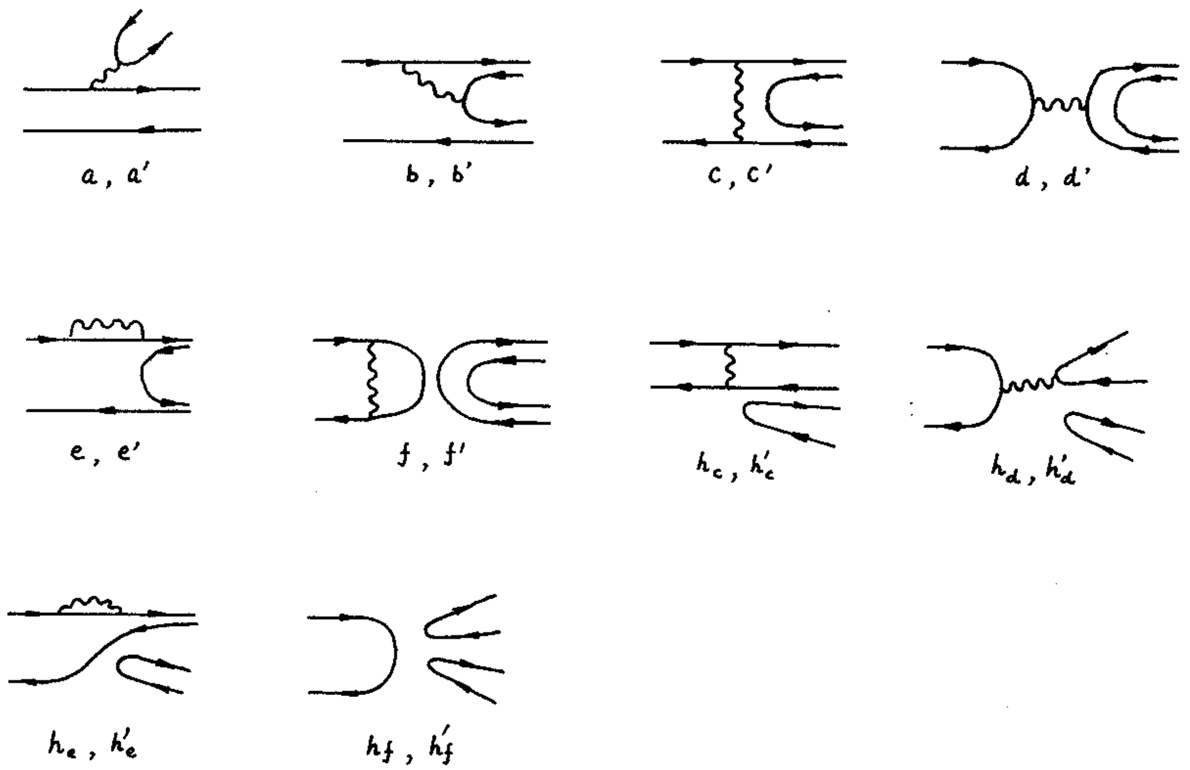

Fig. 1