SLAC – PUB – 3596
March 1985
T/E

WEAK $D \to K\pi$ DECAYS REVISITED*

A. N. KAMAL†

Stanford Linear Accelerator Center
Stanford University, Stanford, California, 94305

and

M. D. SCADRON

Physics Department
University of Arizona, Tucson, Arizona 85721

ABSTRACT

Soft theorems of current algebra are consistently applied to $D \to K\pi$ decay amplitudes from which D^*, F^* and K^* pole contributions have been removed. The K^* pole, ignored in previous calculations, represents the contribution of the flavor annihilation channel. The net effect is an improved, though not entirely satisfactory, understanding of $D \to K\pi$ data.

Submitted to *Physical Review D*

---

* Work supported by the Department of Energy, contracts DE-AC03-76SF00515 and DE-AC02-80ER10663 and Natural Sciences and Engineering Research Council of Canada.

† On leave from Department of Physics, University of Alberta, Edmonton, Alberta, Canada, T6G 2J1.

1. Introduction

Now that the new Mark III data[1] reconfirm that $(D^0 \to \overline{K}^0\pi^0)$ is not color suppressed,[2] it is time to examine the effect of heretofore ignored "helicity-suppressed" W-exchange quark graphs on the theory. A recent model-independent analysis[3] of $D \to K\pi$ decays based on the following two branching fractions[1,4]

$$R_{00} \equiv \Gamma(D^0 \to \overline{K}^0\pi^0)/\Gamma(D^0 \to K^-\pi^+) = 0.35 \pm 0.07 \pm 0.07 \tag{1a}$$

$$R_{0+} \equiv \Gamma(D^0 \to K^-\pi^+)/\Gamma(D^+ \to \overline{K}^0\pi^+) = 3.7 \pm 1.0 \pm 0.8 \tag{1b}$$

(where in the latter we have used $\tau_{D^+}/\tau_{D^0} = 2.5 \pm 0.6$) finds that: (1) real amplitudes cannot fit the two ratios in (1a) and (1b) simultaneously, and (2) a sizeable W-exchange (non-spectator) contribution is needed to lift color-suppression. In this paper we first apply the standard current algebra techniques combined with P-wave vector meson F^{*+} and D^{*0} pole graphs but also include, in the spirit of using vector mesons only, the K^* pole graphs in flavor annihilation channels. Though on-shell this contributions is "helicity-suppressed", it is not a priori obvious that the application of soft-theorems will not result in some constant contribution as a remnant of the K^* pole. We find that the K^* pole nevertheless approximately decouples from the final on-shell decay amplitudes and is thus effectively helicity suppressed.

The result of this procedure can, however, lift color suppression to a degree and come close to explaining the two ratios in (1a) and (1b) for a color-enhanced to color-suppressed F^* to D^* transition ratio about -2.5. One naively expects the absolute magnitude of this ratio to be 3. Furthermore the self-consistent current algebra-PCAC requirement forces the amplitudes in the approximate "vacuum-saturated" quark spectator minus color-suppressed quark spectator form employed in Refs. 5 for all two-body weak decay amplitudes to match favorably the observed scales. One exception is the $(D^0 \to \overline{K}^0\pi^0)$ mode.

In Section 2 we develop current algebra-PCAC theorems for $D \to K\pi$ decays, introducing all possible P-wave vector meson pole graphs. These pole graphs account for the rapid variation of the amplitude as one of the particles is taken off-shell. The background, once the pole contributions are subtracted, is assumed not to have any energy dependence. After noting that the K^* pole in the "flavor annihilation" channel does not contribute significantly to the final on-shell $D \to K\pi$ amplitudes, we attempt to match the decay rate ratios to (1a) and (1b) and find that a near fit is obtained with a F^* to D^* transition ratio of ≈ -2.5. Next in Section 3 we show that the PCAC consistency requirements are identical to vacuum saturation of quark spectator and color-suppressed spectator graphs. We then predict the scales of the three decay amplitudes $(D^0 \to K^-\pi^+)$, $(D^0 \to \overline{K}^0\pi^0)$ and $(D^+ \to \overline{K}^0\pi^+)$.

We summarize our analysis in Section 4 that we have tried to constrain the K^* pole in the flavor-annihilation channel by current algebra and PCAC and find that its contribution to D-decays is minimal. This analysis generates approximately the correct scale for all two-body D-decay amplitudes except $(D^0 \to \overline{K}^0\pi^0)$.

2. Current Algebra-PCAC Theorems for $D \to K\pi$

In what follows, the D-meson will always be kept on mass shell, with $p_D^2 = m_D^2$, where $p_D = D$-meson 4-momentum. The Nambu-Goldstone bosons π and K will be taken off mass-shell with 4-momentum always conserved, $p_D = p_K + p_\pi$, so that $p_K^2 \to m_D^2$ as $p_\pi \to 0$. Such a long extrapolation in p_K^2 is not likely to be smooth as it spans the resonance region. We account for the rapid variation of the amplitude M_P in this extrapolation by vector meson F^*, D^* and K^* poles shown in Figs. 1a-1c. The expectation is that the background amplitude $\overline{M}$ in $M = M_P + \overline{M}$ is smoothly behaved. The on-shell amplitude can then be computed in the usual manner[6]

$$M^{on} = M_P^{on} + M_{CC} - M_P(0) \; , \tag{2}$$

where $M_P(0)$ denotes the soft π or K meson pole amplitude. The charge commutator amplitude M_{CC} is obtained from the PCAC relation, for example with $p_\pi \to 0$ and $f_\pi \approx 93\ MeV$,

$$M_{CC} = -\left\langle \pi, K|H_W|D\right\rangle_{p_\pi \to 0} = \left(\frac{i}{f_\pi}\right) \left\langle K|[Q_5^\pi, H_W]|D\right\rangle \tag{3}$$

combined with $[Q_5, H_W] = -[Q, H_W]$ for H_W built from V-A left-handed currents.

The vector meson pole graphs of Fig. 1 in the limit $p_\pi \to 0$ correspond to

$$(M_P - M_P(0))_{F^*} = M_{P,F^*} \propto \frac{(m_D^2 - m_K^2)}{m_{F^*}^2} \left\langle \pi^+|H_W|F^{*+}\right\rangle \tag{4a}$$

$$(M_P - M_p(0))_{D^*} = -\frac{m_\pi^2}{m_D^2} M_{P,D^*} \propto -\frac{m_\pi^2}{m_D^2} \left\langle \overline{K}^0|H_W|D^{*0}\right\rangle \tag{4b}$$

$$(M_P - M_P(0))_{K^*} = -\frac{(m_D^2 - m_K^2)}{m_K^2} M_{P,K^*} \propto -\frac{(m_D^2 - m_K^2)}{m_{K^*}^2} \left\langle K^{*0} | H_W | D^0 \right\rangle \quad (4c)$$

If we instead take the limit, $p_K \to 0$, then (4) is replaced by

$$(M_P - M_P(0))_{F^*} = -\frac{m_K^2}{m_D^2 - m_K^2} M_{P,F^*} \propto -\frac{m_K^2}{m_{F^*}^2} \left\langle \pi^+ | H_W | F^{*+} \right\rangle \quad (5a)$$

$$(M_P - M_P(0))_{D^*} = M_{P,D^*} \propto \frac{m_D^2}{m_{D^*}^2} \left\langle \overline{K}^0 | H_W | D^{*+} \right\rangle \quad (5b)$$

$$(M_P - M_P(0))_{K^*} = \frac{m_D^2 + m_K^2}{m_K^2} M_{P,K^*} \propto \frac{m_D^2 + m_K^2}{m_{K^*}^2} \left\langle \overline{K}^{*0} | H_W | D^0 \right\rangle \ . \quad (5c)$$

In (4) and (5) M_{P,K^*} represents the K^* pole term with similar definitions for M_{P,D^*} and M_{P,F^*}. We have neglected m_π^2 compared to m_D^2 in (4) and (5).

It is interesting that while the naive vector meson F^* and D^* pole model is recovered in (4a) and (5b), the "helicity-suppressed" (or "mass-suppressed") K^* pole graphs of Fig. 1c is significantly enhanced by a factor $m_D^2/m_K^2 \simeq 14$ in (3c) and (4c). In quark language this means that while the spectator and the color-suppressed spectator graphs of Figs. 2a and 2b remain unaltered, the contribution of K^* pole in the annihilation channel, Fig. 2c, is enhanced to the level of other quark graphs. But in spite of this effect we shall see below that the K^* pole contribution will nevertheless be suppressed in the physical on-shell amplitude due to a consistency requirement imposed by current algebra and PCAC.

To see how this happens quantitatively, we work out in detail the current algebra-PCAC analysis (2)-(5) for the ($D^0 \to K^-\pi^+$) amplitude M^{-+}, the ($D^0 \to \overline{K}^0\pi^0$) amplitude M^{00} and the ($D^+ \to \overline{K}^0\pi^+$) amplitude M^{0+} as $p_\pi \to 0$.

This leads to the following on-shell physical amplitudes,

$$M^{+-} = \frac{i}{\sqrt{2}\, f_\pi} \langle \overline{K}^0 | H_W | D^0 \rangle - g_V \frac{(m_D^2 - m_K^2)}{\sqrt{2}\, m_{F^*}^2} \left\langle \pi^+ | H_W | F^{*+} \right\rangle$$

$$+ g_V \frac{(m_D^2 - m_K^2)}{\sqrt{2}\, m_{K^*}^2} \left\langle \overline{K}^{*0} | H_W | D^0 \right\rangle \tag{6a}$$

$$M^{00} = -\frac{i}{f_\pi} \langle \overline{K}^0 | H_W | D^0 \rangle - g_V \frac{(m_D^2 - m_K^2)}{2\, m_{K^*}^2} \left\langle \overline{K}^{*0} | H_W | D^0 \right\rangle \tag{6b}$$

$$M^{+0} = -\frac{i}{\sqrt{2}\, f_\pi} \langle \overline{K}^0 | H_W | D^0 \rangle - g_V \frac{(m_D^2 - m_K^2)}{\sqrt{2}\, m_{F^*}^2} \left\langle \pi^+ | H_W | F^{*+} \right\rangle , \tag{6c}$$

where g_V is the VPP SU(4) coupling constant and m_π^2 has been neglected compared to m_D^2 throughout. Note also that the $\Delta I = 1$ isospin sum rule

$$M^{+-} + \sqrt{2}\, M^{00} = M^{+0} \tag{7}$$

is identically satisfied by (6).

If we instead take the limit $p_K \to 0$, then current algebra-PCAC leads to the following on-shell matrix elements,

$$M^{-+} = -\frac{i}{\sqrt{2}\, f_K} \left[\langle \overline{K}^0 | H_W | D^0 \rangle + \langle \pi^+ | H_W | F^+ \rangle \right]$$

$$+ \frac{g_V}{\sqrt{2}} \frac{m_K^2}{m_{F^*}^2} \left\langle \pi^+ | H_W | F^{*+} \right\rangle - g_V \frac{(m_D^2 + m_K^2)}{\sqrt{2}\, m_{K^*}^2} \left\langle \overline{K}^{*0} | H_W | D^0 \right\rangle \tag{8a}$$

$$M^{00} = \frac{i}{2\, f_K} \langle \overline{K}^0 | H_W | D^0 \rangle - \frac{g_V}{2} \frac{m_D^2}{m_{D^*}^2} \left\langle \overline{K}^0 | H_W | D^{*0} \right\rangle$$

$$+ \frac{g_V}{2} \frac{(m_D^2 + m_K^2)}{m_{K^*}^2} \left\langle \overline{K}^{*0} | H_W | D^0 \right\rangle \tag{8b}$$

$$M^{0+} = -\frac{i}{\sqrt{2}\,f_K} \left\langle \pi^+|H_W|F^+\right\rangle + \frac{g_V}{\sqrt{2}}\,\frac{m_K^2}{m_{F^*}^2} \left\langle \pi^+|H_W|F^{*+}\right\rangle$$

$$-\frac{g_V}{\sqrt{2}}\,\frac{m_D^2}{m_{D^*}^2} \left\langle \overline{K}^0|H_W|D^{*0}\right\rangle . \qquad (8c)$$

Again (7) is identically satisfied by (8).

Since the on-shell amplitudes must be the same, no matter whether p_K or p_π is made soft, inspection of (6) and (8) shows that the following PCAC-consistency conditions must be valid:

$$\frac{i}{f_K} \left\langle \pi^+|H_W|F^+\right\rangle = g_V\,\frac{m_D^2}{m_{F^*}^2} \left\langle \pi^+|H_W|F^{*+}\right\rangle \qquad (9a)$$

$$\frac{i}{f_\pi} \left\langle \overline{K}^0|H_W|D^0\right\rangle = g_V\,\frac{m_D^2}{m_{D^*}^2} \left\langle \overline{K}^0|H_W|D^{*0}\right\rangle \qquad (9b)$$

$$\frac{i}{f} \left\langle \overline{K}^0|H_W|D^0\right\rangle = -g_V\,\frac{m_D^2}{m_{K^*}^2} \left\langle \overline{K}^{*0}|H_W|D^0\right\rangle , \qquad (9c)$$

where $1/f = \frac{1}{2}\left(\frac{1}{f_\pi} + \frac{1}{f_K}\right)$. With $f_K/f_\pi = 1.25$, which we use throughout, $f_\pi/f = 0.9$. Before studying the significance of the identities (9), we first substitute (9) back into (6) or (8) to obtain the final on-shell $D \to K\pi$ amplitudes,

$$iM(D^0 \to K^-\pi^+) = \frac{1}{\sqrt{2}\,f_K}\left(1 - \frac{m_K^2}{m_D^2}\right) F$$

$$-\frac{1}{\sqrt{2}}\left[\left(\frac{1}{f} - \frac{1}{f_K}\right) + \frac{1}{f}\,\frac{m_K^2}{m_D^2}\right] D \qquad (10a)$$

$$iM(D^0 \to \overline{K}^0\pi^0) = \frac{1}{2}\left[\left(\frac{2}{f_\pi} - \frac{1}{f}\right) + \frac{1}{f}\,\frac{m_K^2}{m_D^2}\right] D \qquad (10b)$$

$$iM(D^+ \to \overline{K}^0\pi^+) = \frac{1}{\sqrt{2}\,f_K}\left(1 - \frac{m_K^2}{m_D^2}\right) F + \frac{1}{\sqrt{2}\,f_\pi} D \qquad (10c)$$

where we have defined

$$F \equiv \langle \pi^+ | H_W | F^+ \rangle \qquad D \equiv \langle \overline{K}^0 | H_W | D^0 \rangle \ . \tag{11}$$

We note that although the K^*-pole term, signalled by (9c), is enhanced to the same size as the D^* pole graphs (signalled by (9b)), its effect in the on-shell amplitudes (signalled by $1/f$ terms in (10) is minimal, largely cancelling against the charge commutator terms in (10a) and (10b). The net effect is close to a model with only F^* and D^* poles (i.e. spectator and color-suppressed spectator quark graphs). For reference, in a model with F^* and D^* poles only and unconstrained by current algebra, (10) is replaced by (where (9a) and (9b) are used),

$$iM(D^0 \to K^-\pi^+) = \frac{1}{\sqrt{2}\, f_K} \left(1 - \frac{m_K^2}{m_D^2}\right) F \tag{12a}$$

$$iM(D^0 \to \overline{K}^0\pi^0) = \frac{D}{2f_\pi} \tag{12b}$$

$$iM(D^+ \to \overline{K}^0\pi^+) = \frac{1}{\sqrt{2}\, f_K} \left(1 - \frac{m_K^2}{m_D^2}\right) F + \frac{1}{\sqrt{2}\, f_\pi} D \tag{12c}$$

The ratios R_{00} and R_{0+} of (1) now depend on the ratio F/D defined in (11). In Table I we have tabulated R_{00} and R_{0+} as functions of F/D. We notice that for $F/D \approx -2.0$ to -2.5, color suppression of R_{00} is partially lifted and we come close to a simultaneous fit to R_{00} and R_{0+}. A fit to R_{00} requires F/D closer to -2.0 while R_{0+} requires it to be closer to -3.0. A magnitude of 3 for F/D corresponds to the color-suppression of $\langle \overline{K}^0 | H_W | D^0 \rangle$ relative to $\langle \pi^+ | H_W | F^+ \rangle$ as expected.[2] Even the relative sign is anticipated once one appreciates[5] that while Fierz reshuffling of quark *fields* in H_W gives[2] $F/D = 3$, the extra minus sign enters this ratio due to the Cartesian phases of hadron *states* in the strong (Ademollo-Gatto) coupling at the vertices $\langle K^- | V_\mu | D^0 \rangle$ versus $\langle \pi^+ | V_\mu | D^0 \rangle$.

3. Vacuum-Saturated $D \to K\pi$ Scales

In this section we test the scales of the three amplitudes in (10) by using vacuum saturation. In Refs. 5 and 7 the authors have discussed the scale of the vacuum-saturated amplitudes for $K^+ \to \pi^+\pi^0$ and $D \to K\pi$ decays and shown that a satisfactory fit to the $K \to 2\pi$ and $D \to K\pi$ amplitudes is obtained through vacuum saturation of the matrix element.

We begin by demonstrating that vacuum-saturation does indeed imply the consistency conditions of (9). More specifically, we assume the usual form for H_W constructed out of left-handed currents,

$$H_W = \frac{G_F}{2\sqrt{2}} \left(J_\mu^\dagger J^\mu + J_\mu J^{\dagger\mu}\right) . \tag{13}$$

Vacuum-saturating the left-hand-side of (9a) leads to

$$\begin{aligned}\frac{i}{f_K} \left\langle \pi^+ | H_W | F^+ \right\rangle &= \frac{i}{f_K} \frac{G_F}{2\sqrt{2}} \left\langle \pi^+ | A_\mu^\dagger | 0 \right\rangle \left\langle 0 | A^\mu | F^+ \right\rangle \\ &= i \frac{f_\pi f_F}{f_K} \frac{G_F}{\sqrt{2}} c_1^2 p^2\end{aligned} \tag{14a}$$

and

$$F \equiv \left\langle \pi^+ | H_W | F^+ \right\rangle = \frac{f_F}{\sqrt{2}} (3.57 \times 10^{-6}\, GeV) \tag{14b}$$

where c_1 is the cosine of the Cabibbo-mixing angle and $p^2 = m_D^2$ for D-decay on shell. The right hand side of (9a) involves the $F^{*+} \to \pi^+$ transition amplitude (note that in defining the matrix elements involving vector particles in (6) and (8) we have already factored out $\epsilon \cdot p$ where ϵ_μ is the polarization 4-vector and

p_μ the 4-momentum of the particle) appearing in the amplitude

$$A(F^{*+} \to \pi^+) \equiv \left\langle \pi^+ | H_W | F^{*+} \right\rangle (\epsilon \cdot p) \ . \tag{15a}$$

With vacuum saturation one has with $J = V - A$,

$$\begin{aligned} A(F^{*+} \to \pi^+) &= \frac{G_F}{2\sqrt{2}} \ \langle \pi^+ | - A_\mu^+ | 0 \rangle \ \left\langle 0 | V^\mu | F^{*+} \right\rangle \\ &= \frac{G_F c_1^2}{\sqrt{2}} \ (i f_\pi) \, (\epsilon \cdot p) \ \frac{m_{F^*}^2}{g_V} \ . \end{aligned} \tag{15b}$$

Comparing (15a) and (15b) we obtain

$$\left\langle \pi^+ | H_W | F^{*+} \right\rangle = \frac{G_F}{\sqrt{2}} \ c_1^2 (i f_\pi) \ \frac{m_{F^*}^2}{g_V} \ . \tag{16}$$

Then (14) and (16) lead to (9a) in the approximation $f_F = f_K$. Similar analyses likewise lead to (9b) and (9c).

Returning now to the decay amplitudes in (10) but with $f_F \neq f_K$, we can compute their magnitudes using the scale of F set by vacuum saturation (14) and an assumed F/D ratio. The magnitudes of the amplitudes are then given by

$$|M_{-+}| = \frac{G_F \, c_1^2 \, f_\pi \, m_D^2 f_F}{2} \ \left[\left(\frac{1}{f_K} + \frac{1}{f} \frac{D}{F} \right) \left(1 - \frac{m_K^2}{m_D^2} \right) - \frac{1}{f_\pi} \frac{D}{F} \right] \tag{17a}$$

$$|M_{00}| = \frac{G_F c_1^2 f_\pi m_D^2 f_F}{\sqrt{2}} \ \left[\frac{1}{f_\pi} - \frac{1}{2f} \left(1 - \frac{m_K^2}{m_D^2} \right) \right] \frac{D}{F} \tag{17b}$$

$$|M_{0+}| = \frac{G_F c_1^2 f_\pi m_D^2 f_F}{2} \ \left[\frac{1}{f_K} \left(1 - \frac{m_K^2}{m_D^2} \right) + \frac{1}{f_\pi} \frac{D}{F} \right] \ . \tag{17c}$$

In Table II we have listed the numerical values of those amplitudes for different values of the ratios F/D and f_F/f_π. In $SU(4)$ breaking f_F/f_π could be[8] $\sqrt{m_c + m_s}/\sqrt{2m_u} \simeq 1.73$.

The "experimental" amplitudes calculated by us are

$$|M_{-+}|_{\exp} = (2.51 \pm 0.22 \pm 0.24)\ 10^{-6}\ GeV \tag{18a}$$

$$|M_{00}|_{\exp} = (1.51 \pm 0.18 \pm 0.17)\ 10^{-6}\ GeV \tag{18b}$$

$$|M_{0+}|_{\exp} = (1.37 \pm 0.15 \pm 0.11)\ 10^{-6}\ GeV\ . \tag{18c}$$

In computing these amplitudes we have used[9]

$$\tau_{D^+} = (8.9 \pm 0.9)\ 10^{-13}\ sec \tag{19a}$$

$$\tau_{D^0} = (3.8 \pm 0.3)\ 10^{-13}\ sec \tag{19b}$$

and the two-body branching ratios in (1) from Ref. 10.

The scales computed by us with $f_F/f_\pi = 1.73$ and $F/D = -3$ are reasonable except for M_{00} which is too low by about two standard deviations. One could raise M_{00} by using $F/D = -2.0$ but then M_{0+} would be lowered further while M_{+-} would rise slightly.

4. Conclusion

Since helicity suppressed quark graphs are usually ignored in $D \to K\pi$ decays, our goal in this paper was to introduce W-exchange (flavor annihilation) diagrams into the theory in a systematic manner. The application of soft theorems of current algebra to $D \to K\pi$ decays entails large extrapolations through kinematic regions populated by resonances. We assume that the resonant behaviour is approximated by vector resonances, D^*, F^*, and K^*, and apply the soft-theorems to a smooth amplitude from which the resonant parts have been removed. We expect this to be a reasonably reliable procedure to incorporate K^* in the theory. The final amplitudes so obtained, Eq. (10), differ slightly from those predicted by a model with D^* and F^* poles alone and unconstrained by current algebra, Eq. (12). The net effect is to lead to an improved, though not a completely satisfactory, fit to the ratios R_{00} and R_{0+}.

Proceeding further we evaluated the magnitudes of the three amplitudes, the scale having been set by vacuum saturation of the matrix element F defined in (11). Since a simultaneous fit to R_{00} and R_{0+} could not be secured we find that the theory reasonably well explains the magnitudes of $(D^0 \to K^-\pi^+)$ and $(D^+ \to \overline{K}^0\pi^+)$ amplitudes, but the troublesome $(D^0 \to \overline{K}^0\pi^0)$ amplitude is about 2 standard deviations below the experimental value.

We, therefore, deduce that the inclusion of the flavor-annihilation channel through a K^* pole in the theory in a consistent manner leads to an improved understanding of the data. Nonetheless we would expect future experiments, particularly on the mode $(D^0 \to \overline{K}^0\pi^0)$, to clarify the situation.

ACKNOWLEDGEMENTS

We wish to thank F. Gilman, D. Hitlin and R. Schindler for discussions at different times. We wish to thank the Theory Group at SLAC for their hospitality.

Table I

F/D	R_{00}	R_{0+}
−2.0	0.25	11.45
−2.1	0.23	9.43
−2.2	0.21	8.0
−2.3	0.19	6.94
−2.4	0.18	6.15
−2.5	0.17	5.53
−2.6	0.15	5.0
−2.7	0.14	4.63

Table II

All ampltiudes in units of 10^{-6} GeV.

f_F/f_π	F/D	$\lvert M_{-+}\rvert$	$\lvert M_{00}\rvert$	$\lvert M_{0+}\rvert$
1.25	−2.0	1.84	0.92	0.54
1.25	−2.5	1.80	0.73	0.77
1.25	−3.0	1.77	0.61	0.92
1.73	−2.0	2.77	1.26	0.76
1.73	−2.5	2.72	1.01	1.07
1.73	−3.0	2.69	0.84	1.27

REFERENCES

1. D. Hitlin, SLAC Summer Institute, July 23-August 3, 1984; Mark III collaboration, XXII International Conference on High Energy Physics, Leipzig, July 1984.
2. N. Cabibbo and L. Maiani, Phys. Rev. Lett. 73B 418 (1978); D. Fakirov and B. Stech, Nucl. Phys. B133, 315 (1978).
3. A. N. Kamal, SLAC-PUB-3443, 1984 (unpublished).
4. R. H. Schindler, private communication to ANK, 1984.
5. M. D. Scadron, Phys. Rev. D29, 1375 (1984); F. Hussain and M. D. Scadron, Phys. Rev. D30, 1492 (1984).
6. See, e.g. the recent review: M. D. Scadron, Reps. Prog. Phys. 44, 213 (1981).
7. B.H.J. McKellar and M. D. Scadron, Phys. Rev. D27, 157 (1983); M. D. Scadron, "Three current algebra-PCAC consistency theorems for $K \to 2\pi$ decays", University of Arizona preprint, 1984.
8. A. Ali, J. G. Körner, G. Kramer and J. Willrodt, Z. Phys. C1, 269 (1979).
9. J. A. Jaros, SLAC-PUB-3519, 1984.
10. D. Hitlin, in Ref. 1.

FIGURE CAPTIONS

1. Vector meson F^*, D^* and K^* pole graphs for $D \to K\pi$ decays. The cross within the circle represents weak transition.

2. Equivalent quark spectator, color suppressed spectator and W-exchange quark graphs for $D \to K\pi$ decays.

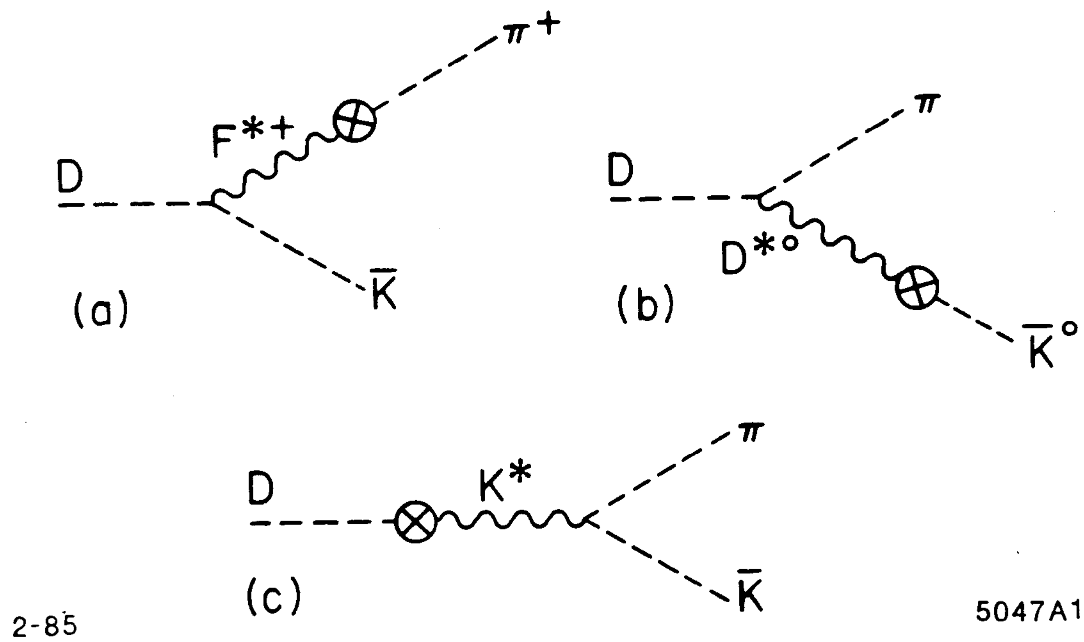

Fig. 1

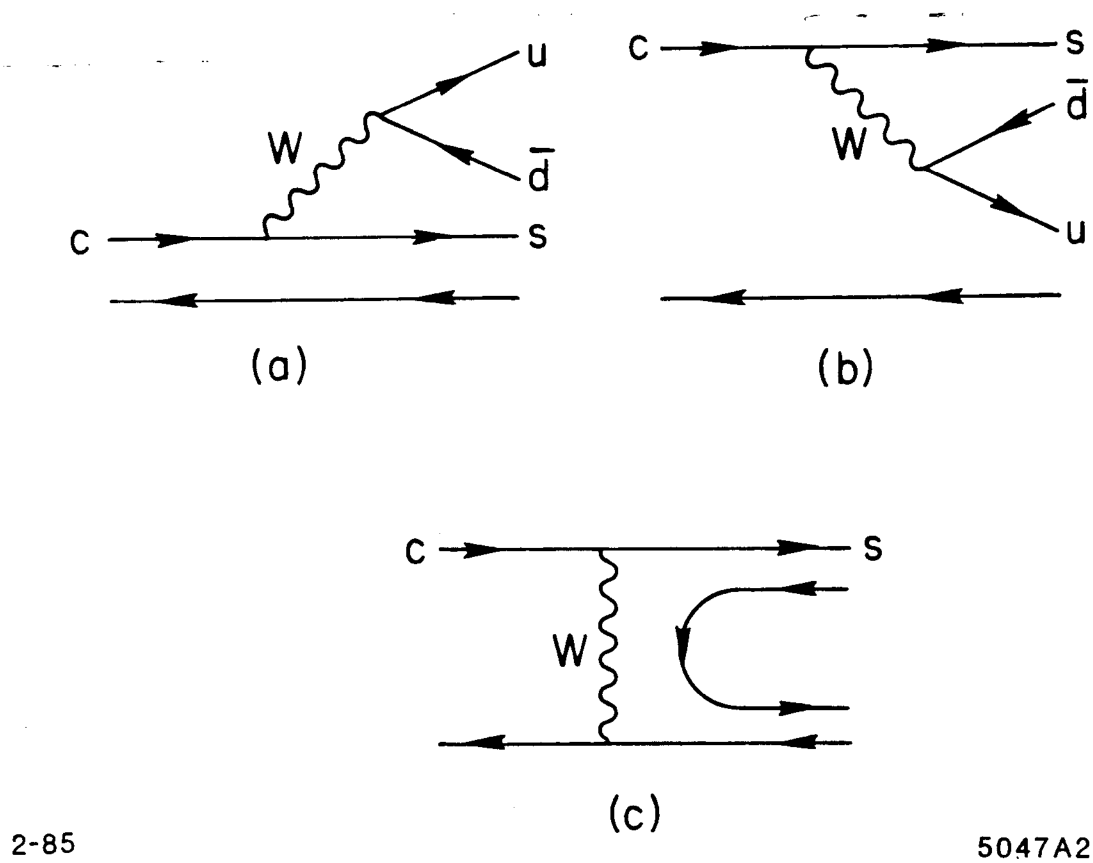

Fig. 2