Penguin contributions to rates and CP asymmetries in non-leptonic B-decays. Possible experimental procedures and estimates.

A. Deandrea, N. Di Bartolomeo and R. Gatto
Département de Physique Théorique, Univ. de Genève

F. Feruglio
Dipartimento di Fisica, Univ. di Padova

G. Nardulli
Dipartimento di Fisica, Univ. di Bari
I.N.F.N., Sezione di Bari

UGVA-DPT 1993/10-837
hep-ph/9310326
October 1993

* Partially supported by the Swiss National Science Foundation
ABSTRACT

We present a study of non-leptonic B-meson decays, partial widths and CP asymmetries, and discuss the possibilities of determining the penguin contributions through less model-dependent phenomenological analyses. In the last section we employ a specific model to give more definite numerical predictions.
1 Introduction and summary of content

In non-leptonic decays of B-mesons the penguin contributions of the effective $\Delta B = 1$ hamiltonian become non-negligible when the tree contributions are suppressed and they are even dominant in certain cases. Moreover for those $B$ decays which could give rise to observable CP asymmetries, the penguin contributions might cause large deviations from the tree predictions [1], even when numerically much smaller than the latter. In such cases a correct estimate of the penguin effects is therefore crucial. We present in this note a study of such decays. We will discuss the role of the penguin amplitudes both in the case where they are not negligible in the computation of the widths and in the case where, although not important to evaluate the decay widths, they are relevant to the analysis of CP asymmetries. At least in principle, the experimental informations on the first set of decays (essentially those corresponding to the Cabibbo suppressed $b- > u\bar{u}s$ transitions) might provide bounds, constraints or even a direct access to those parameters defining the penguin contributions to the CP violating asymmetries. We shall stress as much as possible procedures which are less model-dependent.

The calculations make use of the recently developed two-loop effective $\Delta B = 1$ hamiltonian [2] and of the factorization approximation. The form of the amplitudes are collected in Tables I, II. They depend on the Cabibbo-Kobayashi-Maskawa matrix elements $V_{ij}$, on combinations $a_i$ of the Wilson coefficients of the effective hamiltonian and on the hadronic matrix elements of the weak currents. In view of the inevitable theoretical uncertainties we suggest the experimentalists to mostly rely directly on the parametrized expressions in Tables I and II to fit the theoretical parameters from the ratios of the partial widths which are or will eventually become available (we give some example).

The asymmetries for decays of neutral B-mesons into states with CP self-conjugate particle composition are given in Tables III. The usual asymmetry parameter (neglecting strong phases) $\text{Im}(q\bar{A}/pA)$ depends on the mixing phase $\varphi_M$ and on the amplitudes $A_T e^{i\varphi_T}$ and $A_P e^{i\varphi_P}$ for tree and penguin respectively. The angles $\varphi_T$, $\varphi_P$, and the expressions for the ratios $A_P/A_T$ are reported in Tables III. We recall that in some cases the rate asymmetry is reduced with respect to the fundamental asymmetry.

As mentioned above, Tables III, in conjunction with the previous tables I and II, can be used to extract, in a way which is as much as possible model independent, the relevant parameters, by forming suitable ratios of partial rates and estimating or bounding the asymmetries from experimental data directly. We illustrate such a procedure with three examples, but various possibilities may appear and the procedures finally chosen will presumably depend on the kind of experimental data that will become available at the time of the analysis.

The full predictivity of the model that had been developed in ref. [3] will be exploited in the last part of this note to get at the numbers presented in Tables IV. We are mainly interested in obtaining an order-of-magnitude estimate of the rates for the processes considered in section 2, just to have a rough idea of the rareness of the considered decay modes and of their observability at future dedicated facilities. Indeed, as explained above and shown in detail in section 2, we think that, maybe, the best use of the these channels could consist, via the study of appropriate ratios of rates, in constraining the parameters entering the theoretical analysis via the factorization hypothesis. These predictions should be taken with care, as they are subject to the details of the particular model and
to the present inputs. The theoretical errors are difficult to estimate. In some case their instability with respect to input parameters (for instance $N_c$) suggests that they should be taken with great caution.

A very large literature already exists on B-meson decays. We shall refer to a recent book edited by Stone [4], and for CP violation to the books edited by Wolfenstein [5] and by C. Jarlskog [6].

## 2 Parametrization of the amplitudes

The two-loop effective hamiltonian for $\Delta B = 1$ transitions can be written as follows [2]:

$$H_{NL} = \frac{G_F}{\sqrt{2}} \left[ V_{ub}V_{us}^*(c_1 O_1^u + c_2 O_2^u) + V_{cb}V_{cd}^*(c_1 O_1^c + c_2 O_2^c) + V_{tb}V_{td}^* \sum_{i=3}^{6} c_i O_i \right] + h.c. \quad (2.1)$$

where $q = d, s, c_i$ are the Wilson coefficients at the scale $\mu \approx m_b$; $O_1^{u,c}, O_2^{u,c}$ are the operators:

$$O_1^u = (\bar{u}b)_{V-A}(\bar{q}u)_{V-A}, \quad O_1^c = (\bar{c}b)_{V-A}(\bar{q}c)_{V-A}$$
$$O_2^u = (\bar{q}b)_{V-A}(\bar{u}u)_{V-A}, \quad O_2^c = (\bar{c}b)_{V-A}(\bar{c}c)_{V-A} \quad (2.2)$$

$O_i (i = 3, \ldots 6)$ are the so-called penguin operators

$$O_3 = (\bar{q}b)_{V-A} \sum_{q'} (\bar{q}' q')_{V-A}$$
$$O_4 = \sum_{q'} (\bar{q}' b)_{V-A} (\bar{q} q')_{V-A}$$
$$O_5 = (\bar{q} b)_{V-A} \sum_{q'} (\bar{q}' q')_{V+A}$$
$$O_6 = -2 \sum_{q'} (\bar{q}' (1 - \gamma_5)b)(\bar{q}(1 + \gamma_5)q') \quad (2.3)$$

In the previous formulae $q = d, s$ and $(\bar{u}b)_{V-A} = \bar{u}\gamma\mu(1 - \gamma_5)b$. The values of the Wilson coefficients, for $m_b = 4.8$ GeV, $m_{top} = 150$ GeV and $M_{GMS} = 250$ MeV are [2]

$$c_1 = 1.133, \quad c_2 = -0.291, \quad c_3 = 0.015$$
$$c_4 = -0.034, \quad c_5 = 0.010, \quad c_6 = -0.042 \quad (2.4)$$

The hamiltonian [2] allows to study non leptonic decays of B mesons. In a previous paper [4], using the factorization approach, we focused on processes where only the operators $O_1$ and $O_2$ were relevant, at least for what concerns the rates. Notice that the penguin operators have Wilson coefficients very small as compared to those of $O_1$ and $O_2$, but they become important when the tree diagram is strongly Cabibbo suppressed or when the decay can only occur through penguin diagrams. Here we will be interested in such processes. Moreover we will study the influence of the penguins on CP asymmetries for neutral $B$ mesons.
Let us examine first the Cabibbo suppressed decays; in calculating the rates it turns out that the penguin contribution is relevant in the flavour processes $b \to u\bar{a}s$: in this case the tree CKM factor is $V_{tb}V_{ts}^*$, of the order $\lambda^4$ ($\lambda$ is the Cabibbo angle), while the penguin has the factor $V_{tb}V_{ts}^*$, of the order $\lambda^2$, which compensates the smallness of the Wilson coefficients. In Table I we give the amplitudes for all these processes, calculated using factorization and the following parametrization of the hadronic matrix elements:

$$<P(p')|V^\mu|B(p)> = [(p+p')^\mu + \frac{M_B^2 - M_P^2}{q^2}q^\mu]F_1(q^2) - \frac{M_B^2 - M_P^2}{q^2}q^\mu F_0(q^2)$$

$$(2.5)$$

$$<V(\epsilon,p')| (V^\mu - A^\mu)|B(p)> = \frac{2V(q^2)}{M_B + M_V}\epsilon^{\mu\nu\alpha\beta}\epsilon^*_\nu p_\alpha p'_\beta$$

$$+ i(M_B + M_V) \left[ \epsilon^*_\mu - \frac{\epsilon^* \cdot q}{q^2} q_\mu \right] A_1(q^2)$$

$$- i \frac{\epsilon^* \cdot q}{(M_B + M_V)} \left[ (p+p')^\mu - \frac{M_B^2 - M_V^2}{q^2}q_\mu \right] A_2(q^2)$$

$$+ i\epsilon^* \cdot q \frac{2M_V}{q^2}q_\mu A_0(q^2)$$

$$(2.6)$$

where $P$ is a pseudoscalar meson and $V$ a vector meson, $q = p - p'$,

$$A_0(0) = \frac{M_V - M_B}{2M_V}A_2(0) + \frac{M_V + M_B}{2M_V}A_1(0)$$

and $F_1(0) = F_0(0)$. We take also:

$$<0|A^\mu|P(p)> = -if_{PP}\epsilon^\mu$$

$$<0|V^\mu|V(p,\epsilon)> = f_V M_V \epsilon^\mu$$

$$(2.8)$$

The coefficients $a_i$ ($i = 1, \ldots 6$) are given by

$$a_{2i-1} = c_{2i} + \frac{c_{2i}}{N_c} \quad a_{2i} = c_{2i} + \frac{c_{2i-1}}{N_c} \quad i = 1, 2, 3$$

$$(2.9)$$

where in the naive factorization $N_c$ is the number of colors, but due to the uncertainties of the approach it is treated as a parameter to be determined by the data. For example in $D$ decays the value $N_c = \infty$ agrees with the experiments. In Table II we give the amplitudes in the factorization approximation for the pure penguin decays of $\bar{B}^0$, $\bar{B}_s$ and $B^-$ mesons.

A possible experimental determination of the coefficients $a_i$ could be done through ratios of widths, such that most of the hadronic uncertainties cancel out. As an example one could measure $a_4$ from the ratio:

$$R = \frac{\Gamma(\bar{B}^0 \to \pi^+ K^{*-})}{\Gamma(\bar{B}^0 \to \pi^+ \rho^-)} = \left( \frac{f_{K^*}}{f_\rho} \right)^2 \frac{|V_{ub}V_{us}^*a_1 - V_{ub}V_{ts}^*a_4|^2}{|V_{ub}V_{us}^*a_1|^2}$$

$$(2.10)$$

We remark that the width for $\bar{B}^0 \to \pi^+ K^{*-}$ depends on the relative phase between tree and penguin contributions; in general one should expect a strong and a weak phase, that in this case is $\gamma$. As for the strong phases, they are expected to decrease as the inverse heavy meson mass and therefore we neglect them.
3 CP asymmetries

The penguin amplitude, through interference with the tree amplitude, contributes to CP asymmetries in $B$ decays. Neglecting possible strong phases, we write the amplitude of the process as a sum of a penguin and a tree contribution [1]:

$$A = A_T e^{i\varphi_T} + A_P e^{i\varphi_P}$$  \hspace{1cm} (3.1)

where $\varphi_{T,P}$ are the weak phases. The time dependent asymmetry of a neutral $B$ meson ($B^0$ or $B_s$) decaying into a CP-eigenstate can be written as

$$a(t) = -Im \left( \frac{q}{p} \frac{\bar{A}}{A} \right) \sin(\Delta mt)$$  \hspace{1cm} (3.2)

where

$$A = <f|B^0> \quad \bar{A} = <\bar{f}|ar{B}^0>$$  \hspace{1cm} (3.3)

$q/p$ is the mixing and $\Delta m$ the mass difference of the two neutral $B$ mesons. If $A_P/A_T << 1$ we can make an expansion, obtaining:

$$Im \left( \frac{q}{p} \frac{\bar{A}}{A} \right) = -\sin 2(\varphi_M + \varphi_T) - 2\frac{A_P}{A_T} \cos 2(\varphi_M + \varphi_T) \sin(\varphi_P - \varphi_T)$$  \hspace{1cm} (3.4)

where $\varphi_M$ is the mixing phase, defined as

$$\frac{q}{p} = e^{-2i\varphi_M}$$  \hspace{1cm} (3.5)

If $\varphi_T = \varphi_P$, the penguin does not influence the asymmetry, as it happens in $B^0 \rightarrow \psi K_s$; but in general one has a phase difference. Notice that the relative contribution of the penguin in the asymmetry depends on the values of the angles $\varphi_M$, $\varphi_T$ and $\varphi_P$: even when $A_P/A_T << 1$ it could be quite sizeable (or dominating). In Table III we give, for many $B^0$ and $B_s$ decays into states with CP self-conjugate particle composition, the values of the phases $\varphi_T$ and $\varphi_P$; we give also the branching ratios as in ref. [7], and the ratio $A_P/A_T$ as a function of the coefficients $a_i$, assuming factorization. The angle $\alpha$, $\beta$, $\gamma$ are the usual ones, and $\beta'$ is defined as:

$$\beta' = \text{arg} \left[ -\frac{V_{cs}V_{cb}^*}{V_{ts}V_{tb}^*} \right]$$  \hspace{1cm} (3.6)

This angle is very small, $|\sin 2\beta'| < 0.06$. The knowledge of the values of the coefficients $a_i$ allows to evaluate the ratio $A_P/A_T$; in ref. [8] this one is extracted, for the decay $B^0 \rightarrow \pi^+\pi^-$, from the ratio of the widths of $\pi^+K^-$ to $\pi^+\pi^-$. As discussed in the previous section the advantage of making ratios is the cancellation of some hadronic uncertainties. As examples we will consider the decays $\bar{B}_s \rightarrow D_s^+D_s^-$, $\bar{B}_s \rightarrow \rho^0 K_s$, and $\bar{B}_s \rightarrow K^+K^-$. Other examples can be constructed using our tables. The final choices will depend on the relative quality of the experimental information that will become available.

The amplitude for the process $\bar{B}_s \rightarrow D_s^+D_s^-$ is

$$\bar{A} = A_T e^{i\beta'} + A_P$$  \hspace{1cm} (3.7)
where

\[
A_T = \frac{G_F}{\sqrt{2}} |V_{cb}V_{cs}^*| a_1 < D_s^+|\bar{c}b_--\bar{B}_s><D_s^-|\bar{s}c_-|0>
\]

\[
A_P = \frac{G_F}{\sqrt{2}} |V_{tb}V_{td}^*| \left(a_4 + 2a_6 \frac{M_{B_s}^2}{(m_b - m_c)(m_c + m_s)}\right) < D_s^+|\bar{c}b_--\bar{B}_s><D_s^-|\bar{s}c_-|0>
\]

and \(\bar{q}q' = \bar{q}\gamma^\mu(1 - \gamma_5)q'\). From (3.1) we obtain:

\[
Im \left( \frac{q_A}{p_A} \right) = \frac{\sin(2\beta') + 2x\sin\beta'}{1 + x^2 + 2x\cos\beta'} \approx \frac{2\beta'}{1 + x}
\]

(3.9)

where we have used the smallness of \(\beta' (\beta' \leq 0.03)\). The asymmetry is given by (3.2). The value of \(x = A_P/A_T\) can be extracted from the ratio of the widths

\[
R = \frac{\Gamma(\bar{B}_s \to D_s^+D_s^-)}{\Gamma(\bar{B}_s \to D_s^+\pi^-)} = \frac{\left(\frac{f_{D_s}}{f_\pi}\right)^2 |\vec{p}_{D_s}|}{|\vec{p}_{\pi}|} \left(\frac{F_{B_s \to D_s}(M_{B_s}^2)}{F_{B_s \to D_s}(M_{D_s}^2)}\right)^2 (1 + x^2)
\]

\[
= \left(\frac{f_{D_s}}{f_\pi}\right)^2 |\vec{p}_{D_s}| \left|\frac{(M_{B_s} + M_{D_s})^2 - M_{D_s}^2}{(M_{B_s} + M_{D_s})^2 - M_{\pi}^2}\right|^2 \left|\frac{\xi(v \cdot v'')}{\xi(v \cdot v')}\right|^2 (1 + x^2)
\]

(3.10)

where \(\xi\) is the Isgur-Wise form factor, \(v \cdot v' = M_{B_s}/(2M_{D_s})\) and \(v \cdot v'' = (M_{B_s}^2 + M_{D_s}^2 - M_{\pi}^2)/(2M_{B_s}M_{D_s})\). We work in the infinity quark mass limit.

An interesting decay for the measure of \(\gamma\) is \(\bar{B}_s \to \rho^0K_s\), whose amplitude can be written as

\[
\bar{A} = A_Te^{-i\gamma} + A_Pe^{i\beta}
\]

(3.11)

\[
A_T = \frac{G_F}{\sqrt{2}} |V_{ub}V_{us}^*| a_2 < K_s|\bar{d}b_--\bar{B}_s><\rho^0|\bar{s}u_-|0>
\]

\[
A_P = \frac{G_F}{\sqrt{2}} |V_{tb}V_{td}^*| a_4 < K_s|\bar{d}b_--\bar{B}_s><\rho^0|\bar{s}u_-|0>
\]

(3.12)

For the CP violating asymmetry for the decay \(\bar{B}_s \to \rho^0K_s\) one has

\[
Im \left( \frac{q_A}{p_A} \right) = \frac{-\sin(2\gamma) + 2x\sin(\beta - \gamma) + x^2\sin(2\beta)}{1 + x^2 + 2x\cos(\beta + \gamma)}
\]

(3.13)

For \(\bar{B}_s \to \rho^-K^+\) we have

\[
A = \sqrt{2} \left(\frac{a_1A_T}{a_2}e^{-i\gamma} - A_Pe^{i\beta}\right)
\]

(3.14)

The ratio of the two widths gives

\[
R = \frac{\Gamma(\bar{B}_s \to \rho^0K^0)}{\Gamma(\bar{B}_s \to \rho^-K^+)} = \frac{1}{2} \frac{[1 + x^2 + 2x\cos(\beta + \gamma)]}{[1 + a_2^2x^2/a_1^2 - 2xa_2/a_1\cos(\beta + \gamma)]}
\]

(3.15)

Therefore for each given value of \(\beta\) and \(R\) we can extract \(x = A_P/A_T\) as a function of \(\gamma\); from (3.13) we can after that obtain \(\gamma\), once the asymmetry, given by (3.2), is measured. The ratio \(a_2/a_1\), with its sign, is obtained by experimental results as for example \(BR(B^- \to D^0\pi^-)/BR(B^0 \to D^+\pi^-)\); for instance in [7] we find \(a_2/a_1 \simeq +0.27\).

Another decay potentially interesting to determine \(\gamma\) is \(\bar{B}_s \to K^+K^-\). The amplitude is:

\[
\bar{A} = A_Te^{-i\gamma} + A_P
\]

(3.16)
Similarly to the previous case one can extract the value of $\beta$ as for the ratio 3.15 knowing $ar{A}$ to be clarified. We notice that especially factors. Moreover one has to choose a value for the parameter $N$ in Tables IV. The numerical evaluation of the rates requires the knowledge of the form (and also more risky) numerical estimates. We will do this in the present section and

\[ A_T = \frac{G_F}{\sqrt{2}} |V_{ub} V_{ts}^*| a_1 < K^+ |\bar{B}_s \rangle || K^- |\bar{s} u \rangle |0 > \]
\[ A_P = \frac{G_F}{\sqrt{2}} |V_{tb} V_{ts}^*| \left( a_4 + \frac{2 a_6 M_K^2}{(m_b - m_u)(m_u + m_s)} \right) < K^+ |\bar{B}_s \rangle || K^- |\bar{s} u \rangle |0 > \tag{3.17} \]

Notice that in this case $A_P$ and $A_T$ are of the same order. The asymmetry is proportional to:

\[ Im \left( \frac{q \, \bar{A}}{p \, A} \right) = -\frac{\sin(2\gamma) + 2x \sin \gamma}{1 + x^2 + 2x \cos \gamma} \tag{3.18} \]

Similarly to the previous case one can extract the value of $x$ from the following ratio

\[ R = \frac{\Gamma(\bar{B}_s \rightarrow K^+ \bar{K}^-)}{\Gamma(\bar{B}_s \rightarrow K^+ \pi^-)} = \left( \frac{f_K}{f_\pi} \right)^2 \frac{\lambda^2 [1 + x^2 + 2x \cos \gamma]}{[1 + x^2 y^2 \lambda^4 - 2xy \lambda^2 \cos(\beta + \gamma)]} \tag{3.19} \]

where

\[ y = \frac{\tan \beta}{\tan \beta \cos \gamma + \sin \gamma} \tag{3.20} \]

As for the ratio 3.15 knowing $\beta$, $R$ and the asymmetry 3.18 one can extract the value of $\gamma$.

4 Numerical results

So far we have not exploited the model developed in ref. [3] to attempt at more complete (and also more risky) numerical estimates. We will do this in the present section and in Tables IV. The numerical evaluation of the rates requires the knowledge of the form factors. Moreover one has to choose a value for the parameter $N_c$ initially introduced as giving the number of colors, but usually assumed as a phenomenological parameter to account for the uncertainties of the model. The analysis done in [3] seems to indicate $N_c \approx 2$ as an effective value, but the problem is open and the theoretical approach still to be clarified. We notice that especially $a_2$, $a_3$ and $a_5$ are strongly dependent on $N_c$ and the rates dominated by these coefficients can have large variations.

The results obtained with the model [3] and $N_c = 2$ are reported in Table IVa and IVb, respectively for the decay of Table I and II. In Table IVa we have simply marked with a star (*) the strongly $N_c$ dependent decays, while in Table IVb we have also quoted the values with $N_c = 3$ and $N_c = \infty$, because of the large variations of the branching ratio with $N_c$. We notice that for all the decays of Table I the widths have an interference term between penguin and tree depending on $\cos \gamma$, which at present is unconstrained. Therefore in Table IVa we present the branching ratios for the two extreme values $\cos \gamma = \pm 1$.

Experimentally only upper limits exist at present for the processes in Table IV, and our values are below these data. The most stringent bounds as compared with our results are [2] for $Br(B^- \rightarrow \phi K^- < 8 \times 10^{-5}$) and $Br(\bar{B}^0 \rightarrow \pi^+ K^- < 9 \times 10^{-5}$). The measure of the rate $B^- \rightarrow \phi K^-$, a pure penguin process, will allow to extract the value of $|a_3 + a_4 + a_5|$, which is quite sensitive to $N_c$ (see Table IVb); the rate for $\bar{B}^0 \rightarrow \pi^+ K^-$ depends on the value of $\cos \gamma$ (see Table IVa), therefore a measure of this width will allow a determination of $\gamma$, once known the ratio of penguin to tree contribution, which can for example be measured in the way suggested in [3], from the ratio $\bar{B}^0 \rightarrow \pi^+ \pi^- \rightarrow B^0 \rightarrow \pi^+ K^-$. The measure of the rate for $\bar{B}^0 \rightarrow \pi^+ K^-$ could be an alternative way to determine $\gamma$ with respect to the asymmetry in $\bar{B}_s$ decays, which presents an experimental challenge and needs time-dependent measurements.
**Tables Captions**

**Table I** Amplitudes for non-leptonic decays with tree level contribution strongly Cabibbo suppressed ($V_{ub}V_{us}^*$).

**Table II** Amplitudes for non-leptonic decays that take place only through penguin contributions.

**Table III** $\bar{B}_s$ and $\bar{B}^0$ decays into states with CP self-conjugate particle pairs. The tree level contribution dominates the width. Tree and penguin weak phases $\varphi_T$ and $\varphi_P$ are given together with the rate of the respective amplitudes.

**Table IVa** Branching ratios for non-leptonic decays with tree level contribution strongly Cabibbo suppressed ($V_{ub}V_{us}^*$) are given for two values of the weak angle $\gamma$. The contribution is the same in the two cases when there is no penguin contribution to the amplitude. We take $|V_{ub}| = 0.03$, $|V_{cb}| = |V_{ts}| = 0.042$ and $\tau_B = \tau_{B_s} = 14 \times 10^{-13} s$, $m_b = 5000 \text{MeV}$, $m_s = 150 \text{MeV}$, $m_d = 10 \text{MeV}$ and $m_u = 5 \text{MeV}$. Furthermore we take $f_\eta = f_\pi$. We fixed the value $N_c = 2$, signaling with (*) the cases where there is a strong $N_c$ dependence of the result.

**Table IVb** Branching ratios within the model of [3] for non-leptonic decays that take place only through penguin contributions. As an example of the variation of the result with $N_c$ we have listed the three cases $N_C = 2, 3, \infty$. We take $V_{td} = 0.01$. 

7
References

[1] see for instance M.Gronau, Phys.Rev.Lett. 63 (1989) 1451; and SLAC preprint 5911.

[2] A.J.Buras, M.Jamin, M.E.Lautenbacher and P.H.Weisz, Nucl. Phys. B370 (1992) 69.

[3] R.Casalbuoni, A.Deandrea, N.Di Bartolomeo, F.Feruglio, R.Gatto, and G.Nardulli, Phys. Lett. B299 (1993) 139.

[4] B decays, World Scientific, Singapore (1992), ed. by S.Stone. See in particular the contributions by I.I.Bigi, S.Stone, J.L.Rosner, Y.Nir and H.R.Quinn, I.Duniez and G.Deshpande.

[5] CP violation, North-Holland, Amsterdam (1989), ed. by L.Wolfenstein. See in particular the papers by P.Krawczyk, D.London, R.D.Peccei and H.Steger, by I.I.Bigi and A.I. Sanda, and by L.Wolfenstein.

[6] CP violations, World Scientific, Singapore (1992), ed. by C.Jarlskog. See in particular the contributions by S.Stone, I.I.Bigi, V.A.Khoze, N.G. Uraltsev and A.I.Sanda, L.L.Chau, A.J.Buras, and B.Stech.

[7] A.Deandrea, N.Di Bartolomeo, R.Gatto and G.Nardulli, preprint UGVA-DPT 1993/07-824 (to appear in Phys.Lett.B)

[8] J.P.Silva and L.Wolfenstein, preprint Carnegie Mellon, September 1993.

[9] Particle Data Group, Review of Particle Properties, Phys.Rev.D45 (1992).
This figure "fig1-1.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig2-1.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig3-1.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig1-2.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig2-2.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig3-2.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig1-3.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1
This figure "fig1-4.png" is available in "png" format from:

http://arxiv.org/ps/hep-ph/9310326v1