CP violation in $B \to \phi K_S$ decay at large $\tan \beta$

Seungwon Baek

School of Physics, KIAS, 207-43 Cheongryangri-dong, Seoul 130-722, Korea

(Dated: October 31, 2018)

Abstract

We consider the chargino contribution to the CP violation in $B \to \phi K_S$ decay in the minimal supersymmetric standard model at large $\tan \beta$. It is shown that the Wilson coefficient $C_{8g}$ of the chromomagnetic penguin operator can be significantly enhanced by the chargino-mediated diagrams while satisfying other direct/indirect experimental constraints. The enhanced $C_{8g}$ allows large deviation in the CP asymmetry from the standard model prediction, especially it can explain the apparent anomaly reported by BaBar and Belle.
The measurement of CP asymmetries at B-factories is a powerful probe of new physics (NP). In the standard model (SM), the origin of CP violation is the phase $\delta_{\text{CKM}}$ in the $3 \times 3$ Cabibbo-Kobayashi-Maskawa (CKM) matrix of quark mixing. In general, there can be many new sources of CP violation in new physics models beyond the SM.

The time-dependent CP asymmetry in the neutral $B$ decays to CP eigenstates $B \to f_{\text{CP}}$ gives information on the two classes of CP violation $C_f$ and $S_f$ [1]:

$$A_{\text{CP}}(t) = \frac{\Gamma(B(t) \to f_{\text{CP}}) - \Gamma(B(t) \to f_{\text{CP}})}{\Gamma(B(t) \to f_{\text{CP}}) + \Gamma(B(t) \to f_{\text{CP}})} = -C_f \cos(\Delta m_B t) + S_f \sin(\Delta m_B t), \tag{1}$$

where $\Delta m_B$ is the mass difference of the $B$ system and $B(\bar{B})(t)$ is the state at time $t$ which was $B(\bar{B})$ at $t = 0$. The CP asymmetries $C_f$ and $S_f$ are determined by

$$\lambda_{\text{CP}} \equiv e^{-2i(\beta + \theta_d)} \frac{\bar{A}}{A}, \tag{2}$$

where $\beta(\theta_d)$ is the contribution of SM (NP) to the phase in the $B - \bar{B}$ mixing and $\bar{A}(A)$ is the decay amplitude for $B(\bar{B}) \to f_{\text{CP}}$.

The time-dependent CP asymmetry in $B \to J/\psi K$ decay measured at BaBar [2] and Belle [3] shows the existence of CP violation in the $B$-meson system, and the current world average [1]

$$\sin 2\beta_{J/\psi K_S} \equiv S_{J/\psi K_S} = 0.734 \pm 0.054. \tag{3}$$

is fully consistent with the CKM picture of CP violation of the SM. In the SM, the CP asymmetry in $B \to \phi K_S$ also measures the same angle angle $\beta$ because the CP violation in the decay amplitude is suppressed by the Cabibbo angle $\lambda (\approx 0.22)$: $S_{\phi K_S} = S_{J/\psi K_S} + \mathcal{O}(\lambda^2)$.

Recently, BaBar [4] and Belle [5] have announced the first measurement of time-dependent CP asymmetries in $B \to \phi K_S$. The weighted average of the mixing-induced CP asymmetry

$$\sin 2\beta_{\phi K_S} \equiv S_{\phi K_S} = -0.39 \pm 0.41 \tag{4}$$

differs from the SM prediction of (3) by $2.7\sigma$. The Belle collaboration has also reported the direct CP asymmetry

$$C_{\phi K} = 0.56 \pm 0.43, \tag{5}$$

which is consistent with zero as predicted in the SM.
Contrary to the $B \to J/\psi K_S$ decay where $A/A = 1$ to a good approximation even in the presence of NP, the loop-induced process $B \to \phi K_S$ generally allows large deviation from 1 in phase and modulus of $\overline{A}/A$. There are already many works which explain the apparent deviation (4) in various NP models [6–10].

The measured sin 2$\beta$’s from $B \to \eta' K_S$, $B \to (K^+K^-)K_S$ [5] and sin 2$\alpha$ from $B \to \pi^+\pi^-$ [11] are consistent with the SM although the errors are large. We note that, however, $B \to \phi K_S$ is unique in that it doesn’t have the tree-level amplitude in the SM unlike most other $B$-decays. Therefore, it is not unlikely that the NP manifests itself only in the $B \to \phi K_S$ decay [12].

The minimal supersymmetric(SUSY) standard model (MSSM) has many new CP violating phases besides the CKM phase of the SM. With CP violating phases of order one the electric dipole moments (EDMs) easily exceed the experimental upper bounds by several orders of magnitude. In addition, the general structure of the sfermion mass matrices in the generation space leads unacceptable flavor changing neutral currents (FCNC) by gluino mediation. These SUSY CP and SUSY FCNC problems strongly constrain the MSSM parameters.

In the MSSM, it has been shown that (4) can be accommodated if there exist new flavor structures in the up- or down-type squark mass matrices [6, 10, 13]. In this paper, we will show that the chargino contribution can generate large deviation in $S_\phi K$ at large $\tan \beta$, even if CKM is the only source of flavor mixing.

Specifically, we adopt a decoupling scenario where the masses of the first two generation scalar fermions are very heavy ($\gtrsim \mathcal{O}(10 \, \text{TeV})$), so that the SUSY FCNC and SUSY CP problems are solved without a naturalness problem [14]. We also assume the flavor-changing off-diagonal elements of scalar fermions are vanishing to guarantee the absence of the gluino mediated FCNC. In this case the CKM matrix is the only source of flavor mixing, while there are new CP violating parameters $\mu, M_2$ in the chargino matrix

$$M_C = \begin{pmatrix} M_2 & \sqrt{2}m_W \sin \beta \\ \sqrt{2}m_W \cos \beta & \mu \end{pmatrix}$$

and $A_t$ in the scalar top mass-squared matrix

$$M^2_t = \begin{pmatrix} m^2_Q + m_t^2 + D_L & m_t(A_t^* - \mu \cot \beta) \\ m_t(A_t - \mu^* \cot \beta) & m_t^2 + D_R \end{pmatrix},$$

3
where \( D_L = (1/2 - 2/3 \sin^2 \theta_W) \cos 2\beta m_Z^2 \) and \( D_R = 2/3 \sin^2 \theta_W \cos 2\beta m_Z^2 \).

In this decoupling scenario, it has been shown that the light stop and chargino contributions still allows large direct CP asymmetry in the radiative \( B \) decay up to \( \pm 16\% \) [15]. It should be noted that the new contribution to \( B - B \) mixing is very small and this model is naturally consistent with (3) [15].

The decay \( B \to \phi K_S \) is described by the \( \Delta B = 1 \) effective Hamiltonian [16]. The chargino contribution to the Wilson coefficients of QCD penguin operator is given by

\[
C_{3}^{\chi_\pm} = -\frac{\alpha_s}{12\pi} \sum_{I,k=1}^{2} \frac{m_W^2}{m_{\chi_\pm}^2} (\chi_I^L)^{*}_{k2}(\chi_I^L)_{k3} P_2(x_{Ik}),
\]

(8)

where \( x_{tH} = m_t^2/m_{H^\pm}^2, \) \( x_{Ik} = m_{\chi_I^L}^2/m_{\chi_k^L}^2 \) and \( P_2(x) \) is the loop-function [12]. \( (\chi_I^L(R))_{kq} \) is the stop(\( k \))–chargino(\( I \))–down-quark(\( q_L(R) \)) coupling:

\[
(\chi_I^L)_{kq} = -V_{11}^* S_{\tau_k \tau_L} + V_{12}^* S_{\tau_k \tau_R} \frac{m_t}{\sqrt{2}m_W \sin \beta},
\]

\[
(\chi_I^R)_{kq} = U_{12} S_{\tau_k \tau_L} \frac{m_q}{\sqrt{2}m_W \cos \beta},
\]

(9)

where \( U, V \) (\( S \)) diagonalize(s) the chargino (stop) mass mass matrix. The other Wilson coefficients of QCD penguin operators are simply related to \( C_3 \) by \( C_5 = C_3, C_4 = C_6 = -3C_3, \) where we have neglected the box diagram contributions which are suppressed by \( \lambda \). In the analysis we decouple the charged Higgs contribution by assuming \( m_{H^\pm} = 1 \) TeV. The effect of \( H^\pm \) will be mentioned below. The expressions for the Wilson coefficients of magnetic operators \( C_{7,89}^{\chi_\pm} \) can be found, for example, in [12, 17].

We note that the \( C_{7,89}^{\chi_\pm} \) has the enhancement factors \( m_{\chi_I^L}^2/m_b \) by the chirality flip inside the loop and can dominate the SM contribution. On the other hand the \( C_{3,\ldots,6}^{\chi_\pm} \) preserve the chirality and don’t have such enhancement factors. In addition, due to the super-GIM mechanism, the chargino contribution to \( C_{3,\ldots,6} \) are much smaller than the SM values. The contribution to chirality flipped operators \( C_{7,89}^{\chi_\pm} \) are suppressed by \( m_s/m_b \). We neglect the contribution of electroweak penguin operators which are also expected to be negligible in our scenario. Therefore the large deviation in \( \overline{A}/A \) should be generated solely by \( C_{89} \) in this scenario.

To calculate the hadronic matrix elements we use the QCD factorization method in ref. [16]. In this approach it has been demonstrated that the strong phases of QCD penguin operators cancel out in the SM [7]. Since the NP contribution to \( C_{3,\ldots,6} \) are negligible in our scenario,
the strong phase is small as in the SM. The required \( C_{8g}^\pm(m_b) \) \((C_{8g}^{SM}(m_b) \approx -0.147)\) for large deviation of CP asymmetries can be estimated from the approximate numerical expression for \( \overline{A} \) [7, 16]:

\[
\overline{A} \propto \sum_{p=u,c} V_{ps}^* V_{pb}(a_3 + a_4^p + a_5) \\
\approx -3.9 \times 10^{-4}(3.7e^{0.21i} + 4.5C_{8g}).
\] (10)

In Fig. 1, we show \( S_{\phi K} \) as a function of \( \arg(C_{8g}) \) for \(|C_{8g}| = 0.33\), 0.65 and 1.0. From this figure, we can see \(|C_{8g}| \approx 0.33 - 0.65\) with large positive phase can accommodate the deviation within 1σ.

Since the chargino contributions to \( C_{7\gamma} \) and \( C_{8g} \) have similar structures, one can think that large deviation in \( C_{8g} \) may result in the large deviation \( C_{7\gamma} \). Too large deviation in \( C_{7\gamma} \) will violate the measurement of \( B(B \to X_s\gamma) \), for which we take \( 2 \times 10^{-4} < B(B \to X_s\gamma) < 4.5 \times 10^{-4} \) [18], because it is already consistent with the SM prediction.

Due to the different loop functions, however, the two Wilson coefficients are not strongly correlated, and it is possible to have large deviation in \( C_{8g} \) while keeping \(|C_{7\gamma}|\) constrained to satisfy \( B(B \to X_s\gamma) \). Since \( \chi^R \) in (9) is proportional to \( \tan \beta \) for large \( \tan \beta \), we need relatively large \( \tan \beta \) to have sizable effects.

The neutral Higgs boson \( h^0 \) which is lighter than the \( Z \)-boson at tree level has large radiative corrections [19] which can be approximated at large \( \tan \beta \) as

\[
m_{h^0}^2 \approx m_Z^2 + \frac{3}{2}\frac{m_t^4}{v^2} \log \left( \frac{m_{t_1}m_{t_2}}{m_t^2} \right),
\] (11)
where \( v \approx 246 \text{ GeV} \). LEP II sets the lower limit on the SM-like Higgs boson mass: \( m_{h^0} \gtrsim 114.3 \text{ (GeV)} \) at 95% CL [20]. This limit gives very strong constraint on the stop masses.

At large \( \tan \beta(\sim \mathcal{O}(50)) \), the SUSY QCD and SUSY electroweak correction to the non-holomorphic couplings \( H_u^* D^c Q \) become very important. This gives large correction on the down-type quark masses and some CKM matrix elements [21]

\[
m_b = \frac{m_b}{1 + \tilde{\epsilon}_3 \tan \beta}, \quad V_{IJ} = V_{IJ}^{\text{eff}} \left[ \frac{1 + \tilde{\epsilon}_3 \tan \beta}{1 + \epsilon_0 \tan \beta} \right]
\]

where \( \tilde{\epsilon}_3 \approx \epsilon_0 + \epsilon_Y y_t^2 \) and \( (IJ) = (13)(23)(31)(32) \). \( m_b, V_{IJ}^{\text{eff}} \) are \( b \)-quark mass and CKM elements measured at experiments, respectively. At one-loop and \( SU(2)_L \times U(1)_Y \) symmetric limit, the \( \epsilon_0 \) and \( \epsilon_Y \) are given by

\[
\epsilon_0 = \frac{2\alpha_s}{3\pi} \text{Re} \left( \frac{\mu^*}{m_{\tilde{g}}} \right) j(y_{\tilde{b}\tilde{g}}, y_{\tilde{Q}\tilde{g}}),
\]

\[
\epsilon_Y = \frac{1}{16\pi^2} \text{Re} \left( \frac{A_{\mu}}{\mu} \right) j(y_{\tilde{Q}\mu}, y_{\tilde{t}\mu}),
\]

where \( y_{\tilde{b}\tilde{g}} = m_{\tilde{b}}^2/|m_{\tilde{g}}|^2, y_{\tilde{Q}\tilde{g}} = m_{\tilde{Q}}^2/|m_{\tilde{g}}|^2, y_{\tilde{Q}\mu} = m_{\tilde{Q}}^2/|\mu|^2, y_{\tilde{t}\mu} = m_{\tilde{t}}^2/|\mu|^2 \). The loop-function is given by \( j(x, y) = (j(x) - j(y))/(x - y) \) with \( j(x) = x \log x/(x - 1) \). Note that these SUSY threshold corrections are not easily decoupled even for very heavy superparticles.

For the numerical analysis we fix the CKM matrix by using \( |V_{us}| = 0.2196, |V_{cb}| = 4.12 \times 10^{-2} \) and \( |V_{ub}| = 3.6 \times 10^{-3} \) [20], leaving only \( \delta_{\text{CKM}} \) as free parameter. For example, for \( \delta_{\text{CKM}} = \pi/3 \), we get \( \Delta m_{B_d} = 0.491 \text{ ps}^{-1} \) and \( \sin 2\beta = 0.729 \), which are close to the experimental central values [20]. The free SUSY parameters in our scenario are \( \tan \beta, M_2, \)
FIG. 3: Correlation between $C_{\phi K}$ and $S_{\phi K}$ for $\tan \beta = 60$.

$\mu$, $m_{\tilde{Q}}$, $m_{\tilde{t}}$ and $A_t$ ($m_{H^\pm} = 1$ TeV) (also $m_{\tilde{g}}, m_{\tilde{b}}$ are relevant for large $\tan \beta$). In Fig. 2, we show the distribution of $C_{s_\phi}$ in the complex plane for $\delta_{\text{CKM}} = \pi/3$, $\tan \beta = 35(60)$, $m_{H^\pm} = 1$ TeV, $m_{\tilde{Q}} = 0.5$ TeV, $m_{\tilde{g}} = 1$ TeV, and $m_{b_R} = 0.5$ TeV. We scanned the other parameters as follows:

$$0 < m_{\tilde{t}} < 1 \text{ TeV}, \quad 0 < |\mu| < 1 \text{ TeV},$$

$$0 < |A_t| < 2 \text{ TeV}, \quad 0 < |M_2| < 1 \text{ TeV},$$

$$-\pi < \arg(\mu), \arg(A_t), \arg(M_2) < \pi.$$ (14)

We have fixed the phase on the gluino mass parameter such that $\arg(m_{\tilde{g}}) + \arg(\mu) = \pi$ to maximize the SUSY QCD correction. When scanning, we imposed the $B(B \rightarrow X_s \gamma)$ constraint and the direct search bounds on the (s)particle masses [20]: $m_{h^0} \geq 114.3$ GeV and $m_{\tilde{\chi}^\pm_1}, m_{\tilde{t}_1} \gtrsim 100$ GeV.

From Fig. 2, we can see that our scenario can easily accommodate the discrepancy (4). As mentioned above, we have chosen large value for the charged Higgs mass $m_{H^\pm} = 1$ TeV to safely suppress the Barr-Zee type two-loop EDM constraints which are significant if $\tan \beta$ [22] is large and the pseudo-scalar Higgs boson ($A^0$) is relatively light $^1$. We have checked that for the smaller $m_{H^\pm}$ the larger deviation in $S_{\phi K}$ is possible due to the cancellation in the real part with the chargino contribution [12]. Therefore Fig. 2 is a rather conservative result for $S_{\phi K}$. We have checked that the allowed range for $S_{\phi K}$ is not sensitive to the change in

$^1$ The SUSY contribution to $(g - 2)_\mu$ is also small in this case. [23].
If we impose the constraint (3), $\delta_{\text{CKM}}$ is correlated with $S_{\phi K}$. In Fig 3, the correlation is shown for $\tan \beta = 60$. We can see that it can also accommodate (5) although it favors small negative $C_{\phi K}$, which will be clarified by future experiments.

The direct CP asymmetry in $B \to X_s \gamma$ decay is also expected to be large when $S_{\phi K}$ has large deviation from the SM expectations. We have checked that actually it can be very large but it is not correlated with $S_{\phi K}$. It is because $S_{\phi K}$ is determined by the complex phase on $C_{8g}$ while $A_{CP}(B \to X_s \gamma)$ is mainly controlled by that on $C_{7g}$ [24]. Because we have phase on three independent parameters $\mu$, $A_t$ and $M_2$, the phases of $C_{7g}$ and $C_{8g}$ need not have strong correlations.

The $B(B \to \phi K)$ varies moderately over the parameter space we considered and seldom exceeds $15 \times 10^{-6}$, which is acceptable compared with the experimental measurements [4, 5]. Also the mass difference $\Delta m_s$ in the $B_s - B_s$ system is close to the SM expectation $\Delta m_s \sim 14.5$ ps$^{-1}$ in the most region of parameter space we considered, which may distinguish our scenario from other scenarios in refs. [10, 13].

For large $\tan \beta$ in the MSSM, through the Higgs-mediated FCNC the $B(B_s \to \mu^+\mu^-)$ can be enhanced by a few orders of magnitude over the SM prediction [25]. Observation of this leptonic decay mode, for example at Tevatron Run II, would be clear signal of NP. However, this is possible only for relatively light $A^0$. Since the large deviation in the $S_{\phi K}$, although it needs new CP violating phase(s) of $O(1)$, does not necessarily require light $A^0$ as we have shown, these two decay modes can be complementary to each other in searching for the MSSM at large $\tan \beta$.

In our scenario the sole source of large deviation in $S_{\phi K}$ is $C_{8g}$. It can have simultaneous effects on other decays such as $B \to \phi \phi$, $B \to \pi \pi$, $B \to K \pi$, etc [12].

In conclusion we have considered the chargino contribution to the CP asymmetries $S_{\phi K}$ and $C_{\phi K}$ of $B \to \phi K_S$ decay in the CP violating MSSM scenario at large $\tan \beta$. We have shown that through the enhanced Wilson coefficient $C_{8g}$ of chromo-magnetic penguin operator by the large SUSY threshold corrections [21], there can be large deviations in the CP asymmetries.
Acknowledgments

The author would like to thank S. Y. Choi for invaluable comments and carefully reading the manuscript and E. J. Chun and K. Y. Lee for useful discussions.

[1] Y. Nir, hep-ph/0208080.
[2] B. Aubert et al. [BABAR Collaboration], Phys. Rev. Lett. 87, 091801 (2001) [hep-ex/0107013]; B. Aubert et al. [BABAR Collaboration], Phys. Rev. Lett. 89, 201802 (2002) [hep-ex/0207042].
[3] K. Abe et al. [Belle Collaboration], Phys. Rev. Lett. 87, 091802 (2001) [hep-ex/0107061]; T. Higuchi [Belle Collaboration], hep-ex/0205020.
[4] B. Aubert et al. [BABAR Collaboration], hep-ex/0207070.
[5] K. Abe et al. [Belle Collaboration], hep-ex/0207098.
[6] G. Hiller, Phys. Rev. D 66, 071502 (2002) [hep-ph/0207356].
[7] M. Ciuchini and L. Silvestrini, Phys. Rev. Lett. 89, 231802 (2002) [hep-ph/0208087];
[8] A. Datta, Phys. Rev. D 66, 071702 (2002) [hep-ph/0208016]; B. Dutta, C. S. Kim and S. Oh, Phys. Rev. Lett. 90, 011801 (2003) [hep-ph/0208226].
[9] M. Raidal, Phys. Rev. Lett. 89, 231803 (2002) [hep-ph/0208091]; J. P. Lee and K. Y. Lee, hep-ph/0209290.
[10] S. Khalil and E. Kou, hep-ph/0212023; G. L. Kane, P. Ko, H. b. Wang, C. Kolda, J. H. Park and L. T. Wang, hep-ph/0212092; R. Harnik, D. T. Larson, H. Murayama and A. Pierce, hep-ph/0212180; M. Ciuchini, E. Franco, A. Masiero and L. Silvestrini, hep-ph/0212397.
[11] K. Abe [Belle Collaboration], arXiv:hep-ex/0301032.
[12] S. Baek, work in progress.
[13] T. Moroi, Phys. Lett. B 493, 366 (2000) [hep-ph/0007328]; E. Lunghi and D. Wyler, Phys. Lett. B 521, 320 (2001) [hep-ph/0109149].
[14] See, for example, A. G. Cohen, D. B. Kaplan and A. E. Nelson, Phys. Lett. B 388, 588 (1996) [arXiv:hep-ph/9607394].
[15] S. Baek and P. Ko, Phys. Rev. Lett. 83, 488 (1999) [hep-ph/9812229]; S. Baek and P. Ko, Phys. Lett. B 462, 95 (1999) [hep-ph/9904283].
[16] M. Beneke, G. Buchalla, M. Neubert and C. T. Sachrajda, Nucl. Phys. B 606, 245 (2001)
[hep-ph/0104110].

[17] N. Oshimo, Nucl. Phys. B 404, 20 (1993); R. Barbieri and G. F. Giudice, Phys. Lett. B 309, 86 (1993) [hep-ph/9303270]; P. L. Cho, M. Misiak and D. Wyler, Phys. Rev. D 54, 3329 (1996) [hep-ph/9601360].

[18] S. Chen et al. [CLEO Collaboration], Phys. Rev. Lett. 87, 251807 (2001) [arXiv:hep-ex/0108032].

[19] Y. Okada, M. Yamaguchi and T. Yanagida, Prog. Theor. Phys. 85, 1 (1991).

[20] K. Hagiwara et al. [Particle Data Group Collaboration], Phys. Rev. D 66, 010001 (2002).

[21] L. J. Hall, R. Rattazzi and U. Sarid, Phys. Rev. D 50, 7048 (1994) [hep-ph/9306309]; T. Blazek, S. Raby and S. Pokorski, Phys. Rev. D 52, 4151 (1995) [hep-ph/9504364].

[22] D. Chang, W. Y. Keung and A. Pilaftsis, Phys. Rev. Lett. 82, 900 (1999) [Erratum-ibid. 83, 3972 (1999)] [hep-ph/9811202].

[23] A. Arhrib and S. Baek, Phys. Rev. D 65, 075002 (2002) [hep-ph/0104225]; G. C. Cho, N. Haba and J. Hisano, Phys. Lett. B 529, 117 (2002) [arXiv:hep-ph/0112163]; S. Baek, P. Ko and J. H. Park, Eur. Phys. J. C 24, 613 (2002) [arXiv:hep-ph/0203251].

[24] A. L. Kagan and M. Neubert, Phys. Rev. D 58, 094012 (1998) [hep-ph/9803368].

[25] K. S. Babu and C. F. Kolda, Phys. Rev. Lett. 84, 228 (2000) [hep-ph/9909476]; C. S. Huang, W. Liao, Q. S. Yan and S. H. Zhu, Phys. Rev. D 63, 114021 (2001) [Erratum-ibid. D 64, 059902 (2001)] [hep-ph/0006250]; P. H. Chankowski and L. Slawianowska, Phys. Rev. D 63, 054012 (2001) [hep-ph/0008046]; A. Dedes, H. K. Dreiner and U. Nierste, Phys. Rev. Lett. 87, 251804 (2001) [hep-ph/0108037]; R. Arnowitt, B. Dutta, T. Kamon and M. Tanaka, Phys. Lett. B 538, 121 (2002) [hep-ph/0203069]. C. Bobeth, T. Ewerth, F. Kruger and J. Urban, Phys. Rev. D 66, 074021 (2002) [hep-ph/0204225]. S. Baek, P. Ko and W. Y. Song, Phys. Rev. Lett. 89, 271801 (2002) [hep-ph/0205259]; J. K. Mizukoshi, X. Tata and Y. Wang, Phys. Rev. D 66, 115003 (2002) [hep-ph/0208078]. S. Baek, P. Ko and W. Y. Song, hep-ph/0208112; T. Ibrahim and P. Nath, (to appear in PRD) hep-ph/0208142; G. Isidori and A. Retico, JHEP 0209, 063 (2002) [hep-ph/0208159]; A. Dedes and A. Pilaftsis, Phys. Rev. D 67, 015012 (2003) [hep-ph/0209306]; S. Baek, P. Ko and W. Y. Song, hep-ph/0210373; A. J. Buras, P. H. Chankowski, J. Rosiek and L. Slawianowska, hep-ph/0210145.