Phenomenological Consequences of Right-handed Down Squark Mixings

Chun-Khiang Chua and Wei-Shu Hou
Department of Physics, National Taiwan University, Taipei 10764, R.O.C.

The mixings of $d_5$ quarks, hidden from view in Standard Model (SM), are naturally the largest if one has an Abelian flavor symmetry. With supersymmetry (SUSY) their effects can surface via $d_R$ squark loops. Squark and gluino masses are at TeV scale, but they can still induce effects comparable to SM in $B_d$ (or $B_s$) mixings, while $D^0$ mixing could be close to recent hints from data. In general, $CP$ phases would be different from SM, as may be indicated by recent B Factory data. Presence of non-standard soft SUSY breakings with large tan $\beta$ could enhance $b \rightarrow d\gamma$ (or $s\gamma$) transitions.

PACS numbers: 12.60.Jv, 11.30.Hv, 11.30.Er, 13.25.Hw

With the impressive advent of B Factories, we are entering a new episode of flavor and $CP$ violation studies. Charmless rare $B$ decays hint that $\phi_3 \equiv \arg V_{ub}^\ast$ (PDG phase convention [3]) may be larger than $0^\circ$ suggested by a CKM unitarity fit [3]. First results from both B Factories [3] give smaller sin$2\phi_1$ (or sin$2\beta, \phi_1 \equiv \beta \equiv \arg V_{td}^\ast$) values than “expected” [3]. A plausible picture is that $B_d$ or $B_s$ mixings have additional new physics sources which invalidate $\Delta m_{ub}/\Delta m_{cb}$ constraint, a notion that can be further probed at B Factories, or at the Tevatron collider starting next year. There are also recent hints [3] for $D^0$ mixing, which, if one has a strong phase difference $\arg \delta$ between $D^0 \rightarrow K^+\pi^-$ and $K^-\pi^+$ amplitudes, can again be taken as hinting at new physics. In this Letter we study a generic flavor violation scenario whereby $B_d$ (or $B_s$) and $D^0$ mixings, as well as $b \rightarrow d\gamma$ (or $s\gamma$) transitions, could be measurably affected.

New physics in the flavor sector is likely since little is understood. For example, fermion masses and mixings exhibit an intriguing hierarchical pattern in powers of $\lambda \equiv |V_{us}|$. It suggests a possible underlying symmetry, the breaking of which gives an expansion in $\alpha \sim (S)/M$, with $S$ a scalar field and $M$ a high scale. This “horizontal” (in flavor space) symmetry is Abelian, the commuting nature of horizontal charges in general gives $M_{ij}M_{ji} \sim M_{ii}M_{jj}$ ($i, j$ not summed), hence [3]

$$\frac{M_u}{m_t} \sim \begin{bmatrix} \lambda^7 & \lambda^5 & \lambda^3 \\ \lambda^6 & \lambda^4 & \lambda^2 \\ \lambda^4 & \lambda^2 & 1 \end{bmatrix}, \quad \frac{M_d}{m_b} \sim \begin{bmatrix} \lambda^4 & \lambda^3 & \lambda^2 \\ \lambda^3 & \lambda^2 & \lambda \\ \lambda & 1 & 1 \end{bmatrix}. \quad (1)$$

The diagonal elements correspond to quark masses while the upper right (lower left) parts are diagonalized by $U_{QL}$ ($U_{QR}$) rotations. We note that $M_{d5}^2/m_b$ and $M_{d3}^2/m_b$ are the most prominent off-diagonal elements [3]. Thus, $B_d$ and $B_s$ mixings are naturally susceptible to new physics arising from the right-handed down flavor sector.

As a leading candidate for physics beyond SM, SUSY offers a large toolbox for phenomenology. For example, squark mixings could generate flavor changing neutral currents (FCNC) because of strong $\tilde{g}-\tilde{g}$ coupling. It is customary to take squarks as almost degenerate at scale $\tilde{m}$, and the squark mixing angle in quark mass basis is

$$\delta_{q_i AB}^{ij} \equiv \left[ U_A^\dagger (\tilde{M}_d^2)_{AB} U_{qB} \right]^{ij}/\tilde{m}^2, \quad (2)$$

where $A, B = L, R$, $i, j$ are generation indices and $\tilde{M}_d^2$ squark mass matrices. As $U_{QL}$ is constrained by the CKM matrix $V$, mixing angles in $U_{qR}$ are in general larger. If the breakings of flavor symmetry and SUSY are not closely related, then $(\tilde{M}_d^2)_{LR}$ and $(\tilde{M}_d^2)_{RL} = (\tilde{M}_d^2)_{LR}^{\ast}$ are roughly proportional to respective quark mass matrices, hence their effects are suppressed by $m_q/\tilde{m}$. From Eq. (1), one easily gets $(\tilde{M}_d^2)_{LR}/\tilde{m}^2 \sim \lambda$, while

$$\langle \tilde{M}_d^2 \rangle_{RR} \sim \tilde{m}^2 \begin{bmatrix} 1 & \lambda & \lambda \\ \lambda & 1 & 1 \\ \lambda & 1 & 1 \end{bmatrix}, \quad (3)$$

illustrating that the $RR$ sector could contribute significantly to $B_d$ and $B_s$ mixings via $\delta_{q_i}^{23} \sim \lambda$ and $\delta_{q_i}^{22} \sim 1$.

Defining $x \equiv m_3^2/\tilde{m}^2$, one has the effective Hamiltonian $H_{RR} = -(\alpha^2/216\tilde{m}^2)(C_1\tilde{O}_1 + C_1\tilde{O}_1 + C_4\tilde{O}_4 + C_5\tilde{O}_5)$ induced by gluino-squark box diagrams, where $O_1 = |d_{iL}^\dagger \tilde{\nu}_L b_{L}^\dagger \tilde{\nu}_L b_{L}|, O_{4(5)} = |d_{iR}^\dagger \tilde{\nu}_L b_{L}^\dagger \tilde{\nu}_L b_{R}|$, and [3]

$$C_1 = \left[ \frac{24}{3} x f_{e6}(x) + 66 f_{e6}(x) \right] (\delta_{LL}^3)^2,$nC_{4(5)} \equiv \left( \frac{504}{24} \right) x f_{e6}(x) - 72(\tilde{f}_{e6}(x)) \tilde{m}_L^2 \tilde{m}_R^3, \quad (4)$$

with $\tilde{C}_1\tilde{O}_1$ obtained from $C_1\tilde{O}_1$ by $L \rightarrow R$. Chargino and neutralino box diagram contributions are incorporated but numerically unimportant. Taking into account QCD running [3], it is easy to evaluate the $B$ mixing parameter $M_B^{\tilde{B}} \equiv |M_{12}^\tilde{B}| \sim |M_{12}^\tilde{B}| e^{2i\phi_{B}} = |M_{12}^{SM}| e^{2i\phi_{B}} + |M_{12}^{SUSY}| e^{i\phi_{B}}$.

With $|V_{ub}| = 0.41|V_{cb}|, \phi_{B} = 65^\circ, 85^\circ$, we get $|\delta_{q_i}^{23}| < 10^{-3} = 0.8, 9.2$ and $\Delta m_{SM}^{\tilde{B}} = 0.41, 0.55 \text{ps}^{-1}$, respectively, compared with $\Delta m_{exp}^{B_d} = 0.472 \pm 0.017 \text{ps}^{-1}$ [3]. Allowing $|M_{12}^{SUSY}|$ to be at most of similar size, we find that $m_{\tilde{q}} \sim \tilde{m}$, $m_{\tilde{g}}$ cannot be much lighter than 1.5 TeV. For illustration we plot, in Fig. 1(a) and (b), $\Delta m_{SM}^{\tilde{B}} \equiv 2|M_{12}^{\tilde{B}}|$ and $\sin 2\phi_{B}$ vs. $\phi \equiv \arg \delta_{q_i}^{23}$, respectively, for $\tan \beta = 2$ and $|\mu| < m_{\tilde{g}}$. We see that $\sin 2\phi_{B}$ as measured from $B_d \rightarrow J/\psi K_S$ can range from 0.3 to 1, as compared to
The CKM unitarity bound from $\Delta m_{B_s}$ corresponds to
zero when compared to BaBar and Belle central values [4].

Be relaxed, and the potential conflict on $\tilde{\phi}$ phases, except being clouded by hadronic uncertainties.

There is little impact on penguins, and charmless $B$ decays [8]. By using two (or more) singlet fields $S_i$ to break the $U(1)\times U(1)$ (or higher) Abelian horizontal symmetry, and making use of the holomorphy nature of the superpotential in SUSY models, one can have $M_{d_{12,21}} = 0$ which implies $U_{d_{LL,RR}}^3 = 0$ (or highly suppressed), and likewise $(\tilde{M}_3^2)_{d_{LL,RR}}$ are also suppressed. Thus, $\delta_{d_{LL,RR}}^3$ can be suppressed and the kaon mixing constraint satisfied accordingly.

There is one subtlety arising from our choice of nonvanishing $M_{d_{13}}$. Since $M_{d_{13}}$ is diagonalized by bi-unitary transform, $M_{d_{13}}^2/m_b, M_{d_{13}}^2/m_b \sim \lambda^2, \lambda$ are absorbed by $U_{d_{LL}}^3$, $U_{d_{RR}}^3 \sim \lambda^2, \lambda$, respectively. Imposing $M_{d_{12}}^2 = M_{d_{21}}^2 = 0$, one finds $U_{d_{RR}}^3 \sim \lambda$ is still needed to ensure $M_{d_{13}}^2 \equiv 0$. From Eq. (4) we see that $\delta_{d_{RR}}^2 \sim \lambda$ would again be generated, which is not acceptable. If we now set $M_{d_{13}}^2/m_b$ to zero but retain $M_{d_{13}}^2/m_b \sim 1$, one finds $U_{d_{LL}}^2 \sim \lambda^2$ is still needed, again leading to $U_{d_{RR}}^3 \sim \lambda$. Thus, to keep $(\tilde{M}_3^2)_{d_{LR}}/m_b^2 \sim \lambda$, we need to decouple $s$ flavor from other generations, i.e. $M_{d_{13}}^2$ and $M_{d_{23}}^2$ both set to zero, and we would have no new physics effects in $B_s$ mixing and $b \to s\gamma$ decays. Stringent $\Delta m_K$ and $\varepsilon_K$ constraints lead to 4 texture zeros in $M_d$. In the usual approach of quark-squark alignment, one drops $M_{d_{13}}^2$ and $M_{d_{23}}^2$ (hence $\delta_{d_{RR}}^{13}$ and $\delta_{d_{RR}}^{23}$) to satisfy $B_d$ mixing and $b \to s\gamma$ constraints, allowing for lower $m_{\tilde{q}}, m_{\tilde{g}}$ that can give collider and other signatures. In an earlier work we considered decoupling the $d$ flavor [13], which again has 4 texture zeros. We will return to a discussion of this case later.

A general consequence of quark-squark alignment [8] is worthy of note: $U_{d_{LL}}^{12} \simeq 0$ implies $U_{d_{LL}}^{12} \sim |V_{cd}| = \lambda$, which would generate $D^0 - \bar{D}^0$ mixing since $\delta_{d_{LL}}^3 \sim \lambda$, as one can see from Eq. (4). This is of interest since recent data hint at [1] the possible existence of $D^0$ mixing. The FOCUS experiment reports a $2.2\sigma$ deviation of the lifetime ratio of $D^0 \to K^-\pi^+$ vs. $K^-\pi^+$ from 1, while the CLEO experiment reports a 1.8$\sigma$ effect on $y'_D = y_D\cos\delta_D - x_D\sin\delta_D$ where $x_D \equiv \Delta m_D/\Gamma_D, y_D \equiv \Delta \Gamma_D/\Gamma_D$, and $\delta_D$ is the relative strong phase between $D^0 \to K^+\pi^-$ and $K^+\pi^+$ decay amplitudes. The two results can be better reconciled if $\delta_D \neq 0$. While it is certainly premature to conclude that one has nonvanishing $x_D$ (which would imply new physics), what we find intriguing is that $\delta_{d_{LL}}^3 \sim \lambda$ with $m_{\tilde{s}}, m_{\tilde{g}} \sim$ TeV brings $x_D$ right into the ballpark of present sensitivities! We illustrate $x_D$ vs. $\tilde{m}$ in Fig. 2 for several $m_{\tilde{g}}$ values $\gtrsim$ TeV.

The zeros reflect a possible cancellation between various terms in case the $\delta$'s have common phase. In practice this is unlikely, since the SUSY phases in $\delta_{d_{LL,RR}}^3$ are largely unconstrained, but it illustrates the adjustability of $x_D$. However, one has an explicit example where detectable $D^0$ mixing would likely carry a CP violating phase.

Having satisfied $\Delta m_K, \varepsilon_K$ by construction, one can still have interesting and measurable effects in $B_d$ and $D^0$ mixings even if SUSY breaking is at TeV scale. This is because of large $\delta_{d_{LR}}^2$ and $u_{LL} - c_{LL}$ mixings which follow from Abelian horizontal charges and low energy constraints. Unfortunately, the SUSY scale is so high such that there is practically no impact on penguins such as $c'/\varepsilon, b \to s\gamma$ and $b \to d\gamma$. One also has the depressing situation that the squarks and gluino cannot be produced at the Tevatron or LHC. While we cannot change the D's, we have evidence for physics beyond SM. One such effect is mixing dependent CP viola-

![FIG. 1. (a) $\Delta m_{B_s}$ and (b) $\sin 2\phi_{B_s}$ vs. $\phi \equiv \arg \delta_{d_{LL,RR}}^{13,23}$, including both SM and SUSY effects, for squark mass $\tilde{m} = 1.5$ TeV. The solid (short-dash), long-dash (dotted) curves correspond to $m_{\tilde{g}} = 1.5, 3$ TeV for $\phi_3 = 65^\circ (85^\circ)$, respectively. The horizontal lines in (a) indicate the 2$\sigma$ experimental range; theoretical error would allow larger $\sin 2\Phi_B$ range than shown.](image1)

![FIG. 2. $x_D$ vs. $\tilde{m}$. Dotted, solid, and dash curves are for $m_{\tilde{g}} = 0.8, 1.5$ and 3 TeV, respectively, for $\tan \beta = 2$.](image2)
tion in $b \to s\gamma$ or $d\gamma$ transitions \cite{14}. The effective Hamiltonian is given by $H_{\text{eff}} \propto m_d (C_7 R + C_8^\prime L) \sigma_{\mu\nu} F^{\mu\nu} b$. Mixing dependent $CP$ violation in $B^0 \to M^0\gamma$ decay is rather analogous to the golden $J/\psi K_S$ mode, i.e.

$$a_{M^0\gamma} = \xi \sin 2\theta \sin (2\phi(C_7) - \phi(C_7^\prime)) \sin \Delta m t$$

where $CP(M^0) = \xi M^0 B + \phi(C_7^\prime)$ is the phase of $C_7^\prime$, and $\sin 2\theta \equiv 2 |C_7 C_7^\prime| / (|C_7|^2 + |C_7^\prime|^2)$. One clearly needs both $C_7$ and $C_7^\prime$ for the interference to occur. In SM, however, $C_7^\prime/C_7 \propto m_d/s/m_b$ and is hence negligible. Thus, $a_{M^0\gamma}$ is sensitive to new physics \cite{14}.

At $\bar{m}$ SUSY the contribution is

$$C_{7,\bar{g}} = g_\gamma^2 Q_s \delta_{dLR} g_2(x) - \delta_{dRL} m_s \delta_{dRL} g_4(x) / G_F \bar{m}^2,$$

where $g_i(x) = -d_i / dx (x F_i(x))$ with $F_i(x)$ taken from \cite{15}. Exchanging $L \leftrightarrow R$ gives the correction to $C_7$, and QCD running can be taken from \cite{16}. The chiral or RL enhancement in Eq. (6) is apparent, noted already in our study \cite{12} of large $s\bar{b}$ mixings. It has also been invoked to generate $\epsilon'/\epsilon$ via an analogous $\delta_{LR}^\prime$ term \cite{17} under a horizontal U(2) (hence non-Abelian) symmetry model.

We see that large $\delta_{dLR}^\prime$ or $\delta_{dRL} m_s/m_b$ are needed, which is precisely our case with Abelian horizontal symmetry. The RL enhancement factor $m_s/m_b$ can compensate for quark mass suppression in $\langle M_d^{32} \rangle_{LR}$. Unfortunately, the high SUSY scale leads to too severe a suppression in $1/G_F \bar{m}^2$. We find, however, that large $a_{M^0\gamma}$ is still possible when considering certain non-standard soft breaking terms \cite{18,19}. Allowing for a non-standard $C(H_u^\dagger Y'' D_L D_R^*)$ besides the standard $A_d(H_d Y' D_L D_R^*)$, it is natural that $A_d \sim C \sim m$, hence $\langle M_d^{32} \rangle_{LR} \sim m M_d^{ij}$, and one gains a $\tan \beta \equiv |H_u^\dagger / H_d|$ enhancement factor, while $\langle M_d^{ij} \rangle_{LR} \sim m M_d^{ij}$ is unaffected. Some zeros in $\langle M_2^{ij} \rangle_{LR}$ may be lifted since these C-terms are no longer holomorphirphic, but they are still suppressed. Arising from the superpotential, $M_d$, and hence $U_{QLR}$, is unchanged, so the result for $D^0$ mixing remains unchanged. The $\delta_{dRL}^\prime$ contribution to kaon mixing remains protected by the smallness of $M_2^{ij} / m$. Likewise, for $B_d$ mixing, $\tan \beta$ enhancement of $\delta_{dRL}^\prime$ is insufficient to overcome $m_s / m_b$ suppression and $\delta_{dRL}^\prime$ still dominates.

We illustrate in Fig. 3(a) and (b) the ratio $Br(B \to X_s\gamma)/Br(B \to X_d\gamma)_{\text{SM}}$ and sin2$\theta$ of Eq. (5) with respect to $\bar{m}$, for $m_\tilde{g} = 1.5$ TeV and $\tan \beta = 50, 20$ and 2 (this also illustrates the case of standard A-term only). The rate enhancement over SM can reach a factor of 5, 1.8 and few $\%$, respectively, hence $Br(B \to \rho \gamma)$ could reach $10^{-5}$ level, while sin2$\theta$ can easily reach maximum for large $\tan \beta$. We note that current limits on $B \to \rho \gamma$ are beginning \cite{20} to probe such levels, as the B Factories have demonstrated their $K/\pi$ (hence $K^*/\rho$) separation capabilities, and data is accumulating fast. There is a further advantage in studying mixing dependent $CP$

- Asymmetries $a_{\rho,\gamma}$, $a_{\omega,\gamma}$: $\rho, \omega \to \pi^+ \pi^- (\pi^0)$ gives vertex information but not in $K^{*0} \to K^0\pi^0$ case, and one would have to go to modes such as $B^0 \to K^0\gamma$, where one is penalized by $K^0 0 \to 0 K^0$ branching ratios.

Our exotic “non-standard C-term”, together with large $d_{R-B_R}$ mixing (Eqs. (1) and (3)) and large $\tan \beta$ (motivated by large $m_t / m_b$ ratio), give an existence proof for possible prominence of $B \to \rho \gamma$, $\omega \gamma$ modes, both in rate and mixing dependent $CP$ asymmetries. They should be priority search and study items for the coming years. Taking a more liberal point of view, in principle one can have flavor violating soft SUSY breaking terms \cite{12} which could easily generate $\delta_{dRL,RL}^\prime$ without resorting to non-standard C-terms. Thus, $b \to d\gamma$ search provides a more general probe of flavor violation in SUSY.

We now entertain the case of decoupling $d$ flavor but keeping $M_d^{32} \sim 1$, which was studied in \cite{12} from a different perspective. From consideration of $\Delta m_{K,\epsilon_K}$ and $D^0$ mixing, the squarks and gluinos are again at Tevatron scale. But since $s_{R-B_R}$ mixing is large, there may be one squark that is lighter than the rest. Clearly, $B_s$ mixing can be easily enhanced hence the CKM unitarity constraint through $\Delta m_{B_s}/\Delta m_{B_d}$ again should be relaxed. Thus, a lower sin2$\theta_{B_s}$ than predicted by CKM fit is possible, while the $CP$ phase of $B_s$ mixing is likely nonvanishing, testable at the Tevatron soon. The model, however, is constrained by $b \to s\gamma$. Since $\delta_{dRL}^\prime \delta_{dRL}^\prime = \lambda \sim V_{td} / V_{ts}$ in SM, we can take Fig. 3 as a rough estimate for $b \to s\gamma$ in present case. Allowing for 20% rate uncertainty for the measured $\text{Br}(B \to X_s\gamma) = (3.15 \pm 0.54) \times 10^{-4}$, we see that for heavier $m_\tilde{g} \sim 3$ TeV case, $\tan \beta$ up to 20 is allowed, and sin2$\theta$ can go up to $\sim 0.5$, hence $a_{M^0\gamma}$ study should also be pursued. For lighter $m_\tilde{g}$ such as 1.5 TeV, the enhancement factor for large $\tan \beta$ starts to break the good agreement between SM and experiment, hence it seems one cannot have both large $\tan \beta$ and $\bar{m}$, $m_\tilde{g}$ too light (TeV or less). This should apply to the lightest squark in present case. One may alternatively say that, despite the stringent constraint of $b \to s\gamma$ rate, one can still have nontrivial mixing dependent $CP$ asymmetries.

We give explicit charge assignments for the main case studied. Two $S_2$ fields are used to break the horizontal symmetry, $\langle S_1 \rangle / M \sim \langle S_2 \rangle / M \sim \lambda^{0.5}$, where $\lambda = 0.18$ (to fit the smallness of $V_{ub}$ better). The horizontal charges are $(-1, 0)$ and $(0, -1)$ for $S_1$ and $S_2$, and...
for small tan β [tan β ∼ 50]. With these assignments, $M_u^{21}$, $M_u^{31}$ and $M_d^{21,12}$, $M_d^{23,32}$ vanish, and corresponding elements in $(M_d^2)^{12}_{RR}/m^2$ become $\sim \lambda^2_{12}[7]$ or $\lambda^1_{11}[6]$. The non-standard C-term restores the vanishing elements of $(M_d^2)^{13}_{RR}/m^2$ to some power, but they do not affect quark mass. Additional rotations may arise from the Kähler potential, which may lift the zeros to the so-called filled zeros $\mathbb{F}$. Their effect is small in this model. Detailed discussions will be given elsewhere.

Some remarks are in order. First, our numerics are only illustrative, since the δ’s can not be specified fully. Second, because of stringent $\Delta m_K$ and $\varepsilon_K$ constraints, $(\epsilon'/\varepsilon)^{3\text{SU(3)}}$ in this model is always very small. Third, the neutron edm is well protected by $m_q/m$ in the generic picture. However, with non-standard C-terms, one may need to restrict the phase of $M_d^{13}$ and $(M_d^2)^{11}_{LR}$ induced by $\mu$ to 0.1 when tan β is very large (such as 50). Four, direct CP asymmetries in $b \rightarrow d \gamma$ would get diluted rather than enhanced by SUSY, especially if $a_{\rho\gamma}$, $a_{\omega\gamma}$ are large. Five, for large tan β, the neutralino box diagram contribution to neutral meson mixings become important, especially if one takes a GUT motivated relation for gaugino masses, which also holds true in gauge-mediated SUSY breaking models. However, the qualitative features of Figs. 1 and 2 remain the same. Six, chargino loops involving light stop or chargino may give rise to very significant effects $\mathbb{F}$ for large tan β that may require fine tuning. To avoid this, $|\mu| \sim \text{TeV}$ scale is needed. As for stop, we have followed Ref. $\mathbb{F}$ with the tacit assumption that flavor and SUSY scale are not too far apart, hence the stop does not become too light by large accumulative renormalization group running and hence still satisfy Eq. (2). Finally, with high $m_q$ and $m_{\tilde{g}}$ scale but no tan β enhancement, SUSY induced radiative $c \rightarrow \gamma y$ is smaller than two-loop SM correction, while for $t \rightarrow c\gamma$ it enhances SM result of $\sim 10^{-13}$ by three orders.

In summary, $d_{LR}$ quark mixings are the largest in Abelian horizontal models. Such flavor (and CP) violation effects can be brought to light by $d_{LR}$ loop squarks. Stringent $K^0$ mixing and $\varepsilon_K$ constraints require setting $M_d^{12} = M_d^{21} = 0$. If we choose to retain $M_d^{31}/m_t \sim \lambda$, the s flavor has to be decoupled, and interestingly one does not have to face $b \rightarrow s \gamma$ constraint. Squarks and gluinos have to be at TeV scale, but they can shift $\sin 2\phi_1$ to the low value reported by B Factories. Quark-squark alignment induces $\tilde{u}_L - \tilde{c}_L$ mixing that can give D mixing close to recent hints from CLEO and FOCUS. Penguin related phenomena are in general untouched, but non-standard soft SUSY breaking C-terms could, through large tan β enhancement, bring $B \rightarrow \rho\gamma$, $\omega\gamma$ rates to $10^{-5}$ level, while mixing dependent CP asymmetries could be maximal. Similar effects can be induced by generic flavor violating soft SUSY breaking terms. If one keeps $M_d^{21}/m_b \sim 1$, then $d$ flavor has to be decoupled. $B_s$ mixing can be greatly enhanced with likely nonvanishing CP phase. One again could have measurable $D^0$ mixing, while the more constrained $b \rightarrow s\gamma$ transition could have mixing dependent CP asymmetries of order 50%. The new physics phenomenology outlined here can be tested at B Factories and the Tevatron in the next few years.

Acknowledgement. This work is supported in part by the National Science Council of R.O.C. under Grants NSC-89-2112-M-002-036 and NSC-89-2811-M-002-039.