Supersymmetric Right-Handed s-b Flavor Mixing: Implications of $\bar{B}^0 \to \phi K_S$ Anomaly for B Factories and Colliders

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Two recent experimental developments, when combined, may have far-reaching implications. $S_{\phi K_S} < 0$, if confirmed, would imply large s-b mixing, a new CP phase, and right-handed dynamics. Large Δm_{B_s} would be likely, making the B_s program at hadron machines difficult. Reconstruction of B vertex from K_S at B factories, as shown by BaBar's first measurement of $S_{K_S\pi^0}$, makes $S_{K_S\pi^0\gamma}$ in $\bar{B} \to \bar{K}^{*0}\gamma$ accessible. This would be a boon for B factory upgrades. Supersymmetric Abelian flavor symmetry, independently motivated, can realize all of this with a light $\widetilde{sb}_1$ squark. B factory and collider studies of flavor, CP and supersymmetry, may not be what we had expected.

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With the possible exception of neutrino physics, we have not seen physics beyond the standard model (SM) for 30 years. We seem resigned to have new physics (NP) appearing first only as minute deviations from SM predictions. Of course, at the CERN Large Hadron Collider (LHC) now under construction, we expect to discover supersymmetry (SUSY), the main contender for NP. But short of direct production, indirect effects of SUSY also tend to be relegated to "minute deviations."

With this backdrop, it is intriguing that the B factories have been reporting, for two consecutive years, a possible *large* deviation from the SM above the 2σ level. If this CP violation (CPV) effect is confirmed, it would not only have an impact on the evolution of B factories, the underlying new physics would likely have an impact on colliders as well.

Mixing dependent CPV in $\bar{B}^0 \to J/\psi K_S$ has been established since 2001 [1]. The current value is $\sin 2\Phi_{B_d} = 0.736 \pm 0.049$ [2] [$\Phi_{B_d} = \phi_1(\beta)$ in SM], which measures CPV in B^0-$\bar{B}^0$ mixing. The loop-induced ("penguin") $\bar{B}^0 \to \phi K_S$ process has also been studied. Because of the absence of CPV phases in the penguin loop, the SM predicts $S_{\phi K_S} \cong \sin 2\Phi_{B_d}$ to good accuracy. The current Belle and BaBar average, however, gives [2]

$$S_{\phi K_S} = -0.15 \pm 0.33, \qquad (-0.39 \pm 0.41 \text{ in } 2002) \quad (1)$$

and is still 2.7σ away from 0.74. Admittedly, there is some tension between Belle and BaBar results at the 2.1σ level. For Belle, the 2003 update [3] of $S_{\phi K_S} = -0.96 \pm 0.50^{+0.09}_{-0.11}$ is consistent with its 2002 [4] result, *and is* 3.5σ *away from* 0.74. For BaBar, the 2003 result [2] of $S_{\phi K_S} = 0.45 \pm 0.43 \pm 0.07$ shifted by more than 1σ from 2002 [5] and changed in sign.

Another year is needed for the issue to settle, but the new physics hint as exemplified by the negative central value of Eq. (1) may well be real, and the effect seems large. Such a large effect would require (i) large effective s-b mixing, (ii) a new CP phase, and (iii) right-handed interactions. The last point is needed to account for $S_{K_S\pi^0} = 0.48^{+0.38}_{-00.47} \pm 0.10 \sim \sin 2\Phi_{B_d} > 0$ given recently by BaBar [2], as we explain later.

In this Letter we point out that a preexisting class of models provide all these key ingredients in a natural way. Approximate Abelian flavor symmetry (AFS) [6] implies near maximal s_R-b_R mixing, but dynamics is still lacking. Combining SUSY and AFS (SAFS), one gets maximal $\tilde{s}_R$-$\tilde{b}_R$ squark mixing [7] with an associated CP phase σ [8], and right-handed *strong* $s_R\tilde{b}_R\tilde{g}$ coupling involving the gluino $\tilde{g}$. Low energy constraints push SUSY above the TeV scale, even after decoupling the d flavor. But large $\tilde{s}_R$-$\tilde{b}_R$ mixing can drive one squark (the $\widetilde{sb}_1$) light [8], thereby enhancing the effect in $b \leftrightarrow s$ processes. The upshot from Eq. (1) is a consistent picture of $m_{\widetilde{sb}_1} \approx 200$ GeV, $m_{\tilde{g}} \gtrsim 500$ GeV, and $\sigma \cong 60°$–$70°$.

Let us focus on the 2–3 down sector, as we decouple the d flavor [8] to avoid low energy constraints. The down quark mass matrix, normalized to m_b, has the elements $\hat{M}^{(d)}_{33} \simeq 1$, $\hat{M}^{(d)}_{22} \simeq \lambda^2$, where $\lambda \cong 0.22$. $\hat{M}^{(d)}_{23} \simeq \lambda^2$ is implied by $V_{cb} \simeq \lambda^2$, but we have no information on $\hat{M}^{(d)}_{32}$. With AFS [6], the *Abelian* nature implies [9] $\hat{M}^{(d)}_{23}\hat{M}^{(d)}_{32} \sim \hat{M}^{(d)}_{33}\hat{M}^{(d)}_{22}$, giving $\hat{M}^{(d)}_{32} \sim \hat{M}^{(d)}_{33} \sim 1$. This may be the largest off-diagonal term in $\hat{M}^{(d)}$, but we need to turn to SAFS to get right-handed dynamics. The corresponding RR squark mass matrix can be written as

$$\tilde{M}^{2(sb)}_{RR} = \begin{bmatrix} \tilde{m}^2_{22} & \tilde{m}^2_{23}e^{-i\sigma} \\ \tilde{m}^2_{23}e^{i\sigma} & \tilde{m}^2_{33} \end{bmatrix} \equiv R \begin{bmatrix} \tilde{m}^2_1 & 0 \\ 0 & \tilde{m}^2_2 \end{bmatrix} R^\dagger, \quad (2)$$

where all $\tilde{m}^2_{ij}$ are of order $\tilde{m}^2$, the common squark mass; hence $\tilde{s}_R$-$\tilde{b}_R$ squark mixing is near maximal. Note that Eq. (2) contains a single irremovable phase σ [8] that is on equal footing with $\delta \equiv \arg V^*_{ub}$. The matrix

$$R = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta e^{i\sigma} & \cos\theta e^{i\sigma} \end{bmatrix} \quad (3)$$

diagonalizes $\tilde{M}^{2(sb)}_{RR}$, where θ is expected to be near maximal. In contrast, off-diagonal elements of $(\tilde{M}^2)_{LR} = (\tilde{M}^2)^\dagger_{RL} \sim \tilde{m}M$ and $(\tilde{M}^2)_{LL}$ are suppressed by quark mass and mixing ($V_{\rm CKM}$), respectively.

Low energy constraints remain serious. Even after decoupling the d flavor, stringent kaon constraints imply [8] that $\tilde{m}$ and $m_{\tilde{g}}$ are at the TeV scale or higher. The remarkable thing about the SAFS picture is that one squark can still fall below the TeV scale. Without loss of generality, we take $\tilde{m}^2_{22} = \tilde{m}^2_{33} = \tilde{m}^2 \gtrsim$ TeV. By fine-tuning $\tilde{m}^2_{23}/\tilde{m}^2 \cong 1$ to λ^2 (λ^3) order [8], one can have a "strange-beauty" squark $s\tilde{b}_1$ as light as 200 GeV for $\tilde{m} = 1$ (2) TeV, which is needed to explain $S_{\phi K_S} < 0$, as we shall see. We remark that $|V_{cb}| \sim \lambda^2$ and $|V_{ub}| \lesssim \lambda^3$ suggest that these tunings are not unnatural.

To calculate amplitudes, we need to compute short distance coefficients $c_i^{(\prime)}$ in $\mathcal{H} = \Sigma_i(c_iO_i + c'_iO'_i)$ and evaluate hadronic matrix elements, $\langle f|\mathcal{H}|B\rangle$. Besides the tree level operators $O_{1,2}$, one has [10] the strong, electromagnetic (EM) and Z penguin operators $O^{(\prime)}_{3-6}$, $O^{(\prime)}_{7,8}$, and $O^{(\prime)}_{9,10}$, plus the EM and strong *dipole* penguins $O^{(\prime)}_{11,12}$, which are of primary interest. The operators O'_i arise from NP right-handed dynamics, where large off-diagonal terms demand usage of mass basis of Eq. (2) rather than mass insertions. Since the aim is to explore NP effects, hadronic amplitudes are calculated in naive factorization. We take $\tilde{m}_1 \equiv m_{s\tilde{b}_1} \simeq 200$ GeV, $\tilde{m} = 1, 2$ TeV, and $m_{\tilde{g}} = 0.5, 0.8$ TeV for illustrations.

As shown in Fig. 1(a), it is remarkable that one survives [8] the usually stringent $b \to s\gamma$ constraint. We have used $\mathcal{B}(b \to s\gamma) = (3.14 \times 10^{-4})(|c_{11}|^2 + |c'_{11}|^2)/|c^{\rm SM}_{11}|^2$ with $c^{\rm SM}_{11} \simeq -0.31$. We note that $b \to s\gamma$ is a strong constraint on LR mixing, as can be seen from the constructive LR chiral enhancement effect at $\sigma \sim 180°$, even with $m_q/\tilde{m}$ suppression. But for the dominant RR effect, $b \to s\gamma$ is very forgiving, because c'_{11} contributes to rate only in quadrature. We also see from Fig. 1(a) that $m_{\tilde{g}} = 0.8$ TeV is easier to accommodate, which illustrates our point that SUSY needs to be at the TeV scale.

The $\bar{B} \to \phi K_S$ decay amplitude is

$$\mathcal{A}(\bar{B}^0 \to \phi\bar{K}^0) \propto \left\{\cdots + \frac{\alpha_s}{4\pi}\frac{m_b^2}{q^2}\tilde{S}_{\phi K}(c_{12} + c'_{12})\right\}, \quad (4)$$

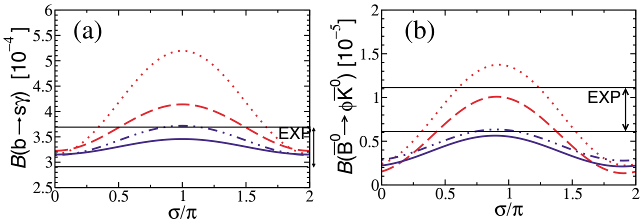

FIG. 1 (color online). (a) $\mathcal{B}(b \to s\gamma)$ and (b) $\mathcal{B}(B^0 \to \phi K^0)$ vs the CP phase σ for $\tilde{m}_1 \equiv m_{s\tilde{b}_1} = 200$ GeV. Solid and dash-dotted (dashed and dotted) lines are for $\tilde{m} = 2, 1$ TeV and $m_{\tilde{g}} = 0.8$ (0.5) TeV, respectively. The 1σ experimental band is indicated.

where $\cdots$ are several terms $\propto c_i + c'_i$ and q is the virtual gluon momentum of the $b \to s$ color dipole. Only c'_{12} is sensitive to the $s\tilde{b}_i$-$\tilde{g}$ loop. The rate, plotted in Fig. 1(b), is not incompatible with data. Combining with Fig. 1(a), however, it is interesting to note that, for $m_{\tilde{g}} = 0.5$ TeV, the $b \to s\gamma$ and $B \to \phi K_S$ rates balance each other at $\sigma \sim 65°, 270°$. This is supported by CP violating data, which selects the former branch.

As shown in Fig. 2(a), for $\sigma \sim 40°$–$90°$, large $\tilde{s}_R$-$\tilde{b}_R$ mixing can indeed [11,12] turn $S_{\phi K_S}$ negative, while for $\sigma \sim 180°$–$360°$, one has $S_{\phi K_S} > \sin 2\Phi_{B_d} \simeq 0.74$. With $\tilde{m}_1$ held fixed, there is little difference between $\tilde{m} = 1$ and 2 TeV. The effect weakens for $\tilde{m}_1 > 200$ GeV, but for $\tilde{m}_1$ as light as 100 GeV, the change is not dramatic. Although $m_{\tilde{g}} \lesssim 500$ GeV is preferred, lowering $m_{\tilde{g}}$ further gives more trouble with low energy constraints. However, as seen from Eq. (4), two hadronic parameters, $\tilde{S}_{\phi K}$ and q^2, accompany c'_{12}. The former arises from evaluating $\langle O^{(\prime)}_{12}\rangle$ and may be larger than the naive factorization result of $\tilde{S}_{\phi K} \simeq -1.3$. For the latter, $q^2 < m_b^2/3$ is possible. Thus, $m_{\tilde{g}} < 500$ GeV may not be needed if $m_b^2|\tilde{S}_{\phi K}|/q^2 > 3.9$. Our parameter choice has been in part to reflect $S_{\phi K} \sim -0.15$ in Eq. (1).

Equation (1) is also opposite in sign to $\bar{B} \to K_S\pi^0$ and $\eta' K_S$, which are dominantly $b \to s$ penguin modes as well. The $\eta' K_S$ mode is more complicated, so let us discuss $\bar{B} \to K_S\pi^0$. The decay amplitude is

$$\mathcal{A}(\bar{B}^0 \to \bar{K}^0\pi^0) \propto \left\{\cdots + \frac{\alpha_s}{4\pi}\frac{m_b^2}{q^2}\tilde{S}_{K^0\pi^0}(c_{12} - c'_{12})\right\}, \quad (5)$$

where the $\cdots$ are many terms $\propto c_i - c'_i$. Compared to Eq. (4), the primed terms change sign because, unlike the vector current production of ϕ, current production of pseudoscalars senses the sign of the axial part of the $V \mp A$ current. As shown in Fig. 2(b), this leads to $S_{K_S\pi^0} \gtrsim 0.74$ for $S_{\phi K_S} < 0$, which is consistent with $S_{K_S\pi^0} = 0.48^{+0.38}_{-00.47} \pm 0.10$ from BaBar [2]. The analogous anticorrelation effect between $S_{\eta' K_S}$ and $S_{\phi K_S}$ has been noted in Refs. [11,13].

We see that the (right-handed) $s\tilde{b}_1$ squark can account for the CPV effects observed in $\bar{B} \to \phi K_S$ vs $\bar{B} \to K_S\pi^0$, $\eta' K_S$. It is interesting that $\sigma \sim 65°$ agrees quite well with what is inferred from Fig. 1 with rates. However, although the NP effect may have emerged first

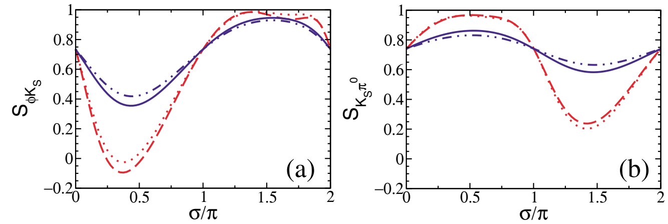

FIG. 2 (color online). (a) $S_{\phi K_S}$ and (b) $S_{K_S\pi^0}$ vs σ with notation as in Fig. 1.

from $\bar{B} \to \phi K_S$, Eqs. (4) and (5) show that measuring such effects in additional hadronic modes f probes really the hadronic parameters $(\tilde{S}/q^2)|_f$ and cannot shed further light on the underlying fundamental parameters such as σ, $m_{s\tilde{b}_1}$, and $m_{\tilde{g}}$. For this purpose, we need to turn to modes that are largely free of hadronic uncertainties.

The first thing that comes to mind is B_s mixing. It has been emphasized [8] that B_s mixing and associated CP violation, $\sin 2\Phi_{B_s}$, are good places to look for the effect of $s\tilde{b}_1$, with Δm_{B_s} just above the present bound of 14.9 ps^{-1} [1] as most interesting. However, that was for gluinos at the TeV scale. For the present case, the large effect of $S_{\phi K_S} < 0$ calls for a lighter gluino. As can be seen from Fig. 3(a), with $m_{\tilde{g}}$ around 500 GeV, $\Delta m_{B_s} \gtrsim$ 70 ps^{-1} *is hard to avoid.* We believe this is a generic feature, not just a consequence within SAFS. Basically, the LR mixing possibility is constrained by $b \to s\gamma$; hence $S_{\phi K_S}$ and Δm_{B_s} are closely linked. Measurement of $\Delta m_{B_s} \gtrsim 70$ ps^{-1} at Fermilab Tevatron run II is now hopeless and would be challenging even for BTeV and LHCb.

Assuming Δm_{B_s} can be measured, we see from Fig. 3(b) that $\sin 2\Phi_{B_s}$ can provide a better measure of the CP phase σ. However, the very fast B_s oscillations would make CP studies in the B_s system such as $B_s \to D_s K$, $\phi\gamma$, and $\phi\eta'$ very challenging. We would be pushing the limits of current vertex detector technology. Resorting to $\Delta\Gamma_{B_s}$ measurables may reduce the need for measuring oscillations, but measurement of $\Delta\Gamma_{B_s}/\Gamma_{B_s} \lesssim 10\%$ itself would be less accurate. A CP conserving probe would be $\Lambda_b \to \Lambda\gamma$ decay, which can be studied only at hadronic machines. Since Λ is expected to keep the polarization of the s quark, it can probe [14,15] the presence of the c'_{11} component of the $b \to s\gamma$ transition, i.e., wrong helicity photons. The effect is measured via the angular parameter $\alpha_\Lambda = (|c_{11}|^2 - |c'_{11}|^2)/(|c_{11}|^2 + |c'_{11}|^2)$, which should be 1 in the SM since c'_{11} vanishes. Hadronic effects are again absent. We find $\alpha_\Lambda \sim 0.6$ for $(\tilde{m}_1, \tilde{m}, m_{\tilde{g}}) = (0.2, 1, 0.5)$ TeV, and it drops with $m_{\tilde{g}}$.

Wrong helicity photons can, in principle, be probed via mixing dependent CPV in $\bar{B}^0 \to \bar{K}^{*0}\gamma$ [15,16], which is free from hadronic uncertainties. By reconstructing $\bar{K}^{*0}$ via $K_S\pi^0$, however, it appears that nature has played a trick on us: $\pi^0 \to \gamma\gamma$ leaves no track, while $K_S \to \pi^+\pi^-$ typically decays outside the silicon vertex detector. This lack of a vertex has been part of the motivation behind the search for rarer $\bar{B}^0 \to \rho^0\gamma$, $\bar{K}_1(1270)^0\gamma$ (both not yet seen), and $\phi K_S\gamma$ [17] modes. However, the recent BaBar result of $S_{K_S\pi^0} = 0.48^{+0.38}_{-00.47} \pm 0.10$ [2], though not yet significant, demonstrates the feasibility of reconstructing the B decay vertex via K_S, which came as quite a surprise. One clearly needs a larger silicon vertex detector with more layers, but *the technique is unique to B factories.* Some fraction of K_S decays would leave hits in outer silicon layers. The B decay vertex is determined by extrapolating the K_S momentum onto the boost axis, which is very close to the B direction. The boost axis is the e^- direction at present. This is why the technique is unique to asymmetric B factories, since with hadronic production one usually does not know the B direction.

Mixing dependent CP violation in exclusive radiative $\bar{B}^0$ decays is given by the formula [15,16]

$$S_{M^0\gamma} = \xi \frac{2|c_{11}c'_{11}|}{|c_{11}|^2 + |c'_{11}|^2} \sin(2\phi_{B_d} - \varphi_{11} - \varphi'_{11}),$$
$$\equiv \xi \sin 2\vartheta_{\rm mix} \sin(2\phi_{B_d} - \varphi_{11} - \varphi'_{11}), \qquad (6)$$

where ξ is the CP eigenvalue of the reconstructed M^0 final state, and $\varphi_{11}^{(\prime)}$ is the CP phase of $c_{11}^{(\prime)}$. Both photon helicities must be present for $\bar{B}^0$ and B^0 decay amplitudes to interfere. In SM, which is purely left-handed, c'_{11}, hence $S_{M^0\gamma}$, vanishes with a light quark mass. Thus, $S_{K_S\pi^0\gamma}$ is a good probe of new physics, now that it can be measured. Equation (6) also shows that $S_{K_S\pi^0\gamma}$ is free from the hadronic effects that plague the hadronic modes. The $B \to K^*$ form factor drops out from the ratio that gives $S_{K_S\pi^0\gamma}$.

We stress that $c_{11}^{(\prime)}$ and $\varphi_{11}^{(\prime)}$ and hence $\sin 2\vartheta_{\rm mix}$ and $S_{K_S\pi^0\gamma}$ are calculable within the present framework. We plot $\sin 2\vartheta_{\rm mix}$ and $S_{K_S\pi^0\gamma}$ vs σ in Figs. 4(a) and 4(b), respectively. For $\sigma \sim 65°$ as favored by $S_{\phi K_S} \lesssim 0$, we find $\sin 2\vartheta_{\rm mix} \sim 0.8$ and $S_{K_S\pi^0\gamma} \sim 0.3 \neq 0$. *The measurement of this effect should be pursued with vigor at B factories.* It would not only confirm new physics but provide a clean measure of the new physics parameters in the future. We remark that the $b \to s\ell^+\ell^-$ rate is unaffected, since the Z penguin correction is suppressed by LR mixing. But c'_{11} can be probed by the forward-backward asymmetry for low $m_{\ell\ell}$ when $c_{11}^{(\prime)}$ is dominant.

A realistic model such as SAFS allows us to be comprehensive and make more definitive predictions. But our

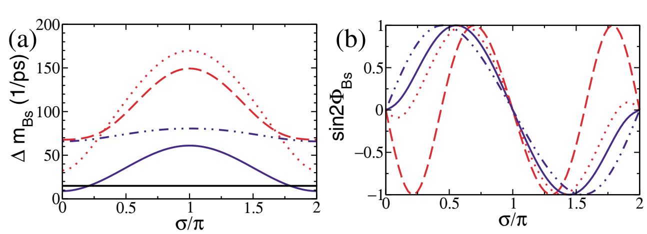

FIG. 3 (color online). (a) Δm_{B_s} and (b) $\sin 2\Phi_{B_s}$ vs σ with notation as in Fig. 1. The horizontal line in (a) is current Δm_{B_s} bound.

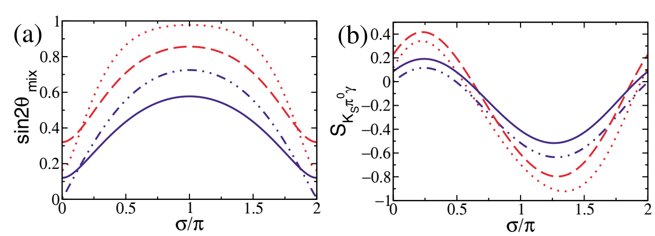

FIG. 4 (color online). (a) $\sin 2\vartheta_{\rm mix}$ and (b) $S_{K_S\pi^0\gamma}$ for $\bar{B}^0 \to \bar{K}^{*0}\gamma$ vs σ with notation as in Fig. 1.

minimal two-particle picture really has only three parameters: $\tilde{m}_1 \lesssim 200$ GeV, $m_{\tilde{g}} \lesssim (\gtrsim ?)$ 500 GeV, and $\sigma \sim 65°$. All other SUSY partners, with the possible exception of a dominantly bino $\tilde{\chi}_1^0$, are at the TeV scale. We do not have a mechanism for making $\tilde{\chi}_1^0$ light, but even $m_{\tilde{\chi}_1^0} \lesssim 100$ GeV is allowed [8] by the $b \to s\gamma$ constraint, which is remarkable. It could still be the lightest SUSY particle (LSP) and hence a candidate for dark matter.

A direct search for $\tilde{sb}_1$, $\tilde{g}$, and $\tilde{\chi}_1^0$ at colliders is imperative, since B factory probes are indirect. One must take into account both [8] $\tilde{sb}_1 \to b\tilde{\chi}_1^0$ and $s\tilde{\chi}_1^0$ decays, which have equal rates. The search should be very similar to a standard $\tilde{b}$ squark search, except that the cross section and mass measurements may not match, because of "leakage" to final states containing s jets, which dilutes b-tagging effectiveness. Discovery at the Tevatron is possible and should be a certainty at the LHC if the picture holds. It is not clear whether the CP phase σ can be probed via direct production, but a combined study at B factories and colliders should be able to determine all the flavor and CP violating SUSY parameters.

We confess to two caveats. First, the s-quark chromoelectric dipole moment is related [18] to the $b \to s$ color dipole by $\tilde{s}_L$-$\tilde{b}_L$ mixing insertion, which is severely constrained by the electric dipole moment of ^{199}Hg. We have $\tilde{s}_L$-$\tilde{b}_L$ mixing $\sim\lambda^2$ and cannot evade this constraint, which applies to all models. However, hadronic uncertainties may be even more involved here. Second, a generic feature of quark-squark alignment (QSA) models [6] is D^0-$\bar{D}^0$ mixing generated by relegating $V_{us} \simeq \lambda$ to up-type quarks. If $m_{\tilde{u},\tilde{c}} \sim 1$–2 TeV also, we typically get $x_D \sim 7\%$ (11%–20%) for $m_{\tilde{g}} = 800$ (500) GeV, compared with the bound of $x_D \equiv \Delta m_D/\Gamma_D \lesssim 2.9\%$ [1]. This makes a 500 GeV gluino problematic and is a reminder of flavor or family interrelations in a realistic setting. It is clear that D^0 mixing should be searched for, and the QSA models should be refined. These issues illustrate the importance of low energy constraints, which pushes SUSY above the TeV scale in the face of large flavor violation.

On a positive note, maximal ν_μ-ν_τ mixing may [19] be related to right-handed $\tilde{s}_R$-$\tilde{b}_R$ mixing in SUSY grand unified theories framework. This adds to the attraction of a light strange-beauty squark, but it involves extra dynamical assumptions at very high scale (including right-handed neutrino mass). Our working scale has been TeV and below and has been based on observed flavor patterns.

Let us conclude. Our main point is that, to have $S_{\phi K_S} < 0$, drastic new physics measures must be present and would be bound to have strong implications at B factories and at colliders. We illustrate with a generic model that combines supersymmetry and Abelian flavor symmetry. It gives rise to maximal $\tilde{s}_R$-$\tilde{b}_R$ mixing, which carries a new CP phase σ, and can make one light $\tilde{sb}_1$ squark via level splitting, even though the SUSY scale is pushed above TeV by low energy constraints. With $m_{\tilde{sb}_1} \sim 200$ GeV, we find a relatively light $m_{\tilde{g}} \sim 500$ GeV is still needed, and large $\sigma \sim 65°$. Consequently, we find B_s probably oscillates faster than 1/70 ps, which casts some shadows on the corresponding CP program. However, $S_{K_S\pi^0\gamma} \sim 0.3 \neq 0$ is predicted and is free of hadronic uncertainties. Furthermore, it can be measured at B factory upgrades utilizing K_S vertex reconstruction. The $\tilde{sb}_1$ squark and the gluino $\tilde{g}$, and possibly a bino $\tilde{\chi}_1^0$, can be searched for at colliders. The $\bar{B} \to \phi K_S$ CP anomaly may be the harbinger of a different flavor, CP and SUSY, landscape than we had anticipated.

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