Flavor Structures of SUSY models

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- Introduction
- Example of "scatter plot" study
- Comments on "benchmarks"

Introduction

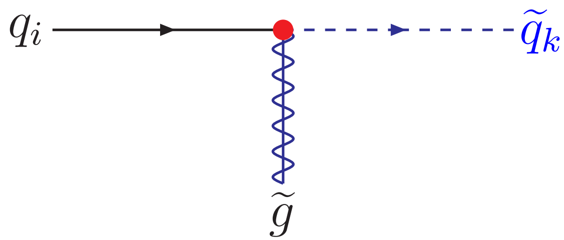
Minimal Supersymmetric Standard Model: a promising candidate for the physics beyond the SM.

MSSM = SM (gauge, Higgs, quarks/leptons, Yukawa)
+ extra Higgs doublet (type-II at tree level)
+ Supersymmetry (superpartners, interactions)
+ soft SUSY breaking ($>$ 100 parameters).

Sources of flavor mixing:

- Yukawa couplings $\rightarrow$ CKM (as in the SM).
- Soft SUSY breaking terms:
  - ▷ Squark/slepton mass matrices,
  - ▷ Trilinear scalar couplings ("A"-terms).

Mismatch between quark and squark mass bases
$\Rightarrow$ flavor mixing in quark–squark–"inos" couplings.



Mass matrices of down-type quarks and squarks:

$$\mathcal{M}_d = Y_D v_1,$$

$$\mathcal{M}^2_{\tilde{d}} = \begin{pmatrix} m_Q^2 + Y_D^\dagger Y_D v_1^2 + D_{d_L} & A_D^\dagger v_1 - \mu Y_D^\dagger v_2 \\ A_D v_1 - \mu^* Y_D v_2 & m_D^2 + Y_D Y_D^\dagger v_1^2 + D_{d_R} \end{pmatrix}, \quad \begin{matrix} \leftarrow \tilde{d}_L \\ \leftarrow \tilde{d}_R \end{matrix}$$

not simultaneously diagonalized *due to the soft SUSY breaking terms* m_Q^2, m_D^2 *and* A_D.

Studying flavor mixing in the MSSM $\Updownarrow$ Studying structure of soft SUSY breaking terms.

Model dependent approach

Assume a SUSY model (scenario), where flavor structures are introduced at energy scales higher than the EW scale.

- flavor-blind SUSY breaking (mSUGRA, $\cdots$).
- extra Yukawa couplings (GUT, ν_R, $\cdots$).
- flavor symmetry (controls Yukawa and SUSY breaking), $\cdots$

$$\Downarrow$$

Calculate the MSSM parameters at the EW scale.

- Flavor structures at high energy scales are encoded through RG running.

$$\Downarrow$$

Evaluate low energy flavor observables and compare with experimental results to obtain constraints/allowed regions in the model parameter space.

Model independent approach

Parametrize general MSSM at the EW scale.

- Define model independent parameters that characterize flavor mixing of SUSY breaking sector.

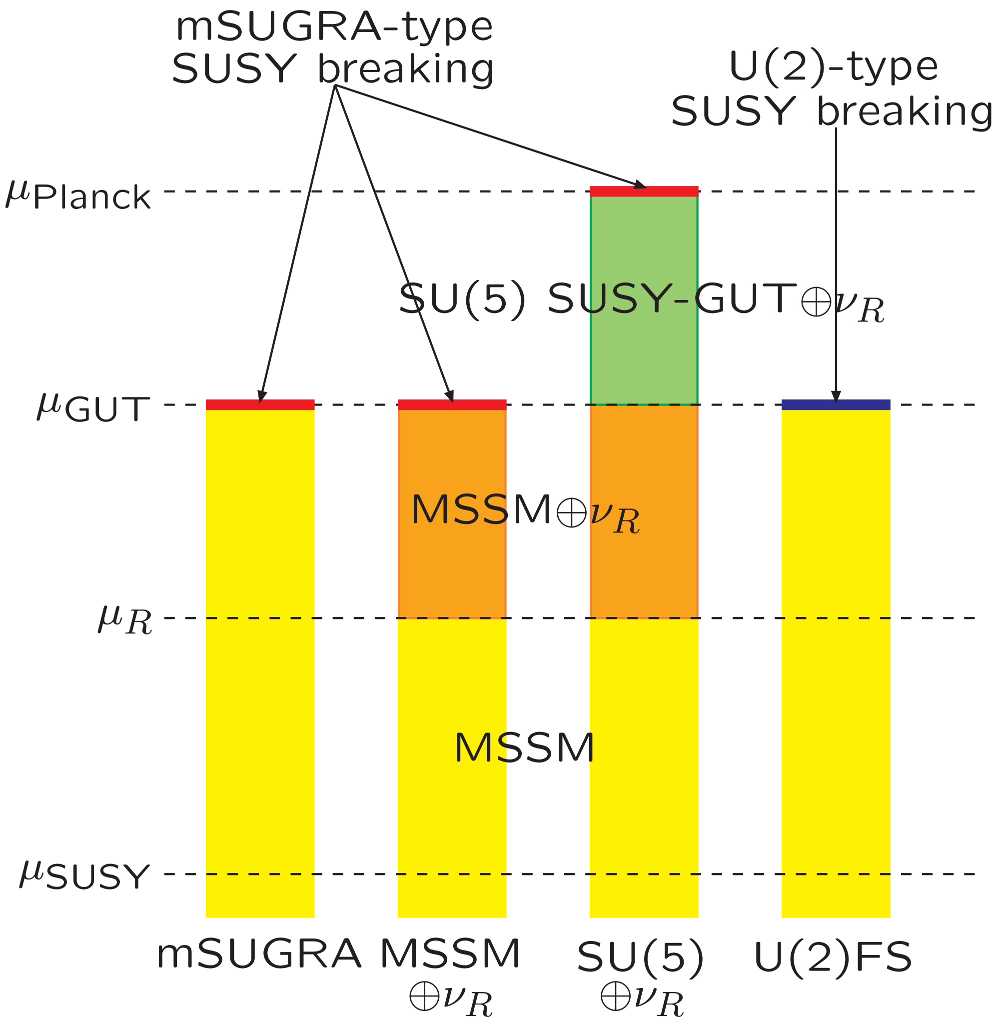
$$\Downarrow$$

Evaluate low energy flavor observables and compare with experimental results to obtain constraints/allowed regions in the model-independent parameters.

- Computations in "$\Downarrow$" are the same for both approaches.

Examples of “model dependent” approach

T. G., Y. Okada, T. Shindou and M. Tanaka, PRD77(2008)095010 [arXiv:0711.2935]



- mSUGRA
  - ▷ Flavor-blind SUSY breaking m_0, $m_{1/2}$, A_0.
  - ▷ Source of flavor mixing: $Y_{U,D}$ (V_{CKM}) only.
- MSSM$\oplus\nu_R$
  - ▷ ν_R introduced for neutrino masses (seesaw).
  - ▷ Y_ν affects running $> \mu_R$.
  - ▷ GUT: quark $\Leftrightarrow$ lepton $> \mu_G$.
- U(2) flavor symmetry
  - ▷ FS controls Yukawas and SUSY breaking.

Flavor mixing/CPV source

- V_{CKM} (all cases) $\Longrightarrow$ $\tilde{q}_L$ mixing (running).
  - ▷ Significant in $\mathrm{B}(b \to s\,\gamma)$, $\tan\beta$ enhanced corrections.
  - ▷ GUT $\Longrightarrow$ $\tilde{\ell}_R$ mixing (Barbieri-Hall). $\mathbf{10} = \{q_L,\, (u_R)^c,\, (e_R)^c\}$.
- Y_ν (cases with ν_R's) $\Longrightarrow$ $\tilde{\ell}_L$ mixing (running above μ_R).
  - ▷ GUT $\Longrightarrow$ $\tilde{d}_R$ mixing (Moroi) $\overline{\mathbf{5}} = \{(d_R)^c,\, \ell_L\}$.
- $m^2_{Q,U,D}(\mu_{\mathrm{GUT}})$ (U(2)FS).
  - ▷ U(2) structure neglected in (s)lepton sector.
- SUSY CPV phases $(\phi_A,\, \phi_\mu,\, \cdots)$.
  - ▷ Affect CP asymmetries in b decays, EDMs (e, n, Hg).

U(2) flavor symmetry model

[Barbieri, Hall and Romanino, PLB401(1997)47]

Motivation: to explain

- hierarchical structure of quark masses and CKM matrix,
- degeneracy of 1st and 2nd generation squarks (in order to suppress SUSY contributions to $K-\bar{K}$ mixing).

Assumptions:

- Transformation properties under FS:
  - ▷ 1st and 2nd generations $\Rightarrow$ doublets of U(2).
  - ▷ 3rd generation and Higgs $\Rightarrow$ singlet of U(2).
- Two-stage flavor symmetry breaking:
  - ▷ U(2) $\xrightarrow{\epsilon}$ U(1) $\xrightarrow{\epsilon'}$ no symmetry.

$$Y_q \approx y_q \begin{pmatrix} 0 & a_q\epsilon' & 0 \\ -a_q\epsilon' & d_q\epsilon & b_q\epsilon \\ 0 & c_q\epsilon & 1 \end{pmatrix}, \qquad m^2_{\tilde{q}} \approx m^2_{\tilde{q}} \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1+r^{\tilde{q}}_{22}\epsilon^2 & r^{\tilde{q}}_{23}\epsilon \\ 0 & r^{\tilde{q}*}_{23}\epsilon & r^{\tilde{q}}_{33} \end{pmatrix}.$$

$V_{cb} = O(\epsilon)$, $V_{us} = O(\epsilon'/\epsilon)$.

Three flavon fields are introduced:

$$\Phi^i, \quad S^{ij} = S^{ji}, \quad A^{ij} = -A^{ji}, \quad i, j = 1, 2.$$

U(2) symmetric superpotential for Yukawas:

$$\begin{aligned} W_{\mathrm{U}(2)} &= y_U \left(U_3^c Q_3 H_2 + \frac{b_U}{M_F} \Phi^i U_i^c Q_3 H_2 + \frac{c_U}{M_F} U_3^c \Phi^i Q_i H_2 \right. \\ &\quad \left. + \frac{d_U}{M_F} S^{ij} U_i^c Q_j H_2 + \frac{a_U}{M_F} A^{ij} U_i^c Q_j H_2 \right) \\ &\quad + y_D \left(D_3^c Q_3 H_1 + \frac{b_D}{M_F} \Phi^i D_i^c Q_3 H_1 + \frac{c_D}{M_F} D_3^c \Phi^i Q_i H_1 \right. \\ &\quad \left. + \frac{d_D}{M_F} S^{ij} D_i^c Q_j H_1 + \frac{a_D}{M_F} A^{ij} D_i^c Q_j H_1 \right) . \end{aligned}$$

$$\frac{\langle \Phi^i \rangle}{M_F} = \delta^{i2} \, \epsilon, \quad \frac{\langle S^{ij} \rangle}{M_F} = \delta^{i2} \, \delta^{j2} \epsilon, \quad \frac{\langle A^{ij} \rangle}{M_F} = \epsilon^{ij} \, \epsilon'.$$

U(2)FS: more on Yukawa matrices

The Yukawa matrices of the U(2) structure

$$Y_q = f_q \begin{pmatrix} 0 & a_q\lambda^3 & 0 \\ -a_q\lambda^3 & d_q\lambda^2 & b_q\lambda^2 \\ 0 & c_q\lambda^2 & 1 \end{pmatrix}, \qquad (\lambda \sim 0.2),$$

lead to relations among eigenvalues (quark masses) and CKM matrix elements:

$$\left|\frac{y_u}{y_c}\right| = \left|\frac{V_{ub}}{V_{cb}}\right|^2 \Big(1 + O(\lambda^2)\Big), \qquad \left|\frac{y_d}{y_s}\right| = \left|\frac{V_{td}}{V_{ts}}\right|^2 \Big(1 + O(\lambda^2)\Big),$$

that fail numerically.

U(2)FS: more on Yukawa matrices

In our calculations, we cheat:

- Diagonalize Yukawa matrices at the GUT scale (identified as FSB scale) to obtain eigenvalues $y_{u,d,s,c,b,t}$ and V_{CKM}.
- Write Yukawa matrices $Y_{U,D}^{\mathsf{U(2)}}$ of the U(2) form in terms of $y_{s,c,b,t}$, V_{CKM} and input parameters b_U, c_U, b_D and λ (with expansion formulae in powers of λ).
- Find unitary matrices that diagonalize $Y_{U,D}^{\mathsf{U(2)}}$.
  - ▷ Eigenvalues $y_{u,d}$ are different from original ones.
- Rotate original (diagonalized) Yukawa matrices with the unitary matrices obtained above.

U(2)FS: more on Yukawa matrices

Example of "pseudo-U(2)" Yukawa matrices
(with $\lambda = 0.2$ and randomly chosen b_U, c_U, b_D):

$$|Y_U| = \begin{pmatrix} 3.5 \times 10^{-6} & 7.5 \times 10^{-5} & 1.9 \times 10^{-8} \\ 7.5 \times 10^{-5} & 3.6 \times 10^{-3} & 4.2 \times 10^{-2} \\ 2.5 \times 10^{-8} & 3.1 \times 10^{-2} & 4.8 \times 10^{-1} \end{pmatrix},$$

$$|Y_D| = \begin{pmatrix} 5.2 \times 10^{-5} & 4.8 \times 10^{-4} & 2.9 \times 10^{-7} \\ 4.8 \times 10^{-4} & 2.5 \times 10^{-3} & 5.8 \times 10^{-3} \\ 4.6 \times 10^{-7} & 4.9 \times 10^{-3} & 1.6 \times 10^{-1} \end{pmatrix}.$$

In this basis, we take

$$m_\Phi^2 = m_0^2 r_0^\Phi \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 + r_{22}^\Phi \lambda^4 & r_{23}^\Phi \lambda^2 \\ 0 & r_{23}^{\Phi *} \lambda^2 & r_{33}^\Phi \end{pmatrix}, \qquad \Phi = Q,\ U,\ D.$$

Structure of the neutrino mass matrices (MSSM$\oplus\nu_R$, SU(5)$\oplus\nu_R$)

Light: $|\Delta m^2_{32}|$(atm) $\gg \Delta m^2_{21}$(sol)

- Normal Hierarchy
  - ▷ $m_3 \gg m_2 \gg m_1 = 0.003$eV. $(\Delta m^2_{21} \gg m^2_1)$
- Inverted Hierarchy
  - ▷ $m_2 > m_1 \gg m_3$.
- Degenerate
  - ▷ $m_3 > m_2 > m_1$, $m^2_1 = (0.1\text{eV})^2 \gg |\Delta m^2_{32}|$.

Heavy (ν_R):

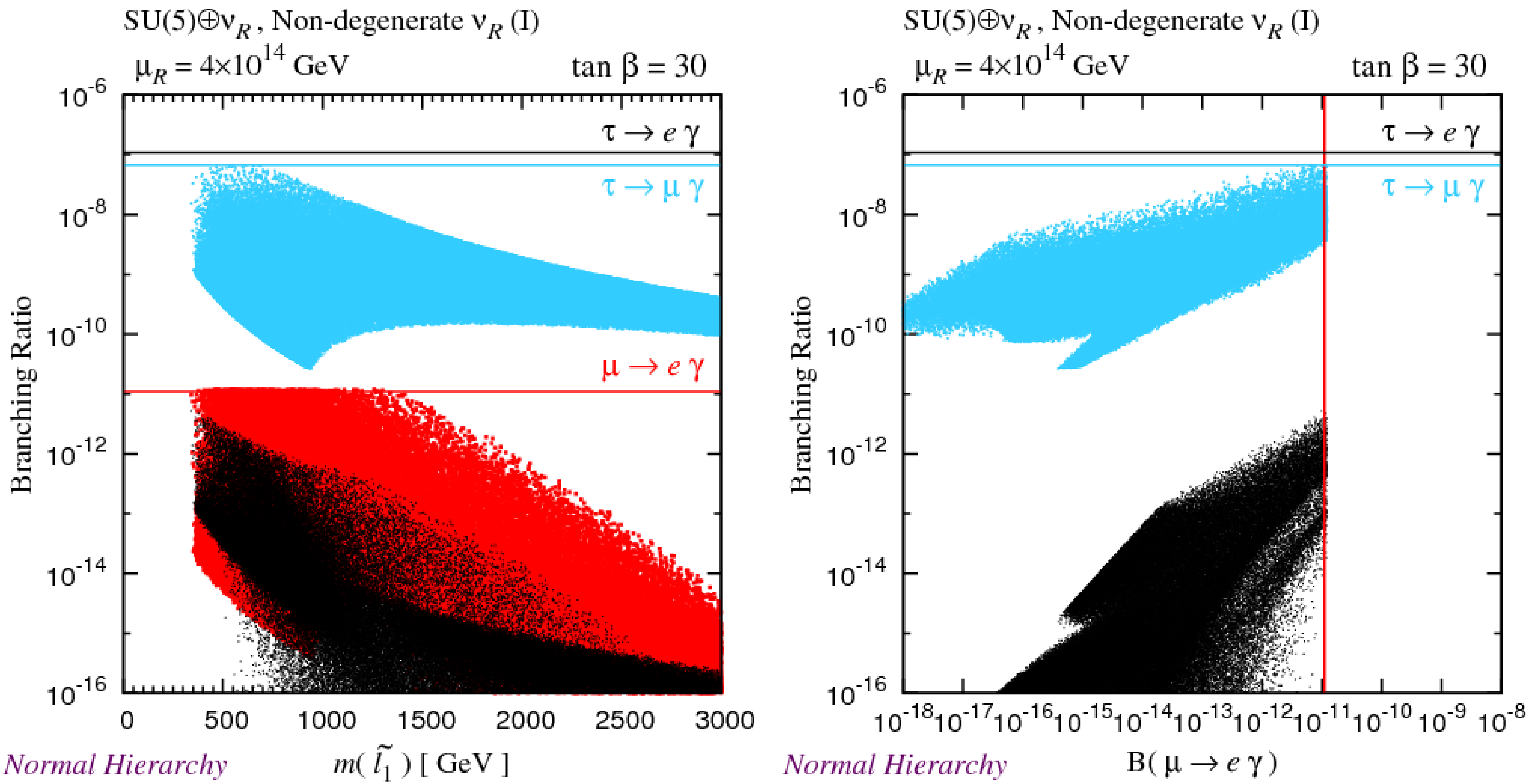
- Degenerate ν_R: $M_{\nu_R} \propto \mathbf{1}$.
  - ▷ $\mu \to e\,\gamma$ enhanced.
- Non-Degenerate ν_R: $M_{\nu_R} \not\propto \mathbf{1}$.
  - ▷ More free parameters in Y_ν.
  - ▷ $\mu \to e\,\gamma$ suppression possible.

(I) $(Y_\nu)_{12} = (Y_\nu)_{21} = 0$, $(Y_\nu)_{13} = (Y_\nu)_{31} = 0$.

(II) $(Y_\nu)_{12} = (Y_\nu)_{21} = 0$, $(Y_\nu)_{23} = (Y_\nu)_{32} = 0$.

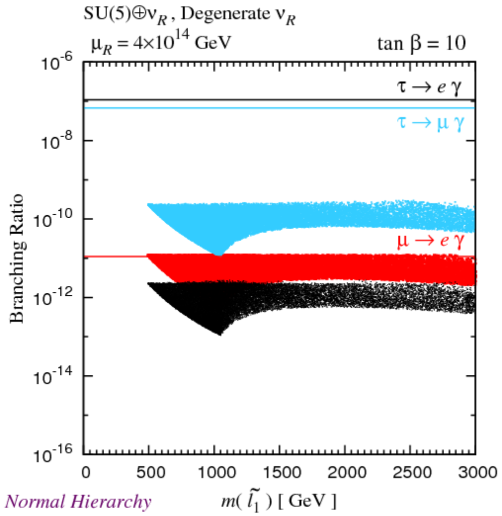
LFV: $\mu \to e\gamma$, $\tau \to \mu\gamma$, $\tau \to e\gamma$

SU(5)$\oplus\nu_R$, Non-degenerate ν_R (I), Normal Hierarchy

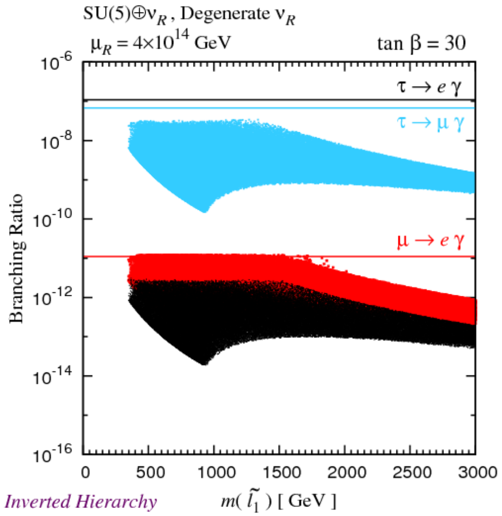


$m_{1/2}(\mu_G) \leq 1.5$TeV, $m_0(\mu_P) \leq 4$TeV scanned.

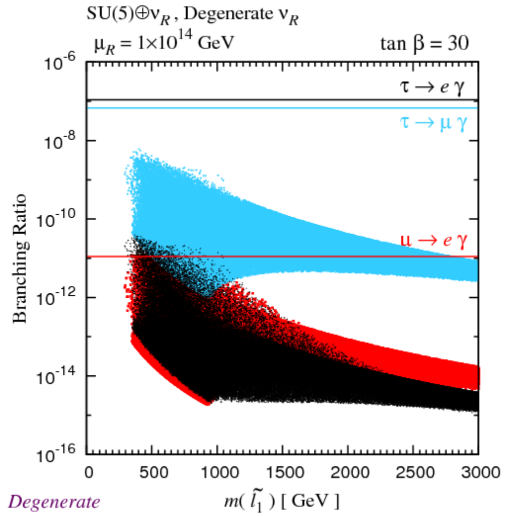
$\mu \to e\gamma$, $\tau \to \mu\gamma$, $\tau \to e\gamma$: SU(5)$\oplus\nu_R$ (Y_ν & $\mu_P \leftrightarrow \mu_G$ running)



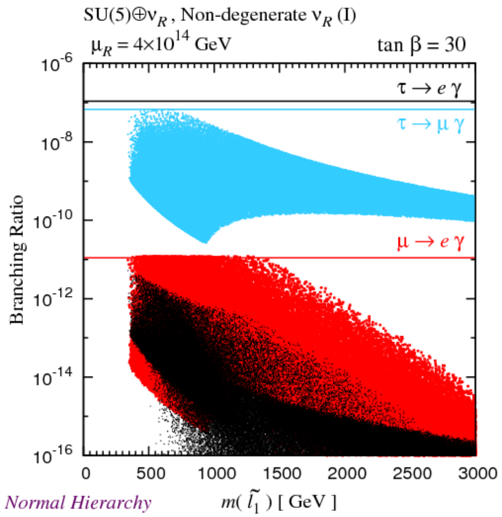
$D\nu_R$-NH



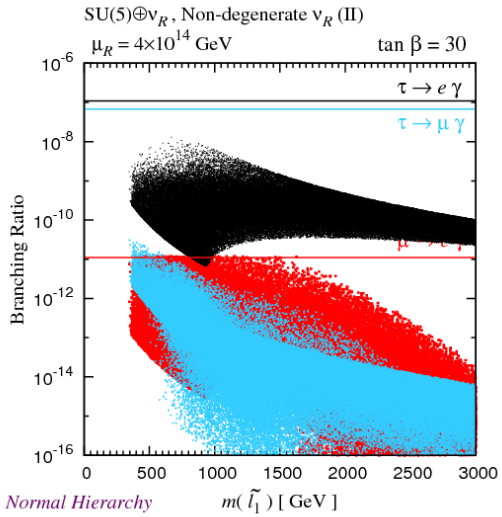
$D\nu_R$-IH



$D\nu_R$-D

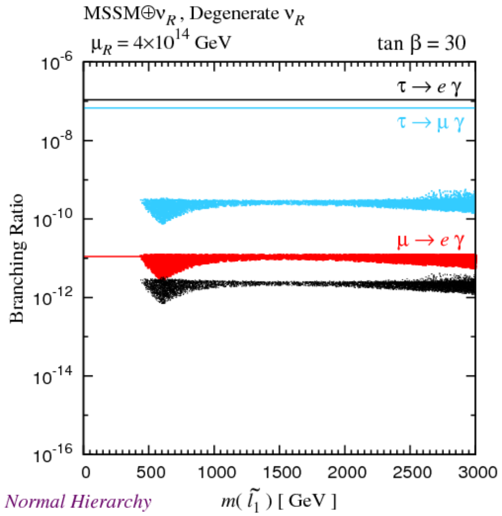


$ND\nu_R$(I)-NH

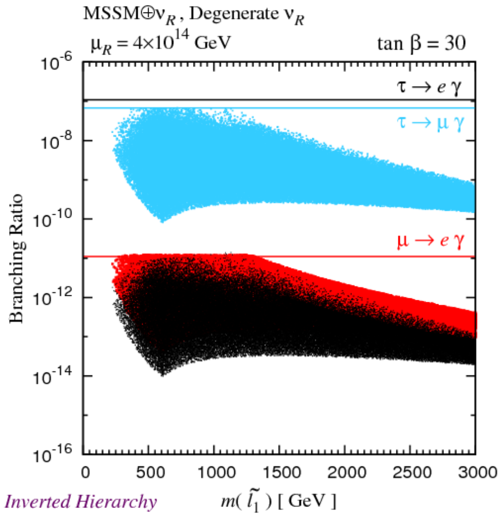


$ND\nu_R$(II)-NH

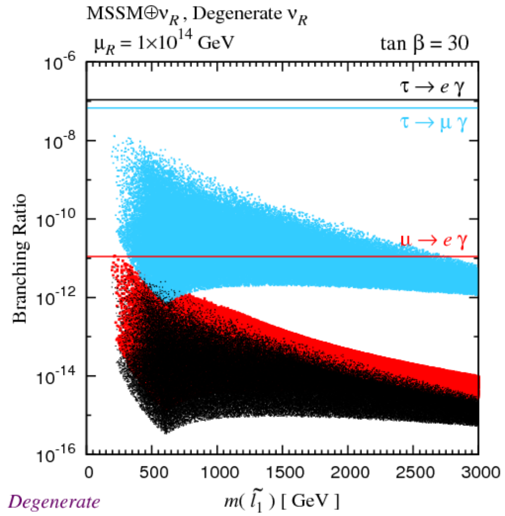
$\mu \to e\gamma$, $\tau \to \mu\gamma$, $\tau \to e\gamma$: MSSM$\oplus\nu_R$ (Y_ν only)



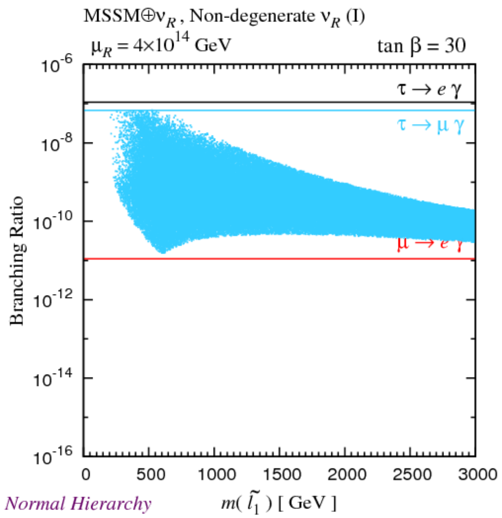
$D\nu_R$-NH



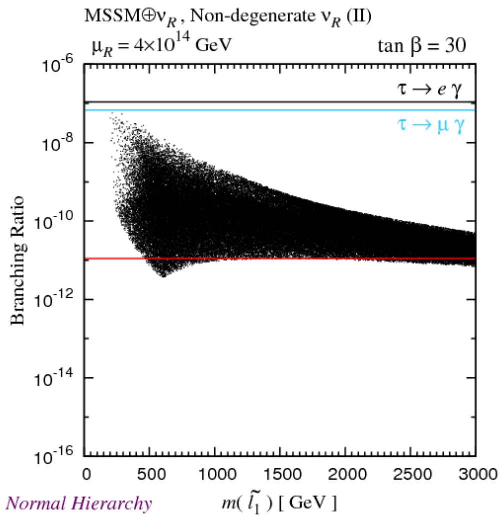
$D\nu_R$-IH



$D\nu_R$-D



$ND\nu_R$(I)-NH



$ND\nu_R$(II)-NH

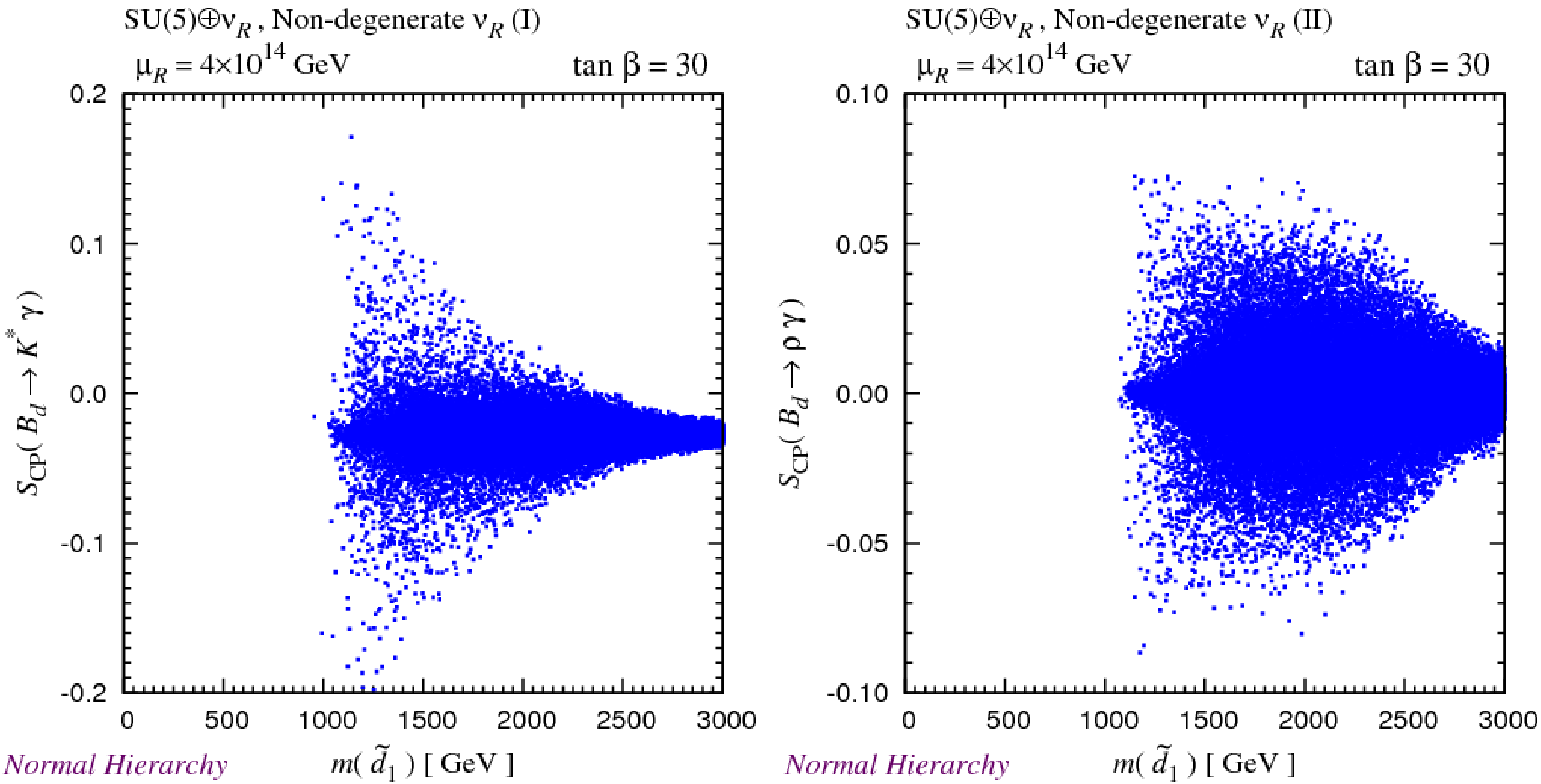
Time-dependent CP asymmetries in $b \to s/b \to d$ decays

- $S_{\mathrm{CP}}(B_d \to K^* \gamma)$, $S_{\mathrm{CP}}(B_d \to \rho \gamma)$
  - ▷ $B_d - \overline{B}_d$ mixing $\otimes$ $b \to s(d)\gamma$ decay.
  - ▷ Interference between $b_R \to s(d)_L \gamma_L$ and $\overline{(b_L)} \to \overline{(s(d)_R)} \gamma_L$; suppressed by $m_{s,d}/m_b$ in SM (Atwood-Gronau-Soni).
- $S_{\mathrm{CP}}(B_d \to \phi K_S)$
  - ▷ $B_d - \overline{B}_d$ mixing $\otimes$ $b \to s s \bar{s}$ decay.
  - ▷ Differs from $S_{\mathrm{CP}}(B_d \to J/\psi K_S)$ if new phase exists in $b \to s$ penguin amplitude.
- $S_{\mathrm{CP}}(B_s \to J/\psi \phi)$
  - ▷ $B_s - \overline{B}_s$ mixing $\otimes$ $b \to s c \bar{c}$ decay.
  - ▷ Small in SM; enhanced if new phase exists in $B_s - \overline{B}_s$ mixing.

$\Longrightarrow$ $\tilde{d}_R$ mixing can contribute to all.

- Significant in SU(5) SUSY-GUT$\oplus\nu_R$ and U(2)FS.

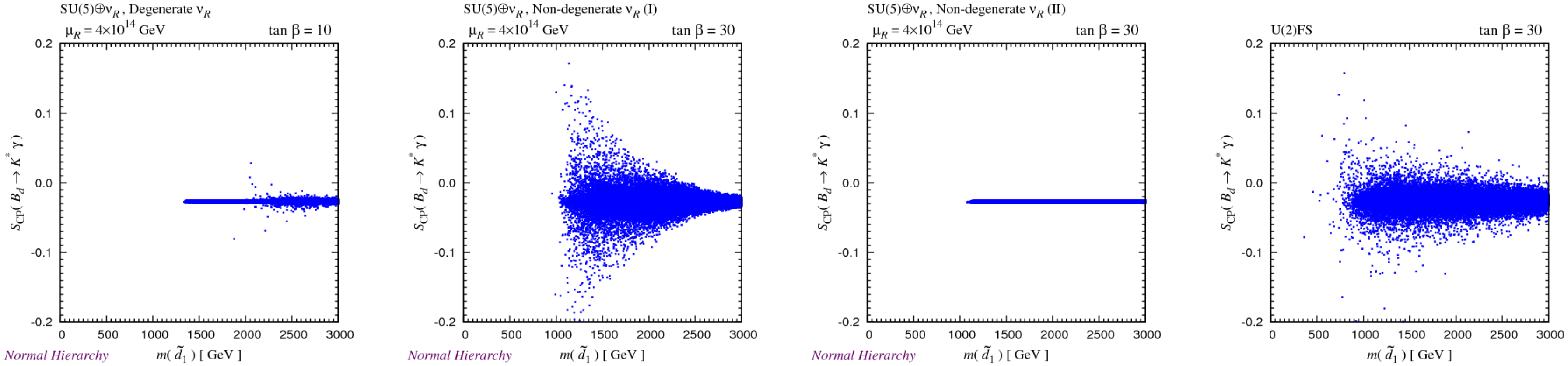
$S_{\rm CP}(B_d \to K^*\gamma)$ [$b \to s$], $S_{\rm CP}(B_d \to \rho\gamma)$ [$b \to d$]



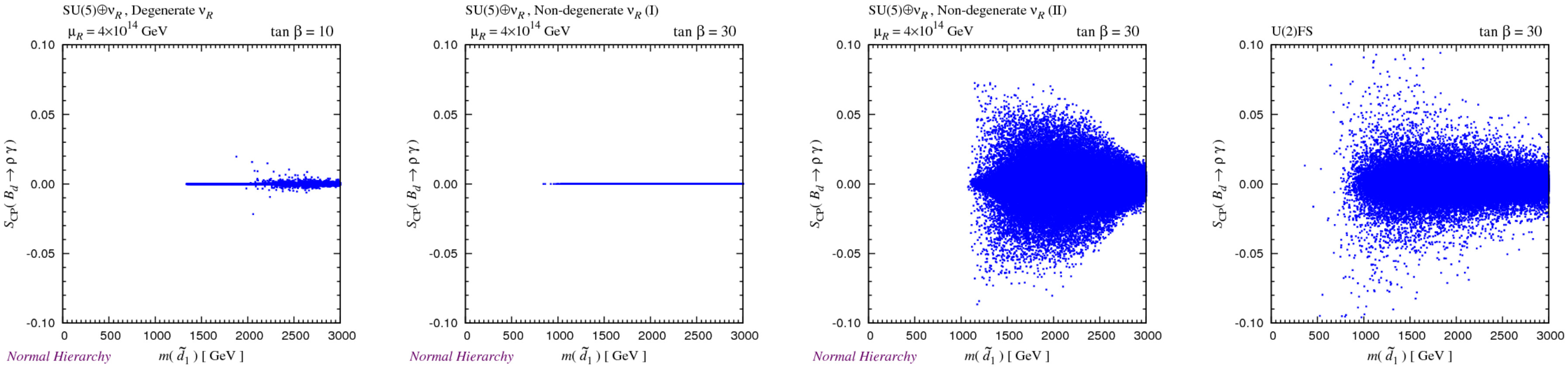
$S_{\rm CP}(B_d \to K^*\gamma)$ $[b \to s]$, $S_{\rm CP}(B_d \to \rho\gamma)$ $[b \to d]$

Significant in SU(5)$\oplus\nu_R$, U(2)FS; small in mSUGRA, MSSM$\oplus\nu_R$.

$S_{\rm CP}(B_d \to K^*\gamma)$ vs. $m(\tilde{d}_1)$



Dν$_R$-NH NDν_R(I)-NH NDν_R(II)-NH U(2)FS

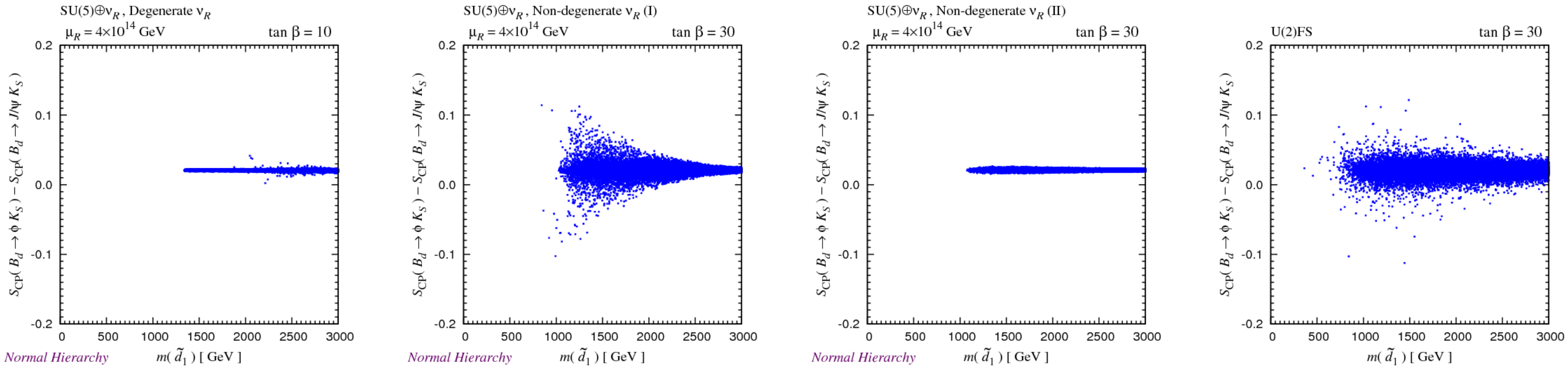


$S_{\rm CP}(B_d \to \rho\gamma)$ vs. $m(\tilde{d}_1)$

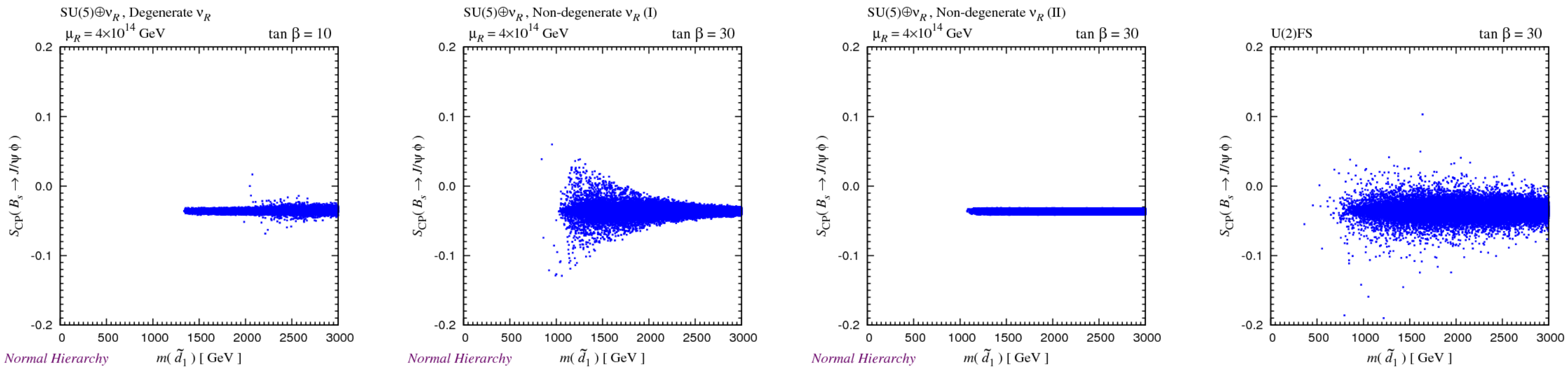
$S_{\mathrm{CP}}(B_d \to \phi K_S)$, $S_{\mathrm{CP}}(B_s \to J/\psi\phi)$ [$b \to s$]

Significant in SU(5)$\oplus\nu_R$, U(2)FS; small in mSUGRA, MSSM$\oplus\nu_R$.

$S_{\mathrm{CP}}(B_d \to \phi K_S) - S_{\mathrm{CP}}(B_d \to J/\psi K_S)$ vs. $m(\tilde{d}_1)$



Dν_R-NH | NDν_R(I)-NH | NDν_R(II)-NH | U(2)FS



$S_{\mathrm{CP}}(B_s \to J/\psi\phi)$ vs. $m(\tilde{d}_1)$

Summary: LFV

Model	$\mu \to e\gamma$	$\tau \to \mu\gamma$	$\tau \to e\gamma$
MSSM$\oplus\nu_R$			
Degenerate ν_R, NH	$\surd$		
Degenerate ν_R, IH	$\surd$	$\surd$	
Degenerate ν_R, D	$\surd$	$\surd$	
Non-degen. ν_R (I), NH		$\surd$	
Non-degen. ν_R (II), NH			$\surd$
SU(5)$\oplus\nu_R$			
Degenerate ν_R, NH	$\surd$		
Degenerate ν_R, IH	$\surd$	$\surd$	
Degenerate ν_R, D	$\surd$	$\surd$	
Non-degen. ν_R (I), NH	$\surd$	$\surd$	
Non-degen. ν_R (II), NH	$\surd$		$\surd$
Exp. sensitivity	10^{-13}	$2-8\times 10^{-9}$	
	MEG	SuperB@$50-75$ab^{-1}	

$\surd$: B$(\mu \to e\,\gamma) \sim 10^{-11}$, B$(\tau \to \mu(e)\gamma) \sim 10^{-8}$ possible.

Summary: Time-dependent CPV in $b \to s(d)$

	$S_{CP}(K^*\gamma)$	$S_{CP}(\rho\gamma)$	$\Delta S_{CP}(\phi K_S)$	$S_{CP}(B_s \to J/\psi\phi)$
SU(5)$\oplus\nu_R$				
Dν_R, NH	~ 0.01	~ 0.01	~ 0.01	~ 0.01
Dν_R, IH	~ 0.2	~ 0.02	~ 0.2	~ 0.1
Dν_R, D	~ 0.01	~ 0.01	~ 0.01	~ 0.01
NDν_R(I), NH	~ 0.2		~ 0.1	~ 0.1
NDν_R(II), NH		~ 0.1		
U(2)FS	~ 0.2	~ 0.1	~ 0.1	~ 0.1
Exp. precision	$0.02-0.03$	$0.08-0.12$	$0.02-0.03$	~ 0.01
		SuperB@$50-75\text{ab}^{-1}$		LHCb@10fb^{-1}

- Small in mSUGRA, MSSM$\oplus\nu_R$.

Benchmark points

In many studies, parameter scans are carried out in the free parameter space of the model.

Parameter scan (scatter plots) tells us:

- Pattern of signals (deviations from SM predictions).
- A region in the space of observables where the model cannot reach.

...but picking up representative points from a bunch of scatter plots is not easy.

A list of *numbers* is requested for simulation study
$\Longrightarrow$ "benchmark points".

Benchmark points

Definition of a "point"?

- A set of MSSM parameters (one point in >100 dimensional parameter space).
  - ▷ Parametrization (mass insertion, SLHA2, $\cdots$)?
  - ▷ Basis (super-CKM), renormalization scheme ($\overline{\text{DR}}$, on-shell, $\cdots$) and scale?
- A list of (flavor) observables.
  - ▷ Flavor observables.
  - ▷ SUSY particle spectrum and couplings (for "interplay" or comparison with "SPS"s).
- Other "intermediate" variables (Wilson coefficients, $\cdots$)?

How to choose a "good" point?

- Theoretically well-motivated.
- Rich experimental signals.
  - ▷ Different patterns.

Super-CKM basis

A supersymmetric (but $SU(2)$ breaking) basis for quarks/squarks, where:

- quark mass (Yukawa) matrices are diagonal;
  - ▷ in what renormalization scheme?
- same basis applied for squarks ⇒ supersymmetric parts of squark mass matrices are diagonal; SUSY breaking parts are not.

$$\begin{pmatrix} V^\dagger_{\mathsf{CKM}} u_L \\ d_L \end{pmatrix} \quad \begin{matrix} u_R \\ d_R \end{matrix} \quad \Leftarrow \mathsf{SUSY} \Rightarrow \quad \begin{pmatrix} V^\dagger_{\mathsf{CKM}} \tilde{u}_L \\ \tilde{d}_L \end{pmatrix} \quad \begin{matrix} \tilde{u}_R \\ \tilde{d}_R \end{matrix}$$

Mass insertion parametrization

$$\mathcal{M}^2_{\tilde{q}} = m^2_{\tilde{q}} \left[\mathbf{1} + \begin{pmatrix} \delta^q_{LL} & \delta^q_{LR} \\ \delta^q_{RL} & \delta^q_{RR} \end{pmatrix} \right], \qquad q = u,\, d.$$

Parametrization of a squark mass matrix with:

- An "average" squark mass $m_{\tilde{q}}$: $m^2_{\tilde{q}} = \mathrm{tr}\,\mathcal{M}^2_{\tilde{q}}/6$.
- "Mass insertion parameters" δ's
  - ▷ Two 3×3 hermitian matrices δ^q_{LL} and δ^q_{RR};
  - ▷ A 3×3 complex matrix $\delta^q_{LR} = \delta^{q\dagger}_{RL}$.
- In super-CKM basis, defined by tree-level "running" parameters in $\overline{\mathrm{DR}}$ scheme, evaluated at m_Z(?).
- Both supersymmetric and SUSY breaking parts included.
- Several different definitions are used in literature.

Example?

Squark/slepton mass matrices in mass insertion parametrization looks like...

$m_{\tilde{d}}$/GeV = 6.06228921e+02 $m_{\tilde{u}}$/GeV = 5.87494919e+02
$m_{\tilde{e}}$/GeV = 3.78445819e+02 $m_{\tilde{\nu}}$/GeV = 3.74915197e+02

$\mathrm{Re}(\delta^d_{LL})_{11}$=1.96204471e-01	$\mathrm{Re}(\delta^d_{LL})_{22}$= 1.95401509e-01	$\mathrm{Re}(\delta^d_{LL})_{33}$=-4.09617128e-01
$\mathrm{Re}(\delta^d_{LL})_{12}$=1.55159093e-04	$\mathrm{Re}(\delta^d_{LL})_{13}$=-3.74657889e-03	$\mathrm{Re}(\delta^d_{LL})_{23}$= 1.89581433e-02
$\mathrm{Im}(\delta^d_{LL})_{12}$=7.33798173e-05	$\mathrm{Im}(\delta^d_{LL})_{13}$=-1.69467815e-03	$\mathrm{Im}(\delta^d_{LL})_{23}$=-3.66826205e-04

$\mathrm{Re}(\delta^d_{RR})_{11}$=1.21046867e-01	$\mathrm{Re}(\delta^d_{RR})_{22}$=7.44399324e-02	$\mathrm{Re}(\delta^d_{RR})_{33}$=-1.77475651e-01
$\mathrm{Re}(\delta^d_{RR})_{12}$=1.16908068e-07	$\mathrm{Re}(\delta^d_{RR})_{13}$=2.66037561e-07	$\mathrm{Re}(\delta^d_{RR})_{23}$=-1.28909769e-05
$\mathrm{Im}(\delta^d_{RR})_{12}$=9.44683072e-08	$\mathrm{Im}(\delta^d_{RR})_{13}$=1.89860024e-07	$\mathrm{Im}(\delta^d_{RR})_{23}$=-2.29376316e-02

$\mathrm{Re}(\delta^d_{LR})_{11}$= 1.09503668e-04	$\mathrm{Re}(\delta^d_{LR})_{12}$= 6.64443466e-10	$\mathrm{Re}(\delta^d_{LR})_{13}$=-1.06114203e-08
$\mathrm{Re}(\delta^d_{LR})_{21}$= 6.81504386e-09	$\mathrm{Re}(\delta^d_{LR})_{22}$= 1.99112393e-03	$\mathrm{Re}(\delta^d_{LR})_{23}$= 2.92716354e-07
$\mathrm{Re}(\delta^d_{LR})_{31}$=-9.13006336e-06	$\mathrm{Re}(\delta^d_{LR})_{32}$= 4.61891379e-05	$\mathrm{Re}(\delta^d_{LR})_{33}$= 1.09682506e-01
$\mathrm{Im}(\delta^d_{LR})_{11}$=-1.30278509e-15	$\mathrm{Im}(\delta^d_{LR})_{12}$= 3.16262352e-10	$\mathrm{Im}(\delta^d_{LR})_{13}$=-4.63202875e-09
$\mathrm{Im}(\delta^d_{LR})_{21}$=-3.22944052e-09	$\mathrm{Im}(\delta^d_{LR})_{22}$=-6.90796809e-13	$\mathrm{Im}(\delta^d_{LR})_{23}$=-4.41018263e-05
$\mathrm{Im}(\delta^d_{LR})_{31}$= 4.11561337e-06	$\mathrm{Im}(\delta^d_{LR})_{32}$= 1.76138113e-06	$\mathrm{Im}(\delta^d_{LR})_{33}$= 3.27148344e-11

$+\delta^u_{LL,RR,LR} + \delta^e_{LL,RR,LR} + \delta^\nu_{LL} +$ other MSSM parameters.

Conclusion

- Flavor physics provides us with information about (flavor) structure of SUSY breaking sector.
- So far, there are a lot of "parameter scan" or "scatter plot" studies, that show interesting patterns of signals.
  $\Longrightarrow$ We may be able to pick up several points as "benchmarks" for SuperB simulation study.
- We agreed with basic parts of the "benchmark":
  - ▷ Definitions of parameters (as "common language").
  - ▷ (List of observables).
- Searches/updates required to find out favorable point(s).
  - ▷ Computational tools (public or private) sufficiently prepared?
    - ∗ Almighty code may not exist, then....?