PROCEEDINGS OF SCIENCE

`SUSY_FLAVOR` library for rare decays in the MSSM

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`SUSY_FLAVOR` is a FORTRAN code calculating over 30 low-energy flavour- and CP-related observables in the R-parity conserving MSSM. The code admits for the most general flavour structure of the SUSY breaking terms and complex flavour-diagonal couplings. It includes the numerically important resummation of chirally enhanced effects and it is fast enough for scanning over a large SUSY-parameter space. The program can be obtained from `http://www.fuw.edu.pl/susy_flavor`.

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SUSY_FLAVOR v2 [1] is a fast FORTRAN 77 program which calculates over 30 low-energy flavour- and CP-related observables in the MSSM taking the fully general set of SUSY parameters as an input. The program works in the following steps:

1. Parameter initialization: the user sets the SUSY breaking terms and other MSSM parameters using the SLHA2 format. SM parameters and hadronic matrix elements can also be modified.
2. Physical masses and the mixing angles: the physical spectrum of the MSSM is calculated by exact numerical diagonalization of the relevant mass matrices.
3. Resummation of the chirally enhanced effects: SUSY_FLAVOR resums all chirally enhanced effects to the relation between the fermion masses and the MSSM Yukawa couplings and calculates the effective Higgs-fermion-fermion and fermion-sfermion-gaugino vertices [2].
4. Wilson coefficients at the SUSY scale: SUSY_FLAVOR calculates the virtual SUSY corrections to the Wilson coefficients of the effective Hamiltonian used to compute the flavour observables.
5. Strong corrections: the matrix elements of the effective Hamiltonian are calculated using the data from lattice QCD. The user can update QCD input if necessary.
6. Evaluation of the physical observables: Table 1 give the list of observables calculated by SUSY_FLAVOR.

The resummation of the chirally enhanced corrections, including the threshold corrections to Yukawa couplings and CKM matrix elements, is an important new feature added to SUSY_FLAVOR in version 2.0. Such corrections arise in the case of large values of $\tan\beta$ or large trilinear SUSY-breaking terms. They formally go beyond the 1-loop approximation, but should be included due to their numerical importance. Implementation of the resummation in SUSY_FLAVOR follows the systematic approach of Refs. [2] and takes into accounts all contributions involving sfermions, gluino, chargino, neutralino and Higgs boson exchanges.

SUSY_FLAVOR v2 is an universal and easy to use numerical tool which can be used by both experimentalists and theoreticians working in the field of supersymmetric flavour physics. The program can be obtained from `http://www.fuw.edu.pl/susy_flavor`.

References

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Observable	Most stringent constraints on	Experiment
$\Delta F = 0$		
$\frac{1}{2}(g-2)_e$	$\mathrm{Re}\left[\delta_{11}^{\ell \mathrm{LR,RL}}\right]$	$(1159652188.4 \pm 4.3) \times 10^{-12}$
$\frac{1}{2}(g-2)_\mu$	$\mathrm{Re}\left[\delta_{22}^{\ell \mathrm{LR,RL}}\right]$	$(11659208.7 \pm 8.7) \times 10^{-10}$
$\frac{1}{2}(g-2)_\tau$	$\mathrm{Re}\left[\delta_{33}^{\ell \mathrm{LR,RL}}\right]$	$< 1.1 \times 10^{-3}$
$\|d_e\|$(ecm)	$\mathrm{Im}\left[\delta_{11}^{\ell \mathrm{LR,RL}}\right]$	$< 1.6 \times 10^{-27}$
$\|d_\mu\|$(ecm)	$\mathrm{Im}\left[\delta_{22}^{\ell \mathrm{LR,RL}}\right]$	$< 2.8 \times 10^{-19}$
$\|d_\tau\|$(ecm)	$\mathrm{Im}\left[\delta_{33}^{\ell \mathrm{LR,RL}}\right]$	$< 1.1 \times 10^{-17}$
$\|d_n\|$(ecm)	$\mathrm{Im}\left[\delta_{11}^{\mathrm{dLR,RL}}\right]$, $\mathrm{Im}\left[\delta_{11}^{\mathrm{uLR,RL}}\right]$	$< 2.9 \times 10^{-26}$
$\Delta F = 1$		
$\mathrm{Br}(\mu \to e\gamma)$	$\delta_{12,21}^{\ell LR,RL}$, $\delta_{12}^{\ell LL,RR}$	$< 2.4 \times 10^{-12}$
$\mathrm{Br}(\tau \to e\gamma)$	$\delta_{13,31}^{\ell LR,RL}$, $\delta_{13}^{\ell LL,RR}$	$< 3.3 \times 10^{-8}$
$\mathrm{Br}(\tau \to \mu\gamma)$	$\delta_{23,32}^{\ell LR,RL}$, $\delta_{23}^{\ell LL,RR}$	$< 4.4 \times 10^{-8}$
$\mathrm{Br}(K_L \to \pi^0 \nu\nu)$	$\delta_{23}^{uLR}, \delta_{13}^{uLR} \times \delta_{23}^{uLR}$	$< 6.7 \times 10^{-8}$
$\mathrm{Br}(K^+ \to \pi^+ \nu\nu)$	sensitive to $\delta_{13}^{uLR} \times \delta_{23}^{uLR}$	$17.3^{+11.5}_{-10.5} \times 10^{-11}$
$\mathrm{Br}(B_d \to ee)$	$\delta_{13}^{dLL,RR}$	$< 1.13 \times 10^{-7}$
$\mathrm{Br}(B_d \to \mu\mu)$	$\delta_{13}^{dLL,RR}$	$< 8 \times 10^{-10}$
$\mathrm{Br}(B_d \to \tau\tau)$	$\delta_{13}^{dLL,RR}$	$< 4.1 \times 10^{-3}$
$\mathrm{Br}(B_s \to ee)$	$\delta_{23}^{dLL,RR}$	$< 7.0 \times 10^{-5}$
$\mathrm{Br}(B_s \to \mu\mu)$	$\delta_{23}^{dLL,RR}$	$3.2^{+1.5}_{-1.2} \times 10^{-9}$
$\mathrm{Br}(B_s \to \tau\tau)$	$\delta_{23}^{dLL,RR}$	$--$
$\mathrm{Br}(B_s \to \mu e)$	$\delta_{23}^{dLL,RR} \times \delta_{12}^{\ell LL,RR}$	$< 2.0 \times 10^{-7}$
$\mathrm{Br}(B_s \to \tau e)$	$\delta_{23}^{dLL,RR} \times \delta_{13}^{\ell LL,RR}$	$< 2.8 \times 10^{-5}$
$\mathrm{Br}(B_s \to \mu\tau)$	$\delta_{23}^{dLL,RR} \times \delta_{23}^{\ell LL,RR}$	$< 2.2 \times 10^{-5}$
$\mathrm{Br}(B^+ \to \tau^+ \nu)$	–	$(1.65 \pm 0.34) \times 10^{-4}$
$\mathrm{Br}(B_d \to D\tau\nu)/\mathrm{Br}(B_d \to Dl\nu)$	–	$(0.407 \pm 0.12 \pm 0.049)$
$\mathrm{Br}(B \to X_s\gamma)$	$\delta_{23}^{dLL,RR}$ for large $\tan\beta$, $\delta_{23,32}^{dLR}$	$(3.52 \pm 0.25) \times 10^{-4}$
$\Delta F = 2$		
$\|\varepsilon_K\|$	$\mathrm{Im}\left[(\delta_{12}^{\mathrm{dLL,RR}})^2\right]$, $\mathrm{Im}\left[(\delta_{12,21}^{\mathrm{dLR}})^2\right]$	$(2.229 \pm 0.010) \times 10^{-3}$
ΔM_K	$\delta_{12}^{dLL,RR}$, $\delta_{12,21}^{dLR}$	$(5.292 \pm 0.009) \times 10^{-3}$ ps^{-1}
ΔM_D	$\delta_{12}^{uLL,RR}$, $\delta_{12,21}^{uLR}$	$(2.37^{+0.66}_{-0.71}) \times 10^{-2}$ ps^{-1}
ΔM_{B_d}	$\delta_{13}^{dLL,RR}$, $\delta_{13,31}^{dLR}$	(0.507 ± 0.005) ps^{-1}
ΔM_{B_s}	$\delta_{23}^{dLL,RR}$, $\delta_{23,32}^{dLR}$	(17.77 ± 0.12) ps^{-1}

Table 1: List of observables calculated by SUSY_FLAVOR v2, their currently measured values or bounds and the elements of the sfermion mass matrices most stringently constrained by the corresponding process.