~~SUSY_FLAVOR~~
2.5)
1510.08840

Observable	SM	Experiment*	Future Thy. $\oplus$ Exp. bound/uncertainty
$\|d_e\|$ [e.cm]	$\lesssim \mathcal{O}(10^{-40})$ [32,33]	$< 8.7 \times 10^{-29}$ [34]	$\lesssim 10^{-30}$ [1,35,36]
$\|d_\mu\|$ [e.cm]	$\lesssim \mathcal{O}(10^{-38})$ [37]	$< 1.6 \times 10^{-19}$ [38]	$\lesssim 10^{-24}$ [1,39]
$\|d_n\|$ [e.cm]	$\lesssim \mathcal{O}(10^{-31})$ [40,41]	$< 2.9 \times 10^{-26}$ [42]	$\lesssim 5 \times 10^{-28}$ [43]
a_e $[10^{-12}]$	1159652182.79 $\pm$ 7.71 [44]	1159652180.73 $\pm$ 28 [45]	$--$
a_μ $[10^{-11}]$	116591802$\pm$49 116591828$\pm$50 [46]	116592089 $\pm$ 63 [47]	$\pm$12 [1]
$\mathrm{Br}(K_L \to \pi^0\,\nu\,\bar{\nu})$	$3.04 \pm 15.7\%$ $\times 10^{-11}$ [48]	$< 2.6 \times 10^{-8}$ [49]	$\pm 6.0\% \pm 5.1\% =$ 7.9% [1,50]
$\mathrm{Br}(K^+ \to \pi^+\,\nu\,\bar{\nu})$ $\times 10^{11}$	$9.2 \pm 8.2\%$ [48]	$17.3^{+11.5}_{-10.5}$ [51]	$\pm 5.4\% \pm 2.2\% =$ 5.8% [1,52]
$\mathrm{Br}(B_d \to X_s\,\gamma)^\dagger$ $\times 10^4$	$3.17 \pm 7.3\%$ [53]	$3.43 \pm 6.7\%$ [54]	$\pm 6.7\% \pm 4.0\% =$ 7.8% [55]
$\mathrm{Br}(B_s \to \mu^+\mu^-)$ $\times 10^9$	$3.74 \pm 4.1\%$ [56]	2.9 ± 0.7 [57]	$\pm 3.2\% \pm 8.6\% =$ 9.2% [58]
$\mathrm{Br}(B_d \to \mu^+\mu^-)$ $\times 10^{10}$	$1.21 \pm 6.1\%$ [56]	$3.6^{+1.6}_{-1.4}$ [57]	$\pm 3.9\% \pm 36.0\% =$ 36.2% [58]
$\mathrm{Br}(B_u \to \tau\nu_\tau)$ $\times 10^4$	$0.779 \pm 8.6\%$ [59]	1.14 ± 0.22 [54]	$\pm 6.0\% \pm 6.3\% =$ 8.7% [55]
$\Delta M_{B_d}[\mathrm{ps}^{-1}]$	$0.545 \pm 16.8\%$ [60]	0.507 ± 0.005 [54]	$\pm 3.7\% \pm 0.9\% =$ 3.8%
$\Delta M_{B_s}[\mathrm{ps}^{-1}]$	$17.70 \pm 15.0\%$ [60]	17.719 ± 0.043 [54]	$\pm 3.1\% \pm 0.2\% =$ 3.1%
$\Delta M_K[10^{-3}\ \mathrm{ps}^{-1}]$	4.824	5.292 ± 0.009 [61]	$--$
$\epsilon_K[10^{-3}]$	$2.319 \pm 9.3\%$ [62]	2.228 ± 0.011 [61]	$--$
$\sin(2\beta)$	$0.695 \pm 5.6\%$ [62]	0.68 ± 0.02 [54]	$\pm 2.1\% \pm 1.2\% =$ 2.4% [58]
$\sin(2\beta_s)$	$0.0375 \pm 4.0\%$ [62]	$-0.04^{+0.13}_{-0.10}$ [54]	$\pm 2.5\% \pm 15.8\% =$ $\pm 16.0\%$ [58]

*All upper bounds are at 90% C.L., $^\dagger E_\gamma > 1.6$ GeV in the B-meson rest frame.

Table 3: The complete set of observables studied in this work. All processes are computed using SUSY_FLAVOR v2.10.

calculations. The most important parameters α_i for our analysis are the CKM angle $|V_{ub}|$ and the CKM phase δ, although we include all the parameters listed in Table 4. The uncertainty in O due to the corresponding error in α_i can be estimated as

$$\sigma_i(O) = \frac{\partial O}{\partial \alpha_i}\sigma(\alpha_i). \tag{1}$$

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Super ISO 3.4

Observable	Combined experimental value	95% C.L. Bound
$\mathrm{BR}(B \to X_s\gamma)$	$(3.43 \pm 0.21 \pm 0.07) \times 10^{-4}$ [109] 0808.1297 + UPDATE	$2.63 \times 10^{-4} \leq \mathrm{BR}(b \to s\gamma) \leq 4.23 \times 10^{-4}$
$\Delta_0(B \to K^*\gamma)$	$(5.2 \pm 2.6) \times 10^{-2}$ (a)	$-1.7 \times 10^{-2} < \Delta_0 < 8.9 \times 10^{-2}$
$\mathrm{BR}(B_u \to \tau\nu_\tau)$ $R_{\tau\nu_\tau}$	$(1.64 \pm 0.34) \times 10^{-4}$ [109] 1.63 ± 0.54 (b)	$0.71 \times 10^{-4} < \mathrm{BR}(B_u \to \tau\nu_\tau) < 2.57 \times 10^{-4}$ $0.56 < R_{\tau\nu_\tau} < 2.70$
$\mathrm{BR}(B \to D^0\tau\nu_\tau)$ $\xi_{D\ell\nu}$	$(8.6 \pm 2.4 \pm 1.1 \pm 0.6) \times 10^{-3}$ [112] $0.416 \pm 0.117 \pm 0.052$ [112]	$2.9 \times 10^{-3} < \mathrm{BR}(B \to D^0\tau\nu_\tau) < 14.2 \times 10^{-3}$ $0.151 < \xi_{D\ell\nu} < 0.681$
$\mathrm{BR}(B_s \to \mu^+\mu^-)$	$(2.9 \pm 0.7) \times 10^{-9}$ [113]	$1.3 \times 10^{-9} < \mathrm{BR}(B_s \to \mu^+\mu^-) < 4.5 \times 10^{-9}$
$\mathrm{BR}(B_d \to \mu^+\mu^-)$	$(3.6^{+1.6}_{-1.4}) \times 10^{-10}$ [113]	$\mathrm{BR}(B_d \to \mu^+\mu^-) < 1.1 \times 10^{-9}$
$\dfrac{\mathrm{BR}(K \to \mu\nu)}{\mathrm{BR}(\pi \to \mu\nu)}$ $R_{\mu 23}$	0.6358 ± 0.0011 (c) 0.999 ± 0.007 [104]	$0.6257 < \dfrac{\mathrm{BR}(K \to \mu\nu)}{\mathrm{BR}(\pi \to \mu\nu)} < 0.6459$ $0.985 < R_{\mu 23} < 1.013$ (d)
$\mathrm{BR}(D_s \to \tau\nu_\tau)$ $\mathrm{BR}(D_s \to \mu\nu_\mu)$ $\mathrm{BR}(D \to \mu\nu_\mu)$	$(5.38 \pm 0.32) \times 10^{-2}$ [97] $5.81 \pm 0.43 \times 10^{-3}$ [97] $(3.82 \pm 0.33) \times 10^{-4}$ [15]	$4.7 \times 10^{-2} < \mathrm{BR}(D_s \to \tau\nu_\tau) < 6.1 \times 10^{-2}$ $4.9 \times 10^{-3} < \mathrm{BR}(D_s \to \mu\nu_\mu) < 6.7 \times 10^{-3}$ $3.0 \times 10^{-4} < \mathrm{BR}(D \to \mu\nu_\mu) < 4.6 \times 10^{-4}$
δa_μ	$(2.55 \pm 0.80) \times 10^{-9}$ [114]	$-2.4 \times 10^{-10} < \delta a_\mu < 5.0 \times 10^{-9}$

Table 17: Suggested limits for the observables implemented in `SuperIso v3.4`. The 95% C.L. bounds presented in this table include both the experimental and the theoretical uncertainties.

(a) Value obtained combining the Babar measurement [110] with the results of [15, 111].
(b) Value deduced from [109].
(c) Value obtained combining the results of [15, 95].
(d) See [21] for a discussion on the uncertainties.

SUSY_FLAVOR 2.53

Observable	Experiment	
$\Delta F = 0$		
$\frac{1}{2}(g-2)_e$	$(1159652188.4 \pm 4.3) \times 10^{-12}$ [51]	
$\frac{1}{2}(g-2)_\mu$	$(11659208.7 \pm 8.7) \times 10^{-10}$ [2]	
$\frac{1}{2}(g-2)_\tau$	$< 1.1 \times 10^{-3}$ [52]	
$\lvert d_e \rvert$(ecm)	$< 1.6 \times 10^{-27}$ [53]	2002
$\lvert d_\mu \rvert$(ecm)	$< 2.8 \times 10^{-19}$ [54]	~~2014 PDG~~ 2004 §.2
$\lvert d_\tau \rvert$(ecm)	$< 1.1 \times 10^{-17}$ [55]	2014 PDG
$\lvert d_n \rvert$(ecm)	$< 2.9 \times 10^{-26}$ [56]	2006
$\Delta F = 1$		
$\mathrm{Br}(\mu \to e\gamma)$	$< 5.7 \times 10^{-13}$ [57]	1303.0754 MEG
$\mathrm{Br}(\tau \to e\gamma)$	$< 3.3 \times 10^{-8}$ [58]	0908.2381 BAB
$\mathrm{Br}(\tau \to \mu\gamma)$	$< 4.4 \times 10^{-8}$ [58]	
$\mathrm{Br}(K_L \to \pi^0\nu\nu)$	$< 6.7 \times 10^{-8}$ [59]	0712.1516 E391a
$\mathrm{Br}(K^+ \to \pi^+\nu\nu)$	$17.3^{+11.5}_{-10.5} \times 10^{-11}$ [60]	0808 E949
$\mathrm{Br}(B_d \to ee)$	$< 1.13 \times 10^{-7}$ [61]	0712 BAB
$\mathrm{Br}(B_d \to \mu\mu)$	$< 7.4 \times 10^{-10}$ [62]	1707 Lb
$\mathrm{Br}(B_d \to \tau\tau)$	$< 4.1 \times 10^{-3}$ [64]	0511015 BAB
$\mathrm{Br}(B_d \to \mu e)$	$< 3.7 \times 10^{-9}$ [63]	1707 Lb
$\mathrm{Br}(B_s \to ee)$	$< 7.0 \times 10^{-5}$ [65]	1997. L3
$\mathrm{Br}(B_s \to \mu\mu)$	$(2.9 \pm 0.7) \times 10^{-9}$ [66]	LHcb+CMS 2013
$\mathrm{Br}(B_s \to \tau\tau)$	$--$	
$\mathrm{Br}(B_s \to \mu e)$	$< 1.4 \times 10^{-8}$ [63]	Lb
$\mathrm{Br}(B_s \to \tau e)$	$< 2.8 \times 10^{-5}$ [55]	
$\mathrm{Br}(B_s \to \mu\tau)$	$< 2.2 \times 10^{-5}$ [55]	
$\mathrm{Br}(B^+ \to \tau^+\nu)$	$(1.14 \pm 0.27) \times 10^{-4}$ [55]	
$\mathrm{Br}(B \to D\tau\nu)/\mathrm{Br}(B \to Dl\nu)$	$(0.440 \pm 0.058 \pm 0.042)$ [67]	1205 baba
$\mathrm{Br}(B \to D^\star\tau\nu)/\mathrm{Br}(B \to D^\star l\nu)$	$(0.332 \pm 0.024 \pm 0.018)$ [67]	
$\mathrm{Br}(B \to X_s\gamma)$	~~$(3.52 \pm 0.25) \times 10^{-4}$~~ [68]	0808.1297
$\mathrm{Br}(t \to ch, uh)$	$< 5.6 \times 10^{-3}$ [69]	CMS 2013
$\Delta F = 2$		
$\lvert \epsilon_K \rvert$	$(2.229 \pm 0.010) \times 10^{-3}$ [55]	
ΔM_K	$(5.292 \pm 0.009) \times 10^{-3}\ \mathrm{ps}^{-1}$ [55]	
ΔM_D	$(2.37^{+0.66}_{-0.71}) \times 10^{-2}\ \mathrm{ps}^{-1}$ [55]	
ΔM_{B_d}	$(0.507 \pm 0.005)\ \mathrm{ps}^{-1}$ [68]	
ΔM_{B_s}	$(17.77 \pm 0.12)\ \mathrm{ps}^{-1}$ [70]	CDF 06

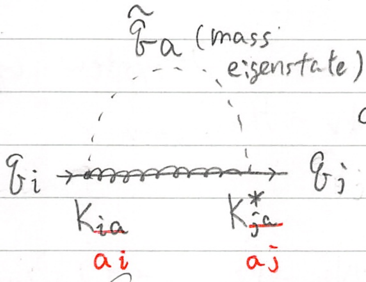
Table 1: List of observables calculated by SUSY_FLAVOR v2.5 and their measured values.

SuperIso 3.4

Observable	Experiment [115–117]	SM prediction
$\mathrm{BR}(B \to X_s \ell^+ \ell^-)_{q^2 \in [1,6]\mathrm{GeV}^2}$	$(1.56 \pm 0.39) \times 10^{-6}$	$(1.73 \pm 0.16) \times 10^{-6}$
$\mathrm{BR}(B \to X_s \ell^+ \ell^-)_{q^2 > 14.4\mathrm{GeV}^2}$	$(4.79 \pm 1.04) \times 10^{-7}$	$(2.20 \pm 0.44) \times 10^{-7}$
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$(0.60 \pm 0.06 \pm 0.05 \pm 0.04 \pm 0.05) \times 10^{-7}$	$(0.70 \pm 0.81) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$0.37 \pm 0.10 \pm 0.04$	0.32 ± 0.20
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$-0.19 \pm 0.40 \pm 0.02$	-0.01 ± 0.04
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$0.03 \pm 0.15 \pm 0.01$	0.17 ± 0.02
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$0.00 \pm 0.52 \pm 0.06$	-0.37 ± 0.03
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$0.45 \pm 0.22 \pm 0.09$	0.52 ± 0.04
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$0.24 \pm 0.22 \pm 0.05$	-0.05 ± 0.04
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [0.1,2]\mathrm{GeV}^2}$	$-0.12 \pm 0.56 \pm 0.04$	0.02 ± 0.04
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$(0.30 \pm 0.03 \pm 0.03 \pm 0.02 \pm 0.02) \times 10^{-7}$	$(0.35 \pm 0.29) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$0.74 \pm 0.10 \pm 0.03$	0.76 ± 0.20
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$-0.29 \pm 0.65 \pm 0.03$	-0.05 ± 0.05
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$0.50 \pm 0.08 \pm 0.02$	0.25 ± 0.09
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$0.74 \pm 0.58 \pm 0.16$	0.54 ± 0.07
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$0.29 \pm 0.39 \pm 0.07$	-0.33 ± 0.11
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$-0.15 \pm 0.38 \pm 0.05$	-0.06 ± 0.06
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [2,4.3]\mathrm{GeV}^2}$	$-0.3 \pm 0.58 \pm 0.14$	0.04 ± 0.05
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$(0.49 \pm 0.04 \pm 0.04 \pm 0.03 \pm 0.04) \times 10^{-7}$	$(0.48 \pm 0.53) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$0.57 \pm 0.07 \pm 0.03$	0.63 ± 0.14
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$0.36 \pm 0.31 \pm 0.03$	-0.11 ± 0.06
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$-0.25 \pm 0.08 \pm 0.02$	-0.36 ± 0.05
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$1.18 \pm 0.30 \pm 0.10$	0.99 ± 0.03
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$-0.19 \pm 0.16 \pm 0.03$	-0.83 ± 0.05
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$0.04 \pm 0.15 \pm 0.05$	-0.02 ± 0.06
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [4.3,8.68]\mathrm{GeV}^2}$	$0.58 \pm 0.38 \pm 0.06$	0.02 ± 0.06
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$(0.56 \pm 0.06 \pm 0.04 \pm 0.04 \pm 0.05) \times 10^{-7}$	$(0.67 \pm 1.17) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$0.33 \pm 0.08 \pm 0.03$	0.39 ± 0.24
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$0.07 \pm 0.28 \pm 0.02$	-0.32 ± 0.70
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$-0.50 \pm 0.03 \pm 0.01$	-0.47 ± 0.14
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$-0.18 \pm 0.70 \pm 0.08$	1.15 ± 0.33
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$-0.79 \pm 0.20 \pm 0.18$	-0.82 ± 0.36
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$0.18 \pm 0.25 \pm 0.03$	0.00 ± 0.00
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [14.18,16]\mathrm{GeV}^2}$	$-0.40 \pm 0.60 \pm 0.06$	0.00 ± 0.01
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$(0.41 \pm 0.04 \pm 0.04 \pm 0.03 \pm 0.03) \times 10^{-7}$	$(0.43 \pm 0.78) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$0.38 \pm 0.09 \pm 0.03$	0.36 ± 0.13
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$-0.71 \pm 0.35 \pm 0.06$	-0.55 ± 0.59
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$-0.32 \pm 0.08 \pm 0.01$	-0.41 ± 0.15
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$0.70 \pm 0.52 \pm 0.06$	1.24 ± 0.25
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$-0.60 \pm 0.19 \pm 0.09$	-0.66 ± 0.37
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$-0.31 \pm 0.38 \pm 0.10$	0.00 ± 0.00
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [16,19]\mathrm{GeV}^2}$	$0.12 \pm 0.54 \pm 0.04$	0.00 ± 0.04
$\langle dBR/dq^2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$(0.34 \pm 0.03 \pm 0.04 \pm 0.02 \pm 0.03) \times 10^{-7}$	$(0.38 \pm 0.33) \times 10^{-7}$
$\langle F_L(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.65 \pm 0.08 \pm 0.03$	0.70 ± 0.21
$\langle P_1(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.15 \pm 0.41 \pm 0.03$	-0.06 ± 0.04
$\langle P_2(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.33 \pm 0.12 \pm 0.02$	0.10 ± 0.08
$\langle P_4'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.58 \pm 0.36 \pm 0.06$	0.53 ± 0.07
$\langle P_5'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.21 \pm 0.21 \pm 0.03$	-0.34 ± 0.10
$\langle P_6'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.18 \pm 0.21 \pm 0.03$	-0.05 ± 0.05
$\langle P_8'(B \to K^* \mu^+ \mu^-)\rangle_{q^2 \in [1,6]\mathrm{GeV}^2}$	$0.46 \pm 0.38 \pm 0.04$	0.03 ± 0.04

Table 18: Experimental results and theoretical predictions for the $b \to s\ell\ell$ observables.

$i = L1, L2, L3, R1, R2, R3$

$\mathcal{M} =$ 

$(K^\dagger K)_{ji}$ $\quad$ $(K^\dagger m^2 K)_{ji}$

$$\propto \sum_a \frac{K_{ai}K^*_{aj}}{p^2-m_a^2} = \sum_a\left[\frac{K_{ai}K^*_{aj}}{p^2-M^2} + \frac{K_{ai}\,\delta m_a^2\, K^*_{aj}}{(p^2-M^2)^2}\right]$$

$$= \frac{1}{p^2-M^2}\left[\delta_{ij} + \sum_a \frac{\delta m_a^2}{p^2-M^2} K_{ai}K^*_{aj}\right]$$

For unitary matrix w. small mixings
$K^*_{ij}K_{jj} \simeq -K^*_{ii}K_{ji}$

$$\sum \delta m_a^2 K_{ai}K^*_{aj} \simeq \delta m_i^2 K_{ii}K^*_{ij} + \delta m_j^2 K_{ji}K^*_{jj}$$

$$\simeq (\delta m_i^2 - \delta m_j^2)K_{ii}K^*_{ij} = (m_i^2 - m_j^2)K_{ii}K^*_{ij}$$

$$\therefore \mathcal{M} \propto 1 + \frac{m_i^2 - m_j^2}{-m^2}K_{ii}K^*_{ij}$$

$$-\mathcal{L} \supset \tilde q^* M_Q^2 \tilde q + \tilde u^* M_U^2 \tilde u + \tilde d^* M_D^2 \tilde d$$ ← in our definition (B.4)

SCKM basis

$V M V^\dagger = \mathrm{diag}$
$\hat q = V^\dagger \tilde q$ mass

$$\tilde q^* M_Q^2 \tilde q = (\tilde q V^\dagger) M_Q^{2\,\mathrm{diag}} (V \tilde q)$$ mass eigen.

$$(Q^\dagger \ \ U)\begin{pmatrix} M_Q & A^\dagger \\ A & M_U \end{pmatrix}\begin{pmatrix} Q \\ U^\dagger \end{pmatrix}$$

$$\hat q_i^* q_i \tilde g + \hat q_i \bar q_i \bar g = \tilde q_i^* V_{ij} q_j \tilde g + \bar q_i \bar g (V^\dagger)_{ij} q_j$$

→ in this definition $K = \cancel{V^T}$ V

In 0812.0511 $\delta^q_{ij} \equiv \frac{m_j^2 - m_i^2}{m_{\tilde q}^2} K_{ij}K^*_{jj} = \frac{m_i^2 - m_j^2}{m_{\tilde q}^2} K_{ii}K^*_{ji}$

and $K \equiv V_{quark} V^\dagger_{squark}$ (B.4)

$$\therefore \delta_{ij} \equiv \frac{j-i}{m_{\tilde q}^2} V^*_{ji}V_{jj} = \frac{i-j}{m_{\tilde q}^2} V^*_{ii}V_{ij} = (-\mathcal{M})^*$$

i.e. $K = V^\dagger$

$$\frac{1}{p^2 - m_a^2} = \frac{1}{p^2 - M^2} + \frac{\delta m_a^2}{(p^2-M^2)^2}$$

$\delta m_a^2 = m_a^2 - M^2$

$$(m_j^2 - m_i^2)K_{ij}K^*_{jj} = (m_j^2 - m_i^2)(-K_{ii}K^*_{ji})$$
$$= -(m_j^2 - m_i^2)K_{ii}K^*_{ji}$$

Mass insertion: $\mathcal{M} \sim \tilde q_i \tilde q_j^* \sim (m^2)_{ji}/M$

$$\therefore \delta_{ij} \simeq \frac{(m^2)^*_{ji}}{\mathrm{mass}^2}$$

No.

Date

Sho Iwamoto

0812.0511 — D-system update δ_{i2}^{n}

$\nparallel$ — Nir + Hochberg

1001.1513

$\parallel$

1002.0900 — Nir + Perez + Ishidori — $\mathrm{Im}\,\delta = 0.3\,\mathrm{Re}\,\delta$

$\nparallel$ ⟷ $\nparallel$

1306.6631 — ~~Perez~~ Shadmi — $\mathrm{Im}\,\delta \sim \mathrm{Re}\,\delta$

Perez Isflah

$Y_d^\dagger U_{CKM} y' y'^\dagger V_{CKM} Y_d$

Write down everything in fermion mass basis

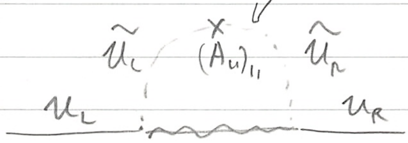
$\delta m_Q^2 = ① \, y y^\dagger \quad \rightarrow \quad y' y'^\dagger$

$\delta m_{d_R}^2 = ① \, \cancel{y} \, Y_d^\dagger y y^\dagger Y_d \quad \rightarrow \quad \cancel{Y_d^{\dagger\,\mathrm{diag}} y' y'^\dagger Y_d^{\mathrm{diag}}}$

$A_u \sim y y^\dagger Y_u \quad \rightarrow \quad y' y'^\dagger Y_u^{\mathrm{diag}}$

$\rightarrow (A_u)_{11} = (y' y'^\dagger)_{11} (Y_u^{\mathrm{diag}})_{11}$

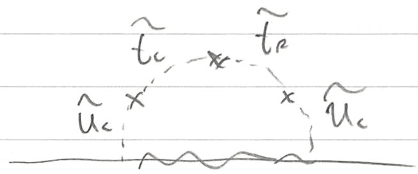
in fer. mass bas

$\rightarrow$ 

is Real

$\rightarrow$ NO EDM

Note that we can have

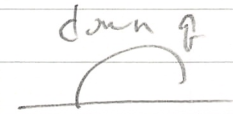


(Non zero and can be $\mathbb{C}$)

$A_d^* = V_{d_L} y y^\dagger Y_d V_{d_R}^\dagger$

$= V_{CKM} y' y'^\dagger V_{CKM}^\dagger Y_d^{\mathrm{diag}}$

$A^*_{d\,11} = (V y' y'^\dagger V^\dagger)_{12} Y_{d2}^{\mathrm{diag}}$

No EDM also for  ? $\rightarrow$ Real

WHY!

No.

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Sho Iwamoto

$$\delta m^2_{d_{RR}} = Y_d^\dagger y y^\dagger Y_d$$

$$= Y_d^{diag\dagger} V^\dagger y' y'^\dagger V Y_d^{diag}$$

$$[\delta m^2_{d_{RR}}]_{ab} = Y^{d*}_{d\,a} (V^\dagger y' y'^\dagger V)_{ab} Y^d_{d\,b}$$

SARAH
Sphero

Calibbi
Paradisi
Ziegler

CPviol in sludgm. ?

$$W = Y_{u\,ij} H_u Q_i \bar{U}_j + Y_{d\,ij} H_d Q_i \bar{D}_j$$

$$Y_u^{diag} = V_{u_L} Y_u V_{u_R}^\dagger \,, \quad Y_d^{diag} = V_{d_L} Y_d V_{d_R}^\dagger$$

$$= H_u\, Q V_{u_L}^\dagger Y_u^{diag} V_{u_R} \bar{U} + H_d\, Q V_{d_L}^\dagger Y_d^{diag} V_{d_R} \bar{D}$$

- HAT-BASIS : down-sector diagonalized
- Tilde-BASIS : up-sector diagonalized

$Q_k = \tilde{Q}_i V_{u_L\,ik}$

$Q_k^* = \tilde{Q}_i^* (V^\dagger)_{ki}$

$\bar{U}_k = (V_{u_R}^\dagger)_{ki} \tilde{\bar{U}}_i$

$\bar{U}_k^* = V_{u_R\,ik} \tilde{\bar{U}}_i^*$

$$= H_u\, \tilde{Q}\, Y_u^{diag} \tilde{\bar{U}} + H_d \tilde{Q}\, V_{u_L} V_{d_L}^\dagger Y_d^{diag} V_{d_R} \bar{D}$$

$$= H_u \hat{Q} V_{d_L} V_{u_L}^\dagger Y_u^{diag} V_{u_R} \bar{U} + H_d \hat{Q}\, Y_d^{diag} \hat{\bar{D}}$$

$$m^2_{ij} Q_i Q_j^* = Q^\dagger m^{2*} Q = Q^{\overset{\text{omitted}}{T}} m^2 Q^*$$

$$= m^2_{ij} \tilde{Q}_k V_{ki} \tilde{Q}_l^* (V^\dagger)_{jl} = \tilde{Q} V_{u_L} m^2 V_{u_L}^\dagger \tilde{Q}^*$$

$$= \hat{Q} V_{d_L} m^2 V_{d_L}^\dagger \hat{Q}^*$$

$$m^2_{ij} \bar{U}_i \bar{U}_j^* = \tilde{\bar{U}}^* V_{u_R} (m^2)^* V_{u_R}^\dagger \tilde{\bar{U}}$$

$$m^2_{ij} \bar{D}_i \bar{D}_j^* = \hat{\bar{D}}^* V_{d_R} (m^2)^* V_{d_R}^\dagger \hat{\bar{D}}$$

$G = T^a \tilde{g}^a$

$\hat{G} = -(T^a)^T \tilde{g}^a$

$\bar{G} = T^a \overline{\tilde{g}^a}$

$$\mathcal{L} \supset -\sqrt{2} g_3 \Big(\underset{\text{squark}}{q_i^*} G \underset{\text{quark}}{Q_i} + \bar{u}_i^* \hat{G} \bar{U}_i + \bar{d}_i^* \hat{G} \bar{D}_i + \bar{G}\, \overline{Q_i}\, q_i + \cdots$$

is diagonal (F.C.) at this stage, i.e. before defining "squark mass eigenstates".

Gilad et al studied for t-c mixing where oscillation does not play an important role

MFV-like

$$m_{\tilde q}^2 = m^2_{\rm diag} + \begin{pmatrix} 0 & \lambda^5 & \lambda^3 \\ \lambda^5 & \lambda^4 & \lambda^2 \\ \lambda^3 & \lambda^2 & 1 \end{pmatrix}$$

off-diagonal $\delta m \sim O(\lambda)$

$$m_{\tilde u_R}^2 = \cdots \begin{pmatrix} 0 & \lambda^4 & \lambda^3 \\ \lambda^4 & \lambda^2 & \lambda \\ \lambda^3 & \lambda & 1 \end{pmatrix} \sim O(\lambda^2)$$

→ $\tilde c_L$ and $\tilde u_L$: degenerate but $O(1)$ mixing
$\tilde c_R$, $\tilde u_R$: 〃 and small mixing

this means that, for "usual" reduction
$\Delta m^2 \gg$ large → ~~mixin~~ squark mixing from CKM
$\Delta m^2 \ll$ small → off-diagonal correction can yield large mixing!!

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MFV-like

$$m^2_{d_L} = \text{diag.} + A^\dagger A \qquad A = y^{\text{diag}} V_{CKM}$$

$$= V^\dagger m^{2\,\text{diag}} V = K m^{2\,\text{diag}} K^\dagger \qquad K = 1 + x$$

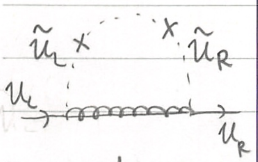
$$= (1+x)(\text{diag} + A^\dagger A)(1-x) \qquad KK^\dagger = 1 + x + x^\dagger$$

$$= \text{diag} + A^\dagger A + xd$$

$$(Q\ \bar U^\dagger)\begin{pmatrix} M_Q & A_U \\ A_U^\dagger & M_{\bar U}\end{pmatrix}\begin{pmatrix} Q^\dagger \\ \bar U\end{pmatrix}$$

$$-\mathcal{L} \supset Q\, \overset{M_Q}{\overset{\shortparallel}{m_Q^{2T}}}\, Q^\dagger + \bar U^\dagger\, \overset{M_U}{\overset{\shortparallel}{m_U^{2T}}}\, \bar U + Q A_U \bar U + \bar U^\dagger A_U^\dagger Q^\dagger$$

$$\begin{array}{cccc} \cup & \cup & \cup & \cup \\ y_{\bar U} y_{\bar U}^\dagger y_{\bar U} y_{\bar U}^\dagger & y_{\bar U}^\dagger y_{\bar U} y_{\bar U}^\dagger y_{\bar U} & y_{\bar U} y_{\bar U}^\dagger Y_{\bar U} & Y_{\bar U}^\dagger y_{\bar U} y_{\bar U}^\dagger \\ & & Y_{\bar U} y_{\bar U}^\dagger y_{\bar U} & y_{\bar U}^\dagger y_{\bar U} Y_{\bar U}^\dagger \end{array}$$



$$\tilde u_L \!-\!\!\times\!\!-\! \tilde u_R = (A_U)_{11} \to (V_{dL} A_U V_{dR}^\dagger)_{11} = V_L y y^\dagger V_L^\dagger Y^d + Y^d V_R y^\dagger y V_R^\dagger$$

$$Y = V_L^\dagger Y^d V_R$$

$$\tilde u_L \!-\!\!\times\!\times\!\!-\! \tilde u_R = (\overset{\hat u_L}{M_Q A_U} \oplus \overset{\hat u_R}{A_U M_U})_{11}$$

$$= V_L M_Q V_L^\dagger V_L y y^\dagger V_L^\dagger Y^d + V_L M_Q V_L^\dagger Y^d V_R y^\dagger y V_R^\dagger \oplus V_L y y^\dagger V_L^\dagger Y^d V_R M_Q V_R^\dagger \quad Y^d V_R y^\dagger y V_R^\dagger V_R M_Q V_R^\dagger$$

$$=: \begin{array}{cc} (H_1 H_2)_{11} Y^d & H_2 Y^d H_4 \\ H_1 Y^d H_3 & Y^d (H_3 H_4)_{11} \end{array}$$