Report from WG-A

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on behalf of the WG-A conveners
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WG-A: Phenomenology

- Our task: discussing new physics signals at SuperB
- Currently we are exploring the following models:

(A) MSSM
(B) SUSY-GUTs (together with MSSM, could be simply SUSY)
(C) Little Higgs model (LHT)
(D) Extra-Dimension model
(E) CKM analysis
(F) Model independent/Effective theory approach

More new physics signals with SuperB are welcome!

Towards the next meeting...

SuperB sensitivity information

- In order to stimulate theoretical works around SuperB, we propose to open a web-site to put up-to-date information of the SuperB sensitivity studies (and related issues).

Observable	B Factories (2 ab^{-1})	Super$B$ (7
$\sin(2\beta)$ $(J/\psi\, K^0)$	0.018	0.005 (
$\cos(2\beta)$ $(J/\psi\, K^{*0})$	0.30	0.05
$\sin(2\beta)$ (Dh^0)	0.10	0.02
$\cos(2\beta)$ (Dh^0)	0.20	0.04
$S(J/\psi\, \pi^0)$	0.10	0.02
$S(D^+D^-)$	0.20	0.03

α $(B \to \pi\pi)$	$\sim 16°$
α $(B \to \rho\rho)$	$\sim 7°$
α $(B \to \rho\pi)$	$\sim 12°$
α (combined)	$\sim 6°$

γ $(B \to DK,\, D \to CP$ eigenstates)	$\sim 15°$
γ $(B \to DK,\, D \to$ suppressed states)	$\sim 12°$
γ $(B \to DK,\, D \to$ multibody states)	$\sim 9°$
γ $(B \to DK$, combined)	$\sim 6°$

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab
$\mathcal{B}(B \to \tau\nu)$	20%	4% (†)
$\mathcal{B}(B \to \mu\nu)$		
$\mathcal{B}(B \to D\tau\nu)$		
$\mathcal{B}(B \to \rho\gamma)$		
$\mathcal{B}(B \to \omega\gamma)$		
$A_{CP}(B \to K^*\gamma)$		
$A_{CP}(B \to \rho\gamma)$	~ 0.20	
$A_{CP}(b \to s\gamma)$	0.012 (†)	
$A_{CP}(b \to (s+d)\gamma)$	0.03	
$S(K^0_S\pi^0\gamma)$	0.15	
$S(\rho^0\gamma)$		
$A_{CP}(B \to K^*\ell\ell)$		
$A^{FB}(B \to K^*\ell\ell)s_0$	25%	9%

$S(\phi K^0)$	0.13	0.02 (∗)
$S(\eta' K^0)$	0.05	0.01 (∗)
$S(K^0_S K^0_S K^0_S)$	0.15	0.02 (∗)
$S(K^0_S \pi^0)$	0.15	0.02 (∗)
$S(\omega K^0_S)$	0.17	0.03 (∗)
$S(f_0 K^0_S)$	0.12	0.02 (∗)

$\|V_{cb}\|$ (exclusive)		1.0% (∗)
$\|V_{cb}\|$ (inclusive)	1% (∗)	0.5% (∗)
$\|V_{ub}\|$ (exclusive)	8% (∗)	3.0% (∗)
$\|V_{ub}\|$ (inclusive)	8% (∗)	2.0% (∗)

✌ polarization of $B \to K^*\nu\nu$

B physics @ U(4S)

As in CDR, some updated on Valencia

Slides from A. Sticchi

Observable	B Factories (2 ab^{-1})	Super$B$ (75 ab^{-1})
$\sin(2\beta)$ $(J/\psi\, K^0)$	0.018	0.005 (†)
$\cos(2\beta)$ $(J/\psi\, K^{*0})$	0.30	0.05
$\sin(2\beta)$ (Dh^0)	0.10	0.02
$\cos(2\beta)$ (Dh^0)	0.20	0.04
$S(J/\psi\, \pi^0)$	0.10	0.02
$S(D^+D^-)$	0.20	0.03
α $(B \to \pi\pi)$	$\sim 16°$	3°
α $(B \to \rho\rho)$	$\sim 7°$	1–2° (∗)
α $(B \to \rho\pi)$	$\sim 12°$	2°
α (combined)	$\sim 6°$	1–2° (∗)
γ $(B \to DK$, $D \to CP$ eigenstates)	$\sim 15°$	2.5°
γ $(B \to DK$, $D \to$ suppressed states)	$\sim 12°$	2.0°
γ $(B \to DK$, $D \to$ multibody states)	$\sim 9°$	1.5°
γ $(B \to DK$, combined)	$\sim 6°$	1–2°
$2\beta + \gamma$ $(D^{(*)\pm}\pi^\mp$, $D^\pm K^0_S\pi^\mp)$	20°	5°
$S(\phi K^0)$	0.13	0.02 (∗)
$S(\eta' K^0)$	0.05	0.01 (∗)
$S(K^0_S K^0_S K^0_S)$	0.15	0.02 (∗)
$S(K^0_S \pi^0)$	0.15	0.02 (∗)
$S(\omega K^0_S)$	0.17	0.03 (∗)
$S(f_0 K^0_S)$	0.12	0.02 (∗)
$\lvert V_{cb}\rvert$ (exclusive)	4% (∗)	1.0% (∗)
$\lvert V_{cb}\rvert$ (inclusive)	1% (∗)	0.5% (∗)
$\lvert V_{ub}\rvert$ (exclusive)	8% (∗)	3.0% (∗)
$\lvert V_{ub}\rvert$ (inclusive)	8% (∗)	2.0% (∗)

Observable	B Factories	ab
$\mathcal{B}(B \to \tau\nu)$	2[illegible]	[illegible]
$\mathcal{B}(B \to \mu\nu)$	visib[illegible]	[illegible]
$\mathcal{B}(B \to D\tau\nu)$	1[illegible]%	2%
$\mathcal{B}(B \to \rho\gamma)$	15%	3% (†)
$\mathcal{B}(B \to \omega\gamma)$	30%	5%
$A_{CP}(B \to K^*\gamma)$	0.007 (†)	0.004 († ∗)
$A_{CP}(B \to \rho\gamma)$	~ 0.20	0.05
$A_{CP}(b \to s\gamma)$	0.012 (†)	0.004 (†)
$A_{CP}(b \to (s+d)\gamma)$	0.03	0.006 (†)
$S(K^0_S\pi^0\gamma)$	0.15	0.02 (∗)
$S(\rho^0\gamma)$	possible	0.10
$A_{CP}(B \to K^*\ell\ell)$	7%	1%
$A^{FB}(B \to K^*\ell\ell)s_0$	25%	9%
$A^{FB}(B \to X_s\ell\ell)s_0$	35%	5%
$\mathcal{B}(B \to K\nu\bar{\nu})$	visible	20%
$\mathcal{B}(B \to \pi\nu\bar{\nu})$	–	possible

Possible also at LHCb

Similar precision at LHCb

τ physics

Process	Sensitivity
$\mathcal{B}(\tau \to \mu\,\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to e\,\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \to \mu\,\mu\,\mu)$	2×10^{-10}
$\mathcal{B}(\tau \to eee)$	2×10^{-10}
$\mathcal{B}(\tau \to \mu\eta)$	4×10^{-10}
$\mathcal{B}(\tau \to e\eta)$	6×10^{-10}
$\mathcal{B}(\tau \to \ell K_s^0)$	2×10^{-10}

Charm at U(4S) and th

Slides from A. Sticchi

Mode	Observable	B Factories	
$D^0 \to K^+K^-$	y_{CP}	2–3 × [illegible]	[illegible]
$D^0 \to K^+\pi^-$	y'_D	2–3 × 10 [illegible]	[illegible]
	x'^2_D	1–2 × [illegible]	[illegible]
$D^0 \to K_S^0\pi^+\pi^-$	y_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
	x_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
Average	y_D	$1\text{–}2 \times 10^{-3}$	3×10^{-4}
	x_D	$2\text{–}3 \times 10^{-3}$	5×10^{-4}
$D^0 \to K^+\pi^-$	x'^2		3×10^{-5}
	y'		7×10^{-4}
$D^0 \to K^+K^-$	y_{CP}		5×10^{-4}
$D^0 \to K_S^0\pi^+\pi^-$	x	*To be evaluated at LHCb*	4.9×10^{-4}
	y		3.5×10^{-4}
	$\lvert q/p \rvert$		3×10^{-2}
	ϕ		2°

Channel	Sensitivity
$D^0 \to e^+e^-$, $D^0 \to \mu^+\mu^-$	1×10^{-8}
$D^0 \to \pi^0 e^+e^-$, $D^0 \to \pi^0\mu^+\mu^-$	2×10^{-8}
$D^0 \to \eta e^+e^-$, $D^0 \to \eta\mu^+\mu^-$	3×10^{-8}
$D^0 \to K_S^0 e^+e^-$, $D^0 \to K_S^0\mu^+\mu^-$	3×10^{-8}
$D^+ \to \pi^+ e^+e^-$, $D^+ \to \pi^+\mu^+\mu^-$	1×10^{-8}
$D^0 \to e^\pm\mu^\mp$	1×10^{-8}
$D^+ \to \pi^+ e^\pm\mu^\mp$	1×10^{-8}
$D^0 \to \pi^0 e^\pm\mu^\mp$	2×10^{-8}
$D^0 \to \eta e^\pm\mu^\mp$	3×10^{-8}
$D^0 \to K_S^0 e^\pm\mu^\mp$	3×10^{-8}
$D^+ \to \pi^- e^+e^+$, $D^+ \to K^- e^+e^+$	1×10^{-8}
$D^+ \to \pi^-\mu^+\mu^+$, $D^+ \to K^-\mu^+\mu^+$	1×10^{-8}
$D^+ \to \pi^- e^\pm\mu^\mp$, $D^+ \to K^- e^\pm\mu^\mp$	1×10^{-8}

B_s at U(5S)

Observable	Error with 1 ab^{-1}	Error with 30 ab^{-1}
$\Delta\Gamma$	0.16 ps^{-1}	0.03 ps^{-1}
Γ	0.07 ps^{-1}	0.01 ps^{-1}
β_s from angular analysis	20°	8°
A_{SL}^s	0.006	0.004
A_{CH}	0.004	0.004
$\mathcal{B}(B_s \to \mu^+\mu^-)$	-	$< 8 \times 10^{-9}$
$\lvert V_{td}/V_{ts} \rvert$	0.08	0.017
$\mathcal{B}(B_s \to \gamma\gamma)$	38%	7%
β_s from $J/\psi\phi$	16°	6°
β_s from $B_s \to K^0\bar{K}^0$	24°	11°

B_s : not discussed today. Maybe to be Revisited for next Workshops

Mini-study group on Benchmark

- In this workshop, we didn't get to a conclusion about the benchmark for flavour physics.
- Many questions remained: shall we have one or not? If yes, how to proceed? What is the use of the benchmark?
- In any case, better to start looking into it. We propose to have a mini-study group to get started (e.g. using wiki). Volunteers are most welcome!

WG-A: Phenomenology

- Our task: discussing new physics signals at SuperB
- Currently we a[...]llowing models:

(A) MSSM
(B) SUSY-GUTs (together with M[...]SUSY)
(C) Little Higgs model (LHT)
(D) Extra-Dimension model
(E) CKM analysis
(F) Model independent/Effective theory approach

SUSY: Shimizu, Nardecchia, Jager

LHT: Blanke, Duling

ED: Gemmler

Model Indep.: Bona, (non)MFV: Zupan, Vives

SUSY breaking, SU(5) etc...

SUSY breaking, SU(5) etc...

Why SUSY? Why S~~US~~Y?

hierarchy
$M_W \ll M_{Pl} \sim M_{seesaw} \sim M_{GUT}$
stabilized

improved unification
of couplings

(thermal relic) dark matter candidate, baryogenesis, strings, ...

EW symmetry breaking is SUSY breaking effect
SUSY nonrenormalization theorem forces this to be
either tree level or nonperturbative = $\mathcal{O}(e^{-c/g^2(\mu)}) = \mathcal{O}((\Lambda/\mu)^{c'})$

disfavoured
(mass sum rules etc)

hierarchy generated,
not only stabilized

$M_{sparticle}$, M_{EW} $= O(\Lambda^2/M_{mess})$

SUSY breaking, SU(5) etc...

talk by M. Nardecchia

Hierarchical Soft Terms

Motivations: [Effective SUSY, Choen Kaplan Lepeintre Nelson '97]

- Complementary to degenerate assumption
- If we start with a degenerate boundary condition at very high energy, we end up to a split situation at low energy because of the Yukawa coupling of the 3rd family
- Welcome to alleviate the SUSY problem

$$A(\Delta F = 1) = f(x)\hat{\delta}_{ij}$$
$$A(\Delta F = 2) = g^{(1)}(x)\hat{\delta}^2_{ij}$$

$$x = \frac{\tilde{m}_3^2}{M^2} \qquad \hat{\delta}_{a3} = \frac{\mathcal{M}^2_{a3}}{\tilde{m}^2_h}$$

There are only 4 flavor violating insertions:

$$\hat{\delta}^{LL}_{bd}, \hat{\delta}^{LL}_{bd}, \hat{\delta}^{RR}_{bd}, \hat{\delta}^{RR}_{bd}$$

$$\hat{\delta}^{LL}_{ij} \equiv \hat{\delta}^{LL}_{i3}\hat{\delta}^{LL*}_{j3}$$
$$\hat{\delta}^{LR}_{ij} \equiv \frac{\mathcal{M}^2_{L3,R3}}{\tilde{m}^2}\hat{\delta}^{LL}_{i3}\hat{\delta}^{RR*}_{j3} \qquad i,j = 1,2$$
$$\hat{\delta}^{LR}_{i3} \equiv \frac{\mathcal{M}^2_{L3,R3}}{\tilde{m}^2}\hat{\delta}^{LL}_{i3}.$$

Correlations in the two frameworks can be very different:

$$\left.\frac{A(\Delta F = 2)}{[A(\Delta F = 1)]^2}\right|_{\text{degenerate}} = \frac{g^{(3)}}{6g^{(1)}}\left(\frac{f}{f^{(1)}}\right)^2 \left.\frac{A(\Delta F = 2)}{[A(\Delta F = 1)]^2}\right|_{\text{hierarchical}}.$$

SUSY breaking, SU(5) etc...

talk by
M. Nardecchia

Provide some prediction for the mass insertion δ's

$$\left|\hat{\delta}_{sb}\right| \approx |V_{ts}^*| \approx 4 \times 10^{-2}$$

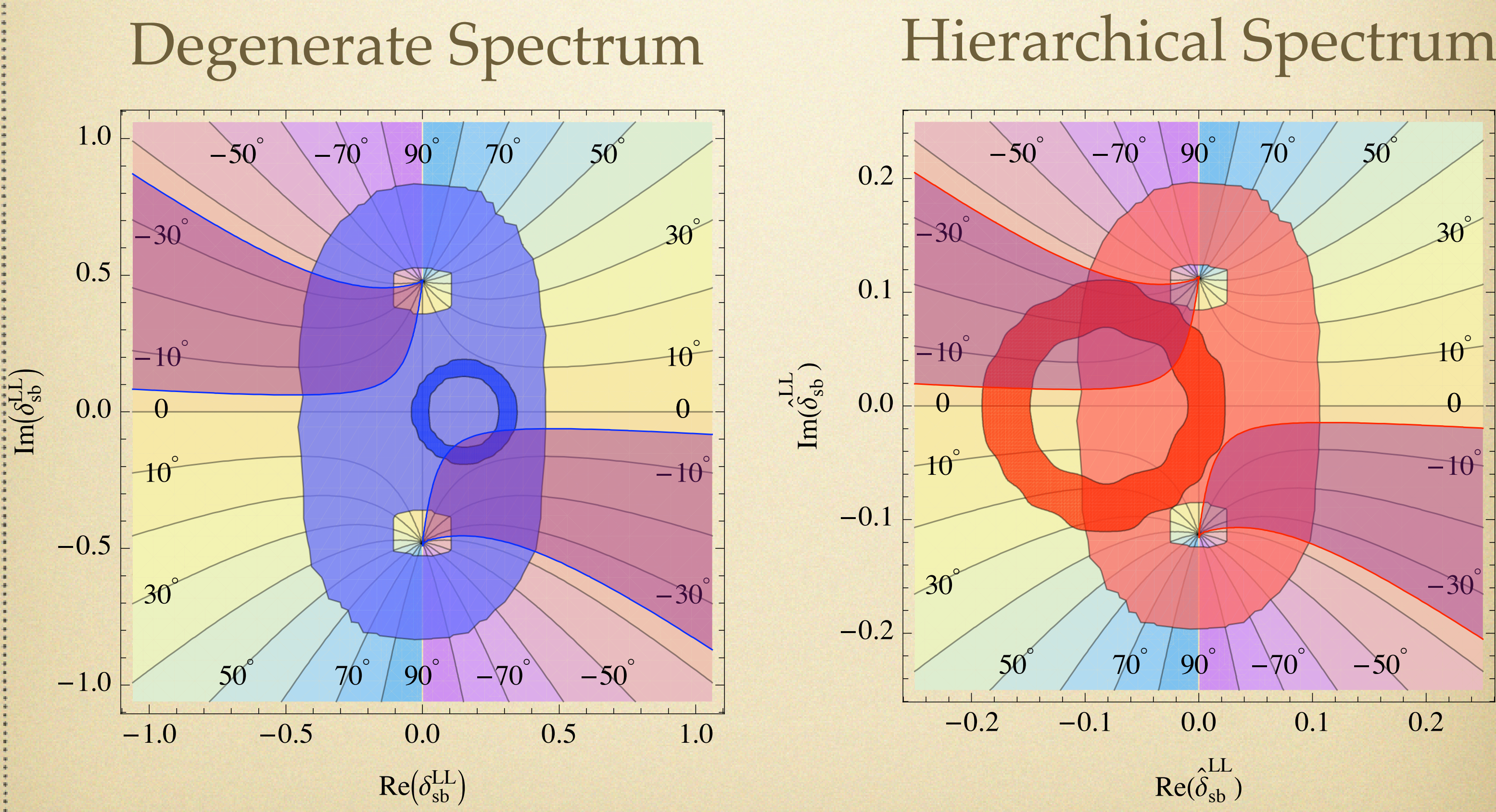
$$\left|\hat{\delta}_{db}\right| \approx |V_{td}^*| \approx 8 \times 10^{-3}$$

$$\left|\hat{\delta}_{db}\hat{\delta}_{bs}\right| \approx 3 \times 10^{-4}$$

SUSY breaking, SU(5) etc...

talk by
M. Nardecchia

Significant difference comparing to the usual degenerate case in ΔM_s, $B \to X_s \gamma$, ϕ_s.



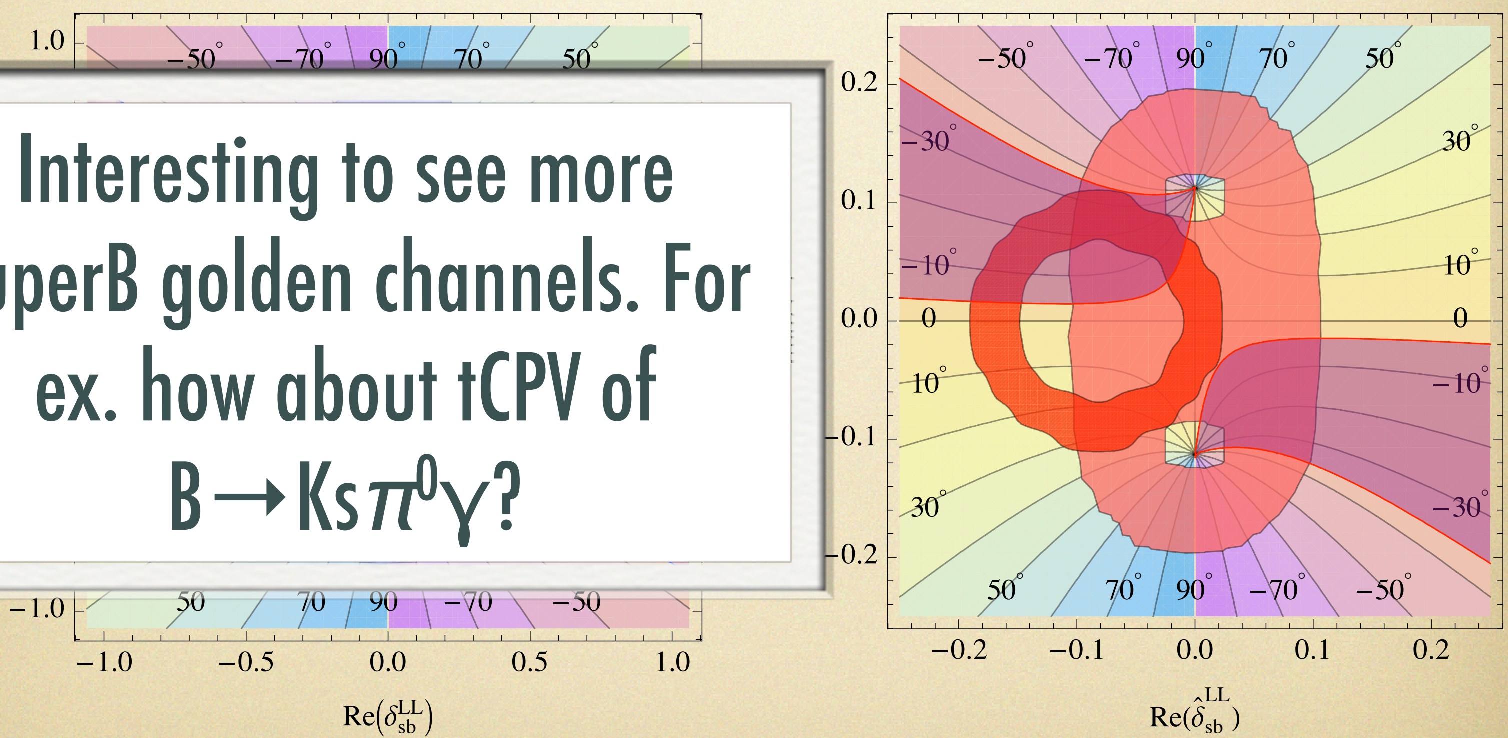
$\tilde{m} = M_{\tilde{g}} = \mu = 350$ GeV, $\tan\beta = 10$, $A = 0$

SUSY breaking, SU(5) etc...

talk by
M. Nardecchia

$$\Delta M_{B_s}, \; B \to X_s\gamma \;, \; \phi_{B_s}$$

Degenerate Spectrum Hierarchical Spectrum



Interesting to see more SuperB golden channels. For ex. how about tCPV of $B \to K_s \pi^0 \gamma$?

$\tilde{m} = M_{\tilde{g}} = \mu = 350$ GeV, $\tan\beta = 10$, $A = 0$

SUSY breaking, SU(5) etc...

talk by
S. Jager

Why SUSY? Why ~~SUSY~~?

hierarchy
$M_W \ll M_{Pl} \sim M_{seesaw} \sim M_{GUT}$
stabilized

improved unification
of couplings

(thermal relic) dark matter candidate, baryogenesis, strings, ...

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SUSY nonrenormalization theorem forces this to be
either tree level or nonperturbative = $\mathcal{O}(e^{-c/g^2(\mu)}) = \mathcal{O}((\Lambda/\mu)^{c'})$

disfavoured
(mass sum rules etc)

hierarchy generated,
not only stabilized

M_{Pl} M_{GUT} M_{mess} Λ $M_{sparticle} \sim M_{EW}$

mSUGRA

$M_{sparticle}$, M

Anomaly, gauge mediation

SUSY breaking, SU(5) etc...

talk by
S. Jager

Why SUSY? Why $\cancel{\text{SUSY}}$?

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disfavoured
(mass sum rules)

Flavour
blind or not?

hierarchy generated,
not only stabilized

M_{Pl} M_{GUT} M_{mess} Λ $M_{sparticle} \sim M_{EW}$

mSUGRA

$M_{sparticle}$, M

Anomaly, gauge mediation

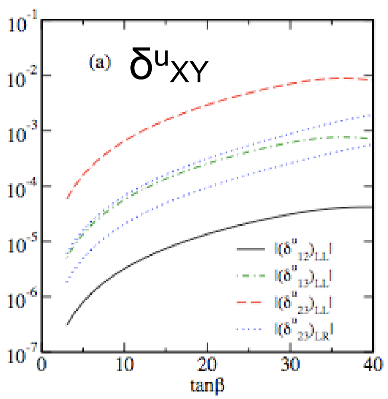
SUSY breaking, SU(5) etc...

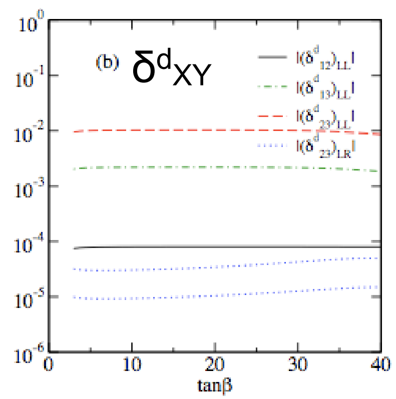
talk by
S. Jager

Anomaly mediation

recent comprehensive study of FCNC   arXiv:0902.4880 [hep-ph]

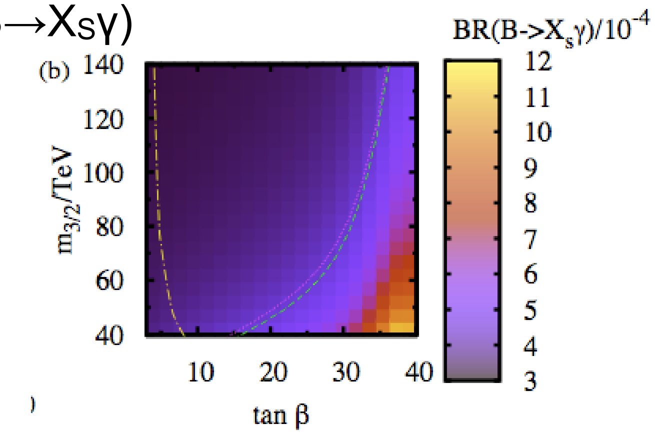
[Allanach, Hiller, Jones, Slavich]

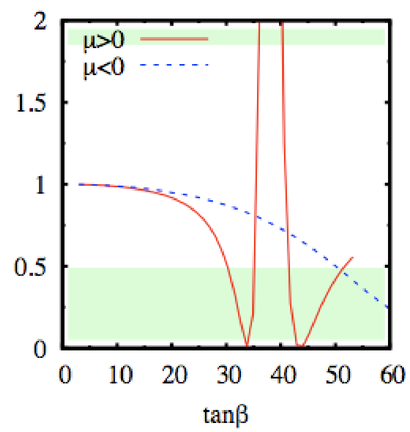




small off-diagonal δ´s
origin: CKM mixing
angles (MFV)

BR($B \to X_s \gamma$)





BR($B \to \tau\nu$) /
BR($B \to \tau\nu$)^{SM}

SUSY breaking, SU(5) etc...

talk by
Y. Shimizu

SUSY SU(5) GUT with right-handed neutrinos

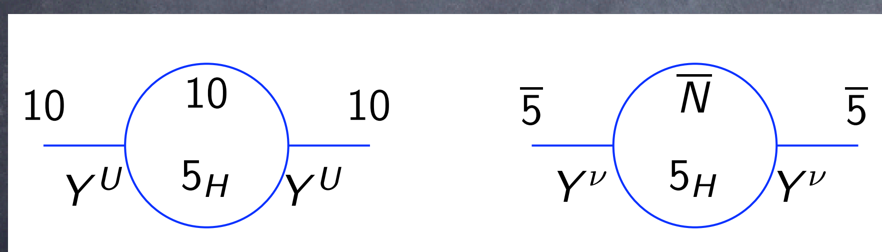
Quarks and leptons are unified

$$W = \frac{1}{4} Y^u_{ij} 10_i 10_j 5_H + \sqrt{2} Y^d_{ij} 10_i \overline{5}_j \overline{5}_H + Y^\nu_{ij} \overline{5}_i \overline{N}_j 5_H + M_{N ij} \overline{N}_i \overline{N}_j,$$

$$\mathbf{10}_i = (Q, \overline{U}, \overline{E})_i,\ \ \overline{\mathbf{5}}_i = (\overline{D}, L)_i, \mathbf{5}_H = (H_C, H_2),\ \ \overline{\mathbf{5}}_H = (\bar{H}_C, H_1)$$

Even if the universality is assumed at the planck scale, flavor mixing is induced for squarks/sleptons.

'86 Borzmati,Masiero,
'95,'96,'99 Hisano et al,



$\mathbf{10} = (Q, \bar{U}, \bar{E})$ CKM mixing

$\bar{\mathbf{5}} = (\bar{D}, L)$ MNS mixing

SUSY breaking, SU(5) etc...

talk by
Y. Shimizu

SU(5) prediction for the mass insertion δ's

$$(\delta^{(d)}_{RR})_{32} \simeq -1\times 10^{-3}\times \mathrm{e}^{i(\varphi_{d_2}-\varphi_{d_3})} \times\left(\frac{m_{\nu_\tau}}{5\times 10^{-2}\mathrm{eV}}\right)\left(\frac{M_{\nu_\tau}}{10^{13}\mathrm{GeV}}\right)\left(\frac{U_{33}U^\star_{23}}{1/2}\right)\left(\frac{3m_0^2+A_0^2}{3m_{\tilde{q}}^2}\right)$$

Immediately provide a correlations...

$$B(\tau\to\mu\gamma)\approx c|(\delta^{(l)}_{LL})_{23}|^2\mu^2\tan^2\beta$$

$$H^{B_s}\approx a(\delta^{(d)}_{LL})_{23}(\delta^{(d)}_{RR})_{23}$$

MFV, Model Independent

Model Independent

talk by
M. Bona

UT analysis including new physics (NP)

Consider for example B_s mixing process.
Given the SM amplitude, we can define

$$C_{B_s} e^{-2i\phi_{B_s}} = \frac{\langle \overline{B}_s | H_{\text{eff}}^{\text{SM}} + H_{\text{eff}}^{\text{NP}} | B_s \rangle}{\langle \overline{B}_s | H_{\text{eff}}^{\text{SM}} | B_s \rangle} = 1 + \frac{A_{\text{NP}} e^{-2i\phi_{\text{NP}}}}{A_{\text{SM}} e^{-2i\beta_s}}$$

All NP effects can be parameterized in terms of one complex parameter for each meson mixing, to be determined in a simultaneous fit with the CKM parameters (now there are enough experimental constraints to do so).
For kaons we use *Re* and *Im*, since the two exp. constraints ε_K and Δm_K are directly related to them (with distinct theoretical issues)

$$C_{\varepsilon_K} = \frac{\mathrm{Im}\langle K^0 | H_{eff}^{full} | \overline{K}^0 \rangle}{\mathrm{Im}\langle K^0 | H_{eff}^{SM} | \overline{K}^0 \rangle}$$

$$C_{\Delta m_K} = \frac{\mathrm{Re}\langle K^0 | H_{eff}^{full} | \overline{K}^0 \rangle}{\mathrm{Re}\langle K^0 | H_{eff}^{SM} | \overline{K}^0 \rangle}$$

Model Independent

talk by
M. Bona

Testing the TeV scale

$$C_i(\Lambda) = F_i \frac{L_i}{\Lambda^2}$$

The dependence of C on Λ changes on flavor structure.
we can consider different flavour scenarios:

- **Generic**: $C(\Lambda) = \alpha/\Lambda^2$ $F_i \sim 1$, arbitrary phase
- **NMFV**: $C(\Lambda) = \alpha \times |F_{SM}|/\Lambda^2$ $F_i \sim |F_{SM}|$, arbitrary phase
- **MFV**: $C(\Lambda) = \alpha \times |F_{SM}|/\Lambda^2$ $F_1 \sim |F_{SM}|$, $F_{i\neq 1} \sim 0$, SM phase

α (L_i) is the coupling among NP and SM

- $\alpha \sim 1$ for strongly coupled NP
- $\alpha \sim \alpha_W$ (α_s) in case of loop coupling through weak (strong) interactions

F_{SM} is the combination of CKM factors for the considered process

If no NP effect is seen
lower bound on NP scale Λ
if NP is seen
upper bound on NP scale Λ

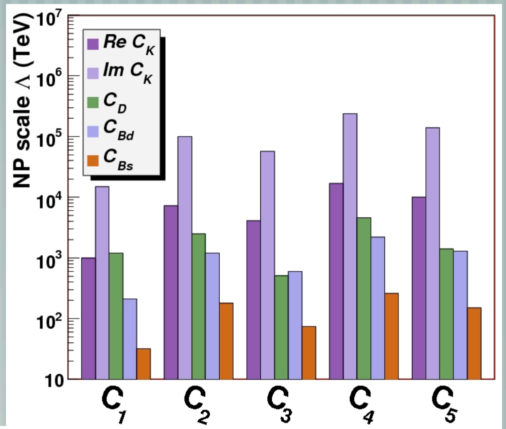
Model indepenent

talk by
M. Bona

Upper and lower bound on the scale

Lower bounds on NP scale from K and B_d physics (in TeV at 95% prob.)

Scenario	strong/tree	α_s loop	α_W loop
MFV	5.5	0.5	0.2
NMFV	62	6.2	2
General	24000	2400	800



Upper bounds on NP scale from B_s:

Scenario	strong/tree	α_s loop	α_W loop
NMFV	35	4	2
General	800	80	30

- the **general** case was already problematic (well known flavour puzzle)
- **NMFV** has problems with the size of the B_s effect vs the (insufficient) suppression in B_d and (in particular) K mixing
- **MFV** is OK for the size of the effects, but the B_s phase cannot be generated

Data suggest some hierarchy in NP mixing which is stronger than the SM one

Non-Minimal Flavour Violation

talk by
Z. Jure

Motivation

two questions

- Y_u, Y_d have $O(1)$ eigenvalues $y_{t,b}$, why are we able to expand $\bar{Q} f(\epsilon_u Y_u, \epsilon_d Y_d) Q$?
  - if $\epsilon_{u,d} \ll 1$: series truncates after first few terms $\Rightarrow$ $\boxed{\text{Linear MFV}}$ $\Rightarrow$ expansion in $Y_{u,d}$
  - if $\epsilon_{u,d} = O(1)$: higher terms important $\Rightarrow$ $\boxed{\text{Nonlinear MFV}}$ $\Rightarrow$ need to reorganize expansion
- can we distinguish LMFV vs. NLMFV?
  - interesting since $\epsilon_{u,d} \propto \log(\mu_W/\Lambda_F)$ $\Rightarrow$ could give a handle on physics at higher scales (with caveats)

Non-Minimal Flavour Violation

talk by
Z. Jure

- enhancements for CPV in $D - \bar{D}$ mixing
  - relevant operators: $(\overline{\tilde{u}}_L^{(2)} \chi\chi^\dagger u_L)^2$, $(\overline{\tilde{u}}_L^{(2)} \chi\chi^\dagger u_L)(\overline{\tilde{u}}_L^{(2)} \phi_d \phi_d^\dagger u_L)$
  - resulting CP violation in mixing $\arg(M_{12}/\Gamma_{12}) = O(5\%)\,(1\ \mathrm{TeV}/\Lambda)^2\,(\sin 2\gamma, \sin\gamma)$

$\tau \to \mu\gamma$ vs $\mu \to e\gamma$

talk by
O. Vives

τ vs μ: where to look for new physics?

Example II: μ versus τ

- Present experimental sensitivity in μ LFV decays:

$$\propto \mathrm{BR}(\mu \to e\gamma) = 10^{-11} \ (10^{-13})$$

while in τ LFV decays:

$$\propto \mathrm{BR}(\tau \to \mu\gamma) = 10^{-8} \ (10^{-9})$$

- Generically we can write $l_i \to l_j\gamma$ transitions:

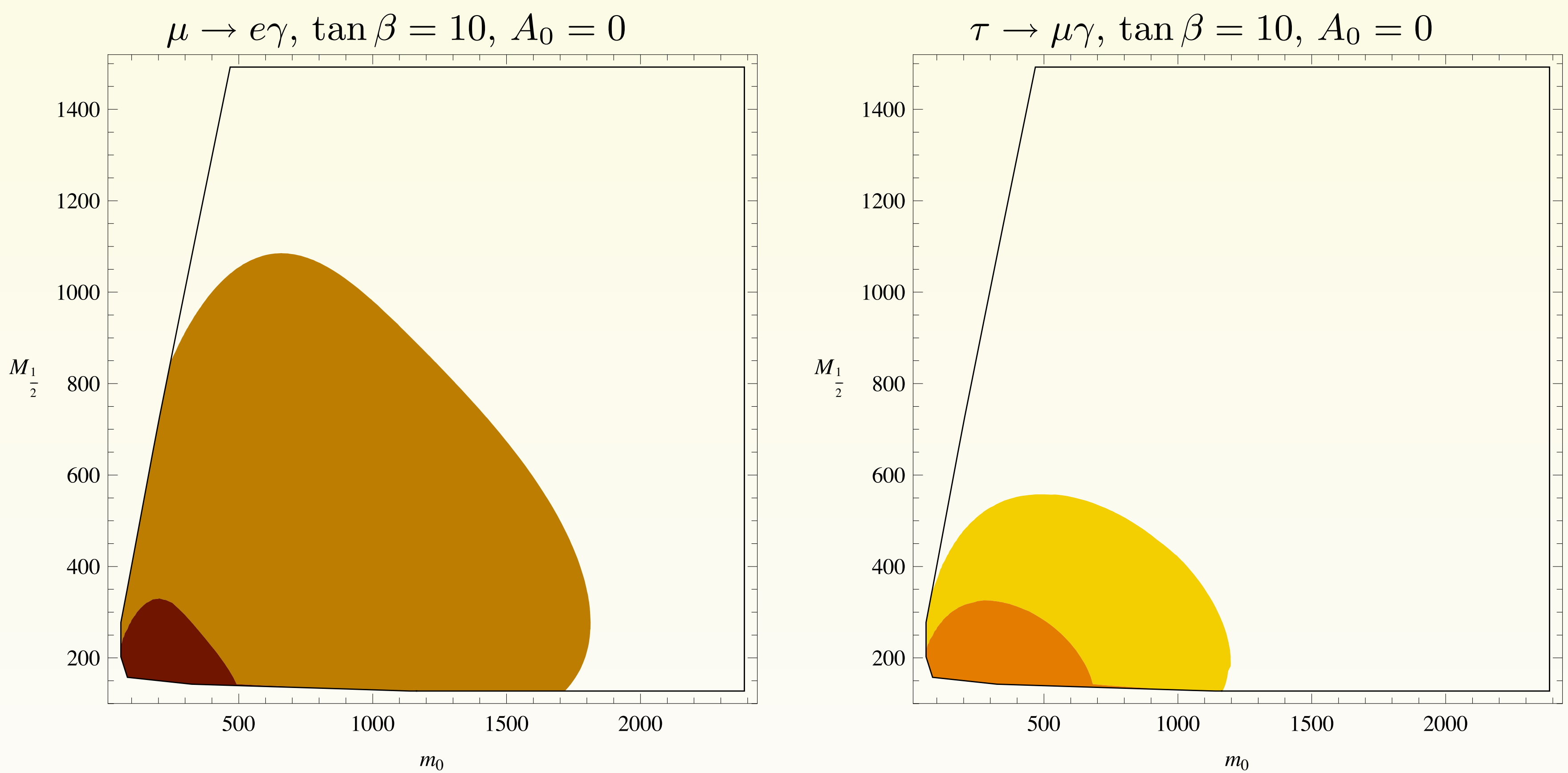
$$\mathrm{BR}(l_i \to l_j\gamma) \simeq \left(\frac{M_W}{M_{NP}}\right)^4 \times |\left(\delta^l\right)_{ij}|^2 \times f(\tan\beta, \mu \ldots),$$

$\Rightarrow$ **Interesting models determined by flavour structure:**
$$|\left(\delta^l\right)_{i3} / \left(\delta^l\right)_{12}| \gtrsim 30 \ (100)$$

$\tau \to \mu\gamma$ vs $\mu \to e\gamma$

talk by
O.Vives

Lepton Flavour Violation



Brown (clear): Present (fut.) $\mu \to e\gamma$ bounds, Orange: Present (fut.) $\tau \to \mu\gamma$ bounds.

Littele Higgs and Extra Dimension

Little Higgs with T-Parity

talk by
B. Duling

The Littlest Higgs Model with T-Parity

Arkani-Hamed, Cohen, Georgi, hep-th/0104005, hep-ph/0105239
Arkani-Hamed, Cohen, Katz, Nelson, hep-ph/0206021
Cheng, Low, hep-ph/0308199, hep-ph/0405243

Little Higgs Idea

Higgs boson as a **pseudo-Goldstone boson**

- **collective symmetry breaking** explains smallness of its mass

- **T-even quark sector**:

$$\begin{pmatrix} u \\ d \end{pmatrix}_L \quad \begin{pmatrix} c \\ s \end{pmatrix}_L \quad \begin{pmatrix} t \\ b \end{pmatrix}_L \quad \begin{matrix} u_R \\ d_R \end{matrix} \quad \begin{matrix} c_R \\ s_R \end{matrix} \quad \begin{matrix} t_R \\ b_R \end{matrix} \quad T_+$$

  - **standard CKM mixing** + mixing of T_+ with t

- **T-odd mirror quark sector**: Low, hep-ph/0409025

$$\begin{pmatrix} u_H \\ d_H \end{pmatrix} \quad \begin{pmatrix} c_H \\ s_H \end{pmatrix} \quad \begin{pmatrix} t_H \\ b_H \end{pmatrix} \quad T_-$$

  - **new CKM-like mixing matrices V_{Hu}, V_{Hd}** parameterizing mirror quark interactions with SM quarks

Little Higgs with T-Parity

talk by B. Duling

relative size of LHT effects: $\propto \frac{1}{\lambda^{i}_{\text{CKM}}}\xi^{i}_{V_{Hd}}$

$$\frac{1}{\lambda_t^{(K)}} \simeq 2500 \gg \frac{1}{\lambda_t^{(d)}} \simeq 100 > \frac{1}{\lambda_t^{(s)}} \simeq 25$$

Large tau to three lepton LFV decays due to the Z contribution!

Small in B Physics?!

	LHT	MSSM
$\frac{Br(\mu^-\to e^- e^+ e^-)}{Br(\mu\to e\gamma)}$	$0.02\ldots 1$	$\sim 6\cdot 10^{-3}$
$\frac{Br(\tau^-\to e^- e^+ e^-)}{Br(\tau\to e\gamma)}$	$0.04\ldots 0.4$	$\sim 1\cdot 10^{-2}$
$\frac{Br(\tau^-\to \mu^- \mu^+ \mu^-)}{Br(\tau\to \mu\gamma)}$	$0.04\ldots 0.4$	$\sim 2\cdot 10^{-3}$ ⋆
$\frac{Br(\tau^-\to e^- \mu^+ \mu^-)}{Br(\tau\to e\gamma)}$	$0.04\ldots 0.3$	$\sim 2\cdot 10^{-3}$ ⋆
$\frac{Br(\tau^-\to \mu^- e^+ e^-)}{Br(\tau\to \mu\gamma)}$	$0.04\ldots 0.3$	$\sim 1\cdot 10^{-2}$

⋆ can be significantly enhanced by Higgs contributions

Paradisi, hep-ph/0508054, hep-ph/0601100

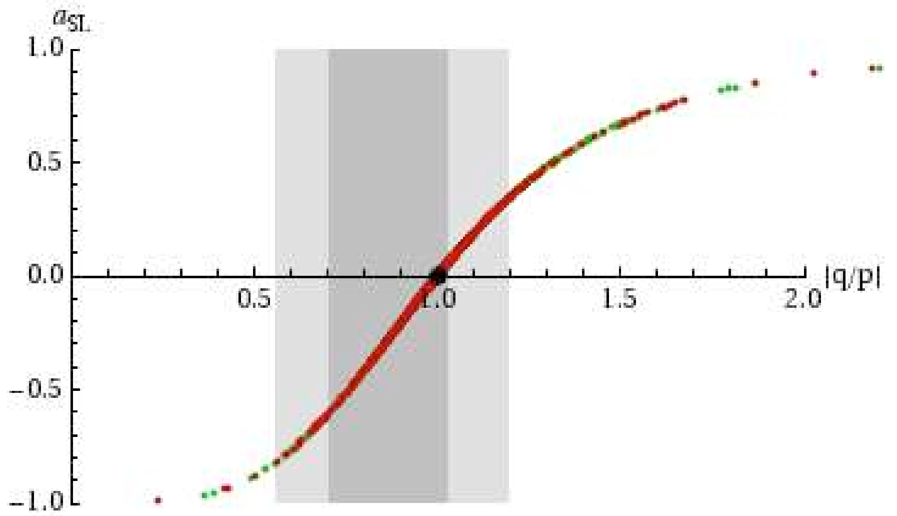
Little Higgs with T-Parity

talk by M. Blanke

CP-Violation in $D^0 - \bar{D}^0$ Oscillations

- $\left|\frac{q}{p}\right| \neq 1$ **measures CP-violation** in $D^0 - \bar{D}^0$ mixing
- exp. signature: **asymmetry in "wrong sign" leptons**

$$a_{\mathsf{SL}} = \frac{\Gamma(D^0 \to \ell^- \bar{\nu} K^{+(*)}) - \Gamma(\bar{D}^0 \to \ell^+ \nu K^{-(*)})}{\Gamma(D^0 \to \ell^- \bar{\nu} K^{+(*)}) + \Gamma(\bar{D}^0 \to \ell^+ \nu K^{-(*)})}$$



BBBR

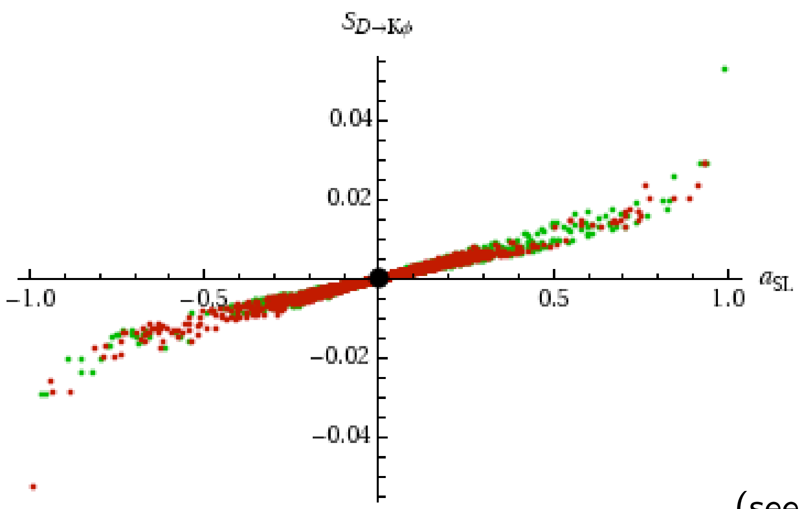
Little Higgs with T-Parity

talk by
M. Blanke

Correlation between various CP-Asymmetries

example: **time-dependent CP-asymmetry in $D \to K_S\phi$**

$$\frac{\Gamma(D^0(t) \to K_S\phi) - \Gamma(\bar{D}^0(t) \to K_S\phi)}{\Gamma(D^0(t) \to K_S\phi) + \Gamma(\bar{D}^0(t) \to K_S\phi)} \equiv S_{D\to K_S\phi}\frac{t}{2\tau_D}$$



$$S_{D\to K_S\phi} \simeq \frac{x_D^2 + y_D^2}{y_D} a_{\mathrm{SL}}$$

BBBR
(see also Grossman, Nir, Perez, 0904.0305)

- **strong correlation with a_{SL}**
- its **violation** would **signal direct CP-violation**

Warped ExtraD with flavour

talk by
K. Gemmler

The Flavour problem

$\Longrightarrow$ gauge hierarchy problem solved

- Hierarchies in masses of quarks and leptons:

$$m_u \approx 5\,MeV, \ldots, m_t \approx 172.5\,GeV$$

$$m_e \approx 0.5\,MeV, \ldots, m_\tau \approx 1800\,MeV$$

- Hierarchies in the CKM mixing:

$$|V_{ud}| \approx 1, \ldots, |V_{ub}| \approx 0.0038$$

Goal: Solution to the flavour problem

- allow the SM fields to propagate in the bulk (except of the Higgs) $\Rightarrow$ 5D fields

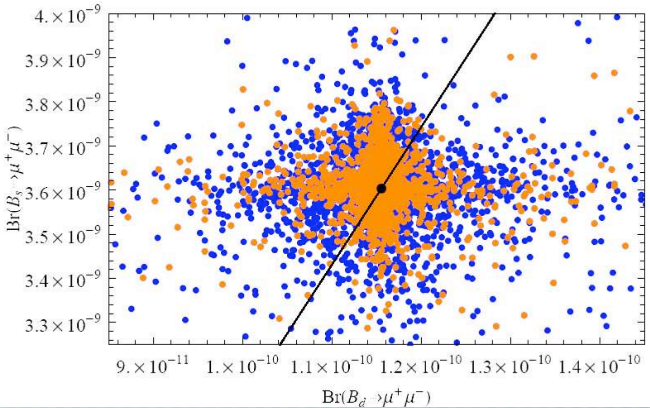
Warped ExtraD with flavour

talk by
K. Gemmler

Rare B decays

$Br(B_s \to \mu^+\mu^-)$ versus $Br(B_d \to \mu^+\mu^-)$:

- The branching ratios for $B_{s,d} \to \mu^+\mu^-$ are modified by at most 20%.
- effects are small and challenging to be measured in future experiments



Relatively new model. More signals in B physics possible. Loop computation is crucial?!