Searching for New Physics via CP Violation

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CP-VIOLATION IN MSSM (AS OPPOSED TO SM)

MOTIVATION:

- FLAVOR AND CP-VIOLATING STRUCTURE OF MSSM CARRIES INFO ABOUT UNDERLYING FUNDAMENTAL THEORY (STRINGS, ...)

- PROGRESS IN EXPERIMENT AND THEORY ENCOURAGING FOR ALTERNATIVE (INDIRECT) SEARCHES FOR SUSY

  K PHYSICS $\Delta M_K = (3.481 \pm 0.009) \times 10^{-15}\,\mathrm{GeV}$

  $\varepsilon = (2.280 \pm 0.013) \times 10^{-3}\, e^{i\frac{\pi}{4}}$

  [KTeV, 02/99] $\frac{\varepsilon'}{\varepsilon} = (28.0 \pm 4.1) \times 10^{-4}$

  SM CONSISTENT $\Rightarrow$ $\frac{\varepsilon'}{\varepsilon}$ SMALLER ($\lesssim 10^{-3}$)

  B PHYSICS CLEANER, NLO AVAILABLE FOR SUSY

  $$A_{CP}^{B} = \frac{\Gamma(\bar{B} \to X_s \gamma) - \Gamma(B \to X_{\bar{s}} \gamma)}{\Gamma(\bar{B} \to X_s \gamma) + \Gamma(B \to X_{\bar{s}} \gamma)} < 1\% \text{ in SM}$$

- EW BARYOGENESIS – POSSIBLE IN MSSM, NOT IN SM

SUSY SOURCES OF CP VIOLATION

- SUPERPOTENTIAL

$$W = h^u_{ij} \hat{Q}_i \hat{H}_2 \hat{u}^c_j + h^d_{ij} \hat{Q}_i \hat{H}_1 \hat{d}^c_j + h^l_{ij} \hat{L}_i \hat{H}_1 \hat{e}^c_j + \mu \hat{H}_1 \hat{H}_2$$

- SOFT SUSY BREAKING TERMS

$$\mathcal{L}_{SOFT} = -M_1 \lambda_1 \lambda_1 - M_2 \lambda_2 \lambda_2 - M_3 \lambda_3 \lambda_3 + h.c.$$

GAUGINO MASSES

$$- m^2_{ij} \Phi^*_i \Phi_j$$

CHIRAL SCALAR MASSES

$$- a^u_{ij} Q_i H_2 u^c_j - a^d_{ij} Q_i H_1 d^c_j - a^l_{ij} L_i H_1 e^c_j + h.c.$$

TRILINEARS

$$- B\mu H_1 H_2 + h.c.$$

HIGGS BILINEAR

PHYSICAL PHASES (AFTER FIELD ROTATIONS):

$\varphi_1, \varphi_3, \varphi_\mu$

$\varphi_{a_{ii}}$ $\quad i = u, d, c, s, t, b, e, \mu, \tau$

$\varphi_{a_{ij}}, \varphi_{m_{ij}}$ $\quad i \neq j$

ALTOGETHER ABOUT 127 PARAMETERS

41 PHASES

(SIMILAR TO WEAK LAGRANGIAN WITH S, V, T, A, P INTERACTIONS)

CONSTRAINTS ON CP PHASES

ELECTRON AND NEUTRON EDM'S

- NO FLAVOR MIXING SUPPRESSION
- 1-LOOP LEVEL CONTRIBUTIONS (DUE TO LR MIXING)

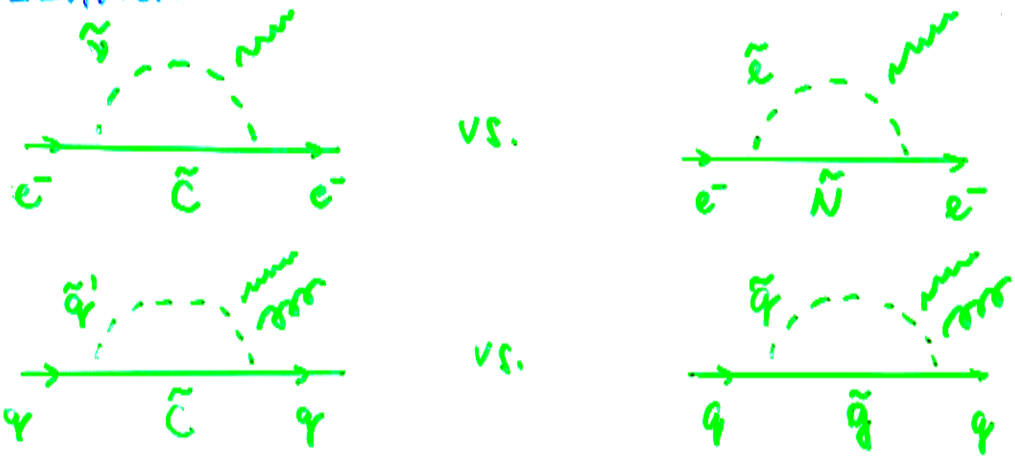
TWO SOLUTIONS (FOR $M_{SUSY} \gtrsim M_Z$)

1) INDIVIDUAL PHASES $< 10^{-2} - 10^{-3}$ FINE TUNING

2) CANCELLATION

e^-: ... vs. ...

n: ... vs. ...



- φ_μ ENTERS CHARGINO GRAPHS WITH OPPOSITE SIGN THAN NEUTRALINO (GLUINO) GRAPHS
- IF φ_1 (φ_3) CORRELATED WITH φ_μ $\Rightarrow$ CANCELLATION
- IF $\varphi_1 \simeq \varphi_3$ BOTH CANCELLATIONS AT THE SAME TIME

$\Rightarrow$ NEED NON-UNIVERSAL GAUGINO MASSES ($\varphi_{1,3} \neq \varphi_2$)

[M.B., G. GOOD, G. KANE '98]

TYPE IIB ORIENTIFOLD STRING MODEL

- NON PERTURBATIVE HETEROTIC STRING
- COMPACTIFICATION OF IIB THEORY ON { ORBIFOLD + DISCRETE WORLDSHEET SYMMETRY
- MATTER FIELD IDENTIFIED WITH OPEN (TYPE I) STRINGS ENDING ON SETS OF D-BRANES

	1 set	D9	$\longrightarrow$	DILATON	S
(up to)	3 sets	D5	$\longrightarrow$	MODULI	T_i

SIMPLEST SCENARIO

[M.B., L. EVERETT, G. KANE, AND J. LYKKEN '99]

$U(1)_Y$, $SU(3)$ in $D\text{-}5_i$

$SU(2)$ in $D\text{-}5_j$ $\quad i \neq j$

$$M_1 = M_3 = \sqrt{3}\, m_{3/2} \cos\theta\, \Theta_1\, e^{-i\alpha_1}$$

$$M_2 = \sqrt{3}\, m_{3/2} \cos\theta\, \Theta_2\, e^{-i\alpha_2} \qquad \text{with } \Theta_1^2 + \Theta_2^2 = 1$$

$$m^2_{Q,L,H_i} = m^2_{3/2} - 3/2\, m^2_{3/2} \sin^2\theta$$

$$m^2_{u,d,e} = m^2_{3/2} - 3\, m^2_{3/2} \sin^2\theta$$

$$A_{e,u,d,t} = -\sqrt{3}\, m_{3/2} \cos\theta\, \Theta_1\, e^{-i\alpha_1}$$

N.B. ALTERNATIVE EMBEDDING $U(1)_Y$, $SU(2)$ / $SU(3)$

DOES NOT ALLOW CANCELLATIONS

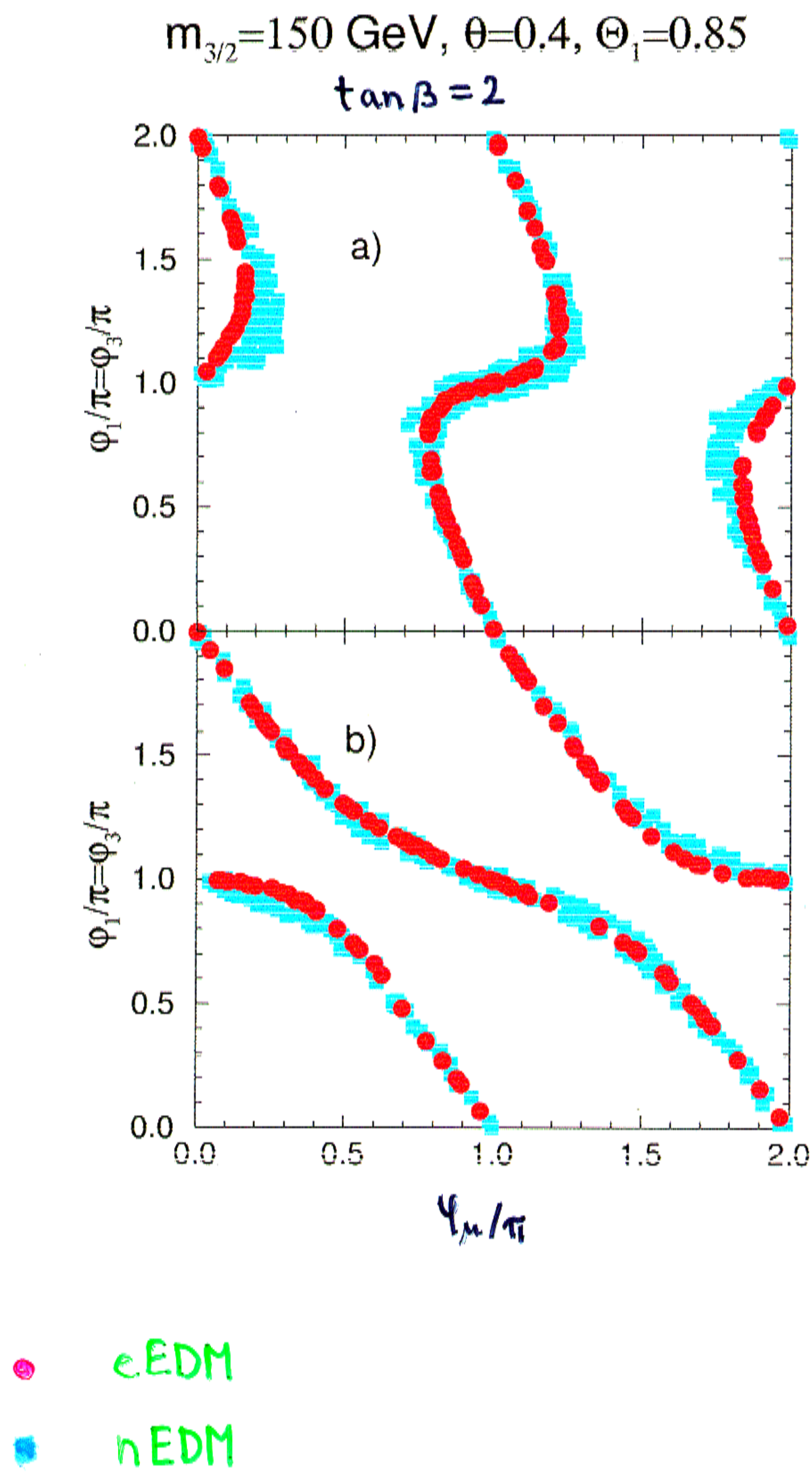
NOTE THAT 105 SUSY PARAMS ARE REDUCED TO **5**!

$m_{3/2}, \theta, \Theta_1, \alpha_1 - \alpha_2, \tan\beta$

ASSUME CKM IS REAL

$\Rightarrow$ ALL CP VIOLATION FROM SUSY

LOOK FOR MINIMAL REQUIREMENTS


m_3/2=150 GeV, θ=0.4, Θ_1=0.85
tan β = 2
a)
b)
φ_1/π=φ_3/π
φ_μ/π
eEDM
nEDM

FLAVOR STRUCTURE

D BRANE MODEL IS FLAVOR DIAGONAL AT M_{GUT}

BUT MODIFICATIONS LIKELY – FLAVOR CHANGING TERMS (KÄHLER POTENTIAL)

- LOW SCALE PHENOMENOLOGICAL APPROACH:

PICK $\Gamma^U_L, \Gamma^U_R, \Gamma^D_L, \Gamma^D_R$

$$\tilde{u}_{L,R} = \Gamma^u_{L,R}\, \tilde{u} \qquad \tilde{d}_{L,R} = \Gamma^d_{L,R}\, \tilde{d}$$

↓ CHIRAL EIGENSTATES → MASS EIGENSTATES

AND CONSIDER CONSEQUENCES FOR OBSERVABLES

D SECTOR

DEFINE $(\delta^d_{ij})_{AB} = \sum_k (\Gamma^d_A)_{ik} (\Gamma^d_B)^*_{jk}$

$i, j = 1, 2, 3$ GENERATIONS

$A, B = L, R$ CHIRALITY

TO EXPLAIN ε_K, $\varepsilon'/\varepsilon_K$ $\quad (\delta_{12})_{LL}, (\delta_{12})_{LR}, (\delta_{12})_{RL}, (\delta_{12})_{RR}$

ASSUME $|(\delta_{12})_{LL}| \gg |(\delta_{12})_{RR}|$ FROM RGE RUNNING

$$|(\delta_{12})_{LR}| \sim \left|\frac{m_s A_{12}}{\tilde{m}^2}\right| \sim 10^{-4} \quad \text{if } \frac{A_{12}}{A} \sim \sin\theta_c$$

CORRECT ORDER TO GET $\varepsilon, \varepsilon'$ RIGHT

$|(\delta_{12})|_{RL}$ suppressed by $\frac{m_d}{m_s}$

KAON SYSTEM

$$|K_S\rangle = \frac{1}{\sqrt{1+\bar{\varepsilon}^2}}\left[|K_1\rangle + \bar{\varepsilon}\,|K_2\rangle\right] \qquad |K_L\rangle = \frac{1}{\sqrt{1+\bar{\varepsilon}^2}}\left[|K_2\rangle + \bar{\varepsilon}\,|K_1\rangle\right]$$

$$|K_1\rangle = |K_0\rangle - |\bar{K}_0\rangle \qquad CP = +1$$

$$|K_2\rangle = |K_0\rangle + |\bar{K}_0\rangle \qquad CP = -1$$

$|K_1\rangle \xrightarrow{\text{DIRECT } \not{CP}} 2\pi$ $\qquad \varepsilon'$

$|K_2\rangle \xrightarrow{\text{INDIRECT } \not{CP}} 2\pi$ $\qquad \varepsilon$

MIXING

$$\mathcal{H}^{K^0\bar{K}^0} = (K_0, \bar{K}_0)\begin{pmatrix} M_{11} - \frac{i}{2}\Gamma_{12} & M_{12} - \frac{i}{2}\Gamma_{12} \\ M_{12}^* - \frac{i}{2}\Gamma_{12}^* & M_{22} - \frac{i}{2}\Gamma_{22} \end{pmatrix}\begin{pmatrix} K_0 \\ \bar{K}_0 \end{pmatrix}$$

DECAY

$$A(K^0 \to \pi^+\pi^-) = \sqrt{\tfrac{2}{3}}\,A_0\,e^{i\delta_0} + \sqrt{\tfrac{1}{3}}\,A_2\,e^{i\delta_2}$$

$$A(K^0 \to \pi^0\pi^0) = \sqrt{\tfrac{2}{3}}\,A_0\,e^{i\delta_0} - 2\sqrt{\tfrac{1}{3}}\,A_2\,e^{i\delta_2}$$

δ_i: strong phases

↑ ISOSPIN

$$\varepsilon = \frac{e^{i\frac{\pi}{4}}}{\sqrt{2}\,\Delta M_K}\left(\mathrm{Im}\,M_{12} + \frac{\mathrm{Im}\,A_0}{\mathrm{Re}\,A_0}\,\mathrm{Re}\,M_{12}\right)$$

$$\varepsilon' = \frac{i}{\sqrt{2}}\,\mathrm{Im}\left(\frac{A_2}{A_0}\right) e^{i(\delta_0 - \delta_2)}$$

$\delta_0 - \delta_2 \simeq \frac{\pi}{4}$

(π SCATTERING)

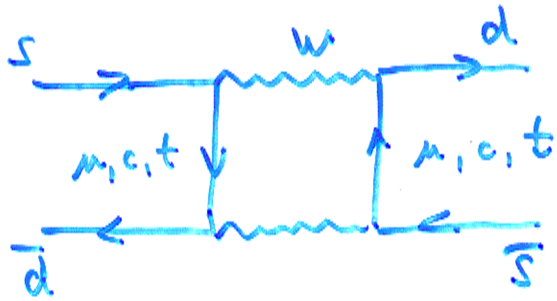
IN OUR FRAMEWORK – D BRANE MODEL SUSY PHASES

$$+\ (\delta_{12})_{LL},\ (\delta_{12})_{LR}$$

COMPLEX

ε : $\Delta S = 2$ INTERACTIONS

SM

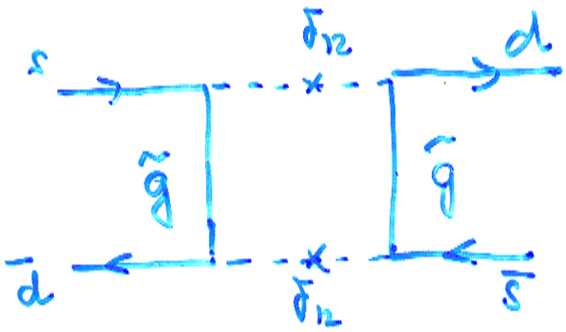


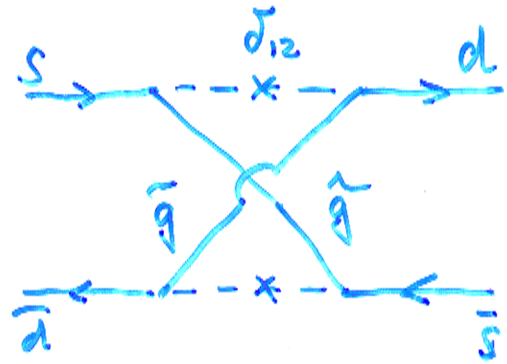
$\Rightarrow O_1 = (\bar{d}\gamma^{\mu} P_L s)(\bar{d}\gamma_{\mu} P_L s)$

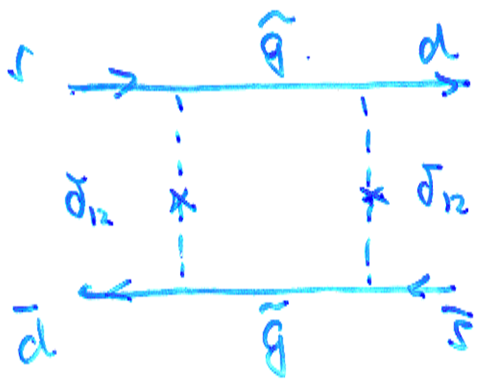
[Buras et al.]

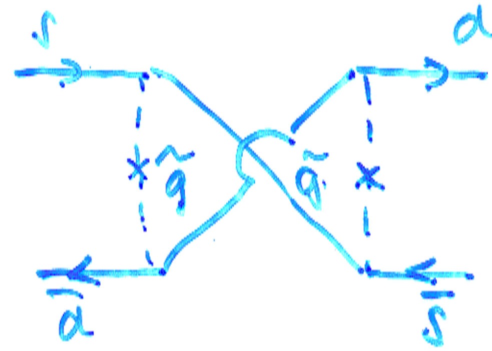
...

SUSY $\quad (\delta_{12})_{AB} = \frac{(\Delta m_{12})_{AB}}{m_{\tilde{q}}^2}$







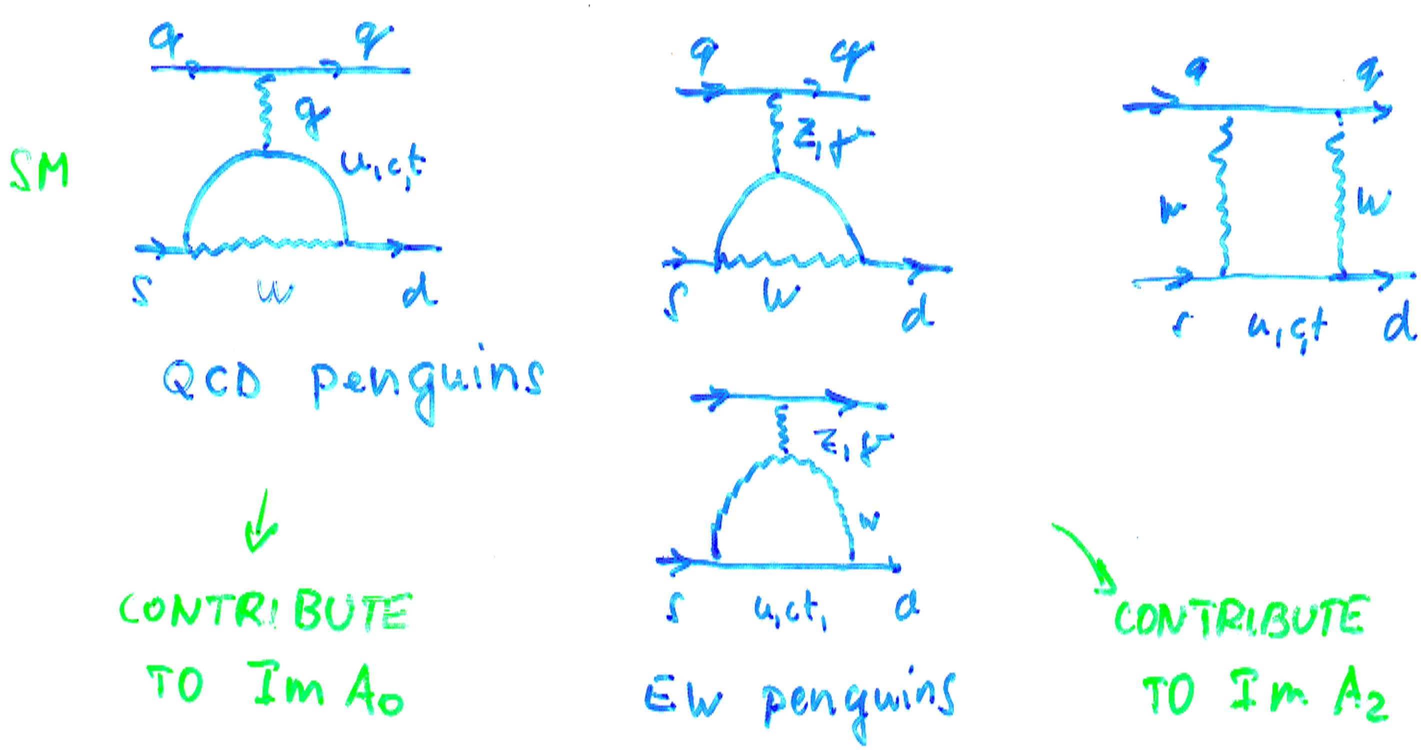


[Ciuchini et al.]

$(\delta_{12})^2_{LL}$	O_1
$(\delta_{12})^2_{RL}\, e^{-2i\varphi_3}$	$O_2 = (\bar{d}^{\alpha}_R s^{\alpha}_L)(\bar{d}^{\beta}_R s^{\beta}_L)$ $O_3 = (\bar{d}^{\alpha}_R s^{\beta}_L)(\bar{d}^{\beta}_R s^{\alpha}_L)$
$(\delta_{12})^2_{LR}\, e^{2i\varphi_3}$	$\tilde{O}_2 = (\bar{d}^{\alpha}_L s^{\alpha}_R)(\bar{d}^{\beta}_L s^{\beta}_R)$ $\tilde{O}_3 = (\bar{d}^{\alpha}_L s^{\beta}_R)(\bar{d}^{\beta}_L s^{\alpha}_R)$
$(\delta_{12})_{LL}(\delta_{12})_{RR}, (\delta_{12})_{LR}(\delta_{12})_{RL}$	$O_4 = (\bar{d}^{\alpha}_R s^{\alpha}_L)(\bar{d}^{\beta}_L s^{\beta}_R)$ $O_5 = (\bar{d}^{\alpha}_R s^{\beta}_L)(\bar{d}^{\beta}_L s^{\alpha}_R)$

- NLO CALCULATION AVAILABLE FOR BOTH SM AND SUSY (EXCEPT SUSY MATCHING CONDITIONS
- MATRIX ELEMENTS TRICKY – FROM LATTICE SIMULATIONS $\langle O_i \rangle = B_i \langle O_i \rangle_{VIA}$

$\underline{\varepsilon'}$: $\Delta S = 1$ INTERACTION



CONTRIBUTE TO $\mathrm{Im}\, A_0$

EW penguins

CONTRIBUTE TO $\mathrm{Im}\, A_2$

STRONG CANCELLATION BETWEEN $\mathrm{Im}\, A_0$ AND $\mathrm{Im}\, A_2$

+ UNCERTAINTY IN MATRIX ELEMENTS $(O_6' - O_{10}')$

$\Rightarrow$ DIFFICULTY IN ESTABLISHING $\frac{\varepsilon'}{\varepsilon}$

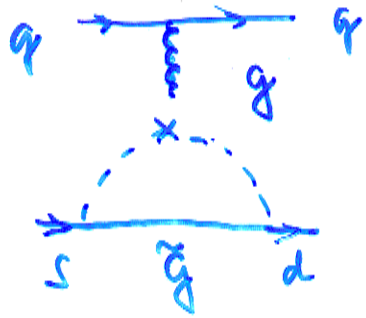
$\frac{\varepsilon'}{\varepsilon} \simeq \text{few} \times 10^{-4} - 20 \times 10^{-4}$

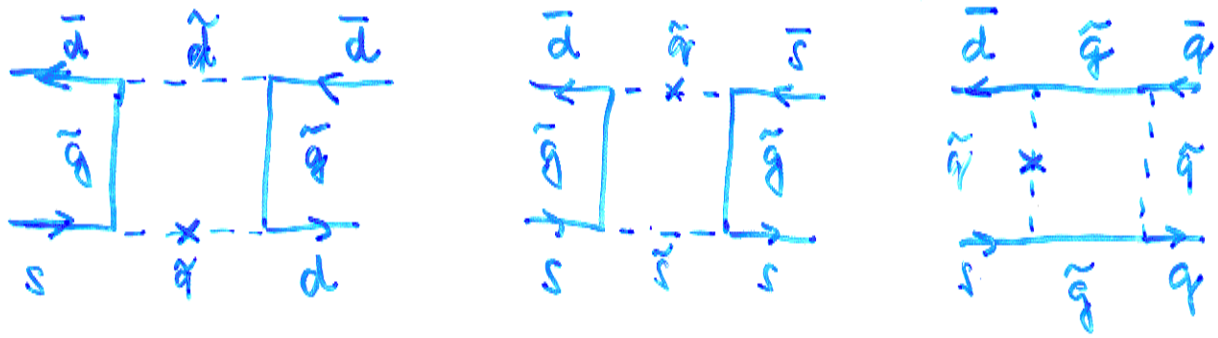
[Buras et al.]
[Bertolini, Eeg and Fabbrichesi]
...

$\varepsilon' \leqq 0$ NOT EXCLUDED!

[Blum et al '99]

SUSY

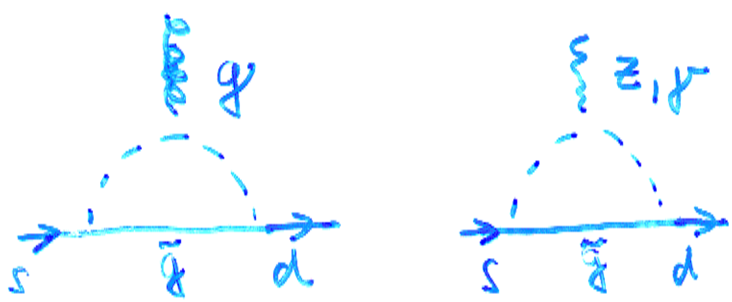




+ crossed

$(\delta_{12})_{LL}$, $(\delta_{12})_{RR}$ $\rightarrow$ $O_3' - O_6'$, $\tilde{O}_3' - \tilde{O}_6'$ operators

CONTRIBUTE ONLY TO $\mathrm{Im}\, A_0$



matrix elements suppressed by $\frac{m_\pi^2}{m_K^2}$ and 0

but LR contrib. enhanced by $\frac{m_{\tilde{g}}}{m_s}$

$(\delta_{12})_{LL}$, $(\delta_{12})_{LR}\, e^{i\varphi_3}$

$(\delta_{12})_{RR}$, $(\delta_{12})_{RL}\, e^{-i\varphi_3}$

O_{11}' , O_{12}'

$\tilde{O}_{11}'$, $\tilde{O}_{12}'$

CONTRIBUTE ONLY TO $\mathrm{Im}\, A_0$

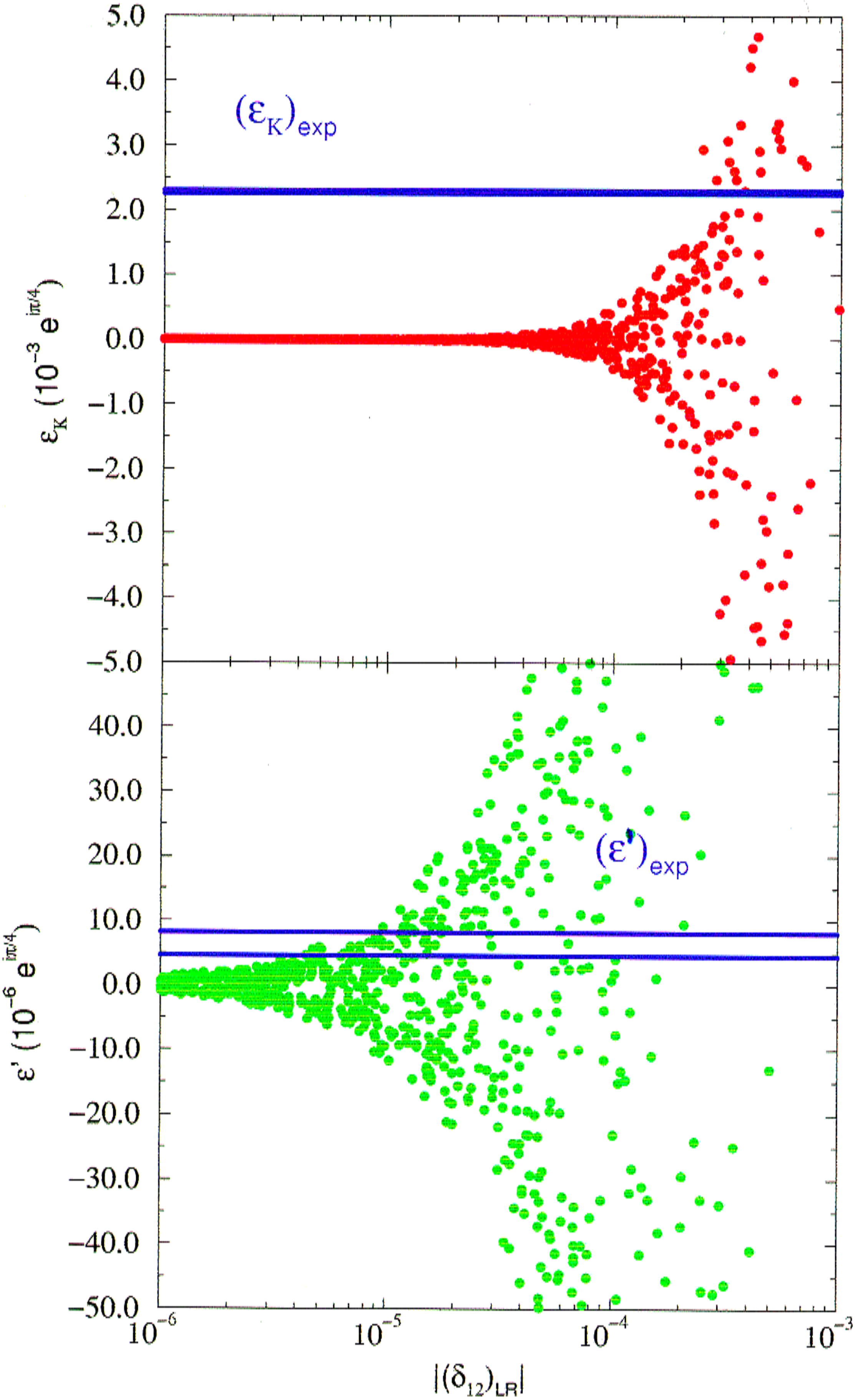
Note: CONTRIBUTION TO $\mathrm{Im}\, A_2$ POSSIBLE FOR MODERATE $\tilde{u} - \tilde{d}$ MASS SPLITTINGS

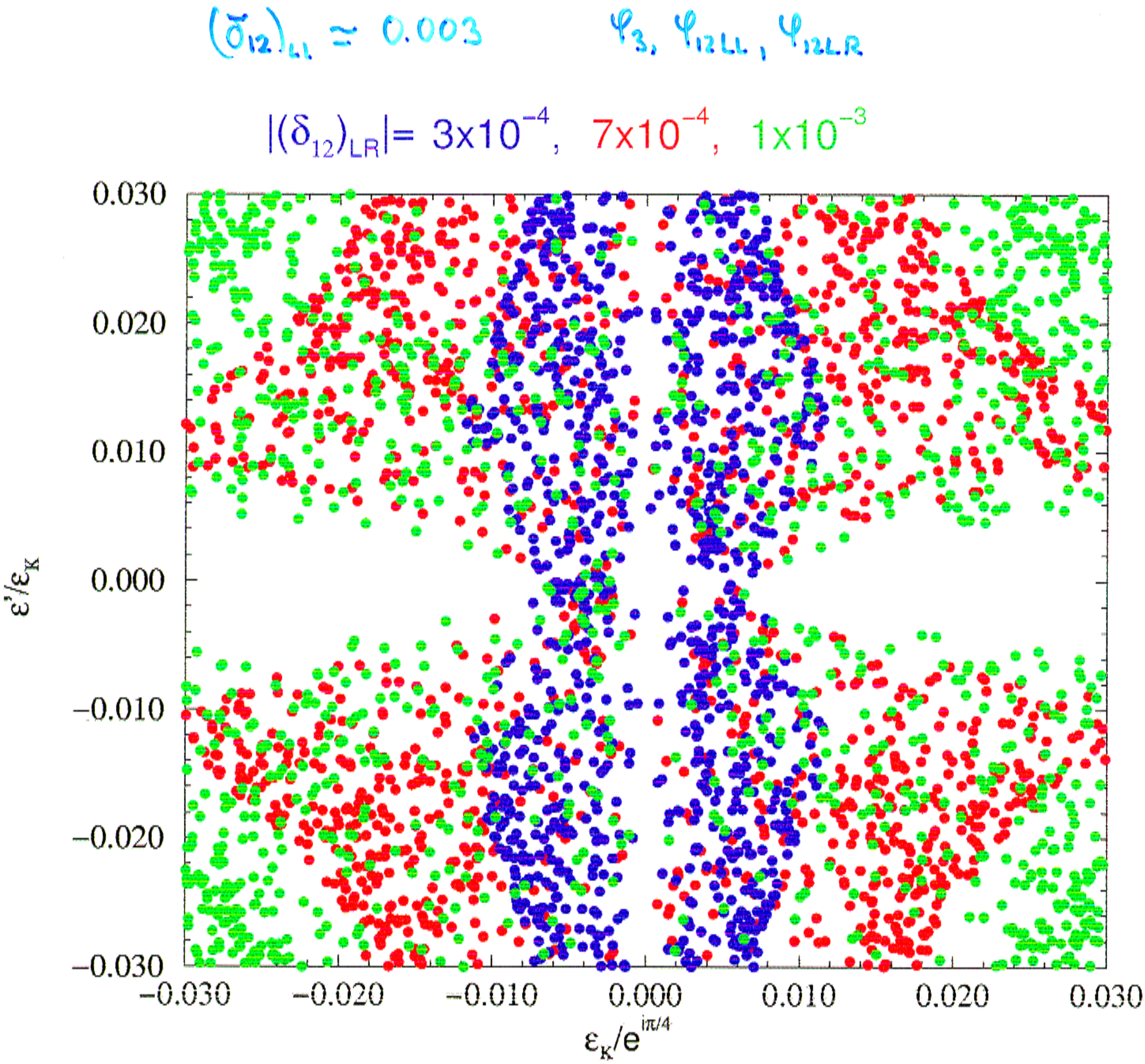
[Kagan, Neubert '99]

[Gabbiani, Gabrielli, Masiero, Silvestrini ; Babu and Barr]

$(\delta_{12})_{LL} = 0.003$ φ_3, φ_{12LL}, φ_{12LR} RANDOM

[M.B., L. EVERETT, G. KANE, S. KING, O. LEBEDEV '99]





$(\delta_{12})_{LL} \simeq 0.003$
$\varphi_3, \varphi_{12LL}, \varphi_{12LR}$
$|(\delta_{12})_{LR}|= 3\times10^{-4}, 7\times10^{-4}, 1\times10^{-3}$
0.030
0.020
0.010
0.000
−0.010
−0.020
−0.030
$\varepsilon'/\varepsilon_K$
−0.030
−0.020
−0.010
0.000
0.010
0.020
0.030
$\varepsilon_K/e^{i\pi/4}$

SUMMARY OF K RESULTS:

- CAN REPRODUCE ε, ε'/ε, $\Delta m_K < \Delta m_K^{exp.}$
- REASONABLE RANGE OF $(\delta_{12})_{LL}$, $(\delta_{12})_{LR}$ GIVES SOLUTION
- ONLY FLAVOR CONSERVING PHASE ENTERING IS φ_3

IMPLICATIONS FOR B DECAYS

TIME DEPENDENT CP ASYMMETRIES RELATED TO UNITARITY TRIANGLE ANGLES

$A^{CP}(B_d \to \psi K_s) \sim \sin 2\beta$

$A^{CP}(B_d \to \pi^+\pi^-) \sim \sin 2\alpha$

$A^{CP}(B_s \to \rho^0 K_s) \sim \sin 2\gamma$

THESE CAN BE USED EVEN BEYOND SM

- CKM IS REAL AND UNITARITY TRIANGLE FLAT

$\Rightarrow \quad |V_{td}| = |V_{cb} \sin \theta_c| \pm |V_{ub}|$ EXP. ALLOWED

- SUSY CONTRIBUTIONS TO B DECAYS SUPPRESSED COMPARED TO TREE LEVEL SM AMPLITUDES

$\Rightarrow$ CP EFFECTS ONLY FROM MIXING

- GLUINO BOXES TYPICALLY GIVE $\Delta m_B \approx 1\%$ OF SM $B\bar{B}$ MIXING + $\not{CP}$ SUPPRESSED BY $\frac{m_b}{\tilde{m}}$

$\sin 2\beta = \mathrm{Im}(\lambda_{\psi K_s})$

$\lambda_{\psi K_s} = \eta_{\psi K_s} e^{i\phi_B} \frac{\bar{A}_{\bar{f}}}{A_f}$

$\downarrow$ CP eigen value

$\bar{A}_{\bar{f}} = \langle \bar{f} | \bar{B}_0 \rangle$

$A_f = \langle f | B_0 \rangle$

here $\bar{A}_{\bar{f}} = A_f$

similarly

$\sin 2\alpha = \mathrm{Im}(\lambda_{\pi\pi})$

Since $\eta_{\psi K_s} = -\eta_{\pi\pi}$ $\quad \sin 2\alpha = -\sin 2\beta$

IF CKM ~~ME~~ IS REAL

U SECTOR

CONSIDER ANSATZ FOR SQUARK MIXINGS:

$$\Gamma_L^u = \begin{pmatrix} 1 & \lambda'+\lambda & \lambda'\cos\tilde\theta & 0 & 0 & -\lambda'\sin\tilde\theta\, e^{i\tilde\varphi} \\ -(\lambda+\lambda') & 1 & \lambda'\cos\tilde\theta & 0 & 0 & -\lambda'\sin\tilde\theta\, e^{i\tilde\varphi} \\ -\lambda' & -\lambda' & \cos\tilde\theta & 0 & 0 & -\sin\tilde\theta\, e^{i\tilde\varphi} \end{pmatrix} + O(\lambda^2)$$

$$\Gamma_R^u = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & \sin\tilde\theta\, e^{-i\tilde\varphi} & 0 & 0 & \cos\tilde\theta \end{pmatrix} + O(\lambda^2)$$

$$\tilde u_i = (\tilde u_1, \tilde u_2, \tilde u_3, \tilde u_4, \tilde u_5, \tilde u_6)$$

$\tilde u_1$ heaviest
$\tilde u_6$ lightest

$$\lambda, \lambda' \simeq 0.2 \simeq \sin\theta_c$$

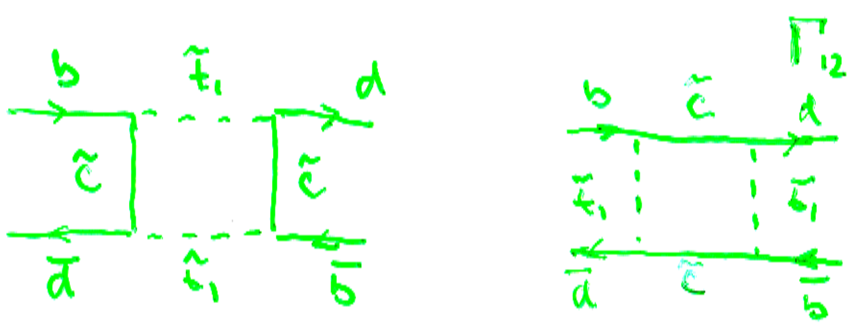
- SUPPRESSES CHARGINO CONTRIBUTION TO $\varepsilon, \varepsilon'$

$$\mathrm{Im}(\Gamma^u_{L16}\Gamma^{u*}_{L26}) = 0$$

- ENHANCES CP VIOLATION IN B_0-$\bar B_0$

$$e^{i\xi_B} \simeq \frac{1-\varepsilon}{1+\varepsilon} = \sqrt{\frac{M_{12}^* - \frac{i}{2}\Gamma_{12}^*}{M_{12} - \frac{i}{2}\Gamma_{12}}} \approx \sqrt{\frac{M_{12}^*}{M_{12}}}$$

$\Gamma_{12} \ll M_{12}$ for B_0-$\bar B_0$



chargino boxes

$$H_{eff}^{\tilde{c}} = \frac{g^4}{128\pi^2} (\bar{d}_L \gamma^\mu b_L)^2 \lambda^2 \sin^2\tilde{\Theta} |V_{11}|^4$$

$$\times \left(1 + \frac{h_t}{g} \frac{V_{12}}{V_{11}} e^{i\tilde{\varphi}} \frac{1}{\tan\tilde{\Theta}}\right)^2 F\left(\frac{m_{\tilde{c}}^2}{m_{\tilde{t}_1}^2}\right)$$

↳ chargino mixing

↳ loop fction

$\left(1 + \frac{h_t}{g} \frac{V_{12}}{V_{11}} e^{i\tilde{\varphi}} \frac{1}{\tan\tilde{\Theta}}\right)^2$ CAN HAVE A LARGE PHASE

$\Rightarrow$ ξ_B LARGE

- USE LOWEST ALLOWED VALUE FOR $|V_{td}| \simeq 0.005$

MINIMIZES $(\Delta m_B)_{SM}$ AND THE BULK COMES FROM SUSY

FOR TYPICAL SUSY MASSES AGREEMENT WITH EXPERIMENTAL VALUE

$$(\Delta m_B)_{EX} \simeq 3 \times 10^{-13} \text{ GeV}$$

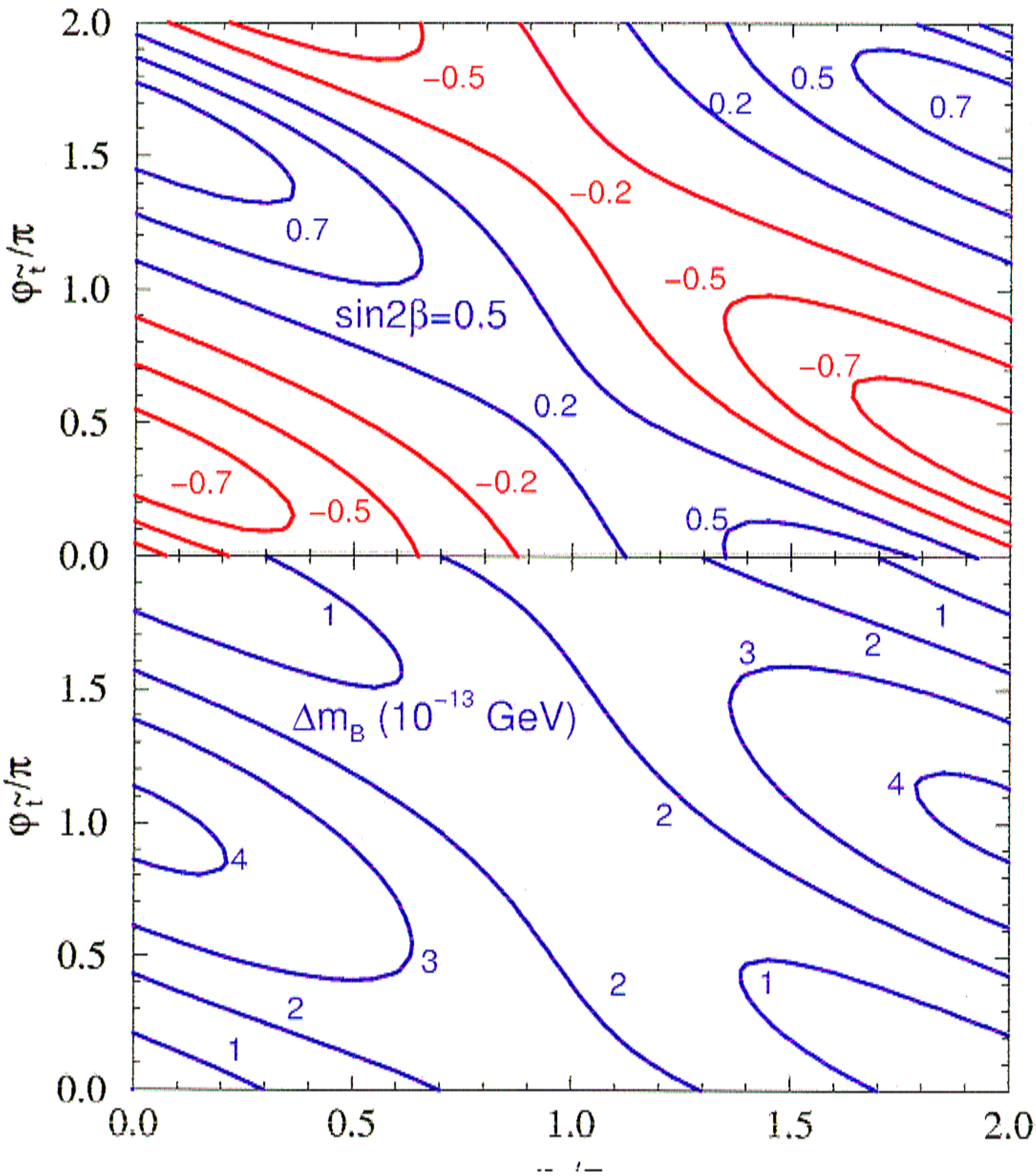
D-brane model

$m_{3/2} = 150$ GeV

$\theta \simeq 0.4$

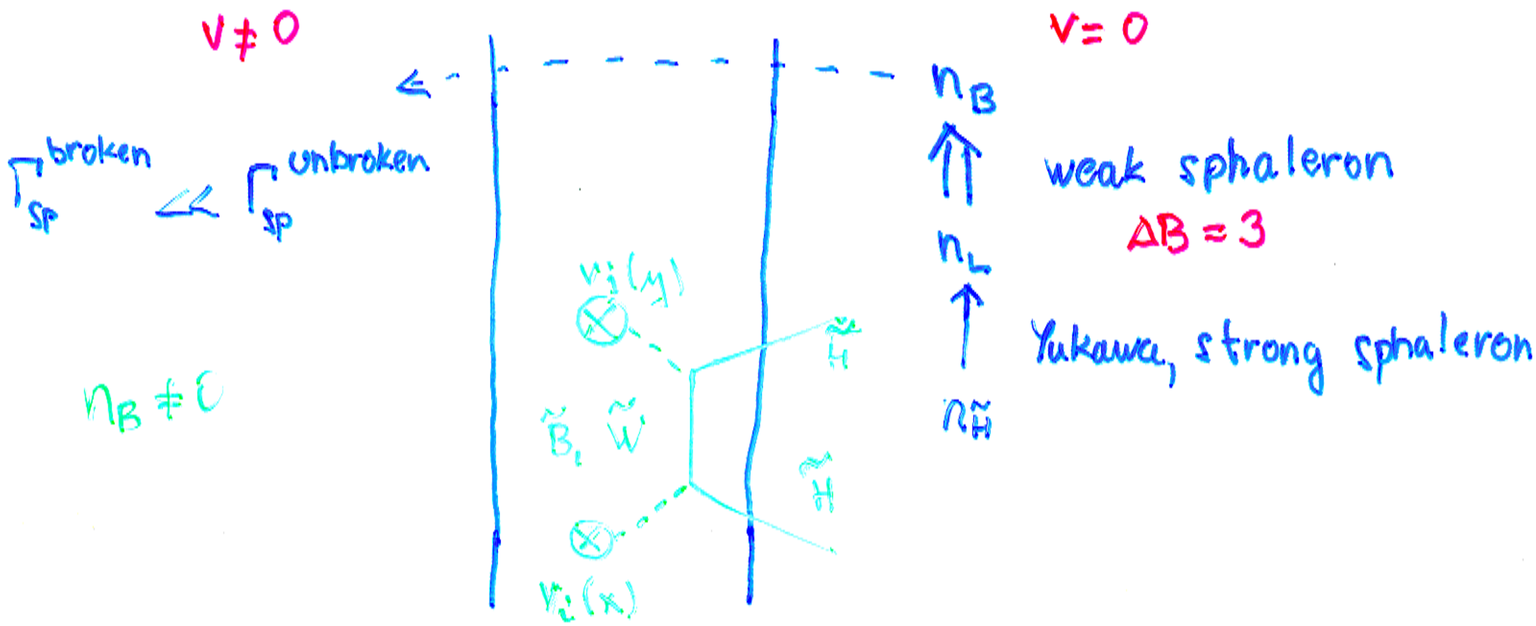
$\Theta_1 \approx 0.85$

+ u squark sector texture ($\lambda' \sim 0.07$, $\theta_t \sim \frac{\pi}{5}$)



EW BARYOGENESIS AND SUSY

- O(1) PHASES IN THE SUSY BREAKING SECTOR ENHANCE THE SOURCES OF n_B
- LIGHT SUSY PARTICLES $(\tilde{t}_R)$ CONTRIBUTE TO THE HIGGS POTENTIAL ⇒ STRONGER 1ST ORDER TRANSITION



TWO RELEVANT SOURCES [Riotto]

1) HIGGSINO $\tilde{H}$

$$S_{\tilde{H}} \sim [v_2 \dot{v}_1 - v_1 \dot{v}_2] \{ 3g^2 \, \mathrm{Im}(M_2 \mu) I_{\tilde{H}\tilde{W}} + g_1^2 \, \mathrm{Im}(M_1 \mu) I_{\tilde{H}\tilde{B}} \}$$

↳ integral over field config.

2) STOP $\tilde{t}_R$

$$S_{\tilde{t}_R} \sim [v_2 \dot{v}_1 - v_1 \dot{v}_2] \, h_t^2 \, \mathrm{Im}(A_t \mu) \, I_{\tilde{t}_R \tilde{t}_L}$$

- PHASE DEPENDENCE FACTORIZES
- LARGE PHASES PRODUCE $\left(\frac{n_B}{s}\right)_{T_c} \gg \left(\frac{n_B}{s}\right)_{OBS} \simeq 4 \times 10^{-11}$

$\sim 10^{-7} - 10^{-8}$

↳ NEED WASHOUT

$M_1 \sim 140$ GeV $M_2 \sim 250$ GeV $\tan\beta \sim 3$

a) $\varphi_\mu = \frac{\pi}{2}$ $\varphi_1 = \frac{\pi}{10}$

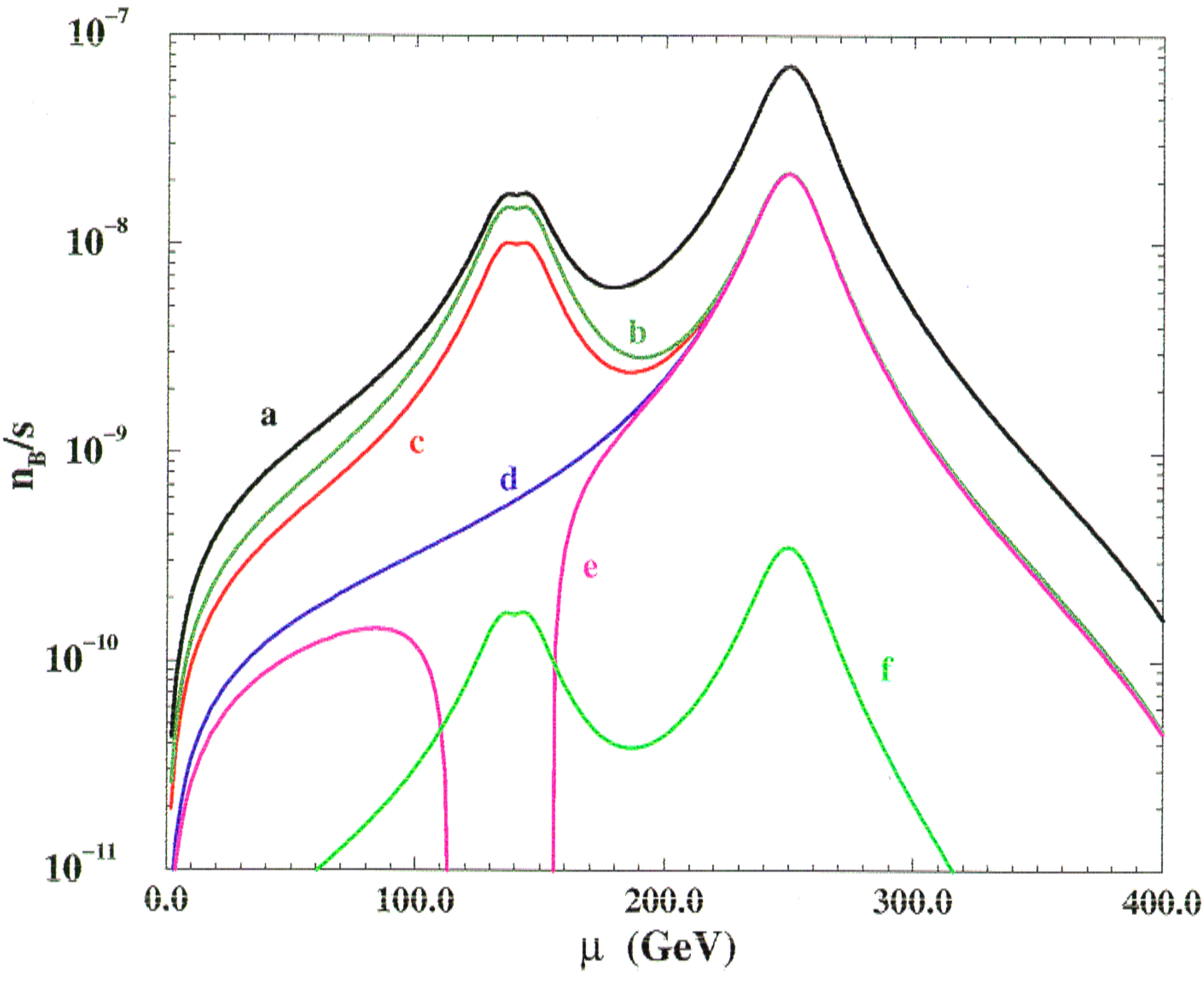
b) $\varphi_\mu = \frac{\pi}{10}$ $\varphi_1 = \frac{\pi}{4}$

c) $\varphi_\mu = \frac{\pi}{10}$ $\varphi_1 = \frac{\pi}{12}$

d) $\varphi_\mu = \frac{\pi}{10}$ $\varphi_1 = -\frac{\pi}{10}$

e) $\varphi_\mu = \frac{\pi}{10}$ $\varphi_1 = -\frac{\pi}{8}$

f) $\varphi_\mu = 5\times10^{-3}$ $\varphi_1 = 5\times10^{-3}$



Observable	Dominant Contribution	Flavor Content
nEDM	$\tilde{g}$, $\tilde{\chi}^+$, $\tilde{\chi}^0$	$(\delta_{dd})_{LR}$, $\sim \tilde{K}_{ud}\tilde{K}^*_{ud}$
ϵ	$\tilde{g}$	$(\delta_{ds})_{LR}$
ϵ'	$\tilde{g}$	$(\delta_{ds})_{LR}$
Δm_K	SM	SM
$K_L \to \pi\nu\bar{\nu}$	SM, $\tilde{g}$	$(\delta_{ds})_{LR}$
Δm_{B_d}	$\tilde{\chi}^+$	$\lvert\tilde{K}_{tb}\tilde{K}^*_{td}\rvert$
Δm_{B_s}	SM, $\tilde{\chi}^+$	$\lvert\tilde{K}_{tb}\tilde{K}^*_{ts}\rvert$
$\sin 2\beta$	$\tilde{\chi}^+$	$\tilde{K}_{tb}\tilde{K}^*_{td}$
$\sin 2\alpha$	$\tilde{\chi}^+$	$\tilde{K}_{tb}\tilde{K}^*_{td}$
$\sin 2\gamma$	$\tilde{\chi}^+$	$\tilde{K}_{tb}\tilde{K}^*_{ts}$
$\mathcal{A}_{CP}(b \to s\gamma)$	$\tilde{\chi}^+$	$\sim \tilde{K}_{tb}\tilde{K}^*_{ts}$
Δm_D	$\tilde{g}$	$\sim \lvert\tilde{K}_{tc}\tilde{K}^*_{tu}\rvert$
n_B/n_γ	$\tilde{\chi}^+$, $\tilde{\chi}^0$, $\tilde{t}_R$	–

CONCLUSIONS

- IF LARGE PHASES ARE INDEED ALLOWED FOR SOFT PARAMETERS → SUSY CAN PROVIDE SOURCE FOR BOTH ε AND ε', OR ε' ONLY

- REQUIRED MAGNITUDES OF $|(\delta_{12})_{LL,RR}|$, $|(\delta_{12})_{LR,RL}|$ ARE $\lesssim \mathcal{O}(10^{-3})$ – COULD BE GENERATED BY RGE EVOLUTION FROM FLAVOR DIAGONAL GUT BOUNDARY CONDITIONS

- B ASYMMETRY CAN PROVIDE A SPECTACULAR SIGNAL $|A_{CP}^{B}| \lesssim 15\%$ VS. ~ 0.5-1% IN SM

- NEXT ROUND OF EXPERIMENTS

  $\frac{\varepsilon'}{\varepsilon}$ SENSITIVITY $\lesssim 1 \times 10^{-4}$ (KTeV, DAΦNE ...)

  B FACTORIES ASYMMETRY MEASUREMENT SHOULD BE ABLE TO DISTINGUISH A_{CP}^{B}

  ⇒ POSSIBLE WINDOW TO STRING (BRANE) PHYSICS

- EW BARYOGENESIS LIVES

BOTTOM LINE: POSSIBLE WITH FLAVOR INDEPENDENT PHASES!