$K^0 - \bar{K}^0$ AND $B^0 - \bar{B}^0$ CONSTRAINTS ON TECHNICOLOR

(w/ G. BURDMAN, E. EICHTEN, T. RADOR)

- DYNAMICAL RESOLUTION OF STRONG - $\cancel{CP}$
  - → RATIONAL CP - PHASES FROM VACUUM ALIGNMENT

- STRUCTURE OF QUARK MASS + MIXING MATRICES
  - → "PRIMORDIAL" $m_q(M_{ETC})$; $U_{L,R}$ + $D_{L,R}$ - $V = U_L^\dagger D_L$, WITH EXAMPLES.

- $|\Delta S| = 2$ AND $|\Delta B| = 2$ INTERACTIONS FROM ETC AND TOPCOLOR.
  - → EW - GENERATION CONSERVATION
  - → $\Lambda_{ETC} = M_{ETC} / g_{ETC}$ VS. m_q

- $B_d^0 - \bar{B}_d^0$ MIXING CONSTRAINT ON TC2

  - → $M_{V_8}, M_{Z'} \gtrsim 5\,TeV$ → < 1% FINE TUNING.

- $K^0 - \bar{K}^0$ $\cancel{CP}$ - PARAMETER ϵ
  - → FURTHER CONSTRAINTS ON M_{V_8}, $M_{Z'}$
  - ... BUT M_{ETC} / g_{ETC} ??

DYNAMICAL RESOLUTION OF STRONG $\not{CP}$

$$\left(\mathcal{M}_{q=u,d}\right)_{ij} = \Lambda^{qT}_{iIJj}\left(W_T\right)_{IJ}\langle\bar{T}T\rangle_{ETC}$$

5-4000 MeV AT $M_{ETC} \simeq 10^4$-10^2 TeV!

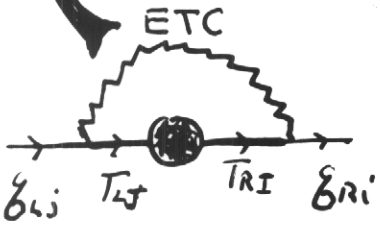
$O\left(\frac{g^2_{ETC}}{M^2_{ETC}}\right)$

$\sim \left(\frac{1}{10^4\,\text{TeV}}\right)^2 - \left(\frac{1}{100\,\text{TeV}}\right)^2$

REAL !

T-FERMION ALIGNMENT MATRIX

$\simeq 4\pi F_T^3\left(\frac{M_{ETC}}{F_T}\right)^{\gamma_m}$ IN WTC.



- $W_T \neq W_T^*$ ($\propto$ PHASE) $\longrightarrow$ SPONTANEOUS $\not{CP}$

PHASES IN W_T ARE OFTEN RATIONAL MULTIPLES OF π:

$$\boxed{\text{ARG}\left(W_T\right)_{IJ} = \frac{m\pi}{N'}} \quad \left\{\begin{array}{l} 0 \leq m \leq N' \\ 1 \leq N' \leq N = \#\ \text{T-DOUBLETS}\end{array}\right.$$

- IF Λ^{qT} PROPERLY MAP RATIONAL W_T-PHASES ONTO $\mathcal{M}_q$, THEY CAN NATURALLY $\longrightarrow$

$$\bar{\theta}_q = \text{ARG}\det\mathcal{M}_q = O\left(\frac{\langle\bar{q}q\rangle}{\langle\bar{T}T\rangle} \lesssim 10^{-10}\right)$$

W/O AXION ; $m_u = 0$!!

Quark Mass + Mixing Matrices

If $\bar{\theta}_q = 0$, $\mathcal{M}_q = \begin{pmatrix} \mathcal{M}_u & 0 \\ 0 & \mathcal{M}_d \end{pmatrix}$ is brought to real, positive, diagonal form by $SU(6)_{L,R}$ matrices

$$Q_{L,R} = \begin{pmatrix} U_{L,R} & 0 \\ 0 & D_{L,R} \end{pmatrix} \in SU(6)_{L,R}$$

$U_{L,R}, D_{L,R} \in U(3)_{L,R}$

$$M_u = U_R^\dagger \mathcal{M}_u U_L \;; \quad M_d = D_R^\dagger \mathcal{M}_d D_L$$

$\mathbf{V = U_L^\dagger D_L}$ = unimodular CKM matrix with <u>one</u> phase δ_{13}, <u>three</u> angles $\theta_{12} > \theta_{23} > \theta_{13}$

→ Additional $\not{CP}$ phases in $U_{L,R}$ and (esp.) $D_{L,R}$ are **observable**, appearing in 4-fermion **ETC** and **Topcolor** interactions.

STRUCTURE OF $\mathcal{M}_{u,d}$; $(U,D)_{L,R}$

- $\mathcal{M}_d$ IS (NEARLY) TRIANGULAR :

- NEED TO SUPPRESS $B_d - \overline{B}_d$ MIXING BY "BOTTOM PIONS" $(M_{\pi_b} \sim 300 \text{ GeV})$.
  (Kominis ; Buchalla, et al.)

- HEAVY – LIGHT MIXING IN $V = U_L^\dagger D_L$ MUST COME FROM $\underline{\underline{D_L}}$ (SEE $\mathcal{M}_u$ -- BELOW).

- $\theta_{12} \sim \lambda > \theta_{23} \sim \lambda^2 > \theta_{13} \sim \lambda^3$

$$\Longrightarrow \quad |\mathcal{M}_{sb}| \gtrsim |\mathcal{M}_{db}| \gg |\mathcal{M}_{bs}|, |\mathcal{M}_{bd}|$$

$$|\mathcal{M}_d| \cong \begin{pmatrix} \sim m_d & \sim\sqrt{m_d m_s} & 0 \\ \sim\sqrt{m_d m_s} & \sim m_s & 0 \\ \sim m_d & \sim m_s & m_b \end{pmatrix}$$

$$D_R \simeq \left(\begin{array}{cc|c} \cdot & \cdot & 0 \\ \cdot & \cdot & 0 \\ \hline 0 & 0 & 1 \end{array}\right)$$

$$D_L \simeq \begin{pmatrix} 1 & \lambda & \lambda^3 \\ \lambda & 1 & \lambda^2 \\ \lambda^3 & \lambda^2 & 1 \end{pmatrix}$$

- m_u IS (NEARLY) BLOCK-DIAGONAL, ANCHORED BY TOPCOLOR-GENERATED $m_{tt} \ggg m_{tu;\,tc},\ m_u,\ m_c, \ldots$

$$|m_u| \cong \begin{pmatrix} \sim m_u & \sim\sqrt{m_u m_c} & \sim m_u \\ \sim\sqrt{m_u m_c} & \sim m_c & \sim m_c \\ \sim m_u & \sim m_c & \underline{m_{tt} \simeq 160\,\mathrm{GeV}} \end{pmatrix}$$

$$\rightarrow \quad U_{L,R} \simeq \left(\begin{array}{cc|c} \cdot & \cdot & 0 \\ \cdot & \cdot & 0 \\ \hline 0 & 0 & 1 \end{array}\right)$$

$$V = U_L^{\dagger} D_L \simeq \begin{pmatrix} \cdot & \cdot & 0 \\ \cdot & \cdot & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & \lambda & \lambda^3 \\ \lambda & 1 & \lambda^2 \\ \lambda^3 & \lambda^2 & 1 \end{pmatrix}$$

IN PARTICULAR:

$$V_{td_i} \cong V_{tb}^{*} V_{td_i} \qquad (d_i = d, s, b)$$

$$\cong U_{Ltt} D_{Lbb}^{*} U_{Ltt}^{*} D_{Lbd_i} \cong \underline{D_{Lbb}^{*} D_{Lbd_i}}$$

Examples

"Model 7c"

→ V is real $(\delta_{13} = 0)$,
but $\epsilon_{ETC} \simeq 2 \times 10^{-3} e^{i\pi/4}$!

"Model 12 a3"

→ V is complex, but → $\epsilon_{S.M.} \simeq -2 \times 10^{-3} e^{i\pi/4}$
ETC + SM can give $\epsilon_{tot.} \simeq 2 \times 10^{-3} e^{i\pi/4}$

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THE MASS MATRIX M_{RL} = PRIMORDIAL M^dagger_q IN POLAR FORM

        (0.000000,0.000000)   (199.322318,0.333333)   (0.000000,0.000000)
 M_u =  (15.554360,-0.333333) (902.460165,-1.000000)  (0.000000,0.000000)
        (0.000000,0.000000)   (0.000000,0.000000)     (162622.296592,0.000000)

        (0.000000,0.000000)   (23.277717,0.000000)    (0.000000,0.000000)
 M_d =  (21.657762,0.000000)  (101.668924,0.333333)   (0.000000,0.000000)
        (16.974376,0.333333)  (144.329035,0.666667)   (3504.642028,0.000000)



NU = -2.299659e-04
DET(M_q) = (8.908e+14,1.065e+11i)
ARGDET(M_q) = 1.195843e-04 ← ROUND-OFF ERROR
EXPECTED DET(M_q) = (8.908e+14,-1.267e+07i)
EXPECTED ARGDET(M_q) = -1.422253e-08 ← ACCURACY OF CALCULATION
THETA-BAR_q = -1.195843e-04



MATRIX AFTER MINIMIZATION, (U,D) = (U_L^+ U_R, D_L^+ D_R)

       (0.972805,0.000001) (0.231626,0.333333) (0.000000,0.000000)
 U =   (-0.231626,-0.333333)(0.972805,-1.000000) (0.000000,0.000000)
       (0.000000,0.000000) (0.000000,0.000000) (1.000000,0.000000)

       (0.914649,-0.666666)(0.404224,0.000000) (0.004602,-0.333335)
 D =   (0.404073,0.000001) (0.913854,-0.333333)(0.039955,-0.666667)
       (0.011945,-0.333332)(0.038405,-0.666667)(0.999191,0.000000)


QUARK MASSES AT M_ETC
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m_u = 3.35
m_c = 924.3
m_t = 162622.3
m_d = 4.74
m_s = 106.3
m_b = 3507.7
```

PARAMETERS FOR CKM

CKM ANGLE_12=0.216506 $= \theta_{12}$

CKM ANGLE_23=0.041111 $= \theta_{23}$

CKM ANGLE_13=0.005523 $= \theta_{13}$

CKM PHASE_13=0.000000 $= \delta_{13}$

THE CKM MATRIX = $V = U_L^\dagger D_L$

	(0.976639 0.000000)	(0.214815 0.000000)	(0.005523 0.000000)
V =	(0.214859 3.141593)	(0.975780 0.000000)	(0.041099 0.000000)
	(0.003440 0.000000)	(0.041325 3.141593)	(0.999140 0.000000)

	(0.976639 0.000000i)	(0.214815 0.000000i)	(0.005523 0.000000i)
V =	(-0.214859 0.000000i)	(0.975780 0.000000i)	(0.041099 0.000000i)
	(0.003440 0.000000i)	(-0.041325 0.000000i)	(0.999140 0.000000i)

	(0.999865 -2.699092)	(0.016432 0.442505)	(0.000000 0.000000)
UL =	(0.016432 -3.746291)	(0.999865 -3.746287)	(0.000000 0.000000)
	(0.000000 0.000000)	(0.000000 0.000000)	(1.000000 -1.651892)

	(0.980038 3.584094)	(0.198752 3.584093)	(0.004847 3.584094)
DL =	(0.198782 -0.604694)	(0.979178 2.536898)	(0.041184 2.536898)
	(0.003440 -1.651890)	(0.041325 1.489701)	(0.999140 -1.651892)

	~~(0.976480 -2.699090)~~	~~(0.215610 -2.699089)~~	(0.000000 0.000000)
UR =	~~(0.215610 -3.746288)~~	~~(0.976480 -0.604694)~~	(0.000000 0.000000)
	(0.000000 0.000000)	(0.000000 0.000000)	~~(1.000000 -1.651892)~~

	(0.976754 -0.604699)	~~(0.214365 2.536896)~~	(0.000273 2.536878)
DR =	(0.214365 3.584094)	(0.976753 3.584096)	(0.001224 3.584105)
	(0.000005 -1.650367)	(0.001254 1.489693)	~~(0.999999 -1.651892)~~

THE MASS MATRIX M_{RL} = PRIMORDIAL M^dagger_q IN POLAR FORM

        ~~(7.000000,0.200000)~~ ~~(1.000000,-0.400000)~~ (0.000000,0.000000)
M_u = ~~(100.000000,0.400000)~~ ~~(890.000000,-0.200000)~~ (0.000000,0.000000)
        ~~(50.000000,-0.400000)~~ ~~(500.000000,0.200000)~~ ~~(160000.00,0.000000)~~

        ~~(8.000000,0.000000)~~ ~~(1.000000,-0.200000)~~ (0.000000,0.000000)
M_d = ~~(25.000000,-0.200000)~~ ~~(200.000000,-0.400000)~~ (0.000000,0.000000)
        ~~(10.000000,0.000000)~~ ~~(140.000000,-0.400000)~~ ~~(3500.000000,0.400000)~~

NU = TRACE(HQ'-HQ'dag)/6 = 5.967662e-04
DET(M_q) = (2.660e+15,-4.609e+11i)
ARGDET(M_q) = -1.732266e-04
EXPECTED DET(M) = (2.660e+15,-1.007e+04i)
EXPECTED ARGDET(M) = -3.786607e-12
THETA-BAR_q = 1.732266e-04

MATRIX AFTER MINIMIZATION, <u>(U,D) = (U_L^+ U_R, D_L^+ D_R)</u>

      ~~(0.993864,-0.200012)~~ ~~(0.109703,-0.399950)~~ (0.000314,0.398856)
U = ~~(0.109702,-0.600061)~~ ~~(0.993960,0.199999)~~ (0.003108,-0.199380)
      (0.000622,0.504745) (0.003061,-0.598531) ~~(0.999995,0.000000)~~

      (0.976165,0.000010) (0.217012,0.200101) (0.002646,-0.017761)
D = (0.216926,-0.799995) (0.975414,0.399998) (0.038875,0.400075)
      (0.006641,-0.679194) (0.038394,0.602935) (0.999241,-0.400000)

~~QUARK MASSES AT M_ETC:~~
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m_u = 6.84
m_c = 895.6
m_t = 160000.8
m_d = 7.52
m_s = 103.0
m_b = 3502.8

PARAMETERS FOR CKM

CKM ANGLE_12=0.235773 $= \theta_{12}$

CKM ANGLE_23=0.043097 $= \theta_{23}$

CKM ANGLE_13=0.003145 $= \theta_{13}$

CKM PHASE_13=-0.957009 $= \delta_{13}$

THE CKM MATRIX = $V = U_L^{\dagger} D_L$

V =	(0.972329 0.000000)	(0.233593 0.000000)	(0.003145 -0.957[illegible])
	(0.233453 3.14113[illegible])	(0.971413 0.00002[illegible])	(0.043084 0.000000)
	(0.008672 0.29218[illegible])	(0.042319 [illegible].127412)	(0.999067 0.000000)

V =	(0.972329 0.000000i)	(0.233593 0.000000i)	(0.001812 0.002571i)
	(-0.233453 0.000108i)	(0.971413 0.000026i)	(0.043084 0.000000i)
	(0.008304 0.002498i)	(-0.042315 0.000600i)	(0.999067 0.000000i)

UL =	(0.993745 2.741096)	(0.111673 1.054881)	(0.000312 1.679198)
	(0.111672 1.484384)	(0.993740 2.9397[illegible])	(0.003125 -0.204824)
	(0.000627 -1.324591)	(0.003077 0.432189)	(0.999995 0.4225[illegible])

DL =	(0.969609 2.767804)	(0.244641 2.285016)	(0.002862 1.680853)
	(0.244536 0.254510)	(0.968815 2.913032)	(0.040001 2.935793)
	(0.007714 0.670153)	(0.039354 3.551821)	(0.999196 0.422545)

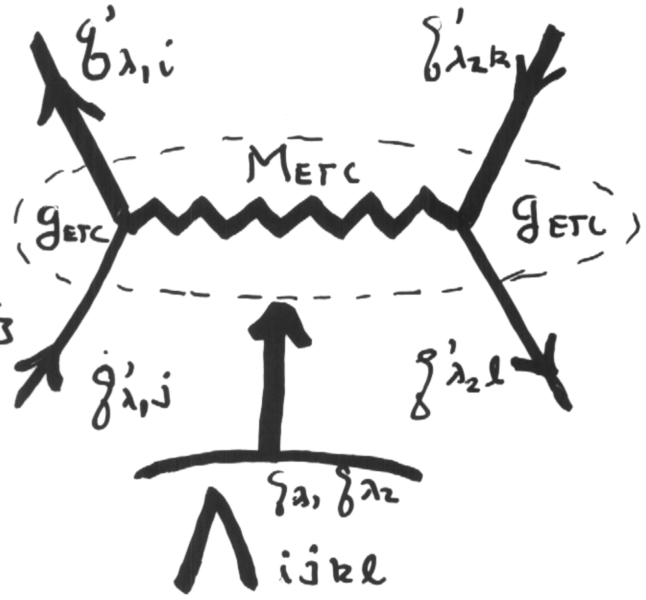
UR =	(0.999998 3.369454)	(0.001982 1.67892[illegible])	(0.000000 0.068169)
	(0.001982 0.860376)	(0.999998 2.31143[illegible])	(0.000018 -1.010182)
	(0.000000 0.476901)	(0.000018 0.602537)	(1.000000 0.422545)

DR =	(0.999597 2.767773)	(0.028396 2.2847[illegible])	(0.000017 2.075324)
	(0.028396 -1.002158)	(0.999596 1.6564[illegible])	(0.001159 1.669428)
	(0.000017 1.919182)	(0.001159 -1.475343)	(0.999999 1.6[illegible])

Mcu.

FCNC Int'ns from ETC, Top-C

$$\mathcal{H}_{ETC} = \sum_{\substack{\lambda_1,\lambda_2 \\ = L,R}} \sum_{\substack{i,j,k,l \\ =1,2,3}}$$



- $\xi'_{\lambda i} = \sum_{j=1}^{3} Q_{\lambda ij}\, \xi_{\lambda j}$; $\xi_i = u_i$ or d_i ; $\lambda = L, R$.

  EW eigenstate ($\xi'_{\lambda i}$) — Mass eigenstate ($\xi_{\lambda j}$)

- **Assume** EW-generation conservation:

$$\Lambda^{\xi_{\lambda_1}, \xi_{\lambda_2}}_{ijkl} = \delta_{il}\,\delta_{jk}\,\Lambda^{\xi_{\lambda_1}, \xi_{\lambda_2}}_{ij} + \delta_{ij}\,\delta_{kl}\,\Lambda'^{\,\xi_{\lambda_1}, \xi_{\lambda_2}}_{ik}$$

- $\Lambda^{\xi_{\lambda_1}, \xi_{\lambda_2}}_{ijkl}$ are **REAL** – CP-conserving

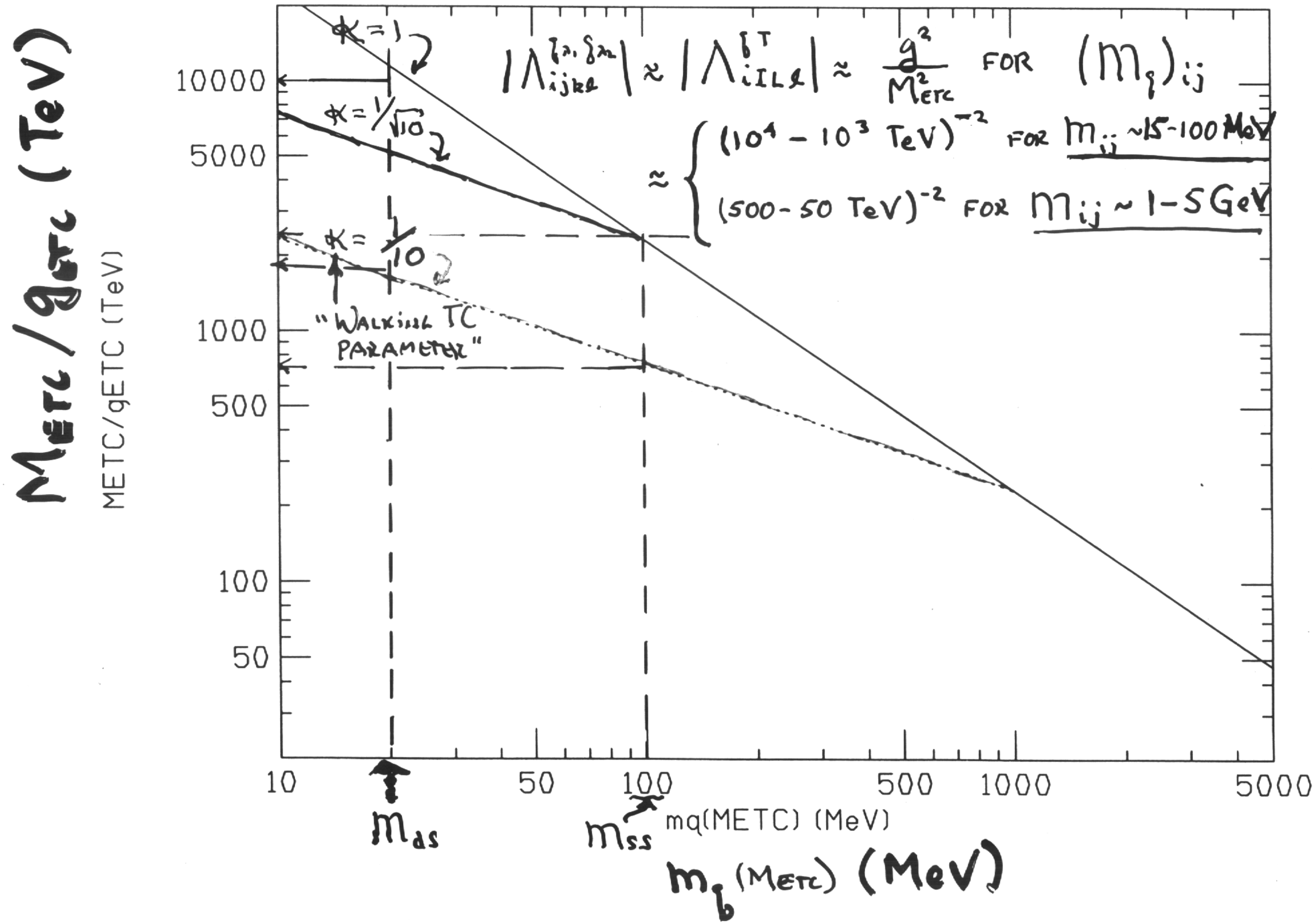
$\Rightarrow$ **FCNC and CP violation induced by $U_{L,R}$; $D_{L,R}$**

SIMILARLY FOR TOP-C

- MEDIATED BY • V_8 ε 8_c

• Z' ε 1_c

MAGNITUDE OF $\Lambda^{\gamma\lambda_1\,\gamma\lambda_2}_{ijkl} \approx \left(\frac{g_{ETC}}{M_{ETC}}\right)^2 \cdots$



$B_d - \bar{B}_d$ Mixing Constrains TC2

(G. Burdman, T. Rador, + K.L., hep-ph/0012073)

$$\frac{g^2_{V_8, Z'}}{M^2_{V_8, Z'}} \sum_{\lambda_1, \lambda_2} \bar{b}'_{\lambda_1} \gamma^\mu \left(\frac{\lambda_A}{2}\right) b'_{\lambda_1} \, \bar{b}'_{\lambda_2} \gamma_\mu \left(\frac{\lambda_A}{2}\right) b'_{\lambda_2}$$

$$\longrightarrow \frac{g^2_{V_8, Z'}}{M^2_{V_8, Z'}} \underbrace{|D^*_{Lbb} D_{Lbd}|^2} \bar{b}_L \gamma^\mu \left(\frac{\lambda_A}{2}\right) d_L \bar{b}_L \gamma_\mu \left(\frac{\lambda_A}{2}\right) d_L$$

+ SUPPRESSED D_{Rbd} - TERMS

ETC IS <u>MUCH</u> WEAKER!

$$\Longrightarrow (\Delta M_{B_d})_{TC2} \equiv 2 |M_{12}(B_d)|_{TC2}$$

$$= \frac{4\pi}{3} \left[\frac{\alpha_C \cot^2\theta_C}{3 M^2_{V_8}} + \frac{\alpha_Y \cot^2\theta_Y (\Delta Y_L)^2}{M^2_{Z'}} \right]$$

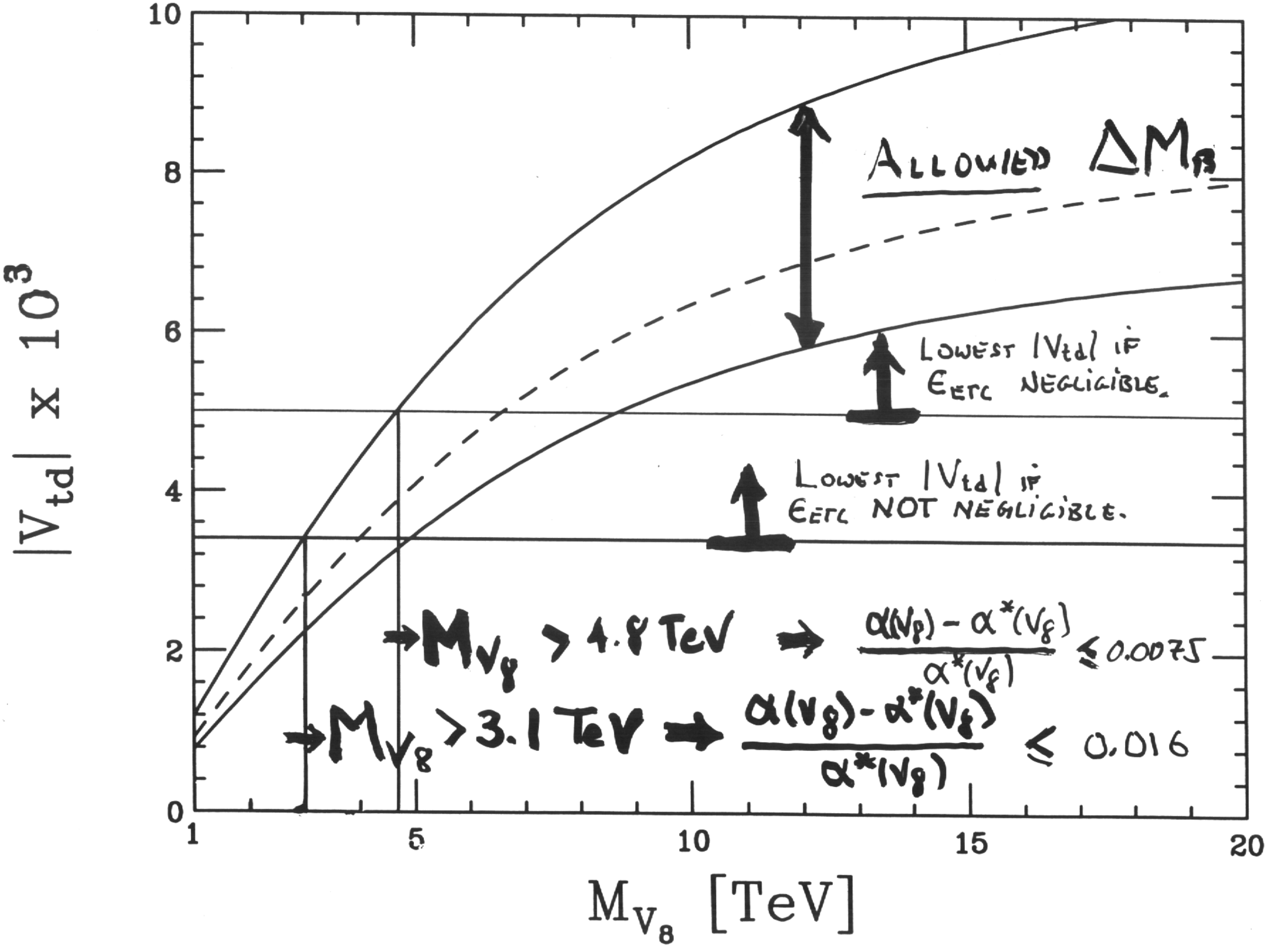
$$\times \underset{\substack{\uparrow \\ \text{QCD}}}{\eta_B} \underbrace{M^2_{B_d} f^2_{B_d} \underset{\substack{\uparrow \\ \text{BAG CONSTANT}}}{B_{B_d}}}_{(200 \pm 40\,\text{MeV})^2} |D^*_{Lbb} D_{Lbd}|^2$$

COMPARE TO

$$(\Delta M_{B_d})_{SM} = \frac{G_F^2}{6\pi^2} \eta_B M^2_{B_d} f^2_{B_d} B_{B_d} S_0(x_t) \times |V^*_{tb} V_{td}|^2$$

$$\cong |D^*_{Lbb} D_{Lbd}|^2 \; !$$

FINE-TUNING OF TC2 COUPLINGS!



$K^0 - \bar{K}^0$ Constraint on ETC+TC2

Standard Model:

$$e^{-i\pi/4}\,\epsilon_{SM} \cong 3.02\ \mathrm{Im}\,\lambda_c \times \left[4.42\ \mathrm{Re}\,\lambda_c + 1.40\times 10^4\ \mathrm{Re}\,\lambda_t \right]$$

$\lambda_c = V_{cd} V_{cs}^*$, $\lambda_t = V_{td} V_{ts}^*$; $\mathrm{Im}\,\lambda_c = -\mathrm{Im}\,\lambda_t$.

ETC:

FOR $\kappa = 1/\sqrt{10}$

$$e^{-i\pi/4}\,\epsilon_{ETC} \cong 8.44\times 10^{-2} \Big\{ -\underset{\sim}{20.2}\ \Lambda^{LR}_{ssss}\,(2000\ \mathrm{TeV})^2 \times \mathrm{Im}\,(D_{Lss} D^*_{Lsd} D_{Rss} D^*_{Rsd})^{\star}$$
$$+\ \underset{\sim}{2}\ \Lambda^{LL}_{ssss}\,(2000\ \mathrm{TeV})^2\ \mathrm{Im}\,(D_{Lss} D^*_{Lsd})^2$$
$$+\ \underset{\sim}{2}\ \Lambda^{RR}_{ssss}\,(2000\ \mathrm{TeV})^2\ \mathrm{Im}\,(D_{Rss} D^*_{Rsd})^2 \Big\}$$

$\star$ Except Model 7c: $\Lambda^{LR}_{sdds}\cdot(4000\ \mathrm{TeV})^2 \leftarrow \frac{1}{10} \lesssim \kappa \lesssim \frac{1}{\sqrt{10}}$
$\times\,\mathrm{Im}\,(D^*_{Lsd} D_{Lds} D^*_{Rdd} D_{Rss} + L \leftrightarrow R)$

TC2:

$$e^{-i\pi/4}\,\epsilon_{TC2} \cong 10^5 \Big\{ \left(\frac{10\ \mathrm{TeV}}{M_{V_8}}\right)^2 \left(\frac{\alpha_c \cot^2\theta_c}{3\pi/4}\right) + \left(\frac{10\ \mathrm{TeV}}{M_{Z'}}\right)^2 \left(\frac{\alpha_Y \cot^2\theta_Y\,(\Delta Y_L)^2}{3\pi/4}\right) \times \mathrm{Im}\,(D_{Lbs} D^*_{Lbd})^2 \Big\}$$

(L→R NEGLIGIBLE!

CONTRIBUTIONS TO $\epsilon \times 10^3$

MODEL	SM	$(ETC)_{LR}$	$(ETC)_{LL}$	$(ETC)_{RR}$	$(TC2)_{LL}$	COMMENT
7c	0	2.38 (!)	0	0	0	PERFECT FIT FOR $\Lambda^{LR}_{sdds} = 1/(4000\,\mathrm{TeV})^2$ ϵ' TOO SMALL!
7d*	+2.28 (!) $\delta_{13} = -0.98$	+9.61	+0.88	+1.02	+8.34	$M_{ETC} \to \infty$ $M_{V_8,Z'} \to \infty$
8c*	+2.18 (!)	−8.94	−0.97	−0.80	+8.20	ETC + TC2 = 0.10 FOR $M_{V_8,Z'} = 8.7$ TeV
12a1*	+1.97	−6.30	+7.76	+0.05	+4.52	$M_{ETC} \to \infty$ $M_{V_8,Z'} \to \infty$
12a2	−2.02	+31.25	−7.92	−1.21	−4.68	ETC + TC2 = 4.33 FOR $M_{ETC} = 2500$ TeV, $M_{V_8,Z'} = 6.9$ TeV
12a3	−1.98	+9.44	−7.68	−0.11	−4.57	$M_{ETC} \simeq 1250$ TeV $M_{V_8,Z'} \to \infty$ $\Rightarrow \epsilon_{ETC} = 4.22$

SUMMARY:

- VACUUM ALIGNMENT IN TC/ETC PROVIDES AN EXQUISITE MECHANISM FOR SOLVING THE STRONG-CP PROBLEM WITH $\bar{\theta}_q \lesssim O(10^{-10})$.

- CONSTRAINTS FROM TC2, SM RESTRICT FORM OF $M_{u,d}$; $U_{L,R}$ + $D_{L,R}$. BUT LOVELY SOLUTIONS ARE EASILY OBTAINED.

- ΔM_{B_d} AND ϵ_K STRONGLY CONSTRAIN TC2 M_{V_8} + $M_{Z'}$ ➡ FINE-TUNING! CAN LARGER $M_{V_{8},Z'}$ BE ACCOMODATED IN TOP-SEESAW MODELS + FIX THIS?

- IT IS <u>EASY</u> FOR SM + ETC (+TC2) TO GIVE THE RIGHT ϵ_K. SOMETIMES LARGE CANCELLATIONS (NATURALLY) OCCUR.

- STILL NEED TO STUDY ϵ', $\sin 2(\beta/\varphi_1)$ ETC.