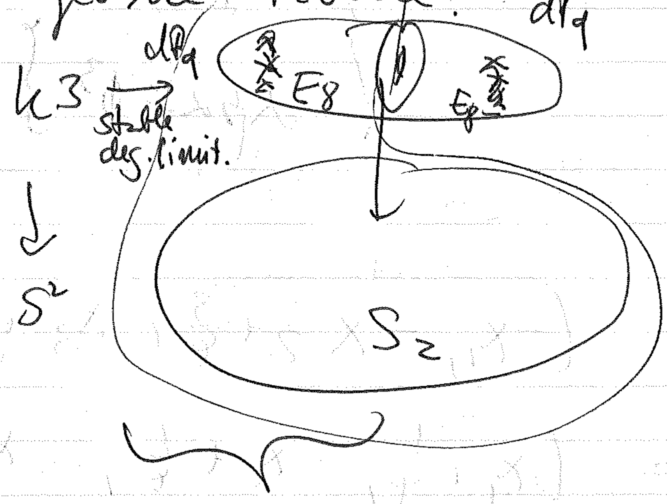
Joe: Talk I: Local to semi-local

Bottom-up approach

1) Local Model.

2) Global Model.

het/F:



gut model localized here.

$\Downarrow$

$E_8 (\times E_8)$ gauge theory $\qquad V$ = v-bdle

$\downarrow \qquad\qquad\qquad\qquad\qquad \Uparrow$

E_8 unfolded. $\longleftarrow$ · Spectral cover

· Higgs bdle.

gauge theory flipped to SU(5)

$E_8 \longrightarrow SU(5)_{GUT} \times SU(5)_\perp$

Goals:

1) SU(5) gauge gp. $\longrightarrow SU(3) \times SU(2) \times U(1)$

2) $3 \times \{10_M, \bar{5}_M\}$, 5_H, $\bar{5}_H$

$$5_H = \begin{pmatrix} T_u \\ H_u \end{pmatrix}, \quad \bar{5}_H = \begin{pmatrix} T_d \\ H_d \end{pmatrix}$$

3) GUT breaking w/ $U(1)_Y$.

$$F_Y \in H_2(S_2, \mathbb{Z}) \to H_2(B_3, \mathbb{Z}).$$

4) Yuks.

Do not want $0 \times 10_M \times \bar{5}_M \times \bar{5}_M$: proton decay.

continuous symm. R-parity tuning.

$$E_8 \longrightarrow SU(5) \times \underbrace{U(1)^4}_{\subset SU(5)_\perp}$$

$$y^2 = x^3 + b_0 z^5 + b_2 z^3 x + b_3 z^2 y + b_4 x^2 z + b_5 xy$$

$z = 0$: S_2.

$$\langle \phi \rangle \sim \begin{pmatrix} t_1 & & \\ & \ddots & \\ & & t_5 \end{pmatrix} \quad \Sigma t_i = 0$$

$$248 \longrightarrow (24,1) + (1,24)$$

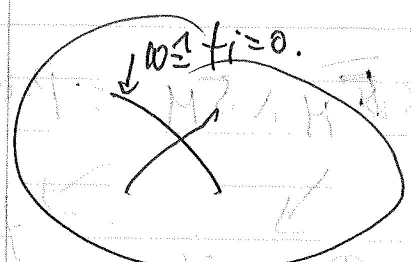
$$+ (10,5) + (\bar{5},10) + c.c.$$

$m \sim [\phi, \phi]$.

5 copies of 10

$m \sim t_i$; $5 \times \bar{5}$ $m \sim t_i + t_j$

$b_m \sim b_0 S_m(t_i)$



monodromy

Yukawas: $SU(5) \times U(1)^4$

$$10_{t_1} \times 10_{t_2} \times \underline{5}_{(t_1+t_2)}$$

$G_{mon.} \subseteq S_5$ $b_5 = 0 = \prod t_i$

$G_{monodr} = S_5$: single 10

$\bar{5}$: $P = 0$.

~~Assume~~ Distinct matter curves are only the ones lifting to different factors of $\mathcal{C}$.

$\mathcal{C}$: $b_0 s^5 + b_2 s^3 + b_3 s^2 + b_4 s + b_5 \sim b_0 \prod (s + t_i)$

$= 0$.

Orbits of t_i & $t_i + t_j$

$\underline{10}$ $\qquad\qquad$ $\underline{\bar{5}}$

components of $\mathcal{C}$

$\mathcal{C}^{(3)}$ $\qquad$ $G \subset S_3 \times \mathbb{Z}_2$.

$\mathcal{C}^{(2)}$.

$\downarrow$

$\boxed{\text{Sym}}$

$\mathcal{C}^{(4)} \times \mathcal{C}^{(1)}$ $\rightsquigarrow$ get more refined models. (orbits alone do not determine all the couplings).

Example 3+2

$U(1)$: $\begin{pmatrix} 2 & & & & \\ & 2 & & & \\ & & 2 & & \\ & & & -3 & \\ & & & & -3 \end{pmatrix}$

	$U(1)_{PQ}$
10_{t_i}	2
10_{t_m}	-3
$\bar{5}_{t_i+t_j}$	4
$\bar{5}_{t_m+t_n}$	-6
$\bar{5}_{t_m+t_i}$	-1

dim 5 proton decay forbidden.

F_Y : affect zero modes in an $SU(5)$ covariant way.

$\bar{5}_M \supset D \quad (\bar{3},1) \quad m$

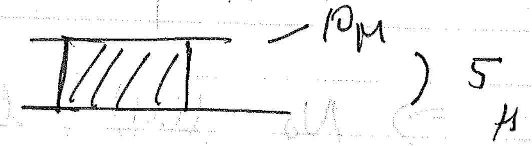
$\qquad\;\; L \quad (1,2) \quad n$

$F_Y\Big|_{\text{Matter}} = 0 \qquad F_Y\Big|_{H} = +1$

$\qquad\qquad\qquad\qquad F_Y\Big|_{\bar{H}} = -1.$

What monodromy gps are possible?

1) $10 \times 10 \times 5$



2) No $U(1)_Y$ on 10_5 & $\bar{5}_M$:

$$C = \sum_{i=1}^{M} C^{(n_i)} \; ; \quad G = \prod S_{n_i}$$

$\Rightarrow$ M different matter curves

$$\Sigma_{10} = \prod_{i=1}^{M} \Sigma_{10,i}$$

$$\Sigma_{\bar{5}} = \prod_{j=1}^{m \leq 2M} \Sigma_{\bar{5},j}.$$

$$\left. \begin{array}{l} K_{S_2} \\ N_{S_2|B_3} \end{array} \right\} \text{data}.$$

M−1 new classes.

$$\Sigma_{\bar{5},i} = a\left[K_{S_2}\right] + b\left[N_{S_2|B_3}\right] + \sum c_i \, \Sigma_{10,i}$$

→ No hypercharge flux on any matter curve possible.

→ No $U(1)$ distinguishing H_u & H_d

→

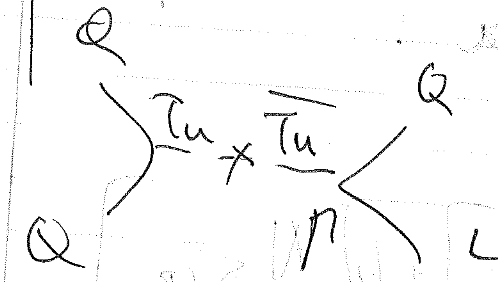
	10_M	$\bar{5}_M$	H_u	H_d
$U(1)_X$	1	-3	-2	2

→ (4+1):

- μ-~~problem~~: refine S_4 further.
- None of the neutrinos models possible.
- Dim 5 proton decay:

$$\frac{1}{\Lambda_{cut}} 10_M \times 10_M \times 10_M \times \bar{5}_M = \frac{QQQL}{\Lambda}$$

$\Lambda > 10^{22}$ GeV   bounds from experiments.



Tune so coupling suppressed

→ very stringent constraints!

→ try to relax these.