

Summary: EFT of known physics: "SM[±]"

$$\begin{aligned}
 \mathcal{L} = & -\frac{1}{2} \text{Tr}(F_3^2) - \frac{1}{2} \text{Tr}(F_2^2) - \frac{1}{4} (B_{\mu\nu})^2 \\
 & + i \sum_{i=1}^3 q_i^+ \not{\partial} q_i + \bar{u}_i^+ \not{\partial} \bar{u}_i + \bar{d}_i^+ \not{\partial} \bar{d}_i \\
 & \quad + l_i^+ \not{\partial} l_i + \bar{e}_i^+ \not{\partial} \bar{e}_i \\
 & - M_W^2 W_\mu^+ W^{-\mu} - \frac{1}{2} M_Z^2 Z_\mu Z^\mu \\
 & - \sum_i m_i^u u_i \bar{u}_i + m_i^d d_i \bar{d}_i + m_i^e e_i \bar{e}_i \\
 & + \mathcal{L}_{SM} \\
 & + \mathcal{L}_{grav} \quad (\text{Einstein-Hilbert} + \text{minimal coupling})
 \end{aligned}$$

} \mathcal{L}_{sym}
 } SM⁻
 } SM[±]

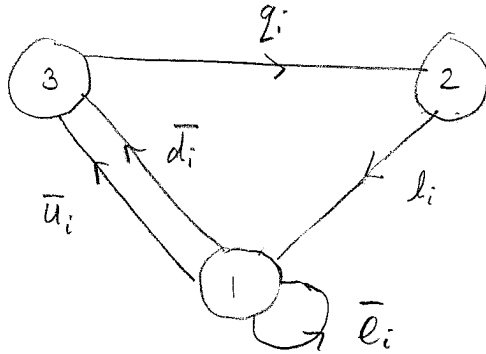
Taking stock

Symmetries: local: $SU(3) \times SU(2) \times U(1)$
 \downarrow
 $U(1)$

Note: \mathcal{L}_{break} = relevant; \sim low E effect

(breaking of marginal origin: not observed)

Useful notation; Moose or quiver



Nodes = groups

Lines = reps arrow out fundamental
 " in anti "

Captures anomaly structure, etc.

global: CPT \checkmark (QFT!) $\not\propto$ $\not\propto$ CP=T \leftarrow phase in CKM (ex)

$$U(1)_B: \begin{array}{l} q \rightarrow e^{i\alpha} q \\ \bar{u}, \bar{d} \rightarrow e^{-i\alpha} \bar{u}, \bar{d} \end{array} \xrightarrow{\text{anomaly}} U(1)_{B-L} \quad (\text{HW})$$

$$U(1)_L: \begin{array}{l} l \rightarrow e^{i\alpha} l \\ \bar{e} \rightarrow e^{-i\alpha} \bar{e} \end{array}$$

Incomplete:

- Don't know \mathcal{L}_{DM}
 - Dark matter / energy
 - Inflation sector
 - gravity - paradoxes
- > empirical
- $U(1)_\psi$ - IR trivial
 - $\mathcal{L}_{\text{break}}$ problematic
 - why $\theta_{\text{QED}} = 0$? (another story ...)

(+ unexplained suggestive patterns - $\alpha_s, m_s, \text{etc.}$)

\Rightarrow seek more complete theory