Higgs Flavour Changing in Little Higgs Models

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arXiv: 1705.08827 [hep-ph]

Little Higgs

Hierarchy problem: the Higgs mass should be of order v (electroweak scale) but it receives quadratic loop corrections of the order of the theory cutoff (Planck scale?)

Naturalness $\Rightarrow$ New Physics at the TeV scale

[SUSY: cancellations of quadratic Higgs mass corrections provided by superpartners]

In LH models the Higgs is a pseudo-Goldstone boson of an approximate global symmetry broken at f (TeV scale) [Arkani-Hamed, Cohen, Georgi '01]

(i) Product group

the SM $SU(2)_L$ group from the diagonal breaking of two or more gauge groups

e.g.: *Littlest* Higgs [Arkani-Hamed, Cohen, Katz, Nelson '02]

(ii) Simple group

the SM $SU(2)_L$ group from the breaking of a larger group into an $SU(2)$ subgroup

e.g.: *Simplest* Little Higgs ($SU(3)$ simple group) [Kaplan, Schmaltz '03]

Little Higgs

– The low energy *dof* described by a nonlinear sigma model, an effective theory valid below a cutoff $\Lambda \sim 4\pi f$ (order of 10 TeV) since then the loop corrections are

$$\Delta M_h^2 \sim \left\{ y_t^2, g^2, \lambda^2 \right\} \frac{\Lambda^2}{16\pi^2} \lesssim (1\ \text{TeV})^2$$

Ultraviolet completion (unknown) is required only for physics above Λ

– The global symmetry explicitly broken by gauge and Yukawa interactions, giving the Higgs a mass and non-derivative interactions, preserving the cancellation of *one-loop* quadratic corrections (collective symmetry breaking)

The sensitivity at two loops to a 10 TeV cutoff is *not unnatural*

LH introduce extra scalars, fermions and gauge bosons: new flavour mixing sources

$\Rightarrow$ Obtain and revise predictions for lepton flavour changing processes

$h \to \mu\tau \qquad Z \to \mu\tau,\ \ell \to \ell'\gamma,\ \mu \to ee\bar{e},\ \mu N \to eN$

Littlest Higgs

[Arkani-Hamed, Cohen, Katz, Nelson '02]

(1) $SU(5) \to SO(5)$ by $\Sigma_0 = \begin{pmatrix} \mathbf{0}_{2\times 2} & 0 & \mathbf{1}_{2\times 2} \\ 0 & 1 & 0 \\ \mathbf{1}_{2\times 2} & 0 & \mathbf{0}_{2\times 2} \end{pmatrix}$, $\quad \Sigma(x) = \mathrm{e}^{\mathrm{i}\Pi/f}\Sigma_0 \mathrm{e}^{\mathrm{i}\Pi^T/f} = \mathrm{e}^{2\mathrm{i}\Pi/f}\Sigma_0$

where $\Pi(x) = \phi^a(x) X^a$ and X^a are the $24 - 10 = 14$ broken generators $\Rightarrow$ 14 GB

$$G \equiv SU(5) \supset [SU(2)\times U(1)]_1 \times [SU(2)\times U(1)]_2 \text{ (gauge)} \xrightarrow{\langle\Sigma\rangle = \Sigma_0} SU(2)_L \times U(1)_Y$$

[unbroken]: $Q_1^a + Q_2^a,\ Y_1 + Y_2 \ \Rightarrow$ 4 gauge bosons (γ, Z, W^+, W^-) remain massless

[broken]: $Q_1^a - Q_2^a,\ Y_1 - Y_2 \ \Rightarrow$ 4 gauge bosons (A_H, Z_H, W_H^+, W_H^-) get masses of order f

4 WBGB $(\eta, \omega^0, \omega^+, \omega^-)$ eaten by (A_H, Z_H, W_H^+, W_H^-)

10 GB: $\underbrace{H \text{ (complex } SU(2) \text{ doublet)}}$, Φ (complex $SU(2)$ triplet, PGB)

(2) EWSB: $SU(2)_L \times U(1)_Y \xrightarrow{\langle H\rangle} U(1)_{\text{QED}} \Rightarrow H = \sqrt{2}\begin{pmatrix} -\mathrm{i}\frac{\pi^+}{\sqrt{2}} \\ \frac{v+h+\mathrm{i}\pi^0}{2} \end{pmatrix}$

3 WBGB (π^0, π^+, π^-) eaten by (Z, W^+, W^-)

1 PGB: h

Littlest Higgs

The matrix of the 14 Goldstone Bosons:

$$\Pi = \begin{pmatrix} -\frac{\omega^0}{2}-\frac{\eta}{\sqrt{20}} & -\frac{\omega^+}{\sqrt{2}} & -\mathrm{i}\frac{\pi^+}{\sqrt{2}} & -\mathrm{i}\Phi^{++} & -\mathrm{i}\frac{\Phi^+}{\sqrt{2}} \\ -\frac{\omega^-}{\sqrt{2}} & \frac{\omega^0}{2}-\frac{\eta}{\sqrt{20}} & \frac{v+h+\mathrm{i}\pi^0}{2} & -\mathrm{i}\frac{\Phi^+}{\sqrt{2}} & \frac{-\mathrm{i}\Phi^0+\Phi^P}{\sqrt{2}} \\ \mathrm{i}\frac{\pi^-}{\sqrt{2}} & \frac{v+h-\mathrm{i}\pi^0}{2} & \sqrt{\frac{4}{5}}\eta & -\mathrm{i}\frac{\pi^+}{\sqrt{2}} & \frac{v+h+\mathrm{i}\pi^0}{2} \\ \mathrm{i}\Phi^{--} & \mathrm{i}\frac{\Phi^-}{\sqrt{2}} & \mathrm{i}\frac{\pi^-}{\sqrt{2}} & -\frac{\omega^0}{2}-\frac{\eta}{\sqrt{20}} & -\frac{\omega^-}{\sqrt{2}} \\ \mathrm{i}\frac{\Phi^-}{\sqrt{2}} & \frac{\mathrm{i}\Phi^0+\Phi^P}{\sqrt{2}} & \frac{v+h-\mathrm{i}\pi^0}{2} & -\frac{\omega^+}{\sqrt{2}} & \frac{\omega^0}{2}-\frac{\eta}{\sqrt{20}} \end{pmatrix}$$

Generators of the gauge subgroup $[SU(2)\times U(1)]_1 \times [SU(2)\times U(1)]_2 \subset SU(5)$:

$$Q_1^a = \frac{1}{2}\begin{pmatrix} \sigma^a & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \mathbf{0}_{2\times 2} \end{pmatrix} \qquad Q_2^a = \frac{1}{2}\begin{pmatrix} \mathbf{0}_{2\times 2} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\sigma^{a*} \end{pmatrix}$$

$$Y_1 = \frac{1}{10}\mathrm{diag}(3,3,-2,-2,-2) \qquad Y_2 = \frac{1}{10}\mathrm{diag}(2,2,2,-3,-3)$$

Littlest Higgs with T-parity

[Cheng, Low '03]

New particles at TeV scale coupling to SM particles $\Rightarrow$ tension with EW precision tests

$\rightsquigarrow$ **T-parity** discrete symmetry under which SM (most of new) particles are even (odd)

– Gauge sector: $G_1 \overset{\mathrm{T}}{\longleftrightarrow} G_2$ with $G_j = (W_j^a, B_j)$ gauge bosons of $[SU(2)\times U(1)]_{j=1,2}$

and $g \equiv g_1 = g_2$, $g' \equiv g'_1 = g'_2$

T-even: $B, W^3(\gamma, Z), W^+, W^- \leftarrow \frac{1}{\sqrt{2}}(G_1 + G_2)$

T-odd: $A_H, Z_H, W_H^+, W_H^- \leftarrow \frac{1}{\sqrt{2}}(G_1 - G_2)$

$$\mathcal{L}_G = \sum_{j=1}^{2}\left[-\frac{1}{2}\mathrm{Tr}\left(\widetilde{W}_{j\mu\nu}\widetilde{W}_j^{\mu\nu}\right) - \frac{1}{4}B_{j\mu\nu}B_j^{\mu\nu}\right]$$

– Scalar sector: $\Pi \overset{\mathrm{T}}{\longrightarrow} -\Omega\Pi\Omega$, where $\Omega = \mathrm{diag}(-1,-1,1,-1,-1)$

$\Rightarrow \Sigma \overset{\mathrm{T}}{\longrightarrow} \Omega\Sigma_0\Sigma^\dagger\Sigma_0\Omega$ $\qquad \Sigma \overset{\mathrm{G}}{\longrightarrow} V\Sigma V^T$

T-even: SM H doublet (h, π^0, π^+, π^-)

T-odd: the others $(\eta, \omega^0, \omega^+, \omega^-, \Phi)$

$$\mathcal{L}_S = \frac{f^2}{8}\mathrm{Tr}\left[(D_\mu\Sigma)^\dagger(D^\mu\Sigma)\right] \supset \text{gauge boson masses}$$

with $D_\mu\Sigma = \partial_\mu\Sigma - \sqrt{2}\mathrm{i}\sum_{j=1}^{2}\left[gW_{j\mu}^a(Q_j^a\Sigma + \Sigma Q_j^{aT}) - g'B_{j\mu}(Y_j\Sigma + \Sigma Y_j^T)\right]$

Littlest Higgs with T-parity

– Fermion (lepton) sector:

(a) Introduce $SU(2)_L$ doublets $l_{1L}, l_{2L}, l_{HR}, \tilde{l}^c_L$ and a singlet χ_R in

$$\Psi_1[\bar{\mathbf{5}}] = \begin{pmatrix} -i\sigma^2 l_{1L} \\ 0 \\ 0 \end{pmatrix} \quad \Psi_2[\mathbf{5}] = \begin{pmatrix} 0 \\ 0 \\ -i\sigma^2 l_{2L} \end{pmatrix} \quad \Psi_R = \begin{pmatrix} -i\sigma^2 \tilde{l}^c_L \\ \chi_R \\ -i\sigma^2 l_{HR} \end{pmatrix}$$

$$\Psi_1 \stackrel{\mathrm{T}}{\longleftrightarrow} \Omega\Sigma_0\Psi_2 \qquad \Psi_1 \stackrel{G}{\longrightarrow} V^*\Psi_1,\ \Psi_2 \stackrel{G}{\longrightarrow} V\Psi_2$$

$$\Psi_R \stackrel{\mathrm{T}}{\longrightarrow} \Omega\Psi_R \qquad \Psi_R \stackrel{G}{\to} U\Psi_R$$

T-even	Standard (light) $l_L = \frac{1}{\sqrt{2}}(l_{1L} - l_{2L}) = (\nu_L \quad \ell_L)^T$	Singlet (decouples) χ_R
T-odd	Mirror (heavy) $l_{HL} = \frac{1}{\sqrt{2}}(l_{1L} + l_{2L}) = (\nu_{HL} \quad \ell_{HL})^T$ $l_{HR} = (\nu_{HR} \quad \ell_{HR})^T$	Mirror partners (decouple?) $\tilde{l}^c_L = (\tilde{\nu}^c_L \quad \tilde{\ell}^c_L)^T$

Littlest Higgs with T-parity

▷ To obtain (heavy, vector-like) mirror fermion masses *preserving* gauge and T

$$\mathcal{L}_{Y_H} = -\kappa f \left(\overline{\Psi}_2 \xi + \overline{\Psi}_1 \Sigma_0 \xi^\dagger\right) \Psi_R + \text{h.c.}$$

$$\xi = e^{i\Pi/f} \xrightarrow{T} \Omega \xi^\dagger \Omega$$

$$\xi \xrightarrow{G} V \xi U^\dagger \equiv U \xi \Sigma_0 V^T \Sigma_0$$

(b) Introduce (light) standard (down-type) fermion singlets (ℓ_R) with mass terms *preserving* gauge and T

[Chen, Tobe, Yuan '06]

$$\mathcal{L}_Y = \frac{i\lambda_\ell}{2\sqrt{2}} f \epsilon_{ij} \epsilon_{xyz} \left[(\overline{\Psi}'_2)_x \Sigma_{iy} \Sigma_{jz} X + \text{T-transformed} \right] \ell_R + \text{h.c.}$$

$$\Psi'_2 = \begin{pmatrix} 0 \\ 0 \\ l_{2L} \end{pmatrix} , \quad X = (\Sigma_{33})^{-\frac{1}{4}} , \quad i,j \in \{1,2\} , \quad x,y,z \in \{3,4,5\}$$

Littlest Higgs with T-parity

▷ So far

$$\mathcal{L}_Y \supset -\frac{\lambda_\ell}{\sqrt{2}} v\, \overline{\ell_L} \ell_R + \text{h.c.}$$

$$\mathcal{L}_{Y_H} \supset -\sqrt{2}\kappa f\, \overline{l_{HL}} l_{HR} + \text{h.c.}$$

(c) To provide the mirror partners $\tilde{l}^c_L$ with (heavy, vector-like) masses is unavoidable to *break* $SO(5)$ by introducing its left-handed counterpart $\tilde{l}^c_R = (\tilde{\nu}^c_R,\ \tilde{\ell}^c_R)^T$ in an incomplete $SO(5)$ representation

$$\Psi_L = \begin{pmatrix} -\mathrm{i}\sigma^2 \tilde{\ell}^c_R \\ 0 \\ 0 \end{pmatrix}$$

$$\boxed{\mathcal{L}_M = -M\, \overline{\tilde{l}_R}\, \tilde{l}_L + \text{h.c.}}$$

Littlest Higgs with T-parity

(d) The gauge interactions with fermions are fixed!

$$\mathcal{L}_F = \mathrm{i}\overline{\Psi}_1\gamma^\mu D^*_\mu\Psi_1 \; + \; \mathrm{i}\overline{\Psi}_2\gamma^\mu D_\mu\Psi_2 + \mathrm{i}\overline{\Psi}_R\gamma^\mu \left(\partial_\mu + \tfrac{1}{2}\xi^\dagger(D_\mu\xi) + \tfrac{1}{2}\xi(\Sigma_0 D^*_\mu \Sigma_0 \xi^\dagger)\right)\Psi_R + (\Psi_R \to \Psi_L)$$

$$\text{with } D_\mu = \partial_\mu - \sqrt{2}\mathrm{i}g(W^a_{1\mu}Q^a_1 + W^a_{2\mu}Q^a_2) + \sqrt{2}\mathrm{i}g'\left(Y_1 B_{1\mu} + Y_2 B_{2\mu}\right)$$

including $\mathcal{O}(v^2/f^2)$ couplings to Goldstones that render one-loop amplitudes (vid. Z-penguins) UV finite [del Águila, JI, Jenkins '09]

(e) The gauge interactions of light right-handed singlets (ℓ_R)

$$\mathcal{L}'_F = \mathrm{i}\bar{\ell}_R\gamma^\mu(\partial_\mu + \mathrm{i}g' y_\ell B_\mu)\ell_R \qquad y_\ell = -1$$

require enlarging $SU(5)$ to assign proper hypercharges...

Littlest Higgs with T-parity

$$SU(5) \supset [SU(2)_1 \times U(1)_1] \times [SU(2)_2 \times U(1)_2]$$

▷ Enlarging $SU(5)$ with two extra $U(1)$ factors ($y = y_1 + y_2$) [Goto, Okada, Yamamoto '09]

$$SU(5) \times U(1)_1'' \times U(1)_2'' \supset [SU(2)_1 \times \underbrace{U(1)_1' \times U(1)_1''}_{\supset U(1)_1}] \times [SU(2)_2 \times \underbrace{U(1)_2' \times U(1)_2''}_{\supset U(1)_2}]$$

Leptons	$SU(2)_1$	$SU(2)_2$	$y_1 = y_1' + y_1''$	$y_2 = y_2' + y_2''$	y_1'	y_2'	y_1''	y_2''
$l_1 = \begin{pmatrix} \nu_{1L} \\ \ell_{1L} \end{pmatrix}$	**2**	**1**	$-\frac{3}{10}$	$-\frac{1}{5}$	$-\frac{3}{10}$	$-\frac{1}{5}$	0	0
$l_2 = \begin{pmatrix} \nu_{2L} \\ \ell_{2L} \end{pmatrix}$	**1**	**2**	$-\frac{1}{5}$	$-\frac{3}{10}$	$-\frac{1}{5}$	$-\frac{3}{10}$	0	0
ν_R	**1**	**1**	0	0	0	0	0	0
ℓ_R	**1**	**1**	$-\frac{1}{2}$	$-\frac{1}{2}$	0	0	$-\frac{1}{2}$	$-\frac{1}{2}$
$l_{HR} = \begin{pmatrix} \nu_{HR} \\ \ell_{HR} \end{pmatrix}$	—	—	—	—	—	—	0	0

LHT (Lepton) Flavour mixing

- T parity $\Rightarrow$ SM (T-even) fermions do not mix with T-odd fermions
- 3 generations: λ_ℓ, κ and M are matrices in flavour space

$$\frac{\lambda_\ell}{\sqrt{2}} v = V_L^\ell \, \mathrm{diag}(m_{\ell i}) \, V_R^{\ell\dagger}$$

$$\begin{pmatrix} \sqrt{2}\kappa f & 0 \\ 0 & M \end{pmatrix} = \begin{pmatrix} V_L^H & 0 \\ 0 & \widetilde{V}_L \end{pmatrix} \begin{pmatrix} \mathrm{diag}(m_{\ell_{Hi}}) & 0 \\ 0 & \mathrm{diag}(m_{\tilde{\ell}_i}) \end{pmatrix} \begin{pmatrix} V_R^{H\dagger} & 0 \\ 0 & \widetilde{V}_R^\dagger \end{pmatrix}$$

- This leads to heavy-light mixings in both charged and neutral currents coupling a left-handed T-odd fermion to a T-odd gauge or Goldstone boson

$$V \equiv V_L^{H\dagger} V_L^\ell \qquad\qquad W \equiv \widetilde{V}_L^T V_L^H$$

  – V parameterizes the misalignment between mirror (l_H) and light leptons (ℓ)

  – W parameterizes the misalignment between mirror partners ($\tilde{l}$) and l_H new

LHT | (Lepton) Flavour mixing

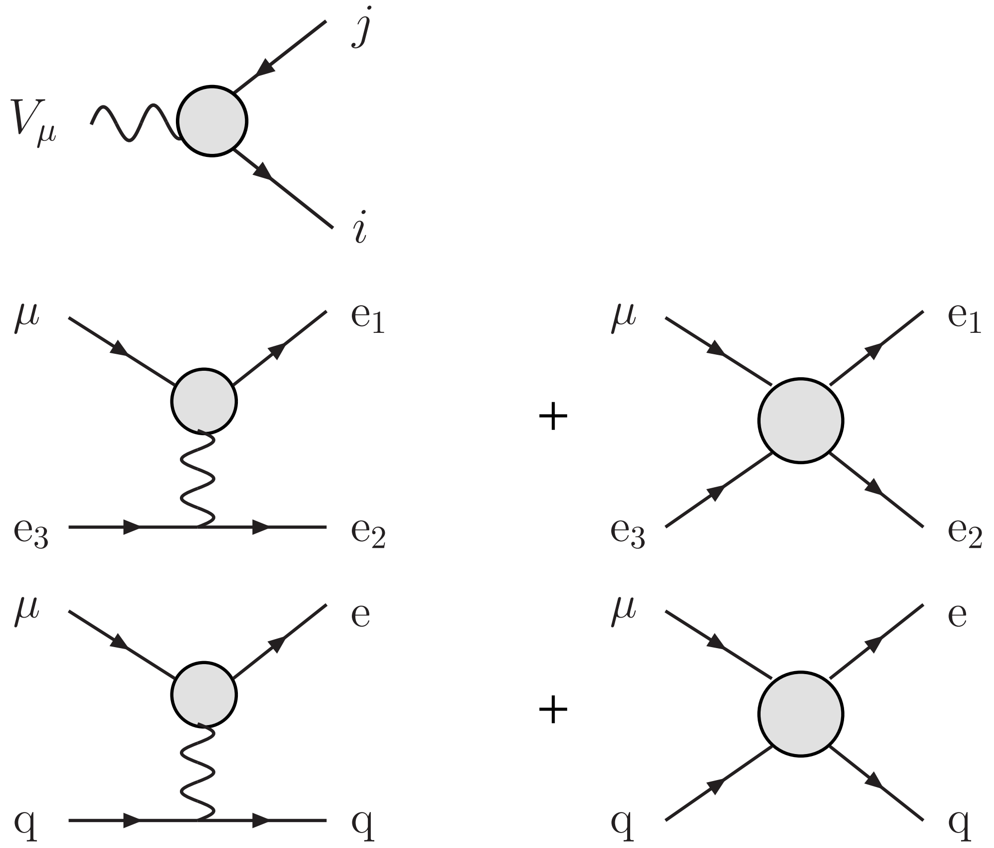
▷ W is a source of LFV, so far ignored assuming that mirror partners decouple.

[Buras *et al* '07]
[del Águila, JI, Jenkins '09]

$\mu \to e\gamma$:

$\mu \to ee\bar{e}$: + crossed ($e_1 \leftrightarrow e_2$)

$\mu N \to eN$: ($q = u, d$)



[In fact we have checked $\tilde{l}$ decoupling in $\ell \to \ell'\gamma$, $\mu \to ee\bar{e}$ and $\mu N \to eN$]

LHT (Lepton) Flavour mixing

▷ But in **LFV Higgs decays** breaking news!!

- The mirror partners $\tilde{l}$ do NOT decouple!
- They are needed to make the amplitude UV finite!
- The complex $SU(2)$ triplet of physical Goldstones Φ $(\Phi^0, \Phi^P, \Phi^{\pm}, \Phi^{\pm\pm})$ also plays a fundamental role for the cancellation of the UV divergences

  [Φ contributions are subleading in v^2/f^2, negligible in other LFV processes]

$\Rightarrow$ **LFV Higgs decays** are sensitive to both V and W

LHT **Physical masses** (to order v^2/f^2)

– Scalar fields get rotated into a diagonal basis after gauge fixing

– Goldstone-gauge interactions provide v^2/f^2 mass corrections

▷ Gauge boson masses [$\mathcal{L}_S$]

$$m_W = \frac{gv}{2}\left(1-\frac{v^2}{12f^2}\right) \qquad m_Z = m_W/c_W \qquad [e = gs_W = g'c_W]$$

$$m_{W_H} = gf\left(1-\frac{v^2}{8f^2}\right) \qquad m_{Z_H} = m_{W_H} \qquad m_{A_H} = \frac{g'f}{\sqrt{5}}\left(1-\frac{5v^2}{8f^2}\right)$$

▷ Fermion masses [$\mathcal{L}_{Y_H}, \mathcal{L}_M$]

$$m_{\ell_{Hi}} = \sqrt{2}\kappa_i f \qquad m_{\nu_{Hi}} = m_{\ell_{Hi}}\left(1-\frac{v^2}{8f^2}\right) \qquad m_{\tilde{\nu}_i^c} = m_{\tilde{\ell}_i^c}$$

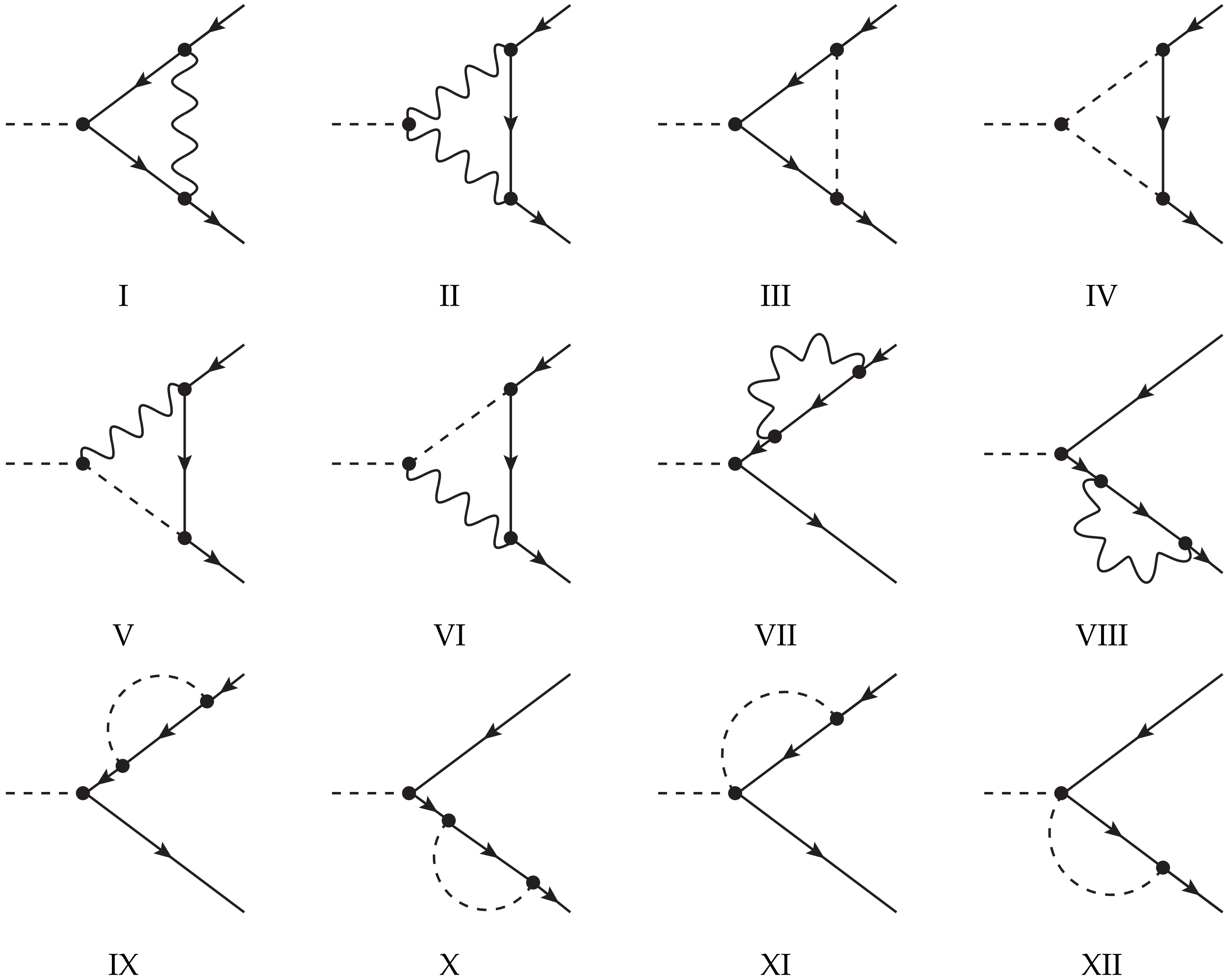
▷ Scalar masses (physical pseudo-Goldstones) [Coleman-Weinberg mechanism]

$$m_h \qquad m_{\Phi^0,\Phi^P,\Phi^\pm,\Phi^{\pm\pm}}$$

LHT | One-loop contributions to LFV Higgs decays | $h \to \mu\bar{\tau}$

('t Hooft-Feynman gauge)

V	S	F
	h	μ, τ
W_H	$\omega^{\pm}$	ν_H
Z_H	ω^0	ℓ_H
A_H	η	$\tilde{\nu}^c$
	Φ^0	$\tilde{\ell}^c$
	Φ^P	
	$\Phi^{\pm}$	
	$\Phi^{\pm\pm}$	



LHT **Amplitude** $h \to \mu\bar{\tau}$

$$\mathcal{M}(h \to \mu\bar{\tau}) = \overline{u}(p_2)\left(\boxed{\frac{m_\mu}{v}}\, c_L^{\mu\tau} P_L + \boxed{\frac{m_\tau}{v}}\, c_R^{\mu\tau} P_R\right) v(p_1)$$

$$c_{L(R)}^{\mu\tau} = \boxed{\frac{g^2}{16\pi^2}}\boxed{\frac{v^2}{f^2}}\left\{ \sum_{i=1}^{3} V_{\mu i}^\dagger V_{i\tau}\, F(m_{\ell_{Hi}}, m_{W_H}, m_{A_H}, m_\Phi) \right.$$
$$\left. + \sum_{i,j,k=1}^{3} V_{\mu i}^\dagger \frac{m_{\ell_{Hi}}}{m_{W_H}} W_{ij}^\dagger W_{jk} \frac{m_{\ell_{Hk}}}{m_{W_H}} V_{k\tau}\, G(m_{\ell_{Hi(k)}}, m_{\tilde{\nu}_j^c}, m_{\ell_{Hk(i)}}, m_{W_H}, m_\Phi) \right\}$$

$$\mathcal{M} \propto \frac{1}{16\pi^2}\frac{v^2}{f^2}\lambda \left\{ \boxed{\delta\kappa^2}\ \boxed{\sin 2\theta_V}\ ,\ \underbrace{\boxed{\overline{\kappa}^2}\ \cos 2\theta_V\ \boxed{\sin 2\theta_W}\ \ln\frac{m^2_{\tilde{\nu}_1^c}}{m^2_{\tilde{\nu}_2^c}}}_{m_{\tilde{\nu}_i^c}\to\infty} \right\}$$

LHT **UV divergences** $h \to \mu\bar{\tau}$ (highly non-trivial cancellations!)

$$\mathcal{M}(h \to \mu\bar{\tau}) = \frac{1}{16\pi^2} \sum_i V^\dagger_{\mu i} V_{i\tau} \frac{m^2_{\ell_{Hi}}}{f^2} \left(\frac{C^{(0)}_{\text{UV}}}{\epsilon} + \frac{C^{(1)}_{\text{UV}}}{\epsilon} \frac{v^2}{f^2} \right) \overline{u}(p_2) \left(\frac{m_\mu}{v} P_L + \frac{m_\tau}{v} P_R \right) v(p_1)$$

$$\epsilon = 4 - D$$

$C^{(0)}_{\text{UV}}$	I	II	III	IV	V+VI	VII+VIII	IX+X	XI+XII	sum
ω, ν_H	–	–	•	•	–	–	1	-1	•
ω^0, ℓ_H	–	–	•	•	–	–	$\frac{1}{2}$	$-\frac{1}{2}$	•
η, ℓ_H	–	–	•	•	–	–	$\frac{1}{10}$	$-\frac{1}{10}$	•
all	–	–	•	•	–	–	$\frac{8}{5}$	$-\frac{8}{5}$	•

- Also finite part is zero

LHT **UV divergences** $h \to \mu\bar{\tau}$ (highly non-trivial cancellations!)

$C_{\text{UV}}^{(1)}$	I	II	III	IV	V+VI	VII+VIII	IX+X	XI+XII	sum	
W_H, ν_H	0	0	–	–	–	•	–	–	0	
W_H, ω, ν_H	–	–	–	–	0	–	–	–	0	$F\vert_{W_H}$
ω, ν_H	–	–	$\frac{1}{4}$	$-\frac{1}{8}$	–	–	$-\frac{1}{6}$	$\frac{5}{24}$	$\frac{1}{6}$	
Z_H, ℓ_H	•	0	–	–	–	•	–	–	0	
Z_H, ω^0, ℓ_H	–	–	–	–	0	–	–	–	0	$F\vert_{Z_H}$ ✓
ω^0, ℓ_H	–	–	•	$-\frac{1}{16}$	–	–	$-\frac{13}{48} + x_H \frac{c_W}{s_W}$	$\frac{7}{16} - x_H \frac{c_W}{s_W}$	$\frac{5}{48}$	
A_H, ℓ_H	•	0	–	–	–	•	–	–	0	
A_H, η, ℓ_H	–	–	–	–	0	–	–	–	0	$F\vert_{A_H}$ ✓
η, ℓ_H	–	–	•	$-\frac{1}{16}$	–	–	$-\frac{23}{240} - x_H \frac{s_W}{5c_W}$	$-\frac{17}{240} + x_H \frac{s_W}{5c_W}$	$-\frac{11}{48}$	
Z_H, A_H, ℓ_H	–	0	–	–	–	–	–	–	0	$F\vert_{Z_H A_H}$ ✓
ω^0, η, ℓ_H	–	–	–	$\frac{1}{8}$	–	–	–	–	$\frac{1}{8}$	
W_H, Φ, ν_H	–	–	–	–	0	–	–	–	0	
Φ, ν_H	–	–	•	•	–	–	$-\frac{1}{8}$	$\frac{1}{24}$	$-\frac{1}{12}$	
ω, Φ, ν_H	–	–	–	$\frac{1}{6}$	–	–	–	–	$\frac{1}{6}$	$F\vert_{\Phi\, l_H}$
ω^0, Φ^P, ℓ_H	–	–	–	$\frac{1}{24}$	–	–	–	–	$\frac{1}{24}$	
η, Φ^P, ℓ_H	–	–	–	$-\frac{1}{24}$	–	–	–	–	$-\frac{1}{24}$	
$\Phi, \tilde{\nu}^c, \nu_H$	–	–	$-\frac{1}{4}$	$\frac{1}{24}$	–	–	•	$-\frac{1}{24}$	$-\frac{1}{4}$	G
all	0	0	0	$\frac{1}{12}$	0	•	$-\frac{49}{120}$	$\frac{39}{120}$	0	$\mathcal{M}$

Conclusions

- The one-loop predictions for flavour violating processes in the LHT are UV-finite when *all* Goldstone interactions compatible with gauge and T symmetry and *all* T-odd leptons (mirror and mirror partners) are included

- The partner leptons do not decouple and introduce a new source of LFV via their couplings to the pseudo-Goldstone scalar triplet Φ showing up in Higgs LFV decays only in the heavy mass limit

- However, *if* partner lepton masses are of same order as the other T-odd particles, all their contributions are expected of similar size in Higgs and gauge-mediated LFV processes ($Z \to \mu\tau$, $\ell \to \ell'\gamma$, $\mu \to e e\bar{e}$, $\mu N \to e N$)

- We find $\mathcal{B}(h \to \mu\tau)$ as large as $\sim 0.5 \times 10^{-6}$ for large mixings and all T-odd particle masses of order of a few TeV