Standard Model – Field content

All fermions in the $(\frac{1}{2},0)$ representation of Lorentz group. (Left-handed)

Left-handed quarks	$q_f^{i,a}(x) = \begin{pmatrix} u^a \\ d^a \end{pmatrix}_f$ (i: SU(2) index, a: SU(3) index)	$(3,\ 2,\ +\frac{1}{6})$	using q to avoid confusion with Q, the electric charge operator
Right-handed up-type quarks	$\bar{u}_f^a(x)$	$(\bar{3},\ 1,\ -2/3)$	"Barred" fields are not any sort of conjugate. They serve to remind us that fields are in the conjugate representation of SU(3) (and U(1))
Right-handed down-type quarks	$\bar{d}_f^a(x)$	$(\bar{3},\ 1,\ 1/3)$	
Left-handed lepton	$\ell_f^i(x) = \begin{pmatrix} \nu \\ e \end{pmatrix}_f$	$(1,\ 2,\ -1/2)$	
Right-handed charged-lepton	$\bar{e}_f(x)$	$(1,\ 1,\ +1)$	

Scalar fields:

Higgs doublet: (scalar) $H(x) = \frac{1}{\sqrt{2}}\begin{pmatrix} \phi_1 + i\phi_2 \\ \phi_3 + i\phi_4 \end{pmatrix}$ $(1,\ 2,\ 1/2)$

Gauge bosons:

			Generators:
U(1) gauge field	$B_\mu(x)$	$(1,\ 1,\ 0)$	$(T^A_{SU(3)})^a{}_b = \frac{\lambda^A}{2}$ (Gell-Mann)
$SU(2)_L$ gauge field	$W_\mu^a(x)$	$(1,\ 3,\ 0)$	$(T^a_{SU(2)})^i{}_j = \frac{\tau^a}{2}$ (Pauli-σ)
SU(3) gauge field (gluons)	$G_\mu^A(x)$	$(8,\ 1,\ 0)$	Y

Lagrangian of the Standard Model of electroweak interactions

Conveniently divided into four parts:

$$\mathcal{L}_{SM} = \mathcal{L}_{\substack{\text{Maxwell}\\ \text{Yang-Mills}}} + \mathcal{L}_{\substack{\text{Dirac-}\\ \text{Weyl}}} + \mathcal{L}_{\text{Higgs}} + \mathcal{L}_{\text{Yukawa}}$$

$$\mathcal{L}_{\substack{\text{Maxwell}\\ \text{Yang-Mills}}} = -\frac{1}{4} B_{\mu\nu} B^{\mu\nu} - \frac{1}{4} W^a_{\mu\nu} W^{\mu\nu\, a} - \frac{1}{4} G^A_{\mu\nu} G^{\mu\nu\, A}$$

where $B_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu$ Hypercharge

$W^a_{\mu\nu} = \partial_\mu W^a_\nu - \partial_\nu W^a_\mu - g\epsilon^{abc} W^b_\mu W^c_\nu$ Weak Isospin

$G^A_{\mu\nu} = \partial_\mu G^A_\nu - \partial_\nu G^A_\mu - g_s f^{ABC} G^B_\mu G^C_\nu$. Colored gluons.

$$\mathcal{L}_{\substack{\text{Dirac-}\\ \text{Weyl}}} = \sum_{\text{generations}} \Big[q^\dagger i\bar{\sigma}^\mu D_\mu q + \bar{u}^\dagger i\bar{\sigma}^\mu D_\mu \bar{u} + \bar{d}^\dagger i\bar{\sigma}^\mu D_\mu \bar{d}$$
$$+ \ell^\dagger i\bar{\sigma}^\mu D_\mu \ell + \bar{e}^\dagger i\bar{\sigma}^\mu D_\mu \bar{e} \Big]$$

where $D_\mu q = \left[\partial_\mu + ig_s T^A_{SU(3)} G^A_\mu + ig T^a_{SU(2)} W^a_\mu + ig'\left(\tfrac{1}{6}\right) B_\mu\right] q$

$D_\mu \bar{u} = \left[\partial_\mu + ig_s \overline{T}^A_{SU(3)} G^A_\mu + ig'\left(\tfrac{-2}{3}\right) B_\mu\right] \bar{u}$

$D_\mu \bar{d} = \left[\partial_\mu + ig_s \overline{T}^A_{SU(3)} G^A_\mu + ig'\left(\tfrac{1}{3}\right) B_\mu\right] \bar{d}$

$D_\mu \ell = \left[\partial_\mu + ig T^a_{SU(2)} W^a_\mu + ig'\left(\tfrac{-1}{2}\right) B_\mu\right] \ell$

$D_\mu \bar{e} = \left[\partial_\mu + ig'(+1) B_\mu\right] \bar{e}$

$$\mathcal{L}_{\text{Higgs}} = (D_\mu H)^\dagger (D^\mu H) - \underbrace{\left(-\mu^2 H^\dagger H + \lambda (H^\dagger H)^2\right)}_{V(H)}$$

where $D_\mu H = \left[\partial_\mu + igT^a W^a_\mu + ig'\left(\tfrac{1}{2}\right) B_\mu\right] H$

$$\mathcal{L}_{\text{Yukawa}} = -\tilde{H}\cdot q^\dagger_f (y_u)_{fg}\, \bar{u}^\dagger_g - H\cdot q^\dagger_f (y_d)_{fg}\, \bar{d}^\dagger_g - H\cdot \ell^\dagger_f (y_\ell)_{fg}\, \bar{e}^\dagger_g + \text{h.c.}$$

sum (horizontally) over generations

$\tilde{H} = -\epsilon_{ij} H^*_j$

$(y_u)_{fg}$, $(y_d)_{fg}$, $(y_\ell)_{fg}$ are neither Hermitian nor unitary.