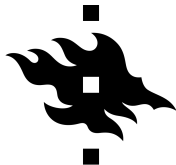


# 331 – gauge extensions and flavour

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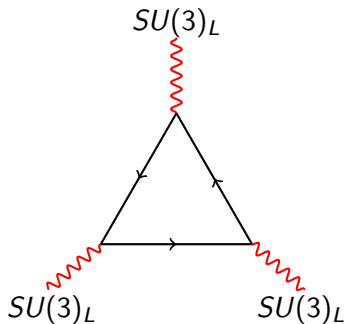
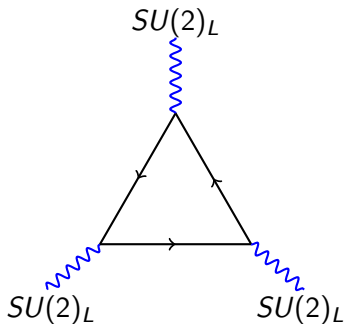
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# The 331 – gauge extension

$$\text{Standard model} = SU(3)_C \times SU(2)_L \times U(1)_Y$$

$$\text{331 – model} = SU(3)_C \times SU(3)_L \times U(1)_X$$



Larger gauge group  $\Rightarrow$  **New particles!**

Fermion representations:

$$\text{Triplets: } L_{L,i} = \begin{pmatrix} \nu_i \\ e_i \\ N_i \end{pmatrix}_L \sim (1, 3, -\frac{1}{3}), \quad Q_{L,1} = \begin{pmatrix} u_1 \\ d_1 \\ U \end{pmatrix}_L \sim (3, 3, \frac{1}{3})$$

$$\text{Antitriplets: } Q_{L,2} = \begin{pmatrix} d_2 \\ u_2 \\ D_1 \end{pmatrix}_L \sim (3, 3^*, 0), \quad Q_{L,3} = \begin{pmatrix} d_3 \\ u_3 \\ D_2 \end{pmatrix}_L \sim (3, 3^*, 0)$$

$SU(3)_L$  - singlets:

$$e_{R,i} \sim (1, 1, -1), \quad N_{R,i} \sim (1, 1, 0),$$

$$u_{R,i} \sim (3, 1, \frac{2}{3}), \quad U_R \sim (3, 1, \frac{2}{3})$$

$$d_{R,i} \sim (3, 1, -\frac{1}{3}), \quad D_{R,1} \sim (3, 1, -\frac{1}{3}), \quad D_{R,2} \sim (3, 1, -\frac{1}{3}), \quad i = 1, 2, 3$$

# Flavour changing neutral currents

Minimal scalar sector:

$$\eta = \begin{pmatrix} \eta^+ \\ \eta^0 \\ \eta'^+ \end{pmatrix} \sim (1, 3, \frac{2}{3}), \quad \rho = \begin{pmatrix} \rho^0 \\ \rho^- \\ \rho'^0 \end{pmatrix} \sim (1, 3, -\frac{1}{3})$$

Quark Yukawa couplings:

$$\mathcal{L}_{down} = \sum_{\gamma=1}^5 y_{1\gamma}^d \bar{Q}'_{L,1} \eta d'_{R,\gamma} + \sum_{\alpha=2}^3 \sum_{\gamma=1}^5 y_{\alpha\gamma}^d \bar{Q}'_{L,\alpha} \rho^* d'_{R,\gamma} + h.c.,$$

$$\mathcal{L}_{up} = \sum_{\gamma=1}^4 y_{1\gamma}^u \bar{Q}'_{L,1} \rho u'_{R,\gamma} + \sum_{\alpha=2}^3 \sum_{\gamma=1}^4 y_{\alpha\gamma}^u \bar{Q}'_{L,\alpha} \eta^* u'_{R,\gamma} + h.c.$$