A Strongly Coupled Fourth Generation at the Tevatron

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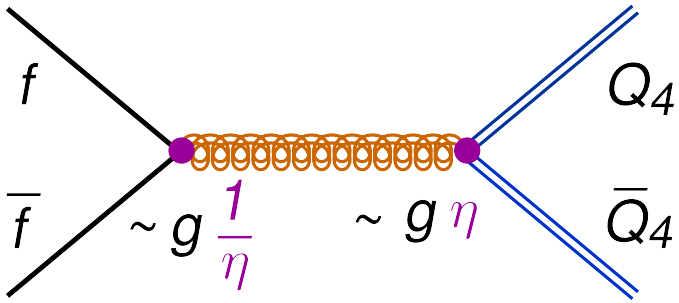
A Strongly Coupled Fourth Generation and EWSB

Assume

- A Chiral Fourth Generation: $Q_{4L}, U_{4R}, D_{4R}, L_4, E_{4R}, N_{4R}$
- A new strong interaction at the $O(1)$ TeV scale:
  - E.g. Broken gauge symmetry $M \sim TeV$, color octet G
  - Strongly coupled to 4th gen.
  - Weaker coupling to lighter generations



with $\eta \sim 3 - 5$

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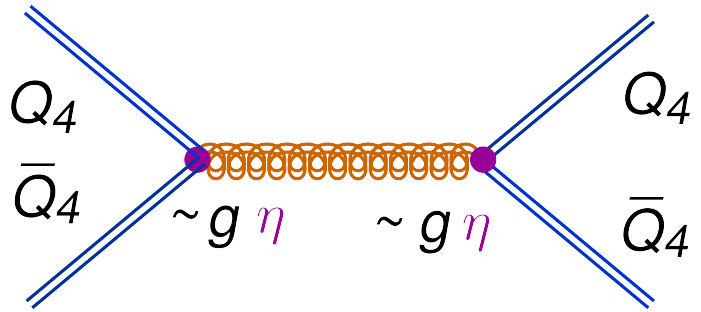
Also



Such that (at least) one 4G quark condenses

$$\text{E.g. } \Rightarrow \langle \bar{D}_4 D_4 \rangle \neq 0$$

- EWSB
- $m_{D_4} \simeq (500 - 600)$ GeV
- Higgs is heavy: $m_h \gtrsim 700$ GeV

Like Top condensation [Bardeen, Hill, Lindner], but with 4G

Fermion Masses

Fermion masses other than m_{D_4}: higher dimensional operators. E.g.

$$\frac{x_{ij}}{\Lambda^2}\ \bar{f}_L^i f_R^j\ \bar{D}_{4R} D_{4L}$$

such that

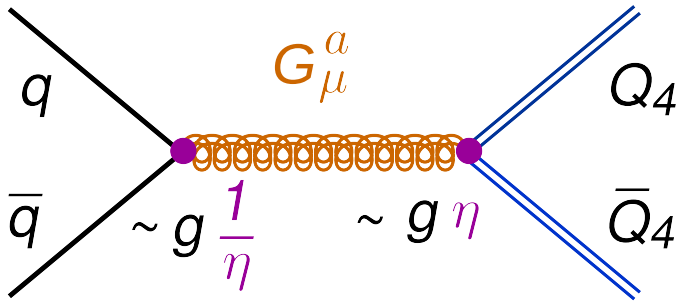
$$m_{ij} \simeq x_{ij}\ \frac{m_{D_4}^3}{\Lambda^2}$$

Setup inspired in warped 5D model with 4G condensation [G.B., Da Rold]

Production at the Tevatron

Production of U_4 and D_4:

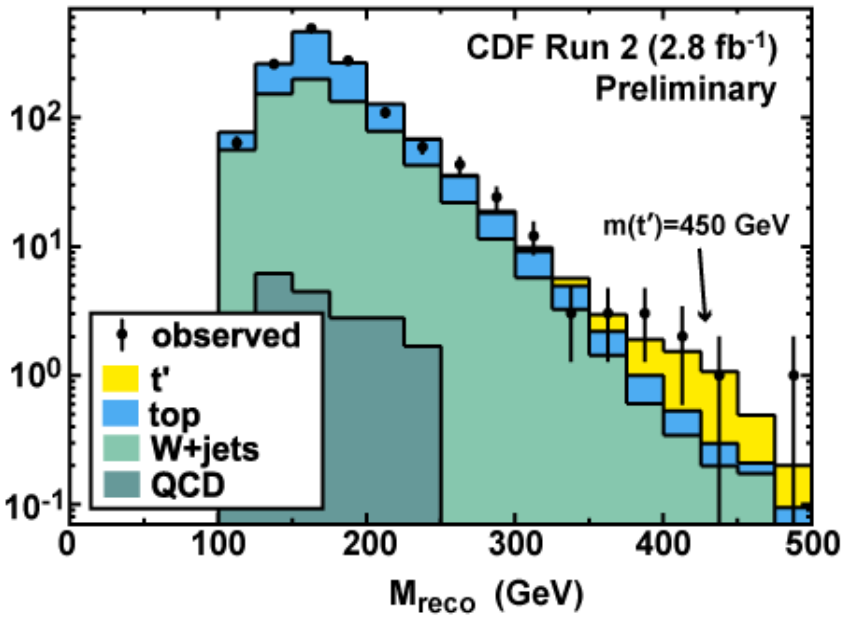
In addition to standard QCD production of U_4, D_4, we also have



What do we choose for masses, couplings ?

Some guidance from data ?

CDF excess in $U_4 \to W\, q$



Fix $m_{U_4} = 450$ GeV

Couplings

Assume D_4 coupling to G_μ is super-critical so that $\langle \bar{D}_4 D_4 \rangle \neq 0$

- $\Rightarrow \eta_{D_4} \gtrsim 5$
- If $\langle \bar{U}_4 U_4 \rangle = 0$ then $\Rightarrow \eta_{U_4} < 5$, We take $\eta_{U_4} = 4$
- T parameter $\Rightarrow |m_{D_4} - m_{U_4}| < M_W$. Take

$$m_{D_4} \simeq (500 - 520) \text{ GeV}$$

U_4 Production at the Tevatron

To get 5 events with 2.8fb^{-1}, in the $W^+W^- \to \ell\nu jj$ channel, and with

- $m_{U_4} = 450$ GeV
- $m_{D_4} \simeq 500$ GeV
- $\eta_{U_4} = 4, \eta_{D_4} = 5$

$$\Rightarrow M_G \simeq 1 \text{ TeV } (\Gamma_G \simeq 400 \text{ GeV})$$

$$\Rightarrow \sigma(pp \to U_4\bar{U}_4 \to b\bar{b}W^+W^-) \simeq 20 \text{ fb}$$

D_4 Production at the Tevatron

With these parameters we get

$$\sigma(pp \to D_4 \bar{D}_4 \to t\bar{t}W^+W^-) \simeq 8 \text{ fb}$$

Recent CDF analysis not yet constraining (smaller acceptance)

Consequences for the LHC

With these parameters at the LHC

- $\sigma(pp \to U_4 \bar{U}_4) \simeq 8$ pb,

  with $\sigma(pp \to U_4 \bar{U}_4)_{\rm QCD} \simeq 3.3$ pb

- $\sigma(pp \to D_4 \bar{D}_4) \simeq 3.8$ pb

  with $\sigma(pp \to D_4 \bar{D}_4)_{\rm QCD} \simeq 1.7$ pb