

A New Strongly Coupled Sector at the Tevatron and the LHC

Gustavo Burdman

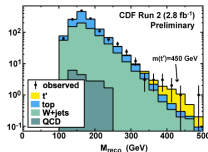
University of São Paulo

In collaboration with *Leonardo de Lima* and *Ricardo Matheus*,
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What can the Tevatron tell us ?

“Just so” new physics hints at the Tevatron

- What can the Tevatron see or almost see (e.g. 3σ 'sh) with $10fb^{-1}/\text{expt.}$?
- Example:
 - Consider U_4 signal at CDF real: $m_4 \simeq 500 \text{ GeV}$



- Assume new physics also in $A_{FB}^t = 0.19 \pm 0.07 \pm 0.02$
- Write effective model \implies make predictions for the LHC

Related Work

References:

- t' at the Tevatron:
 - Dobrescu, Kong, Mahbubani, JHEP **0906**, 001 (2009).
 - Hassanain, March-Russell, Rosa, JHEP **0907**, 077 (2009).
 - ...
- A_{FB}^t :
 - Jung, Murayama, Pierce, Wells, Phys. Rev. D **81**, 015004 (2010).
 - Frampton, Shu, Wang, Phys. Lett. B **683**, 294 (2010).
 - Cao, Heng, Wu, Yang, Phys. Rev. D **81**, 014016 (2010).
 - Jung, Ko, Lee, Nam, arXiv:0912.1105.
 - Barger, Keung, Yu, arXiv:1002.1048.
 - Cao, McKeen, Rosner, Shaughnessy, Wagner, arXiv:1003.3461.
 - ...

A Fourth Generation: What is it good for ?

- If $m_4 \gtrsim 350 \text{ GeV} \rightarrow y_4 \gtrsim 2$
might be hint of a strongly coupled Higgs sector.
- When considering a heavy fourth generation:
natural to assume strong dynamics associated with it.
- For instance:

$$\langle \bar{F}F \rangle \neq 0 \Rightarrow m_F = (500 - 600) \text{ GeV}$$

if new dynamics has scale $\Lambda \simeq O(1)\text{TeV}$

Electroweak Symmetry Breaking and a Fourth Generation

Assume extension of the SM with:

- New Interaction at the TeV scale
- A sequential fourth generation:

$$Q_4, U_4, D_4 \quad L_4, E_4, N_4$$

- New interaction couples strongly to fourth generation
- Condensation of 4G Quarks

$$\langle \bar{Q}_L U_R \rangle \neq 0 \quad \Rightarrow \quad \text{EWSB}$$

Minimal Model

New interaction: Massive Color-octet G'^a with interactions

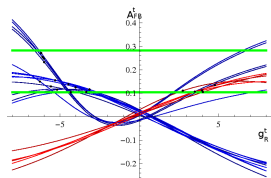
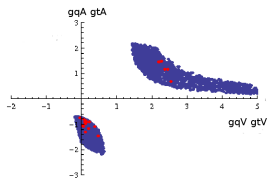
$$\mathcal{L}_{\text{eff}} = g_L^i G_\mu'^a \bar{Q}_i \gamma^\mu T^a Q_i + g_u^i G_\mu'^a \bar{U}_i \gamma^\mu T^a U_i + g_d^i G_\mu'^a \bar{D}_i \gamma^\mu T^a D_i$$

We want:

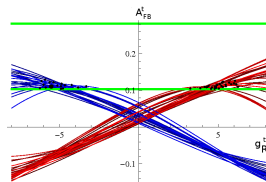
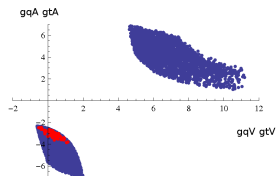
- EWSB: g^4 's large enough for 4G Condensation.
i.e. either $g_L^4 g_u^4 > 8\pi^2/3$ or $g_L^4 g_d^4 > 8\pi^2/3$
- g^q 's small enough (depending on $M_{G'}$) to respect bounds from dijet searches.
- FCNC's: Avoid flavor violation by choosing g^i 's \simeq universal, with only exception of $g_u^3 = g_R^t$.

Top Forward-Backward Asymmetry

$M_G = 1 \text{ TeV}$

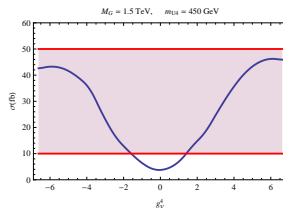
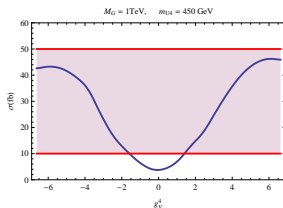


$M_G = 1.5 \text{ GeV}$



Production of U^4 at the Tevatron

Production of $U^4 \bar{U}^4$ via QCD and G' (Tevatron)



corresponding to solutions of A_{FB}^t .

Similar for $\bar{D}_4 D_4$ production.

Signals at the LHC

Large enhancements of U_4 , D_4 production over QCD.

If we consider the solutions giving A_{FB}^t

- $M_{G'} = 1$ TeV, $g_L^4 = g_u^4 = g_V^4 \simeq 5$:

$$\sigma(\bar{U}_4 U_4) \simeq 20 \text{ pb} \simeq 10 \times \sigma(\bar{U}_4 U_4)_{\text{QCD}}$$

- $M_{G'} = 1.5$ TeV, $g_L^4 = g_u^4 = g_V^4$:

$$\sigma(\bar{U}_4 U_4) \simeq 60 \text{ pb}$$

since heavier G' allows larger g^q 's.

Summary/Outlook

- Existence of 4th Generation would suggest special role in EWSB
- Although hints at the Tevatron with 10fb^{-1} , LHC will establish presence of both 4th Generation and new interaction with 1fb^{-1} at 7 TeV
- Outlook:
 - Flavor violation $\implies pp \rightarrow U_4t, D_4b$ (GB, Lascio, '10)
 - Leptons (e.g. GB, Da Rold, Matheus '09)
 - Model building ...