

DY Analysis of a 4D Composite Higgs Model (4D-CHM)

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BUSSTEPP Summer School - Durham University

12 September 2012

- Introduction
- The 4D-CHM
- DY analysis
- Conclusions

BSM Models

Even with the discovery of the Higgs
SM may not be the end of the story

- Hierarchy problem
- Naturalness problem

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Two possible scenarios

Weak coupling

- Supersymmetry

Strong coupling

- Technicolor
- Extra dimensional models
- Composite Higgs

Higgs as a Pseudo Goldstone Boson

A possible scenario: the Higgs doublet from strong dynamics

Strong sector:
Resonances and Higgs
boson

- Spin 1 resonances
- Spin 1/2 resonances
- Higgs

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With the addition of the Higgs as a Pseudo-Goldstone Boson
Higgs naturally light

Agashe, Contino, Pomarol '05

The 4D-CHM [arXiv:1110.1613](https://arxiv.org/abs/1110.1613)

This model ([De Curtis, Redi, Tesi '11](#)) has two sectors:

Elementary sector

- SM quarks
- SM leptons
- SM gauge bosons

Strong sector (TeV scale)

- Gauge bosons resonances
- Fermionic resonances
 - Charge $2/3$ and $-1/3$
 - Charge $5/3$ and $-4/3$

Top/Bottom \longleftrightarrow Heavy fermions

Z^0/W^\pm \longleftrightarrow Heavy gauge bosons

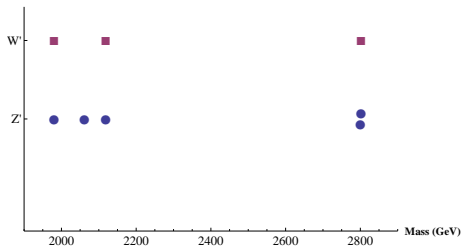
Strong Gauge sector

Gauge group $SO(5) \otimes U(1)$

- 5 neutral gauge resonances: Z_1, Z_2, \dots, Z_5
- 3 charged gauge resonances: W_1, W_2, W_3

Mass scale $\simeq f \cdot g$

- f Scale of the strong sector
- g Strong sector gauge coupling



Masses of the gauge bosons

- 3 and 2 quasi degenerate neutral states
 - $m_{Z_3} - m_{Z_2} \simeq 60 \text{ GeV}$
 - $m_{Z_2} - m_{Z_1} \simeq 80 \text{ GeV}$
- 2 quasi degenerate charged states
 - $m_{W_2} - m_{W_1} \simeq 140 \text{ GeV}$

Widths of the gauge sector

- Neutral states
 - $\Gamma(Z_1) \simeq 120 \text{ GeV}$
 - $\Gamma(Z_2) \simeq 25 \text{ GeV}$
 - $\Gamma(Z_3) \simeq 45 \text{ GeV}$
- Charged states
 - $\Gamma(W_1) \simeq 12 \text{ GeV}$
 - $\Gamma(W_2) \simeq 45 \text{ GeV}$

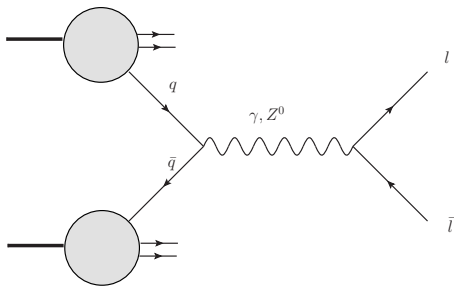
At least for the lightest resonances we have

$$\Delta m > \Gamma$$

DY processes

High energy hadron-hadron scattering

- Annihilation in γ and Z^0
- Decay in a pair of opposite charge leptons

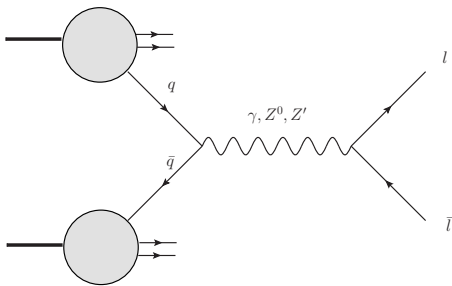


Also charged processes

- Annihilation in W^\pm
- Decay in charged lepton and neutrino

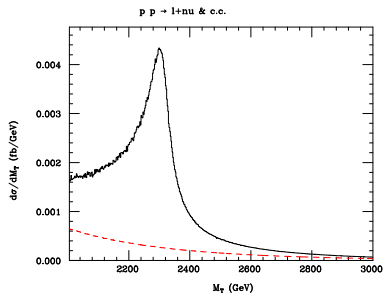
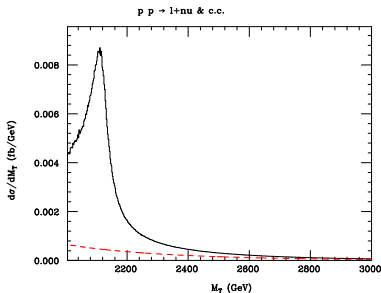
DY processes in the 4D-CHM

Quarks can annihilate also in Z' (and W')



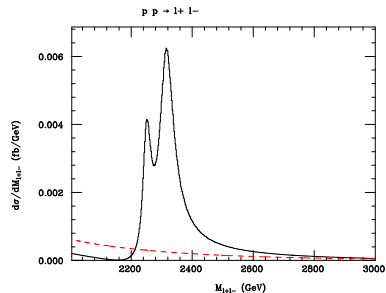
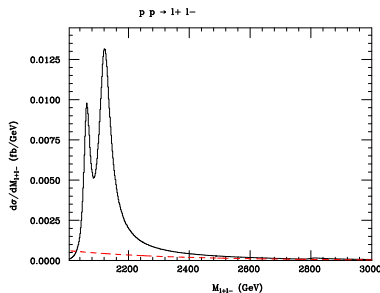
- DY allow us to investigate new gauge boson resonances
- Z' may be discovered as a peak in the dilepton invariant mass spectrum
- W' may be discovered as a peak in the dilepton missing-energy transverse mass spectrum

Charged Current DY



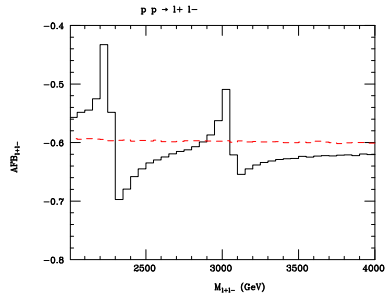
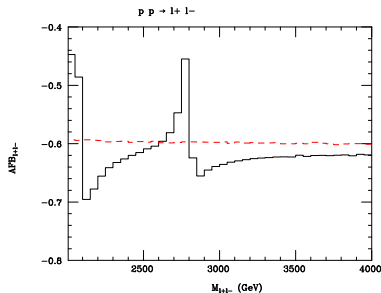
- W_1 doesn't couple to u and d → non detectable in DY
- W_3 too heavy → non detectable in DY
- W_2 peak visible!!
 - Integrate cross section 4D-CHM/SM (fb): 1.33/0.23 and 1.11/0.23

Neutral Current DY



- Z_1 doesn't couple to u and $d \rightarrow$ not detectable in DY
- Z_4 and Z_5 too heavy \rightarrow non detectable in DY
- Z_2 and Z_3 peaks are resolvable!!
 - Integrate cross section 4D-CHM/SM (fb): 1.37/0.21 and 0.78/0.23

Forward-Backward Asymmetry



- Z_4 doesn't couple to u and $d \rightarrow$ not detectable in DY
- Z_5 is detectable in AFB analysis

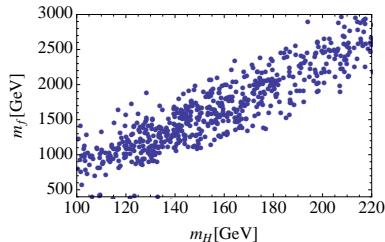
Future Prospects

- Study of the widths and main decay channels of the resonances
- Analysis of the fermionic sector
- Analysis of the Higgs Sector!

...work in progress...

Thank you for the attention!

- Coupling to SM fermions breaks the global symmetry of the strong sector
- Higgs is an approximate Goldstone boson
- Potential dynamically generated - Coleman Weinberg technique
- Correlation between Higgs mass and lightest fermionic resonance



M. Redi and A. Tesi '12