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

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

BSM Models

Soon (!) we will know if the Higgs boson exist

However the 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
- Higgsless models
- Extra dimensional models
- Composite Higgs

Higgs as a Pseudo Goldston 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

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

$$\text{Top/Bottom} \longleftrightarrow \text{Heavy fermions}$$

$$Z^0/W^{\pm} \longleftrightarrow \text{Heavy gauge bosons}$$

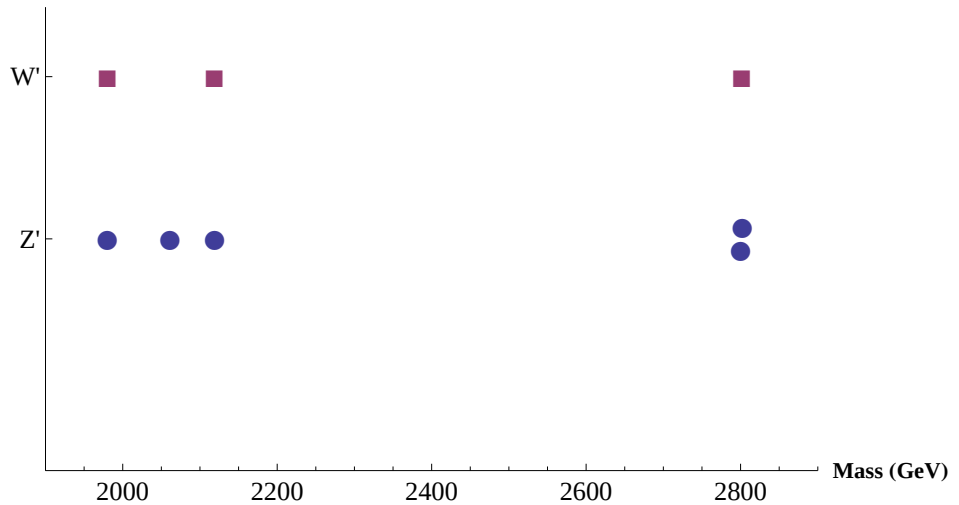
Strong Gauge sector

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

- 5 neutral gauge resonances: $Z_1, Z_2, \ldots, Z_5$
- 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
  - $m_{Z_3} - m_{Z_2} \simeq 60\ GeV$
  - $m_{Z_2} - m_{Z_1} \simeq 80\ GeV$
- 2 quasi degenerate charged states
  - $m_{W_2} - m_{W_1} \simeq 140\ GeV$

Widths of the gauge sector

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

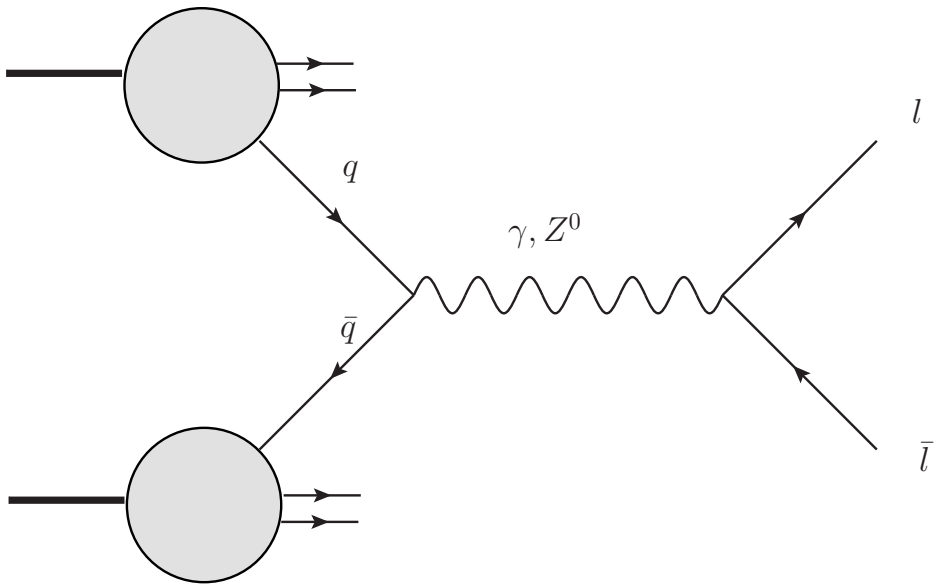
At least for the lightest resonances we have

$$\Delta m > \Gamma$$

DY processes

High energy hadron-hadron scattering

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

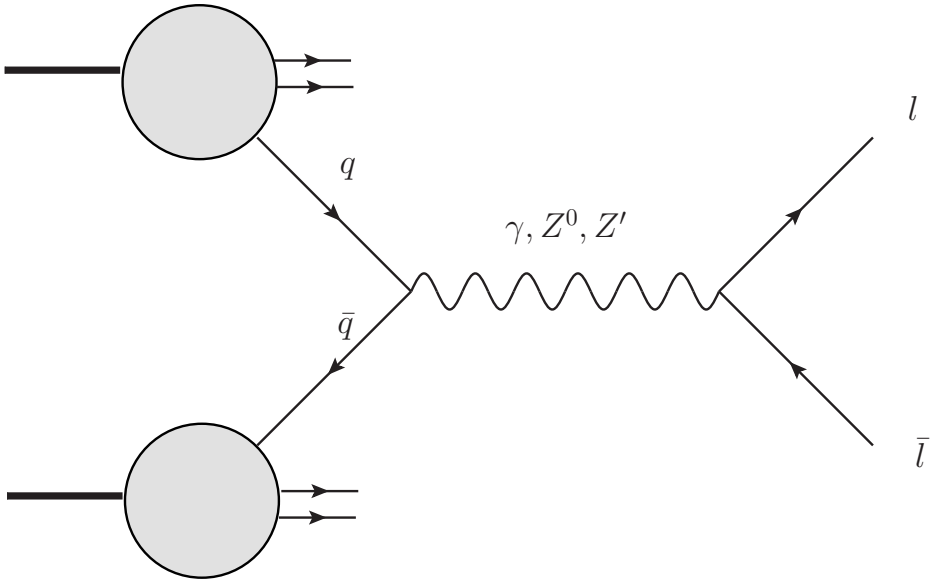


Also charged processes

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

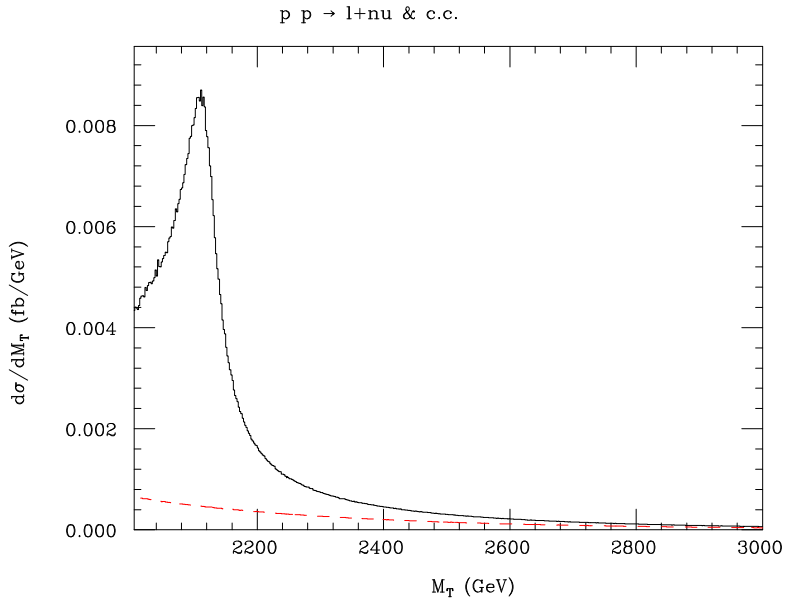
DY processes in the 4D-CHM

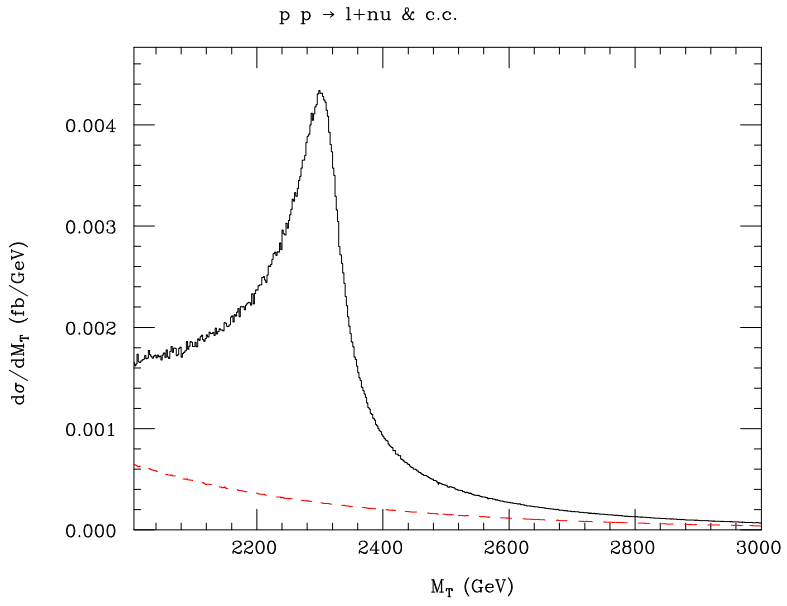
Quarks can annihilate also in Z' (and W')



- DY allow us to investigate new gauge bosons 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

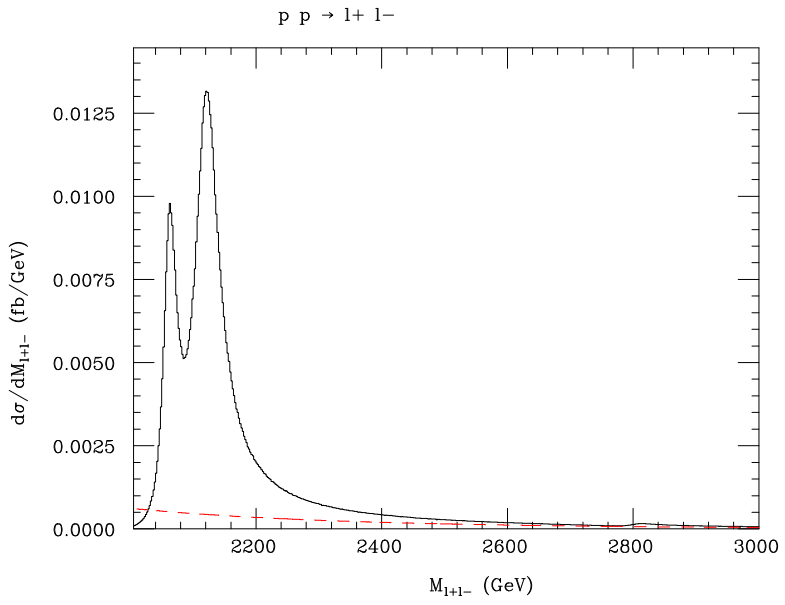
Charged Current DY

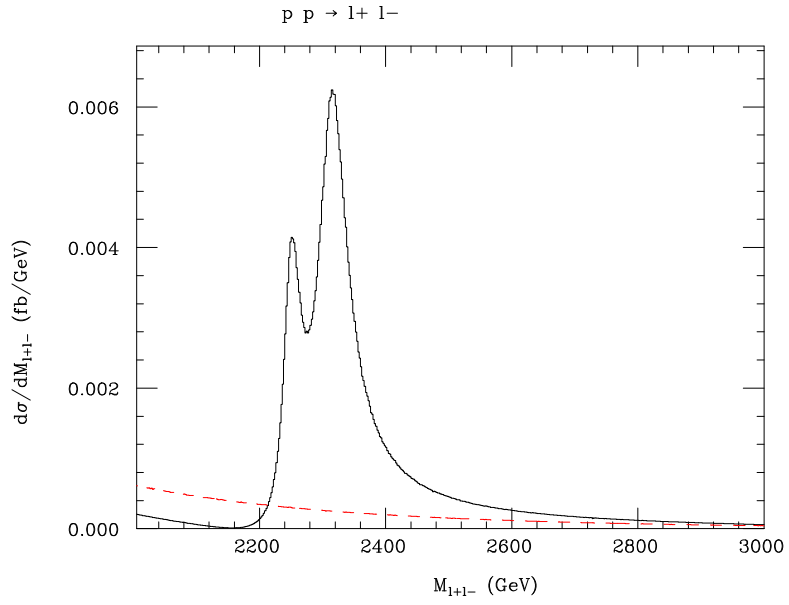




- W_1 doesn't couple to u and d $\rightarrow$ non detectable in DY
- W_3 too heavy $\rightarrow$ non detectable in DY
- W_2 peak visible!!
  - Integrate cross section 4D-CHM/SM (fb): 1.33/0.23 and 1.11/0.23

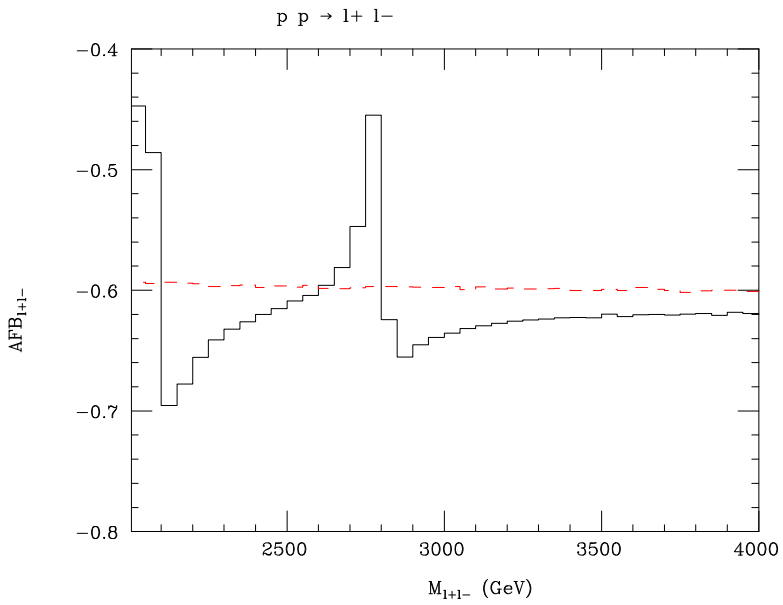
Neutral Current DY

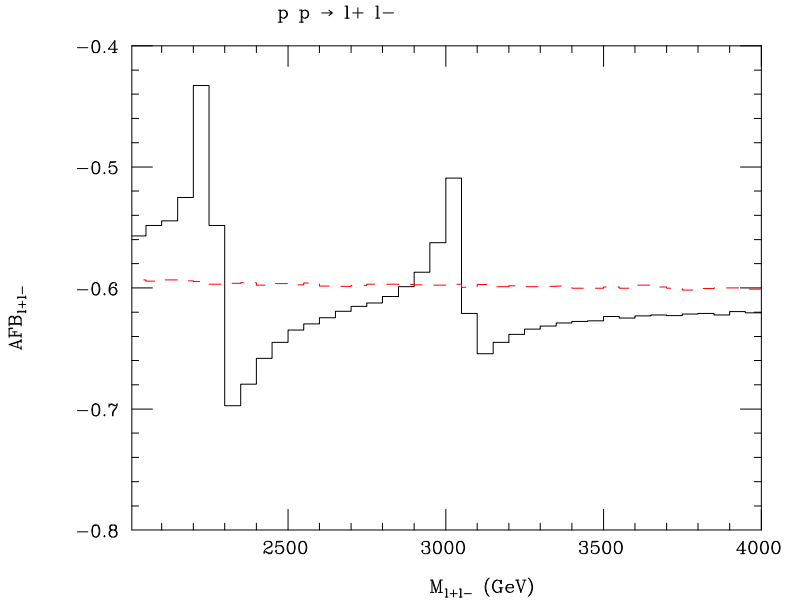




- Z_1 doesn't couple to u and d $\rightarrow$ not detectable in DY
- Z_4 and Z_5 too heavy $\rightarrow$ non detectable in DY
- Z_2 and Z_3 peaks are resolvable!!
  - Integrate cross section 4D-CHM/SM (fb): 1.37/0.21 and 0.78/0.23

Forward-Backward Asymmetry





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

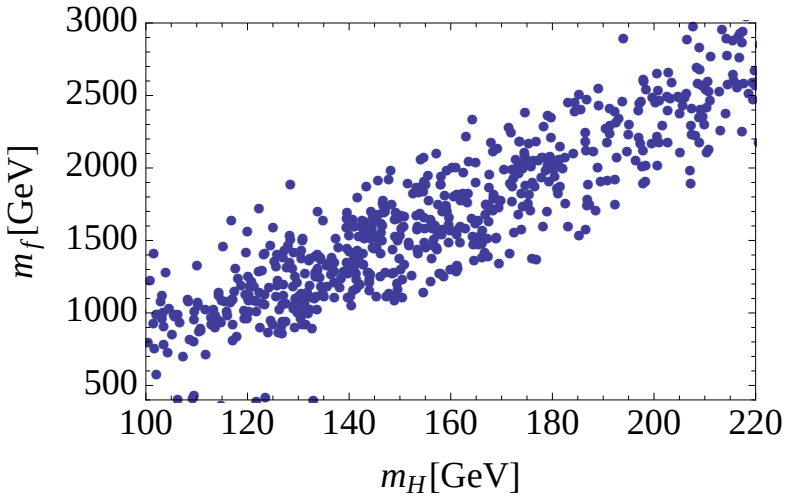
Future Prospects

- 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 dinamically generated - Coleman Weinberg technique
- Correlation between Higgs mass and lightest fermionic resonance



M. Redi and A. Tesi '12