Warped Gauge Bosons at the LHC

(Work in Progress)

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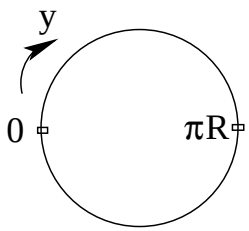
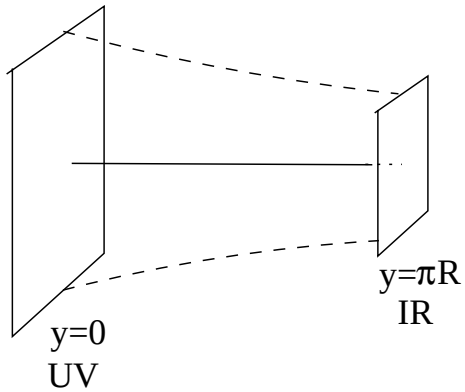
Motivation

- SM Hierarchy Problem: $M_{Pl} \leftrightarrow M_{EW}$
- New dynamics?
  - Extra dimensions (Warped, Flat)
  - Supersymmetry
  - Strong dynamics
  - Little Higgs
- AdS/CFT correspondence

Warped Model

Randall-Sundrum :
Higgs on the IR brane
Z_2Orbifold





Precision Electroweak Constraints (S & T)
Bulk $SU(2)_R \leftrightarrow$ Custodial Symmetry

- T parameter
- $Zb\bar{b}$ coupling

Bulk Gauge Bosons : $SU(2)_L \times SU(2)_R \times U(1)_X$
Bulk Fermions $\rightarrow$ mass hierarchy naturally explained
FCNC's under control

Fermion Sector

[Agashe, Contino, Da Rold, Pomarol]

Custodial Symmetry protects :

- T parameter
- $Zb\bar{b}$

Allows Z' to be ~ 2 TeV
Fermion Reps

- $Q_L = \begin{pmatrix} t_L & \zeta_L \\ b_L & T_L \end{pmatrix} \rightarrow (2,2)$
- $t_R, b_R \rightarrow (1,1)$

$Zb_L b_L$ does not get corrected

Gauge Sector

Focus on Neutral Sector : $SU(2)_L \times SU(2)_R \times U(1)_X$

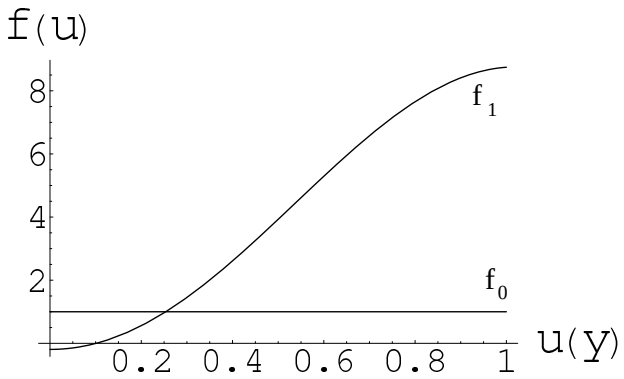
- Three neutral gauge bosons
  - $(W_L^3, W_R^3, X) \leftrightarrow (A, \tilde{Z}, \tilde{Z}_X)$

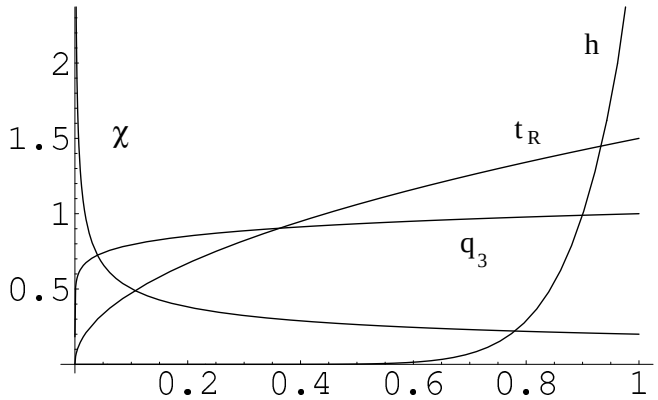
Symmetry Breaking :

- $SU(2)_R \times U(1)_X \rightarrow U(1)_Y$: $\quad (W_L^3, W_R^3, X) \rightarrow (W_L^3, B, Z_X)$
  - $Z_X \quad (-\ ,\ +)$
  - $W_L^3, B \quad (+\ ,\ +)$
- $SU(2)_L \times U(1)_Y \rightarrow U(1)_{EM}$: $\quad (B, W_L^3, Z_X) \rightarrow (A, Z, Z_X)$
  - By Higgs on IR
  - EWSB mixes $(Z, Z_X) \rightarrow (\tilde{Z}, \tilde{Z}_X)$

Wave functions

Zero Mode is SM $(A, Z, 0)$ and ψ
1^{st} Kaluza-Klein (KK) Mode $(A_1, Z_1, Zx_1) \rightarrow Z'$ and ψ_1

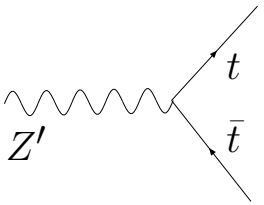


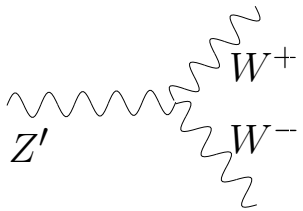


Overlap integrals to get couplings
Compared to SM

- Z' couplings to t_R, h enhanced
- Z'couplings to χ suppressed

Z'decays





Partial Width ($M_{A_1} = 2\ TeV$) :

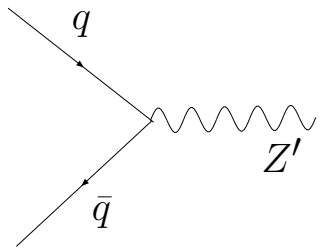
- $\Gamma(A_1 \to t\bar{t}) \approx 60\,\mathrm{GeV}$
- $\Gamma(A_1 \to W^+W^-) \approx 25\,\mathrm{GeV}$

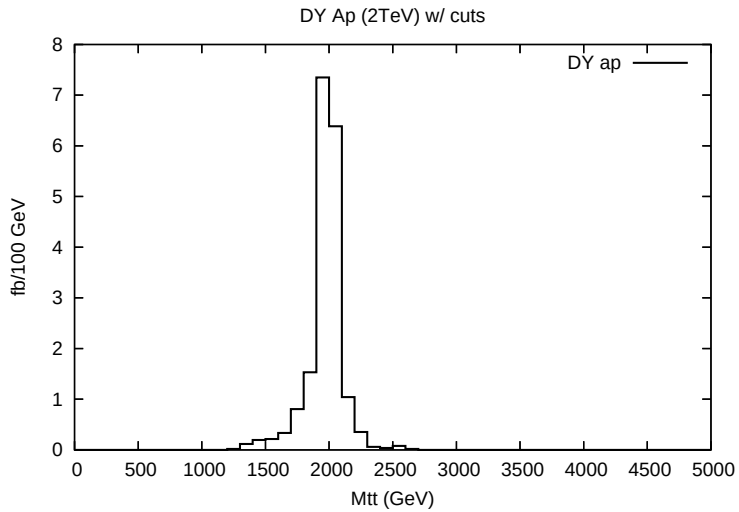
Higgs modes not shown

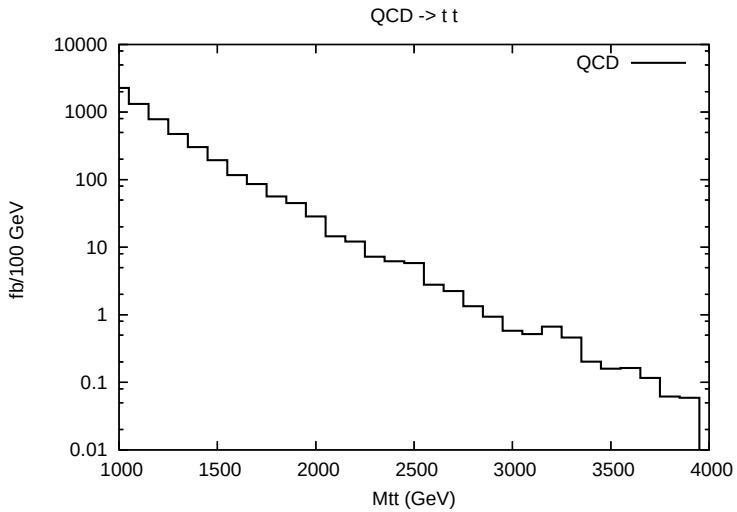
Z' at the LHC

Drell-Yan ($M_{A_1} = 2\ TeV$) :

- $\sigma(pp \to A_1 \to t\bar{t}) \approx 20\,\mathrm{fb}$
- $\sigma(pp \to A_1 \to W^+W^-) \approx 8\,\mathrm{fb}$







For $t\bar{t}$ mode, background : QCD + KK Gluon

Forward-backword asymmetry as a discriminant?

Reconstruction Issues

For $Z' \to t\bar{t}$; $t \to Wb$; $W \to (qq')$ or $(\ell\nu)$

Since t boosted, final state not well separated?

$\Delta R > 0.4$ leads to loss in efficiency

Signature for semi-leptonic mode : $b\bar{b}qq'\ell E_m$

For $Z' \to W^+W^-$

Signature for semi-leptonic mode : $qq'\ell E_m$

Work in progress ...

Conclusions

- Warped model with $SU(2)_L \times SU(2)_R \times U(1)_X$
- A_1 , Z_1 , Zx_1 neutral GB's
- A_1LHC signals explored
- Z_1, Zx_1 work in progress ...

[Thanks to MadGraph, CalcHEP]