

Soft-Wall Models

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Introduction: Warped extra dimensions

5D geometries with a metric

$$ds^2 = e^{-2A(y)} (\eta_{\mu\nu} dx^\mu dx^\nu + dy^2)$$

The RS model ¹

$$\text{AdS: } e^{-2A(y)} = e^{-2ky}$$

- RS1: Two branes. ($y = 0$, UV) ($y = y_s$, IR).
Requires stabilization of brane separation.
GW mechanism²: introduction of a bulk scalar field.

Experimental signature: Kaluza-Klein excitations of particles in the bulk.

¹Randall, Sundrum (1999)

²Goldberger, Wise (2009)

Soft-Wall Models

- Warped models with a single brane ($y=0$).
 - ▶ The metric is generated by the back-reaction of a bulk scalar field.
 - ▶ Metric is AdS near the brane.

- IR brane is replaced by a curvature singularity at finite y (y_s).

- Give rise to interesting phenomenology:
 - ▶ Modelization of QCD properties (AdS/QCD). ¹
 - ▶ Alternative to RS1 for EWSB models. ²
 - ▶ 5D description of unparticles with a mass gap. ³

¹Karch, Katz, Son, Stephanov (2006) ; Gürsoy, Kiritsis (2007)

²Falkowski, Perez-Victoria (2008) ; Batell, Gherghetta, Sword (2008)

³Cacciapaglia, Marandella, Terning (2008) ; Falkowski, Perez-Victoria (2008)

A Soft-Wall Model⁴

$$A(y) = ky - \frac{1}{\nu^2} \log \left(1 - \frac{y}{y_s} \right) , \quad \phi(y) = -\frac{1}{\nu} \log [\nu^2 k (y_s - y)]$$

- The hierarchy between the electroweak scale (ρ) and the Planck scale (k) is given by a double exponential

$$\log \frac{k}{\rho} \sim \frac{e^{-\nu\phi(0)}}{\nu^2}$$

- Very little fine tuning.

⁴Cabrer, von Gersdorff, Quirós (2009)

Electroweak Symmetry Breaking in Soft-Walls⁵

- Introduce a Higgs doublet in the bulk. 5D version of the SM.

$$S_{gauge} = \int d^5x \sqrt{-g} \left[-\frac{1}{4} F_{MN} F^{MN} - |(\partial_M - ig_5 A_M) H|^2 \right]$$

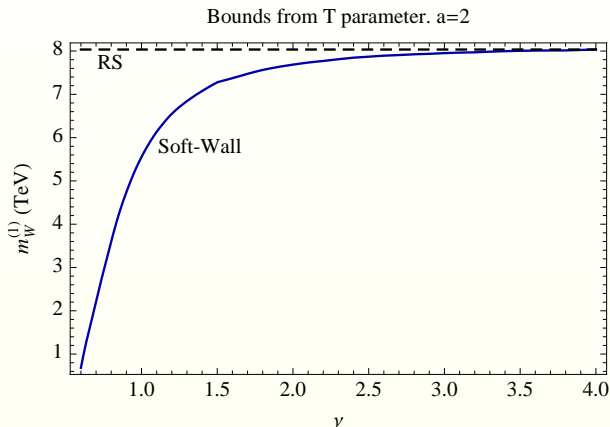
$$H \propto \begin{pmatrix} 0 \\ h(y) + \xi(x, y) \end{pmatrix} \quad h(y) = h_0 e^{aky} \quad (a > 2)$$

- Higgs background localized towards the singularity
- Fermions localized in the UV brane.

⁵Cabrer, von Gersdorff, Quirós (Work in Progress)

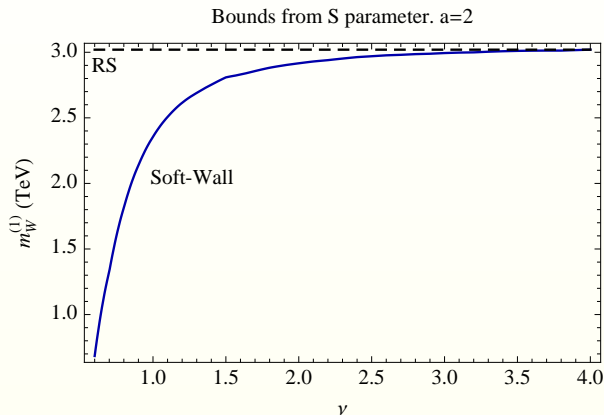
Electroweak Precision Tests

- Lightest new state: KK excitation of gauge bosons.
- Bounds **without** custodial symmetry.



Electroweak Precision Tests

- Lightest new state: KK excitation of gauge bosons.
- Bounds **with** custodial symmetry.



Conclusions

- Soft-Walls are an interesting alternative to Randall-Sundrum models and provide a built-in stabilization mechanism.
- Soft-Wall models could provide an alternative to custodial symmetry in warped 5D models.
- Lower bounds on masses increase discover potential of extra dimensions at the LHC.