Fine-Tuning in Non-Custodial Composite Higgs Models

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Universidad de Granada

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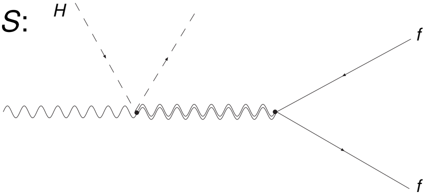
given at Planck 2014

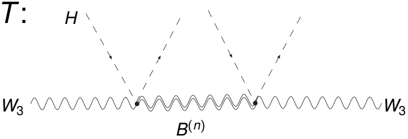
S & T in 5D

	RS	$MAdS_5$
	AdS	Deviates in IR
S	-	Reduced[1]
T	Enhanced	Reduced[2]
[1]Falkowski & Pérez-Victoria		
[2]Cabrer, Gersdorff, Quirós		

S:



T:



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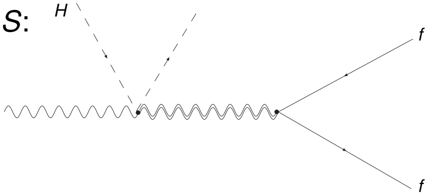
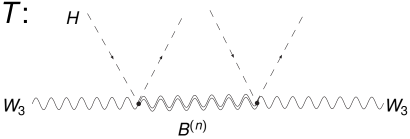
Can solve using $SU(2)_L \times SU(2)_R$
[Agashe, Delgado, May, Sundrum]





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Live Dangerously,
Go Non-Custodial!

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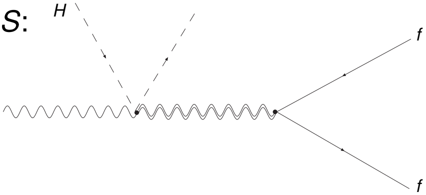

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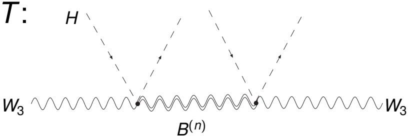

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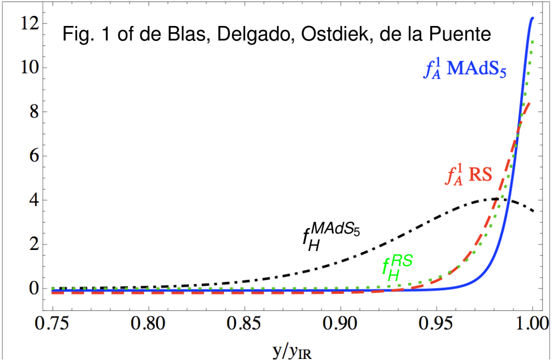

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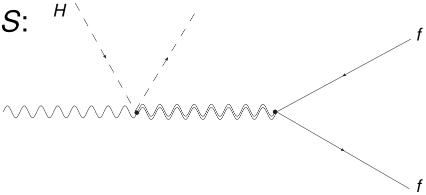

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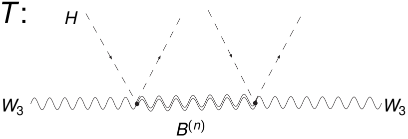


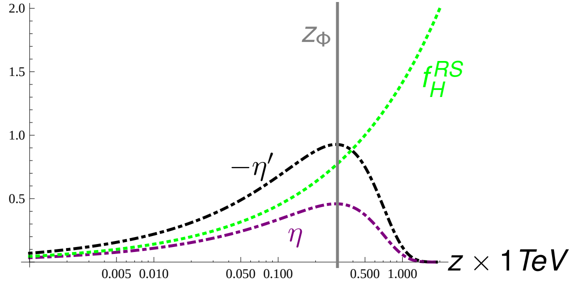
A Calculable Set-up

Control of radiative corrections ⇒ pseudo-Nambu-Goldstone Higgs

$$\widehat{T} = \alpha T = c_T \sin^2\left(\frac{h}{f_h}\right) = c_T s_h^2 = \frac{v_{\rm wk}^2}{f_h^2}$$

$$f_h^2 \sim 10^3 v_{\rm wk}^2 \text{ (pheno)}$$

Use Bulk Scalar to control localization [Falkowski & Pérez-Victoria]

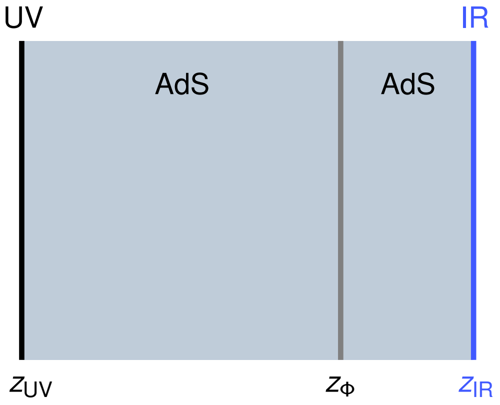


η' gauge part

η scalar part

$$f_h \sim \frac{1}{z_\Phi}$$

Simplified MAdS Model



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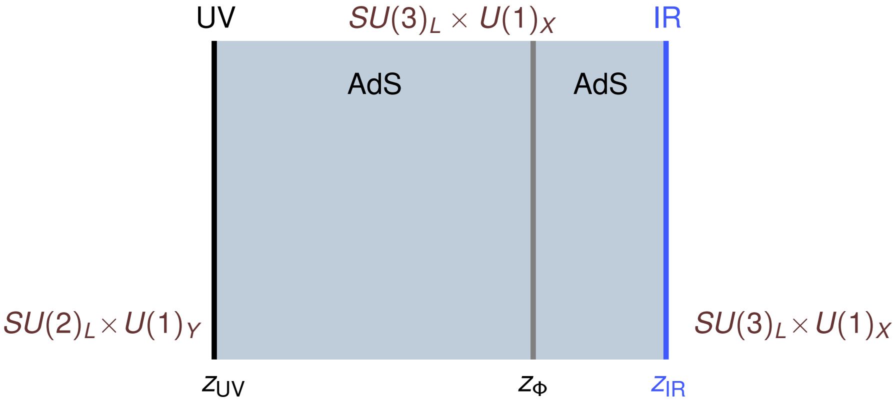

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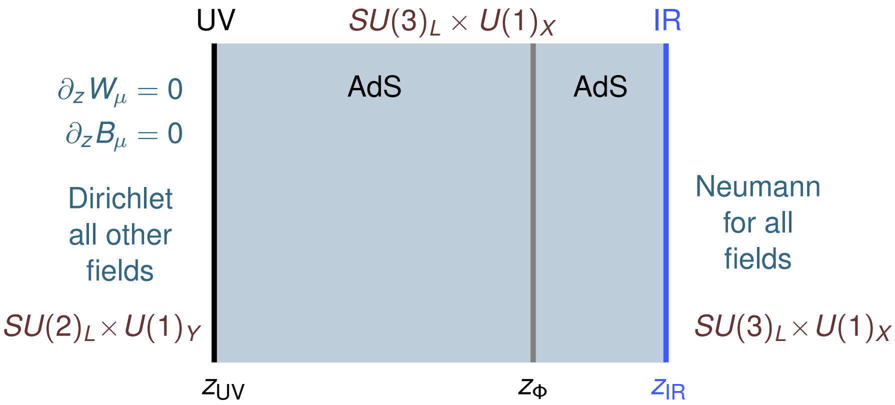

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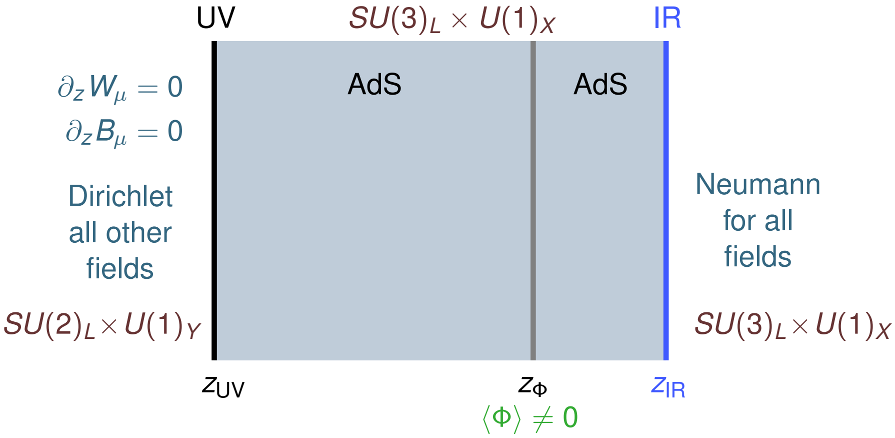

Φ a localized $SU(3)_L$ Adjoint

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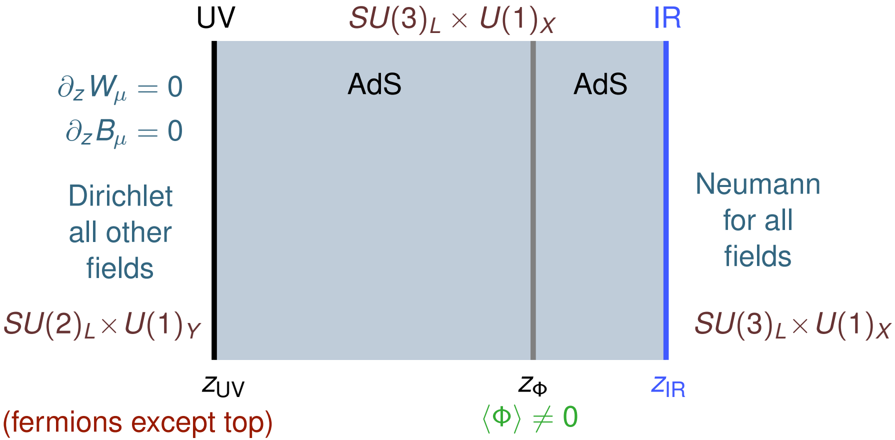
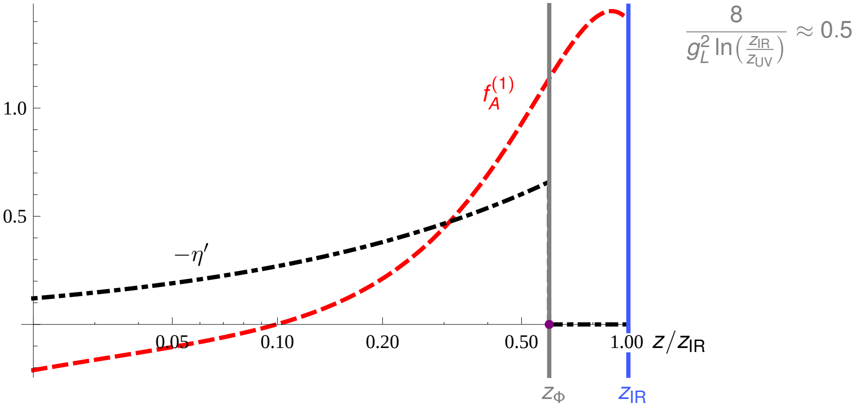


Φ a localized $SU(3)_L$ Adjoint

$\Psi_1 \sim \overline{\mathbf{3}}_{2/3} \supset Q \qquad \Psi_2 \sim \overline{\mathbf{3}}_{2/3} \supset t$

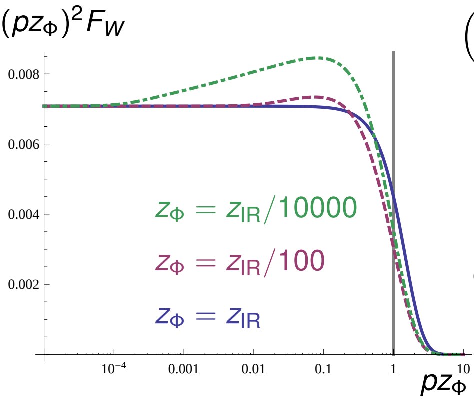
Simplified MAdS Profiles

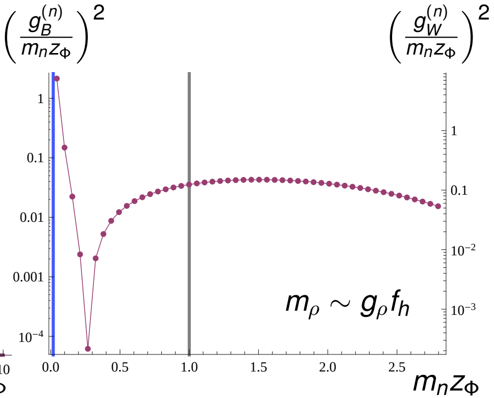


$$f_h^2 = \frac{4}{g_3^2 \eta^2(z_{\text{UV}})} = \frac{8}{g_L^2 \ln\left(\frac{z_{\text{IR}}}{z_{\text{UV}}}\right)} \frac{1}{\frac{1}{\frac{3}{4} g_L^2 \ln\left(\frac{z_{\text{IR}}}{z_{\text{UV}}}\right)} \frac{z_\Phi^2}{z_{\text{UV}}^2 \operatorname{Tr}\langle\Phi\rangle^2} + \left(z_\Phi^2 - z_{\text{UV}}^2\right)} \sim \frac{1}{z_\Phi^2}$$

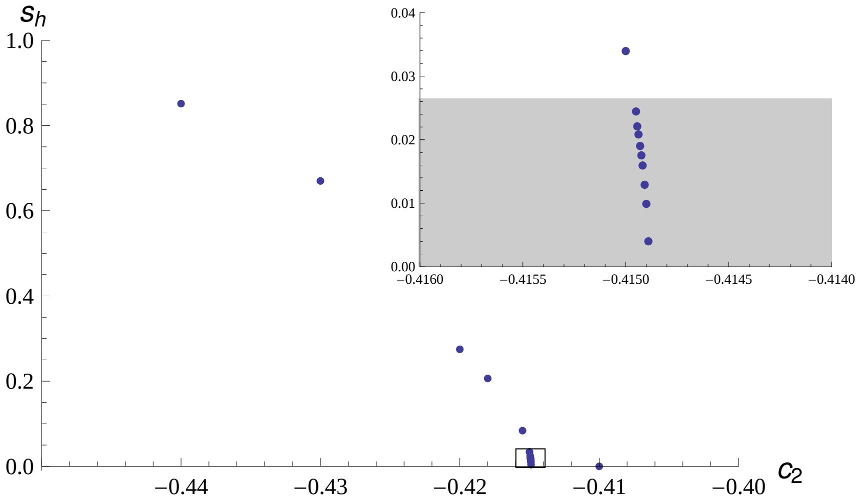
Higgs Potential

$$V_h = \frac{1}{16\pi^2}\int_0^\infty dp\, p^3 \Big[6\ln\big(1 + F_W s_h^2\big) + 3\ln\big(1 + 4F_Z s_h^2(1 - s_h^2)\big) - 12\ln\big(1 + F_{t_1} s_h^2 + F_{t_2} s_h^4\big)\Big]$$





Fine-tuning Higgs Sector



Minimum of Higgs potential keeping M_W/m_{top} fixed, $z_\Phi/z_{\text{IR}} = 0.05$

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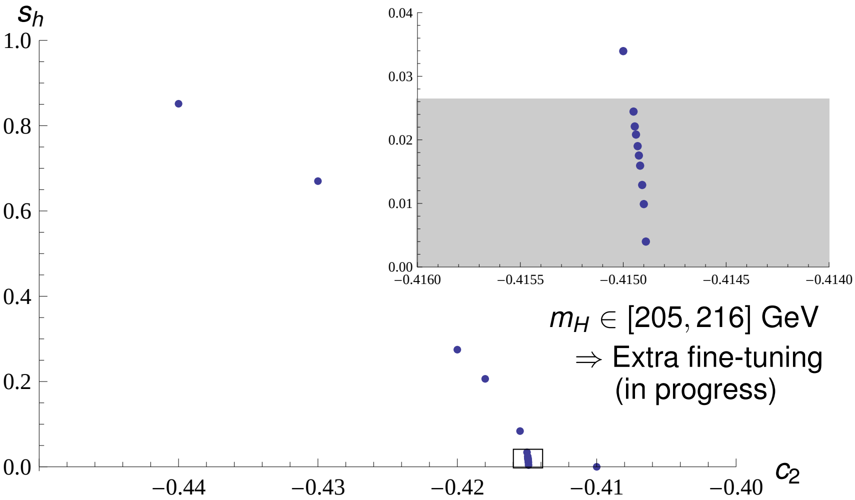

$m_H \in [205, 216]$ GeV
$\Rightarrow$ Extra fine-tuning
(in progress)

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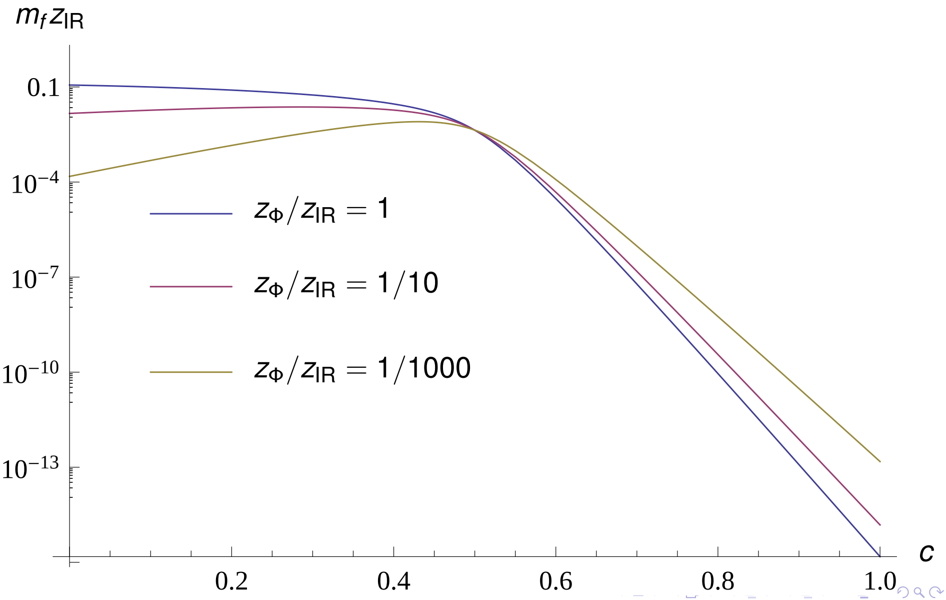
Summary

Studied non-custodial models using Gauge-Higgs

- Calculable setup
- $\hat{T} \sim \frac{v_{wk}^2}{f_h^2} \Rightarrow$ large f_h
- Higgs potential cutoff is f_h
- Many light resonances
  - Weakly coupled to Higgs
  - Strongly coupled to each other
- Fine-tuning increase (as expected)

Fermion Zero Mode



$g^{(n)}$ definition

$$S \supset \int d^4x \left[-\mathbb{i}\eta^{\mu\nu} (\mathrm{D}_\mu H)^\dagger \left(g_W^{(n)} W_\nu^{(n)} + \frac{g_B^{(n)}}{2} B_\nu^{(n)} - \frac{g_{Z'}^{(n)}}{2} Z_\nu'^{(n)} \right) H + \text{h.c.} \right]$$

$$g_{\text{field}}^{(n)} = g_{\text{field}} \int_{z_0}^{z_{\text{IR}}} dz\ f_{\text{field}}^{(n)} \left(e^{-A} {\eta'}^2 + \delta(z - z_\Phi) M \eta^2 \right)$$