The Higgs boson from a soft wall

with C. Csaki and S. J. Lee

Alberto Parolini

Korea University

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Motivation

Address SM Hierarchy Problem: mechanism to protect Higgs mass

$$\left(\frac{v}{\Lambda_{SM}}\right)^2 \begin{cases} \ll 1 \\ \lesssim 1 \end{cases}$$

- Naturalness
- Environmental Selection
- Finite Naturalness, …
- Cosmological Relaxation
- ??

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(still room for new physics
Higgs sector is poorly constrained)

Introduction

approximate scale invariance $\quad \Delta$

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free field theory

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$$\left(\begin{array}{r}\text{departures potentially}\\ \text{signaling no particle}\\ \text{interpretation}\end{array}\right)$$

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$\Bigg($ departures potentially signaling no particle interpretation $\Bigg)$

Alternative possibility:

Higgs pole
(at a mass of 125 GeV) + Higgs continuum

- Bellazzini Csaki Hubisz Lee Serra Terning 1511.08218
- Unhiggs ...

Phenomenological Consequences

- Higgs form factors
- $gg \longrightarrow ZZ$
- $gg \longrightarrow HH$
- $h\bar{t}t$ coupling

A generic model

$$G(p^2) = -\frac{i}{(-p^2 + i\epsilon)^{2-\Delta}}$$

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$$\mathcal{L} = -\frac{1}{2Z_h} h (\partial^2 + \mu^2)^{2-\Delta} h + \frac{1}{2Z_h} (\mu^2 - m_h^2)^{2-\Delta} h^2$$

$$G(p^2) = -\frac{iZ_h}{(\mu^2 - p^2 + i\epsilon)^{2-\Delta} - (\mu^2 - m_h^2)^{2-\Delta}}$$

A 5D description: generalized free field theories

$$ds^2 = a(z)^2(dx^2 - dz^2)$$

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z dependent bulk mass:

$$\phi(z) = e^{\frac{4}{3}\mu(z-R)}\left(\frac{m^2R^2 - 3\mu z}{R^2}\right)$$

$$G(p^2) \sim (\mu^2 - p^2)^{\Delta-2} \qquad\qquad pR \ll 1\,,\ \mu R \ll 1$$

A new 5D model

$$ds^2 = a(z)^2(dx^2 - dz^2)$$

$$a_{UV}(z) = \frac{R}{z} e^{\frac{2}{3}(R-z)\mu_{UV}} \,, \quad a_{IR}(z) = \frac{R_p}{z} e^{\frac{2}{3}(R_p-z)\mu_{IR}}$$

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$$a(z)^{-4}(a(z)a''(z) - 2a'(z)^2) \leq 0$$

wec
holographic a-theorem

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z dependent bulk mass:

$$\phi_{UV}(z) = a_{UV}^{-2}\left(\frac{R}{z}\right)^2\left(m^2 - \frac{3z\mu_{UV}}{R^2}\right)$$

$$\nu^2 = 4 + m^2R^2$$

A new 5D model

$$\left(-\partial_z^2 + \hat{V}\right)\Psi = p^2\Psi$$

Falkowski, Perez-Victoria 0810.4940

$$\begin{aligned}\hat{V} = &\frac{(4\nu^2 - 1 + 4\mu_{UV}^2 z^2)}{4z^2}\theta(z_\delta - z) + \\ &+ \frac{(4\nu^2 - 1 + 4\mu_{IR}^2 z^2)}{4z^2}\theta(z - z_\delta) + \\ &+ (\mu_{UV} - \mu_{IR})\delta(z - z_\delta)\end{aligned}$$

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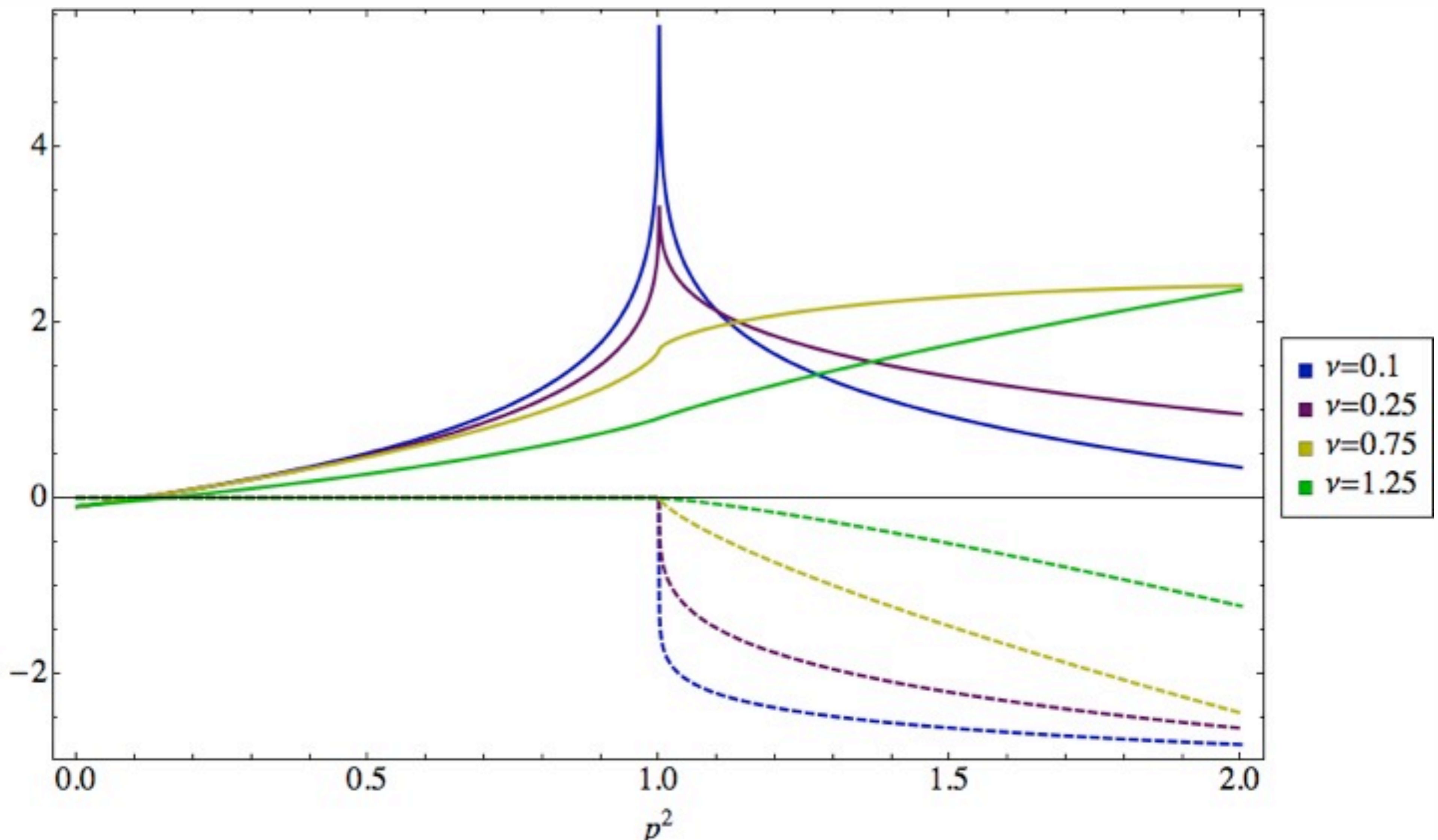
$$S_{eff} = \frac{1}{2}\int \frac{\mathrm{d}^4 p}{(2\pi)^4} h(-p)\hat{\Pi}(p^2)h(p)$$



Conclusions and Outlook

- Novel spectral properties
- Experimental consequences
- Extra dimensional construction
    - background geometry
    - potentially natural theory

Thank You