The Discrete Composite Higgs Model

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based on G. P. and A. Wulzer 1106.2719 [hep-ph]

Introduction

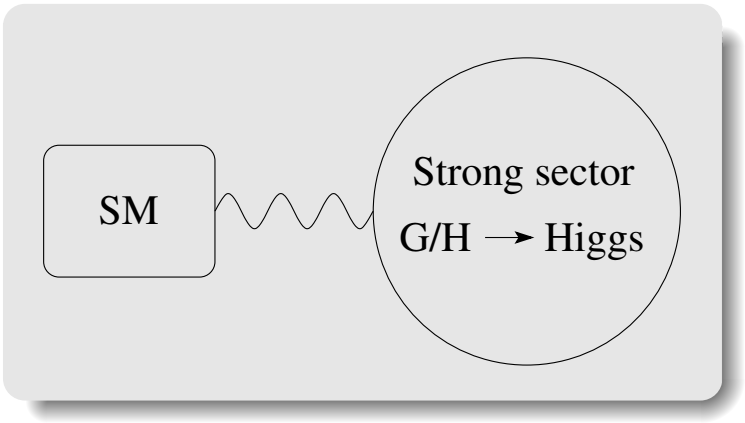
Why a **composite Higgs**?

Solution of the **Hierarchy Problem**:

new **strong sector** dynamically generates the EW scale.

[Georgi, Kaplan (1984), ...]

- **Higgs as a Goldstone** of a spontaneously broken global symmetry $G \longrightarrow H$
  - EW symmetry breaking induced at 1-loop



- Possible **resonances** from the strong sector

Introduction

How can we **describe** a composite Higgs?

Fully general description: **non-linear σ-model**

[Giudice et al. (2007), Barbieri et al. (2007)]

- **no** description of **resonances**
- **non calculable** (eg. Higgs potential, S and T diverge at 1-loop)

Calculable and predictive realization in **extra dimensions**

[Agashe, Contino, Pomarol (2004), ...]

- technically **challenging**
- **several parameters** (also 'hidden' like the **metric**)
- includes many states **not accessible at LHC**

Introduction

Need for a **simplified** framework:

effective description inspired by deconstruction

- Simple 4D **effective theory**
- Description of the **resonances**
  - only lightest resonances are included
  - small number of 'measurable' parameters
  - parametrize many extra-dim. models (eg. different metric)
- **Computable** and **predictive**
  - Higgs potential, S and T computable with three sites

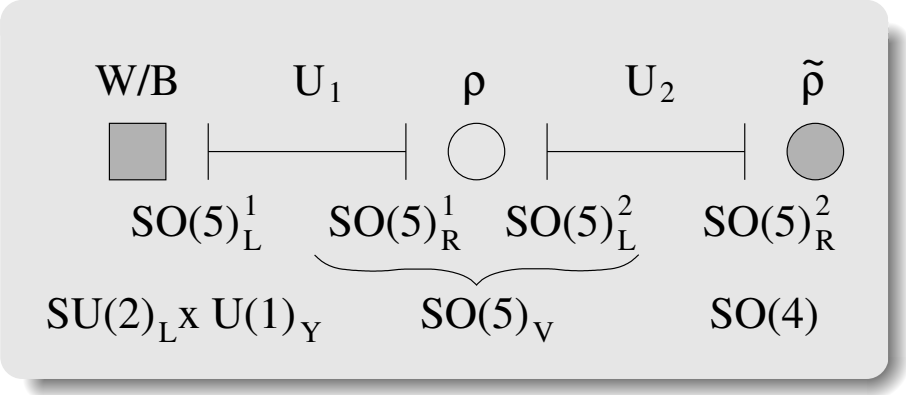
The Model

Minimal model with **three sites**.

Two σ-models:

$SO(5)_L \times SO(5)_R / SO(5)_D$

$$\mathcal{L}^{\pi} = \frac{f^2}{4} \mathrm{Tr}\left[(D_\mu U_i)^t D^\mu U_i\right]$$



Gauging breaks the global symmetries

- description of the gauge **resonances** (ρ and $\widetilde{\rho}$)

Higgs is a Goldstone with respect to **three** symmetries

$\Downarrow$

EWSB effects through **collective breaking**:

cancellation of divergences [Arkani-Hamed et al. (2001), ...]

The Model

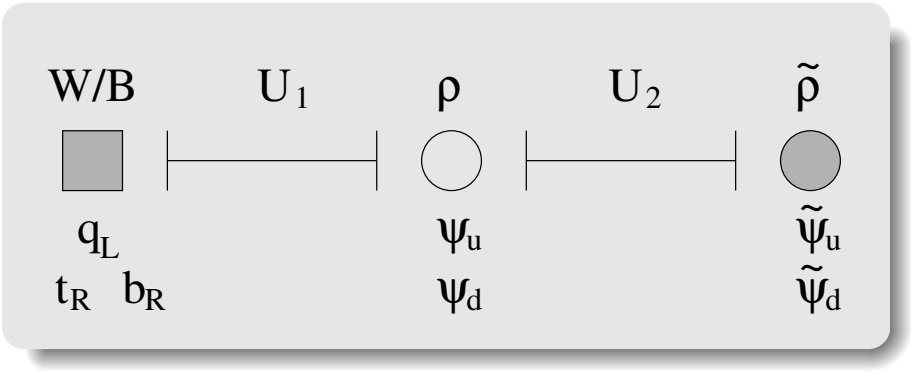
- **Elementary** fermions:

$$q_L, t_R, b_R$$

- **Composite** states:

$$\psi_u, \widetilde{\psi}_u \in \mathbf{5}_{2/3}$$

$$\psi_d, \widetilde{\psi}_d \in \mathbf{5}_{-1/3}$$



Implementation of **partial compositeness**

$$\mathcal{L}^{mix} \sim y_L\, f\, \overline{q}_L^{\alpha}\, (U_1 \psi_R)^{\alpha} + y_R\, f\, \overline{t}_R^{\alpha}\, (U_1 \psi_L)^{\alpha} + \mathrm{h.c.}$$

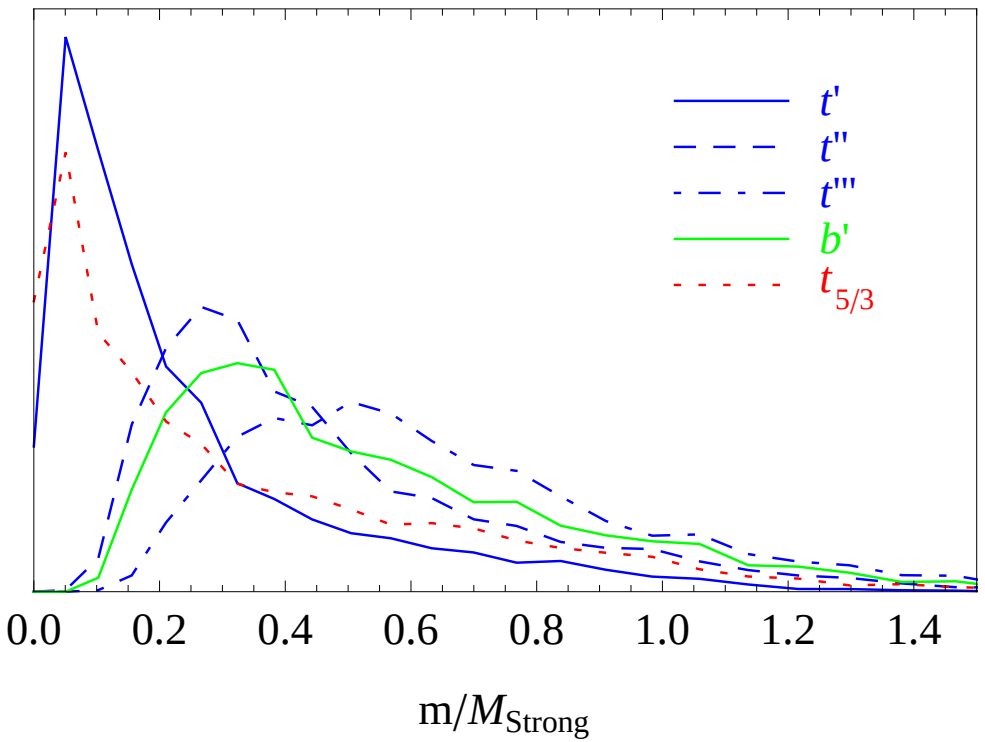
Extra $U(1)_X$ subgroups needed to accommodate Hypercharge.

Phenomenology: the Resonances

- Strong bounds from the S parameter

$$\widehat{S} \simeq \frac{m_w^2}{m_\rho^2} \qquad \Rightarrow \qquad \mathbf{m_\rho \gtrsim 2\ TeV}$$

- Distribution of the fermionic resonance masses
  - **Light partners** are usually present

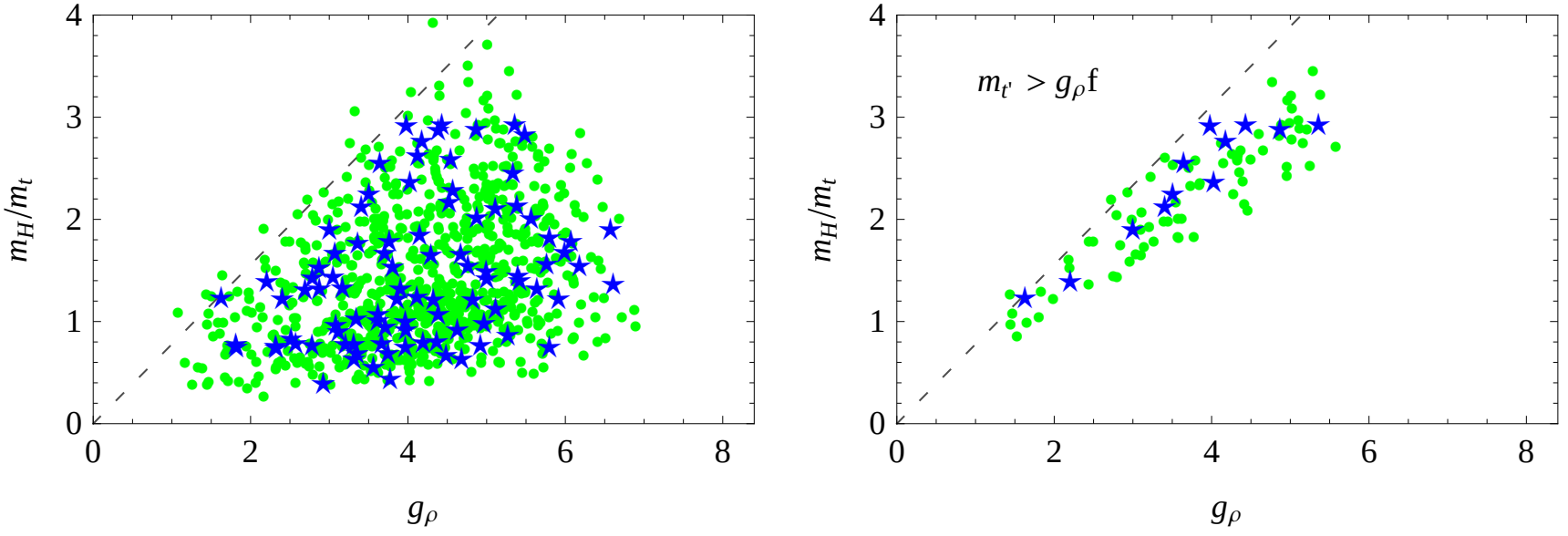


Phenomenology: the Higgs

If the fermionic resonances are **heavy**

$$m_H \sim 4\sqrt{2N_c}\,\frac{g_\rho}{4\pi}\,m_t$$

- Light Higgs **only if light fermonic partners** are present.



($\star$ satisfy the contraint on S-parameter)

Conclusions

We constructed a **simplified effective description** of the composite Higgs framework.

- Simple 4D **effective theory**
- Can be used to parametrize the **resonances** accessible at LHC
- Provides a **computable** and **predictive** set-up

Ongoing projects:

- Implement the model in an **event generator**
- Study **collider phenomenology**