

The Discrete Composite Higgs Model

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based on a work in collaboration with A. Wulzer

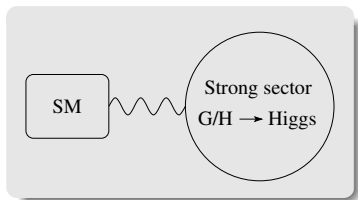
Why a **composite Higgs**?

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 $G \rightarrow H$
 - ▶ EW symmetry breaking induced at 1-loop



- Possible **resonances** from the strong sector

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), ...]

- ▶ **too** specific
- ▶ **several parameters** (also 'hidden' like the **metric**)
- ▶ includes many states **not accessible at LHC**

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

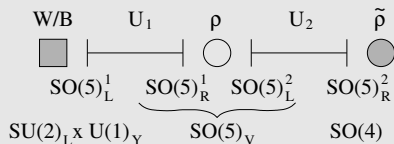
The Model

Minimal model with **three sites**.

Two σ -models:

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

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



Gauging breaks the global symmetries

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

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



EWSB effects through **collective breaking**:

cancellation of divergences

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

The Model

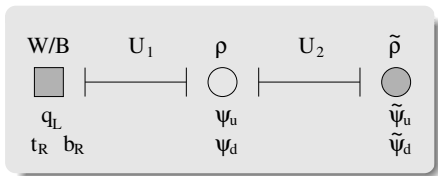
- **Elementary** fermions:

$$q_L, t_R, b_R$$

- **Composite** states:

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

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



Implementation of **partial compositeness**

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

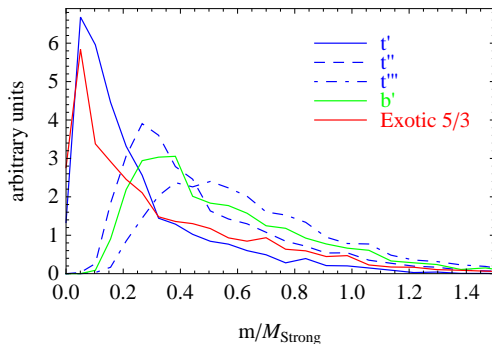
Extra $U(1)_X$ subgroups needed to accommodate Hypercharge.

Phenomenology: the Resonances

- Strong bounds from the S parameter

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

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

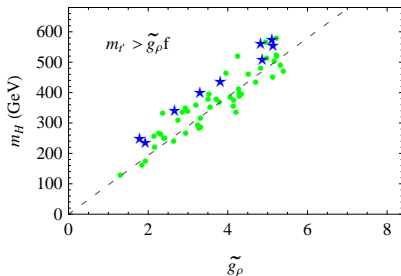
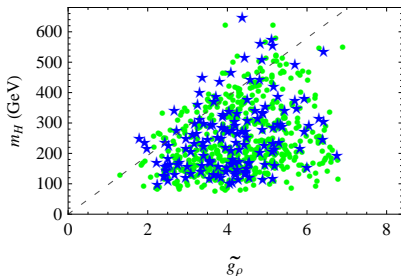


Phenomenology: the Higgs

If the fermionic resonances are **heavy**

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

► Light Higgs **only if light fermionic partners** are present.



(★ correspond to $v/f < 0.4$)

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