

T-parity: its problems and a solution

based on: D. Pappadopulo and A.V. (to appear **soon**)

Alessandro Vichi



Planck 2010

- 1 Relevance of T-parity
- 2 The overlooked problems of T-parity
- 3 Solving the issues
 - The $(N + 1)$ -th (but the 1st really working) model of LHT

Why T-parity?

- LH models successfully explain the lightness of Higgs boson however...
- Stringent constraints from EWPT:

$$\hat{S}, \hat{T} \sim \frac{m_W^2}{m_\rho^2}, \quad m_\rho \sim g_\rho f$$

- T-parity: selection rule forbidding tree level contribution to EWPT:

$$\hat{S}, \hat{T} \sim \frac{\alpha}{4\pi} \frac{m_W^2}{m_\rho^2} \lesssim 10^{-3}$$

- All what we need is a \mathbb{Z}_2 symmetry: SM **even**, all the rest **odd**

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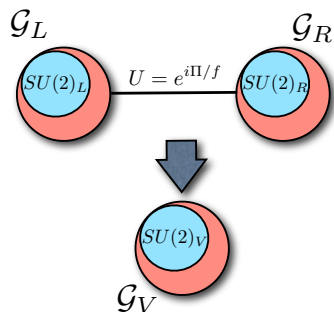
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Nothing new in the bosonic sector



$$\mathbb{Z}_2: L \leftrightarrow R$$

$$A_H \sim A_L - A_R \quad \text{odd}$$

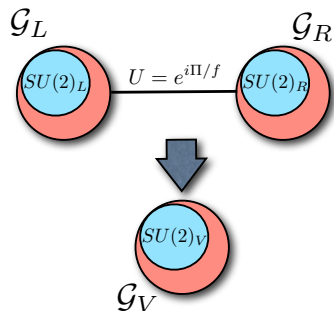
$$A_{SM} \sim A_L + A_R \quad \text{even}$$

$$U \rightarrow U^\dagger \Rightarrow \Pi \quad \text{odd}$$

T-parity: $(L \leftrightarrow R) \circ (SU(2)_V \text{ rotation of } 2\pi)$

- no tree level mixing with heavy vectors
- Higgs the only even PNCB

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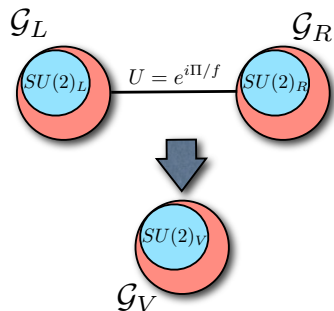
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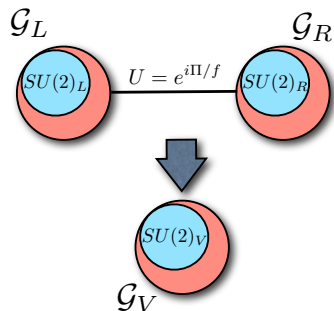
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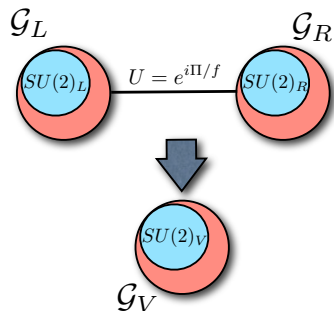
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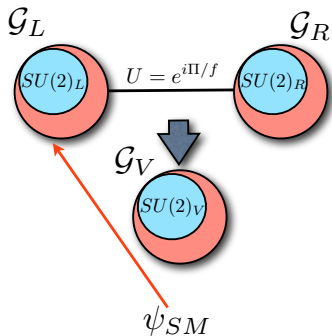
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A complicated fermionic sector

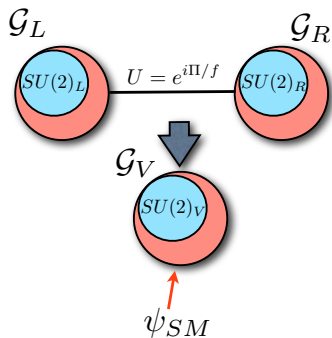
proposal 1



non $L \leftrightarrow R$ invariant

A complicated fermionic sector

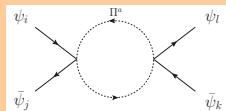
proposal 2



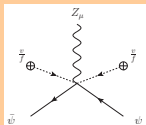
CCWZ construction

strong coupling with
PNGB's from the kinetic
term:

- huge 4-fermion interactions

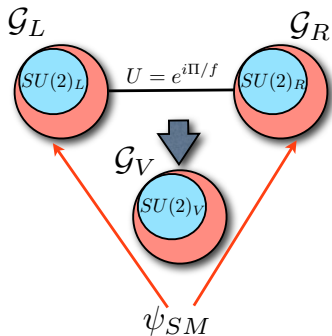


- vertex corrections



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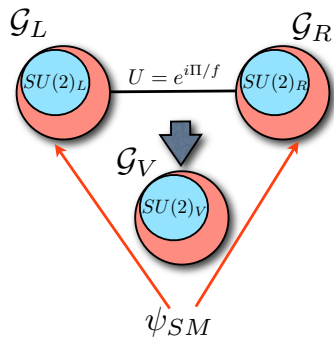
proposal 3



- Any representation invariant under $L \leftrightarrow R$ contains $2m$ doublets
- 1 (even) is the SM doublet
- What about the other $2m - 1$?

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None of the models proposed so far can: [exception: Csaki & al ('08)]

- reproduce the correct light SM spectrum
- prevent the Higgs mass from receiving quadratic corrections

...and as it wasn't enough:

All the models make use of representations of the unbroken \mathcal{G}_V :

- If taken **incomplete** they badly break the global symmetry group:
⇒ corrections to the Higgs mass
- If taken **complete** they generically contain even singlets:

Tensions in T-parity models

- correct light spectrum **VS** Higgs mass @ 2-loops
- absence of large vertex corrections **VS** Higgs mass @ 2-loops

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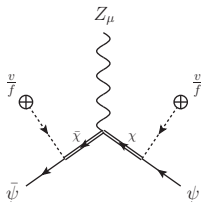
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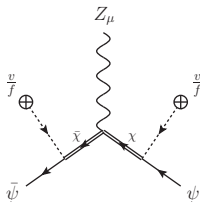
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Solving the issues

Need to extend the coset

[Low (04), Csaki & al ('08)]

an additional **broken** $SU(2) \times U(1)$ is sufficient

[D.Pappadopulo & AV]

Littlest Higgs with T-parity

$$\frac{SU(5)}{SO(5)} \rightarrow \frac{SU(5)}{SO(5)} \times \frac{[SU(2) \times U(1)]^2}{SU(2) \times U(1)}$$

- correct light spectrum
- no vertex corrections
- Higgs mass protected by symmetries exact @ 1 loop
- new T-odd states in the 100-200 GeV range: a scalar triplet and singlet
- compatible with EWPT
- interesting phenomenology
- DM matter candidate (Darkon model)

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Summary

- Model of LHT present in the literature are affected by overlooked pathologies
- We extracted the general recipe and a proposed a specific model

For further details watch out for the ArXiv in the next days