

SO(10) Yukawa Unification vs the LHC

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INGREDIENTS

- Supersymmetric SO(10) GUT
- $t - b - \tau$ Yukawa Unification

$$\lambda_t = \lambda_b = \lambda_\tau = \lambda_{\nu_\tau} = \lambda$$

Minimal Yukawa term for the third family, $W = \lambda \mathbf{16} \mathbf{10} \mathbf{16}$

- D_3 family symmetry: For the first two families to describe Yukawa structure and make predictions for quark & lepton masses and mixing angles.

[Dermisek, Raby, **Phys.Rev. D62 (2000) 015007**]



SOFT MASSES

- Requiring Yukawa unifications heavily constrains the choice of soft-parameters that gives robust EWSB:

$$A_0 \approx -2 m_{16}; \quad m_{10} \approx \sqrt{2} m_{16}$$
$$m_{16} > \text{few TeV}; \quad \mu, M_{12} \ll m_{16}$$

$$\tan \beta \approx 50$$

- The above conditions also require non-universal Higgs masses.
- Other boundary conditions like NUGM, and D-term splitting for scalar masses have also been studied.

χ^2 Analysis

- Model Parameters:

Sector	#	Parameters
gauge	3	$\alpha_G, M_G, \epsilon_3,$
SUSY (GUT scale)	5	$m_{16}, M_{1/2}, A_0, m_{H_u}, m_{H_d},$
textures	11	$\epsilon, \epsilon', \lambda, \rho, \sigma, \tilde{\epsilon}, \xi,$
neutrino	3	$M_{R_1}, M_{R_2}, M_{R_3},$
SUSY (EW scale)	2	$\tan \beta, \mu$

Table 1: Parameters in the DR model.

- Total # of parameters: 24
(compared to 28 in SM/32 in CMSSM)

Some Features

- Quark, charged lepton masses, mixing angles
- EW Precision data
- Neutrino mass differences and mixing angles. Can accommodate reasonably large θ_{13}
- Light Higgs mass: Large A_t , M_{susy}
 - Higgs naturally ~ 125 GeV.

Toughest Constraints

- $BR(B_s \rightarrow \mu^+ \mu^-) < 4.5 \times 10^{-9}$;

Large $\tan\beta \sim 50$ implies heavy CP-odd Higgs > 1200 GeV

- $BR(B_s \rightarrow X_s \gamma) = (3.55 \pm 0.26) \times 10^{-4}$;

Constraints the magnitude of the Wilson coefficient C_7 to be equal to the SM value and $m_{H^0} \geq 10$ TeV

- Recent LHCb results on $B \rightarrow K^* \ell \ell$ constrain the sign of C_7 to be same sign as SM.

Flavor-Physics!

Summary

- Supersymmetric $SO(10)$ GUT with 24 parameters.
- Can describe the quark, charged lepton and neutrino sectors well.
- SUSY spectrum: Heavy scalars (light third generation) & light gauginos.
- Tough constraints from B-physics.