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Fakultät Physik
Theoretische Physik III

Lepton-Flavor violation in a neutrino mass model with discrete S_3 symmetry

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The model

We perform an analysis of the scalar sector in the model of Chen, Frigerio, Ma; Phys. Rev. D70:073008, 2004. It is based on the symmetry group S_3 and is attractive because it is able to explain the observed maximal atmospheric angle in the neutrino sector while maintaining the ability to produce the observed CKM angles.

To generate the required masses of the matter particles as well as their mixings, three scalar electroweak doublets are introduced. The model's symmetry structure leads to manifestly lepton flavor violating couplings through Yukawa interactions with the scalars.

The mixings that also lead to lepton flavor violating couplings are induced by the following assignment of the particles into S3 multiplets:

$(L_2, L_3) \propto \mathbf{2}$ $\quad L_1, \ell_1^c, \phi_1 \propto \mathbf{1}$ $\quad L_i$: electroweak lepton doublet
$(\phi_2, \phi_3) \propto \mathbf{2}$ $\quad \ell_2^c \propto \mathbf{1}$ $\quad \ell_3^c \propto \mathbf{1'}$ $\quad \ell_i^c$: right-handed singlet
ϕ_i : scalar field

Using the following multiplication rules, the Lagrangian can be constructed:

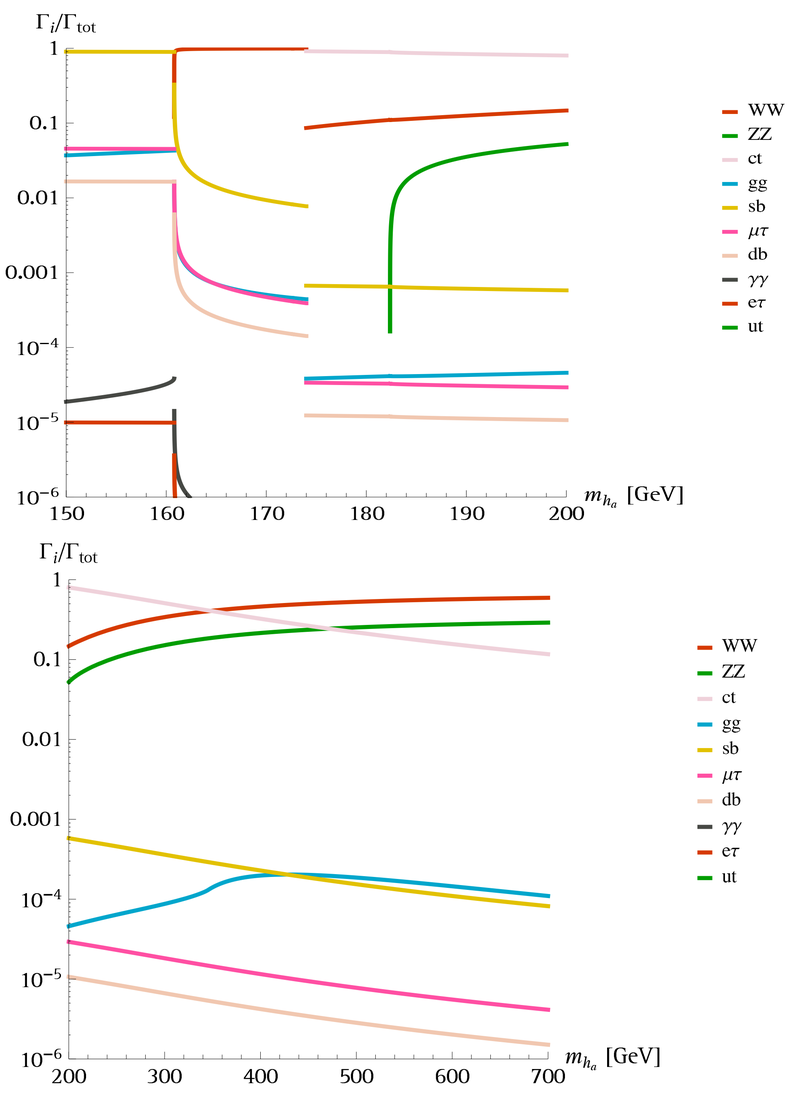
$\mathbf{2} \times \mathbf{2} = \mathbf{1} + \mathbf{1'} + \mathbf{2}$ $\quad \mathbf{1'} \times \mathbf{1'} = \mathbf{1}$

Properties of the scalars

- Three physical neutral scalars emerge after symmetry breaking
- Masses below 400 GeV for all three scalars
- h_b and h_c decay diagonally with an additional off-diagonal 1-2 coupling
- h_a decays only off-diagonally into 2-3 and 1-3

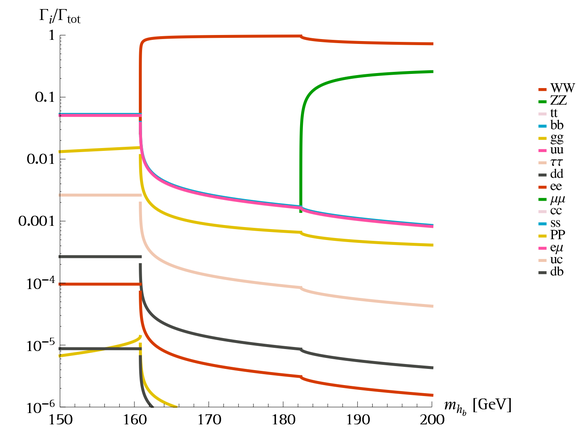
Large branching ratios for off-diagonal decays of h_a

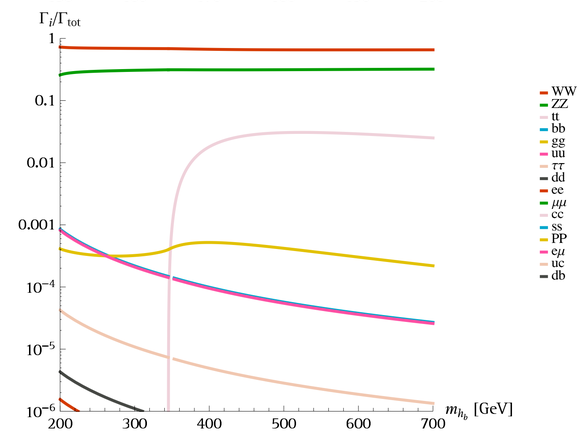
- h_a only decays off-diagonally into quarks and leptons
- In the region of light masses (<200 GeV), the scalar would dominantly decay into *sb* or *ct* pairs, with a small mass region where *WW* dominates
- For heavier masses (<400 GeV), the particle decays dominantly into *ct*, the branching ratio is even larger than the one for the decay into vector bosons
- Clear signature in all mass regions: Even in the *WW* dominated region, the second important decay is into *sb* with a BR of >0.01
- Making this scalar heavy to avoid large LFV branching ratios would require a modification of the minimal model

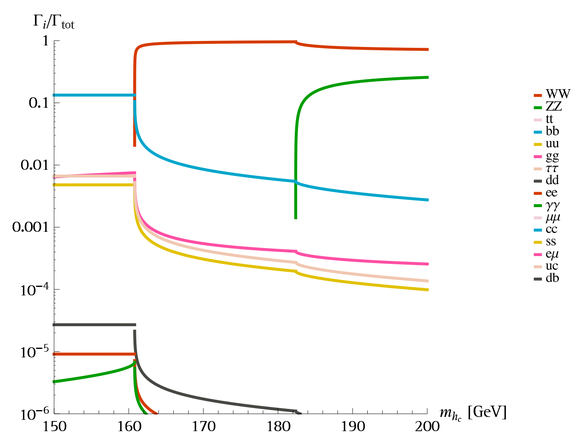


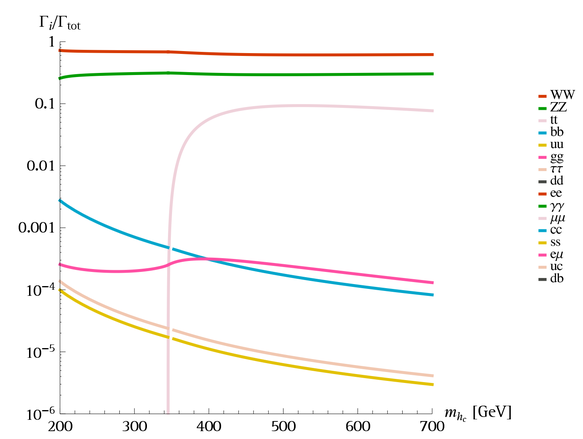
Branching ratios for h_b and h_c

- Similar to Standard Model with some differences:
- Off-diagonal decays are possible, but strongly suppressed
- Couplings are not directly proportional to fermions' masses, which leads to deviations from the SM Higgs decay branching ratios
- Noticable feature: large branching ratio for decay into *uu* (>10^{-4})



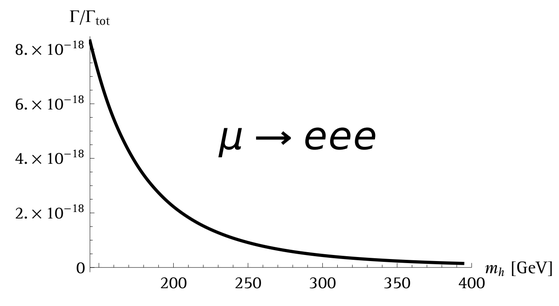


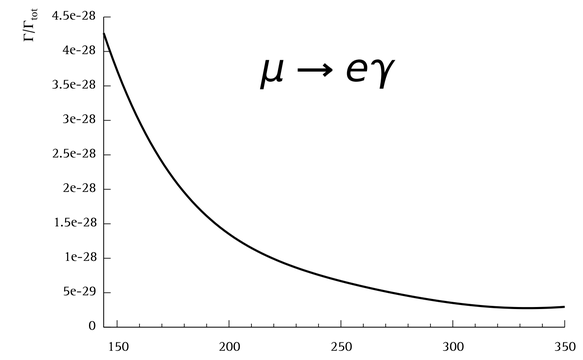




Lepton decays

- LFV muon decays are possible in this model
- Branching ratios are well below the current bounds of 10^{-11} and 10^{-12} for $\mu \to e\gamma$ and $\mu \to eee$





References:
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