SUMMARY OF DOCTORAL THESIS

The author's name: NGUYEN VAN HOP

Thesis title: **The Higgs sector in the 3-3-1 model with the CKS mechanism and the classification of 3-3-1 models based on the weak charge data**

Scientific branch of the thesis: Physics

Major: Theoretical and Mathematical Physics. Code: 9 44 01 03

The name of postgraduate training institution: Hanoi Pedagogical University N2.

1. Thesis purpose and objectives:

   + Fully establishing and investigating the content of gauge bosons as well as their possible properties of related parameters in the 3-3-1 CKS model.

   + Building completely the Higgs sector in the 3-3-1 CKS model and developing some relevant discussion.

   + Categorizing the 3-3-1 models based on their value of parameter β and assignments their left-handed quarks to perform numerical investigation originated from the up-to-date experimental data of the weak charge of Cesium (in the APV phenomena), of proton (in the PVES phenomena) and perturbative limit of Yukawa coupling of the top quark, and then giving predictions on paramter space of the models and their survival ability.

2. Research methods:

   The method of quantum field theory, performed through numerical investigation and computation using the software *Mathematica*.

3. Major results and conclusions:

   - In the thesis, we build and investigate fully the content of gauge bosons on the aspects such as their physical states, mixing angles and masses. Besides,

we also pay attention to the study of the constraints arising from the experimental data on the ρ parameter, giving the estimation of the value range of the VEV v_χ ($3.57\,\text{TeV} \leq v_\chi \leq 6.09\,\text{TeV}$) and of the mass of the new neutral gauge boson Z_2 ($1.42\,\text{TeV} \leq M_{Z_2} \leq 2.42\,\text{TeV}$). We also study the single Z_2 production via Drell-Yan mechanism at the LHC. We have found that Z_2 gauge bosons heavier than about 4 TeV comply with the experimental constraints on the oblique parameter ρ as well as with the collider constraints.

- In the framework of the 3-3-1 CKS model, the scalar potential and its related properties are analyzed and discussed in detail, consisting of the total Higgs potential, the lepton number conservative and lepton number violating ones. Necessarily in the model we determine SM-like Higgs boson h with the squared mass $m_h^2 \simeq \frac{4}{3}\lambda v_\eta^2$ and the scalar dark matter candidate φ_2^0 with its squared mass $\frac{1}{2}v_\eta^2\lambda_2^{\eta\varphi}$. We also consider in detail the Higgs sector in its simplified context where some interesting discussed topics are contribution of the scalar sector to the ρ parameter, phenomenological aspect of the heavy Higgs boson H_4 and dark matter relic density connected to the dark matter candidate of the model.

- In this thesis, with calculations and discussion based on the up-to-date weak charge data from the standard APV and PVES experiments and the perturbative limit of the Yukawa coupling of the top quark, we show the effects of the tree data channels on the parameter spaces of 3-3-1 models. Within a recently proposed 3-3-1 CKS, we get the lowest value of M_{Z2} to be 1.27 TeV. This limit is slightly lower than that concerned from the LHC searches, B decays or ρ parameter data.

- We have also performed studies for the other versions of the 3-3-1 models with three Higgs triplets. Based on the gained results of parameter spaces and their constrains in each of the considered situations, it suggests that models of a specific representation (among rep. A, B or C) and specific β

can be ruled out or not. From our discussion, we emphasize that the information of PVES data of proton and the pertubative limit of top quark Yukawa couplings are as important as that obtained from the APV of Cesium, therefore all of them should be discussed simultaneously to constrain the parameter space of the 3-3-1 models. The numerical calculations have also shown that the allowed regions predicted by the two models reps. B and C disfavor the large M_{Z_2} hence they may be rule out by future constraints from colliders such as LHC, especially the model rep. C. While the model rep. A may still be survived, resulting in that the heaviest quark family must treat differently from the remaining. Furthermore, our work concerns that the improved weak charge data from the future experiments will be important to decide which quark family in realistic 3-3-1 models should be assigned differently from the two remaining families. The recent data of APV and PVES is consistent with the data on the mass difference of neutral mesonin the sense that the third family should be treated differently from the first two. This also gives a reason why the top quark is so heavy.

On behalf of academic supervisors **PhD. Student**

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