

Impressive thesis title

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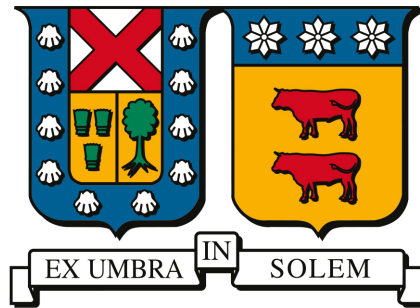
i *Submitted in partial completion of the*

PhD in physical sciences

Abstract

Abstract goes here for both works

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Nature is relentless and unchangeable, and it is indifferent as to whether its hidden reasons and actions are understandable to man or not.

— Galileo Galilei

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Introduction

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1.1 Standard Model

1.2 Contribution

*Alles Gescheite ist schon gedacht worden.
Man muss nur versuchen, es noch einmal zu denken.*

*All intelligent thoughts have already been thought;
what is necessary is only to try to think them again.*

— Johann Wolfgang von Goethe

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Model Building

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2.1 Generating lepton masses and mixings with a heavy vector doublet

SM “flavor puzzle” motivates to build models with additional scalars and fermions in their particle spectrum and with an extended gauge group, supplemented by discrete flavour symmetries, which are usually spontaneously broken, in order to generate the observed pattern of SM fermion masses and mixing angles.

given the current lack of experimental evidence in favor of the traditional big paradigms of Physics beyond the Standard Model, it seems prudent to explore more exotic paths. In recent years, for instance, some groups have pay attention to spin-1 fields transforming in the fundamental representation of $SU(2)_L$. This kind of field may naturally appear, for instance, in models such as: Higgs-Gauge

Unification and Composite Higgs. In a previous paper, our group has studied the phenomenology of a spin-1 doublet which has the same hypercharge of the Higgs doublet. In the context of Composite Higgs, this kind of field may be interpreted as a spin-1 excitation of the Higgs field in analogy to the rho-mesons which can be seen as the spin-1 excitation of the pions. Such a spin-1 doublet cannot be coupled to standard fermions except by the introduction of exotic fields. The simplest alternative is the introduction of a left-handed fermion which is singlet under the SM group. Of course, such an exotic fermion will behave like a sterile neutrino. In this case, the spin-1 doublet will couple the standard leptons to new exotic neutrino. We will show that the introduction of such new fields (the spin-1 doublet and the new sterile left-handed neutrino) can have an impact on neutrino physics by providing a new mechanism for the mass generation of the light active neutrinos.

2.1.1 Discrete symmetries

2.1.2 Vector boson

2.1.3 CKM and PMNS matrices

2.1.4 Neutrino mass generation

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Renormalization and Neutral Meson decays

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3.1 RGE effects on lepton-flavor violating neutral meson decays

3.1.1 Effective Field Theory

A Lagrangian describes a renormalizable theory if it is composed of operators such that $[\mathcal{O}] \leq d$, the spacetime dimension. If this holds, any divergences that appear can be absorbed into a finite number of counterterms. Otherwise, we require an infinite number of counterterms to absorb the divergences, and our theory loses its predictive power. This is why theoretical physicists put so much store in renormalizability for a theory to be of any use.

3.1.2 Lepton Flavor Violation**3.1.3 Renormalization of LFV meson decays**

Appendices

