

UNIVERSIDAD DE LOS ANDES



Phenomenological Study of Search of Heavy Neutrinos, with Displaced Vertices and Vector Boson Fusion

THIS DISSERTATION IS SUBMITTED FOR THE DEGREE OF

PHYSICIST

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BOGOTÁ, D.C.

2017

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Chapter 1

Introduction

Chapter 2

State of the Art

2.1 Standard Model

2.2 Higgs Mechanism

2.3 Neutrinos in the Standard Model

As it was mentioned earlier the SM does not explain the reason why the mass of neutrinos is smaller than the mass of the other fermions by a factor of almost 10^{-6} . Moreover, it does not provide an explanation to the fact that only left handed neutrinos had been observed in nature. In this section we are going to work on possible solutions to these problems. ¹

2.3.1 Dirac Mass

The lagrangian of a free fermion is:

$$L = \bar{\psi} (i\gamma^\mu \partial_\mu - m) \psi \quad (2.1)$$

Where ψ is the Dirac Spinor. The mass is included in the SM through the second term in the former equation, it is called “Dirac mass term”:

$$m\bar{\psi}\psi \quad (2.2)$$

¹The detailed calculation is explain in A

We can write the Dirac Spinor as a sum of it's left- and right- chiral states:

$$m\bar{\psi}\psi = m(\overline{\psi_L + \psi_R})(\psi_L + \psi_R) = m\bar{\psi}_L\psi_R + m\bar{\psi}_R\psi_L \quad (2.3)$$

Previously we have used the fact that: $\bar{\psi}_L\psi_L = \bar{\psi}_R\psi_R = 0$ which is proved in A.

2.4 Seesaw Mechanism

Chapter 3

Important Concepts and Variable Definitions

3.1 Jets

3.2 Cross Section

3.3 Coordinate System of CMS and ATLAS detector at the LCH

3.4 Pseudorapidity

3.5 Minimal Separation Distance Between Particles

3.6 Detector CMS and ATLAS

3.7 MET

3.8 Impact Parameter

Chapter 4

Model and backgrounds

4.1 Signal of Interest

4.2 Backgrounds

4.2.1 W + Jets Background

4.2.2 Drell Yan + Jets Background

4.2.3 $t\bar{t}$ Background

Chapter 5

Methodology

5.1 MadGraph

5.2 Pythia

5.3 Delphes

5.4 ROOT

Chapter 6

Analysis

Appendix A

Neutrinos and Seesaw Mechanism

