Thesis Title
Second Line if Necessary

by

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Abstract

This is my abstract.

Acknowledgments

Blah blah blah.

Statement of Originality

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Chapter 1

Introduction

The cosmic sky has entranced humans for as far as recorded history can trace. As technology evolved, so too did the observation of the universe around us; from the naked eye to primitive telescopes, and eventually to present day space telescopes, like the Hubble Space Telescope and the upcoming James Web Space Telescope **(NEED TO CITE THESE)**. These growing technological leaps have also resulted in the exploration of the incredibly small and eventually resulted in the discovery of the neutrino [8]. It was perhaps inevitable that these two seemingly separate areas of physics would eventually meet.

1.1 Neutrinos

The neutrino is a fundemental particle first proposed by Wolfgang Pauli [2], and then later discovered in 1956 using the byproducts of β^- decay [8]. As research continued into the elusive neutrino, another flavour of neutrino was discovered in 1962 called the muon neutrino (ν_μ) [3] and eventually the final flavour of the tau neutrino (ν_τ) [6].

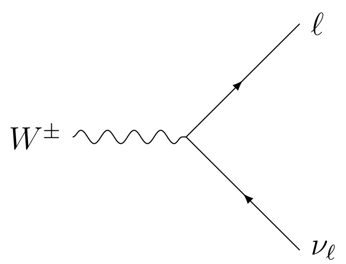

Figure 1.1: The Feynmann diagrams for the vertices that would be included in neutrino interactions using the charged $W^{\pm}$ boson on the left and the neutral Z^0 boson on the right.

1.1.1 Interactions

Neutrinos are neutral and interact only through the Weak interaction. The Weak interaction is a force that is mediated by the $W^{\pm}$ and Z^0 massive bosons, and is the force responsible for decays. The main vertices involved in neutrino interactions are shown in Figure [**?**], where the interacting lepton corresponds with the interacting neutrino flavour.

All interaction involving neutrino production or detection utilize these vertices in some shape or form. We refer to interactions that use the $W^{\pm}$ boson as the Charged Current (CC) interaction [5], and those that use the Z^0 boson as being Neutral Current (NC) interactions [5].

1.1.2 Production & Sources

Solar: Neutrinos produced from the fusion process inside the sun. Go into detail about the process.

Atmospheric: Cosmic rays that interact with the atmosphere produce neutrinos that then shower the earth. Go into detail about process

Geo: Rare decays in the crust eject neutrinos which can be detected.

Active Galactic Nucleus: Active centres of galaxies that are hubs for producing high energy neutrinos

Supernova: Massive Explosions of dying stars that eject high energy neutrinos.

1.1.3 Oscillations

Alongside the discovery of the neutrino and their flavours, another problem arose in the field of neutrino physics: the solar neutrino problem [7]. During the 1960's, an experiment was proposed by Bahcall and Davis to measure the solar neutrino flux, referred to the Homestake experiment [4, 1].

Need to talk about the distance dependence of oscillations, perhaps will need to cover the probability of observing a particular mass of neutrino given the length it travels L. Could do the simple two neutrino example, but should probably do the full formula from some source text.

Chapter 2

Background

2.1 Detection Techniques

Literature dive into different types of neutrino detection techniques.

Cherenkov indirect, ect..?

2.2 Neutrino Telescopes

Generally use Cherenkov radiation as a method of detecting high energy neutrinos from cosmic sources.

2.2.1 IceCube

2.2.2 ANTARES

2.2.3 KM3NET

Chapter 3

The Pacific Ocean Neutrino Explorer

3.1 Detectors

3.1.1 Geometry

3.2 Ocean Networks Canada

Chapter 4

Simulation

4.1 IceCube Framework

4.2 Simulating Neutrinos

4.3 Simulating Muons

4.4 Detector Response

Chapter 5

Reconstruction

5.1 Linefit

5.2 Likelihood

Chapter 6

Results

6.1 Likelihood

Chapter 7

Summary and Conclusions

7.1 Summary

7.2 Future Work

7.3 Conclusion

Bibliography

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