ABSTRACT

Elliot Wesley Parrish, Ph.D.
Department of Physics
Northern Illinois University, 2022
Dhiman Chakraborty and Jahred Adelman, Director

NORTHERN ILLINOIS UNIVERSITY
DE KALB, ILLINOIS

DECEMBER 2022

BY

ELLIOT WESLEY PARRISH
© 2022 Elliot Wesley Parrish

A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

DEPARTMENT OF PHYSICS

Dissertation Director:
Dhiman Chakraborty and Jahred Adelman

ACKNOWLEDGEMENTS

DEDICATION

TABLE OF CONTENTS

Chapter Page

1 Theory 1

1.1 The Standard Model 2

1.1.1 Particles 2

1.1.1.1 Fermions 2

1.1.1.2 Bosons 2

1.1.2 Interactions 2

1.1.2.1 Electromagnetic Interaction 2

1.1.2.2 Weak Interaction 2

1.1.2.3 Strong Interaction 2

1.1.3 The Higgs Mechanism 2

1.2 Supersymmetry 2

1.2.1 MSMM Particles. 2

1.2.2 R-Parity 2

1.2.3 The MSSM Higgs Sector 2

1.3 Charged Higgs Bosons 2

1.3.1 Previous Result 2

2 The LHC and ATLAS Experiment 3

2.1 The Large Hadron Collider 4

Chapter Page

2.2 The ATLAS Detector . . . 4
2.2.1 Inner Detector . . . 4
2.2.1.1 Pixel . . . 4
2.2.1.2 Semiconductor Tracker . . . 4
2.2.1.3 Transition Radiation Tracker . . . 4
2.2.2 Calorimeters . . . 4
2.2.2.1 Liquid Argon Electromagnetic . . . 4
2.2.2.2 Tile Hadronic . . . 4
2.2.3 Muon System . . . 4
2.2.3.1 Monitored Drift Tubes . . . 4
2.2.3.2 Cathode Strip Chambers . . . 4
2.2.3.3 Resistive Plate Chambers . . . 4
2.2.3.4 Thin Gap Chambers . . . 4
2.2.4 Magnet Systems . . . 4
2.2.4.1 Solenoid Magnet . . . 4
2.2.4.2 Toroid Magnet . . . 4
3 Event Reconstruction . . . 5
3.1 Trigger . . . 6
3.2 Inner Detector . . . 6
3.3 Calorimeters . . . 6
3.4 Muon . . . 6
3.5 E Gamma . . . 6
3.6 Jets . . . 6
3.6.1 Flavor Tagging . . . 6

Chapter Page

3.6.2 Tau 6

3.7 $E_{\mathrm{T}}^{\mathrm{miss}}$ 6

4 Conclusion 7

CHAPTER 1

THEORY

1.1 The Standard Model

1.1.1 Particles

1.1.1.1 Fermions

1.1.1.2 Bosons

1.1.2 Interactions

1.1.2.1 Electromagnetic Interaction

1.1.2.2 Weak Interaction

1.1.2.3 Strong Interaction

1.1.3 The Higgs Mechanism

1.2 Supersymmetry

1.2.1 MSMM Particles

CHAPTER 2

THE LHC AND ATLAS EXPERIMENT

2.1 The Large Hadron Collider

2.2 The ATLAS Detector

2.2.1 Inner Detector

2.2.1.1 Pixel

2.2.1.2 Semiconductor Tracker

2.2.1.3 Transition Radiation Tracker

2.2.2 Calorimeters

2.2.2.1 Liquid Argon Electromagnetic

2.2.2.2 Tile Hadronic

2.2.3 Muon System

2.2.3.1 Monitored Drift Tubes

CHAPTER 3
EVENT RECONSTRUCTION

3.1 Trigger

3.2 Inner Detector

3.3 Calorimeters

3.4 Muon

3.5 E Gamma

3.6 Jets

3.6.1 Flavor Tagging

3.6.2 Tau

3.7 $E_{\mathrm{T}}^{\mathrm{miss}}$

HELLO AHHHA $E_{\mathrm{T}}^{\mathrm{miss}}$

CHAPTER 4

CONCLUSION

Appendices