UNIVERSITY OF CALIFORNIA,
IRVINE

The LHC Grows Up: Searches for New Physics in Dilepton Final States and Upgrades to the Muon System of the ATLAS Experiment.

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Physics

by

Daniel Joseph Antrim

Dissertation Committee:
Professor A, Chair
Professor B
Professor C

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DEDICATION

(Optional dedication page)
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ACKNOWLEDGMENTS

I would like to thank...

(You must acknowledge grants and other funding assistance.

You may also acknowledge the contributions of professors and friends.

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Conference name

Another awesome paper **Aug 2012**
Conference name

SOFTWARE

Magical tool `http://your.url.here/`
C++ algorithm that solves TSP in polynomial time.

ABSTRACT OF THE DISSERTATION

The LHC Grows Up: Searches for New Physics in Dilepton Final States and Upgrades to the Muon System of the ATLAS Experiment.

By

Daniel Joseph Antrim

Doctor of Philosophy in Physics

University of California, Irvine, 2019

Professor A, Chair

The abstract of your contribution goes here.

Chapter 1

The Standard Model of Particle Physics

So it goes...

—Kurt Vonnegut, *Slaughterhouse Five*

As it stands, what has become known as the 'Standard Model (SM) of Particle Physics' is nothing less than one of the greatest achievments of mankind, due to both the magnitude by which it has changed our perception of the underlying nature of the universe and to the clever methods and tinkerings by which this nature was unveiled by many clever physicists whose history has become veritable lore. In terms of imagination and insight, it is second only to the Special and General Theories of Relativity – though the two fields are nevertheless intricately intertwined.

Not considering the scientific progress made in the 18^{th} and 19^{th} centuries, and ignoring the ancient Greeks despite their fabled invention atomic theory, the physical insights and major work that lead to the current picture of elementary particle physics described by the SM began with the *annus mirabilis* papers of Albert Einstein in the year 1905 [1, 2, 3]. In these papers, Einstein was able to shed light on the quantization of electromagnetic radiation (building off of the seminal work of Max Planck [4]) and introduce the Special Theory of Relativity. These works laid the conceptual and philosophical groundwork for the major breakthroughs in fundamental physics of the 20^{th} century physics: leading to Bohr's early insights into the origins of the energy spectra and atomic structure of the hydrogen atom [5], de Broglie's notion of wave-particle duality [6], and, eventually, the breakthroughs of Werner Heisenberg, Max Born, and Erwin Schrödinger in the early 1920's that provided a sufficient mathematical and interpretable framework in which to construct the modern theory of non-relativistic quantum mechanics that has since revolutionised all aspects of the physical sciences and technologies that we encounter in our everyday lives. The treatment of non-relativistic quantum mechanics put forth in the early 1920's is, for the most part, what is still taught to physics students today and is still an active area of scientific and philosophical research. However, it was Paul Dirac who was finally able to succesfully marry the theory of the quantum with that of relativity in his relativistic quantum-mechanical treatment of the electron described by the *Dirac equation* [7, 8]. The work and strange imagination of Dirac is finally what led to the work of Dyson, Feynman, Schwinger, and Tomonaga in the area of quantum electrodynamics (QED). The supreme accuracies with which QED describes reality, with its deceptively simple 'Feynman diagrams', has since led to the framework of *quantum field theories* (QFT) being the go-to choice for describing nature. The SM is no less than *an* ultimate conclusion of these works: a consistent set of quantum field theories arrived at in the intervening decades since Feynman, et. al., that describes essentially all aspects of the observed particles and forces that shape the known universe.

1.1 Particles and Forces

Here we will describe briefly what is known as the 'Standard Model of Particle Physics', which will be referred to as the 'Standard Model' or simply the 'SM' throughout this work. The physical insights and major work that lead to the current picture of elementary particle physics as described by the SM is largely described by the theories of Glashow, Weinberg, and Salam in what is now referred to as the GWS Theory. In the literature, the theory of GWS is actually what is referred to as the 'Standard Model' despite it being an incomplete picture of elementary particle physics (it does not mention the theory of coloured objects, Quantum Chromodynamics, for instance) since it laid the basic fundamentals of building models of particles and their field representations under the framework of *gauge theories*.

Serhan is lame.

1.1.1 Gauge Theories

The Electroweak Theory

blahr

Hello

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Appendix A

Basics of Machine Learning