MEASUREMENT OF THE TTTT CROSS SECTION AT 13TEV

by

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A DISSERTATION

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfilment of Requirements

For the Degree of Doctor of Philosophy

Major: Physics and Astronomy

Under the Supervision of Gregory Snow

Lincoln, Nebraska

TBD, TBD

MEASUREMENT OF THE TTTT CROSS SECTION AT 13TEV

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Adviser: Professor Gregory Snow

Abstract

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Chapter 1

Introduction

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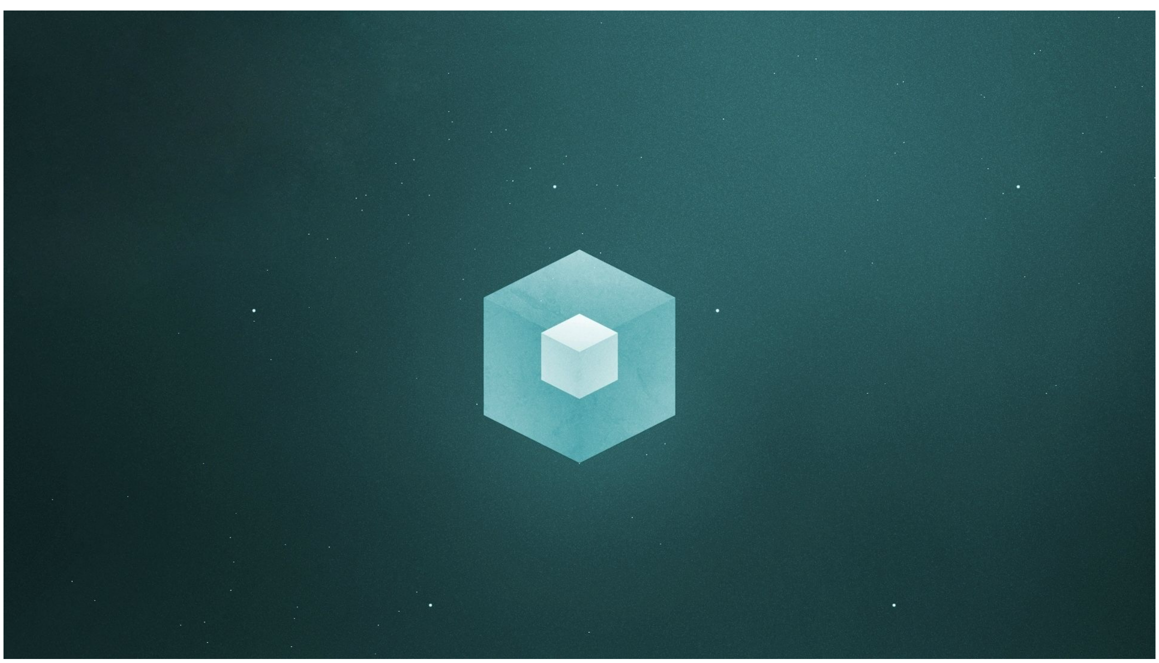

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See Fig. fig. 11

See Fig. fig. 12

And a citation here: [1]

Chapter 2

The Standard Model of Particle Physics

The Standard Model of Particle Physics(SM) stands as one of the most predictive and insightful scientific theories ever written. It is the culmination of a hundred years of intense theoretical exploration and experimental tests. It can sucessfully explain phenomena ranging from nuclear decay and the structure of atoms to the behavior of cosmic ray showers. Included in the theory are three fundamental forces. The first and most familiar is the electromagnetic force which is mediated by the photon and which all particles with electric charge participate. The second is the strong nuclear force. The strong force is mediated by the gluon which controls the interaction between all *colored* particles. It is this force that is responsible for binding quarks together into mesons and baryons, as well as binding protons and neutrons together into atomic nuclei. Finally, the weak nuclear force, which is mediated by the W and Z bosons, and is responsible for nuclear β-decay as well as more exotic processes such as interactions with the ghostly neutrino particle and the decay of the top quark.

Notably, the Standard Model is completely unable to explain why apples fall from trees or why water flows downhill since it lacks a description of the gravitational force. The current most complete theory of gravity is General Relativity, however, despite large and ongoing efforts to unite GR with the Standard Model, no resulting theories have had the necessary self-consistency and predictive power to be accepted. Luckily for those working on collider experiments, the effect of gravity are so overwhelmed by the other three fundamental forces that it can be ignored.

Before describing the Standard Model in more detail, however, it is important to understand how we got to where we are today[1]. The story of particle physics has generally been that of assuming that *something* is a fundamental, indivisible unit of matter, whether it be molecules, atoms, or nucleons, and then discovering that that *something* is in fact composite. Despite this reoccuring story, however, we start with a notable exception: the electron.

Back in 1897, J. J. Thompson and associates investigated the phenomena of "Cathode Rays"[4]. At this point the laws of Maxwell that describe electromagnetism had already been well established, as well as the fact that matter contained, as yet unidentified, charge carriers whose motion results in electric current. Indeed, earlier experiments by Jean Perrin[3] had shown that these Cathode Rays were associated with a stream of negatively charged particles, but not not that they were one in the same. As Thompson puts it,

> [Others] do not deny that electrified particles are shot off from the cathode; they deny, however, that these charged particles have any more to do with the cathode rays than a rifle-ball has with the flash when a rifle is fired.

The contribution of Thompson's experiment was to show that these cathode rays were made up of negatively charged particles, or as he called them "corpuscles". The experimental setup is shown in fig. 21. It consists of a cathode (A) which is simply a heated piece of metal supplied with a negative voltage with respect to earth. An anode (B) made of a metal plug with a central hole is fixed into the "neck" of the experiment and serves to draw the isotropic cathode rays into a beam and shoot it

[1] Much of this discussion loosely follows the summary given by Griffiths in [2].

into the central bulb. The central bulb is coated with a phosphor which shows the position of the beam on the wall of the bulb. A magnetic field is then employed to deflect the beam into an electrometer shown at the bottom of the diagram.

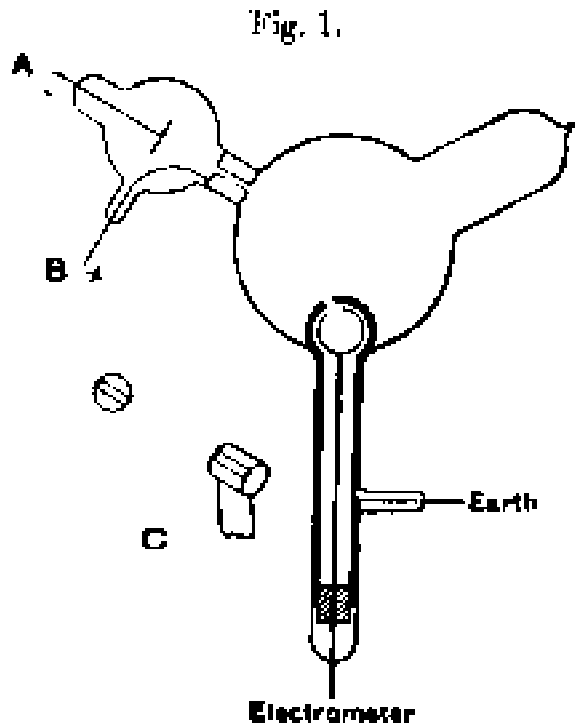

Figure 21: Schematic of Thomson's Cathode Ray Experiment

Thompson found by tracing the path of the cathode rays using the phosphorescent coating that when the beam was bent such that it entered into the electrometer, it regestered a large jump in charge. This implied that the cathode rays and the charge carrying corpuscles were one in the same. Additional experiments by Thomson and others measured the charge-to-mass ratio of these electrons (a name coined by irish physicist George Johnstone Stoney), and found the same results whether the particle source was a heated material, an illuminated one, or from certain radioactive materials. These results lent credence to the idea that the electron was a universal component of matter, and hence the first member of the family of particles in the Standard Model was established.

Chapter 3

Theory

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See Fig. fig. 31 .

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