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A thesis submitted towards the degree of Doctor of Philosophy

School of Physics, Chemistry and Earth Sciences
The Faculty of Sciences, Engineering and Technology
The University of Adelaide

September 26, 2024

Abstract

Abstract yeehaw

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

YOUR NAME

"Dedicated to ya mum"

"I put my heart and my soul into my work, and have lost my mind in the process"
— Vincent Van Gogh

Acknowledgements

I acknowledge your mum

Preface

My supervisor frothed for this section when I said that the intended audience was future students.

- In Chapter 1,
- In Chapter 2,

Charge conjugation is assumed throughout this thesis, unless specified otherwise.

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Chapter 1.

Introduction

Give a short abstract of your chapter here for when your examiner gets bored and wants the tl;dr

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Particle physics experiments perform some of the most precise measurements of natural phenomenon in science. Quantities such as the mass of the electron are known within 1 part in 100 trillion [1].

1.1. Understanding $B^+ \to \mu^+\nu_\mu$ via the Standard Model

The subatomic physics decay $B^+ \to \mu^+\nu_\mu$ is that of an electrically-charged B, a composite particle. The B decays to the electron-like particle, a muon (μ), alongside the electrically neutral neutrino (ν), a particle with near zero mass. The process can be drawn as a Feynman diagram, as in Figure 1.1.

SM theory has also been used to mathematically predict and later experimentally confirm the existence of further ones. A complete explanation of the matter, mediator and resulting mathematical mechanisms of SM is not the focus of this thesis, and thus the scope is limited to how SM explains and predicts $B^+ \to \mu^+\nu_\mu$ process.

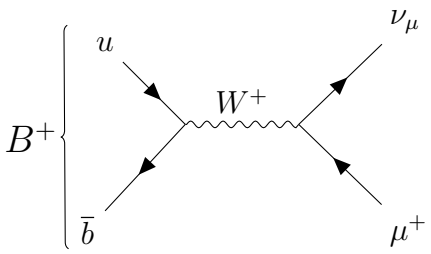

Figure 1.1. A Feynman diagram of the decay $B^+ \to \mu^+\nu_\mu$, indicating the effect of Standard Model forces that facilitate this process.

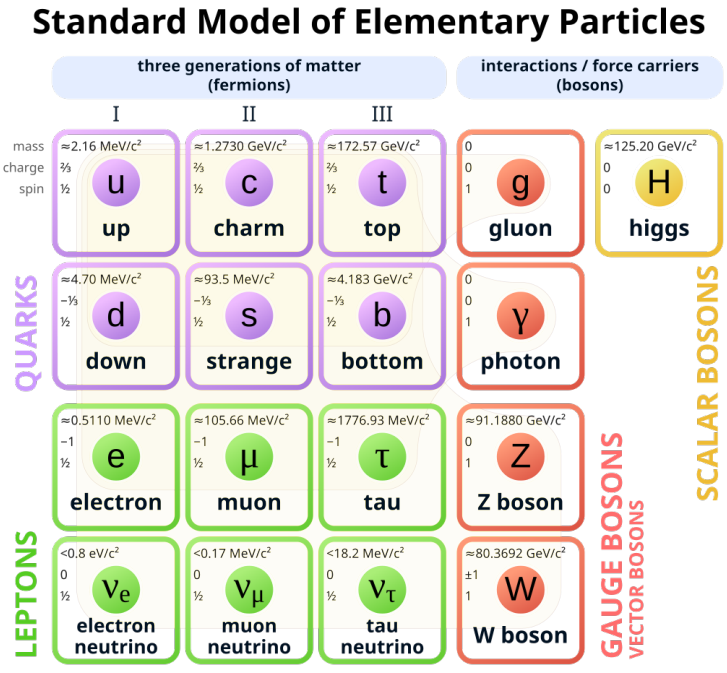

Figure 1.2. The twelve fundamental fermions and five fundamental bosons of the Standard Model of Particle Physics [2]. Each particle is uniquely defined by its mass, charge and intrinsic spin.

1.1.1. Standard Model Particles and their Interactions

Muons and neutrinos

The μ and ν_μ in the final state of $B^+ \to \mu^+\nu_\mu$ are a pair of matter particles referred to as *leptons*. As seen in Figure 1.2, there are six leptons in SM, occurring in three generations of pairs between a neutral and a charged lepton.

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Chapter 2.

The Belle II Experiment

In Chapter 2, blah blah blah

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2.1. The Belle II physics program

2.1.1. Origins

Belle II is a high-energy physics experiment located at the SuperKEKB collider in Tsukuba, Japan. SuperKEKB is an asymmetric energy electron-positron collider, operating at a centre-of-mass energy equivalent to the $\Upsilon(4S)$ resonance i.e. $\sqrt{s}$ =10.58 GeV.

2.2. Summary

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Appendix A.

Appendix 1

A.1. Section 1

Bibliography

[1] E. Tiesinga, P. J. Mohr, D. B. Newell and B. N. Taylor, *CODATA recommended values of the fundamental physical constants: 2018*, *Reviews of Modern Physics* **93** (2021) 025010. 1

[2] Wikimedia Commons, *Standard Model of Elementary Particles*, 2024. 1.2