MONASH University

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MASTERS THESIS

The Search for Axion Like Particles (ALPs) Through B Meson Decays at the LHCb

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Date

Abstract

Acknowledgements

Contents

1 Background and Motivation **4**
- 1.1 Synopsis of the Standard Model . . . 4
- 1.2 The Strong CP Problem . . . 4
  - 1.2.1 Axions . . . 4
  - 1.2.2 Experimental Searches for Axions . . . 4
  - 1.2.3 Axion Like Particles (ALPs) . . . 4
  - 1.2.4 The $B \to K^* A, A \to \gamma\gamma$ Decay Process . . . 4

2 The LHCb Detector **5**
- 2.1 Structure of the LHCb Detector . . . 5
  - 2.1.1 Vertex Locator (VELO) . . . 5
  - 2.1.2 Ring Imaging Cherenkov (RICH) Detector . . . 5
  - 2.1.3 Magnet . . . 5
  - 2.1.4 Calorimeters . . . 5
- 2.2 Data Analysis at the LHCb . . . 5
  - 2.2.1 The LHCb Data Flow . . . 5

3 Experimental Methods **6**

4 Results **7**

5 Discussion **8**

Conclusion **9**

References **9**

Chapter 1

Background and Motivation

1.1 Synopsis of the Standard Model

1.2 The Strong CP Problem

The two discrete symmetries that are essential to the motivation of the Strong CP problem are charge conjugation, C, and parity (i.e. an inversion of spatial coordinates), P. While each of these symmetries can be individually violated by various physical phenomena, their combination CP is known to be conserved in both the strong and electromagnetic interactions, whilst being violated by weak interactions. The strong CP problem arises from the theory pertaining to QCD, which permits such a violation. Despite this, however, such a process has not been experimentally observed. One can examine the QCD Lagrangian in Equation 1.1 below, which has been written to include the CP violating terms

$$\mathcal{L}_{QCD} = -\frac{1}{4}G_{\mu\nu}G^{\mu\nu} - \frac{g_s^2\theta}{32\pi^2}G_{\mu\nu}\tilde{G}^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - me^{i\theta'\gamma_5})\psi \tag{1.1}$$

The terms

1.2.1 Axions

1.2.2 Experimental Searches for Axions

1.2.3 Axion Like Particles (ALPs)

1.2.4 The $B \to K^* A, A \to \gamma\gamma$ Decay Process

Chapter 2

The LHCb Detector

2.1 Structure of the LHCb Detector

2.1.1 Vertex Locator (VELO)

2.1.2 Ring Imaging Cherenkov (RICH) Detector

2.1.3 Magnet

2.1.4 Calorimeters

HCAL

HCAL is awesome

ECAL

ECAL is even more awesome

2.2 Data Analysis at the LHCb

2.2.1 The LHCb Data Flow

Chapter 3

Experimental Methods

Chapter 4

Results

Chapter 5

Discussion

Conclusion