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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Abstract

Acknowledgements

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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 **??** 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 θ is CP violating

1.2.1 Axions

1.2.2 Experimental Searches for Axions

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

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Chapter 2

The LHCb Detector

The LHCb detector is a flavour physics experiment at the Large Hadron Collider (LHC) that aims to reconstruct particles consisting of c and b quarks. It is dedicated to precision measurements of CP violation and rare decays of the aforementioned b hadrons.

2.1 Structure of the LHCb Detector

The LHCb is a single-arm spectrometer with a forward angular coverage from approximately 300 (250) mrad in the bending (non-bending) plane

Chapter 3

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