School of Physics and Astronomy/Astrophysics

MASTERS THESIS

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

Subrahmanya Saicharan Pemmaraju
ID: ...

Supervised by: Prof.Ulrik Egede

Date

Abstract

Acknowledgements

Contents

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 θ is CP violating

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

1.3 Flavour Changing Neutral Currents

1.4 Electroweak Penguin Decays

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. The detector is designed

2.1.1 Vertex Locator (VELO)

2.1.2 Ring Imaging Cherenkov (RICH) Detector

2.1.3 Magnet

A dipole magnet is used to measure the momentum of charged particles by exploiting the curvature of their trajectories in the presence of a magnetic field. The measurement covers the forward acceptance of $\pm$ 250 mrad vertically and of $\pm$300 mrad horizontally. The magnet possesses an integrated magnetic field of 4 Tm for tracks of 10 m length, and is designed to accomodate the varying requirements of the magnetic field, ranging from 2 mT within the RICH envelope, and a maximum value in the regions between the Vertex Locator and the Trigger Tracker tracking station.

The magnet possesses saddle-shaped coils in a window frame yoke with sloping poles in order to match the required detector acceptance

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

2.2.2 Software Overview

2.2.3 The LHCb Simulation Framework

Chapter 3

Experimental Methods

Chapter 4

Results

Chapter 5

Discussion

Conclusion