

Understanding the $K\pi$ spectrum of $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ at LHCb

Alex Shires

High Energy Physics
Blackett Laboratory
Imperial College London

A thesis submitted to Imperial College London
for the degree of Doctor of Philosophy

July 2012

Contents

| | | |
|----------|---|----------|
| 1 | Introduction | 4 |
| 2 | The standard model of particle physics | 5 |
| 3 | The LHCb detector | 6 |
| 3.1 | Intro | 6 |
| 3.2 | subdetectors | 6 |
| 3.3 | Trigger | 6 |
| 4 | Theoretical formulism of $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ | 7 |
| 4.1 | Angular distribution | 7 |
| 4.2 | Matrix elements | 7 |
| 4.3 | Angular observables | 7 |
| 4.4 | higher K_J^{*0} states | 7 |
| 5 | The acceptance correction for $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ at LHCb | 8 |
| 5.1 | acceptance correction intro | 8 |
| 5.2 | Monte CARlo simulations | 8 |
| 5.2.1 | Data-Simulation corrections | 8 |
| 5.3 | A full 4D acceptance correction | 8 |
| 5.3.1 | algorithm | 8 |
| 5.3.2 | validation | 8 |
| 5.3.3 | results | 8 |
| 5.4 | A factorised acceptance correction | 8 |
| 5.4.1 | algorithm | 8 |
| 5.4.2 | validation | 8 |
| 5.4.3 | results | 8 |
| 6 | The S-wave in $B^0 \rightarrow K^+ \pi^- \mu^+ \mu^-$ | 9 |
| 6.1 | The effect of an S-wave on the nagular analysis of $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ | 9 |
| 6.1.1 | theory | 9 |
| 6.1.2 | effect from toy simulations | 9 |
| 6.1.3 | effect on data | 9 |
| 6.2 | Measuring the S-wave in $B^0 \rightarrow K^+ \pi^- \mu^+ \mu^-$ | 9 |
| 6.2.1 | theory | 9 |
| 6.2.2 | measurement expected from toy simulations | 9 |
| 6.2.3 | measurement on data | 9 |

| | | |
|----------|--|-----------|
| 7 | Measuring the D-wave in $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ | 10 |
| 7.1 | angular distribution | 10 |
| 7.2 | angular observables | 10 |
| 7.3 | acceptance correction | 10 |
| 7.4 | Angular fits | 10 |
| 7.4.1 | no $m_{K\pi}$ | 10 |
| 7.4.2 | with $m_{K\pi}$ | 10 |
| 7.5 | Results | 10 |
| 7.6 | conclusion | 10 |
| | Bibliography | 11 |

Chapter 1

Introduction

Processes which contain a $b \rightarrow s$ transition are popular FCNC decays for tests of contributions from new physics [1]

Chapter 2

The standard model of particle physics

Chapter 3

The LHCb detector

3.1 Intro

3.2 subdetectors

3.3 Trigger

Chapter 4

Theoretical formulism of $B^0 \rightarrow K^{*0} \mu^+ \mu^-$

4.1 Angular distribution

4.2 Matrix elements

4.3 Angular observables

4.4 higher K_J^{*0} states

Chapter 5

The acceptance correction for $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ at LHCb

5.1 acceptance correction intro

5.2 Monte CARlo simulations

5.2.1 Data-Simulation corrections

5.3 A full 4D acceptance correction

5.3.1 algorithm

5.3.2 validation

5.3.3 results

5.4 A factorised acceptance correction

5.4.1 algorithm

5.4.2 validation

5.4.3 results

Chapter 6

The S-wave in $B^0 \rightarrow K^+ \pi^- \mu^+ \mu^-$

6.1 The effect of an S-wave on the nagular analysis of $B^0 \rightarrow K^{*0} \mu^+ \mu^-$

6.1.1 theory

6.1.2 effect from toy simulations

6.1.3 effect on data

6.2 Measuring the S-wave in $B^0 \rightarrow K^+ \pi^- \mu^+ \mu^-$

6.2.1 theory

6.2.2 measurement expected from toy simulations

6.2.3 measurement on data

Chapter 7

Measuring the D-wave in $B^0 \rightarrow K^{*0} \mu^+ \mu^-$

- 7.1 angular distribution
- 7.2 angular observables
- 7.3 acceptance correction
- 7.4 Angular fits
 - 7.4.1 no $m_{K\pi}$
 - 7.4.2 with $m_{K\pi}$
- 7.5 Results
- 7.6 conclusion

Bibliography

- [1] D. Melikhov, N. Nikitin, and S. Simula, *Probing right-handed currents in $B^0 \rightarrow K^* \ell^+ \ell^-$ transitions*, Phys.Lett. **B442** (1998) 381, [arXiv:hep-ph/9807464](#).