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Charged Charmless $B_u \rightarrow hhh$ decays

This is a first attempt to create and keep a webpage with all information about the $B_u 2hhh$ analysis. Here can be found presentations in various LHCb meetings and conferences. Note and some important papers can also be found here.

Overview

In the recent past, the B factories have confirmed that the Cabibbo-Kobayashi-Maskawa (CKM) matrix dynamic is the main responsible for the CP violation observed so far. More precisely, any asymmetry observed in charge conjugated B decays can be interpreted as a manifestation of the CKM phases. In the two body scenario, direct CP asymmetry was established by experiments Belle and BaBar.

Although in the three body B meson decay no CP asymmetry has been established, the Belle and BaBar collaboration claim to have seen evidence of direct CP violation but they are unable to confirm this result due to lack of statistics. In this sense, the LHCb experiment has potential to confirm and establish if there is or not CP violation in three body B meson decays.

Some of the most interesting ways for LHCb to detect CP violation is through a Dalitz Plot analysis. From a Dalitz Plot, one can obtain important information about the decay like presence of strong resonances and consequently their width and angular distribution. Even more, some regions of the Dalitz Plot can reveal a constructive or destructive interference between two neighboring resonances. Hence, the comparison of Dalitz Plot surfaces of two charge conjugated B meson is one of the most sensible methods to detect CP violation.

A direct and model independent way to measure the difference between two Dalitz surfaces is the Dalitz Plot Anisotropy or the Mirandize method. This method consists in evaluate the anisotropy by taking into account the bin content of each surface. The main feature of this method is its applicability when dealing with small statistics already in the first year of data taken.

However, to provide a quantitative measurement of the CP violation, a full Dalitz Plot analysis is needed. For instance, the CKM phase Γ can be directly extracted from the $B_u \rightarrow K \pi \pi$ decay. Based on the SU(2) flavor symmetry, the $B_u \rightarrow K^* \pi$ penguin parameters can be used in the B_0 and B_0 bar joint fit to measure the tree phase, from which Γ is obtained. The method is based on the ability to measure independently the relative amplitudes and phases for B_0 and B_0 bar decays in a joint untagged sample.

Also, the search for highly suppressed modes like $B^+ \rightarrow K^- \pi^+ \pi^+$ and $B^+ \rightarrow K^+ K^+ \pi^-$ or some exotic decays violating the baryonic number like $B_u \rightarrow \pi \pi p$ can be included in the LHCb program due to high statistics expected to be produced.

All this prospect makes the $B_u 2hhh$ analysis very promising with rich results expected soon.

Some Experimental Results

Measurement of CP asymmetries in two body decays:

- See <https://twiki.cern.ch/twiki/bin/viewauth/LHCbPhysics/NewCpBhh>

Evidences of CP violation in three body decays:

- BaBar Collaboration $B_u \rightarrow K \pi \pi$: <http://arxiv.org/abs/0803.4451v2> / PRD 78, 012004 (2008)
- Belle Collaboration $B_u \rightarrow K \pi \pi$: <http://arxiv.org/abs/hep-ex/0512066v2> / PRL 96, 251803 (2006)

Dalitz Plot analysis in three body decays:

Charged Charmless $B_u \rightarrow hhh$ decays

- BaBar Collaboration Bu -> pi pi pi: <http://arxiv.org/abs/0902.2051v2> / PRD 79, 072006 (2009)
- Belle Collaboration Bu -> K h h: <http://arxiv.org/abs/hep-ex/0510059v1>
- BaBar Collaboration Bu -> K K pi: <http://arxiv.org/abs/0708.0376v3> / PRL 99, 221801 (2007)
- BaBar Collaboration Bu -> K K K: <http://arxiv.org/abs/hep-ex/0605003v1> / PRD 74, 032003 (2006)
- Belle Collaboration Bu -> p p pi and Bu -> p p K: <http://arxiv.org/abs/0706.4167v3> / PLB 659, 80-86 (2008)

Rare decays:

- Belle Collaboration: <http://arxiv.org/abs/hep-ex/0202017v1> / PRL 88, 181803 (2002)
- BaBar Collaboration: <http://arxiv.org/abs/0808.0900v2> / PRD 78, 091102 (2008)

Some Methods for CP Violation Detection/Measurement:

- Mirandize Method: <http://arxiv.org/abs/0905.4233v3> / PRD 80, 096006 (2009)
- Gamma Measurement: <http://arxiv.org/abs/hep-ph/0703131v1> / PRD 76, 073011 (2007)

LHCb Activities

Recent Presentations on Bu -> hhh:

- CPWG Gamma With Loops Oct/2009: <http://indico.cern.ch/conferenceDisplay.py?confId=61840>
- Stripping Workshop Dec/2009: <http://indico.cern.ch/conferenceDisplay.py?confId=76164>
- CPWG Gamma With Loops Jan/2010: <http://indico.cern.ch/conferenceDisplay.py?confId=77034>
- CPWG Gamma With Loops Mar/2010: <http://indico.cern.ch/conferenceDisplay.py?confId=77079>
- CPWG Gamma With Loops Apr/2010: <http://indico.cern.ch/conferenceDisplay.py?confId=77080>
- CPWG Gamma With Loops May/2010: <http://indico.cern.ch/conferenceDisplay.py?confId=77081>
- CPWG Gamma With Loops Jun/2010: <http://indico.cern.ch/conferenceDisplay.py?confId=77082>

Bu -> hhh Internal Note

- Available here: <http://www.cbpf.br/~alvaro>

Configuration for Real Data Plots

- All cuts and trigger lines used to produced Bu -> hhh real data plots can be found here: <http://www.cbpf.br/~alvaro> under the Slide hhh link.

-- AlvaroGomesDosSantosNeto - 28-May-2010

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