HEPP-CPV-project

John Ronayne (10318997), Kevin Maguire (10318135), Sinead Hales(10318221), Dudley Grant (10275291)
(Dated: November 17, 2013)

I. INTRODUCTION

Short intro here

II. $\hat{P}$, $\hat{C}$ AND $\hat{C}\hat{P}\hat{T}$

III. CP VIOLATION

CP violation was first observed in the mixing of neutral K-mesons by Christenson, Cronin, Fitch and Turlay in 1964 [1]. They observed the $\hat{C}\hat{P} = -1$ state K_L^0 decaying to 2 pions, a state with $\hat{C}\hat{P} = 1$. Although the fraction of K_L^0 decays violating $\hat{C}\hat{P}$ in this way is tiny, the discovery was significant.

IV. CPV IN D-MESON SYSTEM

The quark constituents of the $D^0(1865)$ and $\bar{D}^0(1865)$ mesons are $(c\bar{u})$ and $(u\bar{c})$, respectively. This system is unique as it is the only system which undergoes mixing and contains an up-type quark. As opposed to the K^0,B^0 and B_S, which contain down quarks. This results in different quarks in the mixing box diagrams of these processes, which are illustrated in Fig.(**??**) and (1). The rates for D^0 mixing are expected to be very small as the mixing process shown is suppressed in two ways. If the intermediate quark is a b, then the decay is doubly Cabbibo suppressed[explain? or has it been explained already?], while if the quark is a d or an s then the process is GIM suppressed[Reference John]. Other processes which may not have the same degree of suppression have been proposed, but there are large incertainties in the theoretical calculations of their decay rates [14].

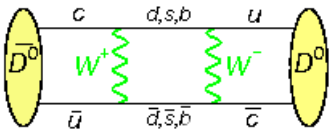

FIG. 1: *Feynmann diagram showing the process by which the two D^0 states mix. This process is the only known mixing process which contain the d,s,b quarks in this position [13]*

The first stage in detecting CPV in any system is to find mixing between a particle and its anti-particle. Clear evidence for mixing between these states was announced in 2007 and published in 2008 by the BaBar collaboration, followed shortly by the Belle collaboration [11][12]. Results from both experiments show a small amount of D^0 mixing with 3.9 σ certainty, at a level of 1%, which is consistent with SM predictions in the order of $\times 10^{-2}$ [14]. However, measured CP violating parameters were consistent with zero, and thus with no CPV. We discuss here the more recent methods and measurements for mixing parameters.

As in the case of Kaon and B-meson mixing we define the CP eigenstates of the D-meson to be linear combinations of flavour eigenstates.

$$|D^0_{1,2}\rangle = p\,|D^0\rangle \pm q\,|\bar{D}^0\rangle$$

Where for normailzation $|p|^2 + |q|^2 = 1$. The $|D_1\rangle$ state is a CP even state while the $|D_2\rangle$ state is a CP odd state. As expected, we will see CPV if $|p|! = |q|$

The two parameters which determine the amount of mixing in a system are defined as:

$$x = \frac{\Delta M}{\Gamma} \qquad\qquad y = \frac{\Delta \Gamma}{2\Gamma}$$

where M is mass and Γ is lieftime and ΔA :

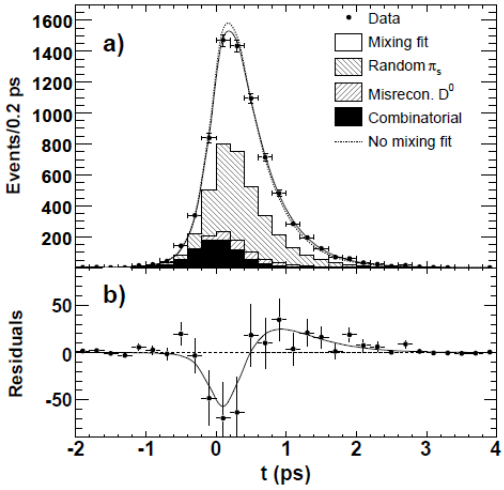

FIG. 2:

Appendix A: Appendix

Difficult calculations in here.

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