

“Study of $B^\pm \rightarrow DK^\pm, D \rightarrow K_S K^\pm \pi^\mp$ for the measurement of CP-violating angle ϕ_3 , and $D^{*\pm} \rightarrow D\pi^\pm, D \rightarrow K_S K^\pm \pi^\mp$ for the modeling of $D \rightarrow K_S K^\pm \pi^\mp$ Dalitz plane



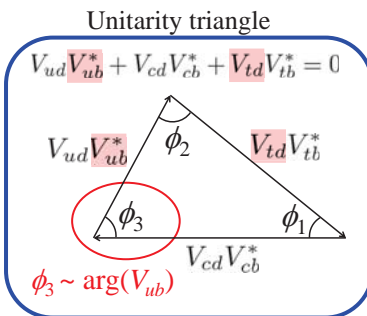
1. Motivation & Theory

CKM (Cabibbo-Kobayashi-Maskawa) Matrix

$$V = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1 - \frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1 - \frac{\lambda^2}{2} & A\lambda^2 \\ A\lambda^3(1 - \rho - i\eta) & -A\lambda^2 & 1 \end{pmatrix} + \mathcal{O}(\lambda^4)$$

$\lambda = \sin \theta_c \sim 0.22$

Unitarity $VV^\dagger = 1$



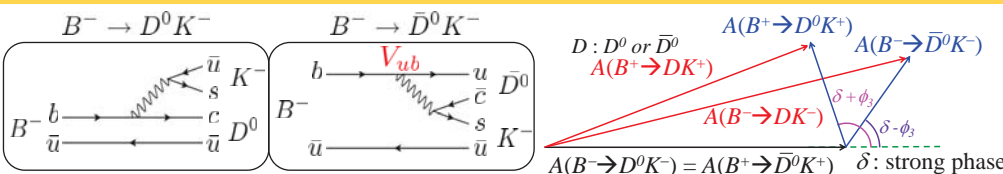
Unitarity triangle is described on complex plane, and represents CP-violation. To understand CP-violation, the angles of this triangle should be measured precisely.

Present limits for each angle

$$\begin{aligned} \phi_1 &= 21.15^\circ \begin{matrix} +0.90^\circ \\ -0.88^\circ \end{matrix} \\ \phi_2 &= 89.0^\circ \begin{matrix} +4.4^\circ \\ -4.2^\circ \end{matrix} \\ \phi_3 &= 68^\circ \begin{matrix} +13^\circ \\ -14^\circ \end{matrix} \end{aligned}$$

The measurement accuracy of ϕ_3 is not so good, and should be improved.

ϕ_3 can be measured by examining the asymmetry between $B^- \rightarrow DK^-$ and $B^+ \rightarrow DK^+$ decays. Among the various B^\pm decays, B^\pm meson which decays to neutral D meson (D^0 or \bar{D}^0) and K^\pm meson is used for ϕ_3 measurement.

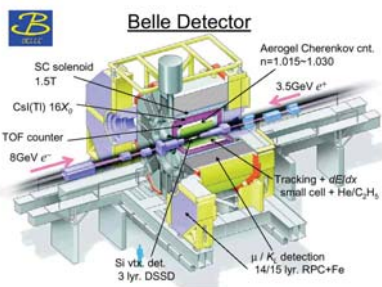


D^0 and \bar{D}^0 can decay to the same final states. Therefore $B^- \rightarrow D^0 K^-$ and $B^- \rightarrow \bar{D}^0 K^-$ decay amplitudes interfere each other. The interfering between D^0 and \bar{D}^0 is used to measure ϕ_3 .

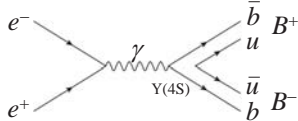
2. Facility KEKB-factory & Belle Detector



KEK@Tukuba



- KEKB-factory is a facility to make B particles.
- High energy electrons and positrons collide, and annihilate in pairs.
- From the pair annihilation, heavy B mesons are generated.

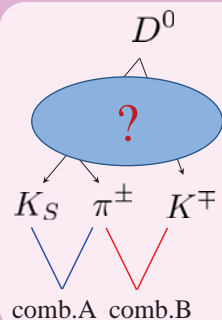


- Belle detector is to search the decays of B particles.
- Belle detector consists of many sub-detectors, and determines the particle type, momentum, charge, and so on.
- The mother particles are reconstructed from detected particles.
- The world largest data of 1014 fb^{-1} had been recorded.

3. Analysis

- Neutral D particles decay to various particles. In this study, $D \rightarrow [K_S K^\pm \pi^\mp]$ decay is searched.
- There are 2 modes in $D \rightarrow K_S K^\pm \pi^\mp$ decays: $D^0 \rightarrow K_S K^- \pi^+$, $D^0 \rightarrow K_S K^+ \pi^-$ and their charge conjugate mode, because both D^0 and \bar{D}^0 can decay into $K_S K^- \pi^+$ and $K_S K^+ \pi^-$.
- D decays into $K_S K \pi$ via many intermediate processes (e.g. $D \rightarrow [K_S \pi^\pm]_{K^*} K^\mp, D \rightarrow [K^- \pi^+]_{K^*} K_S, \dots$ etc.).
- These processes should be separated because strong phases differ. The Dalitz plot analysis is needed.
- $D^0 \rightarrow K_S K^- \pi^+$ cannot be distinguished from $\bar{D}^0 \rightarrow K_S K^- \pi^+$ in $B^\pm \rightarrow DK^\pm$, however, the information of each Dalitz plot is needed to fit $B^\pm \rightarrow DK^\pm, D \rightarrow K_S K^\pm \pi^\mp$ Dalitz plot.
- Therefore, $D^{*\pm} \rightarrow D\pi^\pm, D \rightarrow K_S K^\pm \pi^\mp$ decay which has large statistics and can be distinguished between D^0 and \bar{D}^0 using the charge of $D^{*\pm}$ is studied to model the Dalitz distribution of $D \rightarrow K_S K^\pm \pi^\mp$ decay.

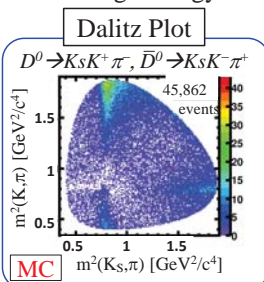
$D^{*\pm} \rightarrow D\pi^\pm, D \rightarrow K_S K^\pm \pi^\mp$: Dalitz analysis



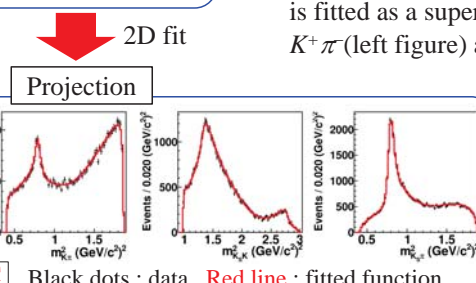
When D decays into 2 particles, and one of them decays furthermore into 2 particles, the reconstructed mass of the correct pair combination yields a mass of a certain particle.

Therefore to verify intermediate states, the plot of combination A versus combination B is used. This is the so called Dalitz plot which is used to extract the value of ϕ_3 .

Dalitz plot is fitted as a superposition of some resonances. The fitting strategy has been confirming using Monte Carlo simulation.



- To fit the Dalitz plot, the effects of the background, efficiency, and resolution have been studying.
- Especially, it was understood that the resolution affect the fitting result contrary to expectation.
- The Dalitz plot of $B \rightarrow DK, D \rightarrow K_S K \pi$ is fitted as a superposition of $D^0 \rightarrow K_S K^- \pi^+$ and $D^0 \rightarrow K_S K^+ \pi^-$.



The fitting method is been established, and the fitting using the real data is being prepared.

4. Summary and Plan

- The precise measurement for ϕ_3 is important in terms of verification for CP-violation.
- $B \rightarrow DK$ decay is used for the measurement of ϕ_3 .
- Among the various D decays, we use $D \rightarrow K_S K^\pm \pi^\mp$ with Dalitz plot.
- To make the model of $D \rightarrow K_S K^\pm \pi^\mp$ decay, $D^{*\pm} \rightarrow D\pi^\pm, D \rightarrow K_S K^\pm \pi^\mp$ is analyzing. The fitting strategy has been confirming.
- Of course, the final purpose is the measurement of ϕ_3 using $B^\pm \rightarrow DK^\pm, D \rightarrow K_S K^\pm \pi^\mp$.