Time dependent Dalitz plot analysis of charmless B0 decays

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- B ($\overline{B}$) mesons: mesons composed of a $\overline{b}$ (b) quark
- Neutral B mesons: $B^0 = \overline{b}d$ or $B_s^0 = \overline{b}s$
- Of interest in this work: charmless decays FCNC

- $B_d^0 \to K_s^0 \pi^+ \pi^-$
- $B_d^0 \to K_s^0 K^+ K^-$
- $B_d^0 \to K_s^0 K^+ \pi^-$
- $B_s^0 \to K_s^0 K^+ K^-$
- $B_s^0 \to K_s^0 K^+ \pi^-$
- $B_s^0 \to K_s^0 \pi^+ \pi^-$

- There is mixing between B^0 mesons and its antiparticle $\overline{B^0}$ via box diagrams

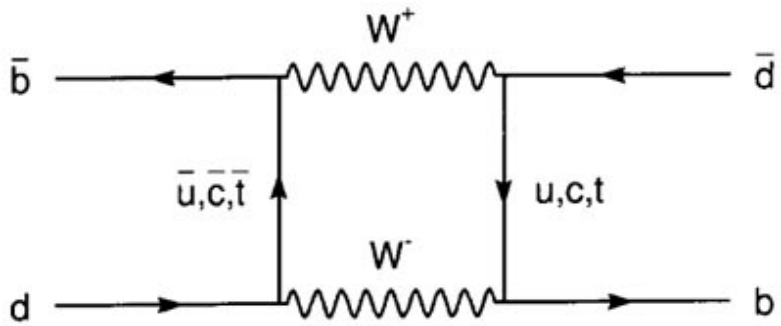

Figure: B mixing box diagram

- mass eigenstates $\neq$ flavour eigenstates
- $|B_L\rangle = p\left|B^0\right\rangle + q\left|\overline{B^0}\right\rangle$; $|B_H\rangle = p\left|B^0\right\rangle - q\left|\overline{B^0}\right\rangle$
- Time evolution: $i\frac{\partial}{\partial t}\begin{pmatrix} p \\ q \end{pmatrix} = \mathcal{H}_{eff}\begin{pmatrix} p \\ q \end{pmatrix}$
- $\mathcal{H}_{eff} = M - i\frac{\Gamma}{2}$

- CP violation: Parity (P) and Charge conjugation (C) symmetries breaking by weak interaction
- In SM: comes from a non vanishing phase in CKM matrix

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix} \equiv \hat{V}_{\mathrm{CKM}} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

Figure: CKM matrix

- B unitarity triangle : less degenerate $\rightarrow$ sector of choice to study CPV

- In decays: three types of CP violation
- Direct violation in decay between $B^0 \to f$ and $\overline{B^0} \to \overline{f}$
- Violation in mixing between $B^0 \to \overline{B^0} \to \overline{f}$ and $\overline{B^0} \to B^0 \to f$
- Mixing induced violation: between direct and with mixing modes

- In order to measure CKM matrix parameters and CP violation observables it is necessary to determine the signal probability density function. It will be done using the Dalitz Plot formalism
- allow to reduce a three-bodies decay to only two kinematic parameters: the center of mass squared of two pairs of daughter particles (ie $K^0\pi^+$and $K^0\pi^-$)

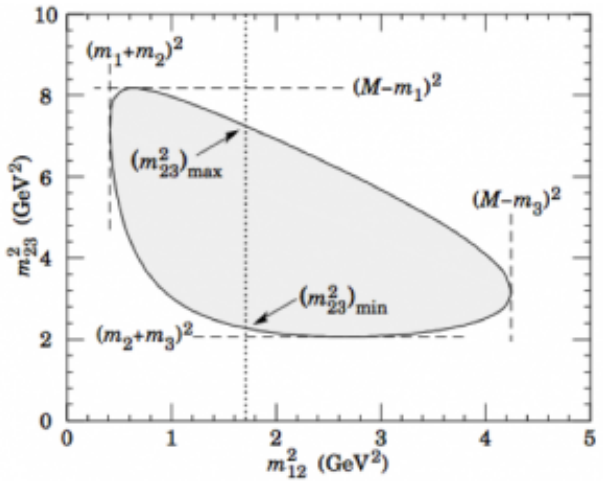

Figure: example of dalitz plot

- With those definitions, the partial decay rate is written as :

$$d\Gamma = \frac{1}{(2\pi)^3} \frac{|\mathcal{A}|^2}{32 m_{B^0}} dm_{12} dm_{23}$$

- $\mathcal{A}$ is the decay amplitude of the B^0 decay mode
- $\mathcal{A}$ is calculated in the isobar approximation in which the total amplitude is written as the sum of intermediate decay channels

- This kind of experiments has already been done in the B-factories BELLE and BaBar
- Our goal is to use the LHCb data sets to conduct the same kind of experiment
- Improved precision on parameters due to better background identification
- wider B energy spectrum $\rightarrow$ more phenomenons (intermediate resonances) to account for $\rightarrow$ better model
- Time dependence requires tagging, lhcb efficiency much lower than the B factories (30% against 5%)