

Recap:

* Effective Hamiltonians at work: K physics

- $\Delta I = \frac{1}{2}$ rule
 Watson theorem
 QCD corrections
 penguins
 negative interference

- E_K Meson-antimeson mixing $\frac{q}{p} = \sqrt{\frac{P_{21}}{P_{12}}} = \frac{2M_{12}^* - i\Gamma_{12}^*}{\Delta M - \frac{i}{2}\Delta\Gamma}$

$$|B_{H,L}\rangle = p|B^0\rangle \pm q|\bar{B}^0\rangle$$

$$\langle B_H | B_L \rangle = \delta = |p|^2 - |q|^2 = \frac{1 - |q/p|^2}{1 + |q/p|^2} = 0 \text{ if CP conserved}$$

Kaon case: $\Delta\Gamma \approx 2\Delta M_K$ & $P_{12} \approx A_0^* A_0$

$$E_K \approx \frac{1 - \lambda_0}{1 + \lambda_0} \approx \frac{e^{-i\frac{\pi}{2}}}{2\Delta M_K} \ln M_{12}$$

- tree-level CKM: $|V_{us}|, |V_{cb}|, |V_{ub}|, \gamma \Rightarrow$ prediction for E_K

* D-D mixing

with respect to KK mixing, $t \rightarrow b$ and $c \rightarrow s$

in K mixing, CP conserving mixing from u and c , CPV from t and b

in D mixing, bottom contribution down by $\frac{m_c^2}{m_b^2} \sim 10^{-3}$

\Rightarrow approx. Two-family \Rightarrow no CPV

GIM \Leftrightarrow SU(3) (U-spin) everything LD

\Rightarrow search for NP in ~~CPV~~ δ

* B-B mixing

$$|P_{12}| < |M_{12}|$$

$$\Delta M_B = 2|M_{12}|$$

$$\frac{\Delta\Gamma}{\Delta M} = \text{Re} \frac{P_{12}}{M_{12}}$$

$$\frac{q}{p} = -\frac{M_{12}^*}{M_{12}} \left(1 - \frac{1}{2} \ln \frac{P_{12}}{M_{12}}\right)$$

$$\left|\frac{q}{p}\right| - 1 = \frac{1}{2} \ln \frac{P_{12}}{M_{12}}$$

Now: can estimate P_{12} !

* CPV in mixing

* Time-dependent CP asymmetries

* UTA

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We need M_{12} and $\frac{P_{12}}{M_{12}}$ for B_d and B_s mesons.

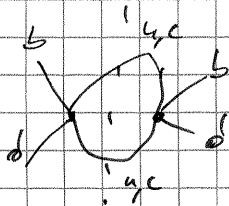
B_d :

M_{12} is easy: $-\frac{G_F^2 M_W^2}{4\pi^2} S_0(x_t) \eta_b \cdot M_B f_B^2 B_B (V_{cb}^* V_{cd})^2$

so that $\left(\frac{q_1}{P_d} = -\frac{(V_{cb} V_{cd}^*)^2}{|V_{cb} V_{cd}^*|^2} \left(1 - \frac{1}{2} \ln \frac{P_{12}}{M_{12}}\right) \right) = -\frac{V_{cb} V_{cd}^*}{V_{cb}^* V_{cd}} \left(1 - \frac{1}{2} \ln \frac{P_{12}}{M_{12}}\right)$

~~For B_s mixing we have~~

~~what about P_{12} ?~~

$P_{12} = \sum_n \langle \bar{B}^0 | H_{\Delta B=1} | n \rangle \langle n | H_{\Delta B=1} | B^0 \rangle =$ 

~~in the $m_b \rightarrow \infty$ limit this object becomes local~~

so that we obtain $P_{12} = -\frac{G_F^2 M_b^2}{2\pi^2 \eta_B} \left(C_1(\mu) \langle \bar{B} | Q_1(\mu) | B \rangle + C_2(\mu) \langle \bar{B} | Q_2 | B \rangle + \mathcal{O}(1/m_b) \right)$

$C_i = (V_{cb}^* V_{cd})^2 D_i^{uu} + 2 V_{cb}^* V_{cd} V_{cb}^* V_{cd} (D_i^{uu} - D_i^{cc}) + (V_{cb}^* V_{cd})^2 (D_i^{cc} + D_i^{uu} - 2D_i^{cu})$

then, $\frac{P_{12}}{M_{12}} = \frac{4\pi M_b^2}{3M_W^2 \eta_B S_0(x_t) \langle \bar{B} | Q_1 | B \rangle} \sum_{i=1,2} \left(D_i^{uu} + 2 \frac{V_{cb}^* V_{cd}}{V_{cb}^* V_{cd}} (D_i^{uu} - D_i^{cc}) + \frac{(V_{cb}^* V_{cd})^2}{(V_{cb}^* V_{cd})^2} \right)$

$(D_i^{cc} + D_i^{uu} - 2D_i^{cu}) \langle \bar{B} | Q_i | B \rangle = \frac{4\pi M_b^2}{3M_W^2 \eta_B S_0(x_t) \langle \bar{B} | Q_1 | B \rangle} \sum_{i=1,2} \langle \bar{B} | Q_i | B \rangle$

$\left(D_i^{uu} - 2 \frac{e^{i\beta}}{r_t} + \frac{e^{2i\beta}}{r_t^2} \right) \Rightarrow \frac{\Delta P_d}{P_d} = (5.3 \pm 0.7) 10^{-3}$
 $\frac{\Delta P_s}{P_s} = (0.16 \pm 0.02)$
 $A_d^{SL} = (3.1 \pm 0.9) 10^{-4}$
 $A_{d}^{CP} = (-5 \pm 50) 10^{-4}$
 $A_s^{SL} = (1.3 \pm 0.4) 10^{-5}$
 $A_s^{CP} = (-2.3 \pm 0.3) 10^{-3}$