Exercise for Colours and Flavours and their consequences Autumn 2019: lecture 8/9/10

Mixing

Derive the formula for ϵ, p and q from the Hamiltonian

$$H = \begin{pmatrix} M & M_{12} \\ M_{12}^* & M \end{pmatrix} - \frac{i}{2} \begin{pmatrix} \Gamma & \Gamma_{12} \\ \Gamma_{12}^* & \Gamma \end{pmatrix}$$

Remember that M, Γ are real and Γ_{12}, Γ_{12} are complex.

Think about how you would measure the differences in the diagonal elements to check if CPT is conserved.

Nonleptonic decays

Interferences

Derive the formula for the Golden decay $B \to \psi K_S$

$$\frac{\overline{A}}{A} = \eta_{\psi K_S} \frac{V_{cb} V_{cs}^*}{V_{cs} V_{cb}^*} \left(\frac{p}{q} \right)_K$$

The last factor is due to the mixing of K^0 and $\overline{K}^0$ to K_S.

Argue for the above from the interfernce long formula and then look at the various tree level contributions to the b and $\bar{b}$ decays.

Penguins and physics

Why did the experiments work very hard to obtain the $b \to s\gamma^*$ decays why not very much effort went into $b \to d\gamma^*$.

Hint: Look at the CKM matrix elements and think wether there might be other contributions that might be larger.

An reading an experimental paper exercise

Try to understand the measurements in the LHCb paper arXiv:1805.06759.