CP Violation in Heavy Flavour Physics	**CPV measurements**
Tutorial 2	May 2018

1. Calculate the e-values of the Hamiltonian matrix describing two state system of decaying kaons. Hint: use the partially finished calculation shown during the lecture.
2. Check by direct substitution that the following time dependent states:

$$|K_S^0(t)\rangle = e^{-\frac{i}{\hbar}\left(m_S - \frac{i}{2}\gamma_S\right)t}|K_S^0\rangle$$

$$|K_L^0(t)\rangle = e^{-\frac{i}{\hbar}\left(m_L - \frac{i}{2}\gamma_L\right)t}|K_L^0\rangle$$

are indeed solutions of the effective Schrodinger equation describing two state kaon system:

$$i\hbar\frac{\partial|\psi(t)\rangle}{\partial t} = \mathcal{H}_{eff}|\psi(t)\rangle$$

3. Find the time dependent probability of the transition of a kaon into an anti-kaon particle:

$$P(\overline{K}^0, t) = |\langle\overline{K}^0|K^0(t)\rangle|^2$$

4. Neutral meson P^0 and its antiparticle $\overline{P^0}$ decays to the same final state f. Calculate:
   a) the decay rates

$$\Gamma_f = |\langle f|H|P^0(t)\rangle|^2 \text{ and } \bar{\Gamma}_f = \left|\langle f\left|H\right|\overline{P^0}(t)\rangle\right|^2$$

   b) the CP asymmetry of the form:

$$a_{CP}(t) = \frac{\Gamma_f - \bar{\Gamma}_f}{\Gamma_f + \bar{\Gamma}_f}$$

5. Show that CP asymmetry for the channel $B^0 \to J/\psi K_S$ ("golden channel") can be used to extract unitary angle β. Start with the asymmetry:

$$a_{CP}(t) = \frac{\Gamma(B^0 \to J/\psi K_S) - \Gamma(\overline{B^0} \to J/\psi K_S)}{\Gamma(B^0 \to J/\psi K_S) + \Gamma(\overline{B^0} \to J/\psi K_S)}$$

6. Write the equation describing the direct CPV in charged B-meson decay, for example $B^0 \to K^+\pi^-$.
7. Determine the sensitivity of CKM γ angle measurement in $B^0 \to D^0K^{*0}$ decay.