CP Violation in Heavy Flavour Physics	**CPV measurements**
Tutorial 2	2021

1. Find the time dependent probability of the transition of a kaon into an anti-kaon particle when CP is conserved and violated. Choose one out of four possibilities of the form:

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

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. Calculate the e-values and e- states of the Hamiltonian matrix describing two state system of decaying kaons. Hint: use the partially finished calculation shown during the lecture.

4. What is the interpretation of off-diagonal elements of the Hamiltonian matrix.

5. (Lecture cont.) Discuss in detail Dirac equations and their solutions for particles and anti-particles considering the interaction term with the electromagnetic field, i.e., by substituting the 4-derivative with covariant 4-derivative: $i\partial_\mu \rightarrow i\partial_\mu - qA_\mu$, where A_μ is the 4-potential. Next, show, using the explicit calculation, how spinors behave w.r.t. the P- and C-parity operators.

6. Check the respective properties of (S), (P), (V) and (A) bi-linear forms under P- and C-parity operators.

7. Show that only by using a mixed (V)-(A) bi-linear form we are able to obtain matrix elements that breaks maximally P- and C-parities.