

## Exercises for Lattice Flavour Physics

1. In today's lecture we considered  $K_{\ell 3}$  ( $K \rightarrow \pi \ell \bar{\nu}_\ell$ ) semileptonic decays, where  $\ell$  is a lepton. Consider instead semileptonic  $D$ -decays ( $D^+ = c\bar{d}$ ,  $D^0 = c\bar{u}$ ).

1. Identify the possible semileptonic decays of the  $D^+$  and  $D^0$  mesons and draw the corresponding quark-flow diagrams.
2. Which CKM matrix-elements can be determined from semileptonic decays of the D-mesons?
3. Let  $q$  be the momentum transfer to the lepton pair. What is the maximum possible value of  $q^2$  in each decay?
4. Look at the website of the "Particle Data Group" (PDG) to determine the branching fractions of the decays which you have identified. Check that you have indeed identified all the decays.

2. Consider the decay of a scalar particle of mass  $M$  into two scalar particles, one with mass  $m$  and the other with zero mass. The amplitude for this decay is  $\lambda$ .

1. Show that the decay width for this decay is

$$\Gamma = \frac{\lambda^2}{16\pi M^3} (M^2 - m^2).$$

2. What are the dimensions of  $\lambda$  and  $\Gamma$ ?