

# FLAVOUR PHYSICS ASSESSMENT

To be returned to Tim Gershon ([T.J.Gershon@warwick.ac.uk](mailto:T.J.Gershon@warwick.ac.uk)) by April 17<sup>th</sup> 2009

Answer the following, each in 100 words or less. (10 marks each)

1. What is the experimental evidence for the existence of exactly three pairs of quarks?
2. Describe the quark content of the three light neutral pseudoscalar mesons ( $\pi^0$ ,  $\eta$ ,  $\eta'$ ), commenting on relevant symmetries.
3. How does the existence of three generations of quarks allow CP violation within the Standard Model?
4. The lightest bottomonia state, the  $\eta_b$ , was discovered in 2008 by BaBar (PRL 101 (2008) 071801). Why was it so hard to discover, considering its (heavier) counterpart, the Y, was discovered in 1977?
5. Why were the first measurements of the B lifetime and of mixing in the B system surprising?

Give brief answers to the following (5 marks each). Use diagrams and calculations as appropriate.

6. What property of the Unitarity Triangle can be measured from the rate of the rare kaon decay  $K_L \rightarrow \pi^0 \nu \bar{\nu}$ ?
7. Estimate the maximum size of direct CP violation in  $D^0 \rightarrow K^+ K^-$  within the Standard Model.
8. The mass differences in the  $B_d$  and  $B_s$  systems are measured to be  $\Delta m_d = (0.511 \pm 0.005 \pm 0.006) \text{ ps}^{-1}$  and  $\Delta m_s = (17.77 \pm 0.10 \pm 0.07) \text{ ps}^{-1}$  respectively. Estimate the ratio of CKM matrix elements  $|V_{td}/V_{ts}|$ .
9. The phase of  $B_s$  oscillations can be measured in  $B_s \rightarrow J/\psi \phi$  decays (in analogy to the measurement of  $\sin(2\beta)$  in  $B_d \rightarrow J/\psi K_S$  decays). Estimate its value within the Standard Model.
10. Why has it not been measured by the B factories?

Finally, in as many words as you like (25 marks)

11. How might physics beyond the Standard Model reveal itself in flavour observables?