

# Examples of oral exam questions for Colours, Flavours and Their Consequences, version HT19/VT20

- How do you determine the number of parameters of a theory? Explain the number of parameters of the Standard Model.
- What is a Majorana and a Dirac mass?
- Give an overview of neutrino mixing? What is the matter-effect?
- Why are the mixing angles called “reactor,” “atmospheric” and “solar.” Describe roughly the main types of experiments done.
- What are the principles behind sum rules? What is input and what is output?
- What is the large  $N_c$  limit, what are planar diagrams and explain why they dominate. Is there some experimental evidence that it is a useful limit?
- Explain the principles behind effective field theory (EFT) and in what way does it differ from a “normal or standard” field theory (like QED).
- Explain the ideas behind matching and integrating out degrees of freedom.
- Linear sigma model, nonlinear sigma model, Technicolor: Explain how these three fit together. In particular how does the previous point give a relation between the nonlinear and linear sigma model.
- What is heavy quark symmetry, HQET (heavy quark effective theory), what is the role of reparametrization invariance.
- Explain Chiral perturbation Theory power counting
- Sketch the one-loop calculation in ChPT
- How can I use interference to get at phases and mass-differences, give an example.
- Discuss roughly how you would calculate  $K \rightarrow \pi\pi$  in the Standard Model. Why are the short-distance corrections large?
- What are Penguin/Box diagrams and why are they so important in flavour physics? I.e. give an example of the CKM elements and possible GIM mechanism suppressions for a particular process. You might also want to think of possible BSM contributions (even if the course didn't have that officially)
- Explain the Coleman-Mandula theorem and how supersymmetry avoids it.
- What are the main supersymmetric multiplets?

- Why are the auxiliary fields useful?
- How does superspace simplify dealing with supersymmetric theories.
- What is soft supersymmetry breaking and why is it useful?
- What is the MSSM?
- Explain roughly how the LEP/LHC experiments obtain limits on supersymmetry. Are there ways to avoid these?