

# Flavour Physics: Week: V

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**Problem 1.** The Higgs boson is an elementary particle produced by the quantum excitation of the Higgs field. The Higgs particle is a massive scalar boson with zero spin, even (positive) parity, no electric charge, and no color charge. The masses of all particles are generated by the Higgs mechanism. It is also very unstable, decaying into other particles almost immediately upon generation. The Higgs boson was discovered in 2012 by the ATLAS and CMS experiments.

- (a) What are the main production mechanism of the Higgs boson at LHC? How could we distinguish them in a detector?
- (b) Draw Feynman diagrams for the main production channels.
- (c) Look for the cross-section of these production channels and estimate how many Higgs should we have from LHC Run 2 ((lumi) = $150\text{ fb}^{-1}$  and  $E_{CM} = 13\text{ TeV}$ )?
- (d) Considering the properties (quantum numbers) of the Higgs boson, what could its decay channels be?
- (e) The Higgs boson couple to the mass of the particles. How do you expect the  $\mathcal{B}$  for those decays depend as a function of the Higgs mass?
- (f) The Higgs boson has been observed using a handful of channels. What are the pros and cons for each decay (detection and  $\mathcal{B}$ )
- (g) Draw the Feynmann diagram for the main decay modes