Exercise for Colours and Flavours and their consequences Autumn 2019: lecture 10-14

Supersymmetry

Equations refer to Martin's lectures, version of January 2016.

2 component notation

- Derive (2.20) and play a bit with (2.18)
- Derive (2.31) from (2.30)

Supersymmetry transformations

Prove (3.3.9) for (some of) $X = F^a_{\mu\nu}, \lambda^a, \lambda^{a\dagger}, D^a$. Note that it is not valid for A^a_μ.

Superspace

Derive (4.5.4)-(4.5.9) from the supersymmetry transformation (4.2.5). This provides a bit more exercise with the 2-component notation and brings us to a now much nicer linear supersymmetry transformation. Some playing with the gauge transformations with the superversion of a gauge transformation is recommended.

Phenomenology

- Redo the derivation of the various Higgs masses in Sec. 8.1 until (8.1.22). Note that similar issues appear in two-Higgs-doublets-models (2HDM) but then the couplings allow for more freedom.
- read Sec. 8.5 to get a feeling for some of the more standard mass patterns.

Final comments for supersymmetry

The lectures by Martin are good but for phenomenology they only scratch the surface. The amount of literature in this area is humongous (or any other word describing very very large). Given the number of possible variations in couplings and masses, but remember the two underlying qualitative conclusions

- e^+e^- colliders limits: $E_{cms}/2$ minus some fraction for efficiencies for essentially all particles
- Hadron colliders and especially the LHC: needs (a number of) isolated leptons and/or missing energy to be detectable, but if that the limits are very good for the strongly interacting particles and OK for the elctroweak interacting ones.
- No missing energy: the LHC limits become quite bad.