08.128.742 Quantum Field Theory III
The Standard Model and Electroweak Theory

Homework set 3

Due December 10, 2020; e-mail (photo or scan) to yu001@uni-mainz by start of discussion session
Please note how long it took you to solve each problem

3-1, 100 pts. Design a collider analysis for the following SM or beyond Standard Model processes at LHC by ATLAS or CMS. This means: (i) identify the collider signature of the process or new physics particle, (ii) identify the main reducible and irreducible SM backgrounds, (iii) what kinematic cuts will help eliminate the reducible backgrounds, and (iv) what further kinematic cuts will enhance the signal compared to the remaining backgrounds.

A, 25 pts. The Standard Model production of same-sign W bosons, $pp \to W^{\pm}W^{\pm}jj$.

B, 25 pts. The Standard Model double Higgs production and extracting the trilinear Higgs coupling.

C, 50 pts. A doublet scalar leptoquark $(\bar{3}, 2, -7/6)$ with a Lagrangian

$$\mathcal{L} = |D_\mu S|^2 + m_S^2|S|^2 + (y_{ij}\bar{L}_L^i S u_R^j + \text{ h.c.}) \ . \tag{1}$$

For simplicity, choose y_{ij} to have only one non-zero entry.