YUKAWA SECTOR RENORMALIZATION IN THE GRIMUS-NEUFELD MODEL

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The study of fundamental particles and their interactions is deeply rooted in the framework of quantum field theory (QFT). In this framework, so far the most successful model is the Standard Model (SM), which has withstood numerous experimental checks. For example, it has correctly predicted the existence of the Higgs boson[1]. However, it does not explain the light masses of neutrinos[2], that are measured experimentally. Thus the SM needs to be extended to do so and the extension we use is the Grimus – Neufeld model (GNM)[3]. The model adds an additional Higgs doublet as well as a Majorana fermion to the SM. In the model, the seesaw mechanism and radiative corrections give the masses to the neutrinos. Having that, the next step is to cross-check the GNM predictions with the experimental data. This is troublesome, because QFT gives unphysical infinities that come from the high energy range, which must be included in QFT. Thus the model needs to be renormalized. Renormalization is a procedure, where we get rid of those infinities by shifting the values of our parameters to compensate for them.

During this study the objective was to renormalize the Yukawa constants that couple the first Higgs doublet with the fermions in the GNM. These constant are important, because after Spontaneous Symmetry breaking they give the fermions their physical mass. The renormalization of the Yukawa constant is achieved by renormalizing the three-point functions of Higgs–fermion interactions. The renormalization is done by using the Simonas Draukšas[4] scheme, which modifies the usual On-Shell renormalization scheme by introducing off-diagonal mass counterterms. Due to the connection between masses and the Yukawa couplings, these off-diagonal counterterms in principle can be related to the Yukawa coupling counterterms.

In this presentation we will present the Yukawa counterterms we have computed in this study. In future studies we will cross-check the the predictions of our model with experimental data.

[1] S. Chatrchyan et al. (CMS Collaboration), “Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC,” Phys. Lett. B, vol. 716, no. 1, pp. 30–61, Sep. 2012.
[2] B. Batell, A. Bhoonah, and W. Huang, “Right-handed neutrino masses from the electroweak scale,” arXiv:2411.07294, 2024.
[3] W. Grimus and H. Neufeld, “Radiative neutrino masses in an SU(2) × U(1) model,” Nucl. Phys. B, vol. 325, no. 1, pp. 18–32, Oct. 1989.
[4] S. Draukšas, Renormalization of the Grimus–Neufeld Model, Ph.D. dissertation, Vilnius Univ., Lithuania, 2024.