BRST SYMMETRY AND GRIMUS-NEUFELD MODEL

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It is not always clear whether intermediate theoretical quantities that lead to physical observables are gauge-dependent. One of the tools to analyze gauge dependence is the Nielsen identities [1], a generalisation of Slavnov-Taylor identities [2], [3], based on BRST symmetry [4]–[6]. Nielsen identities allow the gauge dependence to be expressed in terms of correlation functions involving BRST sources that are associated with the gauge parameters.

In this research, Nielsen identities are applied in the Grimus-Neufeld model [7], which explains small neutrino masses, specifically to investigate the gauge dependence of the neutrino self-energies in the mass eigenstate basis. For this, the Grimus-Neufeld model must be BRST quantized, and the BRST Lagrangian for the neutrino and Higgs sectors must be derived, which is required for calculating the Nielsen identity for the neutrino self-energy. To ensure that the implementation of BRST quantization is consistent, the gauge dependence of the neutrino self-energy is analyzed in two independent ways: 1) by deriving and calculating the Nielsen identity using the BRST Lagrangian; 2) by explicitly calculating the neutrino self-energy and taking the derivatives with respect to the gauge parameters.

The goal of this work is to automate the calculation of the Nielsen identity for the neutrino self-energy using *Mathematica*. The required theoretical framework, methodology, and results are presented.

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