論　文　の　要　旨

題　目　A Study of the Third Family Quark Mass Hierarchy and Flavor-Changing Neutral Current in the Universal Seesaw Model
(ユニバーサルシーソー模型における第三世代のクオーク質量階層性とフレーバーを変える中性カレントの研究)

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The Universal Seesaw Model is an extension of the Standard Model (SM) that aims to explain the mass hierarchy problem between fermions by introducing heavy vector-like fermions (VLFs). These VLFs mix with the SM fermions, providing a seesaw-like mechanism that naturally explains the small masses of the light quarks and leptons while accommodating the heavy masses of the third family quarks. In addition, flavor-changing neutral currents (FCNC) are present at the tree level.

In this thesis, we present the study of the quark sector of the universal seesaw model with $SU(2)_L \times SU(2)_R \times U(1)_{Y'}$ gauge symmetry in the massless case of the two lightest quark families. This model aims to explain the mass hierarchy of the third family quark by introducing a vector-like quark (VLQ) partner for each quark. In this model, we introduce $SU(2)_L$ and $SU(2)_R$ Higgs doublets.

We derive the Lagrangian of the model explicitly for the quark sector, Higgs sector, and kinetic terms of the gauge fields. Starting from a Lagrangian invariant under $SU(2)_L \times SU(2)_R \times U(1)_{Y'}$, we systematically present the Lagrangian at each stage of symmetry breaking. After the $SU(2)_R$ Higgs doublet acquires a non-zero vacuum expectation value (vev), the Lagrangian becomes invariant under the SM gauge symmetry, and further breaking to $U(1)_{\text{em}}$ occurs when the $SU(2)_L$ Higgs doublet acquires its vev. At each stage of the symmetry breaking, we present the Lagrangian with the remaining gauge symmetry. Additionally, we investigate the flavor-changing neutral currents (FCNC) of Higgs (h)and Z-boson in the interaction with the top, heavy top, bottom, and heavy bottom quark.