PHENOMENOLOGY OF SUPERSYMMETRY IN THE MINIMAL SUPERSYMMETRIC SO(10) GRAND UNIFIED THEORY

菊池 樹

The central theme of this thesis is the construction of a minimal supersymmetric (SUSY) SO(10) grand unified theory (GUT) and its applications to the wide ranges of physical phenomena. The first workable minimum SO(10) GUT model was developed by Fukuyama *et al* ., where the neutrino Dirac Yukawa coupling matrix, together with all the other fermion mass matrices, is completely determined, once free parameters in the model are appropriately fixed so as to accommodate the recent neutrino oscillation data. We further develop this model construction, mainly the Higgs superpotential and the detailed analyses of symmetry breaking pattern from SO(10) to the Standard Model $SU(3)_C \times SU(2)_L \times U(1)_Y$. This is indispensable for GUT to be precise next generation Standard Model, but is so tedious that no one has performed in the realistic model building. Using this unambiguous neutrino Dirac Yukawa couplings, we calculate the lepton flavor violating (LFV) processes and the muon g-2 assuming the minimal supergravity scenario. The resultant rates of the LFV processes are found to be large enough to well exceed the proposed future experimental bound, while the magnitude of the muon g-2 can be within the recent result by Brookhaven E821 experiment. Furthermore, there exists a parameter region which can simultaneously realize the neutralino cold dark matter abundance consistent with the recent WMAP data. Also, we analyze the proton decay rate for the dominant decay modes $p \to K^+\bar{\nu}$ by including as many free parameters as possible and varying them. There are two free parameters in the Yukawa sector, while five in the Higgsino sector. It is found that an allowed region exists when the free parameters in the Higgs sector are tuned so as to cancel the proton decay amplitude. The resultant proton lifetime is proportional to $1/\tan^2\beta$ and the allowed region eventually disappears as $\tan\beta$ becomes large. Our model is also applied to the physics of the early universe and obtained the useful constraints.