High Energy Physics - Phenomenology

Common Origin of Soft mu-tau and CP Breaking in Neutrino Seesaw and the Origin of Matter

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Neutrino oscillation data strongly support mu-tau symmetry as a good approximate flavor symmetry of the neutrino sector, which has to appear in any viable theory for neutrino mass-generation. The mu-tau symmetric limit also leads to a vanishing mixing angle \theta_{13} and thus Dirac CP-conservation. Hence the mu-tau breaking is not only small, but also the source of Dirac CP-violation. We conjecture that both discrete mu-tau and CP symmetries are fundamental symmetries of the seesaw Lagrangian (respected by interaction terms), and they are only softly broken, arising from a common origin via a unique dimension-3 Majorana mass-term of the heavy right-handed neutrinos. From this conceptually attractive and simple construction, we can predict the soft mu-tau breaking at low energies, leading to quantitative correlations between the apparently two small deviations \theta_{23} - 45^o and \theta_{13} - 0^o. This nontrivially connects the on-going measurements of mixing angle \theta_{23} with the upcoming experimental probes of \theta_{13}. We find that any deviation of \theta_{23} - 45^o must put a lower limit on \theta_{13}. Furthermore, we deduce the low energy Dirac and Majorana CP violations from a common soft-breaking phase associated with mu-tau breaking in the neutrino seesaw. Finally, we derive the cosmological CP violation via leptogenesis for the baryon asymmetry. We fully reconstruct the leptogenesis CP-asymmetry from the low energy Dirac CP phase and establish a direct link between the cosmological CP-violation and the low energy Jarlskog invariant. In addition, we reveal a new hidden symmetry that connects the solar mixing angle \theta_{12} to its group-parameter, and includes the conventional tri-bimaximal mixing as a special case, allowing deviations from it.

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