Preface

The electron and muon number violating muonium–antimuonium oscillation process in two different models is investigated. First, modifying the Standard Model only by the inclusion of singlet right-handed neutrinos and allowing for general renormalizable interactions producing neutrino masses and mixing, the leading order matrix element contribution to this process is computed in R_ξ gauge thereby establishing the gauge invariance to this order. To give a natural explanation of the smallness of the observed neutrino masses, the see-saw mechanism is explored resulting in three light Majorana neutrinos and three heavy Majorana neutrinos with mass scale $M_R \gg M_W$. Present experimental limits set by the nonobservation of the oscillation process sets a lower limit on M_R of roughly of order 600 GeV. Second, modifying the Minimal Supersymmetric Standard Model by the inclusion of three right-handed neutrino superfields and allowing only intra-generation lepton number violation but not inter-generation lepton number mixing, the muonium–antimuonium conversion can occur while the process $\mu \to e\gamma$ is forbidden. For a wide range of the parameters, the contributions to the muonium–antimuonium oscillation time scale are at least two orders of magnitude below the sensitivity of current experiments. However, if the ratio of the two Higgs field VEVs, tan β, is very small, there is a limited possibility that the contributions are large enough for the present experimental limit to provide an inequality relating tan β with the light neutrino mass scale m_ν which is generated by see-saw mechanism. The resultant lower bound on tan β as a function of m_ν is more stringent than the analogous bounds arising from the muon and electron anomalous magnetic moments as computed using this model.

Beijing, May 2010 Boyang Liu