Models of neutrino masses and baryogenesis

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Abstract. Majorana masses of the neutrino implies lepton number violation and is intimately related to the lepton asymmetry of the universe, which gets related to the baryon asymmetry of the universe in the presence of the sphalerons during the electroweak phase transition. Assuming that the baryon asymmetry of the universe is generated before the electroweak phase transition, it is possible to discriminate different classes of models of neutrino masses. While see-saw mechanism and the triplet Higgs mechanism are preferred, the Zee-type radiative models and the $R$-parity breaking models requires additional inputs to generate baryon asymmetry of the universe during the electroweak phase transition.

Keywords. Neutrino masses; lepton number violation; baryon asymmetry.

PACS Nos 12.60 Fr; 14.60 Pq; 98.80 Cq

1. Introduction

Two important issues of lepton number violation are intimately related to each other. One is the possible existence of neutrino Majorana masses, as evidenced by the ongoing excitement generated by the recent report of atmospheric neutrino oscillations [1], as well as previous other indications of solar [2] and accelerator [3] neutrino oscillations. The other is one of the very challenging question in cosmology to generate the baryon asymmetry of the universe starting from a symmetric universe [4]. Since the electroweak anomalous processes breaks both the baryon and the lepton numbers, still conserving the $(B - L)$ quantum number, the baryon asymmetry of the universe is no longer independent of the lepton number violation of the universe [5–8]. If there is very fast lepton number violation before the electroweak phase transition, then that can erase the $(B - L)$ asymmetry of the universe [6] and hence the baryon asymmetry of the universe. On the other hand, if any lepton asymmetry is generated at some high temperature, that can get converted to a baryon asymmetry of the universe before and during the electroweak phase transition [7].

Lepton number violation is required to give a Majorana mass to the neutrinos. Depending on the scale at which this lepton number is violated, this interaction may or may not satisfy the out-of-equilibrium condition. If this interaction is faster than the expansion rate of the universe, it can erase all lepton asymmetry of the universe before the electroweak phase transition. In those models one then require additional inputs to explain the baryon asymmetry of the universe. On the other hand, in models of leptogenesis the lepton number violating interaction required to give Majorana masses to the neutrino also satisfy the out-of-equilibrium condition. If there is enough CP violation in the leptonic sector [9],