National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: STUDY OF BARYOGENESIS VIA LEPTOGENESIS IN EXTENSION OF STANDARD MODEL WITH TRIPLET HIGGS SCALARS
Speaker	: Sreerupa Chongdar (Rollno : 518ph1002)
Supervisor	: Prof. Sasmita Mishra
Venue	: MC 126
Date and Time	: 31 Jul 2024 (9:30 am)
Abstract	: Two of the most intriguing shortcomings of the Standard Model (SM) are its inability to explain the matter-antimatter asymmetry of the universe and justify the existence of non-zero neutrino mass. This thesis is a study to accommodate neutrino mass generation and address the baryon asymmetry of the Universe (BAU) by extending the SM with triplet Higgs scalars. We consider three models based on type-II seesaw mechanism and study neutrino mass generation and baryogenesis through leptogenesis. The viability of these models is evaluated using the latest neutrino oscillation data. The parameter space study reveals a better understanding of the neutrino mass matrix and predicts neutrino mass hierarchy. With the first model containing two triplet scalars, we study unflavoured and two-flavored leptogenesis with explicit CP violation. The triplet scalars, having two distinct decay modes, provide two tree-level branching ratios. We investigate the effect of the hierarchy between these two branching ratios on the efficiency of leptogenesis. The hierarchy between the branching ratios tends to suppress the CP asymmetry required for successful leptogenesis, which has been compensated by introducing CP-violating phases through the neutrino mass model. We further enhanced the efficiency by considering flavor interactions. We have successfully achieved low-scale leptogenesis by considering the two triplet scalars to have nearly degenerate masses in the TeV scale under the same model framework. Then we study a model with two triplet scalars based on $A_{4}\times Z_{4}$ symmetry which results in spontaneous CP violation (SCPV) by the involvement of one singlet scalar and two scalar fields and predicts the traditional tribimaximal mixing pattern. The phase of the complex vacuum expectation value (vev) of the singlet scalar acts as a common source of CP violation in both low and high-energy sectors. The flavor symmetry of the model prohibits accomplishing baryogenesis through unflavoured leptogenesis. Therefore we perform a rigorous study on the fascinating area of flavoured triplet leptogenesis, incorporating flavour-covariant Boltzmann equations in density matrix formalism. Again, we study the interplay of the hierarchical branching ratios of the decay of triplet scalars and SCPV phase to accommodate the required CP asymmetry to account for the final baryon asymmetry in the observational range. In a minimal type-II seesaw model with one right-handed neutrino and one triplet scalar, we obtain a Fritzsch-type texture for the neutrino mass matrix imposing $A_{4}\times Z_{2}$ symmetry. We study the extra source of charge conjugation and parity (CP) asymmetry from the interference of the tree-level diagram and one-loop vertex diagram involving the triplet scalar. The study of leptogenesis mediated by the right-handed neutrino shows an enhancement in the baryon asymmetry in the case of two-flavored leptogenesis, compared to the unflavoured regime. In the absence of low-energy data to quantify the parameters of the seesaw model, the CP violations in high-energy phenomena like leptogenesis and the same in the lepton sector, measurable in low-energy scale, are believed not to be generally related. In this context, we investigate the relationship between low-scale CP violation from neutrino oscillations and high-scale CP violation necessary for leptogenesis, and we establish a correlation between them.