TEV SCALE SUPERSYMMETRIC EXTENSIONS OF THE STANDARD MODEL AT THE LARGE HADRON COLLIDER

By

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To

My Beloved Parents and My Beloved Wife

Table of Contents

List of Tables

List of Figures

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Abstract

We study the phenomenological and cosmological implications of $B-L$ extension of the SM in both supersymmetric (BLSSM) and non-supersymmetric (BLSM) scenarios. We show that generating non-vanishing neutrino masses through TeV inverse seesaw mechanism leads to a cutoff scale of SM Higgs potential stability of order 10^5 GeV. However, in the BLSM we find that the mixing between the SM-like Higgs and the $B-L$ Higgs plays a crucial role in alleviating the vacuum stability problem. We also provide the constraints of stabilizing the Higgs potential in the supersymmetric $B-L$ model. In addition the predicted sneutrino-antisneutrino oscillation phenomena is explored in the BLSSM, where a type I seesaw mechanism is naturally implemented. We also study direct pair production of such right-handed sneutrinos at the Large Hadron Collider (LHC) and its decay modes, emphasising that their decay into same-sign di-lepton pairs are salient features for probing these particles at the CERN machine. Also, the charge asymmetry present in such same-sign di-lepton signals is analysed.

We also study the single field inflation in the context of supergravity with shift symmetry where the inflaton arises from a charged sector under a $U(1)$ gauge symmetry. Both non-anomalous and anomalous (with Fayet-Iliopoulos term) $U(1)$ are studied. We show that the non-anomalous $U(1)$ scenario is consistent with data of the cosmic microwave background and recent astrophysical measurements. A possible kinetic mixing between $U(1)$ and $U(1)_{B-L}$ is considered in order to allow for natural decay channels of the inflaton, leading to a reheating epoch. Upper limits on the reheating temperature thus turn out to favour an intermediate ($\sim \mathcal{O}(10^{13})$ GeV) scale $B-L$ symmetry breaking.

The problem of moduli stabilization in type IIB superstring theories is analyzed. We focus on the KKLT and Large Volume Scenario (LVS). We show that the predicted