

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Soft Leptogenesis as a Viable Model of Baryogenesis

By

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The fact that we live in a matter-antimatter asymmetric universe is a deep mystery in which the Standard Model (SM) of particle physics falls short of explaining. Imposing supersymmetry (SUSY) on the SM plus right-handed neutrinos with lepton-number-violating Majorana masses results in stability of Higgs mass under quantum corrections, small active neutrino masses and generation of baryon asymmetry of the universe (baryogenesis) through leptogenesis. If SUSY is realized, it has to be broken. The existence of soft SUSY-breaking terms introduce additional CP violating sources which can be utilized in leptogenesis in a scenario termed Soft Leptogenesis (SL).

First, we study the contributions to CP violation in SL paying special attention to the role of thermal corrections. Using both field-theoretical and quantum mechanical approaches we compute the CP asymmetries and conclude that for all soft-SUSY breaking sources of CP violation considered, an exact cancellation between the leading order asymmetries produced in the fermionic and bosonic channels occurs at $T=0$ and hence thermal effects are needed to uplift this cancellation. Motivated by the relevance of quantum effects in resonant leptogenesis (as in SL), we further investigate the impact of the use of quantum Boltzmann equations in SL. Then we study the lepton flavor effects in the temperature range relevant for SL and show that they could enhance the efficiency of SL by up to a factor of ~ 1000 from the unflavored scenario. This enhancement permits larger values of the required lepton-violating soft bilinear term up to a natural SUSY scale (TeV). Finally, we discuss the effective theory appropriate for studying SL at temperatures $T > 10^7$ GeV where the main source of B-L asymmetry is the CP asymmetry of a new anomalous R-charge. This results in baryogenesis through R-genesis with an efficiency that can be up to two orders of magnitude larger than in the usual estimates. Contrary to common belief, a sizeable baryon asymmetry is generated also when thermal effects are neglected.

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