Some implications of $R$-Parity violation in supersymmetry

Abstract

We deal with explicit $R$-parity violation (RPV) in this thesis. $R$-parity is a $Z_2$ symmetry acting on the Minimal Supersymmetric Standard Model (MSSM) fields that forbids these couplings and can be defined as: $R = (-1)^{2s+3B+L}$. With spin $s$, baryon number $B$, and lepton number $L$. All Standard Model (SM) particles have $R$-parity of 1 while SUSY particles have $R$-parity $-1$. This symmetry not only forbids rapid proton decay, it also renders the lightest supersymmetric particle (LSP).

My research interest mainly comprises of the study of application of $R$-Parity violating (RPV) Yukawa couplings in various types of nonleptonic and leptonic physics especially in the area of B-physics and $\tau$ and $\mu$ phenomenology. In the introduction part, we present a detail analysis about different features of various RPV interactions and their bounds.

Results from the experiments in B-physics at CLEO, BaBar, and Belle have attracted lot of attention. Recent data on $B$ meson mixing and decays are, in general, in accord with the SM expectations, except showing a few hiccups:(i) a large phase in $B_s$ mixing, (ii) a significant difference($> 3.5\sigma$) between CP-asymmetries in $B^\pm \rightarrow \pi^0 K^\pm$ and $B_d^0 \rightarrow \pi^\pm K^\mp$ channels, and (iii) a larger than expected branching ratio in $B^0_d \rightarrow \pi^0 \pi^0$ channel. In the second chapter of the we have shown that some selective Baryon ($B$)-number violating Yukawa couplings ($\lambda''$) in RPV SUSY can reconcile all the aforesaid uncorrelated measurements.

In the third chapter, we have studied several issues related with the decays of $\tau$ lepton and the muon ($g - 2$) anomaly. We have investigated some rare FCNC decay processes of $\tau$ and also the muon ($g - 2$) anomaly in the light of RPV-SUSY with Lepton ($L$)-number violating couplings ($\lambda'$). With just two $R$-parity violating couplings, $\lambda'_{223}$ and $\lambda'_{323}$, we correlate several channels, namely, $D_s \rightarrow \ell \nu,(\ell = \mu, \tau), (g - 2)\mu$, and some lepton flavor violating $\tau$ decays. We exhibit our results through observable versus observable correlation plots. We have paid considerable attention to the applications of RPV-SUSY in the low energy sectors from which we can predict some new physics contributions by addressing various anomalies in this sector.