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Review

Supersymmetric Particle Searches

NOTE ON SUPERSYMMETRY

(by Howard E. Haber, Univ. of California, Santa Cruz)

Supersymmetry is an attractive theoretical framework that may permit the consistent unification of particle physics and gravity, which takes place at an energy of order the Planck scale ($\approx 10^{19}$ GeV) [1–3]. However, supersymmetry is clearly not an exact symmetry of nature, and therefore must be broken. In theories of "low-energy" supersymmetry, the effective scale of supersymmetry breaking is tied to the electroweak scale [4,5]. In this way, it is hoped that supersymmetry will ultimately explain the origin of the large hierarchy between the W and Z masses and the Planck scale.

The minimal supersymmetric extension of the Standard Model (MSSM) consists of taking the Standard Model and adding the corresponding supersymmetric partners [6]. In addition, the MSSM contains two hypercharge $Y = \pm 1$ Higgs doublets, which is the minimal structure for the Higgs sector of an anomaly-free supersymmetric extension of the Standard Model that generates mass for both "up"-type and "down"-type quarks (and charged leptons) [7,8]. Supersymmetric interactions consistent with (global) B–L conservation (B =baryon number and L =lepton number) are included. Finally, the most general soft-supersymmetry-breaking terms are added [9]. If supersymmetry is relevant for explaining the scale of electroweak interactions, then the mass parameters that occur in the soft-supersymmetry-breaking terms must be of order 1 TeV or below [10]. Some bounds on these parameters exist due to the absence of supersymmetry particle production at current accelerators, as well as the absence of any evidence for virtual supersymmetric particle exchange in a variety of Standard Model processes [11].

As a consequence of B–L invariance, the MSSM possesses a discrete R-parity invariance, where $R = (-1)^{3(B-L)+2S}$ for a particle of spin S [12]. Note that this formula implies that all the ordinary Standard Model particles have even R-parity, whereas the corresponding supersymmetric partners have odd R-parity. The conservation of R-parity in scattering and decay