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R-parity Conserving Minimal B-L Model

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We propose a simple gauged U(1)B–L extension of the minimal supersymmetric Standard Model (MSSM), where R-parity is conserved as usual in the MSSM. The global B − L (baryon minus lepton number) symmetry in the MSSM is gauged and three MSSM gauge-singlet chiral multiplets with a unit B − L charge are introduced, ensuring the model free from gauge and gravitational anomalies. We assign an odd R-parity for two of the new chiral multiplets and hence they are identified with the right-handed neutrino superfields, while an even R-parity is assigned to the other one. The scalar component of the R-parity even superfield plays the role of a Higgs field and the U(1)B–L symmetry is radiatively broken by a negative mass squared of the scalar generated by the renormalization group running of soft supersymmetry (SUSY) breaking parameters. Therefore, the scale of the U(1)B–L symmetry breaking is controlled by the SUSY breaking parameters and naturally be at the TeV scale. Because of our novel R-parity assignment, three light neutrinos are Dirac particles with one massless state. Since R-parity is conserved, the lightest superpartner (LSP) neutralino is a prime candidate of the cosmological dark matter. Depending on its mass, the lighter Majorana mass eigenstate of a mixture of the B − L gaugino and the fermionic component of the R-parity even superfield appears as a new dark matter candidate. We also discuss collider phenomenology of our model. In particular, the B − L gauge boson (Z), once discovered at the Large Hadron Collider, will be a novel probe of the Dirac nature of the light neutrinos since its invisible decay processes include the final states with one massless (left-handed) neutrino and two Dirac neutrinos, in sharp contrast with usual B − L extension of the SM or MSSM, where the right-handed neutrinos are heavy Majorana particles and decay to the SM leptons.

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