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Supersymmetry for Fermion Masses

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Abstract: It is proposed that supersymmetry (SUSY) may be used to understand fermion mass hierarchies. A family symmetry Z_{3L} is introduced, which is the cyclic symmetry among the three generation SU(2) doublets. SUSY breaks at a high energy scale $\sim 10^{11}$ GeV. The electroweak energy scale $\sim$100 GeV is unnaturally small. No additional global symmetry, like the R-parity, is imposed. The Yukawa couplings and R-parity violating couplings all take their natural values, which are $O(10^{0}\sim 10^{-2})$. Under the family symmetry, only the third generation charged fermions get their masses. This family symmetry is broken in the soft SUSY breaking terms, which result in a hierarchical pattern of the fermion masses. It turns out that for the charged leptons, the τ mass is from the Higgs vacuum expectation value (VEV) and the sneutrino VEVs, the muon mass is due to the sneutrino VEVs, and the electron gains its mass due to both Z_{3L} and SUSY breaking. The large neutrino mixing are produced with neutralinos playing the partial role of right-handed neutrinos. $|V_{e3}|$, which is for ν_e-ν_τ mixing, is expected to be about 0.1. For the quarks, the third generation masses are from the Higgs VEVs, the second generation masses are from quantum corrections, and the down quark mass due to the sneutrino VEVs. It explains m_c/m_s, m_s/m_e, $m_d>m_u$, and so on. Other aspects of the model are discussed.

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