EXPERIMENTAL TESTS FOR NEW SO(10) GRANDUNIFICATION

Rabindra N. Mohapatra*
University of Maryland, Department of Physics and Astronomy
College Park, Maryland 20742, U.S.A.

The recent results on proton decay appear to have ruled out the simplest grandunified model based on the SU(5) group of Georgi and Glashow. The requirement of no mirror and exotic fermions, therefore, leaves SO(10) as the only other simple grand unification group that contains $SU(2)_L$ and $U(1)_Y$ as subgroups. This group has the additional appeal of being left-right symmetric above the GUT-scale. In this report, we discuss possible experimental tests for the SO(10) grandunification.

SO(10), being a group of rank 5, can descend to the standard model group of $SU(3)_C \times SU(2)_L \times U(1)$ via either of the two following maximal subgroups: (a) $SO(10) \to SU(5) \times U(1)$ and (b) $SO(10) \to SU(2)_L \times SU(2)_R \times SU(4)_C$ ($\equiv G_{224P}$). The present observations on proton decay also rule out case (a), leaving us with G_{224P} as the intermediate gauge symmetry group. This group contains several physically interesting intermediate mass scale: M_C, the scale above which quarks and leptons lose their identity; M_{W_R} and M_{Z_R} which represent the scale (and inverse strength) of V + A current interactions. It is important to know how these mass scales are constrained by the present values of $\sin^2\theta_w(m_w) = .22 \pm .02$ and $\alpha_s(m_w) = .10$ to .12. This depends on whether the discrete charge conjugation like symmetry (D-parity) contained in SO(10) breaks simultaneously with the local $SU(2)_R$ symmetry or not. Until the recent work of Chang, Parida and this author,[1] it was customary to assume the former, i.e. D-parity and $SU(2)_R$ symmetries break together. In this case, low energy constraints imply that M_C, $M_{W_R^+} \geq 10^{10} - 10^{11}$ Gev, without constraining the mass of the neutral Z_R-boson. Thus, a second light Z-boson was considered the only window to SO(10) grandunification.

In ref. 1, we pointed out that, there exist several SO(10) Higgs multiplets such as {210} and {45}, which can break the D-parity symmetry, while leaving the local $SU(2)_R$ symmetry in tact. This has the implication that, SO(10) can at some intermediate stage, break to the symmetry $SU(2)_L \times SU(2)_R \times G$, with the left and right-SU(2) gauge couplings unequal ($g_L \neq g_R$), due to asymmetric spectrum of the Higgs bosons. We, then, find that constraints of $\sin^2\theta_W(m_W)$ and $\alpha_s(m_W)$ allow for mass scales M_C and M_{R^+} to be as low as 10^5 Gev, allow ing other experimental windows to SO(10) symmetry such as Neutron-Antineutron oscillation and $K_L^o \to \mu e$ decay, without arbitrary adjustment of parameters.

In view of the extreme importance of this result, we have completed a two-loop analysis[2] of all symmetry breaking chains that involve G_{224P} as an intermediate symmetry; we have used a minimality principle for Higgs multiplets according to which, we use the lowest dimensional SO(10) multiplet that is needed for spontaneous breaking at a given stage. Also, we include the contribution of the Higgs bosons in accordance with the "survival hypothesis". We find that the symmetry breaking chain:

$$SO(10) \xrightarrow[\{54\}]{M_U} SU(2)_L \times SU(2)_R \times SU(4)_C \times P \xrightarrow[\{210\}]{M_P} SU(2)_L \times SU(2)_R \times SU(4)_C \xrightarrow[\{210\}]{M_C = M_{W_R^+}} SU(2)_L \times U(1)_R \times U(1)_{B-L} \times SU(3)_C \xrightarrow[\{126\}]{M_{R^o}} SU(2)_L \times U(1)_Y \times SU(3)_C$$

leads to 10^4 Gev $\leq M_C$, $M_{R^+} \leq 10^7$ Gev, for $.225 \leq \sin^2\theta_W(M_W) \leq .227$, $\alpha_s(m_W) \simeq .1$, 10^{16} Gev $\leq M_U \leq 10^{16.4}$ Gev predicting $M_P = 10^{14}$ Gev, for $M_{R^o} \simeq$ 300 Gev-1 Tev. In this case, we find[3] $\tau_{N-\bar{N}} \simeq 10^7$-$10^9$ sec for reasonable choice of coupling parameters, $B(K_L^o \to \mu\bar{e}) \simeq 10^{-9}$ both of which are within accessible range of present generation of experiments. We also wish to point out that $M_{R^+} \simeq$ 10 to 100 Tev can also provide a satisfactory picture of CP-violation in K-decays involving right-handed currents.[3]

For all the other symmetry breaking chains, the value of $M_{R^+} > 10^6$ for acceptable values of $\sin^2\theta_W$. In this sense, the constraint of CP-violation predicts a unique SO(10) model with D-parity breaking.

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