Nonabelian Electrodynamics and SU(2) × SU(2) Electroweak Theory in LEP1 Data on Z Particle Production

L.B. Crowell*

Recent data obtained by LEP1 are discussed and their potential implication for the existence of a Z' particle. This letter advocates that this fits within the basic tenet of an SU(2) × SU(2) extended theory of the standard model of electroweak interactions. This extended electroweak model is motivated by nonabelian electrodynamics that provides an effective calculus for nonlinear optics.

Keywords: grand unified field theory; O(3) electromagnetic sector, massive A(3) boson

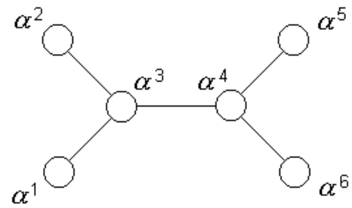
Nonabelian electrodynamics is a formalism electrodynamics with a cyclicity condition that predicts the existence of a magnetic field called $\mathbf{B}^{(3)}$[1]. This magnetic field has been upheld as a reason for Inverse Faraday effects. Nonabelian electrodynamics, often called O(3) electrodynamics, requires that electroweak unification, based on Glashow, Salam, and Weinberg, be modified to include this extension of electrodynamics to a symmetry that is larger than the U(1) gauge theory.

It was recently suggested by Erler and Langacker [2] that an anomaly in Z decay widths points to the existence of *Z'* bosons. These are predicted to exist with a mass estimate of 812 $\mathrm{GeV}^{+339}{}_{-152}$ within the SO(10) GUT model and a Higgs mass posited at 145 $\mathrm{GeV}^{+103}{}_{-61}$. This suggests that a massive neutral boson predicted by Grand Unified Theories has been detected. Further, variants of string theories predict the existence of a large number of these neutral massive bosons.

Analyses of the hadronic peak cross section data obtained at LEP 1[2] implies a small amount of missing invisible width in Z decays. These data imply an effective number of massless neutrinos, $N = 2.985 \pm 0.008$, which is below the prediction of 3 standard neutrinos by the standard model of electroweak interactions. The weak charge Q_W in atomic parity violation can be interpreted as a measurement of the S parameter. This indicates a new $Q_W = -72.06 \pm 0.44$ is found to be above the standard model prediction. This effect is interpreted as due to the occurrence of the Z' particle, which will be referred to as the Z_γ particle.

SO(10) has the six roots α^i $i = 1\ldots 6$. The angle between the connected roots are all 120°, where the roots α^3 α^4 are connected to each other and two other roots. The Dynkin diagram is illustrated below:

* Institute for Advanced Study Alpha Foundation, Institute of Physics, 11 Rutafa Street, Building H, Budapest H - 1165, Hungary.



The decomposition of SO(10) → SU(5) × U(1) is performed by removing the circles representing the roots $\alpha^{1,2,5,6}$ connected by a single branch. The remaining connected graph describes the SU(5) group and the isolated circle is the U(1) group. However, by removing either of the circles $\alpha^{3,4}$ connected by three branches forces SO(10) to decompose into SU(2) × SU(2) × SU(4). Here we have an SU(2) and a mirror SU(2) that describe opposite handed chiral gauge fields, plus an SU(4) gauge field. The chiral fields are precisely the sort of electroweak structure proposed in reference [4]. Presumably since SU(4) can be represented by a 4 that is 3 ⊕ 1 and $\underline{4}$ as $\underline{3} \oplus \underline{1}$, we can decompose this into SU(3) × U(1). Further, the neutrino short fall is a signature of the opposite chiralities of the two "mirrored" SU(2) gauge fields [5].

The SU(2) × SU(2) → SU(2) × O(3)_b predicts the occurrence of a massive photon. So it is possible that these data could corroborate the extended standard model that expands the electromagnetic sector of the theory. What we really understand empirically is QCD and electroweak standard model, and we may have some idea about quantum gravity for at least we do have general relativity and quantum mechanics. This leads to the strange situation that we have reasonable data on TeV range physics and potential ideas about quantum gravity at 10^{19} GeV, with a void of greater ignorance in between. However, these data and analyses suggest theoretical information about GUTs and cast some light on this energy region.

These experimental data do suggest that nonabelian electrodynamics is a valid theory, at least as an extended theory that predicts nonHamiltonian vacuum symmetries. It also suggests that at high energy electrodynamics and the weak interactions are dual field theories. This duality would then exist at energies that may be probed in the TeV range of energy. In order to completely verify that this is the case experiments at the TeV range need to be performed where the Z_γ and Higgs boson can be directly produced.

Acknowledgments

Several private and public sources of funding are acknowledged including the US DoE website http://www.ott.doe.gov/electromagnetic/ which lists over sixty papers and items on higher symmetry electro-dynamics at low energies. The Editor of the Journal of New Energy is gratefully acknowledged for a special issue devoted to an extended electromagnetic sector, and Alain Beaulieu for meticulous preparatory work and suggestions.

References

[1] M. W. Evans, J. P. Vigier, *The Enigmatic Photon, Volume I, The Field* $B^{(3)}$, Kluwer, Dordrecht (1994)

[2] http://xxx.lanl.gov/abs/hep-ph/9910315

[3] LEP and SLD Collaborations, CERN report CERN-EP/9915, 8 Feburary, 1999

[4] L. Crowell, M. Evans, *Found. Phys. Lett*., 12, 4 (1999)

[5] L. Crowell, M. Evans, *Found. Phys. Lett*., 12, 5 (1999)