

NON-ABELIAN SU(2) × SU(2) ELECTROWEAK THEORY  
IN LEP1 DATA ON Z PARTICLE PRODUCTION

ABSTRACT

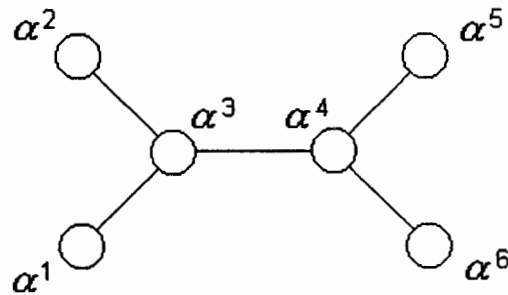
Recent data obtained by LEP1 are discussed and their potential implication for the existence of a  $Z'$  particle. This letter advocates that this fits within the basic tenet of an  $SU(2) \times SU(2)$  extended theory of the standard model of electroweak interactions. This extended electroweak model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

Non-Abelian electrodynamics is a formalism electrodynamics with a cyclicity condition that predicts the existence of a magnetic field called  $B^{(3)}$  [1]. This magnetic field has been upheld as a reason for the inverse Faraday effect. Non-Abelian 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  $812 \text{ GeV}_{-152}^{+339}$  within the  $SO(10)$  GUT model and a Higgs mass posited at  $145 \text{ GeV}_{-61}^{+103}$ . 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 [3] 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  $Z_\gamma$  particle.

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



The decomposition of  $SO(10) \rightarrow SU(5) \times U(1)$  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  $SU(2) \times SU(2) \times SU(4)$ . 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  $3 \oplus 1$  and  $\bar{4}$  as  $\bar{3} \oplus 1$ , we can decompose this into  $SU(3) \times U(1)$ . Further, the neutrino short fall is a signature of the opposite chiralities of the two “mirrored”  $SU(2)$  gauge fields [5].

The  $SU(2) \times SU(2) \rightarrow SU(2) \times O(3)$  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 non-Abelian electrodynamics is a valid theory, at least as an extended theory that predicts non-Hamiltonian 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  $Z_\gamma$  and Higgs boson can be directly produced.

## ACKNOWLEDGMENTS

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## REFERENCES

- [1] M.W. Evans, J.P. Vigié, *The Enigmatic Photon, Volume 1: The Field  $B^{(3)}$* , Kluwer, Dordrecht (1994)
- [2] <http://xxx.lanl.gov/abs/hep-ph/9910315>
- [2] LEP and SLD Collaborations, CERN report CERN-EP/9915, 8 February, 1999.
- [3] L. Crowell, M. Evans, *Found. Phys. Lett.*, **12**, 4 (1999).
- [4] L. Crowell, M. Evans, *Found. Phys. Lett.*, **12**, 5 (1999).