IC/73/133

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

T O P I C A L S E M I N A R

O N

W E A K I N T E R A C T I O N S

26 - 29 June 1973

(SUMMARIES)

1973 MIRAMARE-TRIESTE

IC/73/133

International Atomic Energy Agency

and

United Nations Educational Scientific and Cultural Organization

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

T O P I C A L S E M I N A R

O N

W E A K I N T E R A C T I O N S

26 - 29 June 1973

(SUMMARIES)

MIRAMARE - TRIESTE

July 1973

Please note that copies of papers referred to may be obtained direct from the authors and not from the ICTP.

UNIFIED LEPTON-HADRON SYMMETRY

J.C. Pati *
University of Maryland, College Park, Maryland, USA,

and

Abdus Salam
International Centre for Theoretical Physics, Trieste, Italy,
and
Imperial College, London, UK.

I wish to talk about some of the ideas, in which Abdus Salam and myself have been interested in since about a year[1,2] and some of the recent work, which we are pursuing at present. Our major motivation has been to propose that there is only one basic Fermionic matter, composed of hadrons and leptons with no sharp distinction between them at a deeper level. Baryon number and/or lepton number arise as part of a hierarchy of higher summetry similar to the quantum numbers I_3 and Y rather than being due to ad hoc U(1) symmetries. The fundamental hadrons and leptons belong to a common irreducible representation of the same symmetry group for all matter. We believe that such a unification will provide a tighter classification scheme for leptons and a rational for the coexistence of the hadrons and leptons. It will also lead to a sharper basis for the hadron-lepton universality in the weak and electromagnetic currents.

In a framework of gauge theories of fundamental interactions, such a unification of baryonic and leptonic matter becomes dynamically compelling provided one gauges sufficient degrees of freedom to ensure gauge transform ability of leptons into baryons. The absence of interactions mediated by corresponding gauge mesons (which carry nonzero baryon and lepton numbers) in the present energy domain is then to be attributed to superheavy masses ($\simeq 10^4$ BeV, say) of these gauge bosons arising out of spontaneous symmetry breaking. Such a unification is qualitatively on the same footing as the

* Supported in part by the National Science Foundation under Grant No.NSF GP.

familiar grouping of charged and neutral particles (μ^- and ν_μ, for example) within the same symmetry structure (SU(2) X U(1), for example) and the subsequent gauge unification of forces (electromagnetic and weak), whose low-energy effective strengths differ by as much as $1:10^{-3}$.

Based on this general idea, we had proposed a year ago that the fundamental hadrons and leptons be unified within a $(4,\bar{4})$- representation of a $SU(4') \times SU(4'')$ - group structure, which contains a Han-Nambu like $SU(3') \times SU(3'')$ group. The most suitable identification within $(4,\bar{4})$ leads to a nonet of Han-Nambu like quarks, plus a triplet of charmed hadrons and the known quartet of leptons (ν , e^-, μ^-, ν_μ). Based on this sixteen-plet of basic fermions, we had proposed that the conventional weak, electromagnetic and strong interactions can be generated by a renormalizable, anomaly-free gauge theory with the gauge symmetry group being $= SU(2')_L \times U(1) \times SU(3'')_{L+R}$. The photon is a combination of gauge bosons from the weak ($SU(2)_L$ and U(1)) and strong ($SU(3'')_{L+R}$) gauge groups. Some of the distinct features of such a scheme are: (a) Strong interactions are generated entirely by an $SU(3'')$ octet of colour vector gauge bosons. These are singlets under the familiar $SU(3)_L \times SU(3)_R$ symmtery. (b) The weak gauge bosons are singlets under the colour $SU(3'')$ group. (c) Such a scheme conserves parity and strangeness up to order G_{Fermi} despite loop diagrams and is supported by the spectrum of the low-lying hadrons. (d) The gauge bosons including the strong ones receive mass through spontaneous symmetry breaking; yet global $SU(3'')$ symmetry can be preserved at least to order α.

As per our initial motivation, we are examining at present the consequences of making use of the extended gauges permitted by the model, in particular those that transform baryons into leptons (this corresponds to extending the $SU(3'')_{L+R}$- to $SU(4'')_{L+R}$- gauge group) and also the weak right gauges similar to the left ones.

REFERENCES

1. A preliminary aspect of this work is contained in J.D. Bjorken's review talk at the 16th International Conference on High Energy Physics, Batavia, Ill., September 1972.
2. J.C. Pati and Abdus Salam, Phys. Rev. D8, 1240 (1973).