IC/69/54

INTERNATIONAL ATOMIC ENERGY AGENCY

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

TOPICAL CONFERENCE

ON

DYNAMICAL GROUPS AND INFINITE MULTIPLETS

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

9-14 June 1969

1969

MIRAMARE - TRIESTE

PROPERTIES OF CURRENT ALGEBRA AT INFINITE MOMENTUM AND ITS RELATIONS TO INFINITE-COMPONENT WAVE EQUATIONS

SHAU-JIN CHANG
Institute for Advanced Study, Princeton, NJ, USA,
and
University of Illinois, Urbana, Ill., USA.

This talk is a summary of the work carried out by Professors O'Raifeartaigh, Dashen and myself[1]. The problem which we wish to analyse is the saturation of current algebra at infinite momentum. Assume that the Fubini-Dashen-Gell-Mann sum rule[2),3)] obtained by sandwiching the local commutator of two current densities between one-particle states is approximately satisfied when one keeps only resonant intermediate states. Making the further sharp resonance approximation in which the widths of the unstable states are set equal to zero, we next consider the sum rules obtained by sandwiching the local commutators between resonance and stable particle and between two stable particles. In this way an infinite set of equations are obtained which, in the above approximation, must be satisfied by the form factors for the transitions current + resonance (or stable particle) $\rightarrow$ resonance (or stable particle). We hope to use these coupled equations to predict certain features of the particle spectrum and the form factors.

At first sight, it may seem that the programme outlined above is too general to be capable of producing any predictions. It is known now that this is not the case. In fact, the requirement of covariance puts a very restrictive kinematical constraint on these form factors, which is known as the angular condition[2),4)]. Under the simplifying conditions that: i) only the subalgebra generated by the isospin currents is taken into account and ii) all states are assumed to have the same isospin, with a few further technical assumptions, none of which seems to be serious, we found that

i) all the solutions to this simplified problem are related to some simple infinite-component wave equations;

ii) the mass spectrum has one or more of the following pathologies: a) all masses are the same or, more precisely, the currents do not connect states of different mass, b) the mass spectrum is infinitely degenerate, c) there are states with $M^2 < 0$ which cannot be ignored [5].

It has been known for some time that the current algebra may be saturated by the solutions of some infinite-component wave equations [4), 6)]. Our results seem to be the first indication that the opposite might also be true, i.e., the saturation of current algebra will necessarily lead to the infinite-component wave equations. It is certainly of great interest to find out whether similar results still persist in the case of non-factored isospins.

REFERENCES

1) S. J. Chang, R. F. Dashen and L. O'Raifeartaigh, Phys. Rev. Letters 21, 1026 (1968); "Properties of current algebra at infinite momentum", papers I and II, Phys. Rev. (to be published).

2) R. F. Dashen and M. Gell-Mann, Phys. Rev. Letters 17, 340 (1966);
R. F. Dashen and M. Gell-Mann in Proceedings of the Third Coral Gables Conference on Symmetry Principles at High Energies 1966 (W. H. Freeman and Co., San Francisco 1966).

3) S. Fubini and G. Furlan, Physics 1, 229 (1964).

4) M. Gell-Mann, D. Horn and J. Weyers in Proceedings of the International Conference on Elementary Particles, Heidelberg, Fed. Rep. Germany, 1967, ed. H. Filthuth (North-Holland Publishing Co., Amsterdam 1968);
H. Leutwyler, Phys. Rev. Letters 20, 561 (1968).

5) Our result is related to, but certainly different from, the result of Grodsky and Streater (I. Grodsky and R. Streater, Phys. Rev. Letters 20, 695 (1968)). In our case, we assume current algebra and isospin factorization but make no a priori assumptions concerning the representations of SL(2, C) to which the particles belong. Grodsky and Streater do not assume current algebra, but assume that the current is p-independent and restrict the representations of SL(2, C) by demanding a polynomial bound on the positive frequency projection operator.

6) See the lectures given at this conference by Professor C. Fronsdal. See also C. Fronsdal, Phys. Rev. 156, 1665 (1966); "Infinite-component field theories, Fubini sum rules, completeness and current algebra"-I (to appear in Phys. Rev.) and II (ICTP, Trieste, preprint IC/69/23);
H. Kleinert, Lectures presented at the Karlsruhe Summer School, 1968.