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Physical Symmetries in a Theory of Several Scalar Real Fields

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Abstract. Let us consider a theory of n scalar, real, local, Poincaré covariant quantum fields forming an irreducible set and giving rise to one particle states belonging to the same mass different from zero. The vacuum is unique. It is shown under fairly weak assumptions that every Poincaré and TCP invariant symmetry of the theory, implemented unitarily, which mapps localized elements of the field algebra into operators almost local with respect to the former (such a symmetry we call a physical one) can be defined uniquely in terms of the incoming or outgoing fields and an n-dimensional (real) orthogonal matrix. The symmetry commutes with the scattering matrix. Incidentally we show also that the symmetry groups are compact. A special case of these symmetries are the internal symmetries and symmetries induced by locally conserved currents local with respect to the basic fields and transforming under the same representation of the Poincaré group. We may make linear combinations out the original fields resulting in complex fields and its complex conjugate in a suitable way. The inspection of the representations of the groups $SO(n)$ and their subgroups sheds some light on the s.c. generalized Carruthers Theorem concerning the self- and pair-conjugate multiplets.

1. It is of some interest to explore the problem of physical symmetries starting from a theory of n scalar, real fields subjected to some fairly weak restrictions (see below). By a *physical symmetry* we mean not only internal symmetries (preserving strict locality) but a larger class of symmetries mapping localized elements of the field algebra into operators almost local with respect to the former [1]. We believe that every symmetry induced by a locally conserved current belongs to his class and there are strong indications that it is so (see [2, 3]).

We succeeded in giving the recipe how to find the most general of such a symmetry, provided it is unitarily implemented in the Hilbert space. It commutes with the scattering matrix. Incidentally we showed also that the symmetry groups are compact.

Linear rearrangement of the original fields, suitable for physical problems, yields then a possibility of a classification of the relevant symmetries occuring in the theory of n scalar (not necessarily real) fields. The present results encompass the results obtained earlier by the author [2]. It is worthwhile to notice that some light is shed