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Renormalization of Models with Radiative Mass Generation

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Abstract. The mechanism of radiative mass generation is discussed by means of a simple model with spontaneously broken symmetry. We show how this phenomenon induces an infrared breakdown of the usual perturbative approach and proceed to identify a set of renormalization prescriptions allowing the construction of a new perturbation theory in which the Ward identities of the model are maintained. The original pathologies are reflected in the appearance of square roots and logarithms of the expansion parameter $\hbar$.

1. Introduction

In the last few years attention has been paid to the mechanism of mass generation induced by radiative corrections [1]. The interest is largely due to the phenomenological insights this mechanism may provide such as, for instance, the nature of electron's [2] and pion's mass [1] or the possibility of breaking the C.P. Symmetry [3] at the quantum level.

The phenomenon typically arises when in a classical field model (tree approximation) there are constraints which imply the "accidental" vanishing of some particle masses. This is known to happen, due to the particular "representation content" of the scalar multiplet and to the condition of renormalizability by power counting, in some models with spontaneous symmetry breaking and in gauge models exhibiting the Higgs Kibble [4] (H.K.) mechanism. For example in some H.K. gauge models the classical potential energy of the scalar fields (where no couplings with other fields are present) may be invariant with respect to a larger symmetry group, i.e., one which contains the gauge group as a proper subgroup, this larger symmetry being violated by the other terms of the Lagrangian. It follows that there are "accidentally" more Goldstone bosons than those implied by the symmetry of the model which are not reabsorbed by the H.K. mechanism. These residual massless bosons are named pseudo Goldstone bosons (P.G.B.) [1].

Outside of the H.K. mechanism, some non-gauge models with spontaneous symmetry breaking, may also show radiative mass generation when part of the

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