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Construction of a Strictly Renormalizable Effective Lagrangian for the Massive Abelian Higgs Model

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Abstract. It is shown, using the BPHZ renormalization program and Zimmermann's normal product algorithm, that a strictly renormalizable effective Lagrangian for the Abelian massive Higgs model does exist: Ward identities are fulfilled, and normalization conditions, defining a theory in an indefinite metric Fock space, may be implemented.

1. Introduction

A number of examples of renormalizable Lagrangian models involving symmetry breaking [1–3] have been recently formulated, in versions which do not make use of any symmetric regularization procedure [4–7]. The basic tool is the so-called "normal product algorithm" (NPA) due to Zimmermann [8], which provides a cut-off free formulation of the BPH renormalization procedure.

For models in which symmetric mass parameters do not vanish, there are two alternative ways of using the NPA: one which respects the super-renormalizibility of the non-symmetric couplings [6, 9] and which we shall call, according to Schroer's terminology, "soft quantization", and another one, the "hard quantization", which treats all couplings as having power index 4 [4, 5]. These two methods yield identical Green's functions, according to an equivalence theorem [10, 6]. The first approach meets, however, difficulties in cases where some symmetric mass parameters have to vanish, whereas the second method is applicable to all cases – and only meets difficulties in principle when some renormalized masses vanish.

Recently, Lowenstein, Weinstein and Zimmermann [6] have formulated the soft renormalization method for the massive Abelian Higgs-Kibble model in the Stueckelberg gauge [11] (massive QED of the σ model). In this case, the equivalence theorem [6, 10] ensures that the hard renormalization procedure exists. It turns out, however, that a direct formulation of this hard renormalization is not completely trivial, which is the motivation of this paper.