Commun. math. Phys. 20, 251—267 (1971)

Analytic Renormalisation of the Exponential Interaction and Weak Interaction Singularities

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Received October 13, 1970

Abstract. The parity non conserving interaction of a neutral vector meson with fermions is considered as a mathematical model suitable for investigating divergence problems of the weak interactions. Through the Stückelberg formalism and a canonical transformation the interaction is converted into an exponential form. The exponential interaction is studied, in the second order of perturbation theory, through the method of analytic renormalisation. Generalised amplitudes are introduced as localizable distributions depending on auxiliary complex parameters λ. It is shown that the distributions possess a nonisolated singularity at the physical point λ_0. A method is developed for discarding the singularity thereby obtaining the physical amplitudes as localizable distributions which display a non-analytic dependence on the coupling constant.

I. Introduction

In this paper we study the problem of regularising the exponential interaction of scalar fields in perturbation theory by taking up the analytic renormalisation approach of Speer [1] in a wider distribution theoretic framework. In doing so one meets new technical problems characteristic of a local unrenormalisable theory. We shall study these problems in the second order of perturbation theory (in the exponential interaction). We will show that the earlier results of Volkov [2] and Okubo [3] arise naturally[1] in this framework.

The problem of regularising the exponential interaction is not devoid of physical interest. Our specific interest stems from the earlier work of Lee [6], who showed, by exploiting the Stuckelberg formalism and performing a canonical transformation, that the study of the short distance singularities of the (unrenormalisable) intermediate boson model of weak interaction could be reduced to a study of the iterations of the exponential interaction in perturbation theory. Lee attempted to sum the leading and next to leading singularities of the individual Feynman

[1] Alternative derivations for the propagator (see text) as a distribution have been obtained, recently and independently, by the authors of Ref. [4, 5].