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Dimensionally Renormalized Green's Functions for Theories with Massless Particles. I.

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Abstract. In the framework of dimensional renormalization the existence of Green's functions to all orders of perturbation theory is proved for theories of massless particles without super-renormalizable couplings. For those Green's functions Schwinger's Action Principle holds as in the massive case.

I. Introduction

In a previous publication [1], an attempt was made to give a consistent formulation of the socalled "Dimensional Renormalization" to all orders of perturbation theory such that Schwinger's Action Principle holds. That was done under the provision that all particles were massive. In the present paper we want to relax this condition. More precisely we shall treat here only the case that all particles are massless and the theory contains no interactions of super-renormalizable type. In a subsequent publication we shall come to the general case of both massive and massless particles, which is complicated by the fact that additional finite subtractions for subgraphs with positive superficial degree of divergence have to be made in order to guarantee their correct normalization.

In contrast to the BPHZ method the Action Principle holds unmodified by radiative corrections in almost all cases discussed in the literature, with the exception of the few occasions where these corrections are known to be unavoidable (e.g. Trace identities, Adler-anomaly)[1].

The physical relevance of a renormalization scheme that allows the treatment of massless particles on one hand and in which the Action Principle holds on the other is obvious, especially in view of theories with gauge invariance of the second kind. We want to emphasize, however, that we do not tackle the physical infrared problem here, i.e. the definition of the S-matrix for massless particles.

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[1] The discussion of super-symmetries is still missing in this framework