Commun. math. Phys. 52, 55—75 (1977)

Communications in Mathematical Physics

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

P. Breitenlohner* **

Institute for Theoretical Physics, State University of New York, Stony Brook, N.Y. 11794, USA

D. Maison* ***

Department of Physics, New York University, New York, N.Y. 10003, USA

Abstract. In the framework of dimensional renormalization the existence of Green's functions to all orders of perturbation theory is proved for theories with massless particles, provided all terms in the interaction Lagrangian have infrared degree $\Omega \geqq 4$. If the vanishing of masses is enforced by some symmetry and this symmetry is respected by dimensional regularization, Schwinger's action principle holds for these Green's functions as in the massive case.

I. Introduction

In this work we continue the discussion of the dimensional renormalization. In two previous publications [1, 2] we have outlined the method, or rather a possible version of it, for theories with exclusively massive or massless particles. The purpose of the present paper is to relax these restrictions on the mass. The reason why we have anticipated the case of purely massless theories is that they can be treated completely within the framework of dimensional renormalization, that is to say, the subtraction of pole terms in $n-4$ ($n=$ dimensional regularization parameter) is sufficient to obtain Feynman amplitudes which are well-defined distributions in their external momenta (which clearly is not to say that we can prove anything about the existence of the S-matrix). The reason is that the massless particles do not develop a mass or super-renormalizable couplings through their interaction or the UV-counterterms. This is in contrast to the generalized $BPHZ$-method [3] where mass-counterterms are employed even in theories with massless particles only.

Since it is not entirely self-evident how to define dimensionally regularized Feynman amplitudes in the presence of massless fields, let us give the definition we are going to use. This definition differs from other ones given in the literature [4].

* On leave of absence from Max-Planck-Institut für Physik und Astrophysik, D-8000 München, Federal Republic of Germany

** Supported in part by the National Science Foundation Grant # MPS-74-13208 A01

*** Supported in part by the National Science Foundation Grant # GU 3186