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The one-loop Green's functions of dimensionally reduced gauge theories

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Abstract. We apply the dimensional regularization technique as well as that by dimensional reduction to the calculation of the regularized one-loop Green's functions in d_0-dimensional Yang-Mills theory with real massless scalars and spinors in arbitrary (real) representations of a gauge group G. As a particular example, the super-symmetrically regularized one-loop Green's functions of the $N = 4$ supersymmetric Yang-Mills model are derived.

Keywords. Regularization; gauge theories; supersymmetry.

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1. Introduction

The Kaluza-Klein idea (Kaluza 1921; Klein 1926) initiated the studying of gauge theories in higher dimensions of space-time. It has recently gained further importance due to developments of supersymmetric gauge theories including supergravities. Indeed, many interesting four-dimensional gauge models with extended supersymmetry are closely related to Lagrangian field theories in more than four space-time dimensions. The ten-dimensional supersymmetric Yang-Mills model (with $N = 4$ supersymmetry from the four-dimensional view point) and the ten-dimensional supergravity theories are of special importance due to their relevance to superstrings considered now as the most promising candidates for the unified theory of all fundamental interactions. These field theories arise from superstrings in the low-energy limit.

Introducing higher dimensions had been considered originally as a convenient mathematical tool for analyzing the structure of rather involved gauge theories with extended supersymmetry in four-dimensional space-time. However, recent advances in superstrings (Schwarz 1982, 1985) on the one hand, and the success in unifying Kaluza-Klein programme (Duff *et al* 1986) on the other, have reinforced the importance and possible physical significance of additional dimensions.

Therefore, it is of interest to elaborate the quantum structure of higher-dimensional gauge theories, as regards the effective action, the divergences, the ultraviolet asymptotics of Green's functions and so on. Despite considerable work in this field, only partial results are available for maximally extended supersymmetric gauge theories in view of the absence of a superfield description acceptable for quantum calculations in superspace. Hence, it is reasonable to further develop the conventional perturbative methods, which are familiar in the quantum non-Abelian gauge theory