Commun. Math. Phys. 77, 229–250 (1980)

Communications in Mathematical Physics


# Functional Determinants in Euclidean Yang-Mills Theory*

Constantine Callias[1] and Clifford H. Taubes[2]

[1] Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, MA, 02139, USA
[2] Lyman Laboratory of Physics, Harvard University, Cambridge, MA, 02136, USA

**Abstract.** We study functional determinants entering the path integral for topologically non-trivial sectors of Euclidean SU(2) Yang-Mills theory and we derive some results in exact closed form.

## 1. Introduction

We present in this paper a calculation in exact closed form of some functional determinants arising in the study of quantum corrections about multi-pseudoparticle solutions to Euclidean SU(2) Yang-Mills theory.

Our calculation is a continuation of the results of 't Hooft [1] on the quantum field theory about the single pseudoparticle solution. The isospin-1/2 and fermion determinants that we calculate, however, only partially extend this program.

We have not attempted in this paper to deal with the general $8n-3$ parameter multi-pseudoparticle solutions. Rather we restrict ourselves to the $5n$-parameter one [2]. The obvious extension to the $5n+4$ parameters [2] is impossible for technical reasons having to do with the asymptotic behavior at spatial infinity, as will become apparent in the statement of Proposition 5. Other authors [3] however, have studied the properties of the determinant under conformal transformations and the results can be used to pass from the $5n$ to the $5n+4$ parameters. The case we are studying here has also been attacked independently by Brown and Creamer [4] who use a point-splitting method of regularization and previous knowledge about the Green's function for the covariant Laplacian to calculate the determinant.

Our method uses a Pauli-Villars type of regularization, and the derivation although truly simple covers a much wider class of background configurations than just the self-dual solutions to the Yang-Mills equations; in fact it includes an infinite dimensional manifold of non-self-dual backgrounds. The final answer can

* This work is supported through funds provided by the US Department of Energy (DOE) under Contract EY-76-C-02-3069 and by the National Science Foundation through funds provided under Contract PHY 79-16812

0010-3616/80/0077/0229/$04.40