بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

بعض الوثائـــــق
الاصليـــة تالفـــة

بالرسالة صفحات

لم ترد بالاصل

ON INFINITESIMALLY DEFORMED FIELD THEORY

Thesis

Submitted to The Faculty of Science Zagazig University

For

Ph. D. Degree in Mathematics
(Applied Mathematics)

By

Fawzia Mohamed Elsayed Khaliel
(M. Sc. in Mathematics, Zagazig University)

Supervised by

Prof. Dr.
R. A. Abdellatif
Prof. of Mathematics
Zagazig University

Dr.
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Assistant Prof. of Mathematics
Mansoura University

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1996

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الله

بسم الله الرحمن الرحيم

سُبحانكَ

لا عِلمَ لنا إلا ما علّمتنا إنكَ أنتَ العليمُ الحكيمُ

صدق الله العظيم

ACKNOWLEDGMENT

I wish to express my deep thanks and gratitude to my supervisor professor R.A. Abdellatif for his continuous help and guidance throughout the different stages of the present work.

I wish to offer my gratitude to my supervisor Dr. E. Ahmed for suggesting the problem considered in this thesis, and for his continuous advice and valuable discussions.

I also wish to offer my deep thanks for all members of my family for their invaluable patience, help and support.

ABSTRACT

The present thesis is a study of the infinitesimally deformed (ID) field theory. It consists of three chapters and three appendices .

The first chapter contains an introduction to quantum chromodynamics (QCD) and thermo field dynamics (TFD). It contains also a study of the gauge theory at zero and finite temperature. We also prove that the gauge theory is asymptotically free.

In the second chapter, we discuss the quantum groups and q- deformed oscillator. In particular we show how the properties of q- deformed oscillator are extended to the field theory. In this chapter the anyonic variables are also discussed.

In the third chapter, we discuss the physics of the ID field theory. We apply infinitesimal deformation to φ^4 theory and show that it has no ultraviolet divergences. We also apply infinitesimal deformation to the QCD field theory. We suggest that ID field theory is more suitable than the ordinary one in discribing the high energy interactions and prove that ID QCD theory is also asymptotically free.

The appendix A contains computations of the one - loop corrections at zero temperature.

The appendix B contains computations of the one - loop corrections at finite temperature.

In the appendix C, we calculate some 4 - dimensional integrals by using the cut off method.

CONTENTS

INTRODUCTION

INTRODUCTION

An infinitesimally deformed (ID) field theory is an ordinary field theory with infinitesimal deformation. The notion was first introduced in the study of the harmonic oscillator algebra when quantum groups are applied.

Quantum groups [1-3] are introduced as structures related to the symmetry algebra which possesses tensor products. These tensor products correspond to the operator product algebra in quantum field theory. Hence quantum groups play a role for quantum mechanical systems that is analogous to the role of ordinary groups in classical mechanical systems. Quantum groups are defined as the objects on which the non-commutative Hopf algebra [1-7] is defined. Such as the quantum group Gq which is interpreted as the quantized version of the Lie group G.

The quantum deformation of an algebra u is obtained by deforming the relations of u by changing them in a manner depending on some formal parameter q such that as q -----> 1 the orginal algebra is obtained.

As an application of quantum groups, the q- deformed oscillator [8-11] is introduced in which the ordinary Heisenberg - Weyl algebra [12] is replaced by a non - standard algebra depending on a deformation parameter q where as q ------> 1 we recover the ordinary Heisenberg algebra. Biedenharn [8] showed that for the q- position and q- momentum the uncertainty is minimal only in the limit q ----> 1 and it increases with the occupation number n for $q \neq 1$.

Ahmed et al. [13] considered an infinitesimal deformation $q = 1+\ell$, where ℓ is small and the terms of order ℓ^2 are neglected, for the harmonic oscillator. They deduced the Lagrangian of the ID oscillator and by analogy the ID field theory was constructed .

The ID Heisenberg algebra has been discussed in Refs. [13,14], where it was suggested that this algebra corresponds to the high energy canonical algebra which has a new uncertainty relation at high energy .

The physical meaning of the ID field theory has been discussed in Refs.[10,11,13] where it has been suggested that ID field theory naturally explains confinement and implies a discretization of space- time, hence it has a natural cut off and hence is more suitable than the ordinary field theory in describing high energy interactions.

The purpose of this thesis is to study the ID field theory. The thesis contains three chapters and three appendices.

The first chapter contains elements of zero and finite temperature quantum chromodynamics (QCD). This chapter consists of three sections : the first section is an introduction to QCD [15-17] where properties of QCD are studied. The proof that the theory is asymptotically free is also given. In the second section, we study the thermo field dynamics (TFD) [18] to extend the usual field theory to finite temperature. In the third section, we study the gauge theory at finite temperature using the TFD [19,20] and we prove that QCD is also asymptotically free at finite temperature.

In the second chapter the ID harmonic oscillator is studied. This chapter contains three sections; the first section is an introduction to quantum groups and their properties. The second section is a discussion of the q- deformed oscillator by using quantum groups and explanation of how the properties of this system are extended to the field theory. In the third section, the anyonic variables [21] are studied. These variables correspond to the particles with fractional statistics.

In chapter three, the ID field theories are discussed,. This chapter consists of three sections: the first section is a discussion of the physics of the ID field theory. In particular, we show that this theory naturally explains confinement and implies a discretization of space- time. In the second section, we study the ID φ^4 theory at zero and finite temperature as an example of a scalar field. In the third section, we study the ID QCD field theory and we prove that this theory is also asymptotically free.

The appendix A contains some computations of the one-loop corretion at zero temperature in QCD by using the dimensional regularization technique.

The appendix B contains the same computations given in appendix A calculated at finite temperature.

Finally, the appendix C contains some calculations of 4- dimensional integrals using cut off.

The thesis is ended by conclusions and references.