



شبكة المعلومات الجامعية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



شبكة المعلومات الجامعية
@ ASUNET



شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم



شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكرو فيلم

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 الوثائق الأصلية تالفة

بالرسالة صفحات لم ترد بالاصل

٤٥٨١



UNIVERSITY OF ASSIUT
FACULTY OF SCIENCE
DEPARTMENT OF MATHEMATICS

ELIMINATION OF INFINITIES OF ELECTRODYNAMIC PROCESSES

Thesis Submitted to the Faculty of Science
University of Assiut

For
The Degree of Doctor of Philosophy (Ph. D.)
(Applied Mathematics)

By

Essam Edfawy Mohamad

B. Sc in Mathematics (1983)
M. Sc. in Mathematics (1989)

Supervised By

Prof. Dr.

Afaf A. Sabry

Professor of Applied Mathematics
University College of Women
for Arts, Science and Education
Ain Shams University, Cairo

Prof. Dr.

Mahmoud EL-Sayed EL-Boghdady

Professor of Applied Mathematics
Faculty of Science
Assiut University

Faculty of Science
University of Assiut
EGYPT
1996

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

All gratitude is due to ALLAH EL MAGEED who has ever guided and helped me to bring forth to light this thesis.

I wish to express my deep gratitude to prof. Dr. Afaf A. Sabry prof. of Applied Mathematics, university college of women for Arts, Science and Education, Ain Shams University, who has suggested the problem, and who has generously helped with helpful advices to solve all the problems in my thesis.

I am also greatly indebted to prof. Dr. Mahmoud EL-Sayed Salama El-Boghdady, professor of Applied Mathematics Faculty of Science, Assiut University, for his supervision of my thesis and for his encouragement.

It is a pleasure to express my great thanks to Prof. Dr M.A. Abdel-Gaid , Head of Math. Dept., Faculty of science, Assiut University .

My thanks are also due to the staff members of the math. Dept. for facilities and efforts.

E.Edfawy

CONTENTS

CONTENTS

	page
Introduction.....	1
CHAPTER I	
Lagrangian Formalism in Quantum Electrodynamics and the Free Fields .	
1.1. Lagrangian Formalism in Quantum Electrodynamics	12
1.1.1. Equations of Motion.....	12
1.1.2. Conservation laws.....	13
1.1.3. Explicit expressions for the tensor $t_{\mu\nu,\rho\sigma}$	18
1.2. The Free Electron-positron Field	18
1.3. The Free Electromagnetic Field	25
CHAPTER II	
Interaction between Fields and the S-matrix .	
2.1. The Dirac and Maxwell Fields in Interaction	29
2.2. The S-Matrix	30
CHAPTER III	
Radiative corrections in Lowest order and current operator.	
3.1. Radiative Corrections in Lowest Order	41
3.2. The Current Operator	43
3.3. The Current Operator to First Order and the Charge Renormalisation	44
3.4. Mass Renormalisation	49
3.5. Radiative Corrections to the Current Operator.....	60

3.6. Radiation Reaction on the Electron	67
---	----

CHAPTER IV

Application : Bremsstrahlung in an External Field .

4.1. Bremsstrahlung in an External Field	75
4.2. The differential Scattering Cross Section of Bremsstrahlung for the Scattered Electron	82
4.3. Radiative Correction to the Scattering in an External Field (The Infrared Catastrophe).....	119

CHAPTER V

The Weak Interaction

5.1. The Current-Current Interaction.....	132
5.2. The Yang-Mills Field.....	142
5.3. The Glashow-Salam-Weinberg Model of leptons	150

APPENDICES

1. Hilbert Space and Quantum Formalism	156
2. Properties of the product of γ matrices and Evaluation of Traces.....	168
3. Indefinite Integrals	169
4. Definite Integrals.....	170

REFERENCES.....	178
-----------------	-----

INTRODUCTION

INTRODUCTION

The development in understanding the behaviour of particles and the rules they obey was so quick during our century that it is quite essential to give a short review of the development of thoughts and new concepts leading to the present status.

After Newton, the important development was the discovery by Maxwell of his famous laws of electromagnetism, which at the same time described the electromagnetic waves as described by electric and magnetic vectors.

Relativity is in fact started as a result of considering the invariance of Maxwell's equations in different systems. Lorentz showed that the only linear transformations between x, t and x', t' that keeps the form of Maxwell's equations are the Lorentz transformation, and not the Galilean transformations which kept Newton's equation invariant.

Einstein then the real basis of Relativity on defining the mass as the energy, and then by the discovery of the general relativity.[1]

Quantum mechanics was based on the concept that the motion of particles can not be followed, which was based on the Heisenberg uncertainty principle. This fact implied another more important concept for a system of identical particles. A state of N identical particles can not be differentiated quantum mechanically from a state when they interchange their positions. It follows that $N!$ of what we call classical states originating from the total number of interchanges of the particles constitute only one

quantum state. This concept had a far reaching consequence in statistical mechanics, which was developed before the discovery of quantum mechanics. Originally Boltzman formulated the historically important law of finding statistically the absolute entropy of a system of particles as the logarithm of the total number of available states of the system. Applying his definition to the mixing of two portions of an ideal gas of identical particles led to the well known Gibb's paradox. This paradox was remedied artificially by dividing the calculated number of classical states by $N!$. At that time it was not known the physical reason for this, as quantum mechanics was not yet discovered. After the discovery of quantum mechanics, it is now a common practice to define the statistical states, as quantum states available to the system. The development of quantum mechanics was so quick. It started by introducing a state function $\psi(\vec{x}, t)$ which satisfies the Schrödinger equation, in which the momentum operator is defined as a differential operator

$$p = \frac{\hbar}{i} \frac{\partial}{\partial q} . \quad (1)$$

The function ψ is complex, and its physical meaning comes from the definition of the charge and current densities, as is well known. The Heisenberg first quantisation rules came next:

$$pq - qp = \frac{\hbar}{i} , \quad (2)$$

that the momentum operator satisfies this rule instead of the definition (1). In fact the definition (1) is satisfied by the more general definition (2).

Pauli made the important concept of defining the state ψ as a