بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

MONA MAGHRABY

Ain Shams University
University College for Women
(Arts, Science, and Education)
Department of Mathematics

Some Statistical Aspects for Non-linear Interaction Between Some Quantum Systems

A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE (M.Sc.)
(APPLIED MATHEMATICS)

BY

Asmaa Tarek Mohamed Abd-El latef

Department of Mathematics
University College for Women
Ain Shams University

SUPERVISORS

Prof. Dr. Mohamed M. Ali Ahmed
Professor of Applied Mathematics
Faculty of Science
Al-Azhar University

Prof. Dr. Samia Saeed Al-Azab
Professor of Applied Mathematics
Faculty of Women (Science)
Ain Shams University

Ass. Prof. Doaa Ahmed M. Abu-kahla
Doctor of Applied Mathematics
Faculty of Education
Ain Shams University

(2021)

Ain Shams University
University College for Women
(Arts, Science, and Education)
Department of Mathematics

M.Sc. Thesis
(APPLIED MATHEMATICS)

Title of Thesis:

Some Statistical aspects For Non-linear Interaction between Some Quantum Systems.

Thesis supervisors:

Prof. Dr. Mohamed M. Ali Ahmed
Professor of Applied Mathematics
Faculty of Science
Al-Azhar University

Prof. Dr. Samia Saeed Al-Azab
Professor of Applied Mathematics
Faculty of Women (Science)
Ain Shams University

Ass. Prof. Doaa Ahmed M. Abu-kahla
Doctor of Applied Mathematics
Faculty of Education
Ain Shams University

Ain Shams University
University College for Women
(Arts, Science, and Education)
Department of Mathematics

COURSES

The student has passed the following courses in partial fulfillment of the requirement for an M. Sc. degree:

1.	**Quantum Theory.**	**3h per week**
2.	**Complex Analysis.**	**3h per week**
3.	**Numerical Analysis.**	**3h per week**
4.	**Writing Scientific Research.**	**3h per week**
5.	**Partial Differential Equations.**	**3h per week**
6.	**Computational Methods in Applied Mathematics.**	**3h per week**
7.	**Relativity Quantum Mechanics.**	**3h per week**
8.	**Ethics of Scientific Research.**	**3h per week**

Head of Mathematics Department

قَالُوا۟ سُبْحَٰنَكَ لَا عِلْمَ لَنَآ إِلَّا مَا عَلَّمْتَنَآ ۖ إِنَّكَ أَنتَ ٱلْعَلِيمُ ٱلْحَكِيمُ ۝

(سورة البقرة: 32)

Contents

Acknowledgment

In the name of Allah, the Merciful, the Beneficent. Praise be to Allah, the Lord of all worlds. Prayers and peace be upon our Prophet, Muhammad, his family, and all of his companions.

First and foremost, my limitless thanks to ALLAH , for help, blessing, and showing me the right path to introduce this work. I am totally sure that this work would have never come to light, without ALLAH almighty.

All my profound gratitude goes to Prof. Abdel-Shafy F. Obada, and to my supervisors Prof. Mohamed M. A. Ahmed, Prof. Samia Saeed Al-Azab, and special thanks to Dr. Doaa A. M. Abu-kahla.

My completion of this project could not have been accomplished without their inspiring guidance, encouragement, advice, valuable discussion, and the limitless time and effort they put into researching various topics, answering my many questions and proof reading several times of this thesis. I couldn't imagine having better supervisors and mentors to my thesis study.

All members of the "Quantum seminar" in Al-Azhar university have been brilliant, friendly, and patient collaborators during our studying. I wish to extend my

thanks to Mathematics Department, my Professors, my colleagues and Faculty of Science, University college for women - Ain shams University.

Last and not least, I would like to thank my family for all their support. I am deeply indebted to my parents who raised me with love and encouragement.

Thank you

Cairo, Egypt
2021

Asmaa Tarek.
Asmaa.Tarek@women.asu.edu.eg

Abstract

In this thesis, the interaction between a three-level atom and four systems of N-two-level atoms in different cases is studied. Besides, the atom is coupled with the systems by time-dependent coupling parameters.

The analytical solution of this model is presented. further, the influence of the Kerr-like medium on this model is introduced. The approximate solution of this system and the wave function are obtained, under a specific conditions, and therefore the Schrodinger equation is solved.

Finally, we consider our model, but in different interaction Hamiltonian. The exact solution for the wave function is obtained, by taking some special cases. We investigate some physical statistical properties of the three systems such as the atomic population inversion and the second-order correlation function.

Then also the effects of several parameters such as the numbers of two-level atoms of the four systems and the coupling parameters between spins on these statistical properties are studied.

The analysis of results manifests that correlated behavior can be controlled by

adjusting some parameters like the coupling parameters between spins.

Also, it has been revealed that the atomic inversion and correlation function are greatly affected by the Kerr medium.

List of Figures