



Physics Department

"Nuclear Structure and double Beta –decay in the mass region around $A \approx 130$ Interacting Boson-Fermion Model"

*Dissertation Submitted for the Degree of Doctor of Philosophy in
Nuclear Physics*

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2014



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Approval Stamp

/ /2014

Date of Approval

/ /2014

Approval of Faculty Council

/ /2014

Approval of University Council

/ /2014



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ACKNOWLEDGEMENT

All praise be to Allah for His bounty and blessing letting me finish this work. This thesis, as well as, my entire scientific career, could not have been accomplished without the help, support, and understanding of all the people I have been so lucky to work with during the period of the present work.

I am indebted to:

Prof.Dr.Hosnia Abuzaid , for her excellent supervision and guidance.

Thanks Go also to **Prof. Dr. Afaf M. Nada, Prof. Dr. Daw S. Mosbah Prof. Dr Omar M. Desouky and Dr. Thana M. Abedel Maksoud** for their valuable consultations and continuous assistance through out this process. You have been advisors in the true sense of the word, and I would not have made it through this without your unwavering help , support, and more importantly, for treating me as a colleague and a friend.

My sincere gratitude for:

Prof. Dr. Olaf Scholten for his endless support and enthusiasm. He always have time to answer all my curious questions over 12 years. Also, my sincere gratitude and acknowledgment for letting me introduce the W nuclei paper into my thesis. The paper added a great value to my work.

I'm really full of gratitude and appreciation to my parents , my wife "Um-Mohamoud" , my sons Mohamed, Mint Allah, Awab, Moad ,Tala and Ahmed parallel to their support, patience and encouragement all over the time.

Finally, I'm grateful to all relatives and friends for their continuous inspiration



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ABSTRACT

Theoretical calculations using the Interacting Boson-Fermion Approximation (IBFA-1) of the structure of $^{183,185,187}\text{W}$, $^{123,125,127,129,131}\text{Te}$, $^{125,127,129,131}\text{Xe}$ and $^{123,125}\text{I}$ were made. For $^{183,185,187}\text{W}$ the fermion is coupled to the system of bosons is taken to be in the negative parity $2f_{7/2}, 2f_{5/2}, 3p_{3/2}, 3p_{1/2}$ and in the positive parity $1i_{13/2}$ single-particle orbits, where for $^{123,125,127,129,131}\text{Te}$, $^{125,127,129,131}\text{Xe}$ and $^{123,125}\text{I}$ the fermion that is coupled to the system of bosons is taken to be in the negative parity $3s_{1/2}, 2d_{3/2}, 2d_{5/2}, 1g_{7/2}$ and in the positive parity $1i_{11/2}$ single-particle orbits, The calculated energies of low-spin energy levels of the odd isotopes are found to agree well with the experimental data. Also $B(E2)$, $B(M1)$ values and spectroscopic factors for single-neutron transfer are calculated and compared with experimental data. We wish to point out that, while our calculation with IBFM is standard, studies of this type are important to push the model towards applications to problems related to beta and double-beta decay.



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Thesis included seven chapters:

Chapter 1

A general introduction to the Interacting Boson Model (IBM1), which used in even-even nuclei calculations. In addition an extension for this model (Interacting Boson Fermion Model (IBFM)) is presented for even-odd nuclei calculations.

Chapter 2

A detailed explanation of the models connection to group theory is presented in this chapter. Group theory used to simplify the model Hamiltonian which diagonalized using PHINT computer code for even-even nuclei and ODDA code for odd-even nuclei. Many nuclear properties were calculated using these codes as energy levels, parity, and electromagnetic transitions.

Chapter 3

In this chapter a detailed calculation of the nuclear structure are presented for even-even $^{182,184,186}\text{W}$. Depending on group theory classification a nice shape change of these nuclei remarked from $O(6)$ to $SU(3)$ in $^{182,184,186}\text{W}$ nuclei.

Chapter 4

In this chapter a detailed coupling of single fermion in odd-even nuclei to its even-even core is discussed.

Chapter 5

The properties of nuclear structures, such as parity, energy levels, the spectroscopic factors, and electromagnetic transitions are calculated for odd-even $^{183,185,187}\text{W}$ using. It should be noted that the results are published in the Nuclear Physics A Journal. Due to the success in present



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calculations, referee of our paper recommended of using this model in single and double beta decay.

Chapter 6

The properties of nuclear structures , such as parity , energy levels, the spectroscopic factors, and electromagnetic transitions are calculated for odd-even $^{125,127,129,131}\text{Xe}$ and $^{123,125,127,131}\text{Te}$. We depended on a new even-even calculations(**S. Pascu et al., [2010]**). Our calculation also published in Nuclear Physic A, where the referee described them as a careful study presented Novel aspects worthy of publishing. In this paper we used same single fermion parameters.

Chapter 7

In this chapter we used even-even core of Te isotopes to describe odd-even $^{123-125}\text{I}$ nuclei. Parity , energy levels, the spectroscopic factors, and electromagnetic transitions are compared to data. These calculations accepted in the Eleventh Arab Conference on the Peaceful Uses of Atomic Energy , Sudan, 2012.

Contents

Acknowledgement

Abstract

Contents.....I

List of Figures.....V

List of Tables.....VII

CHAPTER 1

INTRODUCTION AND LITEIRATURE REVIEW

Page

1.1 Introduction.....1

CHAPTER 2

OUTLINES OF INTERACTING BOSON APPROXAMIATION

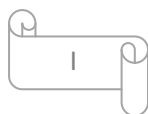
(IBA-1)

2.1 Introduction.....5

2.2 Outline of the model.....7

2.2.1 The Hamilton.....8

2.2.2 Other operators.....10



2.3 Dynamical Symmetries.....	10
2.3.1 The SU(5) limit.....	13
2.3.2 The SU(3) limit.....	17
2.3.3 The O(6) limit.	21
2.4 Energies.....	24

CHAPTER 3

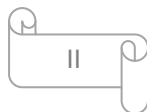
APPLICATIONS TO THE Even-Even ^{182,184,186}W ISOTOPES

3.1 Introduction.....	26
3.2 The Even–Even core.....	28
3.3 E2 Transitions.....	33
3.4 Summary.....	37

CHAPTER 4

INTERACTING BOSON-FERMUON MODEL IBFM-1

4.1 Introduction...../.....	38
4.2 IBFM-1 Hamiltonian.....	38
4.3 E2 and M1 Transitions	41
4.4 Spectroscopic factors.....	43



CHAPTER 5

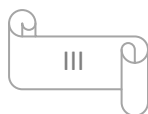
APPLICATIONS TO THE $^{183,185,187}\text{W}$ ISOTOPES

5.1 Introduction.....	45
5.2 Excitation Energies	48
5.3 E2 Transitions.....	54
5.4 Spectroscopic factors.....	56
5.5 Summary.....	59

CHAPTER 6

APPLICATIONS TO THE Tellurium $^{123,125,127,129,131}\text{Te}$ AND Xenon $^{125,127,129,131}\text{Xe}$ ISOTOPES

6.1 Introduction.....	60
6.2 Excitation Energies	62
6.3 E2 & M1 Transitions.....	79
6.4 Spectroscopic factors.....	86
6.5 Double Beta Decay.....	94
6.6 Summary.....	97



CHAPTER 7

APPLICATIONS TO THE $^{123,125}\text{I}$ ISOTOPES

7.1 Introduction.....	98
7.2 Excitation Energies	98
7.3 E2 Transitions.....	104
7.4 Spectroscopic factors.....	105
7.5 Summary.....	107
Conclusion.....	108

LIST OF FIGURES

<i>Fig No.</i>	<i>Item</i>	<i>Page</i>
2.1	A typical spectrum with SU(5) symmetry for N=6. In parenthesis are the values of ν and n_δ	16
2.2	A typical spectrum with SU(3) symmetry for N=6. With the parenthesis the values of λ and μ . Which label the SU(3) representation are given.	18
2.3	A typical spectrum with O(6) symmetry and N= 6. In parenthesis are the values of σ and n_δ .	23
3.1	Calculated energy levels for the even-core nuclei ^{182}W .	30
3.2	Calculated energy levels for the even-core nuclei ^{184}W	31
3.3	Calculated energy levels for the even-core nuclei ^{186}W .	32

5.1	Calculated energies for ^{183}W are compared to data. For each level the excitation energy in keV is given as well as the spin ($\times 2$) and parity.	51
5.2	Same as Fig. 5.1 but for ^{185}W	52
5.3	Same as Fig. 5.1 but for ^{187}W	53
6.1	Calculated energies for ^{123}Te are compared to data . For each level the excitation energy in keV is given as well as the spin ($\times 2$) and parity.	70
6.2	Same as Fig. 6.1 but for ^{125}Te .	71
6.3	Same as Fig. 6.1 but for ^{127}Te	72
6.4	Same as Fig. 6.1 but for ^{129}Te	73

6.5	Same as Fig. 6.1 but for ^{131}Te	74
6.6	Same as Fig. 6.1 but for ^{125}Xe	75
6.7	Same as Fig. 6.1 but for ^{127}Xe	76
6.8	Same as Fig. 6.1 but for ^{129}Xe	77
6.9	Same as Fig. 6.1 but for ^{131}Xe	78
6.10	Behavior of single fermion parameters in A=130 and A=180 region	94
6.11	Calculated spectroscopic factors for $s_{1/2}$, $d_{3/2}$, $d_{5/2}$	95
6.12	$M^{(0\nu)}$ as function of neutron number	96
6.13	Calculated energies for ^{123}I are compared to data[http://www.nndc.bnl.gov/]. For each level the excitation energy in keV is given as well as the spin ($\times 2$) and parity.	99
6.14	Same as Fig 7.1 but for ^{125}I .	100

List of Tables

<i>Table No.</i>	<i>Item</i>	<i>Page</i>
3.1	The IBM-1 parameters as used in our calculations.	29
3.2	Calculated B(E2) values in (e^2b^2) for transitions in the ^{182}W isotopes are compared to experimental data and a previous work by Duval and Barrett .	34
3.3	Calculated B(E2) values in (e^2b^2) for transitions in the ^{184}W isotopes are compared to experimental data and a previous work by Duval and Barrett .	35
3.4	Calculated B(E2) values in (e^2b^2) for transitions in the ^{186}W isotopes are	36

	compared to experimental data and a previous work by Duval and Barrett	
5.1	Occupation probabilities and quasi-particle energies for the $2f_{7/2}, 2f_{5/2}, 3p_{3/2}, 3p_{1/2}$ and the $1i_{13/2}$ single-particle orbits(s.p.o) as used in the calculation of the $^{183,185,187}\text{W}$ isotopes.	49
5.2	Calculated and experimental $B(E2)$ for $^{183,185,187}\text{W}$ isotopes values.	55
5.3	Spectroscopic factors for one neutron transfer from the ground state of ^{182}W to various excited states in ^{183}W are compared with the data .	57
5.4	Spectroscopic factors for one neutron transfer from the ground state of ^{186}W to various excited states in ^{187}W are compared with the data .	58
6.1	The IBFM parameters as used in $^{123-131}\text{Te}$ calculations compared to published values. All parameters are in MeV except χ dimensionless	64
6.2	The $A0$ parameter as used in $^{125-131}\text{Xe}$ calculations compared to published values.	65
6.3	The Γ_0 parameter as used in $^{125-131}\text{Xe}$	65