Physics Department

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

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

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ABSTRACT

Theoretical calculations using the Interacting Boson-Fermion Approximation (IBFA-1) of the structure of ^{183,185,187}W ,^{123,125,127,129,131}Te,^{125,127,129,131}Xe and ^{123,125}I were made. For ^{183,185,187}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}Te,^{125,127,129,131}Xe and ^{123,125}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 dignolized using PHINT computer code for even-even nuclei and ODDA code for odd-even nuclei. Many nuclear propitiates were calculates 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}W. Depending on group theory classification a nice shape change of these nuclei remarked from O(6) to SU(3) in ^{182,184,186}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 addition are calculated for odd-even ^{183,185,187}Wusing. It should be noted that the results are published in the Nuclear Physic A Journal. Due to the success in present

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}Xe and ^{123,125,127,131}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 $^{123\text{-}125}$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.

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