INVESTIGATIONS OF NUCLEAR PARAMETERS OF SOME RADIOACTIVE NUCLEI

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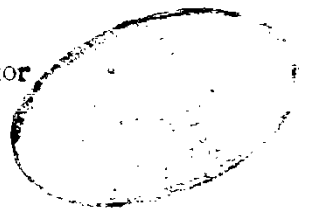

BY
SAMIA MOHAMED EL-BAHI
B. Sc. and M. Sc.

To
Department of Physics
University College for Girls
Ain Shams University
A. R. E.

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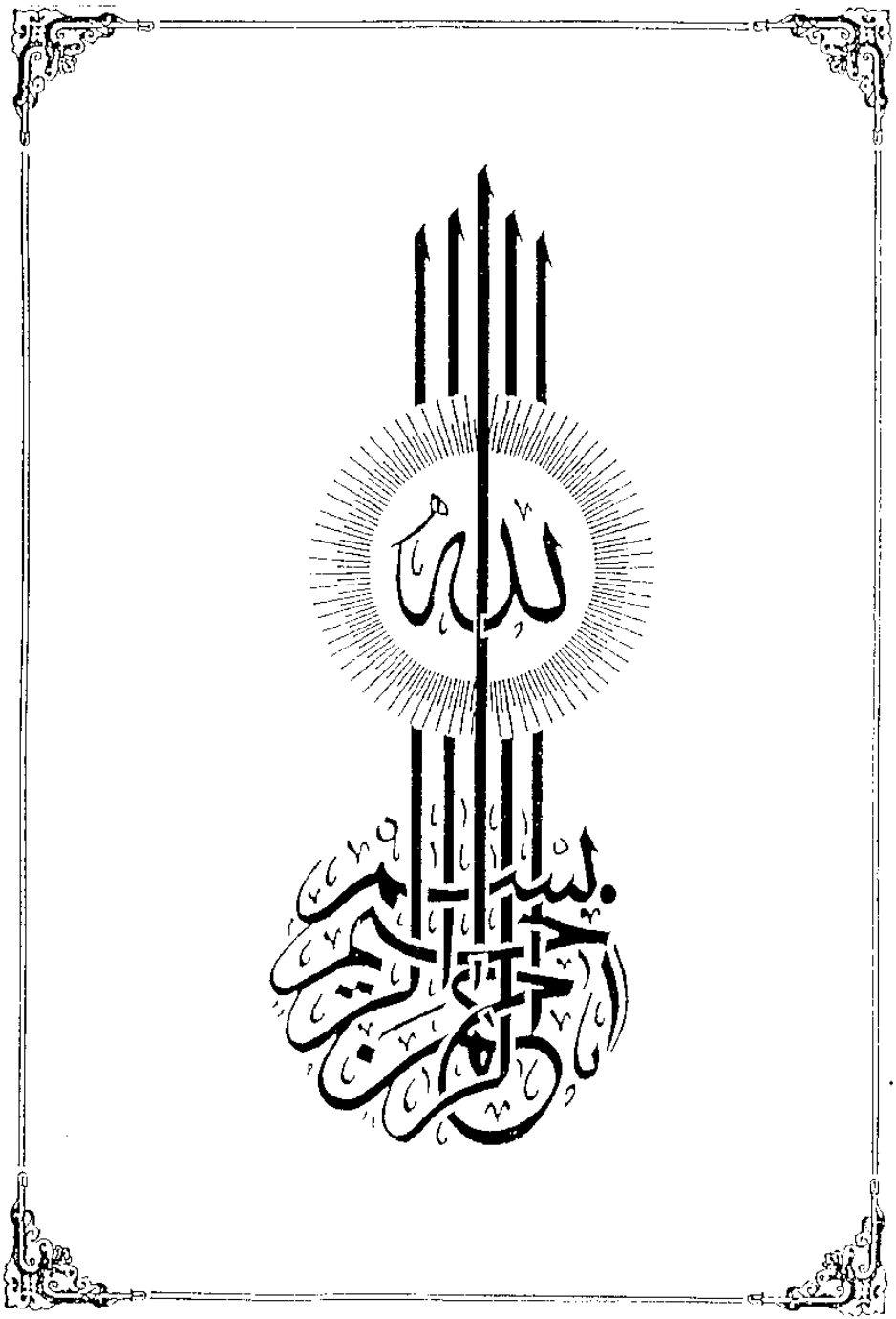
Thesis Advisors	Signature
1. Prof. Dr. A.M. Hassan Reactor and Neutron Physics Department, Nuclear Research Centre, Atomic Energy Authority.	
2. Dr. Aly El Naem Assistant Professor of Physics, University College for Grils, Ain Shams University	
3. Dr. Samia Abdel Malak . Assistant Professor of Physics University College for Girls, Ain Shams University .	Samia Abdel Malak

Approved

Head of Physics Department



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Abstract

The level structures of ^{159}Tb, ^{175}Lu and ^{153}Eu following the β^--decay of ^{159}Gd, β^--decay of ^{175}Lu and electron capture EC-decay of ^{153}Gd, respectively, have been studied utilizing a hyper pure Ge detector for $E_\gamma \leq 60$ keV a high purity Ge and Ge (Li) detectors for $E_\gamma \geq 60$ keV, as well as a Ge(Li)-NaI(Tl) fast-slow coincidence spectrometer. Gamma-ray energies and intensities were extracted from the gamma-ray spectra and gamma-gamma coincidence spectra.

In ^{159}Tb, twenty two gamma-ray transitions have been observed . Four of them at energies of 245±0.5, 269.5±0.3, 371.0±0.5 and 249.1±0.5 keV were observed for the first time belonging to the β^--decay of ^{159}Gd and confirm the excistence of two levels at 384.1 keV and 429.1 keV which were not reported before in the β^--decay of ^{159}Gd.

In ^{175}Lu, ten gamma-ray transitions which could be fitted into the decay scheme of ^{175}Yb. Four of these transitions with energies 89.4, 229.5, 343.4 and 432.8 keV have been observed for the first time which confirm the existence of two energy levels at 343.4 and 432.8 keV not earlier reported to be populated in the β^--decay of ^{175}Yb .

In ^{153}Eu, energies and intensities of the gamma transitions were extracted. These measurements clrify some experimental inconsistancies in the liter-

ature. The half-life of the 103.2 kev level was determined by delayed coincidence method to be 3.85 ± 0.08 ns.

Spin and parity assignments for all observed levels have been made from β^- and EC disintegration consideration and gamma branches. The experimental level schemes is described in terms of theoretical model predictions.

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INTRODUCTION

The study of radioactive nuclei still offers interesting and valuable opportunities for the experimental nuclear physicit. This is true in particular, since development in solid state detectors in combination with modern nuclear electornics and small computers have made possible experimental studies of high sophistication. Although at present a vast amount of information concerning the low energy levels(E_γ <1 MeV) of many nuclei is available, our knowledge on the nuclear level structure of some nuclei is far from complete.

The present thesis deals exclusively with the study of some radioactive nuclei.

The present work is concerned with the experimental studies of gamma-ray energies,transitions intensities, spins, parities and lifetimes for a number of beta-dacay radioactive nuclei. These nuclei have been investigated by observing the gamma-rays following the beta-decay utilizing a hyper pure Ge dectetor for low energy gamma-ray single spectrum measurements ($E_\gamma \leq$ 60KeV)and a nigh purity Ge (HPGe) detector for nigh energy gamma-ray single spectrum measurements ($E_\gamma \geq$ 60 KeV), as well as a Ge(Li)-NaI(Tl) fast-slow coincidence spectrometer.

The thesis contains five chapters,
Chapter I includes a general review on the theory of radioactivity, radiation detectors and their characteristics and the methods of analysis presently used. Chapter I also includes a breif review on shell and collective models.

There is a wide variety of experimental methods available to the nuclear spectroscopist. In the present investigation several instrumental techniques have been employed. These will briefly be reviewed in chapter II.

In chapter III, the level scheme of ^{159}Tb has been investigated by observing the gamma-rays following the β^--decay of 19.6h ^{159}Gd with high purity Ge detector and with a Ge(Li)-NaI(Tl) coincidonce spectrometer Gamma -ray energies and relative intensities were extracted from the gamma-ray spectra and gamma-gamma coincidence spectra. Twenty two gamma-ray transitions have been observed. Four of them at energies of 246.5±0.5, 269.0±0.3, 371.0±0.5 and 429.1±0.5 keV were observed for the first time belonging to the β^- - decay of ^{159}Tb and confirm the existence of two levels at 384 .1 KeV and 429.1 KeV which were not reported before in the β^- -decay of ^{159}Gd. Spin and parity assignments for all

observed levels have been made from beta distintegration consideration and gamma branches. The experimental level scheme of ^{159}Tb is compared with other level schemes of the adjacent ^{157}Tb and ^{161}Tb isotopes.

In chapter IV the β^-- decay of ^{175}Yb has been studied using high purity Ge(HPGe) detector and a Ge (Li)-NaI(Tl) fast-slow coincidence spectrometer. Investigation of the single and coincdence spectra revealed ten gamma-ray transitions which could be fitted into a level scheme of ^{175}Lu. Four of these transitions with energies 89.4,229.5, 343.4 and 432,8 KeV have been observed for the first time which confirm the existence of two energy levels at 343.4 and 432.8 KeV not earlier reported to be populated in the β^--decay of ^{175}Yb. Spin and parity assignments for all observed levels are deduced from log ft values and the gamma-ray branching ratios. The experimental level scheme is described in terms of the Nilsson model and compared with the adjacent ^{177}Lu level scheme.

In the last Chapter V , the level scheme of ^{153}Eu has been investigated by observing the gamma-rays from the electron capture decay of 241.6 d ^{153}Gd with Ge(Li) detector and a Ge(Li)-NaI(Tl) coincidence spectrometer

Energies and intensities of the gamma-transitions were extracted from gamma-ray singles and gamma-gamma coincidence spectra. The half-life of the 103.2Kev level in ^{153}Eu was determined by the delayed coincidence method to be 3.85±0.08 ns. Spin and parity assignments were made from log ft values and gamma-ray branching ratios.

CHAPTER I

SOME ASPECTS ON RADIOACTIVITY, RADIATION DETECTION and NUCLEAR MODELS

CHAPTER I

SOME ASPECTS ON RADIOACTIVITY, RADIATION DETECTION AND NUCLEAR MODELS

The knowledge which had been acquired concerning radioactivity has been gained by studying the interaction of nuclear radiations with matter [1]. Before proceedings to a discussion of the two different types of detetors used presently,consider briefly the nature of these interactions.

I.1. Types of Emission of Radioactive nuclei

The types of nuclear emissions observed from radioactive nuclides [2] are alpha,beta, k-kapture and gamma rays.All types will result from the trarsition from a definite nuclear energy level of the parent nucleus to a definite nuclear energy level of the daughter nucleus.

1. An alpha-decay leads to an element whose nuclear charge is reduced by2 and whose atomic mass number is reduced by 4 as compared to the corresponding quantities of the parent nucleus.

$$ {}_{Z}M^{A} \longrightarrow {}_{Z-2}M^{A-4} + {}_{2}He^{4} $$

2. A β^{-}-decay results in a new duaghter nucleus whose atomic number is increased by one with no change