Spectroscopic Investigation of A Radioactive Isotope

Thesis
Submitted for M.Sc. Degree
in
Nuclear Physics

By
Soheir El- Saied Soliman
(B.Sc.)

Physics Department
Faculty of Science
Ain Shams University

1993

ACKNOWLEDGEMENT

The author would like to express her scincere appreciation to Prof. Dr. K. ELSAIED, Head of Physics Departement of Faculty of Science for her encouragement during this work.

Many thanks due to Prof. Dr. H. ISMAIL, Prof. of Nuclear Physics and Dean of the Faculty of Education for sugesting the field of research, his help and his interest guidance.

Scincere thanks are also due to Prof. Dr. M. MOHSEN, for suggesting the point of research, her interest guidance and valuable discussion during the course of this work.

Deep thanks and appreciation are also extended to Dr. M.A. ABOU-LEILA, Assistant Prof., Phys. Dept., Faculty of Education for his valuable discussions, who helped in interpreting the results and his effort in revising the thesis.

Also I would like to thanks. Dr. A. SROOR, from Faculty of Girls, Ain Shams University, for her valuable help in supervising and analyzing measurements and for valuable discussions through the period of this research.

Deep thanks and appreciation to Dr. S. ABDEL-MALAK, Dr. M. ABDEL-WAHAB and Dr. S. SADEK from the Nuclear Physics laboratory, Faculty of Girls, Ain Shams University .

Scincere thanks are also due to Prof. Dr. A. NIESSEN, and Dr. F. PLEITER , from the Nuclear solid state, Department of the Rijks University of Groningen in the Netherlands, for providind the radiation isotope.

بسم الله الرحمن الرحيم

CONTENTS

ABSTRACT

ABSTRACT

The singles gamma ray spectrum of ^{154}Gd following the β^{-} - decay of ^{154}Eu has been measured up to 600 keV using a planer hyper pure Ge detector and a coaxial hyper pure Ge detector . The energy resolutions are found to be 0.511 keV for 122 keV γ-ray line of ^{57}Co and 1.7 keV for the 1333 keV γ-ray line of ^{60}Co respectively.

The gamma-gamma coincidence measurements have been carried out using HPGe-NaI(Tl) spectrometer provided with a fast-slow coincidence circuit.

The K-shell internal conversion coefficients for ^{154}Gd γ -transitions have been calculated from the gamma and electron intensity data. These coefficients have been compared with the theoretical values and the corresponding types and multipolarities of gamma transitions are deduced.

The half-life of the 123.1 keV state has been measured by means of the NaI(Tl)-NaI(Tl) delayed coincidence technique . The time resolution is found to be 1.46 ns.(FWHM) for ^{60}Co

The results of the present investigation can be summerized as follows:

1) The energies and relative intensities of about 71 γ-ray transitions were determined. Three γ-transitions at energies

165.32 ,431.08 and 448.64 keV were fitted for the first time into the proposed level scheme of ^{154}Gd.

2) The energy level at 1509 keV could not confirmed and were therefore not included in the proposed decay scheme.

3) The k-shell internal conversion coeffecients are determined on the basis of the present γ-ray intensities and the conversion electron intensities and compared with the theortical values of Silv and Band.

4) The fast-slow delayed coincidence life time spectrometer was used to measure the half life of the 123.1 keV level was found to be 1.2$\pm$ .04 ns.

5) The reduced transition probability has been calculated on the basis of the rotational values which was found to be .76±.035 e^2b^2. Also the intrinsic quadropole moment was found to be 6.18±.24 b , which gives a deformation parameter β = 0.27 ± .01

INTRODUCTION

INTRODUCTION

The study of radioactive nuclei still offers interesting and valuable opportunities for the experimental nuclear physics. This is true in particular. Since the devlopment in solid state detectors in combination with modern nuclear electronic have made possible sophisticated experimental studies

Study of decay schemes of radioactive nuclei provides a powerfull tool for testing the validty of nuclear models as well as for gaining knowledge about nuclear structure. Various detectors are used to study gamma-ray energies and intensities of which the scintillation and semi-conductor detectors are the most commonly used ones.

The aim of the present investigation is to study the decay scheme of ^{154}Eu to ^{154}Gd. This scheme was previously studied using different spectroscopic techniques. Morever, some discrepancies have been found concerning the presence of some γ-ray transitions and energy levels. It is of interest to remeasure singles and coincidence gamma spectra.

Scintillation detectors have better effeciency and timing properties while semi-conductor detectors have better energy resolution.

In the present investigation the γ-ray energies E_{γ} up to 600 keV and relative intensities in the decay of ^{154}Gd to ^{154}Eu, have been measured using germanium detector in singles spectrometer. The different cascade relation ships were confirmed through γ-γ coincidence experiments using a NaI (Tl)-Ge fast-slow coincidence spectrometer.

A Na I (Tl)- Na I (Tl) delayed coincidence life time spectrometer was used to measure the half life of the 123.1 level of ^{154}Gd.

The thesis contains three chapters .

The first chapter contains a general review on the interaction of gamma-rays with matter, gamma selection rules and the theortical basis of the life time measurements.

The second chapter contains the different instumental techniques, steps of measurements and system calibration for the spectrometers used in the present investigation.

The results of the present investigation are given in chapter three. A partial decay scheme is proposed and a discusion on the results is included.

LIST OF FIGURES

page

LIST OF TABLES

CHAPTER I
THEORITICAL BASIS