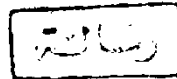
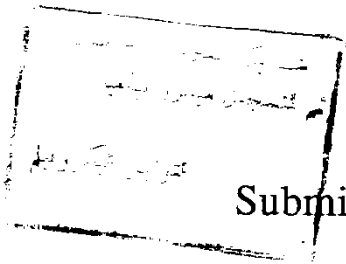




Spectroscopic Investigation of A Radioactive Isotope



Thesis
Submitted for M.Sc. Degree
in
Nuclear Physics

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ABSTRACT

ABSTRACT

The singles gamma ray spectrum of ¹⁵⁴Gd following the β^- decay of ¹⁵⁴Eu has been measured up to 600 keV using a planar 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 ⁵⁷Co and 1.7 keV for the 1333 keV γ -ray line of ⁶⁰Co 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 ¹⁵⁴Gd 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 ⁶⁰Co.

The results of the present investigation can be summarized 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 be confirmed and was therefore not included in the proposed decay scheme.

3) The K-shell internal conversion coefficients are determined on the basis of the present γ -ray intensities and the conversion electron intensities and compared with the theoretical 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 ± 0.04 ns.

5) The reduced transition probability has been calculated on the basis of the rotational values which was found to be $.76 \pm 0.035 e^2 b^2$. Also the intrinsic quadrupole moment was found to be $6.18 \pm 0.24 b$, which gives a deformation parameter $\beta = 0.27 \pm 0.01$.

INTRODUCTION

INTRODUCTION

The study of radioactive nuclei still offers interesting and valuable opportunities for the experimental nuclear physicist. This is true in particular. Since the development 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 powerful tool for testing the validity 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 ¹⁵⁴Eu to ¹⁵⁴Gd. This scheme was previously studied using different spectroscopic techniques. Moreover, 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 efficiency 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 relationships were confirmed through γ - γ coincidence experiments using a NaI (Tl)-Ge fast-slow coincidence spectrometer.

A NaI (Tl)-NaI (Tl) delayed coincidence life time spectrometer was used to measure the half life of the 123.1 keV 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 theoretical basis of the life time measurements.

The second chapter contains the different instrumental 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 discussion on the results is included.

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CHAPTER I

THEORITICAL BASIS