High Spin Spectroscopic Study of a few nearly spherical nuclei in A ∼ 150 region

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Introduction

The investigation of high-spin states of doubly magic nuclei and their neighborhood provide important testing ground for shell model calculations. So far as the nuclei in A ∼ 150 region are concerned, the doubly closed shell structure (Z = 64 and N = 82) persists in ^{146}Gd. Doubly closed nature of ^{146}Gd is indicative of a sharp increasing energy value of 2_1^+ state (see Fig. 1(a)) and decreasing value of R_{42} (see Fig. 1(b)). The present work deals with the spectroscopic study of a few nuclei lying within the vicinity of Z ∼ 64 and N ∼ 82 shell-closures. It is a matter of common fact that high-spin level structures of shell-model type nuclei, in general, is very irregular in nature and this makes the spin and parity assignments of the underlying levels much more difficult. Extensive angular correlation and polarization measurements are needed for unambiguous assignments of spins and parities of the levels observed upto the highest value of excitation. In this direction, we carried out an experiment to obtain high statistics $\gamma\gamma$ coincidence data and preliminary results from the experiment are presented here.

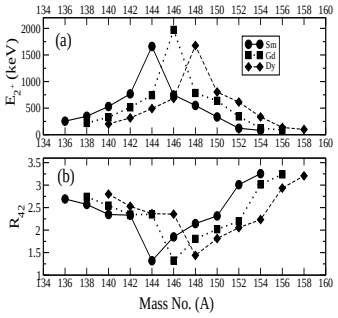

FIG. 1: Variation of (a) energy of 2_1^+ states and (b) R_{42} values along the chain of Sm-, Gd-, and Dy-isotopes. Here, R_{42} represents the ratio between the energy of the 4_1^+ and 2_1^+ states.

Experimental Procedure

The experiment was carried out using the 15UD Pelletron facility at IUAC, New Delhi. An enriched ^{115}In target of ∼ 1.20 mg/cm^2 thickness with a ∼ 9.46 mg/cm^2 Au backing was used. De-excited gamma rays were detected using the **I**ndian **N**ational **G**amma **A**rray (INGA) consisting of sixteen number of Clover detectors. These detectors were placed at 57° (4 detectors), 90° (5 detectors), 123° (4 detectors), and 148° (3 detectors) with respect to the beam direction. The data were analyzed using RADWARE and IUCSORT software packages [1]. The coincidence events were sorted into symmetric and asymmetric (angle dependent) matrices for off-line analy-

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sis. Proper care was made for the correction of on-line drift and gain matching. About 9 × 10^8 $\gamma\gamma$ coincidence data were collected during the experiment. The use of angle dependent asymmetric matrices are helpful for undertaking angular correlation measurements. These correlation measurements in coincidence mode provide necessary information for the assignment of multipolarities of the decaying transitions. The use of Clover detectors provide an added advantage for polarization measurements which would be helpful in determining the electric or magnetic nature of the decaying transitions, so that the unambiguous assignments of parities for the concerned excited levels could be made possible.

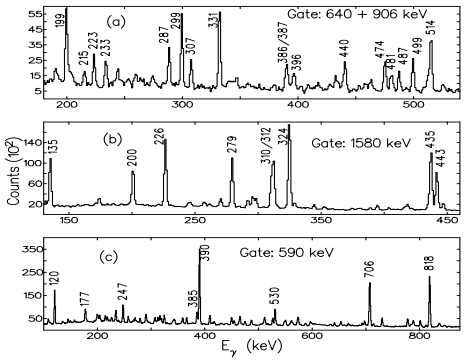

FIG. 2: Part of the γ spectra obtained from coincidence (a) sum gates of 640 keV ($13/2^- \rightarrow 11/2^-$) and 906 keV ($15/2^- \rightarrow 11/2^-$) of ^{145}Tb; (b) gate of 1580 keV ($3^- \rightarrow 0^+$) of ^{146}Gd; (c) gate of 590 keV ($11^+ \rightarrow 10^+$) of ^{146}Tb. In case of ^{145}Tb, sum gates are used because of the two possible decay branches to the ground state.

Experimental Results and Discussion

The representative coincidence spectra for a few nuclei populated in the experiment are shown in Fig.2. It is obvious from the figure that the nucleus, ^{146}Tb populated with highest statistics followed by ^{146}Gd and ^{145}Tb. Previous investigations of these nuclei reveal the existence of quasi-regular type of dipole band structure (*apparently* follows *I(I+1)* relation)at high excitation. As for example, a ΔJ = 1 dipole band is found to develop in ^{145}Tb at $E_x \sim 6$ MeV with J = 37/2 [2], whereas a similar type of band exists at $E_x \sim 8$ MeV with $J^\pi = (23^+)$ in ^{146}Tb [3]. For ^{146}Gd, dipole band like structure appears to develop at $E_x \sim 12$ MeV [4] and the spin-parity of the band head is not known. The coincidence statistics of our present experimental data is found to be almost an order of magnitude more than that obtained in the previous investigations. Thus, it is expected that the complete analysis of the data would lead to assign firmly the spin-parities of the members of the aforementioned bands. These informations would be the first step towards the possible establishments of "shears" band like structure in these nuclei. This type of band like structure has already been established in the neighboring nuclei such as ^{142,143,144}Gd, ^{141}Eu [5] *etc.*, and more recently in ^{143}Eu [6]. Possibility of observation of "shears" band like structure in this mass region is due to the availability of high-j ($h_{11/2}$) proton and neutron orbitals and irregular nature of the observed dipole-like bands in ^{145,146}Tb may be because of their close proximity to Z $\sim$ 64 and N $\sim$ 82 shell closures.

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