Spectroscopy of ^{152}Sm

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Introduction

The level structure of ^{152}Sm continues to provide a challenge to our understanding of nuclear structure. There is a very rapid change in the shape of the nuclear ground state from the apparantly spherical nucleus ^{150}Sm to the well-deformed nucleus ^{154}Sm [1]. The nucleus ^{152}Sm is well suited as a case study for the existence of multi-phonon β and γ vibrations in a deformed nucleus [2].

0_3^+ levels of ^{150}Sm and ^{152}Sm were observed to have different deformation in coexistence with their spherical and deformed ground state respectively [3]. In ^{152}Sm, 0^+ bands are quadrupole phonon multiplet structures interpreted from B(E2) and ρ^2(E0) systematic. Also 0_3^+ level has different mode of excitation from the β and γ modes [4].

Information on the level structure of the rotational band with 0_3^+ and 0_4^+ bandheads are scanty. All the connection of the negative parity bands to the other rotational or vibrational structures are not known as was seen for one of such bands developed on the β vibrational band [1]. Moreover, this nucleus is predicted to have a tetrahedral structure [5] being close to doubly magic tetrahedral nucleus [6]. So, it is important to explore the band structures and their decay relationships to other rotational/vibrational bands in detail.

In the present work, the excited states of ^{152}Sm have been studied using γ ray spectroscopy with twelve Clover HPGe detectors.

Experimental details

The excited states of ^{152}Sm have been populated by the reaction ^{150}Nd (α, 2n) ^{152}Sm with 26 MeV α beam delivered from K-130 cyclotron at VECC, Kolkata. 10 mg/cm^2 thick Nd_2O_3 powder, enriched in ^{150}Nd, deposited on a thin mylar foil, was used as a target. De-exciting γ rays were detected with an array of 12 Clover HPGe detectors out of which, 3 detectors were at 125° and 40° and 6 detectors were at 90°. Detectors were biased through various NIM standard HV power supply modules. Data acquisition was done with PIXIE-16 digitizer based data acquisition system [7], in singles mode. For data sorting and analysis, IUCPIX and RADWARE packages are being used.

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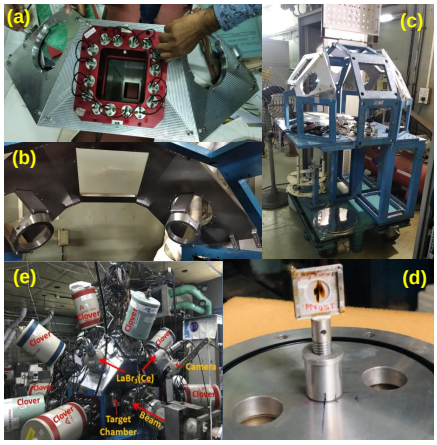

FIG. 1: Sequential development of the setup of Multi-detector Gamma array for in-beam experiment VECC-SINP-(UGC-DAE-CSR) collaboration and different parts of the array.

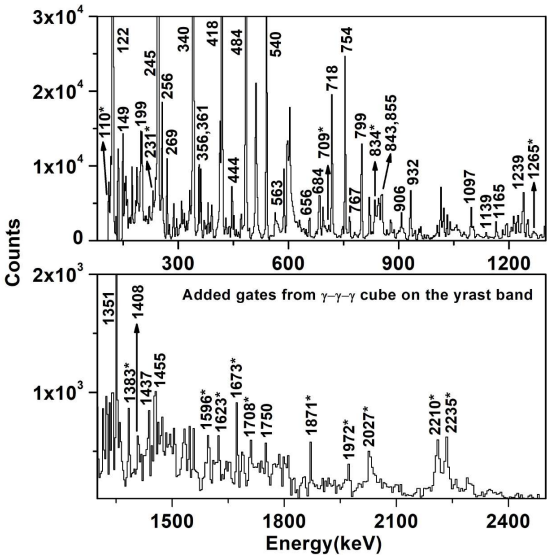

FIG. 2: Added gates corresponding to positive parity yrast band. New γ rays are marked with *.

Development of the experimental setup

The existing gamma array structure, fabricated by SINP, was modified to make the support structure of 12 Clover HPGe and 4 $LaBr_3$ detectors (see Fig. 1). The design and fabrication of the additional removable structure was done at MEG, VECC using precisely machined plates of Aluminum 6061 alloy . The center of the complete structure was aligned with the Channel-3 beam line of the cyclotron by using the Laser tracker with a deviation of (x=-0.86 mm, y=0.70 mm, z=0.37 mm) from the target center.

Analysis and Result

Data have been sorted to construct matrices, cubes and angle matrices for $\gamma-\gamma$, triple γ coincidence studies and DCO analysis, respectively. The energy calibration has been done by using in-beam γ lines of ^{152}Sm. ^{152}Eu source data has been used for efficiency calibration.

$\gamma-\gamma$ and triple γ coincidence data has been analyzed to find different coincidence relationships. Fig. 2 shows the added gates corresponding to +ve parity yrast band. New γ rays are seen that suggest new connection of this band with the other band structures. The -ve parity band structure developed on 1804 keV level has been studied and found to be developed on the γ vibrational band in this nucleus.

Acknowledgments

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References

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