

## Spectroscopy of gamma transitions of $^{118,119}\text{Sb}$

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### Introduction

Nuclei near shell-closure are primarily spherical in shape and exist in the most stable configuration. These nuclei, having few nucleons outside the core, provide important information on the interplay between collective and non-collective modes of excitations. Therefore, these nuclei play an important role to test various nuclear models.

Odd- $A$  Sb isotopes, having only one odd-proton outside  $Z = 50$  shell closure, are suitable candidates to study the shape-driving effect of the proton orbitals available near the Fermi surface. On the other hand, the odd-odd Sb nuclei can be treated as the test candidates to study the combined coupling effect of the odd-proton and odd-neutron orbitals with collective core. Thus, the observation of a rich variety of structural phenomena is expected in these nuclei. In the  $A \approx 120$  region, the  $d_{5/2}$ ,  $g_{7/2}$  and  $h_{11/2}$  orbitals are lying near the proton/neutron Fermi surfaces. Consequently, rotational bands based on these orbitals were reported in several Sb nuclei [1-3]. The generation of higher angular momentum in these weakly deformed nuclei can also take place through shears mechanism, as observed in  $^{116}\text{Sb}$  [4]. In addition to these, the existence of a high -  $K$  isomer is also reported in  $^{117}\text{Sb}$  [1].

In this paper, preliminary results on the spectroscopic study of  $^{118,119}\text{Sb}$  are reported.

### Experiment & Data analysis

Excited states in  $^{118,119}\text{Sb}$  were populated using  $^{116}\text{Cd}(^7\text{Li}, \text{xn})$  fusion-evaporation reaction at  $E_{\text{beam}} = 44$  MeV.  $^7\text{Li}$  beam was provided by the 14UD Pelletron Linac Facility (PLF) of TIFR-BARC, Mumbai. A 15 mg/cm<sup>2</sup> thick self-supporting foil of  $^{116}\text{Cd}$  was used as the target. De-exciting  $\gamma$ -rays were detected by 11 Compton suppressed HPGe clover detectors arranged in 4 different angles, with three each at  $23^\circ$ ,  $40^\circ$ ,  $90^\circ$  and two at  $65^\circ$ .

In this experiment, the beam energy was chosen to maximize the cross-section of  $4n$  ( $^{119}\text{Sb}$ ) evaporation channel. Population of the  $5n$  ( $^{118}\text{Sb}$ ) evaporation channel is also found to be significant at this beam energy. Apart from these, as  $^7\text{Li}$  is a weekly bound projectile, the breakup-fusion and/or incomplete fusion reactions also took place. Consequently,  $^{118}\text{Sn}$ ,  $^{116,117}\text{In}$  nuclei are also populated in this reaction. A Pixie-16 digitizer based data-acquisition system was used to record the valid events in singles and coincidence mode.

The list-mode raw data were processed further through energy calibration procedures to generate the add-back spectra of all the clover detectors. Then, the time stamped data were sorted using MARCOS code [5] to form a  $4k \times 4k$  symmetric  $E_\gamma$ - $E_\gamma$  matrix and were analyzed using Radware software package [6].

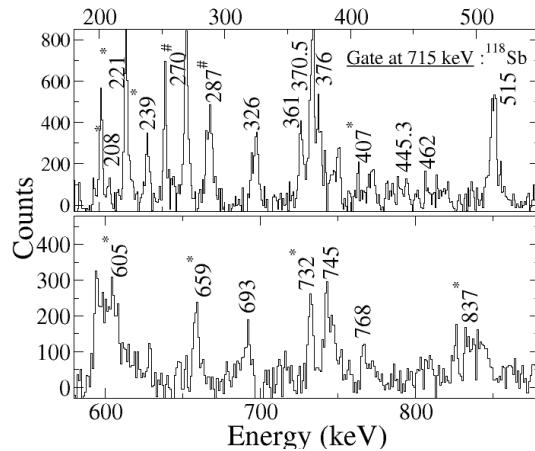
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## Result & Discussion

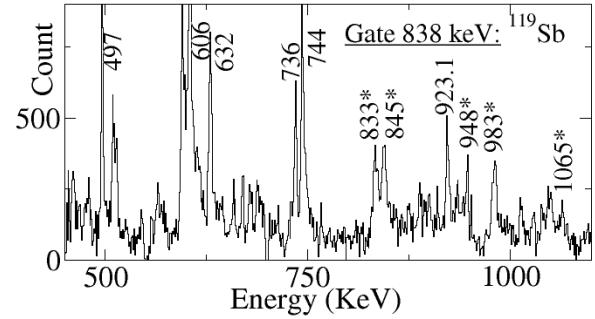
From the present data analysis, all of the reported  $\gamma$ -rays up to  $I \approx 17\hbar$  in  $^{118,119}\text{Sb}$  were observed. For example, the  $\gamma$ -rays of bands 2 and 3 in  $^{118}\text{Sb}$  [2] are shown in the 715 keV energy gated spectra (Fig. 1). The newly observed 221, 239, 407, 605, 659, 732 and 837 keV  $\gamma$ -rays, marked with \* in Fig. 1, are indicating a possible extension of band 3.



**Fig. 1:** Coincidence spectra with the gate on 715 keV transition of  $^{118}\text{Sb}$ . Newly observed  $\gamma$ -rays are marked with \*. '#' marked transitions are from  $^{119}\text{Sb}$ .

Additionally, the placement of two tentatively reported  $\gamma$ -rays, *viz.* 208 and 693 keV [2], were confirmed in this work. In a similar way, the  $\gamma$ -rays of band 3 in  $^{119}\text{Sb}$  [1] are shown in the 838 keV energy gated spectrum (Fig. 2). This band is extended further by placing two more  $\gamma$ -rays of energy 983 and 1065 keV, as shown in Fig. 2. In addition to these, few more  $\gamma$ -rays, marked with \* in Fig. 2, were also observed. This is again indicating a possible extension of Bands 2 and 3 in  $^{119}\text{Sb}$ . Furthermore, the  $E_\gamma$ - $E_\gamma$ - $E_\gamma$  are being analyzed to establish the new bands.

To assign the spins and parities to the excited states, the analysis of DCO and PDCO measurements are in progress.



**Fig. 2:** Coincidence spectrum with the gate of 838 keV ground state transition of  $^{119}\text{Sb}$ ,

## Summary

In-beam  $\gamma$ -ray spectroscopy of  $^{118,119}\text{Sb}$  was carried out via  $^{116}\text{Cd}(^7\text{Li}, \text{xn})$  fusion-evaporation reaction at 44 MeV. Acquired list-mode raw data has been processed and sorted in a symmetric matrix. From the present analysis, the placement of all the previously reported  $\gamma$ -transitions in these two nuclei have been verified and found in agreement. Several new  $\gamma$ -rays are also observed in this work which show a possibility of extending the level schemes of these two nuclei to a great extent. Further data analysis is in progress and the detailed results will be presented.

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