Observation of the oblate $g_{9/2}$ proton-hole band in ^{115}Sb

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Introduction

The nuclei near shell closures have provided a wealth of interesting physics and exhibit different collective structures that coexist with the single-particle structures. The Sb (Z=51) nuclei in A~110-120 region, with single proton above Z=50 core, provides the ideal condition to understand the competition between single-particle and collective degrees of freedom in these nuclei. The odd-A Sb isotopes in this region have dominant non-collective structure at low spin associated with the valence proton in the $d_{5/2}$, $g_{7/2}$ and $h_{11/2}$ orbitals. On the other hand, the collective structures are mainly observed at relatively higher spins [1-3]. It has been found systematically that, the proton 1p-1h excitation across the Z=50 shell gap gives rise to a strongly coupled (ΔJ=1) prolate deformed high-K $\pi g_{9/2}$ proton-hole bands in all these odd-A Sb isotopes [4]. In nearby odd-A $^{115\text{-}121}$I nuclei, the oblate band structures based on high-K $\pi h_{11/2}$ orbital has been observed along with the strongly populated low-K $h_{11/2}$ prolate bands [5-7]. The presence of proton Fermi level near to the $g_{9/2}$ orbital makes it likely to see the low-K $g_{9/2}$ oblate band along with the already known high-K $g_{9/2}$ prolate band in this region, and for that, investigation needs to be done. The present paper reports first time the observation of low-K $\pi g_{9/2}$ oblate band in ^{115}Sb.

Experiment

The excited states of the ^{115}Sb have been populated using the reaction ^{115}In(α, 4nγ)^{115}Sb at a beam energy of 52-MeV from the K-130 Cyclotron at VECC, Kolkata. The $\gamma\gamma$-coincidences were measured with a setup of 11 Compton suppressed clover HPGe detectors [10]. The Pixie-16 digitizer based digital data acquisition system [11] was used to acquire singles and 2–fold coincidence data. The data were sorted using BINDAS [12] and IUCPIX [11] package. Standard ^{152}Eu and ^{133}Ba sources were used for energy calibration, efficiency of the detectors and the polarization asymmetry correction factor measurements.

Analysis and Results

The coincidence relations between different γ–rays were carried out using symmetric matrix and the cube. An angle-dependent asymmetric matrix, between 90^o and 125^o detectors was made to determine the multipolarity of the γ–rays. For the polarization asymmetry measurements of the γ–rays, matrices corresponding to the parallel and perpendicular scattering in 90^o detectors were generated. All the matrices and the cube were analysed using Radware software package [13].

In this work, significant extension to the structure of ^{115}Sb has been made by placing approximately eighty newly observed γ–rays. Figure 1, represents the partial level scheme of ^{115}Sb, showing one of its band structures based on $\pi g_{9/2}$ orbital. The spin and parity assignments to the energy levels has been done by the DCO and PDCO measurements. The high-K $\pi g_{9/2}$ band sequence above 1380 keV, reported earlier [4], has also been observed in the present work. Figure 2, represents the coincidence spectrum corresponding to

this band and shows all the transitions present in the band.

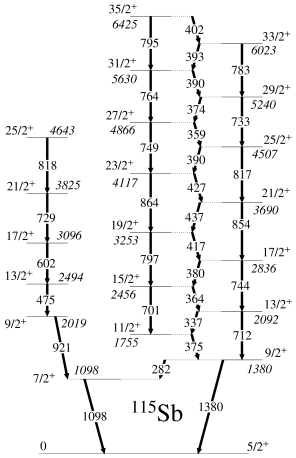

Fig.1: Bands based on $\pi g_{9/2}$ orbital in ^{115}Sb.

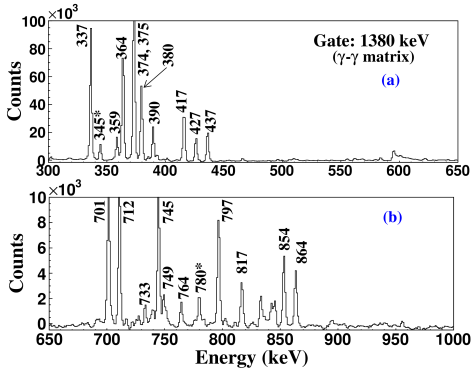

Fig.2: Gated spectra of 1380 keV: (a) lower energy and (b) higher energy part. The newly observed transitions are marked by '*'.

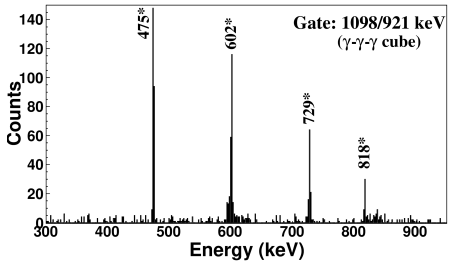

Fig.3: Double-gated spectrum corresponding to 1098 & 921 keV transitions. The newly observed transitions are marked by '*'.

On the left of level scheme, a new sequence: 475, 602, 729 and 818 keV of E2 transitions above 921 keV transition has been observed for the first time in ^{115}Sb. Figure 3, represents the coincidence spectrum corresponding to double gates of 1098 & 921 keV transitions and shows clearly the newly observed rotational band in ^{115}Sb.

Discussion

Due to the presence of the $g_{9/2}$ orbital near the proton Fermi level, the strongly coupled high-K $\pi g_{9/2}$ band with prolate deformation has already been found in ^{115}Sb. A decoupled band has been observed in the present work, as shown in the level scheme (on left) and is due to weak coupling of the valence $\pi g_{9/2}$ proton-hole with the core. This band can be explained as the low-K $\pi g_{9/2}$ oblate band in ^{115}Sb. The coexistence of prolate and oblate bands based on $\pi h_{11/2}$ orbital have been observed already in the neighbouring odd-A $^{115\text{-}121}$I nuclei.

Summary

The excited states of ^{115}Sb have been investigated using α induced fusion evaporation reaction and an array of Compton-suppressed Clover detectors at VECC. A sequence of E2 transitions based on $\pi g_{9/2}$ orbital with oblate deformation has been observed first the time in ^{115}Sb.

Acknowledgment

The sincere efforts from the members of VECC, SINP, UGC-DAE CSR, Kolkata and INGA collaboration for setting up the array are highly acknowledged. The Cyclotron operators of VECC are thanked for providing a good quality Alpha beam. S. Dar acknowledges the financial support from UGC.

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