Study of strongly coupled bands in ^{113}Sb

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Introduction

The low lying states in Antimony isotopes (Z=51) are single particle in nature. These states arise due to the coupling of valance proton $g_{7/2}$, $d_{5/2}$ *and* $h_{11/2}$ orbitals to the spherical Sn (Z=50) core. Collective states in these antimony isotopes are thought to arise from the excitation of $g_{9/2}$ proton across the Z=50 shell gap leading to two particle-one hole (2p-1h) excitations based on the $(g_{7/2})^2 \times (g_{9/2})^{-1}$ configuration. Two such sequences of ΔI=1 bands have been reported in Ref. [1]. Furthermore, many decoupled ΔI=2 rotational-like deformed bands have been recently identified up to high-spin states in different Sb isotopes. These states have been interpreted to arises due to the coupling between the valence nucleons occupying the $h_{11/2}$, $g_{7/2}$, and $d_{5/2}$ orbitals and the 2p-2h deformed core states of Sn. The present work concerns the study of two strongly coupled bands in ^{113}Sb.

Experimental Results

High spin states of ^{113}Sb were populated using the ^{100}Mo(^{19}F, 6n) reaction at a beam energy of 105 MeV at the Inter University Accelerator Centre (IUAC), New Delhi. The target consisted of isotopically enriched (99.5%) ^{100}Mo with a thickness of 2 mg/cm^2 evaporated on 8 mg/cm^2 gold foil. About 25×10^9 twofold and higher γ-γ coincidence events were collected using the Indian National Gamma Array (INGA) comprising 15 Compton-suppressed clover detectors. Four of these detectors were placed at 90^o and 148^o, three at 32^o, and two each at 57^o and 123^o to the beam direction.

Figure 1 shows the partial level scheme of ^{113}Sb. Bands marked 1 and 4 are the two strongly coupled bands for which the results are presented here.

The sequence of states (shown as band 1) arises from the possible configuration $\pi[(g_{7/2})^2 \otimes (g_{9/2}{}^{-1})] \otimes \nu 7^-$ where the $\nu 7^-$ refers to a spherical state of the Sn core. This band has been extended up to the 8543 keV state and a tentative spin of (43/2$^-$) with the placement of the 515 and 996 keV γ-rays. The transitions feeding out of this band to the 21/2$^-$ state of band 2 have also been re-arranged in comparison to that reported by Moon et al. [1].

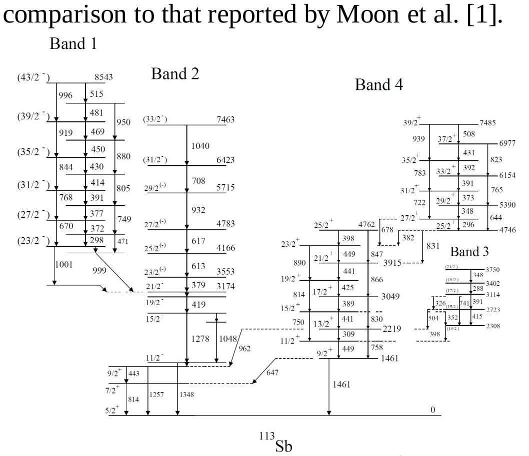

Fig. 1 Partial level scheme of ^{113}Sb

The low-lying levels with spins 5/2$^+$ (g.s.), 7/2$^+$, 9/2$^+$, 11/2$^-$ and 15/2$^-$ in band 2 are spherical states arising from the coupling of the valence proton in the $d_{5/2}$, $g_{7/2}$ and $h_{11/2}$ orbitals to the 0$^+$ and 2$^+$ states of ^{112}Sn. The higher energy states show an irregular level spacing indicating their non-collective nature. The 1040 keV transitions has been added extending the band to an excitation energy of 7463 keV. All previously reported transitions in the band have been confirmed. In addition, several new transitions are found to constitute a short sequence of states marked band 3. This band decays only to the states of band 4 as shown in Fig. 1.

The K = 9/2 band (band 4 in Fig. 1) has been observed up to 7485 keV in the present work. The earlier level scheme for this band reported in Ref. [1] has been considerably revised here. Five new transitions with energies 398 keV, 508 keV, 678 keV, 847 and 939 keV have been placed in the level scheme as shown in Fig. 1. In addition, the ordering of the 389 and 425 keV transitions as reported in [1] has been changed on the basis of the present coincidence relationships.

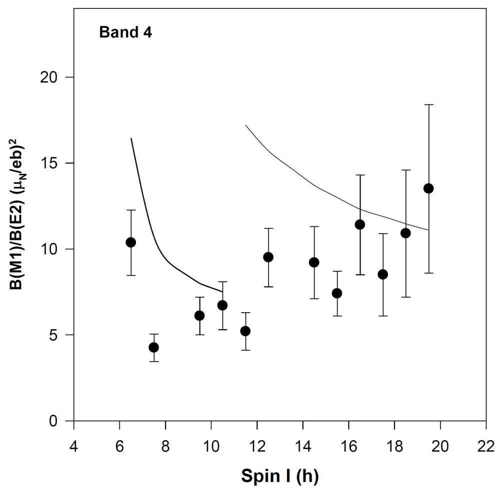

Fig. 2 Plots of experimental *B(M1)/B(E2)* ratios versus spin for states of band 4, before and after the $\nu(h_{11/2})^2$ alignment. The predictions of the Dönau-Frauendorf semiclassical calculations using g_R = 0.45, g_π=1.27, g_ν=-0.21 and Q_o=2.57 eb are also shown as continuous lines.

A similar K = 9/2 band in ^{115}Sb has been previously explained as due to the excitation of a $g_{9/2}$ proton across the Z=50 closed shell [2] and has been confirmed by potential energy surface calculations that predict a deformed minima due to a proton hole in the [404]9/2$^+$ orbital [3]. The band in ^{113}Sb, as in ^{115}Sb, does not show appreciable signature splitting as expected for high-K bands. Also, an abrupt $(h_{11/2})^2$ neutron alignment is observed at a rotational frequency of 0.40 MeV corresponding to an aligned spin of about 7$\hbar$.

Experimental *B(M1)/B(E2)* ratios have been estimated for the states of band 4 assuming that the multipole mixing ratios of the ΔI=1 transitions are small. These results have been compared (see Fig. 2) with the predictions of the Dönau-Frauendorf semiclassical calculations [4]. The quadrupole moment and the g-factors are taken from Ref. [2, 3]. Prior to the alignment, the experimental *B(M1)/B(E2)* ratios tend to decrease with increase in spin. The calculations overestimate the observed results before alignment while predicting the decreasing trend correctly. The experimental ratios for the aligned $\pi(g_{9/2})^{-1} \otimes \nu(h_{11/2})^2$ configuration are also smaller than the predictions. These would suggest that the states belonging to band 4 in ^{113}Sb have a somewhat larger deformation than predicted by the potential surface calculations [3].

References

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