A Comparative Study of the Strongly Coupled Band in-^{111,115}Sb

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Abstract: Strongly coupled band based on $\frac{9}{2}[404]$ *orbital extruding from below the* $Z = 50$ *shell gap have been observed consistently in odd-mass transitional nuclei with reasonable population intensity. However for neutron deficient odd-mass* ^{111}Sb *nucleus, it has been observed that there is a decrease in the strong coupling between the particle and the core in comparison to the higher mass* ^{115}Sb *nucleus.*

Introduction

Odd-mass transitional nuclei show low-spin positive parity band based on $\frac{9}{2}[404]$ orbital. Such bands are observed with $\Delta J = 1$ cascade $M1$ transitions corroborated by $\Delta J = 2$ crossover $E2$ transitions. These bands could be well interpreted by considering strong coupling of the odd-particle to the corresponding even-even core. In the odd-mass neutron deficient ^{111}Sb nucleus, band based on $\frac{9}{2}[404]$ orbital has not been observed[1] from $\frac{15}{2}^+$ state to $\frac{21}{2}^+$ state. The absence of transition has been interpreted as arising due to the change in the deformation parameter β[1]. In the present work we have used Particle Rotor Model with Variable Moment of Inertia formalism[2] to interpret and compare the structure of this strongly coupled band based on $\frac{9}{2}[404]$ orbital.

Result and discussion

The band structure of the strongly coupled band of ^{111,115}Sb based on $\frac{9}{2}[404]$ orbital and extending upto high spin has been well reproduced (fig.1) using PRM. The details of the model has been discussed elsewhere[2]. The calculation has been undertaken using $\mu = 0.48, \kappa = 0.07, \Delta = 1.139, \lambda_{qp} = 45.5MeV$, and deformation parameter $\beta = 0.24$. The best fit was obtained when the Coriolis attenuation factor was zero showing that the levels result from strong coupling of the particle to the core. The present study focusses on the variation of the elastic energy term of PRM given by

$$E_{elastic} = \frac{1}{2}C(\vartheta_{IK} - \vartheta_{0K})^2$$

where C is the stiffness parameter and $\vartheta_{IK}, \vartheta_{0K}$ are the moment of inertia at spin I and at ground state. A plot of this parameter for ^{111,115}Sb has been shown in fig.2.

Since the nuclei in the transitional region are soft rotors, a softness parameter has been

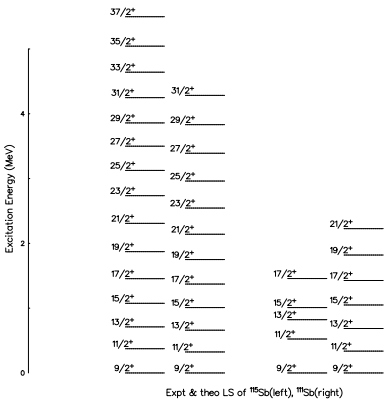

FIG. 1: Exprimental and theoretical positive parity levels in ^{111,115}Sb

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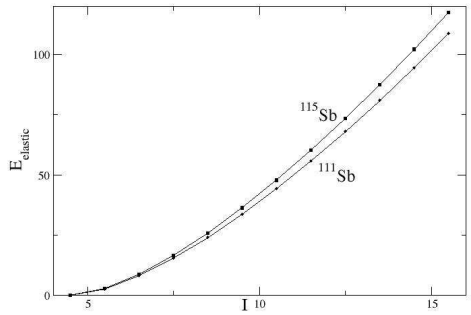

FIG. 2: Elastic energies for ^{111,115}Sb

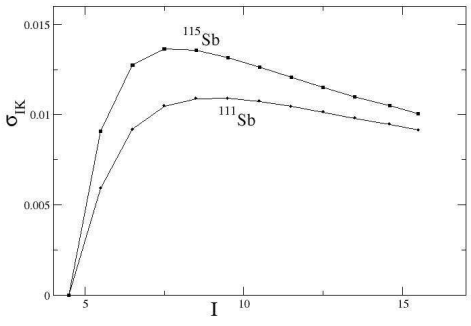

FIG. 3: Softness parameter for ^{111,115}Sb

defined [3] as

$$\sigma_{IK} = \frac{(2I+1)}{2C\vartheta_{IK}^2(3\vartheta_{IK} - 2\vartheta_{0K})}$$

and has been plotted in fig.3 for ^{111,115}Sb. The loss of band structure of ^{111}Sb beyond $\frac{17}{2}^+$ state has been attributed to the decrease in elastic energy coupled to increase in softness with increasing spin. The band structure observed again from $\frac{21}{2}^+$ spin state in ^{111}Sb may be attributed to the decrease of softness parameter from that spin. In case of ^{115}Sb however the strongly coupled band is observed down to $\frac{9}{2}^+$ band head which may be explained from fig.2 as occurring from increase in the elastic energy in comparison to ^{111}Sb. The softness parameter does not increase significantly when compared to the increase in elastic energy for ^{115}Sb.

Conclusion

The strongly coupled band based on $\frac{9}{2}$[404] orbital has been studied in the frame work of PRM. In ^{111}Sb this band is partly observed upto $\frac{15}{2}^+$ spin state after which it is observed from spin $\frac{21}{2}^+$. The loss in the band structure has been attributed to decrease in strong coupling resulting from the decrease in the elastic energy and increase in softness. For ^{115}Sb however the regular band structure of this strongly coupled band is observed down to $\frac{9}{2}^+$ band head.

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