Study of low-lying band stucture of transitional nuclei using Particle-Rotor Model - ^{109}Sb

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Introduction

Sb nuclei with Z=51 is expected to show onset of collective features as it lies close to the primarily spherical Sn nuclei. We have therefore investigated the low-lying band structure of ^{109}Sb nuclei using particle rotor model. We have used that version of PRM which include both pairing and VMI formalism[1,2,3].

The Nilson single particle levels appropriate for odd-proton nuclei in this mass region were calculated (Fig.1) using $\mu=0.48$ and $\kappa=0.07$ [4]. The deformation parameter δ was chosen as 0.20 and was observed to give reasonable fit to both the $\Delta J=2$ and $\Delta J=1$ band built on positive parity 5/2+ and 7/2+ states respectively. Calculations showed that the $\Delta J=2$ ground state band is based on 5/2[422] orbital where as the $\Delta J=1$ band is built on the 7/2[413] orbital. Both these bands could be reproduced without any admixture from other orbitals and have been predicted up to spin 29/2+ and 31/2+ respectively. The best fit was obtained when the Coriolis attenuation factor α was set to zero. The Fermi level was chosen close to the 5/2[422] orbital and the pairing gap $\Delta=12/\sqrt{A}$. The calculated level energies of the band based on the 5/2[422] orbital (Table.1) showed deviation from the experimentaly observed levels. Best fit was obtained with the maximum value of the moment of inertia co-eff. C. The corresponding calculation with the same parameter for the band built on the 7/2+ state gave better fit to the experimental results. The experimental results for both these bands show different structural characteristics. The $\Delta J=2$ band built on the 5/2+ ground state does not show the characteristic of a rotor where as the $\Delta J=1$ band built on the first 7/2+ state behaves like a soft rotor. The theoretical calculation on the other hand shows that both bands built on the 5/2+ and 7/2+ state act as soft rotors. Since the Sb nuclei has one proton above the Z=50 spherical Sn core the gradual onset of collectivity is clearly observed. The present calculation with complete attenuation of Coriolis interaction points to the same features as observed experimentally in ^{109}Sb .

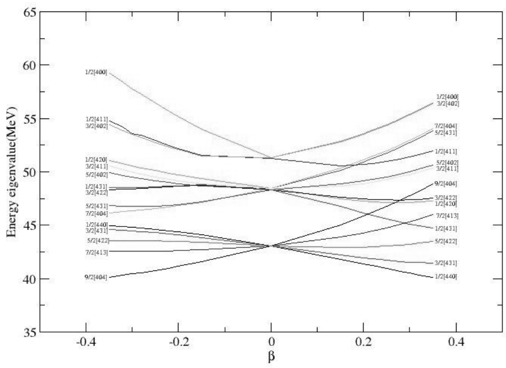

Fig. 1 Relevant Nilson diagram for ^{109}Sb

Conclusion

Calculation of the low-lying band structure of ^{109}Sb using PRM show that there is an onset of collectivity in comparison to the primarily spherical Sn nuclei. The band structure under investigation are based on pure configuration with no admixture. The calculation was pursued with complete attenuation of Coriolis interaction. The nuclei is observed to behave like a soft rotor.

Table 1: These are the positive parity transitions for the orbital3/2[431],5/2[422]for the bands 7/2+ & 5/2+ respectively.

$J_i \rightarrow J_f$	Expt. Energy (in Kev)	Calculated energy (in KeV)	Band & Orbital
9/2+ → 5/2+	1100	454	Band 1
13/2+ → 9/2+	991	622	5/2[422]
17/2+ → 13/2+	1210	757	
21/2+ → 17/2+	–	868	$\Delta J = 2$
25/2+ → 21/2+	–	962	
29/2+ → 25/2+	–	1043	
9/2+ → 7/2+	509	235	Band 2
11/2+ → 9/2+	513	276	3/2[431]
13/2+ → 11/2+	339	314	
15/2+ → 13/2+	78	348	
17/2+ → 15/2+	379	376	$\Delta J = 1$
19/2+ → 17/2+	–	407	
21/2+ → 19/2+	–	433	
23/2+ → 21/2+	–	456	
25/2+ → 23/2+	–	479	
27/2+ → 25/2+	–	500	
29/2+ → 27/2+	–	519	
31/2+ → 29/2+	–	538	

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