Description of collective and non-collective states in $^{120}$Te

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Introduction

Nuclei in $A \approx 120$ with vibrational collective properties at low spin [1] and high-spin deformed bands [2] have been considered. The configurations are labeled by the number of par-}

1. Calculations

In the calculations, parameters derived for $A = 110$ region has been applied [3]. Observed energies have been calculated with respect to a standard rotating drop energy. LublinStrasbourg drop (LSD) [6] with diffuse surface has been considered in order to calculate the rotational energy. An absolute energy scale based on mass excess has also been applied so that different nuclei can be compared. The calculations minimize the energy with respect to the deformation parameters $(\epsilon_2, \epsilon_4, \gamma)$. For $^{120}$Te, $^{114}$Sn with $Z = 50$ and $N = 64$ has been chosen as the core. The configurations have been labelled as $[p_0(n_1)p_2, n_0 n_1 n_2; n_3]$ where $p_1$ is number of proton holes in $(g_{7/2}, d_{5/2})$ and $p_0$ and $p_2$ are the numbers of protons in $(g_{7/2}, d_{3/2})$ and $h_{11/2}$ respectively whereas the number of neutron holes in $(g_{7/2}, d_{3/2})$ have been marked as $n_0$, the number of neutrons occupying $h_{11/2}$, $(h_{9/2}, f_{7/2})$ and $i_{13/2}$ as $n_1$, $n_2$ and $n_3$ respectively.

Results and Conclusions

Experimental and calculated E-E_{ld} vs spin have been shown in upper and lower panel of Fig. 1 respectively. The observed states between 0$^+$ to 18$^+$ can be described by coupling $\pi[(g_{7/2}, d_{5/2})^2]$ to $\nu[h_{11/2}]^{10,2,4}$ (Fig. 1 [2(0)0, 040;0]) $I_{\text{max}} = 6h, 14h, 22h$ respectively. Excitation of one proton from “gd” shell to $h_{11/2}$ with two paired up neutrons in $h_{11/2}$ may explain the negative parity states between 9h to 17h (see Fig. 1 [1(0)1, 040;0]). The configuration $\pi[(g_{7/2}, d_{5/2})^2] \otimes \nu[d_{3/2}, h_{11/2}^{1/2}]$ (see Fig. 1 [2(0)0, 030;0]) which becomes yrast at $I = 21h$. Two separate branches; branch “a” lying between 23h and 25h and branch “b” lying between 22h and 25h have been observed experimentally which feed to the state with $I = 21h$. The yrast branch “a” may have a possible configuration $\pi[(g_{7/2}, d_{5/2})^2, h_{11/2}] \otimes \nu[(h_{11/2})^2]$ (ref. Fig. 1 [1(0)1, 040;0]). On the other hand $\pi[(g_{9/2})^{-2}, (g_{7/2}, d_{5/2})^2, (h_{11/2})^2] \otimes \nu[d_{3/2}, h_{11/2}^{1/2}]$ with two protons excited across $Z = 50$ core may possibly explain the branch “b”.

Five high spin deformed bands have been observed in $^{120}$Te [5]. Yrast band has been tentatively connected to the low spin states through 795 keV transition at 25h of branch “a”; though parity has not been fixed yet. $(\pi[g_{9/2}^2(g_{7/2}, d_{5/2})^2, h_{11/2}^{1/2}] \otimes \nu[(g_{7/2}, d_{5/2})^{-2}, h_{11/2}^6])$ (ref. Fig. 1 [2(2)2, 260;0]) and $(\pi[g_{9/2}^2(g_{7/2}, d_{5/2})^2, h_{11/2}^{1/2}] \otimes \nu[(g_{7/2}, d_{5/2})^{-2}, h_{11/2}^6])$ (ref. Fig. 1 [2(2)2, 260;0])

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FIG. 1: Excitation energies relative to a rotating-liquid drop energy, for observed (upper panel) and calculated (lower panel) valence-space states for $^{120}$Te.

FIG. 2: Comparison of experimentally observed and calculated dynamic moment of inertia $J^2$ vs spin for yrast high-spin deformed band in $^{120}$Te.

$v[(g_{7/2}, d_{5/2})^{-2}, d_{3/2}, b_{11/2}^2] (\text{see Fig. 1})$ [2(2)2, 250;0] may be the two probable configurations for the yrast band. Former one is a positive parity configuration whereas latter one produces negative parity states. Both the configurations produce results comparable to observed ones. Configurations involving $i_{13/2}^{1}\{2(2)2, 452;1\}$ produces very different results as shown in Fig. 1; hence, can be ruled out. Calculated dynamic moment moment of inertia for the above configurations have been compared with the experimental values in Fig. 2; which shows a nice agreement. Both the configurations are associated with $\epsilon_2 \approx 0.28$.

In conclusion the observed phenomena at low and high spin have been successfully described using CNS. Even though CNS results are relevant at high spin region; results agree well at moderate spins too. At low spin; instead of the observed collective phenomenon single particle features have been predicted by CNS. This may be because pairing has not been considered here. Calculated and observed excitation energy for highly deformed band differs by an amount of 1.5 MeV which may be due to non vanishing of pairing at higher spin.

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References