Nuclear structure study at low spin in ^{169}Tm

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Introduction

Nuclear collectivity of nuclei around A ∼ 165 have been topics of interest for research for many years. For odd-A Tm nuclei, sharp backbend (^{165}Tm) to smooth upbend (^{167}Tm) has been observed, around the crossing frequency of $\hbar\omega \sim 0.3$ MeV, with increase in neutron number. Due to lack of data above the bandcrossing for higher Tm isotopes ^{169,171}Tm, it is difficult to get a clear picture of the alignment behavior. Even utilizing the high efficient clover Ge detector array, *i.e.* Indian National Gamma Array (INGA) facility [1], we could not observe any signature of population of other bands than that of the ground state band ([411]1/2$^+$) which is reported earlier [2, 3]. In the present paper we are reporting the experimental results on nuclear behaviour of ^{169}Tm in light of the theoretical calculations.

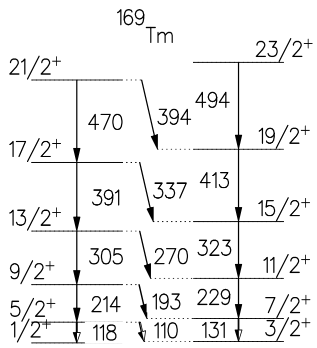

FIG. 1: Coulex gamma transitions in ^{169}Tm.

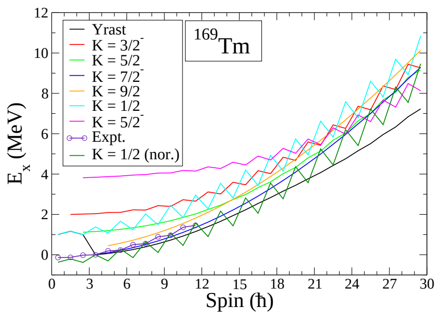

FIG. 2: Projected Shell Model calculation for ^{169}Tm.

Results and Discussions

Coulomb excitation gamma lines ^{169}Tm, as shown in Fig. 1, reported in [3] are confirmed in the present work. Both the aligned angular momentum (i_x) energy staggering S(I) for the odd-A Tm isotopes does not provide a clear picture for the heavier Tm isotopes compared to ^{165}Tm after the crossing frequency, as reported in [2]. In order to have a better understanding of the band structure of ^{169}Tm, Projected Shell model calculation have been done for ^{169}Tm, as shown in Fig. 2.

It shows the variation of excitation energy with spin for both the experimental and calculated values for different K. It has been observed that the results obtained for K=1/2 matches with the experimental points (with proper normalization), with small signature splitting but in opposite phase. The staggering behaviour might be due to the possible existence of triaxiality in ^{169}Tm and the K=1/2 band is not based purely on $\pi d_{3/2}$ orbital.

We performed the B(M1)/B(E2) calculations (using the semi-classical formalism by Dönau and Frauendorf [4]) for ^{169}Tm and compared the result with the experimental

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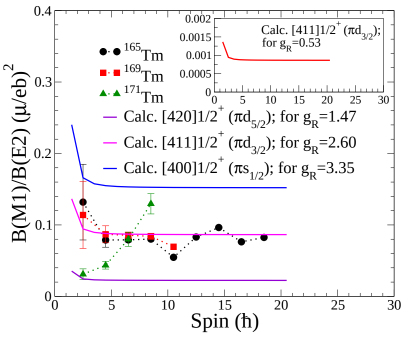

FIG. 3: Experimental (^{165,171}Tm) and calculated (^{169}Tm) values of B(M1)/B(E2) ratio.

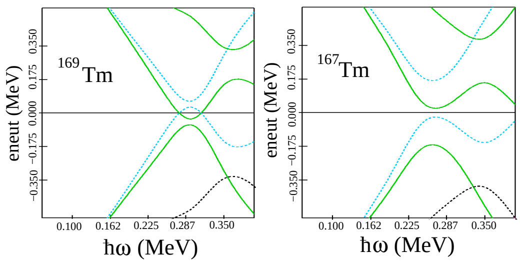

FIG. 4: CSM calculation for single neutron energy levels for ^{169}Tm and ^{167}Tm nuclei.

B(M1)/B(E2) values for ^{165,171}Tm isotopes, as shown in Fig. 3. The calculated values of the ratio is order of magnitude smaller in case of contribution from only $\pi d_{3/2}$ orbital when the rotational gyromagnetic factor (g_R) is 0.53, where as the result falls within the domain of the experimental B(M1)/B(E2) values for other nearest odd-A Tm isotopes for g_R of 2.6. From the above calculation it can be conjectured that the K=1/2 band based on mixture of both $\pi d_{3/2}$ and $\pi s_{1/2}$ orbitals. Fig. 4 depicts Cranked Shell Model (CSM) calculation of single particle energy levels for neutrons in ^{169}Tm and ^{167}Tm nuclei. From Fig. 4 it is clear that the interaction strength in valence orbital is less in ^{169}Tm in comparison to that of ^{167}Tm around the crossing frequency of $\sim$ 0.3 MeV.

Fig.5 shows the results of Total Routhian Surface (TRS) calculation around crossing frequency $\hbar\omega \sim 0.3$ MeV, for both ^{169}Tm and ^{167}Tm. The figure indicates the γ-softness of ^{169}Tm (for $\hbar\omega = 0.301$ MeV, γ = -6° to $\hbar\omega = 0.351$ MeV, γ = -24°) in comparison to the nearest odd-A neighbour ^{167}Tm (for $\hbar\omega = 0.301$ MeV, γ = -10° to $\hbar\omega = 0.351$ MeV, γ = -15°)

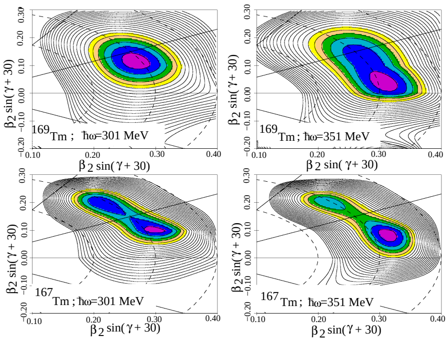

FIG. 5: TRS calculation of ^{169}Tm and ^{167}Tm nuclei around crossing frequency of $\sim$ 0.3 MeV.

Conclusion

Data analysis is underway for possibility of observation of gamma transitions beyond the crossing frequency which is very crucial for systematics of odd-A Tm isotopes. The latest result will be reported during the symposium.

Acknowledgments

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