Evolution of nuclear structure in $^{151-154}Ho$ isotopes

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Introduction

The neutron deficient rare-earth isotopes near the magic nucleus ^{146}Gd have shown multitude of structural features as functions of neutron numbers as well spin [1]. For isotones with N$\leq$ 86, excitation spectra show single particle nature associated with non-collective modes. For $N \geq 88$, strong collectivity in terms of appreciable prolate deformation is manifested in the low lying spectra. But even for those isotopes which are very close to ^{146}Gd, although low spin excitations are usually very irregular and complex indicating spherical shape with single or multi-particle excitations, at relatively higher energies superdeformed (SD) bands are observed. All these observations indicate that these nuclei are very soft against shape changes. So the structural features of these isotopes in this mass region show dramatic evolution with increasing neutron numbers as well as increasing spins.

The neutron deficient isotopes $^{151-154}$Ho have neutron numbers ranging from 84 to 87. They encompass a very significant domain in terms of their neutron numbers. It is expected that their structural features will evolve from single particle type at ^{151}Ho to collective modes at ^{154}Ho. Moreover for each of them, how the structure evolves with increasing spins also bear important consequences. These nuclei have been studied previously to high spins (J$\simeq$ 25, 40, 45 and 20 $\hbar$, respectively) [2, 3]. But even in the latest compilation, there are uncertainties in the spin and parity assignments of the excited levels in ^{151,152,154}Ho. Recently we have studied ^{153}Ho [3]. We found that there is a possibility of shape coexistence in this nucleus even at lower spins. In the present work, experimental data on ^{151,152,154}Ho have been analysed to extend

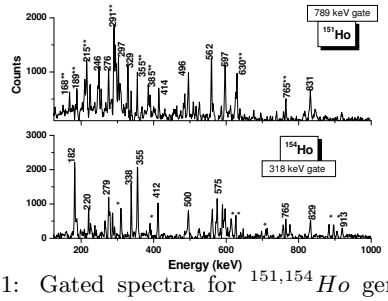

FIG. 1: Gated spectra for $^{151,154}Ho$ generated from gamma-gamma coincidence spectra.

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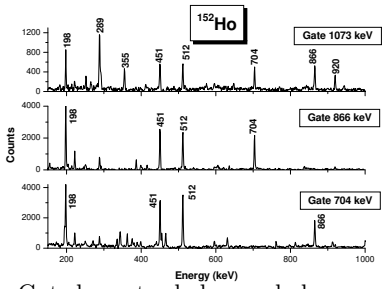

FIG. 2: Gated spectra below and above an isomer for ^{152}Ho.

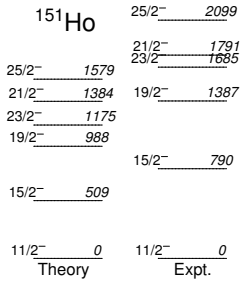

FIG. 3: Comparison of ^{151}Ho low lying spectra with shell model results.

and confirm the existing level schemes. The structural features observed has been interpreted theoretically using shell model as well as Total Routhian surface calculations. Results have been combined with that for ^{153}Ho to study the evolution of structural features in these Ho isotopes with increasing neutron numbers and increasing spin.

Experimental details and Results

We have studied the high-spin states in $^{151,152,154}Ho$, populated by $^{139}_{57}La(^{20}Ne, xn)$ reaction at a projectile energy of 139 MeV. The gamma-gamma coincidence measurements have been done using the multi-detector array of eight Compton suppressed Clover detectors (Indian National Gamma Array, INGA setup) at Variable Energy Cyclotron Centre (VECC), Kolkata, India. The relevant details of the experiment have been discussed in Ref.[3]. Figure 1 and 2 show the gated spectra of ^{151}Ho, ^{154}Ho and ^{152}Ho. We have marked some of the new transitions found from the present work in the figures. Directional correlation and polarisation data are analysed to assign and confirm the spins and parities of the levels. We have suggested several additions

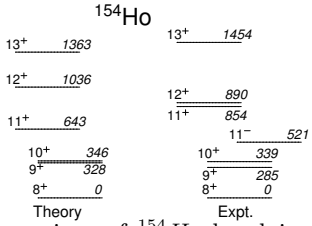

FIG. 4: Comparison of ^{154}Ho low lying spectra with shell model results.

and revisions of the reported level schemes.

Discussions

We have already found [3] that the ^{153}Ho show softness towards shape changes. We have done simple shell model (SM) calculations for the low lying spectra of ^{151}Ho and ^{154}Ho using standard interaction available for this mass region with ^{132}Sn as core. For ^{151}Ho, two neutrons and a proton is taken as active. The results are shown in Fig.3. On the other hand for odd -odd ^{154}Ho, one proton and neutron are taken as active. For ^{151}Ho SM calculation reproduces the level ordering but their energies are not reproduced satisfactorily because of severe truncation used. For ^{154}Ho with the simplest possible configuration the lowest three states are reproduced quite satisfactorily. Reproduction of the ground state spin theoretically for an odd-odd nucleus is quite significant. For higher spins, experimental data clearly show band structure indicating collective excitations. Results of elaborate SM alculations for better representations of these collective states will be presented.

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