Study of Nuclear Structure Properties of Some N=80 Isotones

Amit Kumar[1], Arun Sharma[1] and Arun Bharti[1]*
Department of Physics and Electronics
University of Jammu, Jammu - 180006, INDIA
* *email: arunbharti_2003@yahoo.co.in*

The nuclei around the N= 82 shell closure are a fertile field of spectroscopic investigations, both at low and high spins. The rich variety in shapes and structure arising out of different angular momentum coupling schemes, observed in the light rare earth nuclei with $50 \leq N(Z) \leq 82$ have attracted considerable experimental interest in the recent years. The systematic study of different band structure viz. chiral bands, magnetic rotation bands, highly deformed bands etc. has revealed that multi-particle excitation to $h_{11/2}$ orbitals and alignment of $h_{11/2}$ quasi-particle play an important role, even at very high excitation energies of these nuclei.

In the present work, we have applied Hatree-Fock- Bogoliubov (HFB) frame work to study the properties like yrast spectra, subshell occupation numbers and intrinsic quadrupole moments of some N= 80 isotones.

The total Hamiltonian employed in the present work is

$$H = \sum_{\alpha} \langle \alpha | \epsilon | \alpha \rangle \, a_{\alpha}^{+} a_{\alpha} + \frac{1}{4} \sum_{\alpha\beta\gamma\delta} \langle \alpha\beta | V_A | \gamma\delta \rangle \, a_{\alpha}^{+} a_{\beta}^{+} a_{\delta} a_{\gamma}$$

where ϵ is the single- particle energy and V_A is the two nucleon interaction $(\chi_{pp}, \chi_{nn}, \chi_{np})$ and the matrix elements are written in anti-symmetrised representation.

In the present work, results of calculations are performed on some N=80 isotones like ^{144}Gd, ^{146}Dy and ^{148}Er are presented. The doubly magic nucleus $_{50}Sn^{100}$ is taken as core and the valance space spanned by $3s_{1/2}$, $2d_{3/2}$, $2d_{5/2}$, $2f_{7/2}$, $1g_{7/2}$, $1h_{9/2}$, $1h_{11/2}$ and $1i_{13/2}$ for the proton and neutron has been selected. The spherical single particle energies (S.P.E's) that have been employed (in MeV) are:

$(3s_{1/2}) = 1.40$, $(2d_{3/2}) = 2.0$, $(2d_{5/2}) = 0.0$, $(2f_{7/2}) = 10.9$, $(1g_{7/2}) = 2.50$, $(1h_{9/2}) = 11.5$, $(1h_{11/2}) = 4.0$ and $1i_{13/2} = 13.5$. The S.P.E's of $3s_{1/2}$, $2d_{3/2}$, $2d_{5/2}$, $1g_{7/2}$, and $1h_{11/2}$ are exactly the same as those employed by Vergados and Kuo [1] as well as Federman and Pittel [2].

The S.P.E's of $2f_{7/2}$, $1h_{9/2}$ and $1i_{13/2}$ orbits are taken from the Nilsson diagrams, published in the book [3].

The pairing plus quadrupole-interaction is of the type given in the reference [4]. The pairing part can be written as

$$V_p = \frac{-G}{4} \sum_{\alpha\beta} s_{\alpha} \, s_{\beta} \, a_{\alpha}^{+} a_{\bar{\alpha}}^{+} a_{\bar{\beta}} a_{\beta}$$

The strength for the like particle neutron –neutron (n-n), proton- proton (p-p) and for neutron –proton (n-p) components of the quadrupole- quadrupole interaction for N=80 (^{144}Gd, ^{146}Dy and ^{148}Er) isotones were taken as:

$$\chi_{nn}(\chi_{pp}) = -0.0070 \; MeV \, b^{-4}$$
$$\chi_{np} = -0.0148 \; MeV \; b^{-4}$$

Where $b = \sqrt{\frac{\hbar}{m\omega}}$ is the oscillator parameter.

Here, we are presenting the results on yrast spectra only (Figs.1(a)-1(c)) whereas the other results of calculations on intrinsic quadrupole moments as well as on subshell occupation numbers will be discussed in the presentation in the symposium.

From the results of the calculations, it is found that:

- The low lying experimental yrast states are very well reproduced by HFB calculations.
- The values of intrinsic quadrupole moments obtained from HFB calculation shows a gradual increase as one moves from ^{144}Gd to ^{148}Er indicating, thereby, an increase in deformation as one moves from ^{144}Gd to ^{148}Er, which is in agreement with the experimental results.

- From the results of subshell occupation numbers, it is clear that subshells $3s_{1/2}$, $2d_{3/2}$, $2d_{5/2}$, $1g_{7/2}$ and $1h_{11/2}$ of protons are contributing towards the development of deformation as one moves from ^{144}Gd to ^{148}Er.

In figure 1[a-c] yrast spectra of ^{144}Gd, ^{146}Dy and ^{148}Er respectively are presented.

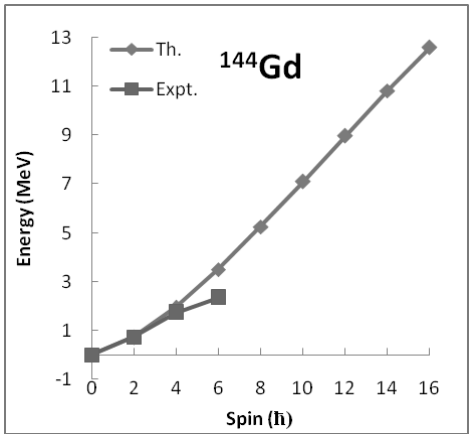

Fig. 1 [a]

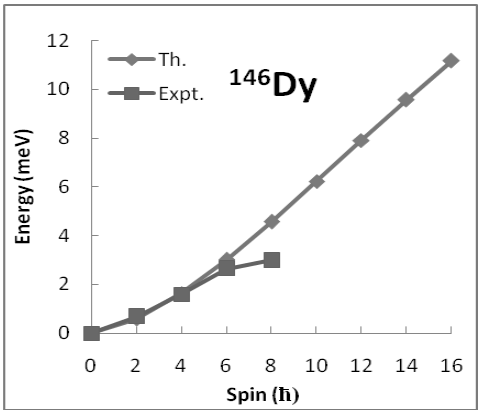

Fig. 1 [b]

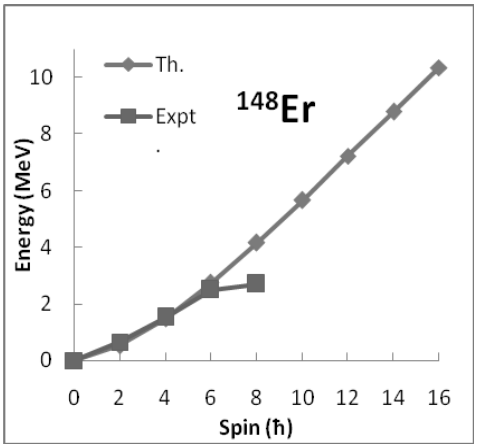

Fig. 1 [c]

References

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