Study of F- spin symmetry and identical spectra in Superdeformed nuclei in A~ 130 mass region

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Introduction

Interacting Boson Model (IBM-2) [1] explains the presence of proton and neutron in nuclear structure. To explain the conception of valence proton and valence neutron counted as particle or holes from the nearest shell; a concept of F-spin is brought into the limelight. The concept of F-spin is assigned to N_π proton bosons and N_υ neutron bosons. In F-spin; the value of $F = \frac{1}{2}$ is assigned to the proton bosons and $F_0 = -\frac{1}{2}$ is assigned to the neutron bosons, respectively. The invariance in F-spin leads to the occurrence of F-spin multiplets in correspondence to isospin multiplets. The validity of F-spin is studied by many of the authors [2-3]. The F_0 symmetry in F-spin in rare earth region is studied by Jain and Casten [4]. The comparison between F-spin and N_pN_n with global empirical systematics is studied by Gupta. et al. [5]. In the framework of F-spin concept and N_pN_n scheme; Mittal and Devi [6] determines the low- spin identical bands in light nuclei. The concept of F-spin and N_pN_n provides an impressive results when applied to superdeformed bands (SD bands). Using the concept of F- spin and N_pN_n scheme Mittal and Sharma [7] investigates the $\pm F_0$ symmetry and identical bands spectra in SD nuclei in $72 \leq N \leq 86$ region.

Formalism

The presence of proton and neutron in Interacting Boson Model (IBM-2) can be explained under the concept of F-spin. Mathematically F-spin can be determined as

$$F = \frac{N_\pi + N_\upsilon}{2} \qquad (1)$$

with its projection as

$$F_0 = \frac{N_\pi - N_\upsilon}{2} \qquad (2)$$

To study the identical spectra in superdeformed nuclei; one can make the use of N_pN_n scheme. The saturation factor (SF) defined as

$$SF = N_p N_n (N_p + N_n) \qquad (3)$$

Saha and Sen [8] attained $(SF)_{max} = 9520$. But in the present region of study we examined that the maximum value of saturation factor comes in case of SD nucleus ^{132}Nd so that

$$(SF)_{max} = 2000$$

With the help of this $(SF)_{max}$; we can calculate saturation parameter (SP) as

$$SP = \left(1 + \frac{SF}{(SF)_{max}}\right)^{-1} \qquad (4)$$

To calculate SF values, the experimental data has been taken from the tables of Singh et al. [9] and continuously updated data from National Nuclear Data Centre [10]. In this paper we have applied the above stated formulas in A~130 mass region and observes F_0 symmetry by using the concept of F-spin and N_pN_n scheme. The investigation of identical spectra in A~130 mass region can be attained; by using the concept of saturation factor (SF) and saturation parameter (SP).

Results and Discussion

We obtained F_0 values, saturation factor and saturation parameter by using eq. (1), eq. (2), eq. (3) and eq. (4). The data has been taken from the ref [9, 10]. The variation of F_0 values versus N_pN_n present for the SD bands in A~130 mass region is shown in Fig.1. It is highly interesting to note from Fig.1. that the pairs of SD nuclei like ^{130}Ce have same $|F_0|$ values and symmetric with ^{134}Nd. Similarly ^{131}Ce have same $|F_0|$ values and is symmetric with ^{133}Pr and also ^{131}Pr have same $|F_0|$ values and is symmetric with ^{133}Nd. The Fig.1. clearly indicates that the nuclei with symmetric $\pm F_0$ values in F-spin multiplets have identical N_pN_n values. The values of SP and SF are summarized in Table 1. It is noted from Table 1 that nuclei like ^{130}Ce is having identical SP and SF values with ^{134}Nd. Similarly ^{131}Ce is having identical SP and SF values with ^{133}Pr and also ^{131}Pr is having identical SP and SF values with

^{133}Nd. From the data calculated in the Table 1; one can reach to the conclusion that the nuclei having equal values of SF and SP shows low- spin and superdeformed identical spectra.
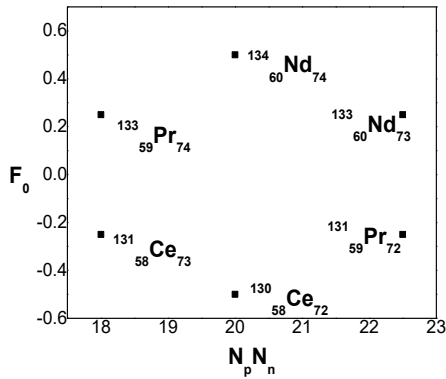

Fig.1. The variation of F_0 values versus N_pN_n in A~130 mass region.

Table 1. The structure factor (SF), structure parameter (SP) and N_pN_n values in A~130 mass region.

SD NUCLEI	SF	SP	N_pN_n
^{130}Ce	1440	0.5813	20
^{131}Ce	1224	0.6203	18
^{132}Ce	1024	0.6613	16
^{131}Pr	1710	0.5390	22.5
^{133}Pr	1224	0.6203	18
^{132}Nd	2000	0.5	25
^{133}Nd	1710	0.5390	22.5
^{134}Nd	1440	0.5813	20

Conclusion

In this present work, we have presented the variation of F_0 values with N_pN_n. It is highly interesting to note that the pairs of nuclei with same F_o values in F-spin multiplets have same N_pN_n. It can be concluded that pairs of nuclei having equal SF and SP values shows the low-spin and identical superdeformed-spectra.

References
[1] A. Arima et al., Phys. Lett. B66 (1977) 205.
[2] H. Harter et al., Phys. Lett. B157 (1985) 1.
[3] P. Von Brentano et al., J. Phys. G11 (1985) L85.
[4] A. K. Jain and R. F. Casten, Modern Phy. Lett. A3 (1988) 743.
[5] J. B. Gupta et al., International Journal of Modern Physics A, Vol. 5, No. 6 (1990) 1155-1164.
[6] H. M. Mittal and Vidya Devi, Int. J. Nucl. Energy Sci. Tech., 6 (2011) 224.
[7] H. M. Mittal and N. Sharma, Armenian Journal of Phys. 5 (2012) 165-175.
[8] M. Saha and S. Sen, Phys. Rev. C46 (1992) R 1587.
[9] B. Singh et al., Vol. 97 (2002) 241-592.
[10] www. nndc.bnl.gov.