Low spin identical bands in adjacent even-even nuclei of A=120-200 region

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Abstract

The study of identical bands in neighboring even-even nuclei of A = 120-200 mass region by the influence of moment of inertia is carried out. A correlation to identify such nuclei is based on the concept of N_pN_n scheme (where N_p number of valence proton and N_n number of valence neutron) and F-spin multiplets. The F-spin multiplets are found to be constant for the ground and gamma bands whereas vary for the beta band. The F-spin multiplets are also helpful to understand the structure of nuclei.

Introduction

The neutron deficient (N<82) light mass (A=120-150) rare earth nuclei lying far from the β-stability line has been of current interest in nuclear structure theory. The level pattern of these even Z-even N nuclei differ from N >82 nuclei in the degree of deformation. Here in N<82 region the energy ratio ($R_{4/2}=E(4_1^+)/E(2_1^+)$) lie between 2.0-3.1. Also most of nuclei are γ-soft [1]. Therefore the study of identical bands in this region is of current interest. Casten et al. [2] have studied the low spin identical bands in ^{156}Dy-^{180}Os widely dispersed nuclei. A simple correlation exists between the nuclei showing identical spectra and their valence neutron proton (N_p), neutron number (N_n). The identification of such a correlation scheme provided the clue to understand the identical band phenomenon. A very important concept of F-spin plays an important role to understand the structure of IBM-2. Then it was natural to assume that the nuclei with equal total boson number $N_B=N_p+N_n$ should have the same deformation and identical spectra. The number of valance proton N_p and neutron N_n has a total $N= (N_p+N_n)/2 = N_\pi+N_\nu$ bosons. The projection of these nuclei are denoted as $F_0 = (N_\pi+N_\nu)/2$ [3]. These N_π proton

boson and N_ν neutron boson are assigned F-spin F=1/2 with projections F_0=1/2, (proton bosons) and F_0 =-1/2 (neutron bosons) respectively. Harter et al. [4] observed that IBM-2 Hamiltonian and projected IBM-1 Hamiltonian gave the same energies for states of maximum F-spin provided they have pure F-spin. The projected IBM-1 Hamiltonian will give constant energies across F-spin multiplet when IBM-2 parameters and $N_\pi + N_\nu$ product have constant values. Since product of value $N_pN_n = 4(F^2 - F_0^2)$, the pair of nuclei having same F value with projections $+F_0$ and $-F_0$ will have the same value of N_pN_n and may be expected that nuclei exhibit the identical excitation energies. The aim of the present work is to search the identical bands in Xe-Gd nuclei. We study it in terms of F-spin multiplet or ensembles of nuclei expected to have similar properties. For this the experimental data are taken from [5].

Result and Discussion

In Fig. 1 we show the variation of excitation energy of ground and gamma bands for N>82 region nuclei where the value of N_p and N_n are mentioned below each nucleus.

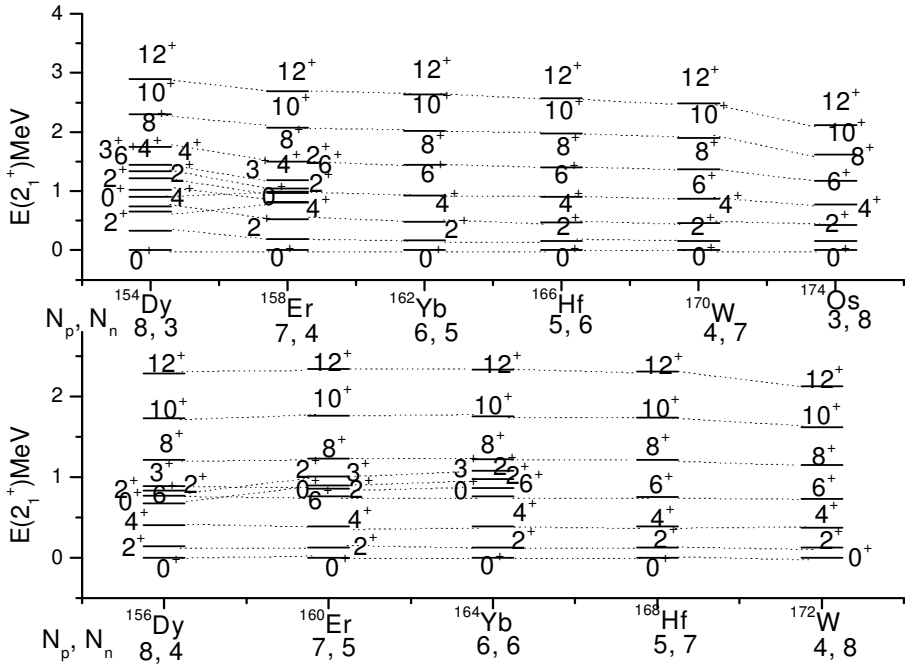

Fig.1 F-spin multiplets with F=11/2 and F=12, N_p and N_n are proton and neutron boson numbers. We show the levels of ground band, gamma band and beta band.

For both odd and even value of N_pN_n multiplet the excitation energies of the ground bands are quite constant and show close agreement with each other. Hence excitation energies of ground and gamma bands show constant behavior upto $J=12^+$ spin level. It is impressive that how constant the energy of ground and gamma bands when we consider that the two multiplet contain nuclei of different mass number. A small deviation occurs in ^{174}Os and ^{172}W at higher spin level i.e. $J=12^+$.

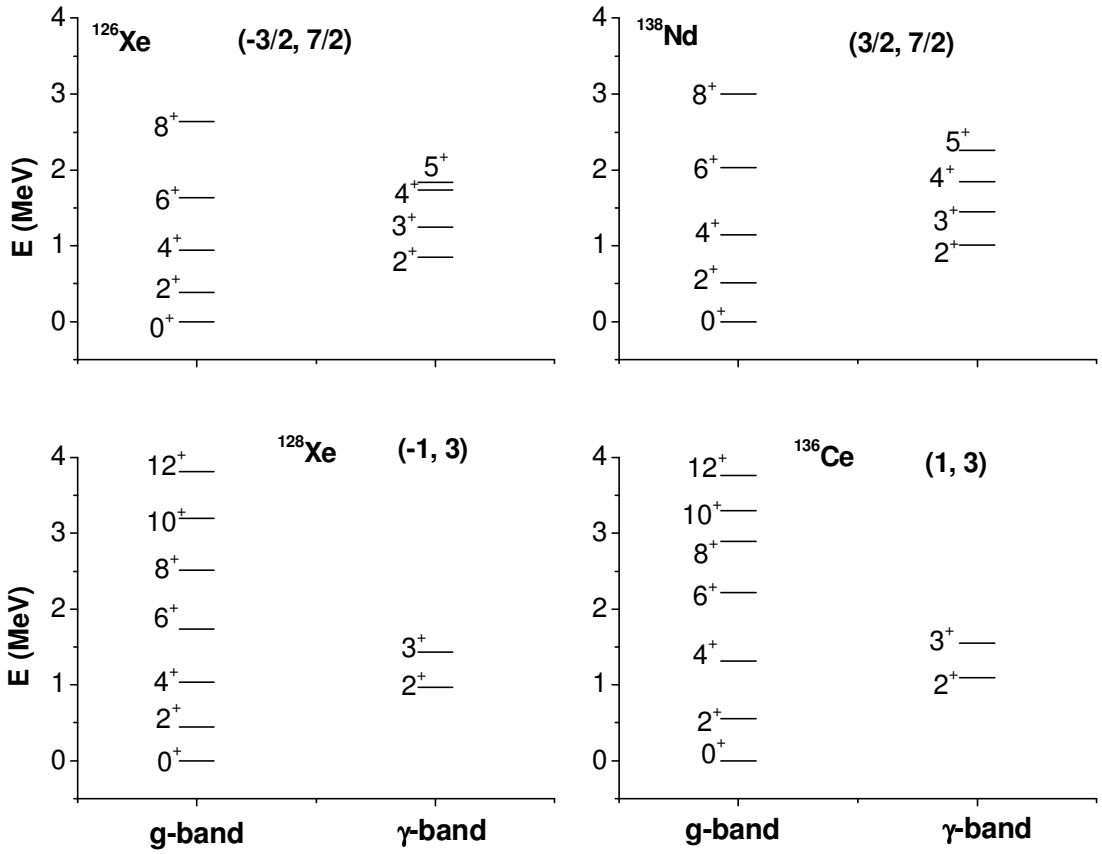

Fig. 2 The pairs conjugate nuclei having the same $|F_0|$ and N_pN_n ,N_n values are compared for their band spectra for $N < 82$ region.

In Fig. 2-4 we have compared the g-band and γ-band spectra of pair of conjugate nuclei having the same $|F_0|$ and $(N_p+N_n)/2$ values, i.e. the ^{126}Xe having F_0=-3/2 and $(N_p+N_n)/2$=7/2 is symmetric with ^{136}Nd with F_0=3/2 and $(N_p+N_n)/2$=7/2. Hence ^{128}Xe, ^{126}Ba, ^{128}Ba, ^{130}Ba and ^{130}Ce show symmetry with ^{136}Ce, ^{138}Sm, ^{136}Nd, ^{134}Ce and ^{134}Nd respectively. The agreement amongst the pair is impressive. There is no violation of this symmetry in the experimental data in this (N<82) region. It allows predicting the existence of identical bands in this region.

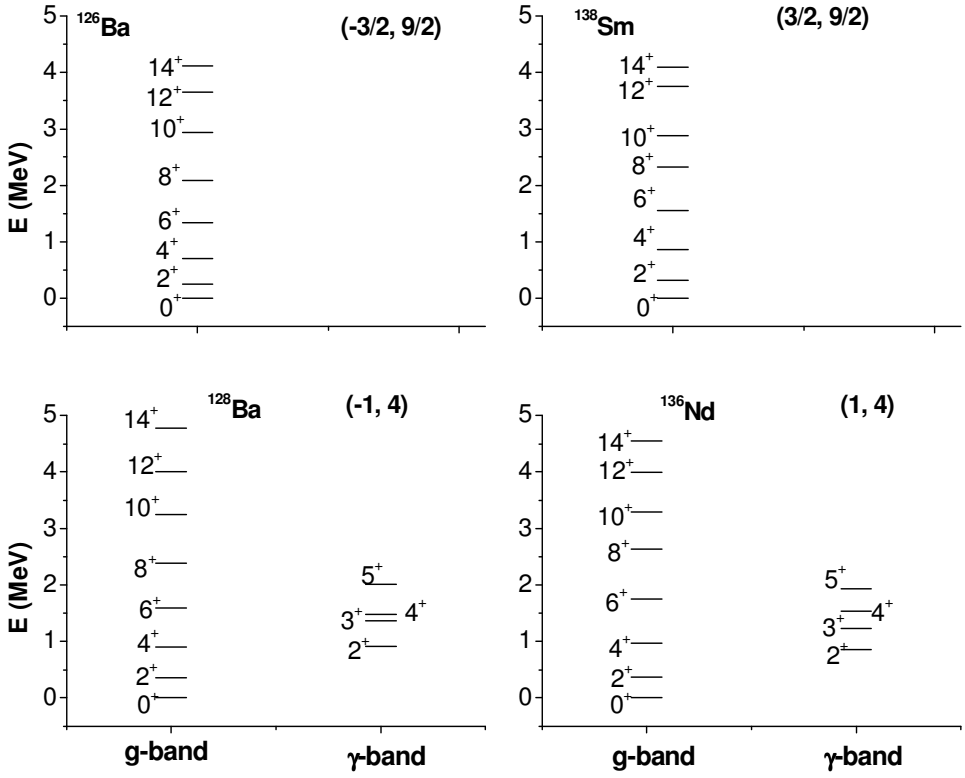

Fig.3 The pairs conjugate nuclei having the same $|F_0|$ and N_pN_n, N_n values are compared for their band spectra for N < 82 region.

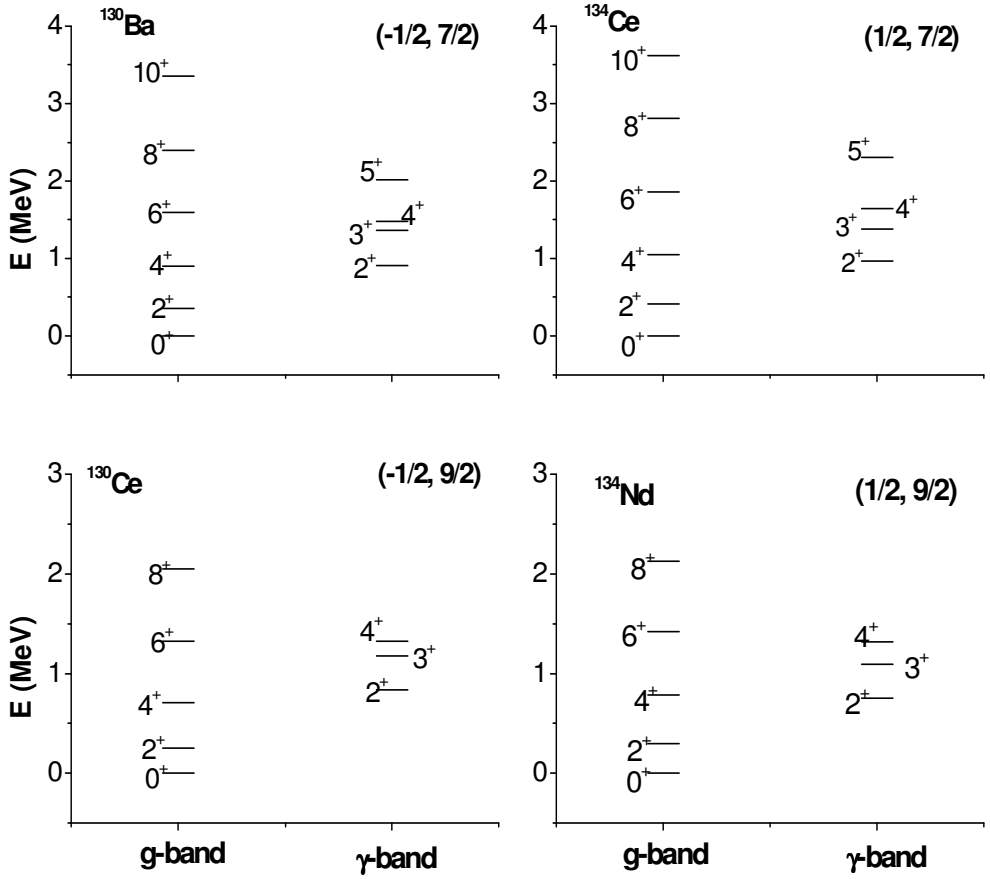

Fig.4 The pairs conjugate nuclei having the same $|F_0|$ and N_pN_n, N_n values are compared for their band spectra for N < 82 region.

Conclusion

In the above description we firstly observed that the ground and gamma band energies of F-spin multiplet in N<82 and N>82 region nuclei are constant. These data are helpful to describe the F-spin structure. Secondly the nuclei in an F-spin multiplet have F_0 $(N_p - N_n)/4$ values from -F to +F [5]. We observe that the nuclei with symmetric F_0 values in an F-spin multiplet have identical N_pN_n values. The agreement is excellent. Therefore more data will necessary to confirm the nature and extent of this kind of symmetry.

References

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