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X(5) Description For Nuclei at A~ 100 Mass Region

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Introduction

The understanding of atomic nuclei at phase transitional point is one of the challenging problem in nuclear physics. The X(5) symmetry at phase transitional point [1,2] was first observed to analyse the structure of nuclei during the transition from U(5) spherically symmetric to SU(3) deformed rotor. Empirical examples close to these symmetry were found in A~100 region. Zr and Sr are chosen as X(5) examples. Any discussion related to nuclear structure and its growth across the N-Z plane is the idea of magic numbers, as we going away from the magic numbers the deformation in the nuclei rises. Three limits of structural indication has been studied by Interacting Boson Approximation (IBA) [3] are U(5) spherically symmetric, SU(3) deformed rotor and O(6) ϒ- unstable.

The IBA Hamiltonian can be written as

$$H = \in n_d - KQ.Q$$

The first portion of Hamiltonian is spherical driving and second portion is deformation driving and $\frac{K}{\in}$ ratio is replaced by bounded parameter ζ varies between 0 and 1.

The first order phase transition between U(5)-SU(3) is represented by a line on Casten triangle fig [1].

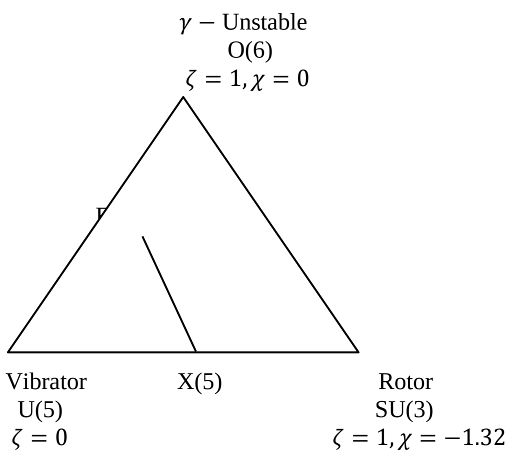

Fig.1 symmetry triangle for nuclear structure

The present work focused on the critical point X(5) symmetry where structure changes most dramatically. This kind of phase transition is more challenging since it is β, ϒ dependent. The ellipsoidal parameter β varies from 0 to .2 and ϒ varies from 0° to maximally 30° for transitional nuclei U(5) to SU(3). In place of β, $R_{4/2} = \frac{E4_1^+}{E2_1^+}$ as structural indicator [4] studied as function of neutron number and sharp rise is observed at critical point X(5) where the two minima cross and shape change from U(5) to SU(3) in Fig 2.

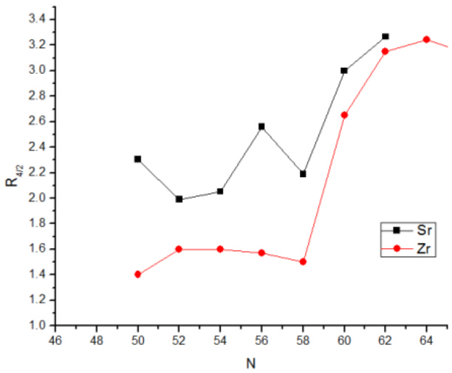

Fig. 2 $R_{4/2}$ varies as a function of N (neutron number) and around at N= 60 (A~100) sharp peak is observable.

We have also investigated the differential variation of experimental two neutron separation energy data taken from National Nuclear Data Centre [4] as a function of N (neutron number) in fig.3

The differential variation in neutron energy studied as

$$dS_{2n}(Z,N) = \frac{S_{2n}(Z,N+2) - S_{2n}(Z,N)}{2}$$

On investigating the derivative of S_{2n}, X(5) critical symmetry is seen near N = 60 isotopes of Zr-Sr.

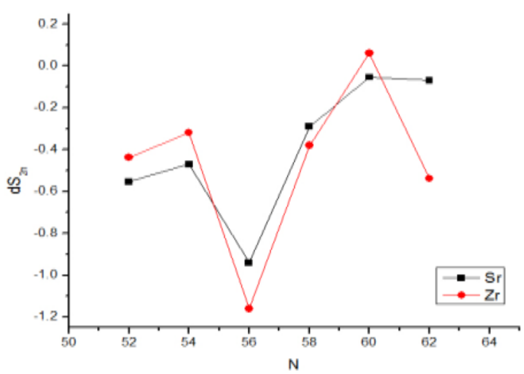

Fig.3. dS_{2n} plotted as function of N shows critical phase transition point at N= 60 where two phase coexist.

Role of nucleonic promiscuity P- factor

The P- factor = $\frac{2N_pN_n}{N_p+N_n}$ measure of average integrated collectivity [5] where N_p and N_n are number of valance protons and neutrons, respectively. N_pN_n represent p-n interaction strength in range of 200-250 KeV and N_p+N_n represent the pairing interaction in order of 1 MeV. The p-n interaction starts to dominate around p ~ 5. The locus of P ~ 5 for N-Z plane [6] provides an idea of X5 like phase transitional behaviour.
Figure 4 shows the $R_{4/2}$ ratio plotted against P. The ratio is convenient indicator X(5) transitional like characteristic for A~ 100 region.

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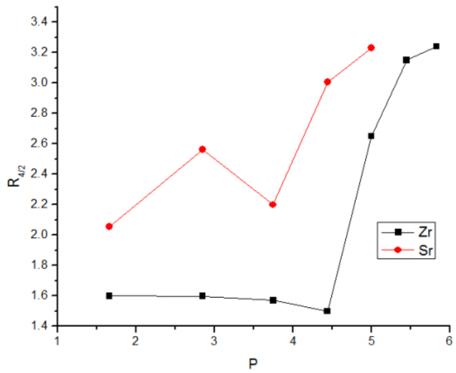

Fig 4 Plot for Zr- Sr in A~100 mass region

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