Study of Valence Mirror Nuclei in relation to N_pN_n

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Introduction

In order to study the behavior of the distinct states of nucleon known as proton and neutron under the strong nuclear interaction, mirror nuclei have always become a unique platform. When stimulated, mirror nuclei exhibit striking similarities. This kind of nuclei shows strong similarities in their excited states, which has been thoroughly studied in the past and indicates the isospin symmetry [1]. Valence mirror nuclei are the one having different magic cores, but they still have the same numbers of valence protons and valence neutrons, in the major shell, respectively. Such pairs of valence mirror nuclei have also been referred to as quasi mirror nuclei. Pseudo mirror nuclei are another term for mirror-like nuclei, which Moscrop et. al. introduced based on the N_pN_n values. According to Casten, if subshell closures are carefully considered, various properties of the nuclei in different mass ranges can be plotted as smooth curves as a function of N_pN_n, where N_pN_n is the product of the number of the valence neutrons (N_n) and the valence protons (N_p) counted from the closest closed shells for each type of nucleon [2].

Based on the previous studies about mirror nuclei, in the present study we have done the systematics of the mirror energy difference at certain spins in the valence mirror nuclei and pseudo mirror nuclei.

Theoretical Approach

Since the proton-neutron force determines nuclear structure, a quantitative measurement of it should be a valuable systematizing parameter. The NpNn nearest to closed shells affects the strength of the proton-neutron interaction. As a result of this idea, it was possible to strength of the proton-neutron interaction. As a result of this idea, it was possible to examine various mass regions much more easily as, if the empirical systematic was plotted against N_pN_n rather than against A, N, or Z [3-4].

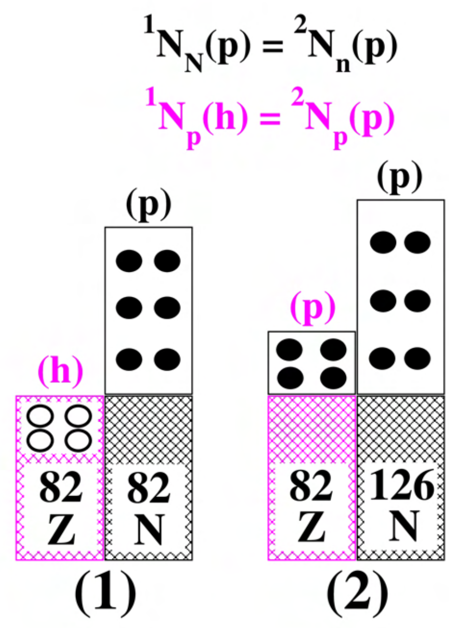

Fig.1 Schematic diagram to represent the N_pN_n valence mirror nuclei and the data considered for analysis.

Fig.1. shows the schematic diagram to get acquaint with the data considered for the analysis. Here are two sets of four rectangular blocks labeled as (1) and (2) at the bottom of the sets. Set-(1) consists of one rectangular blocks in magenta color representing protons and two rectangular blocks in black color placed one above the other representing neutrons. Crossed-net filled base Blocks in magenta and black color

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represent the shell closure of protons and neutrons respectively for ^{164}Pb core. Inside the magenta colored box, there exists a white colored box having unfilled elliptical shapes represents proton holes while black colored box having filled elliptical shapes represents neutron particles. Equations mentioned shows how the valence particles are related among the pair of nuclei.

In this way one can understand that the set-(1) symbolizes those nuclei which are having ^{164}Pb core containing proton holes and neutron particles. In similar fashion the set-(2) symbolizes those nuclei which are having ^{208}Pb core containing proton particles and neutron particles.

The mirror nuclei exhibit slight variations in excitation energy between identical states. Mirror Energy Difference (MED) is the name given to these minute variations. Fig.2. shows comparative level scheme of pseudo mirror nuclei [5-7]. It can be followed that the pair of nuclei labeled as (A) are having good similarity in the level scheme, but the same have been not observed for those labeled as (B). Analogous to mirror energy difference, here the concept of N_pN_n valence mirror energy difference have been introduced and calculated for various N_pN_n valence mirror nuclei belonging to ^{164}Pb and ^{208}Pb cores.

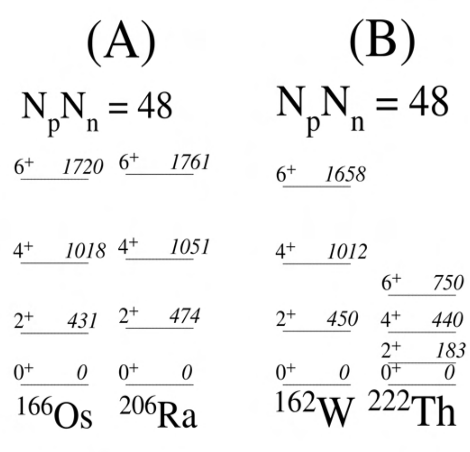

Fig.2 Level scheme various pair of Pseudo Mirror Nuclei having the same N_pN_n value.

It is therefore interesting to study the mirror energy difference in the identical NpNn valence mirror nuclei ($VMED_{NpNn}$) with regards to N_pN_n.

Results and Discussion

Figure 3 shows the systematic variation of N_pN_n valence mirror energy difference ($VMED_{NpNn}$) with N_pN_n value for 2^+ state in various pair of nuclei from different magic core. From all these we conclude that the variation of $VMED_{NpNn}$ with N_pN_n follows smooth exponential decay trend for all the pair of N_pN_n valence mirror nuclei under consideration. The detailed analysis for many other nuclei will be presented.

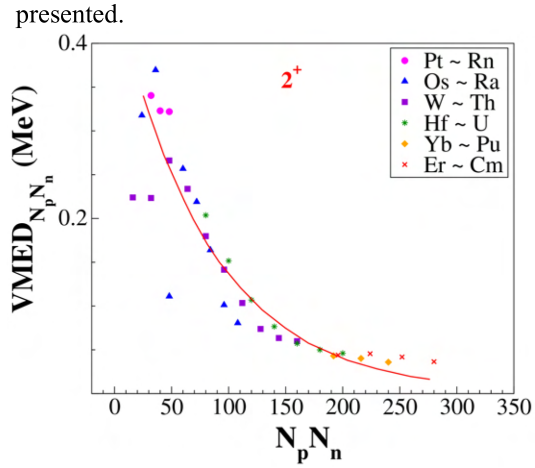

Fig.3 Systematic of N_pN_n valence mirror energy difference ($VMED_{NpNn}$) with.

Acknowledgement

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