Test of validly of linear band mixing theory for light mass Ni- Sn region

Satendra Sharma[1],* Adamu Chiroma[1,2], Rajesh Kumar[3] and Vikas Katoch[4]
[1]*Deptartment of Physics, Yobe State University, Km 7 Gujba Road, PMB 1144, Damaturu, NIGERIA*
[2]*Deptartment of Science and Laboratory Techniques, Federal Polytechnic, Damaturu, NIGERIA*
[3]*Noida Institute of Engineering &Technology, Dr. APJ Abdul Kalam Technical University, Gr. Noida, INDIA*
[4]*RKG Institute of Technology, Dr. APJ Abdul Kalam Technical University, Ghaziabad, INDIA*
. * email: ss110096@gmail.com

Introduction

The linear band mixing theory [1] is used for treating the deviations of $B(E2;I_\gamma \rightarrow Ig/Ig^{'})$ and $B(E2;I_\beta \rightarrow Ig/Ig^{'})$ branching ratios from Alaga values [2]. The first order band mixing was successful for ($\gamma \rightarrow g$) transitions for well deformed nuclei [3]. Gupta and Sharma tested the limit of validity of linear band mixing theory for rare earth mass region for Nd to Hg nuclei [4]. This work has been extended for light mass Ni- Sn nuclei. It is expected that the collectivity is less in this region except few nuclei.

Linear Band Mixing Theory

In adiabatic limit (band mixing parameter, $a_\lambda=0$) the interband B(E2) branching ratio is given by [1]:

$$\frac{B(E2;I_{i\lambda}-I_{f0})}{B(E2;I_{i\lambda}-I_{f'0})}=\frac{C^2}{C'^2}=R\,(Alagavalue) \quad (1)$$

Where $C=\langle I_iK_i2\Delta K|I_fK_f\rangle$, $\lambda=0, 2$. If $a_\lambda \neq 0$,

$$B(E2;\ I_{i\lambda} \rightarrow I_{f0}) = M_\lambda\ C^2\,[1+ a\ f(I_i,\ I_f)]^2 \quad (2)$$

where, $f(I_i,\ I_f) = I_f(I_f+1) - I_i(I_i+1)$, and M_λ is intrinsic matrix element. The B(E2) ratio is M_λ independent and is given by:

$$\text{B(E2) ratio} = R\,\frac{[1+a_\lambda\, f(I_i,I_f)]^2}{[1+a_\lambda\, f(I_i,I_{f'})]^2} \quad (3)$$

The B(E2) branching ratios can be determined from the energy (E_γ) and intensity (I_γ) of γ-rays experimental data using the following relation:

$$\frac{B(E2;I_{i\lambda}-I_{f0})}{B(E2;I_{i\lambda}-I_{f'0})}=\frac{I_\gamma(I_i \rightarrow I_f)}{I_\gamma(I_i \rightarrow I_{f'})}\frac{E^5{}_\gamma}{E^5{}_\gamma} \quad (4)$$

The value of a_λ can be obtained. Most of the experimental data points are taken from the nndc website [5]. The experimental B(E2) branching ratios are calculated from Eq.(4) by using the energy (E_γ) and intensity (I_γ) of γ-rays for different interband transitions for Ni to Sn region which covers N= 28 to 82 and Z= 28 to 50. The experimental B(E2) ratios are plotted versus N and data is divided for N=28 to 50 and N =50 to 82 for clarity. On each plot the Alaga value (a_2 = 0, or rotor model RM), vibrational model value (VM), and modified B(E2) values for a_2 = 0.025 and 0.05 are shown for useful comparison. The error bars are not shown to keep the illustration readable. Different symbols are used for different series of isotopes and one can read the values of B(E2) ratio for a given value of N.

Results and Discussion

The B(E2; $2_\gamma \rightarrow 0g/2g$) ratio

The variation of B(E2; $2_\gamma \rightarrow 0g/2g$) vs. N is shown in Fig. 1 and Fig. 2 for N= 28 to 50 and N=50 to 82, respectively. The Alaga value (=RM) is 0.7 and VM value is zero. This ratio is reduced to 0.5 and 0.35 for a_2= 0.025 and 0.05, respectively; showing 15% and 30% correction in 1+ a_2 f(I, I$^{'}$) factor. Most of the data points are close to VM limit except Ge (N=46, see Fig. 1) and Pd (N=70, see Fig. 2). So for this ratio the correction factor will be very high for a perturbation expansion to be valid.

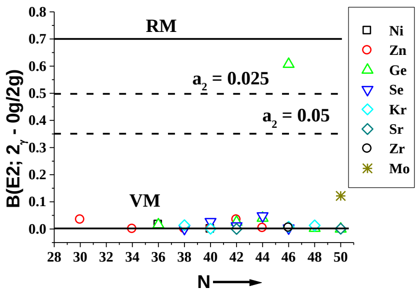

Fig. 1 The variation of B(E2; 2γ→0g/2g) versus N (=28 to 50) for Ni to Sn region.

The B(E2; $2_\gamma \rightarrow 2g/4g$) ratio

The variation of B(E2; $2_\gamma \rightarrow 2g/4g$) vs. N is shown in Fig. 3 and Fig. 4 for N= 28 to 50 and N=50 to 82, respectively. The Alaga value (=RM) is 0.5 and VM value is zero. Most of the data points are close to VM limit. So for this ratio also the correction factor will be very high for a perturbation expansion to be valid.

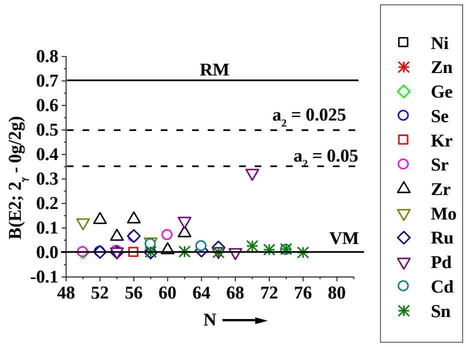

Fig. 2 Same as Fig.1 for N =50 to 82.

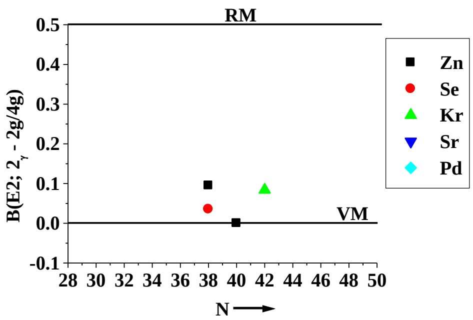

Fig. 3 The variation of B(E2; 2γ→2g/4g) versus N (=28 to 50) for Ni to Sn region.

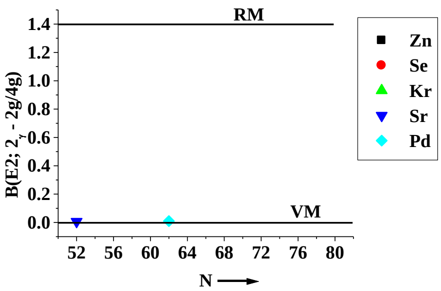

Fig. 4 Same as Fig.3 for N =52 to 80.

The B(E2; $3_\gamma \rightarrow 2g/4g$) ratio

The variation of B(E2; $3_\gamma \rightarrow 0g/2g$) vs. N is shown in Fig. 5 and Fig. 6 for N= 28 to 50 and N=50 to 82, respectively. The Alaga value (=RM) is 2.5 and VM value is zero. This ratio is reduced to 1.25 and 0.6 for a_2= 0.025 and 0.05, respectively; showing 20% and 40% correction in 1+ a_2 f(I, I') factor. Most of the data points are close to VM limit except Mo (N=60, see Fig. 6).

The graphs for B(E2; $4_\gamma \rightarrow 2g/4g$) and B(E2; $I_\beta \rightarrow I_g/I'_g$) ratios will be presented.

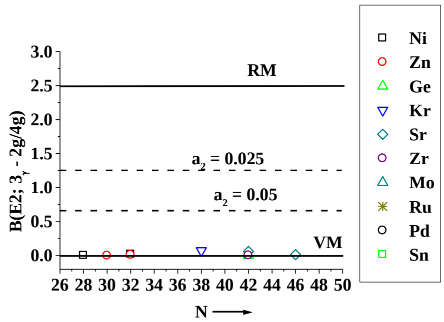

Fig. 5 The variation of B(E2; 3γ→2g/4g) versus N (=28 to 50) for Ni to Sn region.

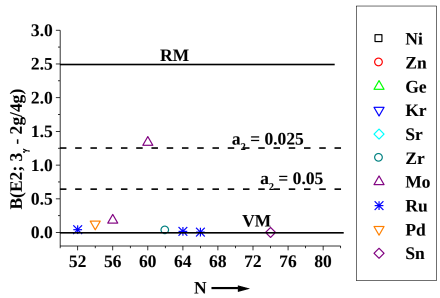

Fig. 6 Same as Fig.5 for N =52 to 80.

Conclusions

The first order band mixing theory is not adequate for explaining the deviations of B(E2) ratios for (γ→g) transitions from Alaga values for Ni-Sn region.

Acknowledgement

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