Phenomenological description of even-even isotopes in the $A < 100$ mass region

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Introduction

The study of even-even nuclei in the $A < 100$ mass region have recently become important testing ground for most of advanced theories.There is clear evidence for a major change in nature of ground state levels below $J = 18\hbar$ shown in previous study [1]-[6]. A very regular structure is developed at higher value of spin. This phenomenon is called the backbending effect which occurs as one plots the moment of inertia versus the square of the rotational frequncy. These nuclei have several interseing feature such as oblate and prolate defomations as well as rapid variations in shape as a function of both spin and mass number.

The band crossing effect looks much more dramatic if the variation in the vibrational frequency ω instead of J is used as an independent variable. Johnson et al. [7] choose to represent the excitaion energy $E(J)$ of the ground state level in terms of plot between the nuclear moment of inertia ϕ and the squared rotaional frequency ω^2. Such plots have revealed that in some cases ϕ increases so rapidly with J that ω^2 actually decraeses as higher spin states as reached and resulting in appearance of back bending in these plots.

Several workers have confirmed that backbending could be influenced by the ground state band energy spacing and the pairing gap [8]-[9]. The moment of inertia is almost doubled and is approaching the value of rigid rotation suggest that the transition is associated with pair correlation. The main purpose of the present work is to investigate Ge, Se and Kr even-even isotopes of nuclei in a phenomenological way in the framework of two parameter and three parameters formula [10].

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Backbending phenomena in some even-even nuclei

In the present work an attempt is made to study the behavior of the backbending phenomena in the ground state bands for ^{66}Ge and ^{76}Se even-even nuclei using the ab formula, power law and SRF formula along with the experimental values. The plots of the calculated data of $2\phi/\hbar^2$ versus $(\hbar\omega)^2$ for the above mentioned isotopes are given in Fig. 1, where the experimental data are also presented. From the excitation energies E(I) of the ground state bands we deduce the nuclear moment of inertia and the squared rotational frequency ω^2 by using the most sensitive relations

$$\frac{2\phi}{\hbar^2} = \frac{4J-2}{E(J)-E(J-2)} \tag{1}$$

$$(\hbar\omega)^2 = (J^2-J+1)\left(\frac{E(J)-E(J-2)}{2J-1}\right)^2 \tag{2}$$

Results and Discussion

In Fig.1 the experimental data show a clear evidence of backbending phenomenon in all the presented nuclei at $J = 8-12\hbar$. It is clear from the same figure that the predictions of experiment and other calculaed formula such as ab, power law and SRF describe very well the ground state levels in ^{66}Ge and ^{76}Se nuclei. Furthermore, the predictions of the calculated result reproduce very well backbending phenomena. Similarly for ^{76}Kr and ^{80}Kr nuclei the experimental and calculated results show the good agreement for the ground state level (see Fig.2)

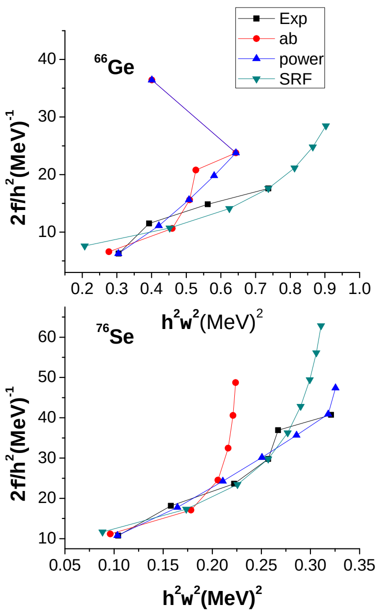

FIG. 1: Calculated and experimental moment of inertia $2\phi/\hbar^2$ vs. $(\hbar\omega)^2$ for yrast band level for ^{66}Ge and ^{76}Se nuclei.

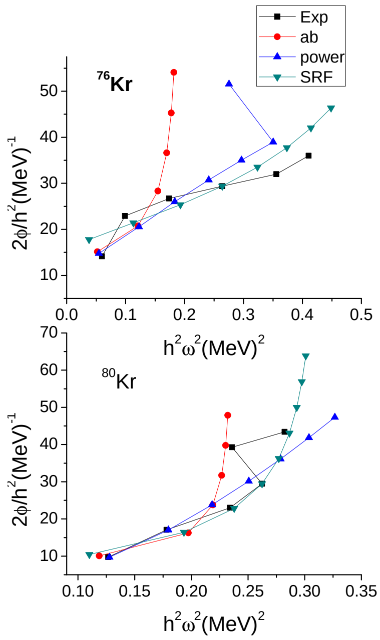

FIG. 2: Calculated and experimental moment of inertia $2\phi/\hbar^2$ vs. $(\hbar\omega)^2$ for yrast band level for ^{76}Kr and ^{80}Kr nuclei.

Conclusion

The present work suggests that the calculated result of ab, power law and SRF formula give a fairly accurate description of the backbending in actinide nuclei, in support to our previous calculations [10]. As a consequance, the appearance of the backbending phenomena in medium light nuclei at low spins ($\mathrm{I} = 8 - 12\hbar$) can be interpreted in the framework of the pairing force.

Acknowledgments

We are grateful to Dr. J.B.Gupta (Ramjas College, Delhi University, Delhi) for constant encouragement. Author also thanks to IET Bhaddal for providing research facility.

References

[1] J.A.Cameron, M. A. Bentley, et al., Physics Letters B, **235**, 239-244 (1990).

[2] F. Brandolini, S. M. Lenzi, et al., Nuclear Physics A, **642**, 387-406(1998).

[3] E. Caurier, A. P. Zuker, et al., Physical Review C, **50**, 225-236 (1994).

[4] V. Velzquez, J. G. Hirsch, and Y. Sun, (2001) Nuclear Physics A, **686**, 129-140 (2001).

[5] K. Hara, Y. Sun, and T. Mizusaki, Physical Review Letters, **83**, 1922-1925 (1999).

[6] A. A. Raduta and R. Budaca, (2011) Physical Review C, **84** ,(2011)

[7] A. Johnson, H. Ryde, and S. A. Hjorth, Nuclear Physics A, **179**, 753-768 (1972).

[8] G. B. Hagemann and I. Hamamoto, Physical Review C, **46**, 838- 844 (1992).

[9] J. Y. Zeng, T. H. Jin and Z. J. Zhao, Physical Review C, **50**, 1388-1397 (1994).

[10] V. Devi, DAE Symposium (Sumbitted) (2016)