Triaxial energy relation to describe rotational band in $^{98\text{-}112}$Ru nuclei

▲Yuvraj Singh[1], Chhail Bihari[2], A.K. Varshney[3], Mani Varshney[4] M Singh[5], K.K. Gupta[1] and D.K. Gupta[5]

1. Govt. College Dhaliara-177103 (H.P) INDIA

2. Bon Maharaj Engg. College, Vrindavan, Mathura-281121 (U.P.) INDIA

3. Govt. College Jogendranagar-176125 (H.P) INDIA

4. S. S. L. D. Girls Engineering College Aligarh-202001, INDIA

5. S. V. College, Aligarh-202001(U.P.)

▲Email: *ypchingi@gmail.com*

1. Introduction:

In a broader perspective rotation vibration coupling parameter (b) is considered changing with the change in excitation energy (ε_I) and is evaluated on fitting experimental energy for $^{98\text{-}112}$Ru isotopes in the frame work of general asymmetric rotor model [1]. The moment of inertia parameter (a), common to yrast and quasi-γ band, is calculated from deformation parameter (β) using general empirical relation [2].

$$a = \frac{\hbar^2}{J_0} = \frac{408}{\beta^2 A^{7/3}}$$

The observed smooth correlations (ε_I vs 'b') enable one to predict the unknown energy of low- lying positive parity of doubly even Ru nuclei employing only one parameter (γ) and the trajectories obtained in ε_I vs 'b' [3].

The present work is undertaken to suggest some suitable equation for these trajectories which are similar in shape in $^{98\text{-}112}$Ru nuclei. We observe that curves are exponential and as such should obey a relation

$$\varepsilon_I = cb^d \qquad (1)$$

Where 'c' and'd' are constants and ε_I and 'b' are two parameters of the general asymmetric rotor model. The values of constants can be evaluated on fitting two known values of ε_I and 'b' for a particular nucleus. ε_I and 'b' are excitation energy given by the model on specific value of 'γ' and rotation vibration coupling strengths at different spins of yrast as well as quasi - γ band levels of a nucleus. This proposed equation is similar to the two parameter formula given by Gupta et al., [4] with a difference that the later applies to yrast band of well deformed and γ-soft nuclei only while the first one is meant for rotational levels of triaxial rotor which includes yrast as well as quasi- γ band. In addition there are different parameters hence, instead of energy E and spin J, the presently proposed relation carries, model energy (ε_I) and rotation vibration coupling strengths (b).

2. Discussion and Conclusion:

We take $^{98,\ 104,\ 112}$Ru for testing the proposed equation and see whether these equations describe the other levels e.g. 10_1^+, 12_1^+, 6_2^+, 7_1^+, 8_2^+, 9_1^+, 10_2^+, 11_1^+, 12_2^+ levels while filling the values of ε_I and 'b' for 6_1^+ and 8_1^+ levels. Table 1 shows the values of constants 'c' and'd'. In order to test whether the proposed relation reproduced the values of 'b' on filling known values of ε_I for $^{98,\ 104,\ 112}$Ru nuclei, we compare the values of 'b' obtained from the relation proposed and from the graphs for unknown levels. The results are listed in table 2. The following observations are made.

1. As atomic mass (A) increases the value of 'c' decrease.
2. The trend of parameter'd' with atomic mass (A) is not clear.

^{112}Ru is the best example in which the proposed equation faithfully describes the values of b which are very close to the values obtained from the graph. It is not irrelevant to mention therefore that ^{112}Ru is the nucleus

which needs only one parameter 'γ' for description of rotational levels up to I =12^+. This is also not surprising that this nucleus is the only one for A ~ 100 mass region that is recommended as triaxial in the work of MeCutchan et al., [5] we can very safely call it γ – rigid nucleus since it needs the least number of parameters (i.e. γ alone) for describing rotation levels. However ^{98}Ru which is recommended as triaxial in the work of Liao ji zhi [1] is not showing very good closeness in the true values of 'b'.

Table 1
The parameters 'c' and'd' are used in ^{98,104,112}Ru nuclei.

Nucleus	'c'	'd'
^{98}Ru	13085	-1.1097
^{104}Ru	11607	-1.1394
^{112}Ru	7917	-1.0787

Table 2
The values 'b' is calculated from graph and relation in$^{98, 104,112}$Ru nuclei.

Levels	^{98}Ru Values from 'b'		^{104}Ru Values from 'b'		^{112}Ru Values from 'b'	
	Graph	Relation	Graph	Relation	Graph	Relation
10_1^+	-	-	80	78	70	70
12_1^+	-	-	57	59	50	52
6_2^+	135	143	-	-	-	-
7_1^+	120	128	-	-	-	-
8_2^+	85	98	-	-	-	-
9_1^+	82	93	75	61	70	67
10_2^+	65	69	50	56	50	48
11_1^+	65	70	55	57	50	51
12_2^+	50	53	40	43	40	37

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