Correlations between the deformation variables (β, γ) in even-even nuclei of gamma band from $42 \leq Z \leq 80$.

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Introduction

The basic description of shape and structure of nuclei is defined by the quadrupole deformation, namely axial parameter (β) and triaxiality parameter (γ) [1]. The triaxiality parameters (γ) is strongly related to gamma band seen in even-even nuclei and their band-head energy[2]. The different shapes of nucleus can also be illustrated for given axial parameter(β) with variation of triaxiality parameter(γ) between $30° \leq \gamma \leq 60°$.

In this paper, we have calculated the deformation parameter (β, γ) over the range of nuclei $42 \leq \text{Z} \leq 80$ for all even-even isotopes using Davydov and Filippov model[3] or rigid triaxial rotor model(RTRM). The focus of the present work is to look the correlation between quadrupole deformation parameter(β) with both mass number and triaxiality parameter(γ) to get simpler description for nuclear shape.

Calculation of deformation (β, γ) parameters:

The deformation parameters (β, γ) are calculated using RTRM[3]. In our work, the parameters are calculated using two methods. In first method, the triaxiality parameter(γ) is taken from energy ratio, while in the second method, the ratio of the reduced transition probabilty were taken. The formula used in the first method is given as below,

$$\sin^2(3\gamma) = \frac{9}{8}\left[1 - \left(\frac{R_e - 1}{R_e + 1}\right)^2\right] \qquad (1)$$

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Here R_e is the ratio of energy of the bandhead of the γ band to the energy of first excited state of the yrast band. The axial parameter (β) is obtained using the relation:

$$\beta = \frac{1224}{E_{2_1^+} A^{7/3}} \left(\frac{9 - \sqrt{81 - 72\sin^2(3\gamma)}}{4\sin^2(3\gamma)} \right)^{1/2} \qquad (2)$$

Here A is the atomic mass. The value of deformation parameters (β, γ) using the first method are labeled as β_e and γ_e. In the second method, the triaxiality parameter (γ) is calculated using the following relations:

$$\begin{aligned} R_b &= \frac{B(E2; 2_2^+ \rightarrow 2_1^+)}{B(E2; 2_2^+ \rightarrow 0_1^+)} \\ &= \frac{20}{7}\left(\frac{\sin^2(3\gamma)}{X - (3 - 2\sin^2(3\gamma))\sqrt{X}}\right) \end{aligned} \qquad (3)$$

Here $X = (9 - 8\sin^2(3\gamma))$. For the β value

$$B(E2; 2_1^+ \rightarrow 0_1^+) = \frac{e^2 Q_o^2}{32\pi}\left[1 + \frac{3 - 2\sin^2(3\gamma)}{(9 - 8\sin^2(3\gamma))^{1/2}}\right] \qquad (4)$$

where $Q_o = 9ZR^2\beta/\sqrt{5\pi}$. We have labeled them as β_b and γ_b.

Results and Discussions

In the Figs.1-2, the variation of axial param-

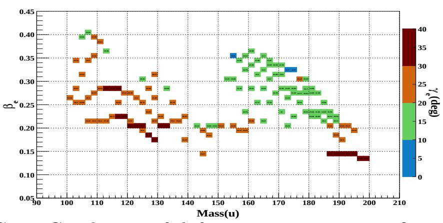

FIG. 1: Corelation of deformation parameter β_e with both atomic mass number and triaxial parameter γ_e

eter (β) is shown w.r.t. both atomic mass(A) and triaxiality parameter(γ). From the Fig.1, it is depicted that for mass region $100 \leq A \leq 150$ the value of β_e lies in the range to 0.17-0.41. The strong triaixiality($\gamma_e > 30°$) was observed for ^{112,114,116}Pd ($\beta_e \sim$ 0.28-0.29), ^{116,118}Cd($\beta_e \sim$ 0.23), ^{120,122,124,126,128}Te(β_e in 0.17-0.21) and ^{130}Xe(β_e ~0.20). The $150 \leq A \leq 200$ the value of β_e varied to 0.13-0.36 and showing strong triaxiality for nuclei ^{186,188,190,192,194,196,198}Hg β_e in 0.13-0.15.

The deformation parameters(β_b, γ_b) obtained

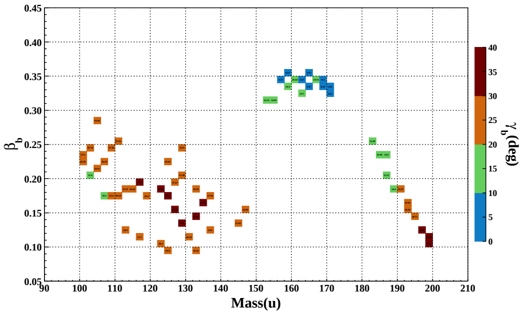

FIG. 2: Corelation of deformation parameter β_b with both atomic mass number and triaxial parameter γ_b

by second method is shown in Fig.2. In the mass region $100 \leq A \leq 150$, the β_b value are lies in the range of 0.095-0.280. The second method had predicted the strong triaxility in ^{116}Cd $\beta_b = 0.195$, ^{122,124,126,128}Te with β_b lies in range 0.99-0.186, ^{132}Xe with $\beta_b = 0.144$, ^{134}Ba $\beta_b = 0.165$. The strong triaxiality is seen ^{198}Pt β_b= 0.115 and ^{198}Hg β_b= 0.108 for the nuclei in mass region $150 \leq A \leq 198$.

Conclusion:

Based on our systematics, we can say the following:

1. The triaxiality parameter (γ) obtained using RTRM reaveals a tendency of gradually increase or decrease of quadrupole deformation (β) with mass number (A). For havier mass nuclei (A>150), there is lower value of triaxiality except Hg and Pt. This study clearly verified that previously suggestion that γ best possibility in weakly deformed nuclei[4].
2. The deformation parameters (γ,β) are found closely correlated from our result, and few details in the literature [5, 6] suggest that these parameters may be correlated. If this is true, we can write β and γ can be expressed as one single variable and get a simpler description of nuclear shapes.

The rigid triaxial rotor model represents only an approximate description. The more result will be presented during the symposium.

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