Systematic dependence of B(E2)↑ on asymmetry parameter γ_0

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Introduction

The reduced electric quadrupole transition probability, $B(E2;0_1^+\rightarrow2_1^+)$ of even–even nuclides have been compiled by Raman et. al [1] and its variation versus A have been shown for $0\leq A\leq260$ region. The observed values have been compared with various theoretical models [1]. The $B(E2;0_1^+\rightarrow2_1^+)$ is a good indicator of the collectivity in even-even nuclei. The intrinsic quadrupole moment, Q_0, can be deduced from the $B(E2;0_1^+\rightarrow2_1^+)$ value, i.e.

$$B(E2;0_1^+\rightarrow2_1^+) = (5/16\pi)\, e^2Q_0^2.$$

In Rigid Triaxial Rotor (RTR) model [2] the $b(E2;2_1^+\rightarrow0_1^+)$ values in unit of $(e^2Q_0^2/16\pi)$ are related to asymmetry parameter γ_0:

$$b(E2;2_1^+\rightarrow0_1^+) =$$

$$½\{1+[(3-2\mathrm{Sin}^2 3\gamma_0) /(\sqrt{(9-8\mathrm{Sin}^2 3\gamma_0)})]\}.$$

The RTR model is a simple way to describe nuclear structure of a nucleus. This model was widely used to explain energy levels, B(E2) values and B(E2) ratios for inter and intra-band transitions. Earlier, Bohr & Mottelson [3] observed that nuclei are no longer to be considered deformed in the original sense at $\gamma_0=24^0$ and the nucleus is expected to take any shape, including triaxial. Earlier, a review on inter-band B(E2) ratio in the RTR model for rare earth and light mass region have been presented by Gupta & Sharma [4] and Mittal-Sharma-Gupta [5] to test the internal consistence of the RTR model predictions.

In the present work, we search for a systematic dependence of $B(E2;0_1\rightarrow2_1)$ values on asymmetry parameter (γ_0) in rare-earth region. The whole data is divided into four quadrants as suggested by Gupta et. al [6].

Result and Discussions

Determination of γ_0

There are various methods [2, 4, 5] to calculate γ_0. The determination of γ_0 from the energy ratio R_γ ($=E_{2\gamma}/E_{2g}$) is more relevant as discussed by Gupta & Sharma [4]. We have calculated γ_0 from R_γ using the equation:

$$\gamma_0 = \frac{1}{3}\sin^{-1}\left[\frac{9}{8}\left\{1-\left(\frac{R_\gamma-1}{R_\gamma+1}\right)^2\right\}\right]^{1/2}.$$

The energy values of $E_{2\gamma}$ and E_{2g} are taken from the website of National Nuclear Data Centre, Brookhaven National Laboratory, USA [7].

The variation of $B(E2;\, 0_1^+\rightarrow2_1^+)$ vs. γ_0

The dependence of energy of first 2^+ states of even-even nuclei on neutron number tells about the nuclear core deformation. We have extended this search of systematic in the reduced electric quadrupole transition rate B(E2) values for Z=50-82, N=82-126. To understand the variation of B(E2) with γ_0, the whole data is divided into four quadrants as discussed in ref. [5,8,9]. The variation of B(E2) values against γ_0 are shown in figs. 1 to 3. For Quadrant-I (Q-I), the plot of B(E2) values vs. γ_0 is shown in fig. 1 for Ba-Dy. The plot of B(E2) values versus γ_0 yields a smooth falling curve of B(E2) with increasing γ_0 reflecting the smooth decrease of nuclear deformation. The data points are not lying on the straight line. For Quadrant-II (Q-II), the plot of B(E2) values vs. γ_0 is shown in fig. 2. Most of the data points are lying on the straight line and indication that the B(E2) values are linearly dependent on γ_0. The variation of B(E2) vs. γ_0 for Q-III is same as for Q-I (see Fig. 3).

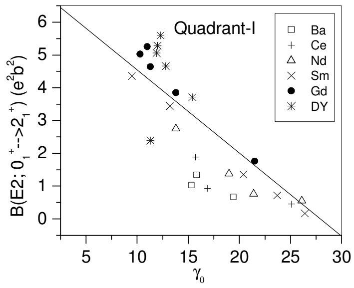

Fig. 1 Plot of B(E2) vs. γ_0 in Q-I.

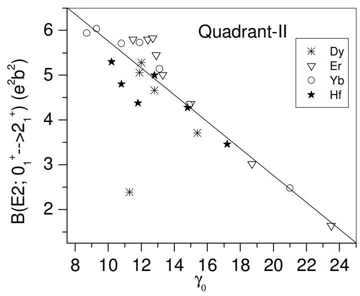

Fig. 2 Plot of B(E2) vs. γ_0 in Q-II

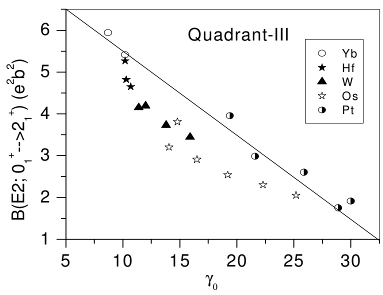

Fig. 3 Plot of B(E2) vs. γ_0 in Q-III

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