Evidence of identical super deformed bands in N=112 isotones

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Introduction

The first discrete line super deformed states in mass A=150 were found in ^{152}Dy [1]. With the discovery of several other examples of super deformation in neighboring nuclei [2-6], it became apparent that some properties of these bands differed considerably. In particular, the dynamic moment of inertia $\vartheta^{(2)}$ and excitation frequencies were seen to vary from one example to the next. It is expected that excited super deformed bands would be built in particle hole excitation and it is not clear how these particle excitations should affect the properties of super deformed bands. Firstly, excited super deformed bands were observed in A=150 mass region mainly in ^{150}Gd and ^{151}Tb [7]. In this paper, we studied the super deformed bands in ^{191}Au, ^{192}Hg and ^{193}Tl (N=112 isotones). These super deformed bands are seen to have similar properties to the observed super deformed bands in their Z+1, N=112 isotones. In particular, the transition energies are almost identical.

Calculation

All super deformed bands are ΔI=2 bands, and the spin differ by 2 (units of ħ). From classical mechanics, it can be shown that

$$\vartheta^{(2)} = \vartheta^{(1)} + \omega \frac{d\vartheta(1)}{d\omega}$$

If $\vartheta^{(1)}$ does not vary with ω, then

$$\vartheta^{(1)} = \vartheta^{(2)}$$

and

$$\vartheta^{(2)} = \frac{\Delta I}{\Delta\omega} = \frac{2}{\omega_2 - \omega_1}$$

by using above equations and data taken from Table of super deformed nuclear bands and fission isomers [8], we calculated the moment of inertia and rotational frequency for superdeformed bands in N=112 isotones ^{191}Au (1st band) and ^{192}Hg (1st band) and other super deformed bands in their Z+1, N = 112 isotones ^{192}Hg (3rd band) and ^{193}Tl (1st band).

Results and Discussion

A plot of $\vartheta^{(2)}$ for the 1st super deformed band in ^{191}Au [Fig. 1] gives a curve which closely follows the $\vartheta^{(2)}$ curve traced out by the 1st super deformed band in ^{192}Hg. Also the 2nd super deformed band in ^{191}Au follows the $\vartheta^{(2)}$ curves traced out by the 1st super deformed band in ^{191}Au and 1st super deformed band in ^{192}Hg. Similarly, in ^{192}Hg (3rd super deformed band) has $\vartheta^{(2)}$ values which resemble those of observed in ^{193}Tl (1st SD band) and ^{192}Hg (1st SD band) [see. Fig. 2].

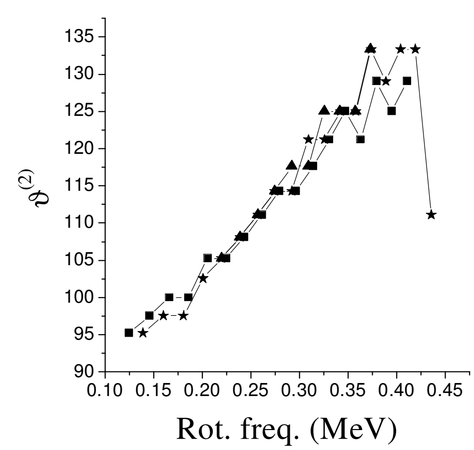

Fig.1 The dynamic moment of inertia $\vartheta^{(2)}$ ($\hbar^2$/MeV) as a function of rotational frequency for 1st super deformed band in ^{191}Au (line with box symbols) together with $\vartheta^{(2)}$ for 2nd super deformed band in ^{191}Au (triangle symbol) and 1st super deformed band in ^{192}Hg(starsymbol).

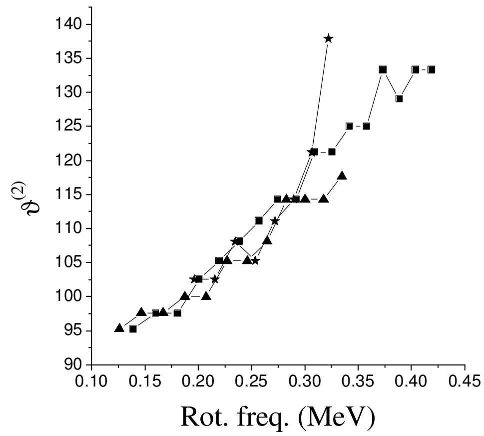

Fig.2 The dynamic moment of inertia $\vartheta^{(2)}$ ($\hbar^2$/MeV) as a function of rotational frequency for 1st band in ^{192}Hg (box symbol) and 1st band in ^{193}Tl (triangle symbol) and 3rd band in ^{192}Hg (star symbol).

These remarkable similarities are further illustrated when direct comparison between the γ–ray energies are made [see Fig. 3] and Fig. 4 shows the differences between the γ–ray energies observed in the identical bands in the pairs of nuclei ^{191}Au - ^{192}Hg and ^{192}Hg – ^{193}Tl. It is approximately zero for ^{191}Au - ^{192}Hg pair and close to zero for ^{192}Hg-^{193}Tl pair.

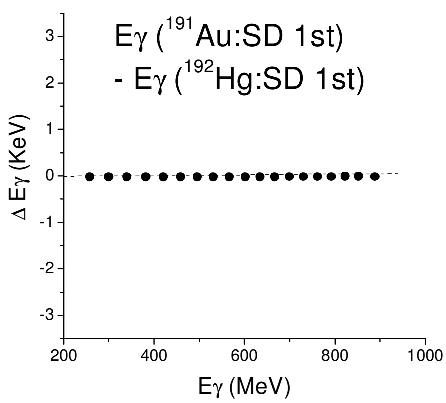

Fig.3 The differences in γ-ray energies between the bands in ^{191}Au (1st SD) and ^{192}Hg (1st super deformed)

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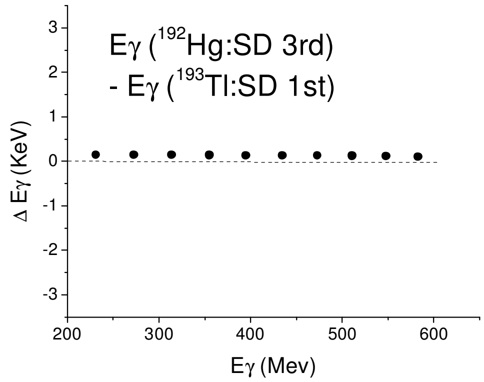

Fig.4 The differences in γ-ray energies between the bands in ^{192}Hg (3rd super deformed) and ^{193}Tl (1st super deformed).

This is clearly seen by considering two super deformed bands in ^{191}Au and ^{192}Hg that there are no excited super deformed bands in N = 112 isotones. In summary, no excited super deformed bands have been observed in ^{191}Au and ^{192}Hg. The dynamic moment of inertia and the transition energies for the bands were found to be remarkably close to those observed in super deformed bands in their Z+1, N = 112 isotones.

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