Features of SD bands in odd – odd nuclei of A=190 mass region

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Introduction

Although interest in super-deformed (SD) nuclei has waned in recent years, they continue to pose a number of open questions which remain unanswered by theory. One of the most intriguing difference between the properties of super deformed nuclei in the A = 150 and A = 190 region is the behavior of the dynamic moment of inertia $\vartheta^{(2)}$ as a function of rotational frequency ħω. The vast majority of super deformed bands near A = 190 display a pronounced increase of $\vartheta^{(2)}$ with ħω. It has been shown that the occupation of specific high–N intruder orbital cannot account for this observed rise [1-3]. Instead it has been suggested that quasiparticle alignments and the resulting changes in pairing might play an essential role [4-6]. The rate of increase of $\vartheta^{(2)}$ with ħω have been noted when comparing even–even nuclei with odd–even neighbors. For example, the somewhat steeper slope in $\vartheta^{(2)}$ of the SD band of ^{192}Hg, when compared with that of SD bands in ^{193}Tl and ^{191}Hg has been interpreted in terms of blocking of either the proton or the neutron alignment in the odd–even neighbor [3]. We feel that a study of the behavior of $\vartheta^{(2)}$ in SD bands of odd–odd nuclei should be particularly revealing. If both the odd proton and odd neutron occupy the high-N intruder orbital, the alignments should be blocked and, as a result the moment of inertia should be constant with frequency. As we show, this does not appear to be the case always.

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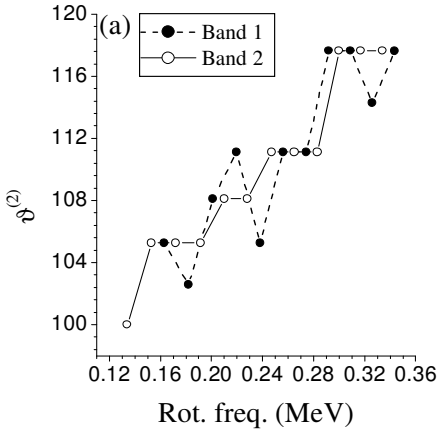
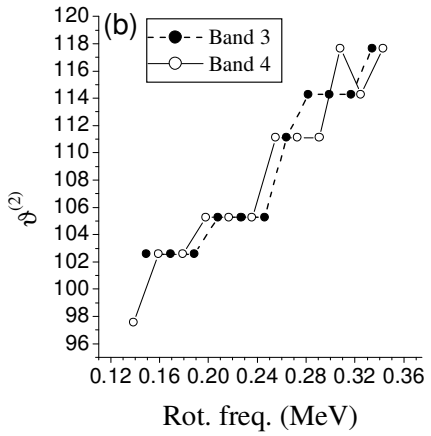
Discussions

Six super deformed bands have been observed in two doubly-odd nuclei namely ^{194}Tl [7] and ^{192}Tl each. For all the bands in ^{194}Tl, the dynamic moment of inertia $\vartheta^{(2)}$ is found to be increasing with rotational frequency ħω as shown in Fig 1. None of these bands are characterized by constant moment of inertia. A comparison of the properties of the six SD bands with those of the neighboring nuclei and particularly with ^{192}Tl allows one to propose quasi-particle configurations for all the bands. Of the six SD bands in ^{192}Tl, four SD bands have a reasonably constant value of the dynamic moment of inertia $\vartheta^{(2)}$ with rotational frequency. It has been suggested that the alignment of quasi-particles occupying the high–N intruder orbital play an essential role in the evolution of $\vartheta^{(2)}$ with ħω [8]. On the other hand, in the case of ^{194}Tl $\vartheta^{(2)}$ displays the more typical rise with ħω for all six SD bands. If we look at the plots in Fig 1, it is highly interesting to note that the dynamic moment of inertia rises in steps in most of the bands.





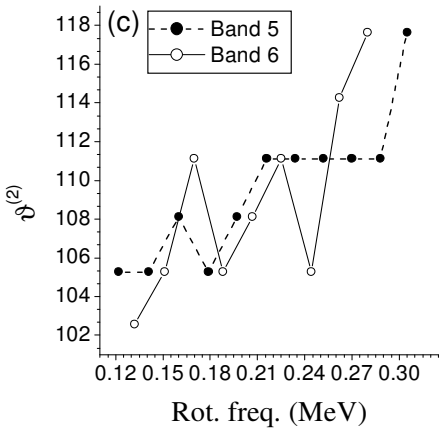


Fig 1. Dynamic moments of inertia $\vartheta^{(2)}$ ($\hbar^2$/MeV) for the six SD bands in ^{194}Tl. (a) Dynamic moments of inertia for bands 1 and 2, (b) for bands 3 and 4 and (c) for bands 5 and 6.

The bands in ^{192}Tl involve proton and neutron excitations which have been observed in odd-even neighboring SD nuclei ^{191}Tl and ^{191}Hg. An alignment of a N = 7 neutron pair, which is calculated [9-10] to occur in ^{191}Tl (and ^{192}Hg) within $0.15 < \hbar\omega < 0.3$ MeV is blocked in ^{192}Tl (and ^{191}Hg) when the odd neutron occupies a $j_{15/2}$ orbital. An alignment of a pair of N = 6 protons is calculated [8-9] to occur in the range $0.25 < \hbar\omega < 0.4$ MeV in ^{191}Hg (and ^{192}Hg). This alignment is also blocked in ^{192}Tl (and ^{191}Tl) when proton occupies an $i_{13/2}$ orbital. At low values of $\hbar\omega$, calculations [8-9] show that the occupation of both the $\pi i_{13/2}$ and $\nu j_{15/2}$ orbitals will result in an additional contribution to $\vartheta^{(2)}$ with respect to odd – even neighboring nuclei. On the basis of this discussion, we have found that band 3 and band 4 in ^{192}Tl are labeled as $\pi_6^5 \times \nu_7^{3.}$ Their rise is almost similar to their respective odd – even neighboring nuclei.

However, the plots for ^{194}Tl suggest that there is no evidence of such blocking of proton and neutron alignment in the six SD bands of ^{194}Tl. On the other hand, appearance of a step like structure poses new questions about way the dynamic moment of inertia changes in this nucleus. A discussion of this feature will be presented.

References

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