

Study of a dipole band in the ^{134}Ba nucleus at high spin states

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Introduction

The nuclei in the mass $A \sim 130$ region are transitional nuclei and have γ -soft character. Many high spin phenomena such as shape coexistence, magnetic rotational (MR) bands, chiral bands and spin isomers were observed in these nuclei [1–4]. In particular, the dipole ($\Delta I = 1$) bands built on the multi-quasiparticle (qp) configurations are seen in the $^{131,132,133}Ba$ ($N = 75, 76, 77$) and $^{135,136}Ce$ ($N = 77, 78$) nuclei [1, 2, 5–7]. In the ^{136}Ce nucleus, the dipole ($\Delta I = 1$) band based on the configuration $\pi[g_{7/2}h_{11/2}] \otimes \nu[h_{11/2}]^2$ exhibits the MR character.

In the present study, the high spin states above the $I = 10^+\hbar$ were investigated for the first time to look for the dipole ($\Delta I = 1$) band as observed in the neighbouring nuclei.

Experimental Details

The ^{134}Ba nucleus was populated using the reaction $^{124}Sn(^{13}C, 3n)^{134}Ba$ at a beam energy of 48 MeV, provided by the Pelletron accelerator at Tata Institute of Fundamental Research (TIFR), Mumbai. The ^{124}Sn target had a thickness of 1.5 mg/cm^2 , with the ^{197}Au backing of thickness 6 mg/cm^2 . The γ -rays decaying from the ^{134}Ba nucleus were detected using the Indian National Gamma Array (INGA), consisting 11 compton suppressed

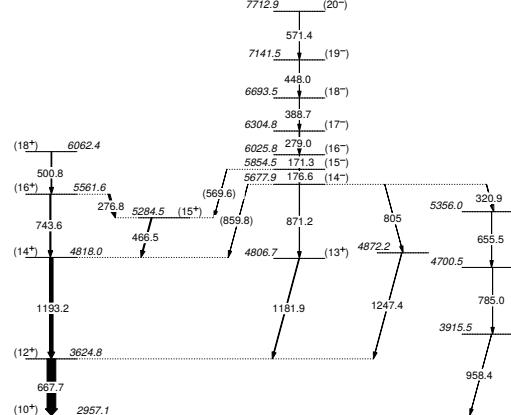


FIG. 1: Partial level scheme of ^{134}Ba nucleus above the $10^+\hbar$ state.

clover detectors, with 3, 3, 1 and 4 clovers placed at 157^0 , 140^0 , 115^0 and 90^0 with respect to the beam direction, respectively.

Results and Discussion

In this work, the level scheme of the ^{134}Ba nucleus has been extended upto spin $I = 20\hbar$. The partial level scheme of the ^{134}Ba nucleus above the $I = 10^+\hbar$ state is shown in Fig. 1. The placement of γ -ray transitions in the level scheme was done on the basis of relative intensity, coincidence and anticoincidence relations of the γ -ray transitions from the γ - γ and γ - γ - γ analysis. All the γ -ray transitions in the coincidence of 171- and 176 keV γ -ray transitions are shown in the Fig. 2.

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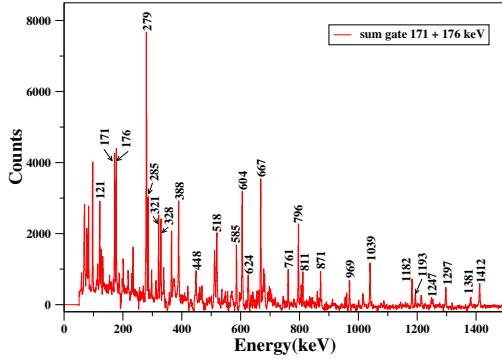


FIG. 2: Sum gate spectrum of 171- and 176 keV γ -ray transitions.

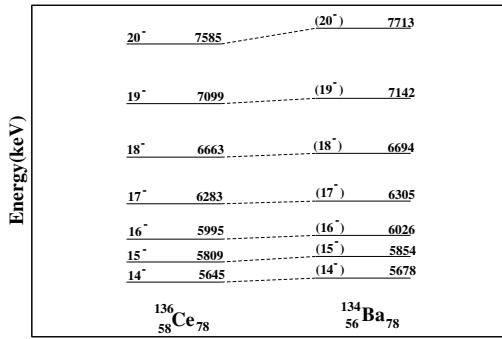


FIG. 3: Comparison of energy levels of the dipole band in the ^{134}Ba nucleus with the similar dipole band observed in the ^{136}Ce nucleus.

The ground state band above the spin $I = 10^+\hbar$ at 2957 keV level energy is extended upto spin $I = (18^+)\hbar$ at 6062 keV level energy. The 500.8-, 667.7-, 743.6-, 1193.2 keV γ -ray transitions consisting this positive parity band are E2 in nature.

A negative parity band is also observed above the 5678 keV energy level. The γ -ray transitions of this band have the dipole character. This negative parity band is similar to the the $(\Delta I = 1)$ dipole band based on multi quasi-particle configurations as observed

in the other Ba isotopes and $N = 78$ isotope i.e; ^{136}Ce nucleus. Fig. 3 shows the comparison of the energy levels of the $(\Delta I = 1)$ dipole bands observed in the ^{134}Ba and ^{136}Ce nucleus.

Conclusion

The excited states of the ^{134}Ba nucleus above the spin $I = 10^+\hbar$ have been studied and the level scheme has been extended upto $I = 20\hbar$ spin. The $(\Delta I = 1)$ dipole band is observed at the $(14^-)\hbar$ state at 5678 keV level energy.. The theoretical calculations to understand these bands are in progress.

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References

- [1] S. Juutinen *et. al.*, Phys. Rev. **C51**, 1699(1995).
- [2] S. Lakshmi *et. al.*, Phys. Rev. **C69**, 014319(2004).
- [3] S. Mukhopadhyay *et. al.*, Phys. Rev. Lett. **99**, 172501(2007).
- [4] J. Gizon *et. al.*, Nucl. Phys. **A252**, 509(1975).
- [5] Navneet Kaur *et. al.*, Eur. Phys. J. **A50**, 5(2014).
- [6] S. Juutinen *et. al.*, Phys. Rev. **C52**, 2946(1995).
- [7] R. Ma *et. al.*, Phys. Rev. **C41**, 2624(1990).
- [8] T. Morek *et. al.*, Z. Phys. **A298**, 267(1980).