

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

Neelam^{1,*}, Suresh Kumar¹, K. Rojeeta Devi¹, Naveen Kumar^{1,2},
 F. S. Babra³, Md. Sazedur R. Laskar³, S. Biswas³, S. Saha³,
 P. Singh³, R. Palit³, S. Samanta⁴, S. Das⁴, and Ashok Kumar⁵

¹Department of Physics and Astrophysics,
 University of Delhi, Delhi-110007, India

²Govt. Degree College, Dhaliara, Himachal Pradesh, 177103, India

³Department of Nuclear and Atomic Physics,
 Tata Institute of Fundamental Research, Mumbai 40005, India

⁴UGC-DAE Consortium for Scientific Research, Kolkata-700098, India and
⁵Department of Physics, Panjab University, Chandigarh 160014, India

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 $^{131,132,133}\text{Ba}$ ($N = 75, 76, 77$) and $^{135,136}\text{Ce}$ ($N = 77, 78$) 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 $I = 10^+ \hbar$ state 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 $^{124}\text{Sn}(^{13}\text{C}, 3n)^{134}\text{Ba}$ 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

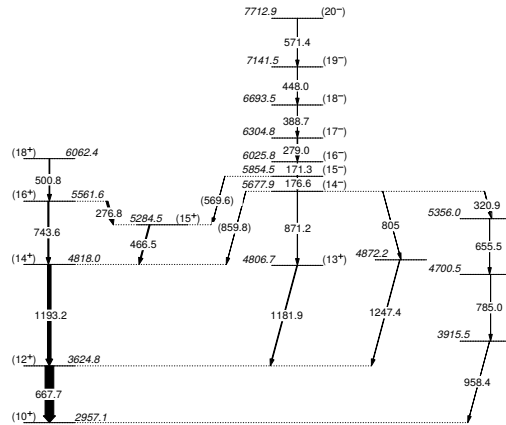


FIG. 1: Partial level scheme of ^{134}Ba nucleus above the $10^+ \hbar$ state.

clover detectors, with 3, 3, 1 and 4 clovers placed at 157° , 140° , 115° and 90° 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.

*Electronic address: du.neelam@gmail.com

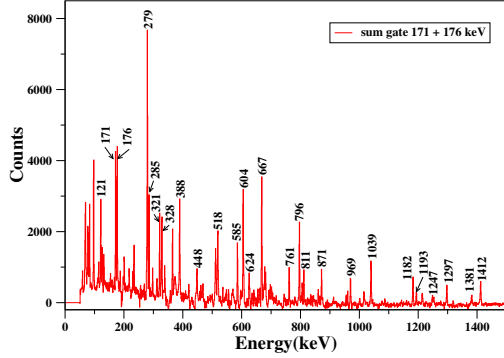


FIG. 2: Sum gate spectrum of 171- and 176 keV γ -ray transitions.

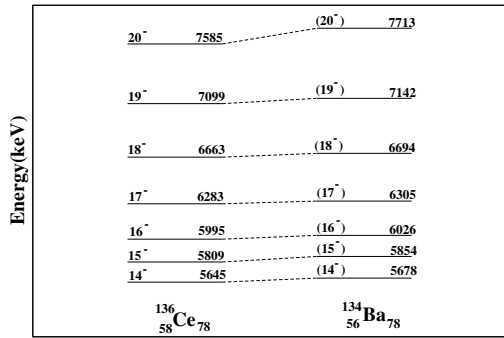


FIG. 3: Comparison of energy levels of the dipole band in the ^{134}Ba nucleus with the similar dipole band observed in the ^{136}Ce nucleus.

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 $N = 78$ isotone 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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