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

Neelam[1],* Suresh Kumar[1], K. Rojeeta Devi[1], Naveen Kumar[1,2], F. S. Babra[3], Md. Sazedur R. Laskar[3], S. Biswas[3], S. Saha[3], P. Singh[3], R. Palit[3], S. Samanta[4], S. Das[4], and Ashok Kumar[5]

[1]*Department of Physics and Astrophysics, University of Delhi, Delhi-110007, India*
[2]*Govt. Degree College, Dhaliara, Himachal Pradesh, 177103, India*
[3]*Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai 40005, India*
[4]*UGC-DAE Consortium for Scientific Research, Kolkata-700098, India and*
[5]*Department 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 (ΔI = 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 (ΔI = 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 (ΔI = 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 supressed clover detectrors, 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.

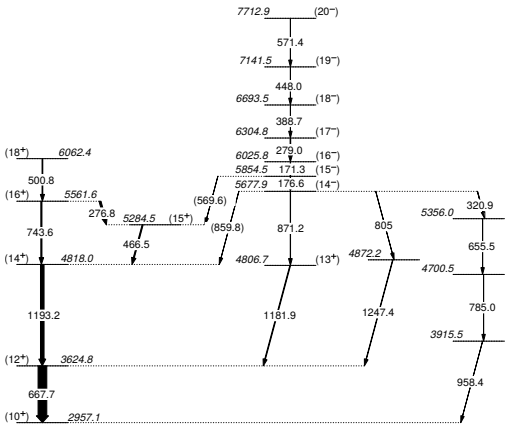

FIG. 1: Partial level scheme of ^{134}Ba nucleus above the $10^+\hbar$ state.

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

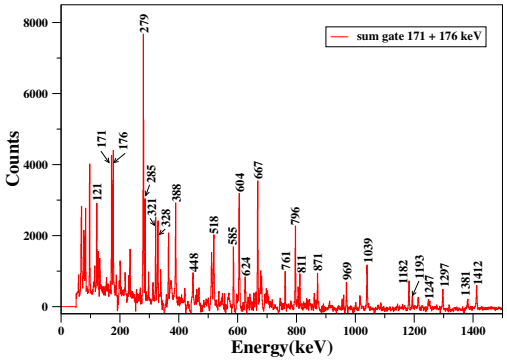

FIG. 2: Sum gate spectum of 171- and 176 keV γ-ray transitions.

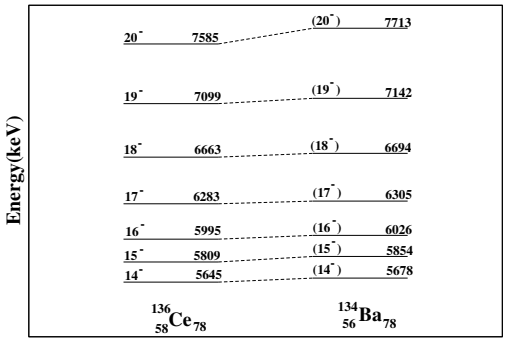

FIG. 3: Comparison of energy levels of the dipole band in the ^{134}Ba nucleus with the similar dipole band observed in the ^{136}Ce nucleus.

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 (ΔI = 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 (ΔI = 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 (ΔI = 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.

Acknowledgments

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