High Spin Spectroscopy of ^{131}Ba

Navneet Kaur[1], A.Kumar[1], Amandeep Singh[1], Varinderjit Singh[1], Rohit Sandal[1], Rajbir Kaur[1], B.R.Behra[1], K.P.Singh[1], G.Singh[1], H.P.sharma[2], Suresh Kumar[3], M.Kumar.Raja[4], P.V.Madhusudhan Rao[4], S.Muralithar[5], R.P.Singh[5,] Rakesh Kumar[5], R.K.Bhowmik[5], N.Madhvan[5]

1 Department of Physics, Panjab University, Chandigarh,
2 Department of Physics, B.H.U. Varanasi, India
3 Department of Physics, D.U, India
4 Nuclear Physics Department, Andhara University, Vishakapatnam-India
5 Inter University Accelerator Ccentre, Aruna Asaf Ali Marg, New Delhi-110067, India
**email: ashok@pu.ac.in*

Introduction

Nuclei with mass A ~130 have been of great interest to experimental studies of high spin states. In this mass region, as the proton Fermi surface lies near the bottom of the ´$h_{11/2}$ sub-shell and the neutron Fermi surface lies near the top of the ɜ$h_{11/2}$ sub-shell, the rotational alignment of a pair of proton from the lower $h_{11/2}$ mid-shell drives the nucleus to a near prolate (ɔ~0º) shape while the rotational alignment of a pair of $h_{11/2}$ neutron from the upper mid-shell drives the nucleus to near oblate shape (ɔ~60º). Thus the different excitation of quasiparticles may drive the nucleus to form different shapes and shape coexistence has been observed in this mass region. A particularly interesting scenario occurs when the occupation of shape-driving orbital at the Fermi surface removes axial symmetry and forces the nucleus to addopt a triaxial shape. Interesting feature of this mass region is the existence of regular M1 bands which have been considered to be a promising candidates of magnetic rotation . In several nuclei of the A ~ 130 mass region M1 bands [1] are known. In present work, our aim is to study these phenomena in ^{131}Ba.

Experimental Set-up

In the present work, the high spin states in ^{131}Ba have been studied through the ^{122}Sn (^{13}C, 4n) ^{131}Ba heavy ion fusion evaporation reaction with a beam of 65 MeV energy. The experiment was carried out at the 14-UD pelletron accelerator at IUAC, New Delhi India, which delivered ^{13}C beam on a ~1.0 mg/cm^2 thick ^{122}Sn target with Au (6.7mg/cm^2) backing. The ɔ decay following the reaction was studied using an array consisting of 15 Compton suppressed clover detectors of INGA (Indian National Gamma Array) placed at the angle of 32º, 57º, 90º, 123º, 148º with respect to the beam direction. The data were collected when three or more clovers were fired using CAMAC crate.

Result and Discussion

Earlier, this nucleus [2] has been populated using the ^{122}Sn (^{13}C, 4n ɔ) reaction at the bombarding energy of 57 MeV with the array of 5 Germanium detectors. In that work, for few bands the spin and parity was tentatively assigned and for two bands no spin and parity was assigned. Since the clover detectors have been used in the present experiment, polarization measurements are possible to assign the spin/parity where it is unknown. All the earlier gamma rays have been recognized in ^{131}Ba and some new transitions have also been placed in level scheme.

Multipolarity of de-exciting ɔ-rays were deduced from the observed ɔ-ɔ angular correlation measurements. For $R_{DCO,}$ ɔ-ɔ matrices were constructed where one axis corresponds to a ɔ-ray recorded by 148º and other ɔ-rays recorded by 90º detectors. A gate corresponding to a ɔ-ray of known multipolarity was taken on one axis (say, the x-axis) and coincident spectrum was projected on other axis. Next the same gate was set on the y-axis and projection was made along another axis. Using gates of known quadrupole or dipole transitions, we define R_{DCO} as follows:

$$R_{DCO} = \frac{I(\gamma_{1:} : 148^{o} \; gated \;\; by \; \gamma_2 : 90^{o})}{I(\gamma_1 : 90^{o} \; gated \;\; by \; \gamma_2 : 148^{o})}$$

We have calculated DCO ratio (shown in Fig.1) by gating pure dipole transitions (i.e. 1112 keV) and found that the multipolarity of transitions of the band shown by asterisk in Fig. 3 are also of dipole nature.

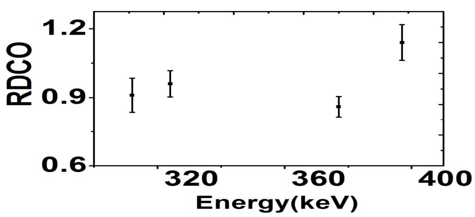

Fig.1 DCO Ratio

For polarization measurements, the individual crystal is considered as scatterer and two adjacent crystals as observers, within a single clover detector. The linear polarization of the radiation can typically be determined through a difference between the number of Compton scattered ɔ-rays in reaction plane N_{11}, and perpendicular to it, N_{9}. Two asymmetric matrices were constructed by placing events that contain the energy recorded in all detectors along one axis whereas the other axis corresponds to ɔ-ray scattered in a perpendicular or parallel segment of clover w.r.t. beam axis. The asymmetry parameter a (shown in Fig.2), because of the asymmetry of present experimental configuration, has been deduced using radioactive source and is expressed as:

$$a = \frac{N_{11}}{N_{\perp}}$$

Polarization constant has been calculated for 324 keV transition by gating 1112 keV ($21/2^{+}$-$19/2^{-}$) transition. Expression for polarization constant (φ) is given by

$$\Delta = \frac{aN_{\perp} - N_{11}}{aN_{\perp} + N_{11}}$$

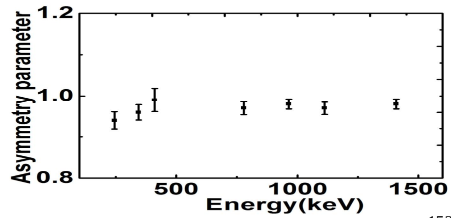

Fig.2 Asymmetry parameter using ^{152}Eu source

For 324 keV transition, the value of φ is negative and this transition is of magnetic nature. Therefore, in the light of RDCO and polarization measurement, we assigned the positive parity to these states and the transition between them is of dipole nature. Earlier spin and parity of this band was unknown. The analysis is in progress and the results for other bands will also be presented.

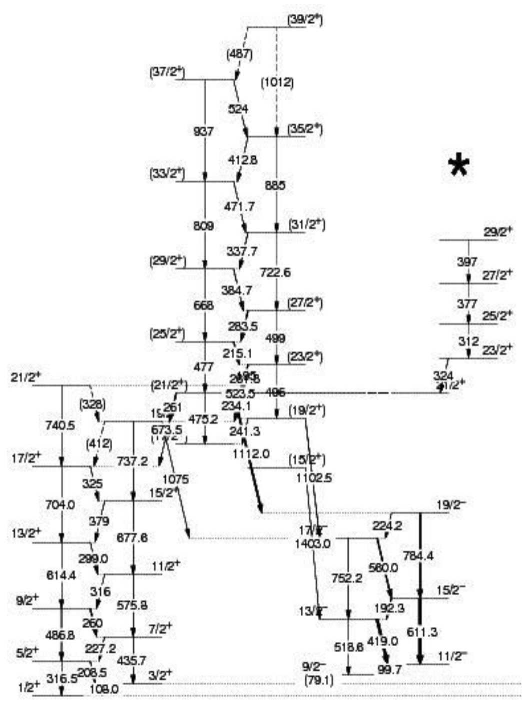

Fig.3 Partial level scheme showing band of interest with asterisk (*).

References

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