

Abrupt Change in the rotational behaviour of a negative-parity band in the ^{85}Sr nucleus

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Introduction

In a deformed nucleus, the higher angular momentum states are generated by a collective rotation either about a principal axis or a tilted axis. In some cases, the total angular momentum is produced by the alignment of neutron and proton angular momentum vectors through specific coupling schemes [1–3]. However, in some nuclei a transition from the principal axis to the tilted axis is observed [4]. From the experimental observations such as staggering, B(M1) transition rates etc., it is possible to observe this phase transition. In this work, we are reporting such phenomenon in $A = 85$ mass region. In the ^{85}Sr nucleus, a negative parity band was investigated through lifetime measurements which was supposed to show the magnetic rotation [5] phenomenon as it was found in the ^{83}Kr nucleus ($N = 47$ isotone, best example of magnetic rotation in mass 85 region).

Experimental details

The ^{85}Sr nucleus was investigated for high-spin states via the reaction $^{76}\text{Ge}(^{13}\text{C},4n)^{85}\text{Sr}$ using a ^{13}C beam of 45 MeV from the Pelletron accelerator at Tata Institute of Fundamental Research (TIFR), Mumbai. The ^{76}Ge target of thickness $850 \mu\text{g}/\text{cm}^2$ with $7.06 \text{ mg}/\text{cm}^2$ ^{181}Ta backing was used. Gamma rays were detected using Indian National

Gamma Array (INGA) by using 15 Compton-suppressed clover detectors at 157° , 140° , 115° , 90° , 65° and 40° with respect to the beam direction. The data were sorted using Multi-pARAmeter time stamped based COincidence Search (MARCOS) and analysed by DAMM and RADWARE for different matrices to generate gated spectrum. The asymmetric matrices consisting of events at 40° , 140° and 157° detectors along one axis and rest of the detectors on other axis were created using MARCOS, and gate spectra were generated using DAMM and RADWARE for lifetime analysis. The LINESHAPE [6] programme was used to calculate the lifetime of different transitions.

Results and discussion

In the ^{85}Sr nucleus, the lifetime of the states were measured for band 4 (negative-parity) above $I^\pi = 21/2^+$ state [7] using the DSAM. In this band the lineshapes were observed for the dipole γ -ray transitions viz. 964.6, 432.0, 906.3, 686.8, 595.6 and 333.1 keV and quadrupole γ -ray transitions having energies of 1338.0, 1146.3 and 1396.6 keV. Fig. 1 shows the experimental data along with the lineshape obtained for the 333.1- and 686.8-keV transitions. In Fig. 2 and 3, the B(M1) and B(E2) rates, respectively, are plotted which are obtained in the present work. In these figures, we have also shown the transition rates of the dipole bands in the ^{83}Kr nucleus [5] and ^{109}Ag nucleus [4] to provide the resemblance of the phenomenon. It is clear that the structure of the band 4 of the ^{85}Sr nucleus does

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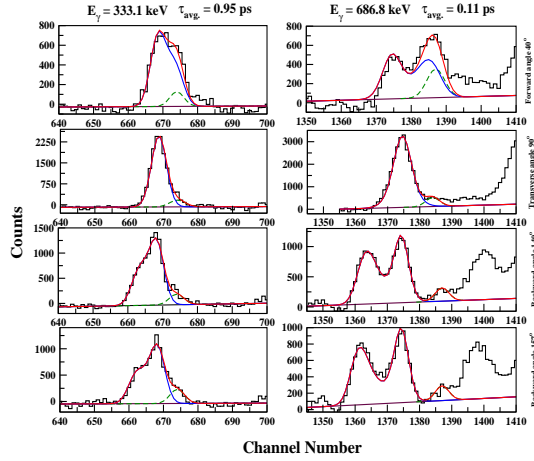


FIG. 1: The experimental data along with the lineshape obtained for the 333- and 686-keV transitions in the negative-parity band (band 4) of ^{85}Sr [7] at 40° , 90° , 140° and 157° angles.

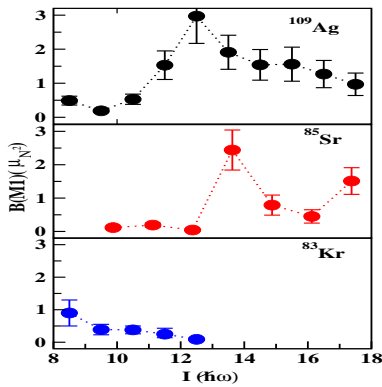


FIG. 2: Plot showing the variation of $B(M1)$ values as a function of spin for ^{109}Ag , ^{85}Sr and ^{83}Kr nuclei.

not have magnetic rotation (MR) phenomenon similar to the dipole band in the ^{83}Kr nucleus. However, the behaviour of the $B(M1)$ and $B(E2)$ rates show similar behaviour as observed in positive-parity band in ^{109}Ag which has the characteristics of abrupt change from principal axis to tilted axis [4]. Therefore, in the present work we report that band 4 of the ^{85}Sr nucleus has the characteristics of this

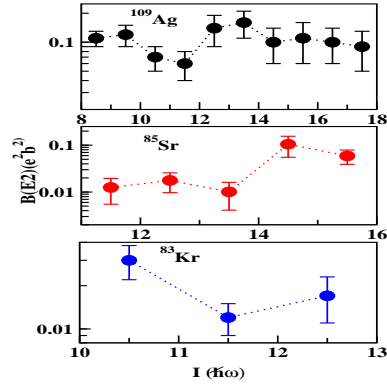


FIG. 3: Plot showing the variation of $B(E2)$ values as a function of spin for ^{109}Ag , ^{85}Sr and ^{83}Kr nuclei.

abrupt change from principal axis to tilted axis. The theoretical calculations to understand this phenomenon are in progress.

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