Polarization and Angular correlation measurements in ^{84}Sr

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Introduction

The nuclei near A≈85 lie in a transitional region which change structure from axial deformed to spherical shapes. The ^{84}Sr nucleus has four holes near the N=50 neutron shell closure. This nucleus has already been investigated for high spin via the $^{51}V(^{36}S, p2n)$, $^{52}Cr(^{36}S, 2p2n)$ [1] and $^{59}Co(^{28}Si, 3p)$ [2] reactions and lifetime measurements are also reported in these studies. Recently, the low-lying spin states were studied using the $^{85}Rb(p, 2n)$ reaction [3]. Also, the $^{70}Zn(^{18}O, 4n)$ reaction was employed to re-investigate the high spin states of the ^{84}Sr [4]. These studies report many discrepancies on the intensities of the γ-rays and in some cases on the spin-parity assignments prior to their work. Previously, the spin-parity assignments were based on angular distribution co-efficients and DCO ratio measurements.

In the present work, we are reporting the re-investigation of intermediate state and spin-parity assignment based on DCO states and polarization measurements. The polarization measurements were performed first time to obtain the multipole character of the γ-ray transitions.

Experimental details

The excited states of the ^{84}Sr nucleus were populated using the $^{76}Ge(^{12}C, 4n)^{84}Sr$ reac-

tion at a beam energy of 58 MeV at Inter University Accelerator Centre (IUAC), New Delhi. The ^{76}Ge target consisted of a 750 μg/cm^2 metallic foil with 8.2 mg/cm^2 backing of Ta. Indian National Gamma Array (INGA) spectrometer was used to detect the de-exciting γ-rays. The coincidence data was sorted to generate two and three fold matrices using INGASORT package and were analyzed with the RADWARE [5] software package.
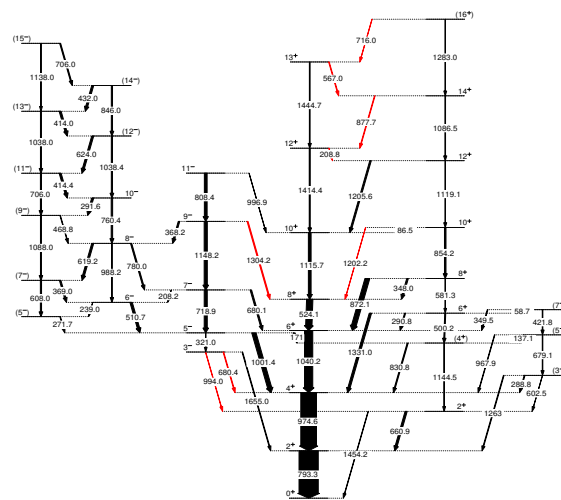

Figure 1: The proposed level scheme of ^{84}Sr nucleus.

The polarization asymmetry was obtained by measuring the ratio of counts $N_{\parallel}/N_{\perp}$ of

Compton scattered events in the clover detector placed at 90°. Directional Correlations of the Oriented (DCO) states ratios were obtained by analysing an asymmetric matrix (148° vs 90°).
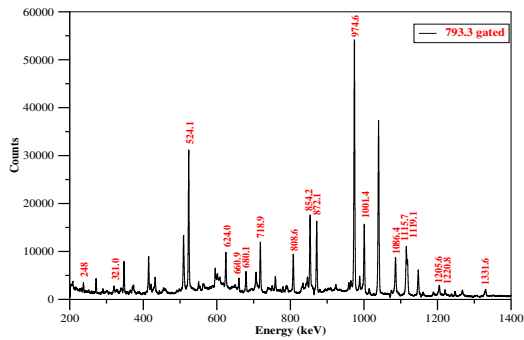
Results & Discussions

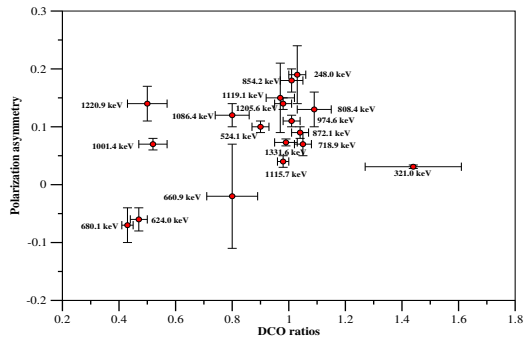**Figure 2:** The spectrum showing the γ-rays in the gate of 793.3 keV.

Figure 3: R_{DCO} vs polarization asymmetry (Δ) plot for different γ-ray transitions.

The level scheme for the intermediate states obtained from the present work is shown in the Fig. 1. The presence of the γ-rays belongs to ^{84}Sr nucleus is shown in Fig. 2. In Fig. 3, the results of DCO states ratios and polarization asymmetry measurements are presented. The new γ-rays having energy 58.7-, 86.5-, 137.1-, 208.8-, 567.0-, 680.4-, 716.0-, 877.7-, 994.0-, 1202.2- and 1304.2 keV were placed as inter-connecting transitions among various bands. The cube analysis were performed to verify the placement of previous placed γ-ray transitions. The γ-rays of energy 793.3-, 974.6-, 1040.2-, 524.1-, 1115.7-, 1414.4- and 1444.7 keV have E2 character which leads to the spin-parity assignments of the Yrast band. The E1 character is established for 680.4-, 1001.4- and 680.1 keV and confirmed the negative parity for 3^-, 5^- and 7^- for the octupole band. Further, E2 character of 1148.2 and 808.4 keV transitions confirms the spin and parity of 9^- and 11^- state of the above band. Similarly, the spin-parity of quasi-γ band is confirmed in this work. The placement of 624.0 and 414.4 keV transitions is interchanged for the band above $I^\pi = (5^-)$. Based on the DCO and polarization measurement E2 character is established for 760.4 and 1086.5 keV transitions. The 414.4 and 624.0 has $D + Q$ nature based on the DCO ratio values. Also, it was found that 1040 keV is a multiple placed γ-ray. The theoretical work to understand the experimental results is in progress.

References

[1] G. Garcia Bermudez *et al.*, Phys. Rev. C **49**, 6 (1994).

[2] S. Chattopadhyay, H. C. Jain, M. L. Jhingan, and C. R. Praharaj, Phys. Rev. C **50**, 1 (1994).

[3] N. Yoshikawa, Y.Shida, O.Hashimoto, M.Sakai, and T.Numao, Nucl. Phys. A **327**, 477 (1979).

[4] KANG XuZhong, *et al.*, Sci China Phys Mech Astron, **53**, 10 (2010).

[5] D. C. Radford, Nucl. Instrum. Methods Phys. Res. A **361**, 297 (1995).