Evidence of E(5) symmetry in ^{74}Se

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Introduction

Phase transitions in atomic nuclei have become one of the most spectacular subjects that have been investigated over years. Two distinct critical phase transitional points have been identified in the pathway of the spherical to deformed one. One critical point is situated in between the spherical and the γ-vibrational limit that has been termed as E(5) symmetry breaking whereas other symmetry, X(5), fall in the path of γ-vibration to deformed system [1]. Recently, several experimental and theoretical investigations have been performed to reveal the X(5) and E(5) symmetry structures. Indeed, the experimental evidences in ^{152}Sm, ^{150}Nd and ^{154}Gd nuclei strongly support their X(5) behaviour [1] whereas E(5) critical point has been identified in ^{134}Ba and ^{128}Xe only, until today [1]. Recently, we have established an experimental evidence of exact E(5) symmetry in ^{82}Kr [2]. This prompts our motivation of examining the critical point nuclei throughout the nuclear chart to get complete picture of the phase transitional behavior.

The present experimental study aims to investigate the E(5) critical point symmetry in ^{74}Se nucleus. The experimental $R_{4/2} = 2.15$ (for ^{74}Se) which are closes to the predicted value of 2.20 [1]. The previous measurement on this nucleus extracted the B(E2) transition rates of the ground state band up to the 6^+ state and within the error bars transition strength are in well agreement with the E(5) prediction [1]. The low lying structure of these nucleus has very similar to the established E(5) nucleus ^{82}Kr. These signatures predicted that ^{74}Se would be the next candidates of the island of E(5) limit, more specially, in $A \approx 80$ mass region.

Experimental Details

The low spin states of the ^{74}Se have been populated by the fusion evaporation reaction ^{72}Ge(^{4}He, 2n)^{74}Se at a beam energy of 28 MeV delivered from K130 cyclotron, Variable Energy Cyclotron Centre, Kolkata. The target (3.4 mg/cm^2 natural Ge) was prepared by centrifuge method on a thick myler backing. The de-exciting γ-rays were detected by the Indian National Gamma Array (INGA) which consist of 11 Compton suppressed clover detectors, positioned at three different angles (40°, 90°, and 125°) with respect to the beam direction. The data were sorted in to symmetric and angle dependent γ - γ matrices, and γ - γ - γ cube using the BiNDAS [3] code and

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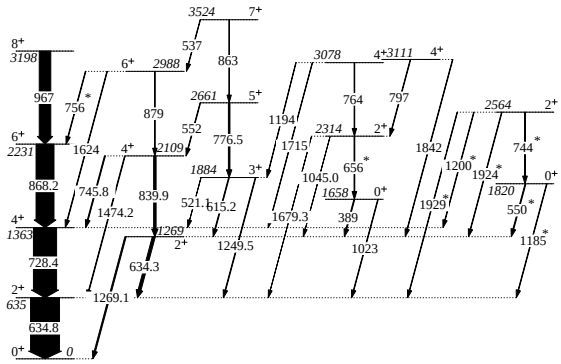

FIG. 1: The partial level scheme of ^{74}Se obtained the present work. The level energies are rounded off to the nearest keV. The newly observed transitions have been marked by the asterisks.

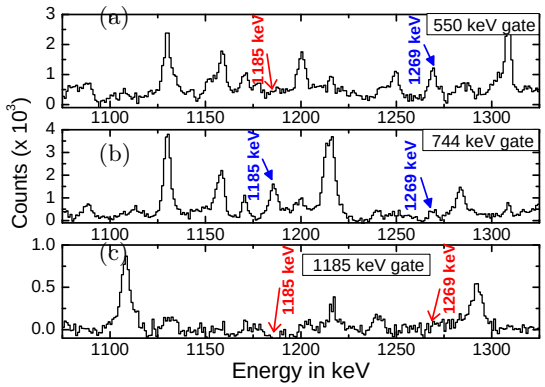

FIG. 2: The coincidence spectra for the gate set on (a) 550-keV, (b) 744-keV, and (c) 1185-keV obtained the present work.

analyzed using the INGASORT [4] and RADWARE [5] packages.

Results & Discussions

In the present work, we have re-investigated the low-spin states of ^{74}Se [6, 7]. Several new γ-ray transitions have been established from the coincidence measurements. The proposed partial level scheme shown in Fig. 1 is compared with the possible E(5) levels [1]. A possible $\xi = 2$ family band has been established having excitation energy of 1820-keV. A new γ-transition of energy 1185-keV has been observed in 744-keV gate but remain absent in 550-keV gate (Figs. 2 (a) and (b)). Thus, the 1820-keV state is decaying via the 1185-keV transition to the 2^+, 635-keV state of the yrast band. The presence of 1820-keV energy level is also confirmed through the absence of the 1269-keV ($2^+ \rightarrow 0^+$) γ transition in the 1185-keV gated spectrum (Fig. 2 c), which is observed in the 550-keV and 744-keV gated spectra. The 0^+ levels at 1820-keV and 1658-keV show preferred decay to the 2^+, 635-keV and 2^+, 1269-keV states, respectively, indicating that they might be associated with the bandhead of the $\xi = 2$ family of levels, and the 0^+ state arising from the three phonon. Measured values $\frac{B(E2:550-keV)}{B(E2:1185-keV)} \leq 0.09(2)$, and $\frac{B(E2:1023-keV)}{B(E2:388-keV)} = 0.11(1)$, these low values are consistent with the IBA predictions. These observations corroborate the assignment of the 1820-keV and 1658-keV states as the two-phonon and three-phonon 0^+ levels of E(5) dynamical symmetry, respectively. The detail structure of the E(5) symmetry and its emergence in ^{74}Se will be discussed at the time of presentation.

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