

Observation of multipole E3 transitions in ^{74}Se

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1. INTRODUCTION

In the even-even isotopes, as the spin increases, negative and positive parity levels become interlaced with spacings roughly appropriate to a single band. The levels in these bands are connected by both strong electric quadrupole and strong electric dipole transitions. Only in restricted regions of the nuclear chart, the excitation spectrum of nuclei are explained with the assumption of octupole deformations. These regions occur when a pair of single-particle orbitals with $\Delta l=3$ and $\Delta j=3$ having large octupole-interaction matrix elements lies close to each other.

For the even-even nuclei, the low lying 3^- state is observed in their excitation spectrum. These nuclei exhibit a pair of almost degenerate opposite parity band structures with connecting $E3$ matrix elements. Such parity doublet bands are the signature of octupole deformation. The experimental signatures of the octupole interaction are the collective $E3$ transition rates and the enhanced $E1$ transition rates between the opposite parity states.

Experimental data of the $B(E3)$ transition rates are scarce as these are very difficult to access experimentally.

In the $A \approx 80$ mass region, the nuclei with particle (proton or neutron) number 34 ($g_{9/2} \leftrightarrow p_{3/2}$ coupling) tend to incline towards the octupole deformation, β_3 [1]. The $B(E3; 3_1^- \rightarrow 0_1^+)$ values have been measured in $^{74,76,78,80,82}\text{Se}$ and $^{78,80,82,84,86}\text{Kr}$ nuclei [2]. Though these values span several orders of magnitude, any connection between the $B(E1)$ and $B(E3)$ transition rates is not obvious. These are the direct indication of octupole collectivity for nuclei in $A \approx 80$ mass region. The present work is motivated to search for the $E3$ transitions in ^{74}Se to explore the possibility of existence of octupole collectivity in this nucleus.

2. EXPERIMENTAL DETAILS

The excited states of the ^{74}Se have been populated through the reaction of the 28-MeV ^4He projectile with the ^{74}Ge target. The α beam was delivered by the room temperature cyclotron at VECC, Kolkata. The target 6.0 mg/cm^2 ^{74}Ge was prepared by centrifuge method on a thick myler backing. The Indian National Gamma Array (INGA), consisting of eleven Compton-suppressed $HPGE$ clover de-

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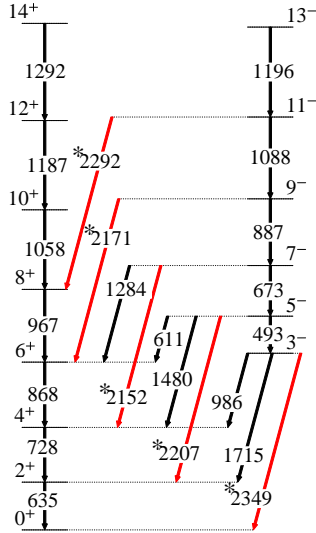


FIG. 1: Partial level scheme of ^{74}Se obtained from the present work. Newly observed transitions are coloured by red and marked by asterisk.

tectors and a *HPGE LEPS* arranged in three different angles $40^\circ(2)$, $90^\circ(6)$, and $125^\circ(3)$ with respect to the beam direction, was used as the γ spectrometer. A *PIXIE* – 16 based digital data acquisition system, was employed to record the time stamped γ events in single and coincidence modes. The data were sorted into γ - γ matrices, symmetric as well as angle dependent, and γ - γ - γ cube using the *MARCOS* [3], and the *BiNDAS* [4] codes and analyzed using the *RADWARE* [5] package.

3. RESULTS AND DISCUSSION

This is the first report of the observation of five $E3$ transitions between two opposite parity bands in any nucleus of the periodic table. The proposed partial level scheme of ^{74}Se , obtained from the present work, is shown in Fig. 1. The single gated spectrum created by the 493, and 673-keV transitions, shown in Figs. 2(a) and 2(b), exhibit the newly observed $E3$ transitions of energies 2349 keV and 2207 keV along with the previously reported transitions. The measured $B(E3)$ transition strengths show rapid increase with spin as depicted in Table I. This confirm the existence of octupole collectivity in ^{74}Se . Other details

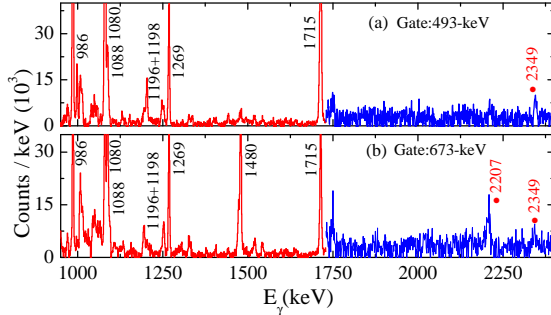


FIG. 2: Gated spectrum created by the (a) 493-keV and (b) 673-keV transitions showing newly observed $E3$ transitions labelled by red colored numbers (marked by red \bullet). The region after 1730-keV of the spectrum (colored by blue) has been multiplied by five to increase visibility of the peaks.

will be presented during the conference.

TABLE I: $B(E3)$ transition rates in ^{74}Se .

E_γ (keV)	$I_i \rightarrow I_f$	$\text{Br}(\%)$	$B(E3)(e^2b^3)$
2349	$3^- \rightarrow 0^+$	1.3	0.0117
2207	$5^- \rightarrow 2^+$	4.1	0.1885
2152	$7^- \rightarrow 4^+$	0.9	0.1076
2171	$9^- \rightarrow 6^+$	2.4	2.780
2292	$11^- \rightarrow 8^+$	1.6	1.796

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