Multi-quasiparticle states in ^{127}I

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Introduction

The observation of collective and non-collective multi-quasiparticle states in several odd-A Sb (Z=51), I (Z=53) and Cs (Z=55) isotopes is quite common in A∼130 mass region. In odd-A $^{121-125}$Sb isotopes, several isomeric states have been reported based on $\pi g_{7/2} \otimes \nu(h_{11/2}s_{1/2})$, $\pi g_{7/2} \otimes \nu(h_{11/2}d_{3/2})$ and $\pi g_{7/2} \otimes \nu(h^2_{11/2})$ three quasiparticle configuration [1, 2]. In the case of $^{123-129}$Cs, a number of positive and negative parity bands have been found, associated with $\pi h_{11/2} \otimes \nu(h^2_{11/2})$, $\pi h_{11/2} \otimes \nu h_{11/2} \otimes \nu(g_{7/2}/d_{3/2}/s_{1/2})$ and $\pi g^{-1}_{9/2} \otimes \nu(h^2_{11/2})$ configuration [3–6].

Several three-quasiparticle bands associated with $\pi(g_{7/2}/d_{5/2}) \otimes \nu(h_{11/2})^2$ configuration with different γ-deformation were observed systematically in $^{123-127}$I [7–11]. Although several other states in ^{127}I were also reported by the earlier author [9], but in lack of essential experimental data, further no nuclear structural information was possible to extract for these state. Another interesting fact about these states is that, no such states were observed in the other neighboring iodine isotopes. Hence, it is important to understand the origin of these states and therefore, γ-ray spectroscopy of ^{127}I was carried out.

Experimental Details

The high spin states in ^{127}I were populated via ^{124}Sn(^{7}Li, 4nγ) fusion-evaporation reaction at E_{beam}=33 MeV, obtained from the 15UD pelletron accelerator [12] of Inter University Accelerator Centre, New Delhi. An isotopically enriched ^{124}Sn foil with a thickness of 1.5 mg/sq.cm, rolled on a 10 mg/sq.cm thick ^{197}Au backing formed the target. An array of fifteen clover detectors (INGA) [13]) were used to detect the de-exciting γ-rays. The detectors have been placed at a distance of ∼24 cm from the target along with the anti-Compton shields. A CAMAC based analogue data acquisition system was used to record the 1×10^9 valid γ-γ events. The Eγ-Eγ symmetric matrix and angle dependent asymmetric matrices were constructed by sorting of the gain matched list mode row data to carry out the γ-γ coincidence, angular correlation and linear polarization data analysis.

Results and Discussion

The partial level scheme of the proposed multi-quasiparticle states has been shown in figure 1. A very weak 799.8 keV γ-transition has been placed in the level scheme from the present data analysis. The γ-rays decaying from the states of current interest have been shown in the energy gated spectrum (figure 2). The multipolarity of 547.2, 357.8, 748.1, 390.2, 761.0 and 774.8 keV γ-rays have been determined from the Directional Correlation of Oriented states (DCO) ratio, deduced from angular correlation measurement, using the following relation:

$$R_{DCO} = \frac{I_{\gamma_1} \text{ at } 32^\circ, \text{ gated by } \gamma_2 \text{ at } 90^\circ}{I_{\gamma_1} \text{ at } 90^\circ, \text{ gated by } \gamma_2 \text{ at } 32^\circ}$$

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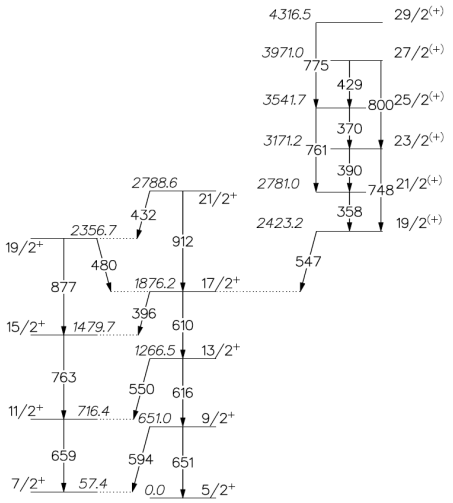

FIG. 1: Partial level scheme of ^{127}I.

In the previous study on ^{127}I, a non-collective multi-quasiparticle configuration based on $\pi(g_{7/2}/d_{5/2})$ and $\nu h_{11/2}$ orbitals has been proposed for the states above $19/2^{(+)}$ at 2423.2 keV [9], but no such states have been reported in lighter mass $^{121-125}$I isotopes.

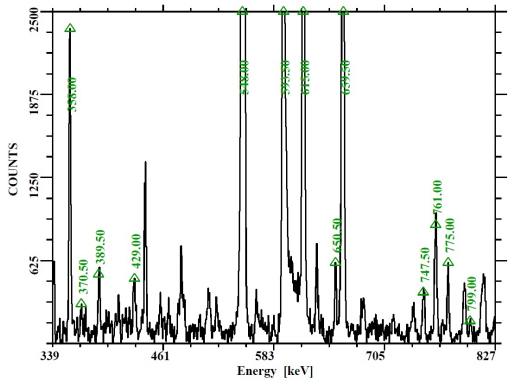

FIG. 2: The γ-rays of interest decaying from the multi-quasiparticles states are shown in the energy gate on 609.6 keV.

Also, such non-collective multi-quasiparticle states have not been seen in ^{125}Sb and ^{129}Cs (N=74) isotones. Therefore, in order to infer the structure of those states, a thorough spectroscopic study become very important. The spin of states above 2423.2 keV have been assigned from the present R_{DCO} results as listed in table 1. The spin assignment of the states belonging to $\pi(g_{7/2}/d_{5/2})$ band have been discussed in ref. [11]

TABLE I: Energies, angular correlation ratios, reduced transition probabilities, level energies, and spin assignments of γ-transitions of ^{127}I.

E_{level} (keV)	J^{π}_{level}	Eγ (keV)	R_{DCO}
2423.2	$19/2^{(+)}$	547.2	0.53(5)[a]
2781.0	$21/2^{(+)}$	357.8	0.51(7)[a]
3171.2	$23/2^{(+)}$	748.1	2.05(66)[b]
		390.2	1.02(13)[d]
3541.7	$25/2^{(+)}$	761.0	2.02(88)[c]
		370.5	
3971.0	$27/2^{(+)}$	799.8	
		428.0	
4316.5	$29/2^{(+)}$	774.8	2.16(63)[d]

[a]Deduced from 609.7 keV E2 gate.
[b]Deduced from 547.2 keV dipole gate.
[c]Deduced from 357.8 keV dipole gate.

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