Experimental evidence for coexisting structures in ^{125}I

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Properties of the collective bands in ^{125}I, populated in ^{123}Sb$(\alpha,2n\gamma)^{125}$I reaction at $E=30$ MeV, have been studied from γ-ray angular distributions and excitation functions. Spins and parities are inferred for several states. New $E2/M1$ mixing ratios are deduced for five transitions. A three-quasiparticle collective band is proposed on the basis of these and earlier results. The shapes of the ground state yrast band and the $g_{9/2}$ band are discussed, providing evidence for the coexistence of prolate and oblate collective states.

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I. INTRODUCTION

Transitional nuclei with $Z>50$ and $A\sim110-130$ have been a subject of much interest as they exhibit significant variations of shapes and deformations with the configuration of the valance quasiparticles. The odd-mass iodine ($Z=53$) nuclei, lying between the spherical ($Z=50$) and the well deformed ($Z=57$) nuclei are representative of the characteristic features of these transitional nuclei. Calculations of Liang *et al.* [1] for the low-lying single particle excitations for a range of iodine isotopes predict competing oblate and prolate shapes for the $d_{5/2}$ and $g_{7/2}$ configurations of protons. Experimental results in ^{119,121,123}I isotopes, however, show evidence of oblate shape being associated with the bands based on these configurations [2–4]. Three-quasiparticle rotational sequences have also been identified in ^{117,119,121}I [2,3,5] and ^{125,127}Cs nuclei [6,7].

The relatively neutron-rich ^{125}I is difficult to populate up to high spins and is less studied compared to the lighter ones. Our recent work on the structure of ^{125}I [8] shows the positive parity bands based on the $\pi g_{7/2}$ and $\pi d_{5/2}$ configurations to be closely similar to those in ^{119,121,123}I isotopes. An excited sequence of states built on the 2350.3 keV was found to be similar to three-quasiparticle bands observed in ^{125}Cs [6] and ^{119,121}I [2,3]. Although, significant additions and alterations were made to the level scheme in this work [8] and states were observed up to 3868.2 keV, spin and parity assignments, mostly based on the systematics of similar bands in neighboring nuclei, remain uncertain. A better understanding of the structures of the various bands in ^{125}I is possible only with definite information on the spins and parities of the levels and the nature of the transitions, both in band and interband. The motivation of the present work is to provide further experimental data on the tentatively proposed three-quasiparticle band and the other low-lying sequences based on different configurations of the odd proton in ^{125}I in order to infer structural details.

II. EXPERIMENTAL METHODS

Excited states of ^{125}I were populated in the reaction ^{123}Sb$(\alpha,2n\gamma)^{125}$I at $E=30$ MeV at the Variable Energy Cyclotron Centre, Calcutta. The target consisted of enriched (99%) elemental ^{123}Sb with a thickness of 10 mg/cm^2. Angular distributions $[\gamma(\theta)]$ of γ rays were measured at 35°, 45°, 60°, 75°, and 90° with respect to the beam direction, for multipolarity and spin assignments. Two HPGe detectors, with relative efficiency of about 25% and energy resolution of ~2.6 keV at 1.33 MeV, placed at a distance of 25 cm from the target, were used. One of these detectors was located at 55° to the beam for normalization purposes. The angular distribution coefficients A_k/A_0 $(k=2,4)$ were determined from the least squares fits of the normalized data to the Legendre expansion

$$W(\theta)=1+(A_2/A_0)P_2(\cos\theta)+(A_4/A_0)P_4(\cos\theta), \quad (1)$$

where the P_k $(\cos\theta)$ $(k=2,4)$ are the Legendre polynomials [9]. The experimental angular distributions were compared with the theoretical ones [10] using χ^2 analysis procedure. The code THDST [11] which incorporates the definition proposed by Krane and Steffen [12] for the γ-ray multipole mixing ratio δ, was used for this purpose. The width of the assumed Gaussian distribution of the substate population σ, determined for prominent stretched $E2$ transitions, was found to lie in the range $1.8<\sigma<2.4$, in close agreement with the average value $\sigma_{\rm av}=2.2\pm0.3$, reported previously for light ion reactions [13]. The χ^2 analyses were carried out for probable spins of the initial state I_i deexciting to a final state with a predetermined spin value I_f. Spin hypotheses leading to χ^2 distributions lying above the 0.1% probability limit were rejected [14]. The $E2/M1$ mixing ratios δ were extracted from the minimum in the χ^2 distribution. The errors in the values of δ were taken at 1% probability limit [14]. Relative excitation functions were studied at $E=25$, 27, 30, and 33 MeV to provide supportive evidence for the spin assignments.

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

Parts of the level scheme of ^{125}I, reported in our earlier work [8], are reproduced in Fig. 1, along with the new results obtained in this work. The bands are labeled by the band numbers. The γ-ray and level energies and the intensities of the transitions are also taken from our previous work [8]. The results of the angular distribution measurements and

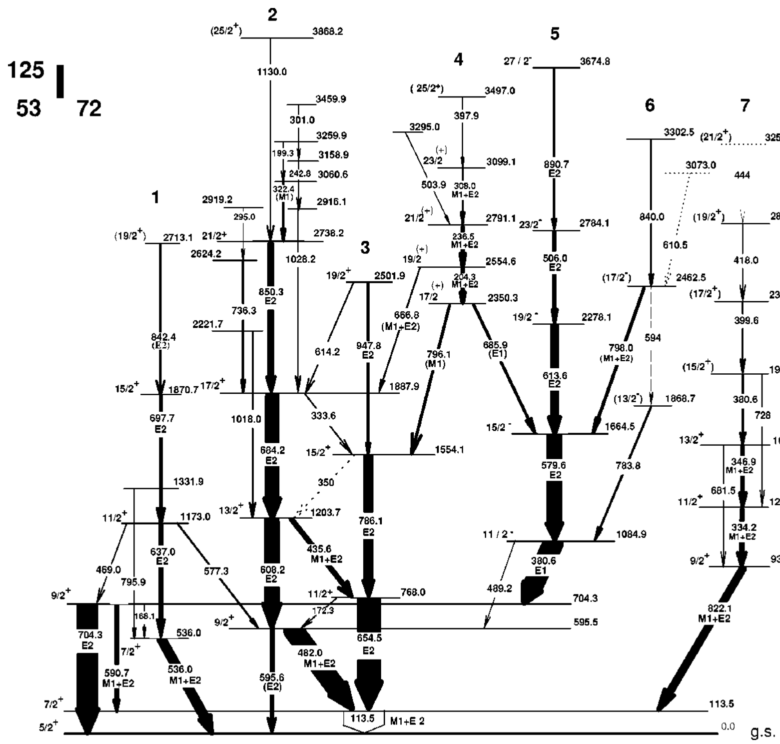

FIG. 1. Proposed level scheme of ^{125}I from this and our earlier work reported in Ref. [8]. The transition and level energies are given in keV and the widths of the arrows indicate their relative intensities.

TABLE I. Results of γ-ray angular distribution measurements in ^{125}I. The multipolarity assignments for mixed transitions are based on the A_k/A_0 values and the multipole mixing ratios δ, presented in Table II. Spin and parity assignments are discussed in the text. The γ-ray and level energies are from Ref. [8].

E_γ (keV)	E_{level} (keV)	A_2/A_0	A_4/A_0	Multipolarity	$I_i^\pi \rightarrow I_f^\pi$
204.3	2554.6	-0.59 ± 0.04	-0.06 ± 0.06	$M1+E2$	$\frac{19}{2}(+) \rightarrow \frac{17}{2}(+)$
308.0	3099.1	-0.63 ± 0.11	-0.09 ± 0.12	$M1+E2$	$\frac{23}{2}(+) \rightarrow \frac{21}{2}(+)$
334.2	1269.8	-0.05 ± 0.05	0.01 ± 0.08	$M1+E2$	$\frac{11}{2}+ \rightarrow \frac{9}{2}+$
346.9	1616.7	-0.06 ± 0.05	0.02 ± 0.06	$M1+E2$	$\frac{13}{2}+ \rightarrow \frac{11}{2}+$
380.6	1084.9	-0.18 ± 0.01	0.02 ± 0.03	$E1$	$\frac{11}{2}- \rightarrow \frac{9}{2}+$
435.6	1203.7	-0.70 ± 0.05	-0.04 ± 0.06	$M1+E2$	$\frac{13}{2}+ \rightarrow \frac{11}{2}+$
482.0	595.5	-0.62 ± 0.03	-0.01 ± 0.03	$M1+E2$	$\frac{9}{2}+ \rightarrow \frac{7}{2}+$
506.0	2784.1	0.28 ± 0.05	-0.06 ± 0.05	$E2$	$\frac{23}{2}- \rightarrow \frac{19}{2}-$
536.0	536.0	-0.43 ± 0.05	0.14 ± 0.06	$M1+E2$	$\frac{7}{2}+ \rightarrow \frac{5}{2}+$
579.6	1664.5	0.23 ± 0.03	0.02 ± 0.04	$E2$	$\frac{15}{2}- \rightarrow \frac{11}{2}-$
590.7	704.3	0.16 ± 0.07	0.06 ± 0.06	$M1+E2$	$\frac{9}{2}+ \rightarrow \frac{7}{2}+$
608.2	1203.7	0.38 ± 0.04	0.06 ± 0.04	$E2$	$\frac{13}{2}+ \rightarrow \frac{9}{2}+$
613.6	2278.1	0.25 ± 0.04	-0.05 ± 0.04	$E2$	$\frac{19}{2}- \rightarrow \frac{15}{2}-$
637.0	1173.0	0.21 ± 0.09	-0.03 ± 0.11	$E2$	$\frac{11}{2}+ \rightarrow \frac{7}{2}+$
654.5	768.0	0.37 ± 0.04	-0.07 ± 0.06	$E2$	$\frac{11}{2}+ \rightarrow \frac{7}{2}+$
666.8	2554.6	-0.38 ± 0.15	0.26 ± 0.25	$(M1+E2)$	$\frac{19}{2}(+) \rightarrow \frac{17}{2}+$
697.7	1870.7	0.23 ± 0.05	0.01 ± 0.06	$E2$	$\frac{15}{2}+ \rightarrow \frac{11}{2}+$
704.3	704.3	0.27 ± 0.02	0.10 ± 0.03	$E2$	$\frac{9}{2}+ \rightarrow \frac{5}{2}+$
786.1	1554.1	0.18 ± 0.06	-0.04 ± 0.06	$E2$	$\frac{15}{2}+ \rightarrow \frac{11}{2}+$
822.1	935.6	-0.11 ± 0.07	-0.05 ± 0.09	$M1+E2$	$\frac{9}{2}+ \rightarrow \frac{7}{2}+$
850.3	2738.2	0.23 ± 0.06	-0.03 ± 0.08	$E2$	$\frac{21}{2}+ \rightarrow \frac{17}{2}+$
890.7	3674.8	0.21 ± 0.09	0.03 ± 0.13	$E2$	$\frac{27}{2}- \rightarrow \frac{23}{2}-$
947.8	2501.9	0.39 ± 0.08	0.10 ± 0.11	$E2$	$\frac{19}{2}+ \rightarrow \frac{15}{2}+$

TABLE II. Results of $E2/M1$ mixing ratio (δ) for the transitions in ^{125}I.

E_γ (keV)	δ Present	Previous[a]
204.3	$-0.23^{+0.04}_{-0.03}$	
308.0	$-0.31^{+0.12}_{-0.10}$	
334.2	0.14 ± 0.01	0.11 ± 0.05
346.9	0.11 ± 0.04	0.12 ± 0.05
380.6	$0.04^{+0.03}_{-0.02}$	
435.6	$-0.34^{+0.07}_{-0.11}$	0.33 ± 0.08
482.0	-0.23 ± 0.03	$-2.0<\delta<0.4$
536.0	-0.13 ± 0.06	
590.7	$0.15^{+0.06}_{-0.07}$	0.28 ± 0.08
666.8	$-0.19^{+0.23}_{-0.33}$	
736.3	$-0.07<\delta<+0.12$	
822.1	$0.12^{+0.05}_{-0.03}$	0.20 ± 0.07

[a]Previous δ values are taken from Ref. [13].

spin and multipolarity assignments are summarized in Table I. The multipole mixing ratios δ deduced for transitions of mixed multipolarity are given in Table II.

The spin and parity assignments for the states at 0.0(g.s.), 113.5, 536.0, 595.5, 704.3, 768.0, 1203.7, and 1887.9 keV (see Fig. 1) are already established from previous studies and compiled in Ref. [15]. The present γ-ray angular distribution studies for the 637.0 and 697.7 keV transitions in band 1, establish their stretched quadrupole nature. With a previously established spin of $\frac{7}{2}^+$ for the bandhead at 536.0 keV, the present results provide firm spin assignments of $\frac{11}{2}^+$ and $\frac{15}{2}^+$ for the 1173.0 and 1870.7 keV states, respectively. The $E2/M1$ mixing ratio for the 536.0 keV transition from the bandhead, hitherto unreported, is found to be negative. Although reported to be pure $M1$ in nature [15], the 536.0 keV transition is found to have significant $E2$ admixture. Based on the observed regularity of the γ-ray energies within the band, the highest state at 2713.1 keV is assigned a tentative spin of $(\frac{19}{2}^+)$.

Similarly, the spins of the levels in bands 2 and 3 are confirmed up to 2738.2 keV from the present work, establishing their $\Delta I=2$ nature (Fig 1). The sequences are connected by several interband transitions, of which the 435.6 and 482.0 keV γ rays are strong. The angular distribution measurements on these two transitions show their $M1+E2$ nature. The $E2/M1$ mixing ratios of $\delta=-0.34^{+0.07}_{-0.11}$ and -0.23 ± 0.03 were estimated for the 435.6 and 482.0 keV γ rays, respectively (Fig. 2). These two results disagree with those reported by Shroy *et al.* [13], one of which has a positive sign (Table II). However, the present $E2/M1$ mixing ratios are similar with respect to their sign to the mixing ratios reported for transitions in the ground state bands in the other ^{121,123,127}I isotopes [3,13,16]. As reported previously [3], for strongly coupled bands based on a single-quasiproton configuration, the sign of the $E2/M1$ mixing ratio δ is the same as the sign of the intrinsic quadrupole moment Q_o for $Z=53$, since $(g_K-g_R)>0$ for the relevant proton orbitals (g_K is the single-particle g factor and g_R is the rotational g factor [$\sim Z/A$]). Therefore, the negative sign of the mixing ratios for the interband 435.6 and 482.0 keV transitions may be related to an oblate shape for this band, as in the other neighboring ^{119,121,123}I isotopes [2–4].

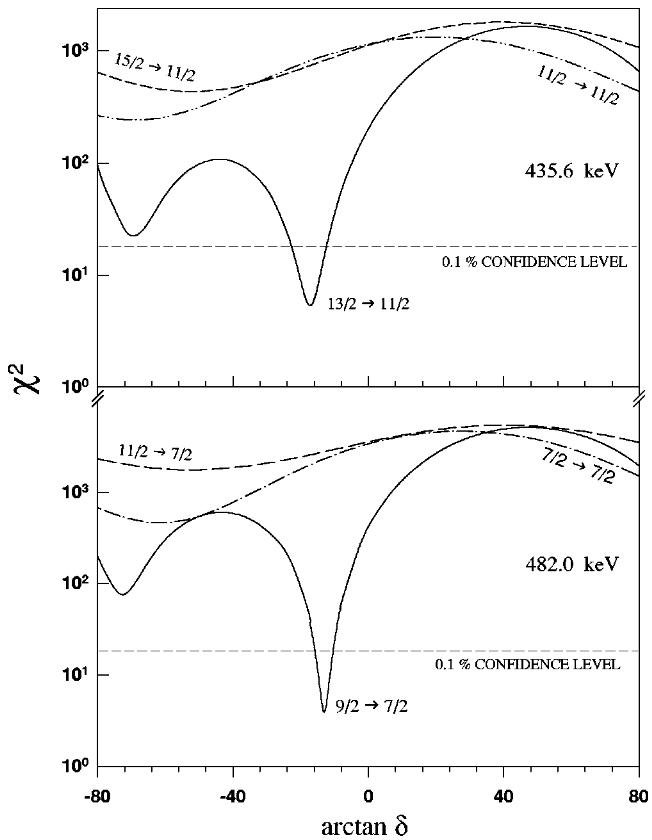

FIG. 2. $\chi^2(\delta)$ fits to the 435.6 and 482.0 keV transitions belonging to the ground state yrast band.

The strong interband transitions (435.6 and 482.0 keV) between bands 2 and 3 suggest that these bands have similar configurations with a large overlap in their wave functions. Other interband transitions are also observed connecting states up to 2501.9 keV [8]. Based on this and the systematics of similar bands in the neighboring iodine nuclei [2–4], the two $\Delta I=2$ bands, bands 2 and 3, may be interpreted as the $\alpha=+\frac{1}{2}$ and $-\frac{1}{2}$ signature partners, respectively. A plot of $\{[E(I)-E(I-1)]\}/2I$ vs $2I$ shows that the signature splitting for this band in ^{125}I is small (Fig. 3). This is common for the lighter iodine isotopes as well, for which the energy splitting plots are also included in Fig. 3 for comparison. Cranked-shell-model (CSM) calculations reported by Liang *et al.* [3] have reproduced the small signature splitting observed in the positive-parity yrast band in ^{121}I by associating the band with the oblate $\pi g_{7/2}[404]\frac{7}{2}^+$ orbital with possible admixture of $\pi d_{5/2}[402]\frac{5}{2}^+$. A similar configuration may be attributed to the positive-parity yrast band in ^{125}I, guided by the similarity in the signature splitting in the band for the two nuclei (Fig. 3).

An interesting feature which emerges from Fig. 3 is the reversal of the phase of the energy staggering in this band for the odd mass $^{119-125}$I isotopes. While the inversion occurs at a spin of $\frac{15}{2}\hbar$ in ^{119,121}I, it shifts to $\frac{17}{2}\hbar$ for the heavier

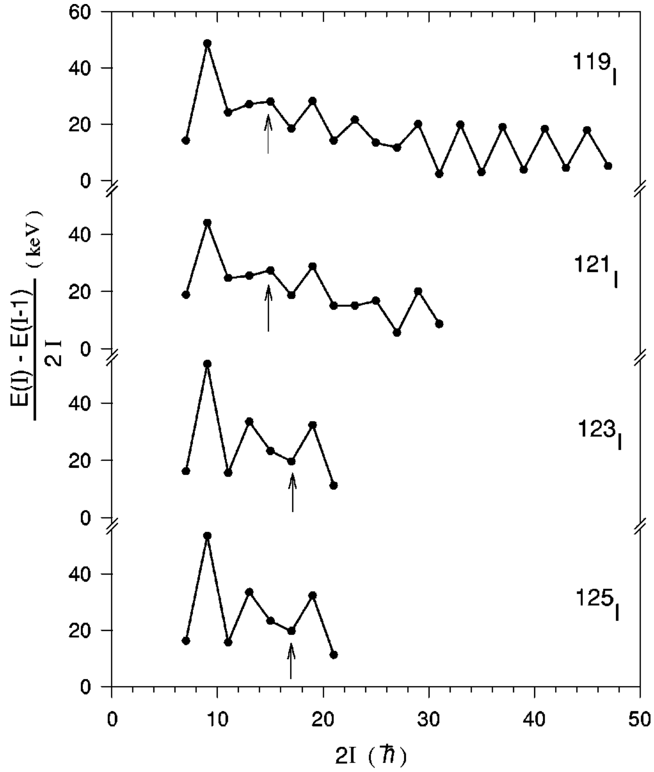

FIG. 3. $[E(I)-E(I-1)]/2I$ vs $2I$ plots for the states of the postive parity yrast bands in the odd-mass $^{119-125}$I nuclei. The arrows indicate the position of the signature inversion.

^{123,125}I nuclei. The observation of signature inversion at low spins has been previously interpreted to indicate a deviation from the axially symmetric shape [17].

Three-quasiparticle bands have been previously reported in several odd mass iodine and ceasium nuclei [2,3,5–7], built upon an excited isomeric state. The bandhead energies are all above 2 MeV and the spin varies from $\frac{17}{2}$ to $\frac{23}{2}$. In ^{125}I, the 2350.3 keV state ($T_{1/2}$=1.6±0.3 ns [18]) with a tentative spin of (17/2) and the sequence of states up to 3497.0 keV built upon this level, has been interpreted as a rotational band (band 4) in our earlier work [8]. The sequence was also tentatively described to have a three-quasiparticle structure as in the other neighboring odd mass I and Cs nuclei.

In the present work, $\gamma(\theta)$ and excitation functions have been measured for the in-band 204.3 and 308.0 keV transitions of band 4 and the interband 666.8 keV γ ray from the 2554.6 keV level feeding the 1887.9 keV, $\frac{17}{2}^+$ state of the yrast band (Fig. 1). While no information is available on the multipolarity of the 666.8 keV γ ray, a dipole character is tentatively assigned for the other two γ rays [13,19]. The present A_k/A_0 coefficients and the multipole mixing ratios δ for the three transitions (Fig. 4) are consistent with their $M1+E2$ assignment. The $\gamma(\theta)$ for the in-band 236.5 keV transition could not be measured in this work due to interference from the strong 238.2 keV γ ray (from ^{19}Ne). However, the previously reported A_k/A_0 values for the 236.5 keV transition are also consistent with a $M1+E2$ assignment [19]. Hence, the sequence of states up to 3099.1 keV, deexciting via the cascade of 308.0, 236.5, and 204.3 keV transitions, is identified as a $\Delta I=1$ band (band 4).

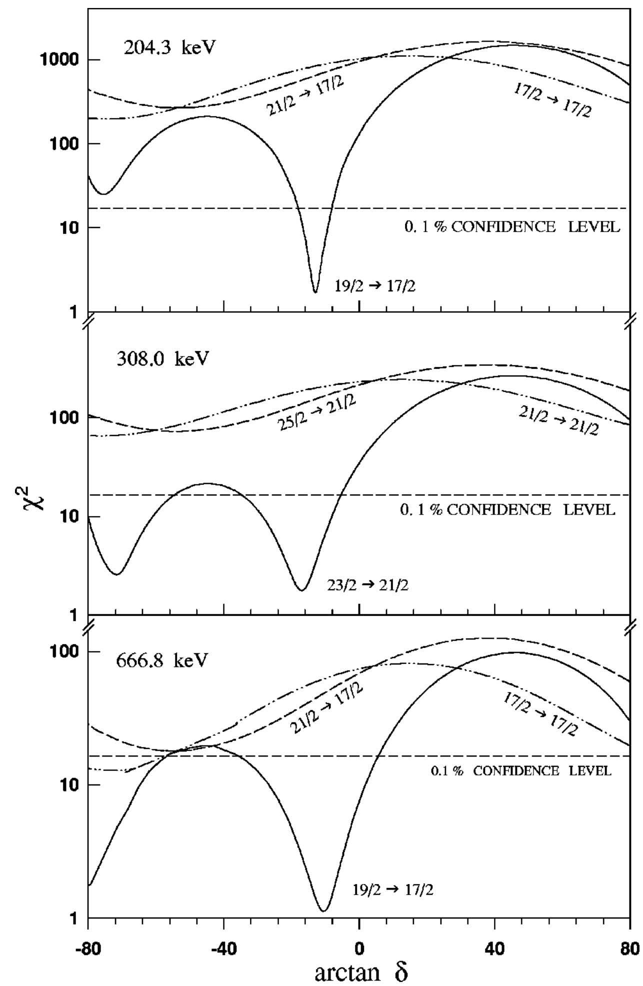

FIG. 4. $\chi^2(\delta)$ fits to the 204.3, 308.0, and 666.8 keV transitions from the states of band 4.

The spin and parity assignment for the bandhead at 2350.3 keV cannot be obtained from the angular distributions of the 685.9 and 796.1 keV transitions which depopulate this state, since both γ rays are doublets in the levels scheme (Fig. 1). However, it is noted that the 685.9 and 796.1 keV γ rays decay to states with spin and parity $I^\pi=\frac{15}{2}^-$ and $\frac{15}{2}^+$, respectively (these I^π assignments are discussed elsewhere in this text). Furthermore, both 685.9 and 796.1 keV transitions are strong and observed with equal relative intensities [8]. It follows, therefore, that the spin of the 2350.3 keV state is restricted to $\frac{13}{2},\frac{15}{2}$, or $\frac{17}{2}$, since otherwise, one of the two transitions depopulating the bandhead would be predominantly $M2$ in nature, which is unlikely. The spin of the next higher state in the band at 2554.6 keV, deexciting via the 204.3 keV $\Delta I=1$ transition (Fig. 1), is then limited to $\frac{15}{2},\frac{17}{2}$, or $\frac{19}{2}$. The $\chi^2(\delta)$ analysis for the 666.8 keV transition from the same state rules out $\frac{17}{2}$ and favors a spin of $\frac{19}{2}$ for the 2554.6 keV state (Fig. 4). The lowest possible spin of $\frac{15}{2}$ is ruled out from the relative excitation function for the 666.8 keV transition (Fig. 5). Accordingly, a spin assignment of $\frac{19}{2}$ is proposed for the 2554.6 keV state

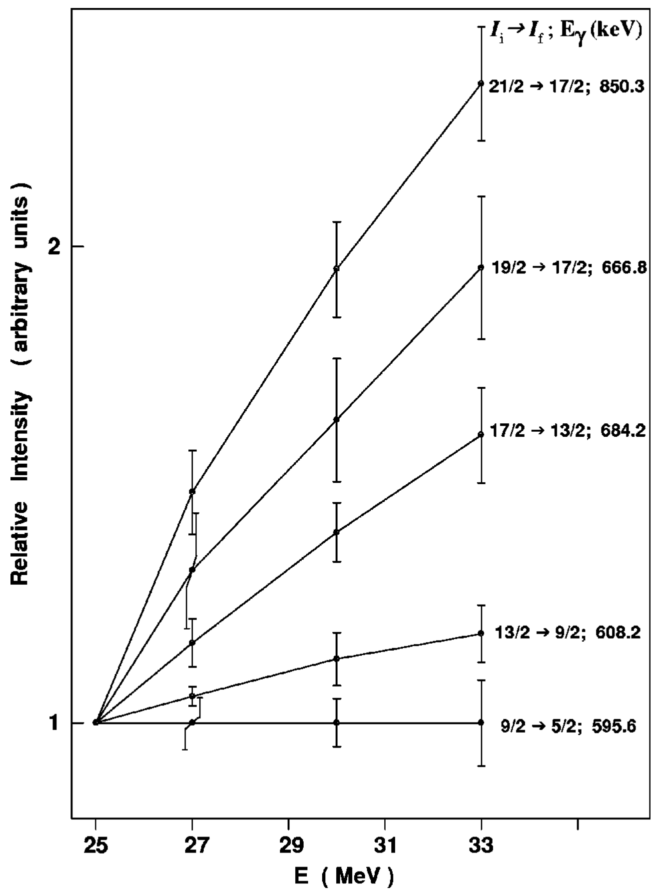

FIG. 5. Relative yields of the 666.8 keV γ ray from the 2554.6 keV state of band 4 with respect to the transitions in band 2.

and the spin of the bandhead at 2350.3 keV is restricted to $\frac{17}{2}$.

With the $M1+E2$ assignment already established for the higher-lying 236.5 and 308.0 keV γ rays in this sequence, spin values of $\frac{21}{2}$ and $\frac{23}{2}$ are assigned to the higher band members at 2791.1 and 3099.1 keV, respectively. A tentative spin of $(\frac{25}{2})$ is proposed for the highest state at 3497.0 keV on the basis of the observed regularities within the band.

The $E2/M1$ mixing ratio for the interband 666.8 keV transition, feeding the $\frac{17}{2}^+$ state of band 3, is found to be $\delta=-0.19^{+0.23}_{-0.33}$ indicating sizable quadrupole admixture. Although with large errors, this result indicates that the parity of the 2554.6 keV state is likely to be positive. A negative parity for this state would imply a $\sim$4% $M2$ admixture in the 666.8 keV γ ray. Hence, the 2554.6 keV state, as well as the other states in this band, are tentatively assigned a positive parity, considering the errors in the δ value. Positive-parity assignment has also been previously suggested for similar three quasiparticle bands in the lighter ^{119,121}I nuclei by Liang *et al.* [3]. The same authors have proposed the three-quasiparticle configuration $\pi h_{11/2}\otimes\nu g_{7/2}\otimes\nu h_{11/2}$ for the analogous band in ^{121}I. The configuration includes the high-K $[404]7/2^+$ neutron orbital from the $\nu g_{7/2}$ shell and explains the strong $\Delta I=1$ transitions and the lack of signature splitting in the band. The states of band 4 in ^{125}I are also found to decay by strong $\Delta I=1$ transitions and no crossover $E2$ transitions are observed. Considering the similarities in the properties of the three-quasiparticle bands in ^{121}I and ^{125}I, it is possible that band 4 in the latter nucleus also has a similar configuration as for ^{121}I. Three-quasiparticle sequences have not been reported in ^{123}I.

Kostova *et al.* have estimated lifetimes of several states in band 4 from the delayed $\gamma-$rf method [18]. The level scheme for band 4 has since been altered in our earlier work [8] where the placements of the 204.3 and 236.5 keV transitions have been interchanged. In the present level scheme, the 2791.1 keV state is fed by the prompt 308.0 keV transition (no discernible centroid shift observed for this γ ray according to Ref. [18]) and decays via the 236.5 keV γ ray. Therefore, the lifetime of 0.2 ns, corresponding to the centroid shift measured by Kostova *et al.* for the 236.5 keV γ ray, should be attributed to the 2791.1 keV state. The 2554.6 keV state is then fed by the delayed 236.5 keV transition and the shift measured in Ref. [18] for the 204.3 keV γ ray, which depopulates this state, would reflect only the upper limit of the level lifetime. Thus, the 2554.6 keV state is expected have $T_{1/2}\leqslant 0.3$ ns.

Lower limits of reduced transition probabilities of $B(E2)\geqslant 5.0$ W.u. and $B(M1)\geqslant 5.7\times 10^{-3}$ W.u. have been estimated for the 204.3 keV transition using $T_{1/2}\leqslant 0.3$ ns for the 2554.6 keV state and the present multipole mixing ratio $\delta=-0.23^{+0.04}_{-0.03}$ for the 204.3 keV γ ray. The $B(E2)$ result indicates the presence of collectivity in the structure of the proposed three quasiparticle band (band 4). However, crossover $E2$ transitions from the 2791.1 and 3099.1 keV states, with calculated relative intensities of about 4 units (with respect to 100 for the 654.5 keV γ ray [8]), were not observed clearly enough in the relevant gated spectra for their placement in the level scheme. The relative intensities were calculated using $\delta=-0.25$ (assumed to be similar to other δ values in the band) and -0.31 (present work) for the 236.5 and 308.0 keV $\Delta I=1$ transitions, respectively, and an effective $K=15/2$, as for the 3-qp band in ^{119}I [2]. It is expected that experiments using more efficient detector systems will permit the observation of the crossover $E2$ transitions in the three quasiparticle band as in ^{119}I and ^{125}Cs where such transitions have indeed been reported [2,6].

The spin assignments for all levels belonging to the favored negative-parity sequence (band 5) are confirmed from the present work. The present $\chi^2(\delta)$ analysis [Fig. 6(a)] for the 380.6 keV γ ray, which predominantly deexcites the bandhead at 1084.9 keV to the $\frac{9}{2}^+$ state at 704.3 keV, yields $\delta=0.04^{+0.03}_{-0.02}$, supporting the $E1$ nature of the transition, as already proposed by Hagemann *et al.* [19] from conversion electron measurements. The analysis further favors a spin of $\frac{11}{2}$ for the bandhead, although the spin $\frac{7}{2}$ is not ruled out. The relative excitation function for this γ ray, however, clearly indicates that the bandhead spin must be greater than $\frac{9}{2}$ [Fig. 6(b)]. Hence, a firm spin assignment of $\frac{11}{2}^-$ is proposed for the 1084.9 keV state. The effects of the interference due to the weak 380.6 keV γ ray in band 7 is not expected to be significant in these measurements. The stretched $E2$ nature of the inband transitions within band 5, obtained from the present $\gamma(\theta)$ studies, then provide the spin assignments for

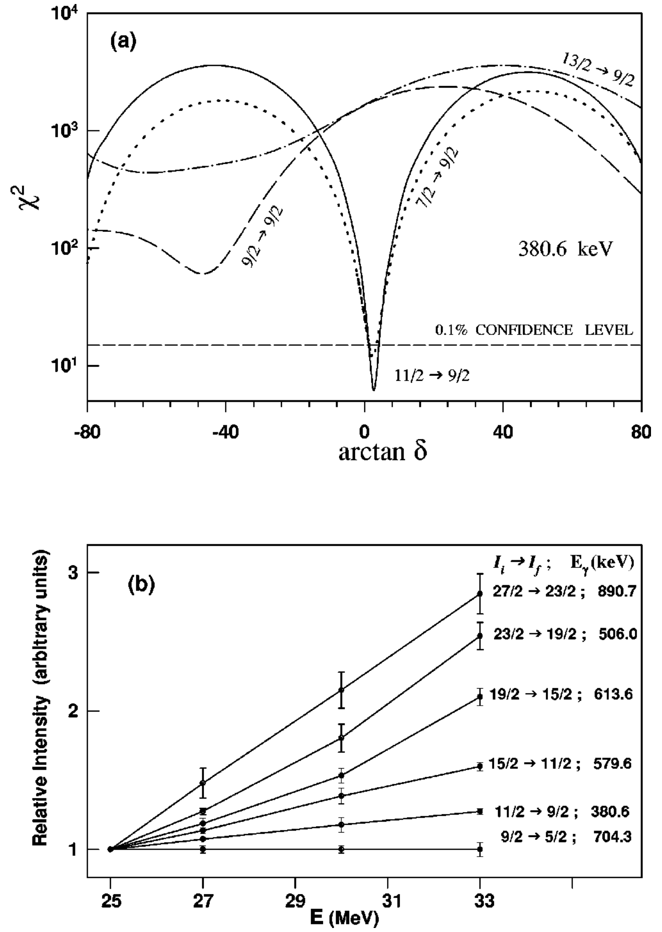

FIG. 6. Plots of (a) $\chi^2(\delta)$ fits to the 380.6 keV transition deexciting the bandhead of band 5 and (b) yields of the 380.6 keV and the in-band transitions of band 5 relative to the yield of the 704.3 keV transition.

all levels up to 3674.8 keV (Table I).

The close agreement of the experimental level scheme with that predicted from the core-quasiparticle model of Kostova *et al.* [18] suggests that the band is probably based on the configuration $\pi(h_{11/2})$ with a prolate deformation. The identification of the unfavored $\alpha=\frac{1}{2}$ signature partner of this band in our earlier work [8], labeled band 6 in Fig. 1, shows the presence of large signature splitting leading to an inversion in the level ordering. This favors the rotationally aligned nature of the $\pi h_{11/2}$ band and indicates that it is associated with the prolate $\pi(h_{11/2})[550]\frac{1}{2}^-$ Nilsson orbital. Previously, the unfavored band has been reported only in ^{119}I but not observed in ^{121,123}I, probably due to their weak intensity.

The $g_{9/2}$ band in ^{125}I (band 7) has been observed up to 2814.9 keV [8]. The present $\gamma(\theta)$ studies confirm the previously reported $M1+E2$ nature of the 822.1 keV transition (Table I) which deexcites the bandhead at 935.6 keV (Fig. 1). The $\chi^2(\delta)$ analysis and the relative excitations for this transition confirm the spin assignment of $9/2^+$ f or the bandhead. The $\chi^2(\delta)$ plots for the 334.2 and 346.9 keV inband transitions, support the spin assignments for the two higher levels at 1269.8 and 1616.7 keV. The positive sign of the δ values for these transitions corroborates the earlier [18] interpretation of a prolate shape for the $g_{9/2}$ band. The absence of signature splitting in the band suggests that the configuration includes the high-K proton orbital $\pi(g_{9/2})[404]\frac{9}{2}^+$.

Several noncollective states, all above 2 MeV excitation energy, feed the states of the positive-parity yrast band in ^{125}I (band 2). Similar feedings from noncollective states are also reported in the lighter iodine isotopes. Noncollective oblate states have been observed in these nuclei leading to band termination at spins of $\sim\frac{33}{2}$ [3,20–22]. These features can however, only be studied if the bands are extended to higher spins.

IV. SUMMARY

The structural aspects of the ^{125}I nucleus, not reported in much detail in the literature, have been attempted to be studied in the present work from γ-ray angular distributions and excitation function measurements. Definite spin and parity assignments are proposed in six bands, reported earlier in this nucleus. The γ-ray multipolarities have been deduced for several transitions and new $E2/M1$ mixing ratios are reported for five γ rays. Three of these mixing ratios provide the basis for inferring the spin and parity assignments for band 4. A three-quasiparticle structure is proposed for this band on the basis of the observed characteristics and their similarity with ^{121}I. The earlier lifetime results for states of this band have been revised following an alteration in the level scheme. The deduced $B(E2)$ value indicates the presence of collectivity in the band. Bands 2 and 3 are interpreted as the $\alpha=+\frac{1}{2}$ and $\alpha=-\frac{1}{2}$ signature partners of the strongly coupled $\pi d_{5/2}$ yrast band. The sign of the δ values for the strong 435.6 and 482.0 keV transitions connecting bands 2 and 3, which differ from those reported earlier, and for the $\Delta I=1$ transitions in band 7, have been used to infer the shapes associated with these single-quasiparticle bands. This leads to evidence for the coexistence of both oblate and prolate shapes in ^{125}I, as in several other odd-A nuclei in this mass region.

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