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Collective band structures in neutron-rich ^{106,107}Tc

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The high spin states of neutron-rich ^{106,107}Tc nuclei have been reinvestigated by observing prompt γ rays from the spontaneous fission of ^{252}Cf. In ^{106}Tc, a previously known collective band is expanded, and a new collective band is identified. In ^{107}Tc, a collective band based on the $\pi 5/2^-[303]$ orbital is confirmed and extended. Inconsistencies in the configuration assignments for positive parity bands in ^{105,107}Tc in the previous reports are clarified. The spins and parities as well as the configurations for the two bands in ^{106}Tc are assigned according to the angular momentum alignments and g-factor calculations. Other characteristics for the observed bands are discussed.

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I. INTRODUCTION

With the development of large γ-ray detector array, major progress in understanding the nuclear structures in neutron-rich nuclei at the $A \sim 100$ region has been made by measuring the prompt γ rays emitted from the fragments produced in the spontaneous fission or the induced fission of heavy nuclei. New insights include the sudden onset of large quadrupole deformation [1,2], superdeformed ground states [2], triaxial deformation [3], two-phonon γ-vibrational bands [4–7], chiral doublet bands [8,9], and semidecoupled bands [10].

For the neutron-rich Tc isotopes, some high spin state and low excited state results have been published for odd-A ^{103,105,107,109,111}Tc [11–16], and odd-odd ^{106,108,110}Tc [13, 15,17]. Many collective band structures have been observed in these isotopes. However, compared with the other isotopes, the results in ^{106}Tc need to be reinvestigated. Even in the odd-A isotopes, such as in ^{105,107}Tc, some results still need to be reexamined. In the present work, we report on reinvestigations of the high spin states in ^{106,107}Tc. For ^{106}Tc, some new transitions are identified and a new collective band is established. For ^{107}Tc, a collective band based on the $\pi 5/2^-[303]$ orbital is confirmed and extended.

II. EXPERIMENT AND RESULTS

The high spin states of ^{106,107}Tc have been investigated by measuring the prompt γ rays emitted from the fragments produced in the spontaneous fission of ^{252}Cf. The experiment was carried out at the Lawrence Berkeley National Laboratory. A ^{252}Cf source of strength ~60 μ Ci was sandwiched between two Fe foils of thickness of 10 mg/cm^2. The source then was placed at the center of the Gammasphere detector array which, for this experiment, consisted of 102 Compton-suppressed Ge detectors. A total of 5.7×10^{11} triple- and higher-fold γ-coincidence events were collected. The coincidence data were analyzed with the RADWARE software package [18].

Through γ-γ-γ coincidence analysis, many new transitions in ^{106,107}Tc are identified. A new level scheme for ^{106}Tc and an extended band in ^{107}Tc in the present work are shown in Fig. 1. The collective bands in ^{106}Tc are labeled above the scheme.

Some low spin levels and γ transitions in ^{106}Tc have been observed from the β decay of ^{106}Mo [19]. However, the transitions reported for ^{106}Tc [19] are not observed in our fission studies, as indicated in our previous report [13]. So the energy of the lowest level of ^{106}Tc in Fig. 1 cannot be determined by the present work. Thus, the level scheme of ^{106}Tc in Fig. 1 sits at an unknown energy x keV, as denoted in Ref. [13]. Above that, all the level energies are added with the x keV.

From the scheme of ^{106}Tc in Fig. 1, one can see that two collective bands labeled (1) and (2) have been observed. In Ref. [13], band (1) based on the $406.9 + x$ keV level was established up to an excitation energy at $2339.4 + x$ keV. We add two new levels at $2066.2 + x$ and $3204.7 + x$ keV, along with four new transitions of 716.8, 865.2, 444.0 and 273.3 keV to this band. Band (2) is based on the $256.5 + x$ keV level. The bandhead level at $256.5 + x$ keV of band (2) was observed in Ref. [13]. Above that, all the levels and transitions along with the 369.6 keV transition under band (2) are newly identified in the present work. We also carried out a lifetime measurement for the bandhead level at $256.5 + x$ keV of band (2) in ^{106}Tc using the method in Ref. [20]. From our analysis, about 10(3) ns lifetime for this level was obtained. A total of 11 new levels and 19 new γ transitions in ^{106}Tc are identified in addition to those in Ref. [13].

To illustrate the basis for the new levels, Fig. 2 shows two of the many double-gated coincidence γ-ray spectra in ^{106}Tc. In Fig. 2(a), the γ-ray spectrum is obtained by double gating on the 91.7 and 315.2 keV γ transitions. One can see all the new identified transitions above the bandhead level at $406.9 + x$ keV of band (1) in ^{106}Tc. Figure 2(b) shows a coincidence spectrum with the double-gated energies of 164.8

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TABLE I. γ-transition energies, relative transition intensities, and assignments of spin and parity (I^π) values in ^{106}Tc.

E_γ (keV)	$I_i^\pi \rightarrow I_f^\pi$	I_γ (%)
91.7		
164.8	$(6^-)\rightarrow$	
241.7	$(5^+)\rightarrow(6^-)$	78(2)
315.2	$(4^+)\rightarrow$	100(7)
369.6	$(7^-)\rightarrow$	122(6)
Band (1)		
91.3	$(5^+)\rightarrow(4^+)$	
150.6	$(6^+)\rightarrow(5^+)$	54(2)
158.3	$(7^+)\rightarrow(6^+)$	24(2)
241.9	$(6^+)\rightarrow(4^+)$	12(1)
254.5	$(8^+)\rightarrow(7^+)$	22(1)
272.8	$(10^+)\rightarrow(9^+)$	9.0(21)
273.3	$(12^+)\rightarrow(11^+)$	9.1(18)
287.8	$(9^+)\rightarrow(8^+)$	16(2)
308.9	$(7^+)\rightarrow(5^+)$	9.8(17)
412.8	$(8^+)\rightarrow(6^+)$	13(2)
444.0	$(11^+)\rightarrow(10^+)$	11(2)
542.3	$(9^+)\rightarrow(7^+)$	12(2)
560.6	$(10^+)\rightarrow(8^+)$	15(3)
716.8	$(11^+)\rightarrow(9^+)$	4.5(9)
717.3	$(12^+)\rightarrow(10^+)$	2.9(6)
865.2	$(14^+)\rightarrow(12^+)$	2.5(5)
Band (2)		
204.8	$(7^-)\rightarrow(6^-)$	90(5)
229.2	$(8^-)\rightarrow(7^-)$	50(6)
264.3	$(9^-)\rightarrow(8^-)$	9.7(15)
293.2	$(10^-)\rightarrow(9^-)$	1.7(3)
310.8	$(11^-)\rightarrow(10^-)$	2.5(5)
375.8	$(12^-)\rightarrow(11^-)$	0.5(1)
434.0	$(8^-)\rightarrow(6^-)$	68(8)
493.5	$(9^-)\rightarrow(7^-)$	18(1)
557.5	$(10^-)\rightarrow(8^-)$	4.4(5)
604.0	$(11^-)\rightarrow(9^-)$	3.3(6)
686.6	$(12^-)\rightarrow(10^-)$	2.8(5)
727.3	$(13^-)\rightarrow(11^-)$	1.4(3)
799.4	$(14^-)\rightarrow(12^-)$	0.6(2)
834.7	$(15^-)\rightarrow(13^-)$	1.2(2)

and 434.0 keV. One can see most of the γ transitions seen above the $690.5 + x$ level in Fig. 1. From each spectrum, one can also see the known fission partner's transitions, such as the 205.6 and 404.7 keV ones in ^{142}Cs ($4n$) [13], the 282.3, 397.2, 406.7, 498.9, and 557.9 keV ones in ^{143}Cs ($3n$) [13], and the 369.5, 481.0, 632.4 and 658.4 keV ones in ^{141}Cs ($5n$) [13]. Table I shows the γ-transition energies, relative transition intensities, and spin and parity (I^π) assignments (in the following discussion) in ^{106}Tc. The γ-transition intensities are normalized to that of the 315.2 keV γ-transition.

In the earlier report [13], a band structure with five levels at $162.0 + x$, $368.3 + x$, $601.5 + x$, $890.1 + x$, and $1551.8 + x$ keV, along with five transitions of 206.3, 233.2, 288.6, 521.6, and 661.7 keV as well as a linking 162.0 keV transition, was reported for ^{106}Tc. However, in Ref. [14], these levels and transitions were assigned as the members of the $\pi 5/2^-[303]$ band in ^{107}Tc. But this band was not reported in another study of ^{107}Tc [12]. To clarify the inconsistency in these reports, we analyzed the data of the relative yield distributions of correlated fission fragment pairs of Tc-Cs isotopes using the method in Ref. [10]. The intensity ratios of the Tc partner's γ transitions of 388.9 keV in ^{141}Cs and 397.2 keV in ^{143}Cs can be calculated in the present work. When we gate on the 91.7 and 315.2 keV γ transitions in ^{106}Tc, the value of this ratio is 0.43(5). When we gate on the known 71.7 and 138.4 keV and the 172.3 and 329.0 keV γ transitions in ^{107}Tc [12], these values are obtained as 1.89(3) and 1.95(6), respectively. Then, when we gate on the 45.9 and 161.6 keV γ transitions, which belong to the members of the disputed structure in Refs. [13,14], the value of 2.11(14) is obtained. This result indicates that these levels and transitions of ^{106}Tc reported in Ref. [13] should belong to ^{107}Tc, as reported in Ref. [14]. In the present work, this collective band of ^{107}Tc is extended, as shown in Fig. 1 also. Four new levels at 2383.9, 2771.9, 3274.2, 3728.0 keV along with eight new transitions of 294.6, 367.8, 345.7, 440.7, 786.4, 828.7, 890.3, and 956.1 keV are added to this band. An uncertain transition of 288.6 keV [14] is confirmed as 288.9 keV in this work. Figure 3 shows the γ-ray spectrum obtained by double gating on the 161.6 and 438.7 keV γ transitions in ^{107}Tc. One can see all the transitions of this collective band in ^{107}Tc, along with some Cs partner transitions.

III. DISCUSSION

The Tc isotopes with $Z = 43$ lie between Mo ($Z = 42$) and Ru ($Z = 44$). In ^{105,107}Tc, large β_2 deformation ($\sim$0.38) and large triaxiality ($\gamma \sim -22.5^\circ$) have been reported [12]. It can be expected that the ^{106}Tc nucleus has large triaxiality and β_2 deformation also. According to the deformed shell model, the configurations of observed collective bands in the odd-odd ^{106}Tc are expected to be composed of the single-proton states in odd-Z ^{105}Tc isotope and the single-neutron states in odd-N ^{105}Mo isotone. Using the Nilsson diagrams, for the ^{106}Tc with $Z = 43$, $N = 63$ taking the β_2 parameter around 0.3$\sim$0.4, the single-particle orbitals expected near the Fermi level are $5/2^+[422]$, $5/2^-[303]$, $3/2^-[312]$, $7/2^+[413]$, $1/2^-[301]$, and $1/2^+[431]/[420]$ for protons, and $3/2^+[411]$, $3/2^-[541]$, $5/2^+[413]$, $5/2^-[532]$, $1/2^+[411]$, $7/2^-[523]$, $5/2^+[402]$, and $1/2^+[541]$ for neutrons. The $\pi 1/2^+[431]$ orbital is mixed with the $\pi 1/2^+[420]$ one, as discussed for ^{105}Tc [12] and ^{108}Tc [17]. The most probable configurations of the odd-odd nucleus come from the experimentally observed bands of the neighboring odd-A nuclei. The single-particle neutron bands observed in ^{105}Mo [6,21] are $5/2^-[532]$, $3/2^+[411]$, $1/2^+[411]$, and $5/2^+[413]$. But the configurations of the single-particle proton bands observed in ^{105,107}Tc [12,14] still need to be discussed.

A. Configurations of observed bands in ^{105,107}Tc

In our recent publications, the collective bands in the odd-A ^{105,107,109}Tc [12] and ^{111}Tc [15] have been expanded and updated. The observed bands were assigned as $\pi 7/2^+[413]$,

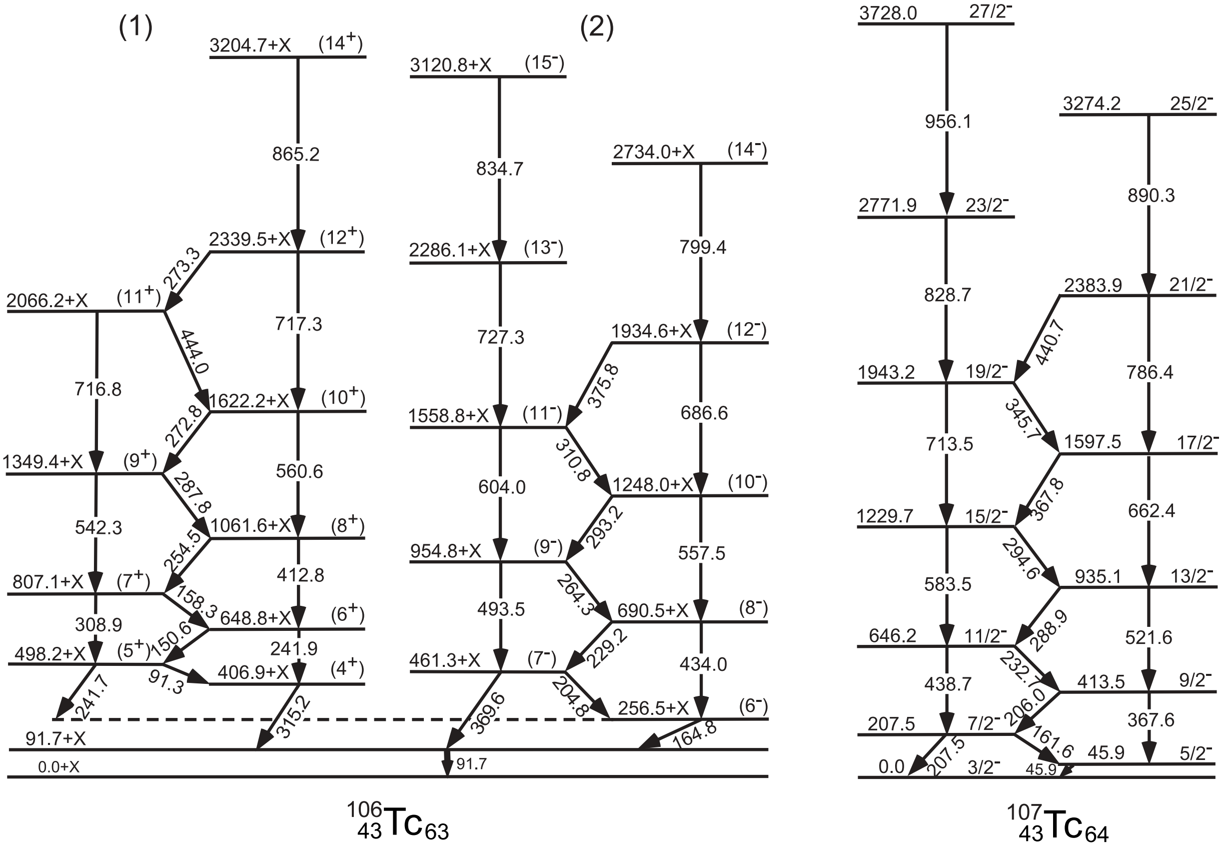

FIG. 1. Level scheme of ^{106}Tc and the $\pi 5/2^-[303]$ band in ^{107}Tc.

$\pi 5/2^-[303]$, $\pi 1/2^+[431]/[420]$, and $\pi 3/2^-[301]$ in ^{105}Tc, $\pi 7/2^+[413]$ and $\pi 1/2^+[431]/1/2^+[420]$ in ^{107}Tc, $\pi 7/2^+[413]$ in ^{109,111}Tc. In Ref. [16], Simpson *et al.* identified an isomer state that was assigned as the $3/2^+$ level of the $1/2^+[431]$ intruder band in ^{107}Tc. In a recent publication [14], two bands reported in ^{107}Tc were assigned as $\pi 5/2^-[303]$ and $\pi 5/2^+[422]$. The $\pi 5/2^-[303]$ assignment for the band of ^{107}Tc, which is expanded in the present work as shown in Fig. 1, agrees with that in Ref. [12]. However, in ^{105,107}Tc, the configuration of the $\pi 7/2^+[413]$ band based on a $7/2^+$ level assigned in Ref. [12] is different from that in Ref. [14], where the same band was assigned as $\pi 5/2^+[422]$ based on a $5/2^+$ level. To determine which configuration is right, we have carried out the g-factor analysis for this band. For an odd-A nucleus, the theoretical estimated $g_K^{\rm th}$ can be calculated with the equation [22]:

$$g_K^{\rm th} = g_l + \frac{(g_s - g_l)}{2K} GMS(K \to K), \tag{1}$$

where $g_{s\pi} = 0.6 g_{s\pi}^{\rm free} = 3.352$ and $g_l = 1$ for the odd-Z nucleus, and $g_{s\nu} = 0.6 g_{s\nu}^{\rm free} = -2.296$ and $g_l = 0$ for the odd-N nucleus. The $GMS(K \to K)$ is a quantity dependent on the deformation parameter β, tabulated in Ref. [23]. For an odd-odd nucleus, the $g_K^{\rm th}$ can be calculated using the equation [24]

$$g_K^{\rm th} = \left[\Omega_\pi g_\pi^{\rm th} + \Omega_\nu g_\nu^{\rm th}\right]/K, \tag{2}$$

where $K = \Omega_\pi + \Omega_\nu$. The experimental $g_K^{\rm ex}$ can be obtained as follows [25]:

$$\left|\left(g_K^{\rm ex} - g_R\right)/Q_0\right| = 0.934 E_\gamma |\delta|^{-1}[(I-1)(I+1)]^{-1/2} \quad (e\,{\rm b})^{-1}, \tag{3}$$

and

$$I_\gamma/I'_\gamma = 2K^2(2I-1)(E_\gamma/E'_\gamma)^5(1+\delta^{-2}) \times [(I+1)(I-1+K)(I-1-K)]^{-1} \tag{4}$$

where E_γ is the energy in MeV of the cascade γ ray from an initial state of spin I to the state with spin $(I-1)$, and δ^2 is the $E2/M1$ mix ratio in this transition. $E_{\gamma'}(I_{\gamma'})$ is the energy in MeV (intensity) of the crossover transition from the state of spin I to the state with spin $(I-2)$. Q_0 can be obtained by [26]

$$Q_0 = \tfrac{4}{5} Z A^{\frac{2}{3}} {r_0}^2 \varepsilon \left(1 + \tfrac{1}{2}\varepsilon\right), \tag{5}$$

where $\varepsilon = 0.96\beta$.

Taking $\beta = 0.3$ and $g_l = 1$, we obtained $g_K^{\rm th}(5/2^+[422]) = +1.36$ and $g_K^{\rm th}(7/2^+[413]) = +1.31$ for the odd-A Tc isotopes. Using the high-statistic γ-transition branching ratio data from Ref. [12], we can calculate the experimental $g_K^{\rm ex}$ values. For ^{107}Tc, taking $Q_0 = 5.01$ b and $g_R = 0.4$, the experimental average values of the collective band levels are $g_K^{\rm ex}(5/2^+) = +2.66(16)$ and $g_K^{\rm ex}(7/2^+) = +1.82(5)$. For ^{105}Tc, taking $Q_0 = 4.94$ b and $g_R = 0.4$, the experimental

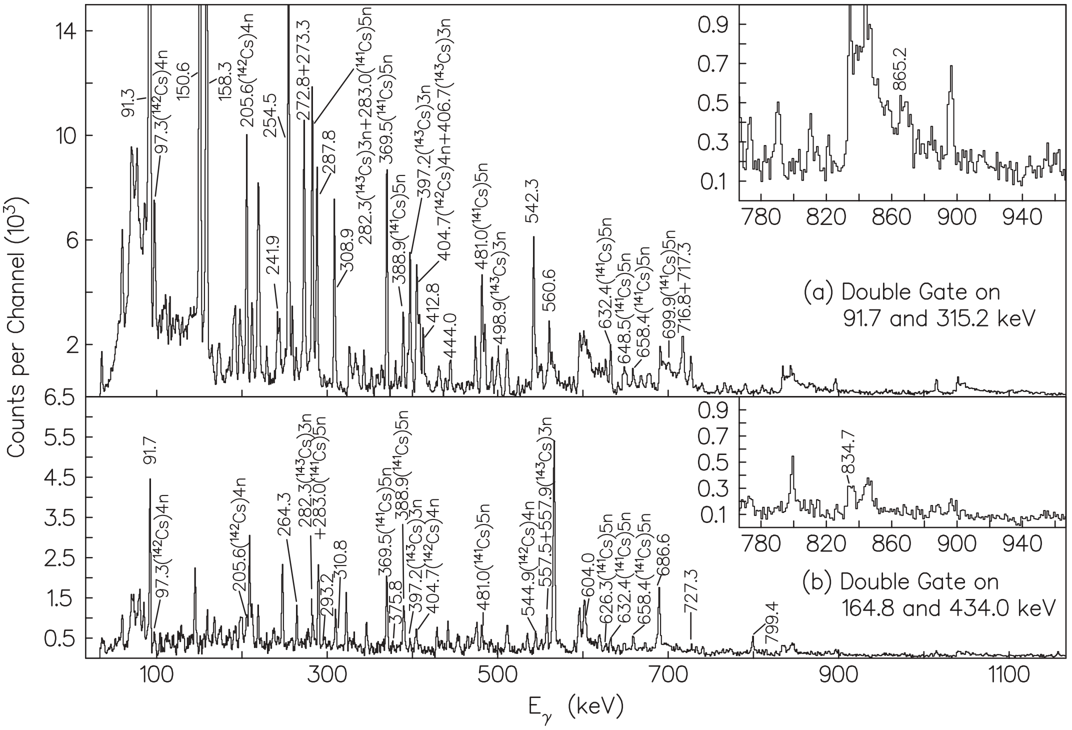

FIG. 2. γ-ray spectra of ^{106}Tc obtained by (a) double gating on 91.7 and 315.2 keV γ transitions, and (b) double gating on 164.8 and 434.0 keV γ transit ions.

average values of the collective band levels are $g_K^{\rm ex}(5/2^+) = +1.97(8)$ and $g_K^{\rm ex}(7/2^+) = +1.45(7)$. For ^{109}Tc, taking $Q_0 = 5.07$ b and $g_R = 0.4$, the experimental average values of the collective band levels are $g_K^{\rm ex}(5/2^+) = +2.19(8)$ and $g_K^{\rm ex}(7/2^+) = +1.55(6)$. One can see that for the $\pi 5/2^+[422]$ bands, the experimental $g_K^{\rm ex}(5/2^+)$ values in ^{105,107,109}Tc are far from the theoretical ones. But for the $\pi 7/2^+[413]$ bands, the experimental $g_K^{\rm ex}(7/2^+)$ values are near the theoretical ones. So the configuration for this positive parity band in ^{105,107,109}Tc should be $\pi 7/2^+[413]$ based on the $7/2^+$ level as reported

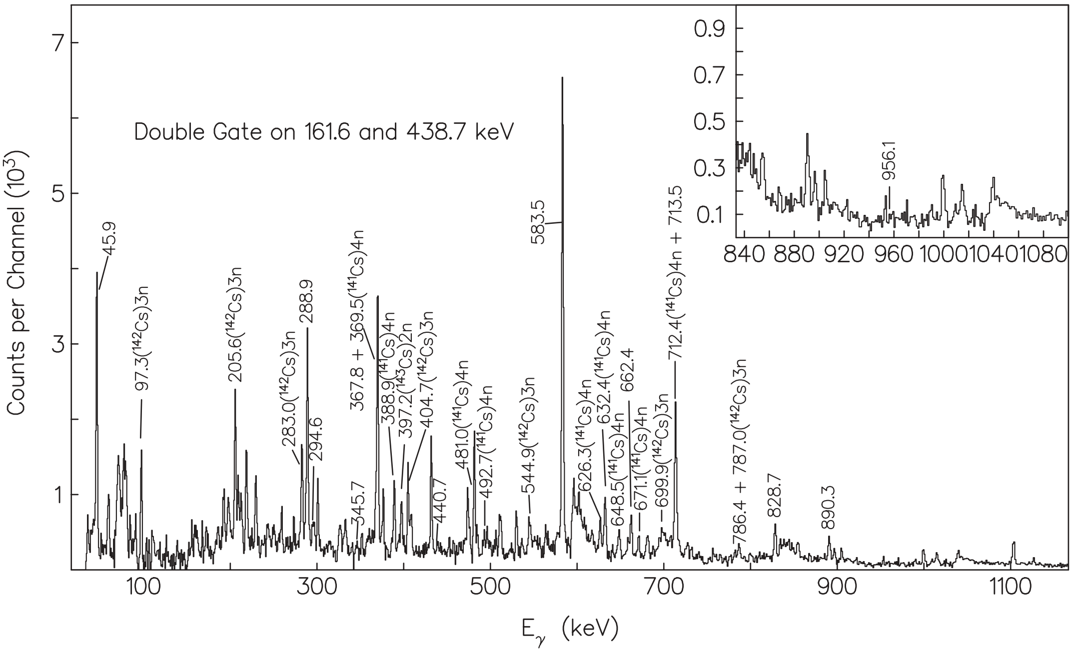

FIG. 3. The γ-ray spectrum of the collective band in ^{107}Tc obtained by double gating on 161.6 and 438.7 keV γ transitions.

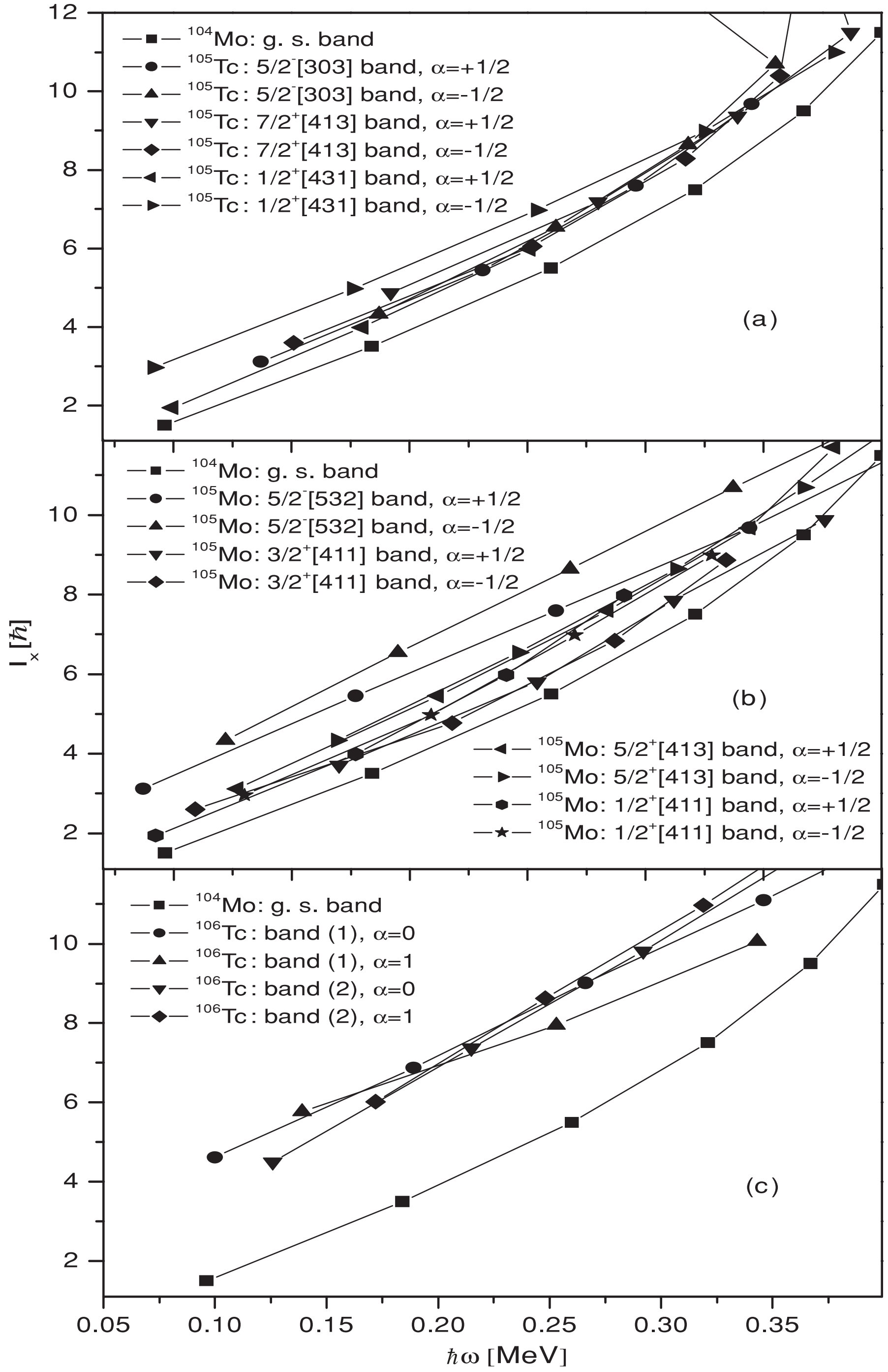

FIG. 4. Total angular momentum alignments I_x for observed bands in (a) ^{105}Tc, (b) ^{105}Mo, and (c) ^{106}Tc, along with the ground state (g.s.) band in ^{104}Mo in each figure.

in Refs. [12,13], instead of the $\pi 5/2^+[422]$ as reported in Ref. [14]. Another evidence supporting our assignment is the regular spacings inside the band. If this band originates from the $\pi 5/2^+[422]$ orbital, the level space between the $9/2^+$ and $5/2^+$ levels is too small compared with the other level spacings inside this band in each isotope.

B. Observed bands in ^{106}Tc

In the previous report [13], the spin and parity (I^π) were not assigned for any level in ^{106}Tc. The configurations of the bands in odd-odd ^{106}Tc are most probably composed of the experimental observed single-proton states in its odd-A isotope ^{105}Tc and single-neutron states in the odd-A isotone ^{105}Mo. They are $\pi 5/2^-[303]$, $\pi 7/2^+[413]$, and $\pi 1/2^+[431]/[420]$ in ^{105}Tc [12], and $\nu 11/2^-[532]$, $\nu 3/2^+[411]$, $\nu 5/2^+[413]$, and $\nu 1/2^+[411]$ in ^{105}Mo [6]. We suggest that the possible configurations for bands (1) and (2) in ^{106}Tc are $\pi 1/2^+[431]/[420]$ with $\alpha = -1/2$ component $\otimes \nu 5/2^+[413]$, which belong to the $\pi g_{7/2}/d_{5/2}$ and $\nu d_{5/2}$ subshells, and $\pi 7/2^+[413] \otimes \nu 5/2^-[532]$, which belong to the $\pi g_{9/2}$ and $\nu h_{11/2}$ subshells, respectively.

To give evidence for the above configuration assignments, we analyzed the angular momentum alignments with the method used in Refs. [17,22,27,28]. The alignment i_{xpn} in an odd-odd nucleus equals the sum of the i_{xp} and i_{xn}, which are the alignments of the collective bands in the neighboring odd-A isotope and isotone, respectively. Then the i_{xpn}, i_{xp}, and i_{xn} values for the collective bands can be obtained from the calculated I_x in the odd-odd and odd-A nuclei by subtracting the I_x of the ground state (g.s.) band in the neighboring even-even nucleus, respectively. The I_x is calculated as a function of the rotational frequency ω from the usual formula $I_x = \sqrt{(I_\alpha + 1/2)^2 - K^2}$, where $I_\alpha = (I_i + I_f)/2$ and $\hbar\omega = (E_i - E_f)/2$. We propose $K = 3$ for band (1) and $K = 6$ for band (2) in ^{106}Tc. Figure 4 shows the spin alignments I_x vs the rotational frequency $\hbar\omega$ in the observed bands in ^{105}Tc [12], ^{105}Mo [6], and ^{106}Tc in the present work along with that in the ground state band in ^{104}Mo. The average alignment values i_x calculated over the range of $\hbar\omega$ from 100 to 350 keV are 1.0$\hbar$ for the $5/2^-[303]$ band, 1.3$\hbar$ for the $7/2^+[413]$ band, and 0.6$\hbar$ for the $\alpha = +1/2$ component and 1.6$\hbar$ for the $\alpha = -1/2$ component for the $1/2^+[431]/[420]$ band in ^{105}Tc; and 2.3$\hbar$ for the $5/2^-[532]$ band, 0.7$\hbar$ for the $3/2^+[411]$ band, 1.4$\hbar$ for the $5/2^+[413]$ band, and 0.8$\hbar$ for the $1/2^+[411]$ band in ^{105}Mo. The average i_x values for ^{106}Tc are 3.0$\hbar$ for band (1) and 3.7$\hbar$ for band (2). So the average i_x value of band (1) in ^{106}Tc is near to the sum of the average i_x values of the $1/2^+[431]/[420]$ band ($\alpha = -1/2$) in ^{105}Tc and the $5/2^+[413]$ band in ^{105}Mo, and the value of band (2) is near to the sum of the values of the $7/2^+[413]$ band in ^{105}Tc and the $5/2^-[532]$ band in ^{105}Mo. Because of the large decouple effect observed between the $\alpha = +1/2$ and $\alpha = -1/2$ components for the $1/2^+[431]/[420]$ band in ^{105}Tc, here we separately give the i_x value in each signature component and will consider the coupling in the odd-odd nuclei independently. That is, we take the $\pi 1/2^+[431]/[420](\alpha = -1/2) \otimes \nu 5/2^+[413]$ for band (1) in ^{106}Tc. From the above analysis, the configurations of the two bandheads (1) and (2) in ^{106}Tc were shown to be consistent with a description in terms of the $\pi 1/2^+[431](\alpha = -1/2) \otimes \nu 5/2^+[413]$ and $\pi 7/2^+[413] \otimes \nu 5/2^-[532]$, respectively. Bands (1) and (2) in ^{106}Tc were based on the bandhead levels at $I^\pi = 4^+$ with $K^\pi = 3^+$, and at $I^\pi = 6^-$ with $K^\pi = 6^-$, respectively. In band (1), the I value is different from the K value. The reason is that the bandhead spin I is caused by the bandhead spin $I = 3/2$ of the $\pi 1/2^+[431](\alpha = -1/2)$ band coupling with the bandhead spin 5/2 of the $\nu 5/2^+[413]$, whereas the K value is caused by $\Omega = 1/2$ of the $\pi 1/2^+[431]$ orbital coupling with $\Omega = 5/2$ of the $\nu 5/2^+[413]$ orbital. Thus, the spins and parities for all levels in bands (1) and (2) have been tentatively assigned, as shown in Fig. 1.

Furthermore, by using the method in Sec. III A, the values of theoretical g_k^{th} and experimental g_k^{ex} for bands (1) and (2) in ^{106}Tc can be calculated to confirm the configuration assignments of the observed bands. The calculated value of g_K^{th} for the configuration of $\pi 1/2^+[431] \otimes \nu 5/2^+[413]$ for band (1) in ^{106}Tc is 0.275. And the experimental value of g_K^{ex} is 0.57(9). Comparing the theoretical value with the experimental value, it looks like they are different from each other. The reason is that the configuration is a mixture of $\pi 1/2^+[431]$ and $\pi 1/2^+[420]$. For the configuration of $\pi 1/2^+[420] \otimes \nu 5/2^+[413]$ for band (1), the calculated value of g_K^{th} is 0.55. So the g_K^{th} value for a mixed configuration can be near the experimental value. For band (2), g_K^{th} is 0.63, and g_K^{ex} is 0.52(11). One can see that the experimental value is near the theoretical value. This analysis gives further evidence for the configuration assignments for bands (1) and (2) in ^{106}Tc.

Plots of the kinematic moments of inertia J_1 against rotational frequency $\hbar\omega$ for the bands of ^{106}Tc as well as the $\pi 1/2^+[431]$ and $\pi 7/2^+[413]$ bands of ^{105}Tc and the $\nu 5/2^+[413]$ and $\nu 5/2^-[532]$ bands of ^{105}Mo are shown in Fig. 5. The J_1 values for the bands of the odd-odd nuclei should be larger than those of the corresponding bands of odd-A nuclei but less than that of the rigid body. The calculated rigid body value for ^{106}Tc is 49.1$\hbar^2$ MeV^{-1}. From Fig. 5, one can see that

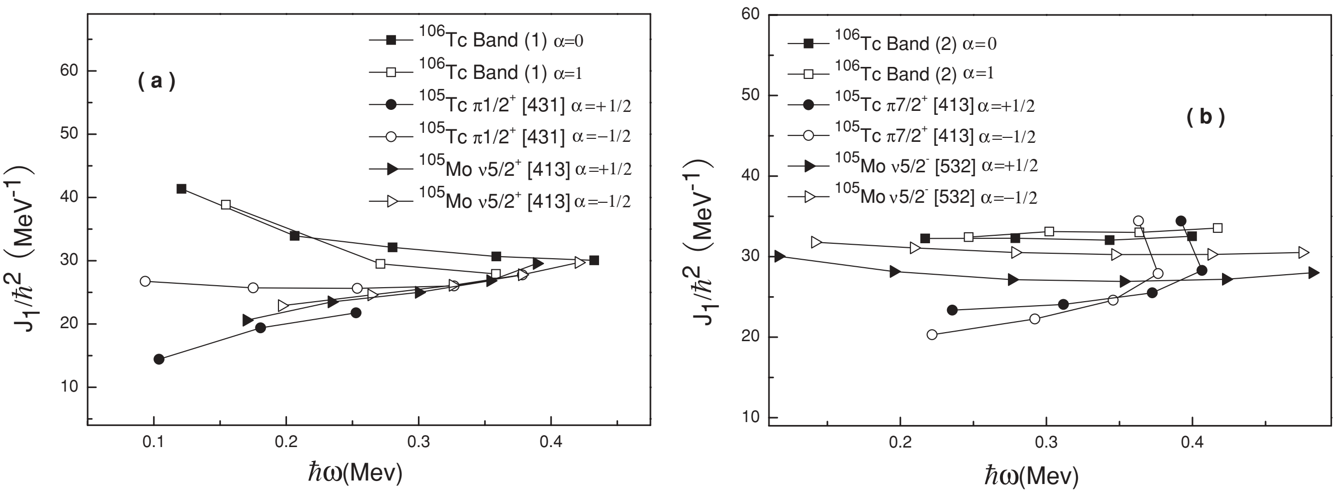

FIG. 5. Plots of moments of inertia J_1 vs rotational frequency $\hbar\omega$ for (a) band (1) of ^{106}Tc with neighboring odd-A nucleus for $\pi 1/2^+[431]$ band of ^{105}Tc and $\nu 5/2^+[413]$ band of ^{105}Mo, and (b) band (2) of ^{106}Tc with neighboring odd-A nucleus for $\pi 7/2^+[413]$ band of ^{105}Tc and $\nu 5/2^-[532]$ band of ^{105}Mo.

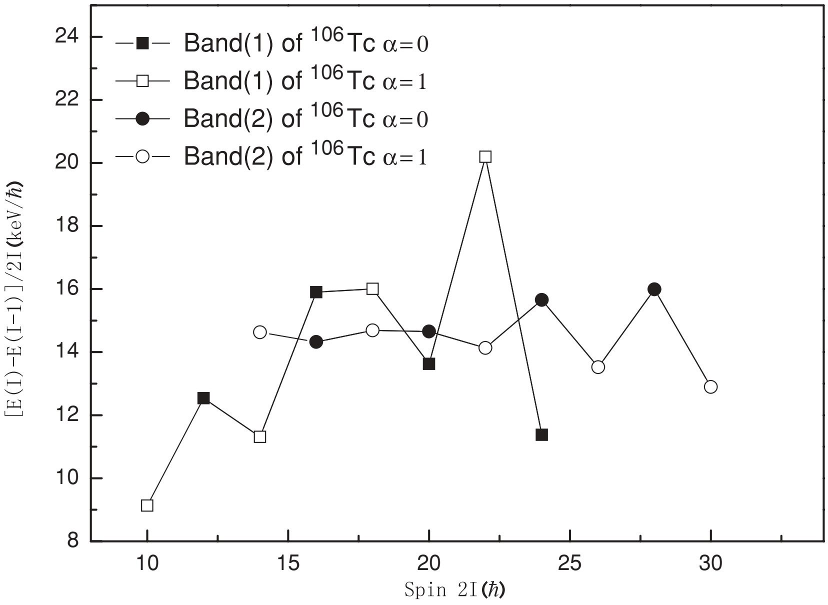

FIG. 6. Signature splittings for the two bands as a function of the spin I in ^{106}Tc.

the curves varying with $\hbar\omega$ of bands (1) and (2) in ^{106}Tc are larger than the corresponding bands of odd-A nuclei before backbendings and less than the rigid body value. These results also indicate that the configurations assigned to the collective bands of ^{106}Tc are reasonable.

Plots of the signature splittings $S(I) = [E(I) - E(I - 1)]/2I$ against spin I for bands (1) and (2) in ^{106}Tc are shown in Fig. 6. One can see that the curve of band (1) in ^{106}Tc has a larger signature splitting than that of band (2). Also, with increasing spin, the signature splittings in both bands increase. The large signature splittings in ^{106}Tc may be caused by the Coriolis coupling. The Coriolis coupling increases with spin and results in increased signature splitting with spin, as discussed in Ref. [29]. When the spins I equal to 9 and 11 $\hbar$, signature inversions occur in bands (1) and (2). These may be caused by the triaxial deformation in ^{106}Tc.

IV. SUMMARY

In the present work, the high spin states in ^{106,107}Tc have been studied. A new level scheme of ^{106}Tc has been established. A previous known band structure is confirmed and expanded, and another collective is newly identified. In ^{107}Tc, a collective band built on the $\pi 5/2^-[303]$ orbital has been reexamined and extended. Through the angular momentum alignment analysis and g-factor calculations, the configurations for the observed two bands in ^{106}Tc are suggested. These bands are originated from the $\pi 1/2^+[431](\alpha = -1/2) \otimes \nu 5/2^+[413]$ and $\pi 7/2^+[413] \otimes \nu 5/2^-[532]$, respectively. It indicates that the method of angular momentum alignment analysis and g-factor calculation to assign the configurations for the odd-odd-A nuclei in this region is useful. It shows that the ^{106}Tc nucleus has large triaxiality and well-deformed quadrupole deformation. The disputed configuration for a band in the odd-A Tc isotopes was determined to be $\pi 7/2^+[413]$ instead of $\pi 5/2^+[422]$. Large signature splittings with increasing spin and signature inversions were observed in ^{106}Tc.

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