Levels of ^{123}Te and ^{125}Te and the decay of 13.3-h ^{123}I and 2.7-yr ^{125}Sb†

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(Received 13 July 1976)

The decay of 13.3-h ^{123}I to levels of ^{123}Te and the decay of 2.7-yr ^{125}Sb to levels of ^{125}Te have been studied. Forty-four γ rays were attributed to the decay of ^{123}I and all but three were placed among 16 levels, 14 of which are also observed in (p, t) reaction studies and 11 in (a, p) reaction studies. Three previously unobserved low-intensity $E1$ transitions and one new $M2$ transition were observed in the decay of ^{125}Sb. The detailed systematics of the odd-mass Te nuclei are compared to current particle-vibration and cluster models.

[RADIOACTIVITY Measured E_γ, I_γ; deduced ^{123}Te, ^{125}Te levels, J^π values.]

I. INTRODUCTION

Inspection of the recent *Nuclear Data Sheet* compilations on ^{123}Te and ^{125}Te by Auble[1,2] shows that these nuclei have been studied by many diverse techniques. This variety of information and the relative simplicity of calculations for nuclides near closed shells has allowed a number of theoretical approaches to be attempted on the odd-mass Te nuclei. However, no detailed studies of the ^{123}I decay have been reported. For ^{125}Sb decay no Compton suppression studies have been undertaken.[1] Here we have sought to better delineate the level properties of ^{123}Te and ^{125}Te by detailed γ-ray spectroscopy studies.

II. EXPERIMENTAL PROCEDURES AND RESULTS

A. 2.7-yr ^{125}Sb

Sources of ^{125}Sb were obtained commercially and chemically purified periodically over a period of three years to insure that the observed γ rays followed both the chemical separation of antimony[3] and the 2.7-yr half-life of the isotope. The γ-ray spectrum was measured periodically during that period using a Compton suppression spectrometer and several Ge(Li) spectrometers. The γ rays that remained with the sample and followed a 2.7-h half-life are tabulated in Table I. Previously unobserved γ rays at 19.9, 146.08, 314.94, and 497.36 keV were observed and a 110.842-keV γ ray not regularly observed in earlier studies was confirmed in low intensity. Energy values of other γ rays are in good agreement with the values adopted by Auble.[1] Intensity values for the more intense γ rays were determined by measuring thin ^{125}Sb sources on several different spectrometers at source-to-detector distances from 20 to 100 cm.

B. 58-day ^{125}Te^m

Periodic purification of the ^{125}Sb source resulted in the preparation of intense sources of 58-day ^{125}Te^m. We measured the relative intensity of the $E5$ crossover isomeric transition from the $\frac{11}{2}^-$ isomer to the $\frac{1}{2}^+$ ground state. The intensity relative to the 104-keV $M4$ transition was measured to be 1.4×10^{-6}. In Fig. 1 we show the 144.78-keV $E5$ crossover isomeric transition measured in a 19-day counting period.

C. 13.3-h ^{123}I

Sources of 13.3-h ^{123}I were produced by the ^{123}Te$(p,n)^{123}$I reaction on isotopically enriched targets and chemically purified to remove Fe, Mn, and Br impurities; 4.2-day ^{124}I, 13.2-day ^{126}I, and 12.6-h ^{130}I impurity activities[4-6] produced from the respective (p,n) reactions on ^{124}Te, ^{128}Te, and ^{130}Te were low, but not negligible. In addition, 8.0-day ^{131}I activity[7] grew in from the decay of 25-min ^{131}Te^g, which resulted from the ^{130}Te$(n,\gamma)^{131}$Te reaction of secondary neutrons on ^{130}Te. The γ rays of ^{124}I, ^{130}I, and ^{131}I were used as internal calibration standards for the determination of the energies of the ^{123}I γ rays. Ordinary and Compton suppression Ge(Li) spectrometers were used to measure the γ-ray spectra as a function of time on the several sources. A Compton suppression spectrum is shown in Fig. 2. The γ rays that were observed to follow a 13.3-h half-life are tabulated in Table II and include all the γ rays observed by Sodd *et al.*[8] and by Ragaini *et al.*[9] Because of the high intensity of the 158.97-keV γ ray, no new γ-γ coincidence measurements were made. Further, it was possible to place the newly observed γ rays on the basis of the precise energy values and the results[10,11] of the (p,t) and (d,p) reaction studies. We have observed 44 γ

TABLE I. γ-ray energies and intensities observed in the decay of 2.7-yr ^{125}Sb to levels of ^{125}Te.

$E_\gamma(\Delta E_\gamma)$ [a]	$I_\gamma(\Delta I_\gamma)$[a] ($\gamma$ rays per 1000 decays)	From	To
19.88(15)	0.2(1)	463	443
35.504(15)	b	36	g.s.
109.276(15)	b	145	35
110.89(12) [c]	0.009(1) [c]	636	525
116.952(11)	2.55(4)	642	525
114.780(25)	b	145	g.s.
146.08(10)	0.0062(4)	671	525
172.615(15)	1.82(3)	636	463
176.334(11)	67.9(2)	321	145
178.78(5)	0.27(4)	642	463
198.65(6)	0.13(3)	642	443
204.129(25)	3.23(4)	525	321
208.088(25)	2.36(4)	671	463
227.911(35)	1.32(4)	671	443
314.94(11)	0.042(4)	636	321
321.03(4)	4.10(4)	642	321
380.435(20)	15.2(1)	525	145
408.01(4)	1.83(6)	443	35
427.889(15)	294.4(9)	463	35
443.497(35)	3.03(7)	443	g.s.
463.383(15)	104.5(2)	463	g.s.
491.28(–)	<0.0004	636	145
497.36(12)	0.036(4)	642	145
600.557(18)	177.8(3)	636	35
606.641(19)	50.2(1)	642	35
635.895(18)	113.2(2)	671	35
671.409(20)	18.0(4)	671	g.s.
693(–)	<0.0009	729	35

[a] The numbers in parentheses represent the uncertainty in the last digits of the numbers to which they are appended.

[b] This γ ray is in transient equilibrium with the ^{125}Sb decay. True transient equilibrium was not reached in these samples because of continued milking of the 58-day ^{125}Te^m and repurification of the 2.77-yr ^{125}Sb.

[c] This value was determined from spectra of ^{125}Sb that had been recorded immediately after chemical separation from the ^{125}Te^m daughter.

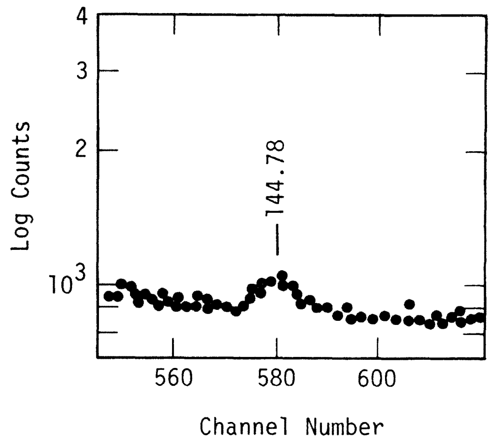

FIG. 1. Portion of spectra from chemically isolated ^{125}Te^m showing the 144.78-keV γ ray. This spectra was accumulated over a 19-day measurement period (*nota bene*, detector/cave background lines showed no photopeaks at this energy). A 1.6-mm Cd absorber was placed between source and detector to reduce x-ray contribution.

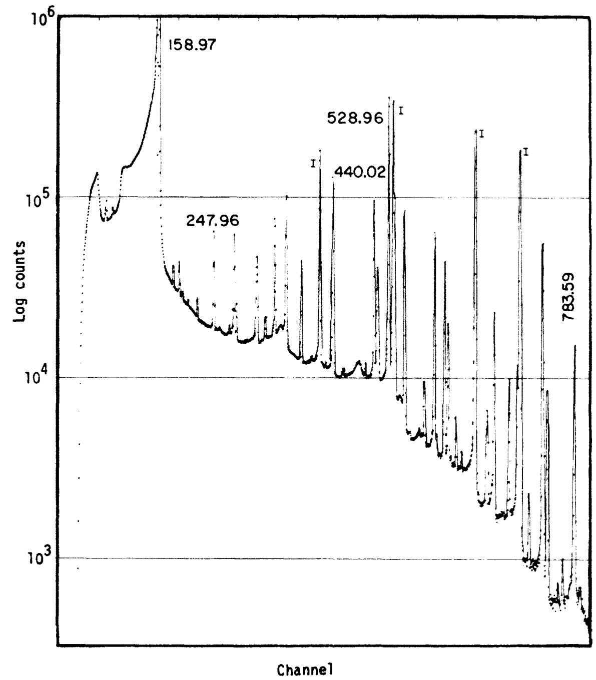

FIG. 2. Compton suppression spectra of ^{123}I from a chemically isolated source produced by the ^{123}Te(p,n)-^{123}I reaction. Each of the ^{124}I, ^{126}I, and ^{130}I impurities have been measured separately on the same Compton suppression spectrometer.

rays in the decay of 13-h ^{123}I, 41 of which are assigned to the decay scheme.

III. DECAY SCHEMES

A. 2.7-yr ^{125}Sb

We show the decay scheme of 2.7-yr ^{125}Sb in Fig. 3. We have also shown the spectroscopic values for the ^{124}Te$(d,p)^{125}$Te reaction[12] and the ^{126}Te$(d,t)^{125}$Te reaction[13] as well as the $B(E2)$ values (relative to the $0^+ \to 2^+$ transition in ^{124}Te) for Coulomb excitation[14] and the known level lifetimes.[15] The logft values were calculated by assuming negligible direct β feeding to the ground

TABLE II. γ-ray energies and intensities observed in the decay of 13.3-h ^{123}I to levels of ^{123}Te.

$E_\gamma(\Delta E_\gamma)$ [a]	$I_\gamma(\Delta I_\gamma)$ [a,b]	From	To
158.97(5)	10 000	159	g.s.
174.2(3)	0.10(3)	1068	894
182.61(6)	1.55(5)	687	505
190.7(1)	0.06(2)	(438)	(247)
		(532)	(342)
192.17(7)	2.38(8)	647	505
197.26 [c]	0.04(2)	894	697
198.26 [d]	0.4(1)	688	489
206.82 [d]	0.4(1)	894	688
207.82 [d]	0.13(4)	697	489
242.32(–) [e]	≤0.04	489	247
247.96(5)	8.54(15)	688	440
257.51(15)	0.18(5)	697	440
259.0(2)	0.11(5)	(697)	(438)
278.36(12)	0.27(5)	784	505
281.03(5)	9.5(1)	440	159
285.32(11)	0.51(5)	532	247
329.38(17)	0.31(7)	769	440
330.70(8)	1.39(5)	489	159
343.73(14)	0.51(5)	783	440
346.35(5)	15.1(1)	505	159
405.02(13)	0.35(7)	894	489
437.5(3)	0.09(9)	1036	599
440.02(5)	51.4(6)	440	g.s.
450.07(–) [e]	≤0.02	697	247
454.76(15)	0.47(6)	894	440
505.33(5)	37.9(3)	505	g.s.
528.96(5)	167.0(5)	687	159
538.54(5)	45.8(5)	697	159
556.05(13)	0.37(5)	996	440
562.79(12)	0.13(5)	1068	505
578.26(20)	0.18(5)	1068	489
599.69(16)	0.31(11)	599	g.s.
610.05(23)	0.13(4)	769	159
624.57(5)	10.0(1)	783	159
628.26(22)	0.19(3)	1068	440
687.95(8)	3.21(15)	687	g.s.
735.78(7)	7.39(14)	894	159
760.85(20)	0.075(25)		
783.59(6)	7.13(14)	783	g.s.
837.10(20)	0.06(1)	996	159
887.52(17)	0.13(8)	1036	159
894.8(2)	0.11(3)	894	g.s.
898.2(2)	0.07(4)		
909.12(12)	0.16(3)	1068	159
1036.63(17)	0.12(3)	1036	g.s.
1068.12(15)	0.17(1)	1068	g.s.

[a] The numbers in parentheses represent the uncertainty in the last digits of the numbers to which they are appended.

[b] γ-ray intensity relative to the 158.97-keV γ ray taken as 10 000.

[c] The γ energies listed are those appropriate for the listed placements, the peak centroid was 198.16 keV.

[d] The γ energies listed are those appropriate for the placements, the peak centroid was 207.07 keV.

[e] Energy determined from level energy difference.

state of ^{125}Te (a $\frac{7}{2}^+$ to $\frac{1}{2}^+$ transition) and a 13.6% branch[1] to the $\frac{11}{2}^-$ isomer at 144.8 keV. No intensity value is shown for the 35.4-, 109.3-, and 144.8-keV γ rays as the periodic chemical separations did not allow the isomer to come to true transient equilibrium.

Our observation of a 19.88-keV γ ray allows the first realistic accounting of how the known $\frac{3}{2}^+$ level at 443 keV is populated in the β decay of $\frac{7}{2}^+$ ^{125}Sb. Previously a γ-ray intensity imbalance required β population of this level and an unrealistically low logft value for a $\frac{7}{2}^+ \to \frac{3}{2}^+$ second forbidden β transition. When the theoretical conversion coefficient for the 19-keV transition is used in conjunction with our γ-ray intensity, the total population of the 443-keV level can be accounted for. Further, the placement of a 19.88-keV γ ray as depopulating the 463-keV level is consistent with the expected speed of such a transition. If we use our branching ratios for the depopulation of this 463-keV level and the known lifetime of that level, we obtain a hindrance of 30 over the Moszkowski[16] estimate.

Graue *et al.*[12] observed a level at 729 keV that exhibited an $l = 2$ angular distribution in their ^{124}Te$(d,p)^{125}$Te studies, thus limiting the J^π value to $\frac{5}{2}^+$ or $\frac{3}{2}^+$. In either case one would expect depopulation of this level by a 693-keV γ ray to the 35-keV $\frac{3}{2}^+$ level. We set an upper limit of >0.0009 parts per decay of ^{125}Sb for this γ ray and the possible population of the 729-keV level. This value corresponds to a logft of >11. We suggest a $J^\pi = \frac{3}{2}^+$ for the 729-keV level, however, $\frac{5}{2}^+$ cannot be totally excluded on strict β-decay strength rules. From the systematics of the odd-mass Te nuclei, we expect an $\frac{1}{2}^+$ level at approximately 560 keV. Such a level, if populated by a cascade from higher-lying level would decay by a 525 ± 10-keV γ ray. Accordingly, we searched the Compton suppression spectra for γ rays in the 515- to 535-keV region and set a limit of >0.0008 for the populate of any $\frac{1}{2}^+$ level at 560 ± 10 keV.

B. 13.3-h ^{123}I

The decay scheme for 13.3-h ^{123}I to levels of ^{123}Te is shown in Fig. 4. The Q_{EC} value of 1200 keV shown in Fig. 2 is a calculated value.[17] We were unable to observe any 13.3-h component in the annihilation radiation that arose from the 4.2-day ^{124}I and 13.6-day ^{126}I present in the sample. As the principal electron capture branch is to the level at 159 keV, the uncertainty in the decay curve for the annihilation radiation permits us to set an upper limit of 1250 keV for the Q_{EC}. We also show the levels and l values measured in the

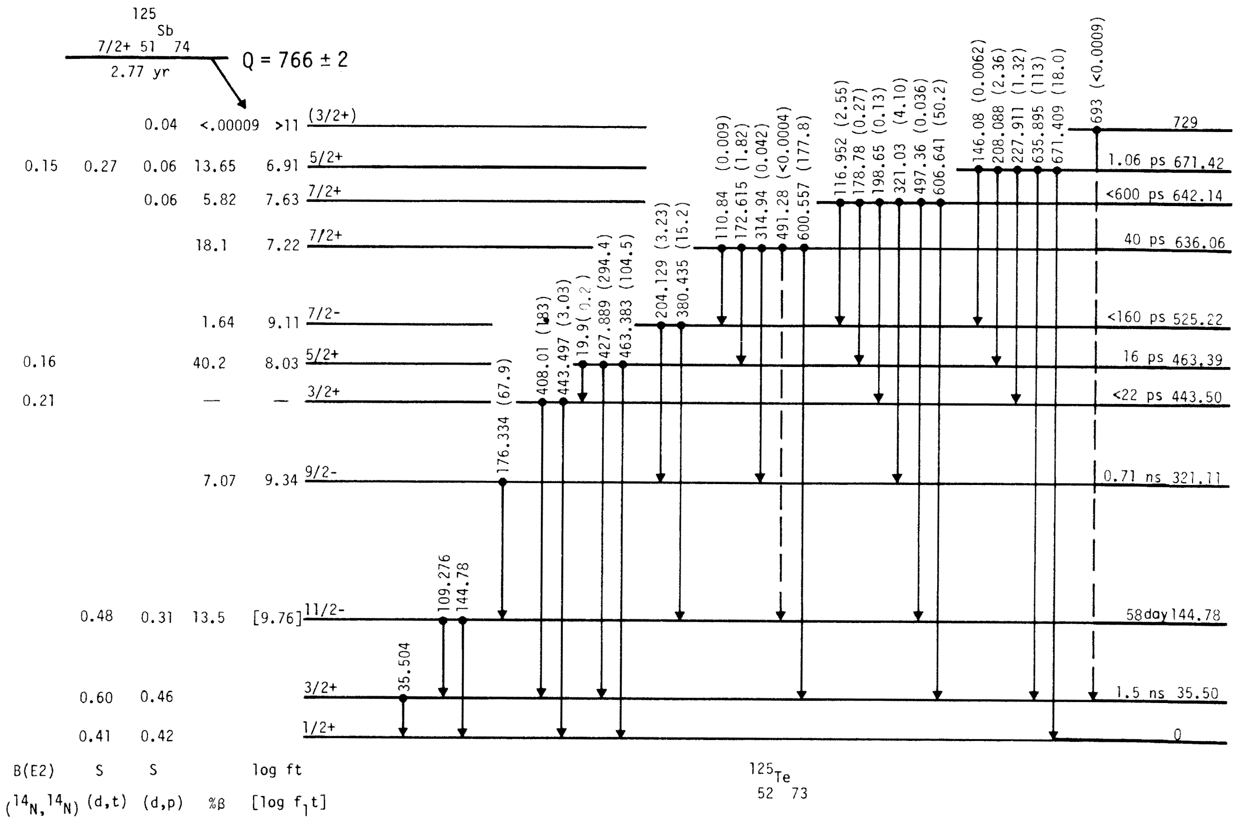

FIG. 3. Decay scheme of 2.7-yr ^{125}Sb.

^{125}Te$(p,t)^{123}$Te reaction[10,18,19] and the ^{122}Te$(d,p)^{123}$Te reaction,[11] and note the close agreement.

The spin and parity assignments for the 158.97-, 247.39-, and 440.02-keV levels were previously established[2] from Coulomb excitation reaction studies and radioactive decay studies. The $l=0$ value for transfer to the 697.51-keV level combined with the γ branch to the $\frac{3}{2}^+$ level at 158.97 keV are consistent only with a $\frac{7}{2}^+$ assignment for the 697.51-keV level. Seltz and Hintz[19] suggest an $l=5$ transfer for the 489.69-keV level. A $\frac{9}{2}^-$ or $\frac{11}{2}^-$ assignment would be inconsistent with the γ-ray feeding to the $\frac{3}{2}^+$ level at 158.97 keV and the numerous γ-ray branches from higher-lying $\frac{3}{2}^+$ or $\frac{5}{2}^+$ levels. As the $l=4$ angulàr distribution is similar to the $l=5$ angular distribution and the level is populated weakly in the (p,t) reaction a $\frac{7}{2}^+$ assignment is proposed for this level.

Recent ion-implantation, perturbed angular-correlation studies[20] have established $\frac{5}{2}^+$ spin and parity for the 505.34-keV level.

The levels at 687.95, 783.58, and 894.07 keV were all populated in $l=2$ (p,t) reactions, all feed the $\frac{1}{2}^+$ ground state, all show numerous γ branches, and are fed with similar logft values. We cannot distinguish between the $\frac{3}{2}^+$ and $\frac{5}{2}^+$ possibilities.

The levels at 1068.12 and 1036.6 were observed in the (p,t) reactions but no l values were determined. Spins and parities of $\frac{3}{2}^+$ and $\frac{5}{2}^+$ are not inconsistent with the observed β- and γ-decay data or the (p,t) reaction data. The levels at 764.2 and 996.05 keV feed only the two $\frac{3}{2}^+$ levels at 158.07 and 440.02 keV. The 769.2-keV level was not observed in any of the reaction studies, whereas the 996.0-keV level could possibly be identified with the $l=3$ level at 990 keV in the (p,t) reaction. If the two are the same level, only a $\frac{5}{2}^-$ spin and parity are consistent with all of the data.

We postulate a tentative level at 532 keV with J^π of $\frac{7}{2}^-$. A level has been observed to be weakly populated in (p,t) studies at approximately this energy. The 285.3-keV γ ray we observed can be placed as representing the decay of a 532-keV level to the 247-keV $\frac{11}{2}^-$ isomer. Such an assignment would explain Ragaini *et al.*'s[9] measurement that 0.01% of all ^{123}I decays populate the $\frac{11}{2}^-$ isomer. We find no feeding of the possible 532-keV level from higher-lying levels, which suggests it is fed directly in β decay of the $\frac{5}{2}^+$ ^{123}I

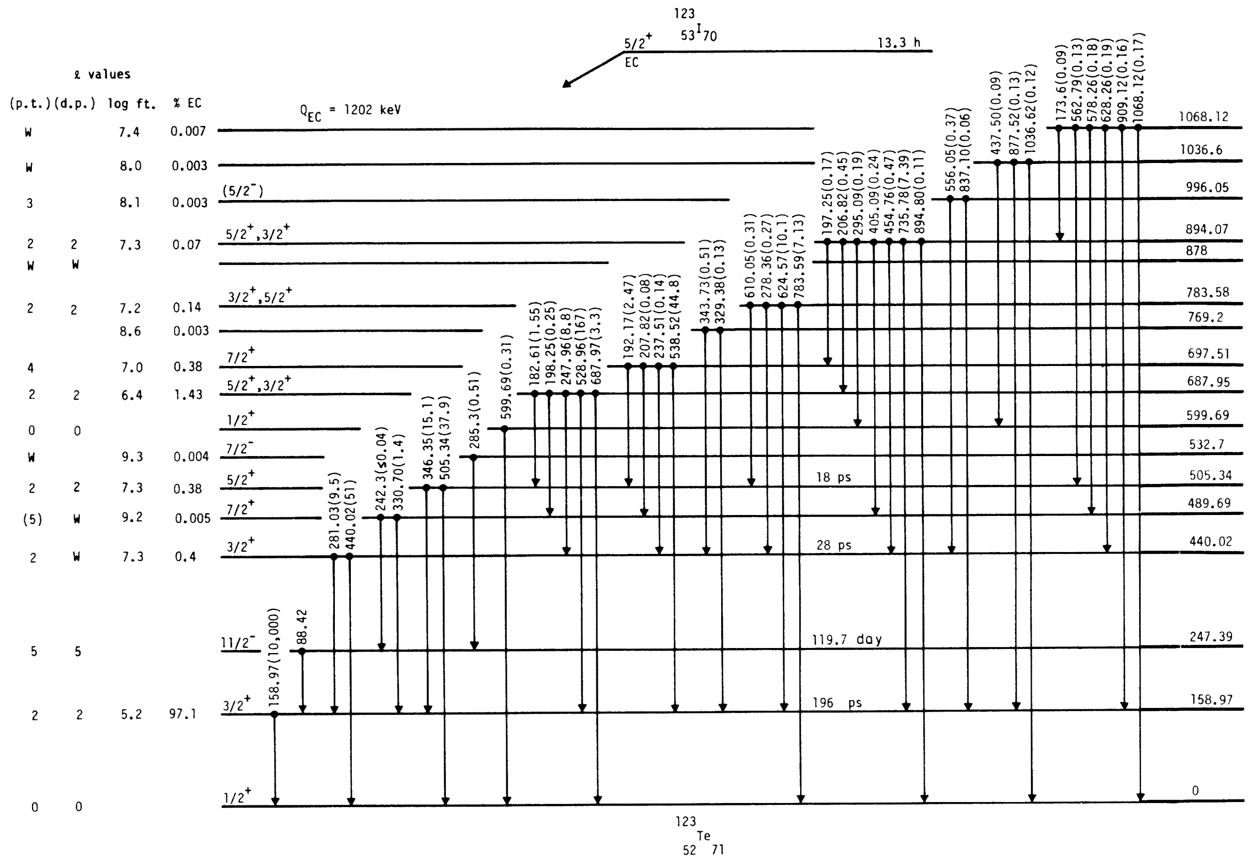

FIG. 4. Decay scheme of 13.3-h ^{123}I.

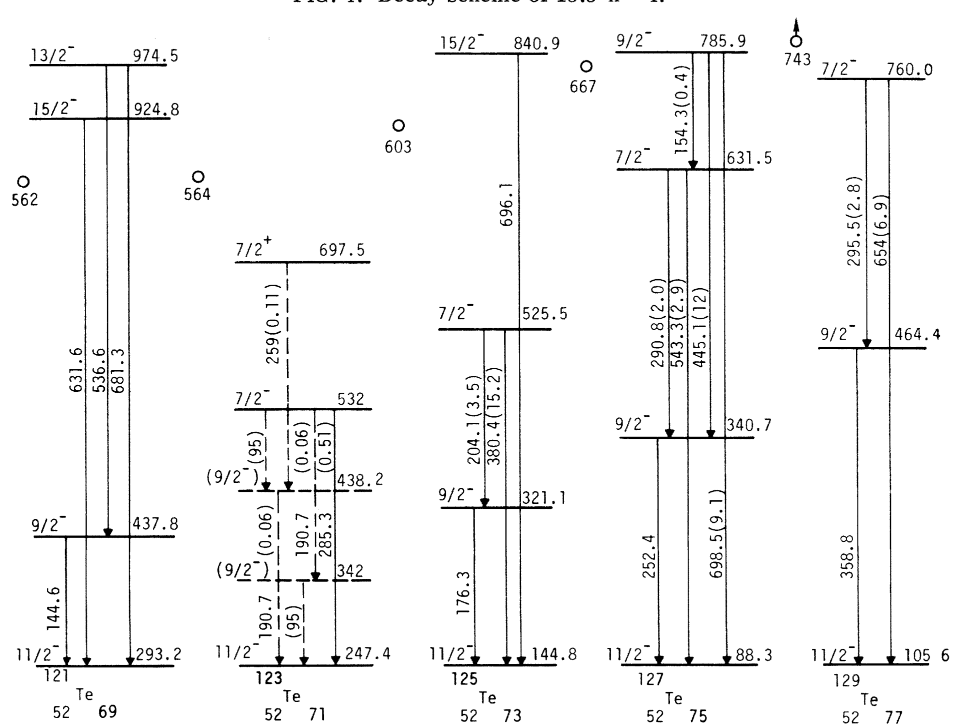

FIG. 5. Systematics of low-lying negative-parity states.

ground state. We take these properties as suggesting a $\frac{7}{2}^-$-J^π value for the level.

We show the low-lying negative-parity[21-25] levels for ^{121}Te through ^{129}Te in Fig. 5. The remaining unplaced low-energy γ rays in the decay of ^{123}I are at 190 and 259 keV. We suggest that the 190-keV γ ray can participate in the cascade through a $\frac{9}{2}^-$ level from the $\frac{7}{2}^-$ or higher levels. We show two possibilities in Fig. 5, and note that systematics support the placement of $\frac{9}{2}^-$ level at 95 keV above the $\frac{11}{2}^-$ isomer, whereas the 259-keV γ ray could cascade from the $\frac{7}{2}^+$ level through a $\frac{9}{2}^-$ level 190 keV above the $\frac{11}{2}^-$ isomer. Any low-intensity 95-keV transition is completely masked by the 159-keV transition even in the Compton suppression spectra.

IV. DISCUSSION

The systematic variations in the levels of both even- and odd-mass Te nuclides have received considerable experimental and theoretical attention. The large number of stable isotopes, including two odd-mass isotopes and the presence of a number of long-lived β-decay parents that are relatively easily prepared have made it possible to accumulate a wide variety of experimental data from Coulomb excitation, (d,p), (d,t), (p,t), (n,γ), and $(\alpha,xn\gamma)$ reaction studies, as well as many types of studies using radioactive sources. This variety of information coupled with the relative simplicity of calculations for nuclides near closed shells has also permitted a variety of theoretical approaches to the structure of these near-proton closed-shell Te nuclides. From these studies has emerged a general vibrational description for the even-mass isotopes and evidence that a majority of the levels of the odd-mass isotopes result from the coupling of the five shell model single-particle states to the even-even core. The systematics of the filling of the single-particle states (except for the $g_{7/2}$ state) has been examined in detail by Lien, Vaagen, and Graue[11] for the nuclides $A = 123$–131. The coupling of single-particle states to the core to form many high-spin states has been noted by Kerek *et al.*[26] for ^{125}Te.

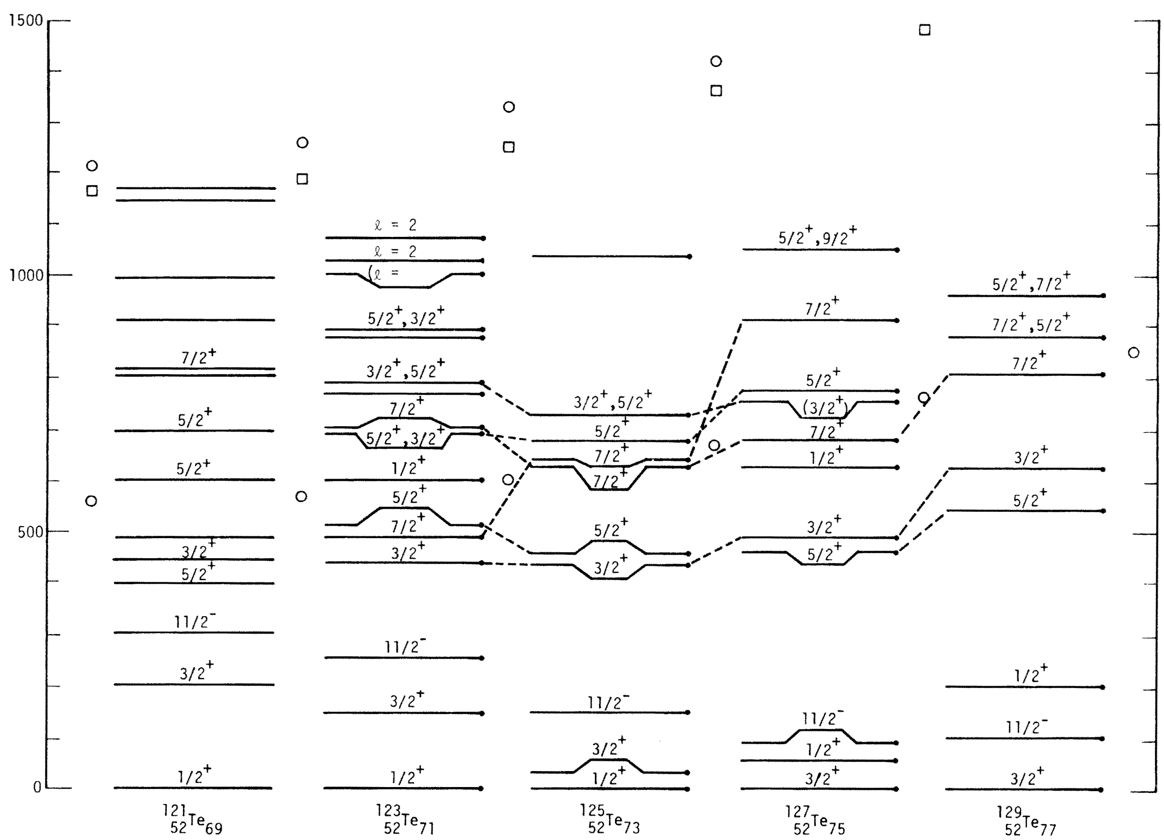

FIG. 6. Systematics of low-lying positive-parity states. The dots and squares represent the positions of the 2^+ and 4^+ states, respectively, in the intervening even-even Te nuclides.

Our new data pertain to the character and systematic variations of low-lying low-spin states. We will discuss these systematics, make some comparisons with theoretical calculations, and examine the multipole character of the decay of several states for which detailed properties have been measured.

The low-lying odd-parity levels of ^{121}Te to ^{129}Te are shown in Fig. 3 along with the energies of the first 2^+ state of the adjacent even-even nucleus. The presence of the $\frac{15}{2}^-$ states at energies close to those of the core is consistent with the simple particle $(h_{11/2})$ plus core description put forward by Kisslinger and Sorensen.[27] On the other hand, the low-lying $\frac{9}{2}^-$ states have long required a more complex description. These states have been described as three quasiparticle states, $(h_{11/2})^3{}_{9/2}$, by Kisslinger[28] and the measured[29,30] g factor found to agree with such a description. Recently Fogelberg *et al.*[31] have identified a $\frac{9}{2}^-$ level in both ^{121}Sn and ^{123}Sn. These levels occur at approximately 50% of the first phonon energy in the corresponding even-even core. Their drop below the position of the $h_{11/2}$ state in the Xe nuclides[1,2] has required a more complete description than the simple three-quasiparticle structure. Recent cluster-model calculations[32] incorporate dressed five-quasiparticle (qp) clusters to account for low-lying $J-2$ levels such as the $\frac{5}{2}^+$ state $(g_{9/2})^5{}_{5/2}$ in ^{101}Tc. Inspection of Fig. 3 shows the sharp drop in position of the $\frac{7}{2}^-$ level, especially between ^{127}Te and ^{125}Te and that its lowest positions ^{123}Te and ^{125}Te correspond to the presence of approximately five particles and approximately five holes in the $h_{11/2}$ shell.[11] In $^{131}_{52}$Te$_{79}$ which is not shown in Fig. 5, and which has no possibility of a five-qp cluster, the $\frac{7}{2}^-$ level is 854 keV above the $\frac{11}{2}^-$ isomer and the position of the first 2^+ state in ^{130}Te is 840 keV.[23] We note that an alternative description based on a strong Coriolis interaction has met with success in the heavier proton nuclei such as ^{133}La (see Refs. 33–35).

In contrast to the negative-parity levels, the low-lying even-parity states, shown in Fig. 6, show no such sharp variations.[21-23,36,37] Instead, the $s_{1/2}$ and $d_{3/2}$ states vary slowly as neutron pairs are added, a hextuplet of mixed states with $(s_{1/2}\otimes 2^+)_{3/2^+,5/2^+}$ and $(d_{3/2}\otimes 2^+)_{1/2,3/2,5/2,7/2}$ configurations, and $g_{7/2}$ and $d_{5/2}$ hole states (the latter $d_{5/2}$ states are not well identified). The hextuplet is seen most clearly in ^{127}Te where the $(d_{3/2}\otimes 2^+)\frac{1}{2}^+, \frac{7}{2}^+$ states are found lying near the pho-

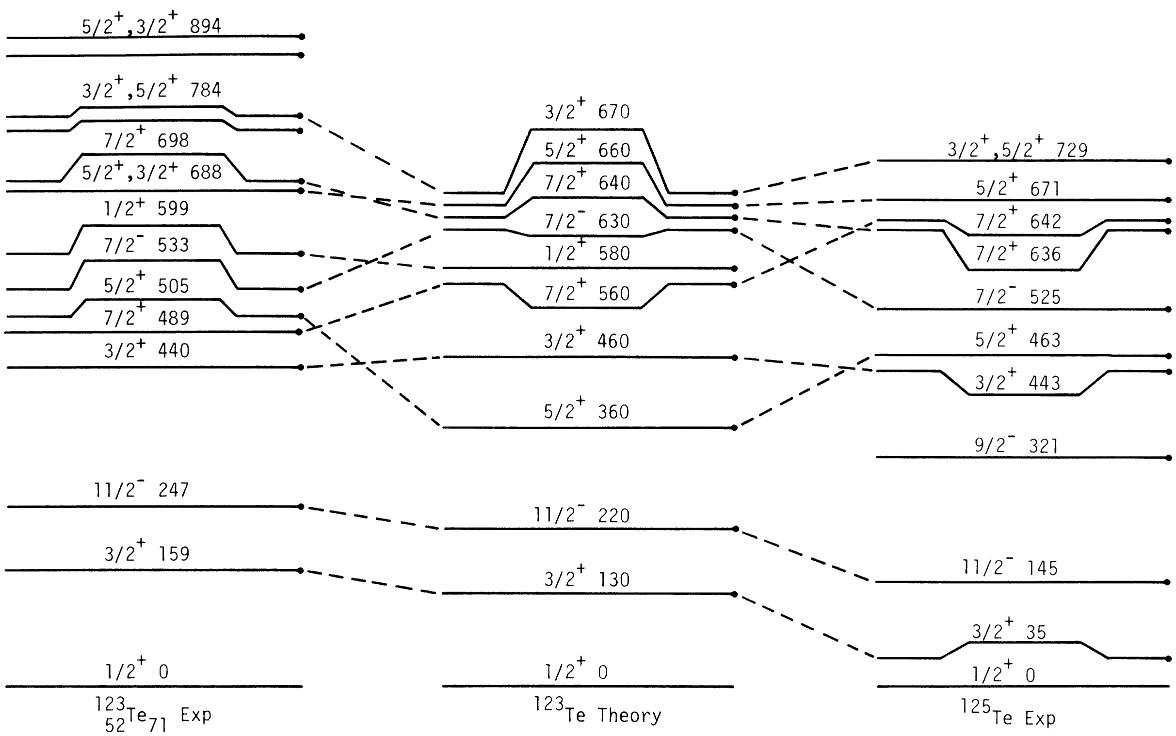

FIG. 7. Comparison of observed low-lying ^{123}Te and ^{125}Te levels with positions calculated by Kisslinger and Kumar (Ref. 38).

non energy and the mixed $\frac{3}{2}^+$ and $\frac{5}{2}^+$ states lying approximately equidistant above and below the phonon. A similar structure is observed for ^{125}Te and ^{123}Te although the $\frac{1}{2}^+$ state is not identified in ^{125}Te. As shown in Fig. 7, the levels of ^{123}Te and ^{125}Te compare well with the levels calculated for ^{123}Te by Kisslinger and Kumar.[38] Their pairing plus quadrupole calculations improved the earlier calculations by permitting more higher vibrational components to mix into the lower-lying states.

In Table III, we have tabulated the γ-ray decay characteristics for the levels above 400 keV. The calculated values were computed using coefficients and statistical factors given by Moszkowski.[16] It is important to recognize that the coefficients differ from those given in the *Table of Isotopes*[41] and the Weisskopf estimate tabulated by Wilkinson.[42] When comparing the hinderance factors care must be taken to insure that the experimental values are compared with theoretical values that have been computed in the same way. For the lifetime of the levels at 642.14 and 525.22 keV, only upper limits of <600 and <160 ps, respectively, have been determined. Hence, for the purpose of comparison, we have assumed values of 400 and 100 ps, respectively. Several interesting features can be noted in Table III. The $E2$ branching from both $\frac{5}{2}^+$ states to both low-lying $\frac{1}{2}^+$ and $\frac{3}{2}^+$ states is

TABLE III. γ-ray hindrances in ^{123}Te.

Level $t_{1/2}$[a] J_i	E_γ	J_f^π	ML, EL	$\delta\left(\frac{E2}{M1}, \frac{M2}{E1}\right)$[b]	t_γ	$t_{M1,E1}$[c] (calc)	$\frac{t_\gamma(1+\delta^2)}{t_{(M1,E1)}}$	$t_{E2,M2}$[c] (calc)	$\frac{[(1+\delta^2)/t_\gamma\delta^2]}{t_{(M2,E2)}}$
671.42	641.42	$\frac{1}{2}^+$	$E2$		8 ps			110 ps	0.07
1.06 ps	635.89	$\frac{3}{2}^+$	$M1/E2$	0.34 ±0.005	1.26 ps	0.08 ps	18	140 ps	0.08
$\frac{5}{2}^+$	227.91	$\frac{3}{2}^+$	$M1/E2$		108 ps	1.7 ps		24 ns	
	208.09	$\frac{5}{2}^+$	$M1/E2$	~0	61 ps	2.7 ps	22	38 ns	
	146.08	$\frac{7}{2}^-$	$E1$		23 ns	0.09 ps	2.5 ± 10^5		
642.14	606.64	$\frac{3}{2}^+$	$E2$		451 ps			142 ps	3.2
(400 ps)	497.36	$\frac{11}{2}^-$	$M2$		630 ns			4.8 ns	131
$\frac{7}{2}^+$	321.03	$\frac{9}{2}^-$	$E1/M2$	0.016±0.008	5.5 ns	5.0 fs	10^6	96 ns	223
	198.65	$\frac{3}{2}^+$	$E2$		174 ns			38 ns	4.6
	178.78	$\frac{5}{2}^+$	$M1/E2$	~0?	84 ns	3.3 ps		81 ns	
	116.95	$\frac{7}{2}^-$	$E1$		9.1 ns	0.17 ps	5.3×10^4		
636.06	600.56	$\frac{3}{2}^+$	$E2$		40 ps			149 ps	0.27
40 ps	(491.28)	$\frac{11}{2}^-$	$M2$		<18 μs			5.1 ns	$>3.5\times10^3$
$\frac{7}{2}^+$	314.94	$\frac{9}{2}^-$	$E1$		171 ns	5.4 fs	32×10^6		
	172.61	$\frac{5}{2}^+$	$M1/E2$		4 ns	3.6 ps		99 ns	
	110.84	$\frac{7}{2}^-$	$E1$		800 ns	0.02 ps	4×10^6		
525.2^2	380.44	$\frac{11}{2}^-$	$E2$		120 ps			830 ps	0.15
(100 ps)	204.13	$\frac{9}{2}^-$	$M1/E2$		600 ps	1.7 ps		42 ns	
$\frac{7}{2}^-$									
463.39	463.38	$\frac{1}{2}^+$	$E2$		64 ps			700 ps	0.09
16 ps	427.89	$\frac{3}{2}^+$	$M1/E2$	0.54 ±0.02	21 ps	0.26 ps	104	1050 ps	0.19
$\frac{5}{2}^+$	19.9	$\frac{3}{2}^+$	$M1/E2$		64 ns	2.5 ns	26	4.8 ns	
442.50	443.50	$\frac{1}{2}^+$	$M1/E2$		30 ps	0.27 ps		887 ps	
19 ps	408.01	$\frac{3}{2}^+$	$M1/E2$		52 ps	0.35 ps		1320 ps	
$\frac{3}{2}^+$									

[a]References 15, 20, and 39.
[b]Reference 36.
[c]These are the Moszkowski estimates (see Ref. 16).

comparable and suggest nearly equal mixing between the $(s_{1/2}\otimes 2^+)_{5/2^+}$ and $(d_{3/2}\otimes 2^+)_{5/2^+}$ configurations. The mixing of the $\frac{3}{2}^+$ states is much less clear. The total Coulomb excitation to the two $\frac{5}{2}^+$ states is 0.31. As the excitation to the $\frac{3}{2}^+$ state would be expected to be less by $\frac{4}{6}$, we note that the Coulomb excitation to the 443.50-keV level accounts for much of the $(s_{1/2}\otimes 2^+)_{3/2^+}$ configuration. The 729-keV $\frac{3}{2}^+$ state is observed[12] with a much stronger spectroscopic factor in the (d,p) reaction, indicating considerably more single-particle character than the 443.50-keV level.

A common feature in the decay of the ^{125}Te levels is the hindrance of ~10^6 for the $E1$ transition. One exception is the strong $E1$ branch from the $g_{7/2}$ hole state at 642.14-keV level to the $\frac{7}{2}^-$ state at 525.22 keV. This branch may indicate some small single-particle $f_{7/2}$ component in the configuration of the 525.22-keV level. Such an admixture would account for the observable population of the 525.22-keV level in the (d,p) reaction and the (p,t) reaction of the 532-keV level in ^{123}Te.

Recently we have shown the orthogonality of hole states to particle-phonon states in the Sb nuclei.[34,35,40] Here in ^{125}Te, two $\frac{7}{2}^+$ levels exist within 6 keV of each other at ~650 keV. We suggest that the lower 636-keV level arises from particle-phonon coupling while the upper arises from a $g_{7/2}$-hole configuration. We base this on our identification of an $M2$ transition in the decay of $\frac{7}{2}^-$ 642-keV level to the 144-keV $\frac{11}{2}^-$ isomer. The hindrance of ~82 for this transition as shown in Table III is consistent with $M2$ hindrances in this mass region for $g_{7/2}\rightarrow h_{11/2}$ transitions. For example similar studies[31] for the higher-mass Sn isotopes have also revealed sizable hindrances for the $E2$ and $M2$ transitions from the $\frac{7}{2}^+$ hole state to the $d_{3/2}$ and $h_{11/2}$ states.[43] However, for the lower $\frac{7}{2}^+$ level we can only set a limit on any possible $M2$ transition intensity. Further, the known lifetime of this level and our branching ratios show enhanced $E2$ decay, characteristic of the deexcitation of particle-phonon levels. Our description of these two levels is supported by the work of Kerek *et al.*[26] Their in-beam γ-ray measurements have led them to identify a $\frac{15}{2}^+\rightarrow\frac{11}{2}^+\rightarrow\frac{7}{2}^+\rightarrow\frac{3}{2}^+$ yrast cascade. The $\frac{7}{2}^+$ level that is predominately populated in this phonon deexcitation cascade is the 636-keV level. The population of the two $\frac{7}{2}^+$ levels by β decay is hindered compared with that expected for an allowed $\frac{7}{2}^+\rightarrow\frac{7}{2}^+$ transition. However, this hindrance is consistent with the nature of the levels since β decay to particle-phonon levels is known to be hindered and pairing strongly reduces the $g_{7/2}$ particle to $g_{7/2}$ hole transition.

†Work performed under the auspices of the U. S. Energy Research & Development Administration, under contract No. W-7405-Eng-48.

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[43]*Nota bene*: When comparing our results and those of Fogelberg *et al.* (Ref. 31) care must be taken as they use Weisskopf single-particle estimates (without statistical factor). For $E1$, $E2$, and $M1$ transitions the differences are small; however, for $M2$ transitions the Moszkowski rate is 3.8 times greater; in addition the statistical factor is 25/11. Incorporation of these factors brings Fogelberg *et al.* (Ref. 31) $M2$ hindrances into line with the values deduced here and those of P. A. Baedecker, A. Pakkanen, and W. B. Walters, Nucl. Phys. A158, 607 (1970).