Levels of odd-mass Xe populated in the beta decay of ^{129}Cs, and ^{133}I†

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The decay schemes of ^{129}Cs and ^{133}I have been studied in order to extend the detailed level properties of odd-mass Xe. For ^{129}Cs, decay levels in ^{129}Xe are identified at (J^π values in parentheses) ground state ($\frac{1}{2}^+$), 39.57 ($\frac{3}{2}^+$), 236.14 ($\frac{11}{2}^-$), 318.18 ($\frac{3}{2}^+$), 321.70 ($\frac{5}{2}^+$), 411.49 ($\frac{1}{2}^+$), 572.67 ($\frac{5}{2}^+$), 588.55 ($\frac{3}{2}^+$), 624.32 ($\frac{7}{2}^+$), 904.31 ($\frac{1}{2}^+$), and 946.03 keV ($\frac{3}{2}^+$); for ^{133}I, decay levels in ^{133}Xe are identified at ground state ($\frac{3}{2}^+$), 233.22 ($\frac{11}{2}^-$), 262.70 ($\frac{1}{2}^+$), 529.87 ($\frac{5}{2}^+$), 680.24 ($\frac{3}{2}^+$), 743.75 ($\frac{9}{2}^-$, $\frac{7}{2}^-$), 875.32 ($\frac{7}{2}^+$), 911.46 ($\frac{3}{2}^+$), 1052.29 ($\frac{5}{2}^+$), 1236.44 ($\frac{7}{2}^+$), 1298.22 ($\frac{5}{2}^+$), 1350.32 ($\frac{5}{2}^+$), 1386.15 ($\frac{7}{2}^+$), and 1589.92 keV ($\frac{7}{2}^+$, $\frac{5}{2}^+$). Gas chromatography techniques were used to determine a branching ratio of $(2.88 \pm 0.02)\%$ of all ^{133}I decays populating the ^{133}Xe $\frac{11}{2}^-$ isomer. These levels and their properties are compared with other odd-mass Xe nuclei and their level properties.

[RADIOACTIVITY ^{129}Cs (mass separated) ^{133}I (chemically isolated from fission) measured $E\gamma$, $I\gamma$, γ-γ coin; deduced $\log ft$. ^{129}Xe and ^{133}Xe deduced levels, J, π.]

INTRODUCTION

Both the even- and odd-mass Xe nuclides are of considerable interest because a wide variety of theoretical models of the nucleus may be used to describe the observed levels. The light even-mass Xe nuclides exhibit characteristics[1,2] that have been fitted theoretically by a variable moment-of-inertia approach,[3] by a quasirotational approach,[4] by a vibrational approach, and more recently by an approach emphasizing small γ deformations.[5] Those nuclides near the $N = 82$ closed shell appear to be vibrational in character with two-particle states important above the proton pairing energy.[6-11] The energy levels, moments, and electromagnetic transition properties of lighter odd-mass nuclides have been calculated[3,9]; however, the heavier odd-mass Xe nuclei have not been fitted well by the quasiparticle-plus-phonon calculations[12] nor by intermediate coupling calculations.[9] More recently, cluster-model calculations have shown some success.[13,14]

The present study was undertaken to develop detailed level decay systematics of the odd-mass Xe nuclei. We have paid particular attention to the properties of the levels that would be expected to arise from the coupling of the odd neutron to the even-even core.

EXPERIMENTAL

A. ^{133}I sources

Radiochemically pure 20.8-h ^{133}I has been difficult to obtain because impurities of either 6.7-h ^{135}I or 8.0-day ^{131}I are obtained also in fission products. If the sample is studied soon after fission, interference from 6.7-h ^{135}I (and 52-min ^{134}I) predominates. If the 6.7-h ^{135}I is allowed to decay, then 8.0-day ^{131}I will interfere. In the most recent study of the decay scheme of 20.8-h ^{133}I by Saxena and Sharma,[15] considerable interference by ^{135}I and ^{131}I was present.

We prepared ^{133}I both by conventional chemistry and by automated fast chemistry. Samples generated using conventional chemistry were separated and mounted as Te metal. Counting was started 10 h later to allow the ^{133}Te to decay into ^{133}I. These samples contained large amounts of ^{134}I, as well as ^{131}I and ^{132}I, but were intense enough to allow γ-ray measurements using the LLL anti-Compton spectrometer.

Almost pure ^{133}I was prepared using an automated fast chemistry system.[14] The chemistry was performed 30 s after the end of irradiation and Sb was collected at the end of 1 min. This allowed 11-s ^{134}Sb to decay into ^{134}Te before the Sb fraction was collected and Te was discarded. Following a 2.5-min growth period Te was collected and Sb discarded. This allowed the 2.4-min ^{133}Sb to decay into ^{133}Te^m and minimized the contribution from 23-min ^{131}Sb. ^{132}Sb also decayed feeding 78-h ^{132}Te, but, because of its relatively long half-life, its specific activity was very low compared with the ^{133}Te^m. These samples were allowed to decay into almost pure ^{133}I.

A third group of samples was prepared using the same fast chemistry system plus an isomer milking technique. The ^{133}Te^m was oxidized to Te^{VI} and allowed to decay for 12 to 15 min. In the reaction $^{133}\mathrm{Te}^{m4+} \xrightarrow[e^-]{\text{I.T.}} {}^{133}\mathrm{Te}^{g4+}$, the conversion electrons reduce the ground chemical state to the 4+ oxidization state. It was then possible to extract the $^{133}Te^{g}$. Several milks were made, combined, and allowed to decay into ^{133}I. These sources, albeit having low specific activity, were pure ^{133}I.

B. Sources used to determine the total fractional population of $^{133}Xe^{m}$ from ^{133}I decay

We determined the fraction of ^{133}I that decays to $^{133}Xe^{m}$ by using our gas chromatography facility to periodically isolate the daughter xenon activities of iodine fission products. In this technique, a foil of fissionable material was irradiated at the Livermore pool-type reactor and then dissolved in a gas tight glass vessel. After dissolution, inactive carrier xenon gas was thoroughly mixed with the fission product solution. Once thoroughly mixed, the gases in solution were purged from solution with helium. Once purged of gas, the fission product vessel was sealed off from the system and new gaseous fission products were allowed to grow back into solution until time for a subsequent purge had arrived. Meanwhile, the purged gas that had been swept out of the fission product vessel was adsorbed onto a refrigerated charcoal column. The xenon was isolated from the gaseous fission product mixture by semiautomated Fontanilla elution-chromatography and transferred to a calibrated aluminum vial for γ-ray spectroscopy analysis. This process was repeated several times as soon as sufficient xenon had grown into solution.

The first xenon sample, which was isolated a few hours after irradiation, contained $^{133}Xe^{m}$ and $^{133}Xe^{g}$ that had both grown in from ^{133}I decay and had been produced from independent fission yield. Hence, only the second and subsequent collections were used for measurement of the $^{133}Xe^{m}$ to $^{133}Xe^{g}$ ratio. In addition, the second period of growth in these experiments started at least 12.5 h after irradiation; hence, ^{133}I was undergoing simple radioactive decay as the contribution of all precursors had become insignificant.

Five separate experiments were performed, in which nine individual milking samples were collected during periods ranging from 24 to 330 h after irradiation.

C. ^{129}Cs sources

The ^{129}Cs sources were made by two methods. In the first, the $^{130}Ba(n,2n)^{129}Ba \to ^{129}Cs$ reaction and decay sequence was used and no chemical separation was performed.

The second method was mass separation. In this set of experiments sources were produced by the $^{127}I(\alpha,2n)^{129}Cs$ reaction using NdI_3 as the target material at the LBL 223.5-cm cyclotron. The NdI_3 was dissolved in H_2O and Cs was separated from the Nd and I. The Cs separation was accomplished by extraction into an organic phase with tetraphenyl boron. The organic phase was back extracted, evaporated to dryness in an isotope separator source holder, and mass separated.

A computer-based $\gamma\gamma$ coincidence spectrometer was used to take Ge(Li) $\gamma\gamma$ coincidence spectra.

TABLE I. The γ rays observed in the decay of ^{133}I.

$E\gamma$ ($\Delta E\gamma$) (keV)	$I\gamma$ ($\Delta I\gamma$)[a] (rel.)	Assignment From	To
150.880 (59)	0.34 (7)	680	529
[176.970 (69)]	[0.9 (2)]	(1052	815)
233.221 (15)	I.T.	233	g.s.
245.950 (79)	0.4 (1)	1298	1052
262.702 (6)	4.13 (7)	262	g.s.
267.173 (19)	1.35 (6)	529	262
345.434 (45)	1.2 (2)	875	529
361.086 (52)	1.3 (4)	1236	875
372.050 (150)	0.11 (6)	1052	680
381.594 (65)	0.52 (5)	911	529
386.852 (50)	0.68 (5)	1298	911
418.047 (15)	1.77 (11)	680	262
422.910 (12)	3.58 (6)	1298	875
438.871 (84)	0.46 (5)	1350	911
510.530 (4)	21.0 (2)	743	233
529.872 (3)	1000 (4)	529	g.s.
537.726 (95)	0.41 (8)	1589	1052
556.173 (76)	0.23 (3)	1236	680
567.080 (380)	0.04 (3)		
617.974 (14)	6.25 (6)	1298	680
648.757 (59)	0.65 (15)	911	263
670.095 (83)	0.49 (6)	1350	680
678.650 (250)	0.25 (8)	1590	911
680.247 (11)	7.47 (9)	680	g.s.
706.578 (8)	17.3 (2)	1236	529
768.382 (15)	5.29 (9)	1298	529
789.594 (56)	0.58 (4)	1052	262
820.506 (22)	1.78 (5)	1350	529
856.278 (7)	14.3 (2)	1386	529
875.329 (5)	51.8 (2)	875	g.s.
909.674 (27)	2.46 (7)	1589	680
911.493 (53)	0.53 (7)	911	g.s.
1018.100 (500)	0.07 (3)	(1252	233)
1035.580 (250)	0.10 (2)	1298	263
1052.296 (18)	6.39 (7)	1052	g.s.
1060.071 (58)	1.59 (6)	1589	529
1087.710 (95)	0.14 (2)	1350	262
1236.411 (6)	17.3 (2)	1236	g.s.
1298.223 (5)	27.0 (2)	1298	g.s.
1350.378 (31)	1.72 (4)	1350	g.s.
1386.150 (97)	0.10 (3)	1386	g.s.
1589.940 (250)	0.034 (5)	1590	g.s.

[a] An error of 2% must be added in quadrature to account for the overall knowledge in the Ge(Li) detector efficiency curve.

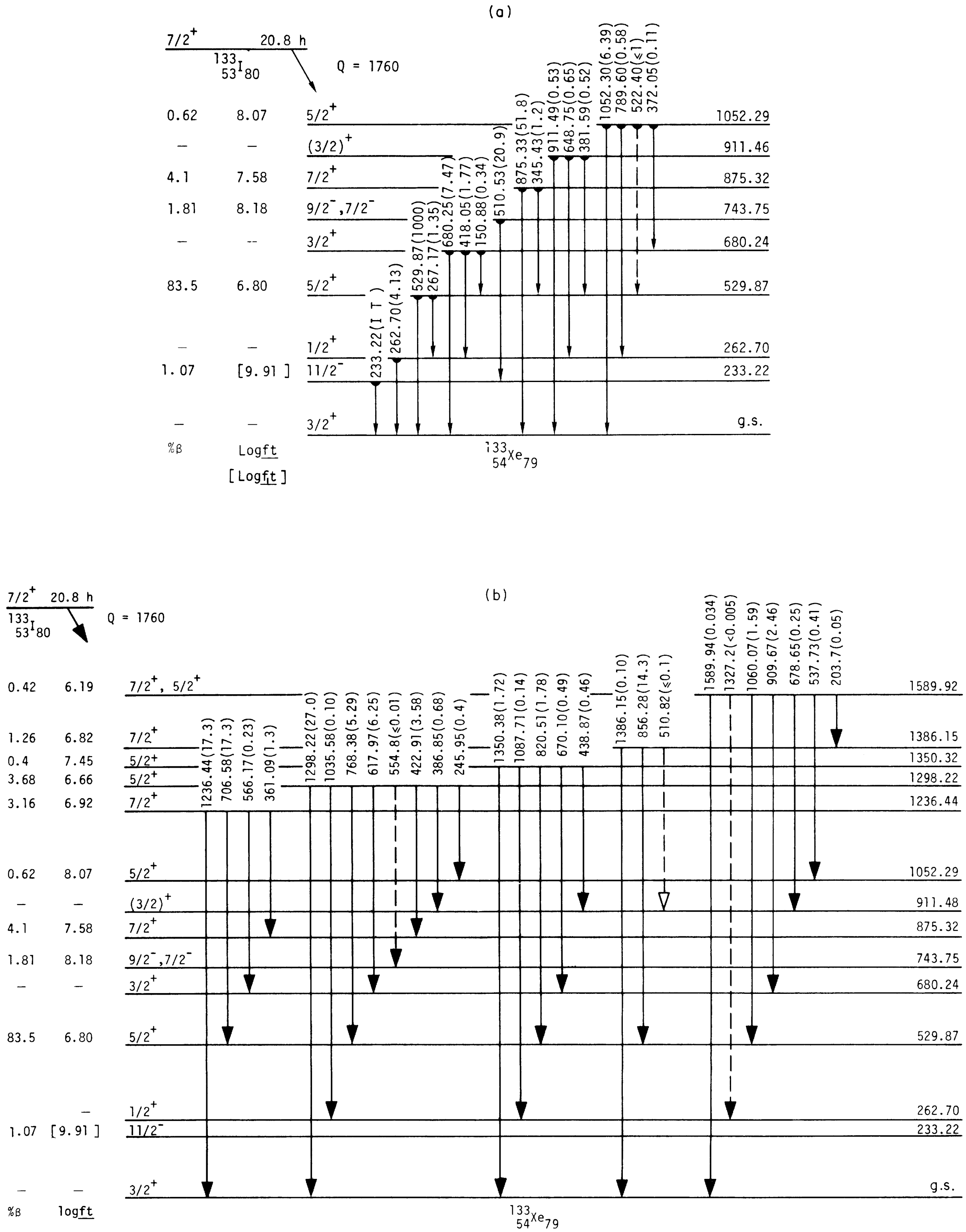

FIG. 1. Decay scheme for 20.8-h ^{133}I for (a) levels below 1100 keV and (b) levels above 1100 keV (n.b. photon intensities are given on the decay scheme. We use square brackets to distinguish $\log f_1 t$ values).

EXPERIMENTAL RESULTS AND DISCUSSION

A. Decay of ^{133}I to ^{133}Xe

In Table I we tabulate the γ rays assigned to ^{133}I decay and show intensity limits for several other γ rays whose presence either cannot be confirmed or would have an influence on spin and parity assignments. The decay scheme shown in Figs. 1(a) and 1(b) includes 24 γ rays observed by Saxena and Sharma.[15] However, the significant differences with the earlier decay scheme of Saxena and Sharma include the addition of 15 new transitions, a new level at 911.46 keV, the absence of levels at 1733 and 1404.8 keV, the failure to observe doublet character for the 875.3- and 510.2-keV γ rays, and the absence of a weak 608.0-keV γ ray feeding the 743.4-keV level.

With the observation of γ-ray branches to the $\frac{1}{2}^+$ level at 262.7 keV, a $\frac{5}{2}^+$ spin and parity can be assigned to levels at 1350.37, 1298.22, and 1052.29 keV. The newly observed ground state branch from the 1386.15-keV level limits the spin and parity to values less than or equal to $\frac{7}{2}^+$. The confirmed absence of β decay to the 680.24-keV level suggests a $\frac{3}{2}^+$ assignment. The weak, or possibly absent, β branch to the new 911.46-keV level also suggests a $\frac{3}{2}^+$ spin.

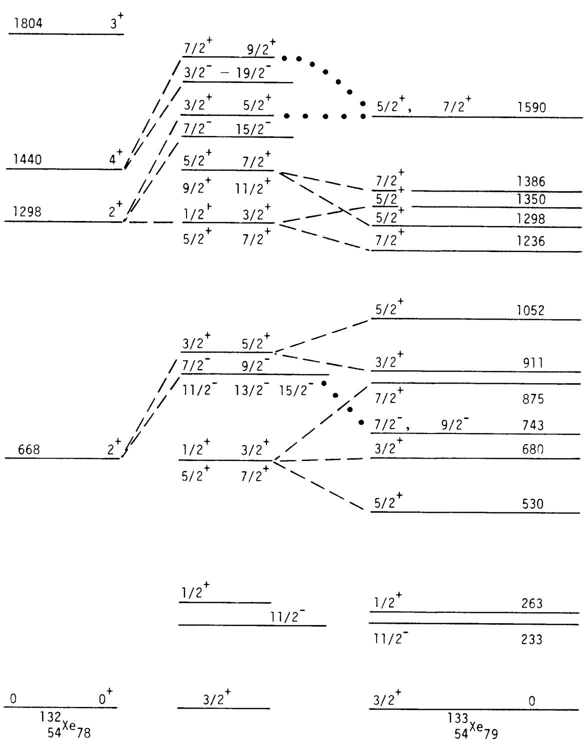

FIG. 2. Levels of ^{133}Xe that arise from a zero-order coupling of the known single-particle states of ^{133}Xe to the known ^{132}Xe core excitations.

The spin of the negative parity level at 743.75 keV remains uncertain. The sizeable β branch eliminates the $\frac{11}{2}^-$ possibility but does not distinguish between $\frac{9}{2}^-$ and $\frac{7}{2}^-$. Because no $E1$ transitions were observed from known $\frac{5}{2}^+$ states, a slight preference for $\frac{9}{2}^-$ exists, although no $E1$ transitions were observed from the known $\frac{7}{2}^+$ states either.

The results of the recent orientation studies of Koene, Ligthart, and Postma[7] are in accord with our measurements and leave uncertainties in the spin and parity assignments only for the 743.41-keV negative parity level, the new 911.96-keV possible $\frac{3}{2}^+$ level, and the $\frac{5}{2}^+$ or $\frac{7}{2}^+$ level at 1589.92 keV.

Figure 2 shows the levels of ^{133}Xe plotted with the levels predicted by assuming the basic structure of ^{133}Xe to be that of a neutron in the $h_{11/2}$, $d_{3/2}$, or $s_{1/2}$ orbitals coupled to the ^{132}Xe core.[11] With a parent spin and parity of $\frac{7}{2}^+$, strong β decay should be observed to the $\frac{5}{2}^+$, $\frac{7}{2}^+$, and $\frac{9}{2}^+$ levels with weaker decay to the $\frac{5}{2}^-$, $\frac{7}{2}^-$, and $\frac{9}{2}^-$ levels. All of the $\frac{5}{2}^+$ and $\frac{7}{2}^+$ levels predicted below 1700 keV are observed, except one $\frac{5}{2}^+$ or $\frac{7}{2}^+$ level near 1700 keV. Only one $\frac{9}{2}^+$ level is predicted below 1700 keV, and it is surprising that we did not observe it. Earlier work had indicated a level at 1405 keV that decayed only to the 530-keV level by an 875-keV γ ray. We do not show such a level because we observed no evidence for doublet character for the 875-keV peak. Furthermore, careful examination of the coincidence spectrum presented by Saxena and Sharma indicates that the presence of the 875-keV γ ray in the 530-keV gate may be accounted for by random coincidences. Based on the size of the 364- and 529-keV peaks, and the approximately 5 to 100 ratio of relative intensities for the 875- and 530-keV peaks, a random peak height of between 6 and 8 counts could be expected for the 875-keV peak, a value close to the observed value. We also observed indirect population to the two lowest-lying $\frac{3}{2}^+$ levels.

The $\frac{5}{2}^+$ level at 1052 keV is seen to have a relatively much stronger $E2$ branch to the $\frac{1}{2}^+$ state than the $\frac{5}{2}^+$ level at 530 keV. We also note that the $\frac{7}{2}^+$ level at 1386 keV, whose suggested configuration is $|\frac{3}{2}2\,4\rangle$, has a relatively weaker branch to the ground state than does the $\frac{7}{2}^+$ 1236-keV level with a proposed $|\frac{3}{2}1\,2\rangle$ configuration. The $\frac{5}{2}^+$ level at 1298 keV shows high δ values for its stronger transitions and strong feeding to the $\frac{3}{2}^+$, $\frac{5}{2}^+$, and $\frac{7}{2}^+$ members of the $|\frac{3}{2}1\,2\rangle$ multiplet. The other $\frac{5}{2}^+$ level at 1350 keV has relatively stronger branches to the $\frac{3}{2}^+$ and $\frac{1}{2}^+$ single-particle levels. These suggest that the 1298-keV level has a sizable $|\frac{3}{2}2\,4\rangle$ component and the 1350-keV level a sizable $|\frac{3}{2}2\,2\rangle$

component.

We conclude by noting that both qualitative and quantitative reasons exist to suggest that the levels of ^{133}Xe can be interpreted largely as a single neutron coupled to the ^{132}Xe core. Small components in the wave functions may represent a three-hole cluster in the shell at $N=82$, especially for the $\frac{3}{2}^+$ states, as suggested by Paar and Koene.[13]

B. Population of ^{133}Xe^m from the decay of ^{133}I

The unweighted average of our gaseous milking and counting experiments gives a value of (2.883 ± 0.023)% of all ^{133}I decays populating the ^{133}Xe isomeric level. This was arrived at by analyses of our counting data using a computer code based on the Bateman equations for radioactive decay along a chain. As necessary input parameters to this code, we used the following half-life values: ^{133}I, 20.8 h; ^{133}Xe^m, 2.191 days; and ^{133}Xe, 5.243 days.

C. Decay of ^{129}Cs to ^{129}Xe

The γ-ray energies and intensities for the decay of ^{129}Cs are given in Table II. A portion of the ^{129}Cs spectra is shown in Fig. 3, and the decay scheme is given in Fig. 4. The γ rays placed by $\gamma\gamma$ coincidence spectra are also shown in Fig. 4. Our work confirms the results of Graffee and Walters, who performed the last detailed study of ^{129}Cs. We place several additional γ rays, not observed by Graffee and Walters,[16] in the level scheme. Other decay scheme investigations,[17,18] which are of poorer quality, have been presented since. For example, five other possible γ rays suggested by Gfoller and Flammersfeld[19] and Begzhanov *et al.*[20] are not observed in the decay of ^{129}Cs but can be assigned to the decay of ^{129}Ba. For the J^π assignments we have used the recent results of Marest *et al.*[21] and the works cited in the compilation by Horen.[22]

We propose a new level at 572.67 keV based on our observation of two γ rays, one at 572.7 keV, and the other at 533.096 keV, which forms a resolved doublet with the 534.546-keV γ ray. The γ-ray branching and the lack of electron capture feeding suggest a $\frac{5}{2}^+$ assignment for this level. A level at 624 keV has been assigned a J^π value of $\frac{7}{2}^+$ by Rezanka *et al.*[23] in their $(\alpha, 3n\gamma)$ studies. They observe a branching ratio of 2 to 1 for depopulation to the 39- and 321-keV levels. We can identify a possible 585-keV component to the multiplet at 580 to 590 keV and also set a consistent limit on a 302.6-keV γ ray. We suggest that this level is fed by cascade from a higher-lying level. The 321.70-keV γ ray we observe could have a small contribution from a 946- to 624-keV transition.

TABLE II. The γ rays observed in the decay of ^{129}Cs.

$E\gamma$ ($\Delta E\gamma$) (keV)		$I\gamma$ ($\Delta I\gamma$) [a] (rel.)		Assignment From	To
29.485 29.802		2740	(100)	$K\alpha_1$ +	$K\alpha_2$
33.644		505	(15)	$K\beta_2$	
34.446		125	(4)	$K\beta_1$	
39.581	(15)	97	(3)	39	g.s.
89.790	(75)	0.08	(2)	411	321
93.329	(3)	21.3	(6)	411	318
177.036	(10)	8.8	(1)	588	411
266.820	(7)	8.9	(1)	588	321
270.352	(5)	6.95	(8)	588	318
278.614	(4)	43.2	(9)	318	39
282.131	(6)	7.9	(1)	321	39
[302.600	(–)]	(≤0.01)		624	321
318.180	(2)	80	(1)	318	g.s.
321.700	(25)	2.3	(2)	321	g.s.
357.518	(62)	0.19	(3)	946	588
371.918	(2)	1000	(3)	411	39
373.360	(150)	0.4	(4)	946	572
411.490	(2)	729	(3)	411	g.s.
492.781	(36)	0.37	(3)	904	411
510.975	(85)	0.185	(25)	β^+	
533.096	(35)	0.31	(2)	572	39
534.546	(15)	0.69	(3)	946	411
548.945	(8)	111	(1)	588	39
572.730	(110)	0.050	(12)	572	g.s.
582.600	(110)	0.03	(2)	904	321
[585.000	(200)]	[0.015	(9)]	624	39
586.111	(42)	0.42	(4)	904	318
588.549	(8)	19.7	(4)	588	g.s.
624.312	(9)	0.92	(2)	946	321
627.884	(85)	0.056	(12)	946	318
846.740	(8)	1.05	(3)	904	39
904.306	(55)	0.27	(2)	904	g.s.
906.425	(6)	7.19	(5)	946	39
946.046	(6)	2.27	(2)	946	g.s.

[a] See footnote a in Table I.

The ^{129}Cs level scheme is normalized using the K x-ray intensity, $\omega_K = 0.88$, and correcting for contributions for x rays resulting from internal conversion. A value of $Q_\epsilon = 1205 \pm 20$ keV is determined for ^{129}Cs decay using the intensity of the annihilation radiation and the electron capture intensity to the ^{129}Xe ground state determined during normalization.

Our more detailed decay scheme allows comparison of the levels of ^{129}Xe and their properties to the predictions of a weak coupling model. This model predicts six levels at the first phonon. The γ-ray branching from the 411- and 624-keV levels is consistent with these configurations. The $E2$ from the 411-keV level to the 321-keV level is hindered by a factor of 10 over that to the 39-keV

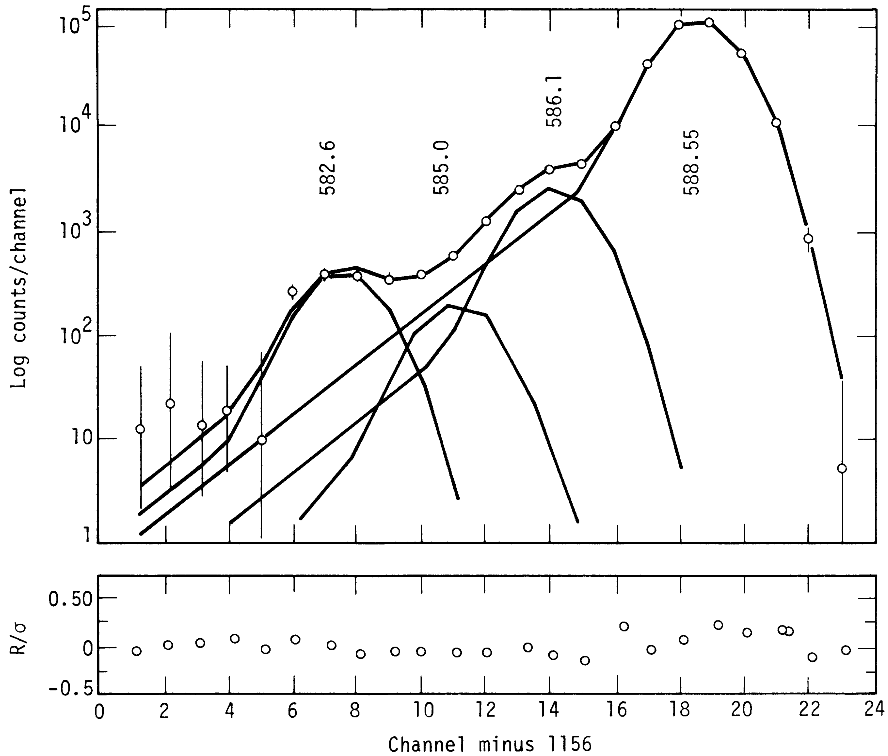

FIG. 3. GAMMANL multiplet analysis of the 580-keV quartet in the spectra of mass separated ^{129}Cs.

level.[33] The $M1$ transitions between the first phonon coupled levels are not allowed in a strict sense. However, they can proceed through a phonon-to-phonon transition if the $|\frac{1}{2}1\,2\rangle$ and $|\frac{3}{2}1\,2\rangle$ configurations have the proper phases so that the $M1$ matrix elements do not cancel.[24,25] Thus, the 93-keV transition from the 411-keV level to the 318-keV level presumably proceeds through a $|\frac{3}{2}1\,2\rangle \rightarrow |\frac{1}{2}1\,2\rangle$ transition while the 177-keV transition from the 588-keV level to the 411-keV level occurs through a $|\frac{1}{2}1\,2\rangle \rightarrow |\frac{3}{2}1\,2\rangle$ transition.

The 904- and 946-keV levels occur at an energy of excitation at which the $|j2\,2\rangle$ configurations are expected. However, both levels exhibit approximately equal transition probabilities to the $|j0\,0\rangle$ and $|j1\,2\rangle$ levels.

D. Levels of ^{131}Xe and ^{135}Xe populated in the decay of ^{131}I and ^{135}I

For purposes of comparison with the level properties of ^{129}Xe and ^{133}Xe, we present the decay scheme of ^{131}I in Fig. 5 and the partial decay scheme of ^{135}I in Fig. 6. The experimental details for ^{131}I have been presented elsewhere,[26] as have those of the ^{135}I decay.[27]

The decay of ^{131}I populates the levels with higher J^{π} values and allows comparison of their properties with the weak coupling model. The $\frac{7}{2}^+$ level at 637 keV has an $E2$ branching both to the ground state $\frac{3}{2}^+$ with $|\frac{3}{2}0\,0\rangle$ and to the $\frac{3}{2}^+$ level at 404 keV. Here the $E2$ to the ground state is enhanced by a factor of 33 over the transition to the 404-keV level, which presumably proceeds through a $|\frac{3}{2}1\,2\rangle \rightarrow |\frac{3}{2}0\,0\rangle$ transition. Both second phonon $\frac{5}{2}^+$ levels are observed in the decay of ^{131}I. In these, as in the ^{133}Xe case, the transition from the upper $\frac{5}{2}^+$ level to the lower $\frac{5}{2}^+$ level is greatly hindered. Such a transition could occur through cancellation of the $M1$ transition matrix elements.

The levels of ^{135}Xe are restricted to a hole in the 82-neutron shell. The levels and their properties are discussed elsewhere[27,28] and compared to the calculations of Heyde and Brussard.[28,29] However, the decay properties of the $\frac{5}{2}^+$ level at 1457 keV in ^{135}Xe should be compared to those of the other odd-mass Xe.

The change in configuration allows the $\frac{5}{2}^+_2 \rightarrow \frac{5}{2}^+_1$ decay to proceed readily. For example, if we assume a little $E2$ in the 197- or 1457-keV transition, then the $\frac{5}{2}^+_2 \rightarrow \frac{5}{2}^+_1$ transition has equal probability to the $\frac{5}{2}^+_2 \rightarrow \frac{3}{2}^+$ ground state transition.

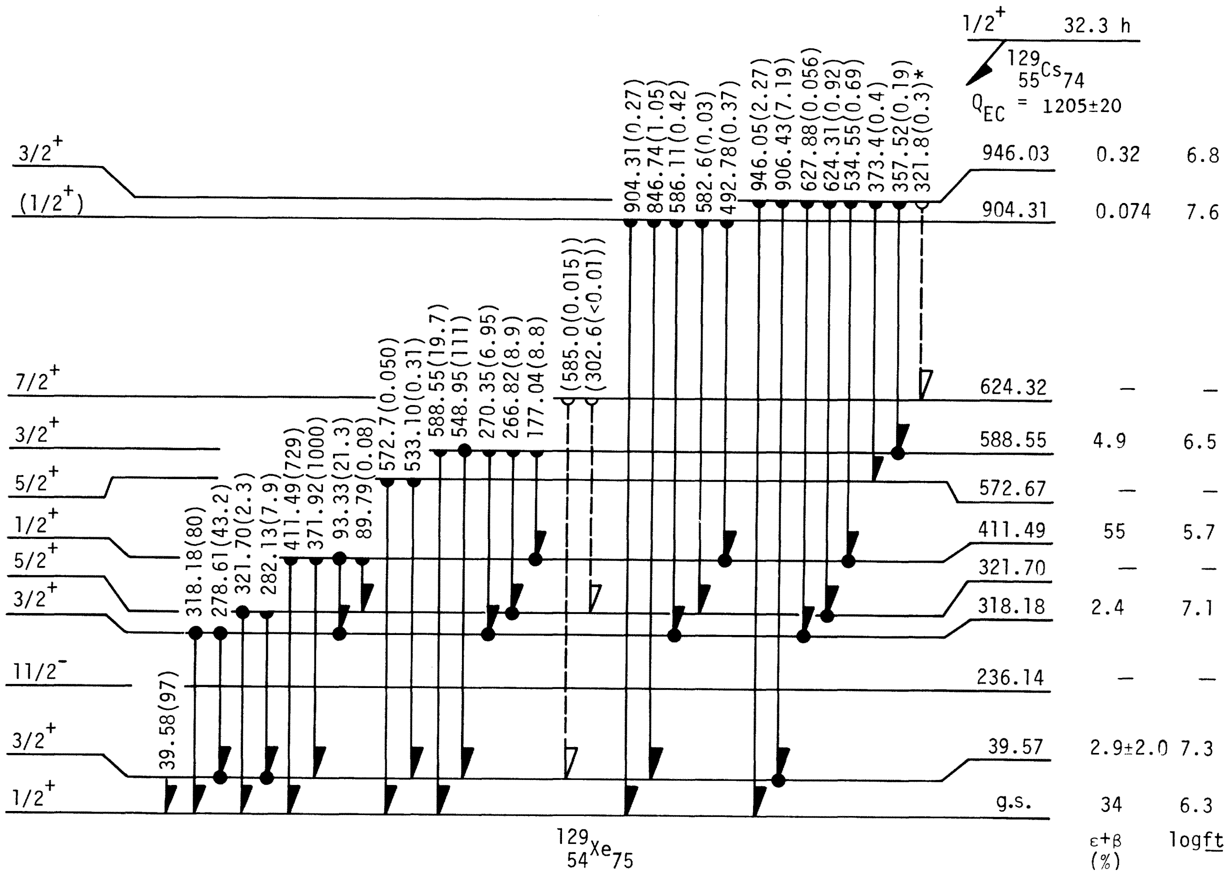

FIG. 4. Decay scheme for ^{129}Cs. A full circle at the bottom of the arrow indicates placement of a γ ray by $\gamma\gamma$ coincidence. A full circle at the top of the arrow indicates that a coincidence gate was set on this γ ray. A half circle indicates placement by the Reitz principle. The position of the $\frac{11}{2}^-$ isomer is included for completeness (n.b. photon intensities are given on the decay scheme).

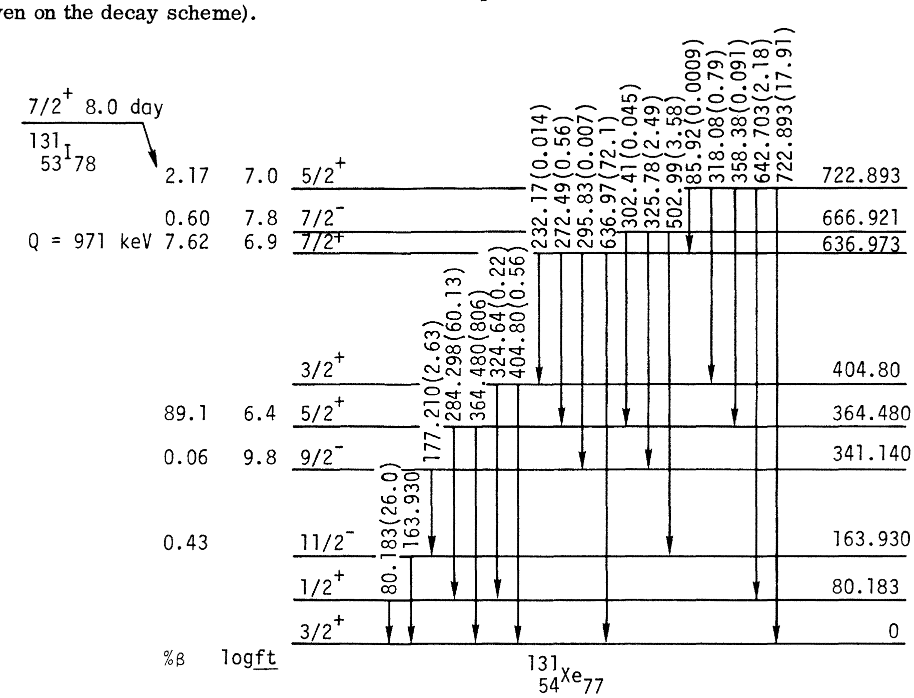

FIG. 5. Decay scheme of 8-day ^{131}I (see Ref. 26 for experimental details).

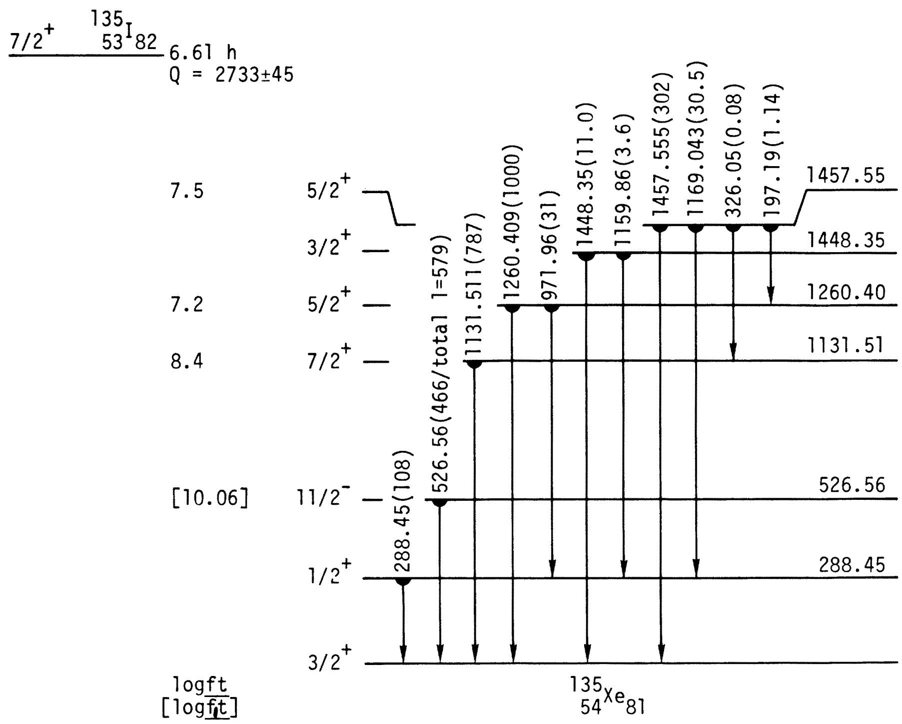

FIG. 6. Partial decay scheme of ^{135}I showing level properties of the first six levels in ^{135}Xe.

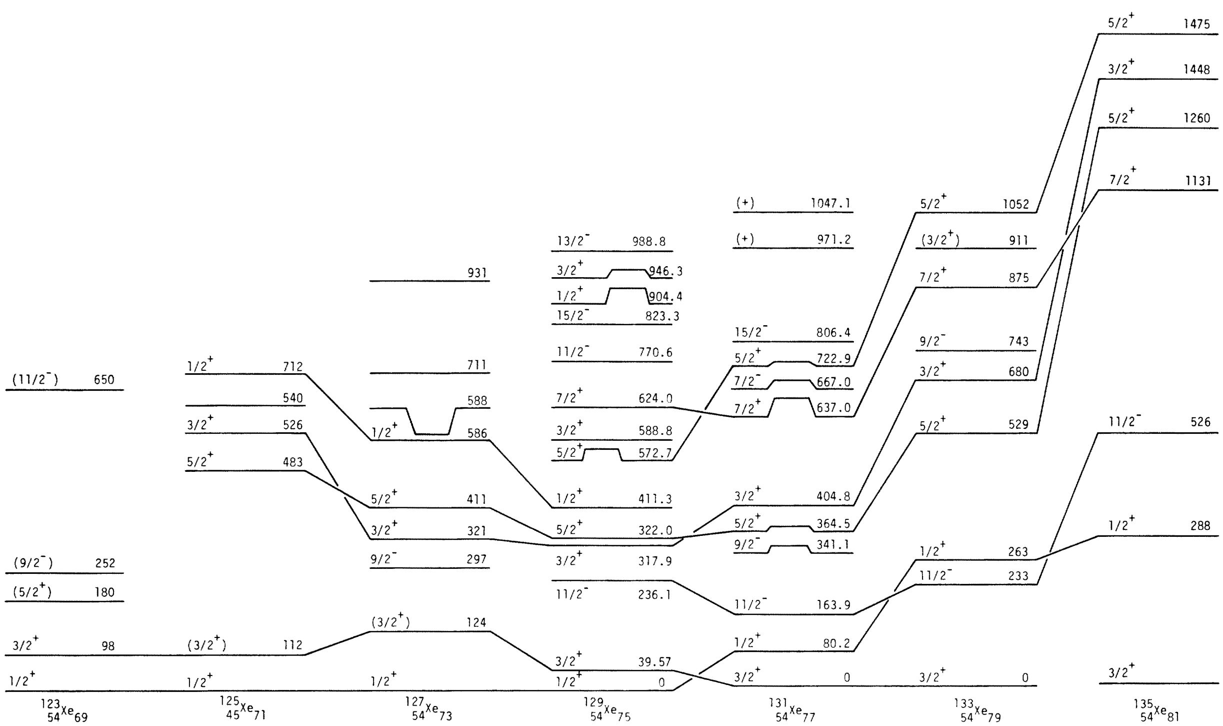

FIG. 7. Systematics of odd-mass xenon nuclei. Data for ^{123}Xe and ^{125}Xe are taken from the literature (Refs. 18 and 34).

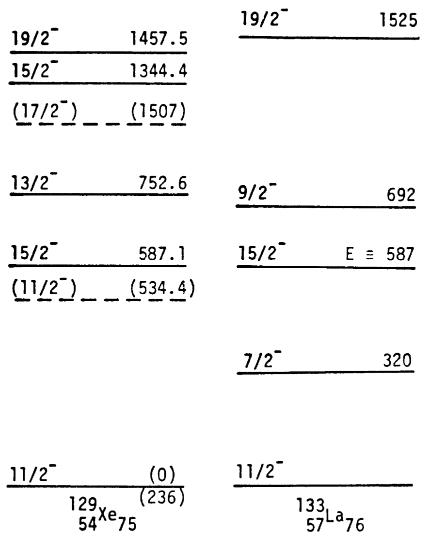

FIG. 8. Negative parity levels in ^{129}Xe and neighboring nuclei. (*Nota bene:* Level energies of ^{135}La have been adjusted so that the $\frac{15}{2}^-$ level has the same energy as the ^{129}Xe $\frac{15}{2}^-$ level.)

E. General systematics of the odd mass Xe nuclei

Inspection of Fig. 7 shows that our studies of ^{129}Xe and ^{133}Xe now provide a fairly complete picture of the odd-mass xenon from closed shell down to mass 129. However, the figure also serves to illustrate the paucity of detailed information on the lighter Xe nuclei. The detailed systematic data on these nuclei are needed before a thorough test can be made of predictions of the weak coupling model.[9,19] The limited systematic data we have developed do show that the properties of the positive parity levels are described very well by a weak coupling model.[9,19] However, the detailed decay properties of the levels suggest some deviation for the heavier nuclei.[29] The two levels with J^π value of $\frac{5}{2}^+$ observed in the Xe nuclei are consistent with a linear combination of particle-core configuration: $a\left|\frac{3}{2}1\,2\right\rangle + b\left|\frac{1}{2}1\,2\right\rangle$ for dominant configuration. The two exceptions we have discussed are the ^{135}Xe and ^{133}Xe levels where the ^{135}Xe must be described as a hole coupled to the ^{136}Xe core, and ^{133}Xe may have three-particle contributions, although the latter is doubtful.

F. Odd parity levels in the N=75 nuclei

Although the even parity levels of the $N=75$ nuclei vary systematically as proton pairs are added to the core beyond the $Z=50$ shell closure, the odd parity levels have no apparent systematic behavior. In the ^{127}Te nucleus, which has a good vibrational core, the low-lying levels have been described by coupling of the $h_{11/2}$ orbital to the vibrational core and, for the 341-keV $\frac{9}{2}^-$ level, by three-particle effects.[29] For ^{133}Ce an apparent quasirotational band has been postulated to account for the negative parity levels observed. More detailed data on ^{129}Xe and ^{131}Ba levels would be most useful in testing concepts based on the influence of Coriolis force on their somewhat deformable even-even cores. In particular, as shown in Fig. 8, several high spin states have been identified in ^{129}Xe by ^{128}Te$(\alpha, 3n\gamma)$ reaction studies.[23] These levels when compared to recent results on ^{133}La, shown on the right of Fig. 8 suggest that the triaxial-rotor-plus-particle model[29-32] (TRP) may more properly describe the negative parity levels than the simple phonon coupling model.[29-32]

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