Gamma rays from thermal neutron capture in ^{136}Xe†

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The γ-ray spectrum following thermal neutron capture in ^{136}Xe has been studied with a Compton-suppression spectrometer. The Q value for the reaction has been measured as $Q(n,\gamma) = 4025.5 \pm 0.3$ keV. Levels populated by primary transitions from the capture state correlate well with those populated by $l = 1$ transfers in the (d,p) and (p,p_0) reactions. The data indicate a strong correlation between reduced transition probabilities for the primary transitions and spectroscopic factors for final levels.

[NUCLEAR REACTIONS ^{136}Xe$(n_{th},\gamma)^{137}$Xe; measured E_γ, I_γ; Ge(Li) Compton suppression spectrometer; deduced Q; ^{137}Xe deduced levels, J,π.]

I. INTRODUCTION

The nucleus ^{137}Xe is populated by decay of the delayed-neutron precursor ^{137}I and is one of the few nuclides for which essentially all experimental data required for a detailed study of delayed-neutron emission can be obtained. At present, high-resolution neutron spectra have been measured,[1,2] and some information has been obtained on the most intense γ-ray transitions from ^{137}I decay.[3] Of interest in these studies is the role played by γ-ray emission in modifying the neutron spectrum as a result of the high l values required for neutron emission. Based on the adopted value of 3862 ± 20 keV (Ref. 4) for the neutron binding energy (B_n) in ^{137}Xe, Nuh *et al.*[3] reported the observation of γ-ray emission from neutron unbound levels near 3.9 MeV in this nuclide. However, as pointed out by Tovedal and Fogelberg,[5] this conclusion is in doubt because of the large discrepancy between the two experimentally derived values of B_n. The adopted value is based on the study of the ^{136}Xe(d,p) reaction by Moore *et al.*[6] and is to be compared with the value 4045 ± 60 keV obtained from the earlier study of the same reaction by Schneid and Rosner.[7] Because of this discrepancy and its importance to the delayed neutron emission problem, we were led to study the capture γ-ray spectrum of ^{136}Xe, expecting this experiment to yield a more accurate value of B_n.

Measurements of γ rays from neutron capture in ^{136}Xe have not been reported previously. In addition to the (d,p) studies referred to above, the level structure of ^{137}Xe has also been studied via isobaric analog resonances in proton elastic scattering on ^{136}Xe.[8] In conjunction with the (d,p) data, the results from the proton resonance studies have located levels below 3.0 MeV in ^{137}Xe that possess the principal part of the f and p single-particle neutron strength. Those levels arising from $p_{1/2}$ and $p_{3/2}$ neutron excitations can be expected to be populated by $E1$ decay of the $\frac{1}{2}^+$ capture state in ^{137}Xe.

II. EXPERIMENTAL PROCEDURE

γ rays from the reaction ^{136}Xe(n,γ) were studied with the capture γ-ray facility at the Livermore pool-type reactor.[9] This facility provides a thermal neutron flux at the target position of about 10^7 n cm^{-2} sec^{-1} and reaction γ rays can be viewed simultaneously with a three-crystal pair spectrometer and a Compton-suppression spectrometer. A sample containing about 6.1 g of enriched[10] ^{136}Xe (99%) was maintained at the target position as the solid in an aluminum cryostat constructed specifically for this purpose.[11] With this device, the spectrometers viewed the equivalent of 1.84 g of aluminum, 0.15 g of nitrogen, and 0.003 g of manganese from the cryostat materials in addition to the solid xenon target. Based on a cross section of $\sigma_\gamma = 0.16 \pm 0.03$ b,[12] we calculated ^{136}Xe to be the cause for approximately 50% of the captures within the solid angles subtended by the detectors.

We identified the γ rays from capture in the xenon by comparing spectra taken with the cryostat filled and with it emptied. Because the maximum capture γ-ray energy from ^{136}Xe was expected to be about 3.3 MeV, spectra were taken only with the Compton-suppression spectrometer. Data in the energy range 0.1 to 4.8 MeV were accumulated for a total of 60 h for the filled cryostat and 15 h for the empty cryostat. All data were taken with an 8192-channel pulse-height analyzer. Digital gain stabilization was employed throughout.

III. DATA ANALYSIS AND RESULTS

In Fig. 1 we show γ-ray spectra comparing the data from the filled and emptied cryostat. Notwithstanding the intense lines from capture in ^{27}Al

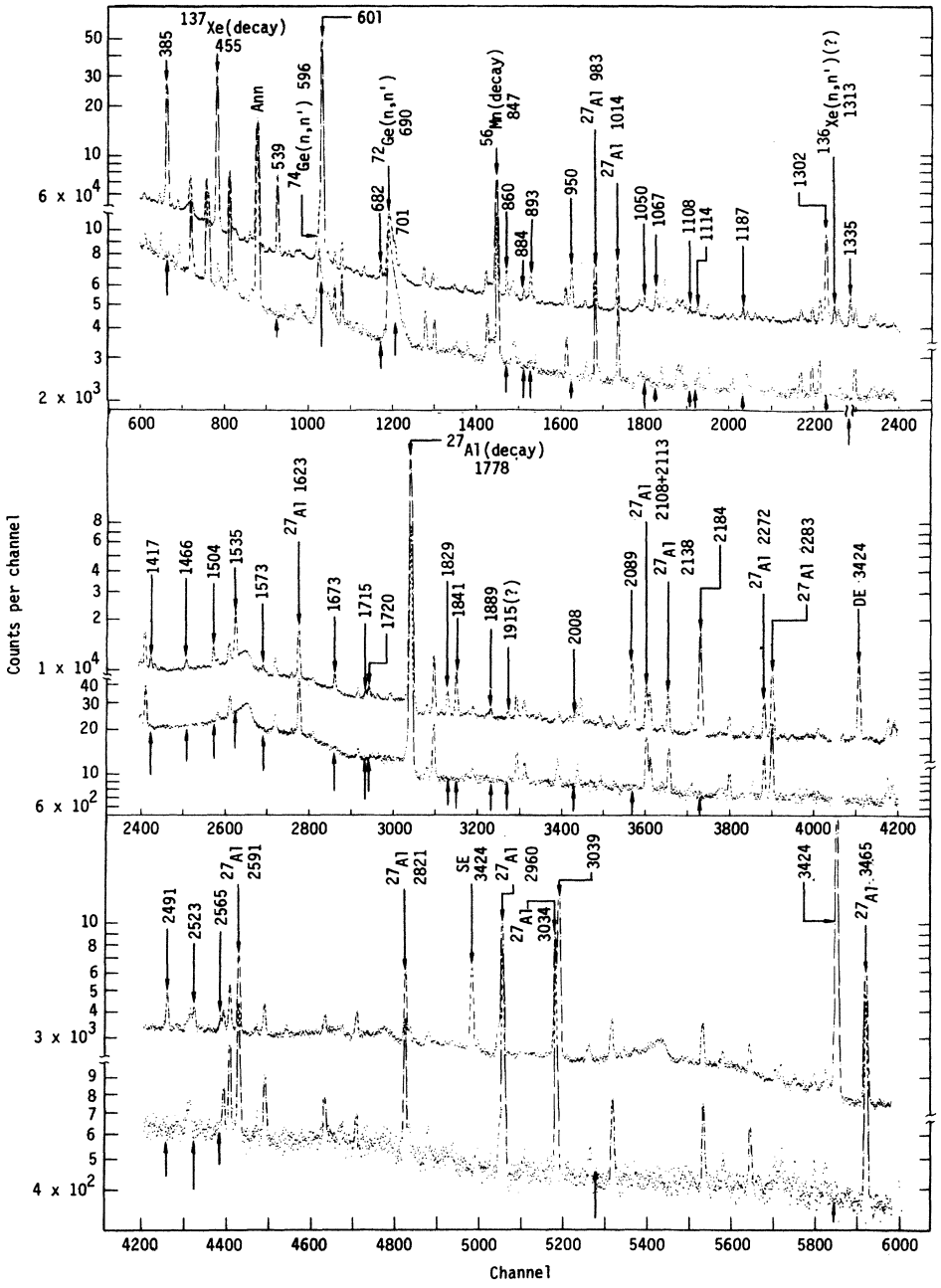

FIG. 1. γ-ray spectra from the filled (top) and emptied (bottom) cryostat. An arrow in the background spectrum indicates where the ^{136}Xe capture line identified in the upper spectrum would be located. Lines thought to be due to ^{136}Xe capture are identified only by energy. Lines otherwise unidentified are due to unknown contaminants in the cryostat and surrounding material.

and ^{55}Mn, and from decay of ^{28}Al and ^{56}Mn, the transitions from capture in the xenon are easily discernible. The energies and intensities of all lines were obtained by analysis of the spectral data with the computer code GAMANAL.[13] To obtain a reasonably precise energy calibration, a 16-h capture spectrum was accumulated simultaneously with a ^{56}Co standard. These data provided accurate energies for a number of the more intense lines in the xenon spectrum. The calibration was extended over the energy range studied by combining these measurements with a nonlinearity distribution obtained from a spectrum of mixed standards taken with the same electronic settings. The

TABLE I. Energies and relative intensities of γ rays from thermal neutron capture in ^{136}Xe.

E_γ (keV)[a]	I_γ (relative)	E_γ (keV)[b]	Placement
268.35±0.15	2.1 ±0.2		1936-1668
385.16±0.10	30 ±3		986-601
538.93±0.10	9.9 ±1.0		1841-1302
601.01±0.11	100 ±10	600.5±0.1	601-0
681.97±0.15	0.97±0.11		1668-986
701.23±0.25	2.3 ±0.2	701.5±0.3	1302-601
860.27±0.14	1.3 ±0.5		1461-601
884.17±0.18	0.87±0.12[c]		
893.23±0.15	2.3 ±0.2		2609-1715 2196-1302
950.18±0.13	3.5 ±0.4		1936-986
1050.51±0.20	1.4 ±0.3		
1067.14±0.14	1.9 ±0.2		1668-601
1108.06±0.38	0.59±0.18		
1114.35±0.27	0.27±0.06		1715-601
1187.55±0.19	1.1 ±0.2		2490-1302
1302.67±0.11	12 ±1	1302.8±0.2	1302-0
1335.49±0.14	2.5 ±0.3		1936-601
1416.91±0.17	1.0 ±0.1		Capture-2609
1466.23±0.20	0.90±0.13		2452-986
1504.30±0.15	1.9 ±0.2		2490-986
1535.09±0.12	6.7 ±0.7		Capture-2490
1573.12±0.27	0.43±0.10		Capture-2452
1673.00±0.17	~0.8[d]		
1715.57±0.26	0.59±0.12	1716.5±0.3	1715-0
1720.54±0.20	0.92±0.15		
1829.44±0.15	1.5 ±0.2		Capture-2196
1841.49±0.13	3.0 ±0.3		1841-0
1889.21±0.25	0.48±0.08		2490-601
1915.42±0.31	0.40±0.09		
2007.80±0.44	0.24±0.06		2609-601
2088.93±0.12	5.3 ±0.5		Capture-1936
2183.88±0.10	12 ±1		Capture-1841
2490.48±0.16	1.6 ±0.2		2490-0
2522.88±0.32	0.56±0.09		
2564.64±0.34	0.44±0.09		Capture-1461
3039.37±0.11	15 ±2		Capture-986
3424.55±0.11	46±5		Capture-601

[a]The data have not been corrected for nuclear recoil. The errors quoted represent statistical fitting errors plus our estimate of the systematic error defining the nonlinearity distribution of the analyzer system.

[b]γ-ray energies from the ^{137}I β^- decay (Ref. 3).

[c]Assignment to ^{136}Xe(n,γ) is uncertain. This energy closely corresponds to the 884.09-keV $4_1^+ \rightarrow 2^+$ transition on ^{134}Xe. Other transitions due to the ^{134}Xe(n,n') reaction were not observed and would have been masked by background from the cryostat.

[d]Intensity corrected for contribution from the 2183.9-keV single escape peak.

energies of the transitions from the standard sources were taken from the compilations in Refs. 14–17.

Once the analysis had been performed, the spectra from the filled and emptied cryostat were compared (Fig. 1) and all lines present in the former but not in the latter were tentatively assigned to the capture spectrum of ^{136}Xe. A search was then made for transitions due to capture in other xenon isotopes and to inelastic neutron scattering from the small, high-energy component in the neutron beam. The transition at 1313.1 keV with an intensity of 1.26 compared with that at 601.0-keV (taken as 100) agrees well[18] with the energy of the first excited (2^+) level in ^{136}Xe. We have therefore assumed that this transition results from the reaction ^{136}Xe(n,n'). No definite evidence could be found for lines from ^{134}Xe(n,n') or from inelastic scattering on the lighter xenon isotopes. The transitions at 847.0, 1613.8, and 766.7 keV that arise in the decay of the first and second 2^+ levels in ^{134}Xe, lie close to lines from capture in the cryostat material and could not be resolved.[19] The weak transition at 884.17±0.18 keV agrees well with the energy of 884.09 keV for the $4_1^+ \rightarrow 2_1^+$ transition in ^{134}Xe. The source of this transition is considered unknown. A search for transitions from decay of low-lying levels in ^{135}Xe gave no evidence for transitions from the reaction ^{134}Xe(n,γ). (Assuming that the xenon contained 1% of ^{134}Xe, about 1.6% of all captures in the target should result from this isotope.) Thus all of the remaining lines were assigned to the capture spectrum of ^{136}Xe, and the energies and relative intensities of these are given in Table I.

For comparison, we have included in Table I the energies of corresponding lines seen in the β decay of ^{137}I.[3] While the energy agreement for the transitions at 701.2 and 1302.7 keV is good, the disagreement for the transitions at 601.0 and 1715.6 keV is substantial. As discussed in Sec. IV, our data define a level at 1302.5 keV that decays by a ground state transition and by the transition at 701.2 keV to the first excited state at 601.0 keV. The sum $(601.01\pm0.11)+(701.23\pm0.25)=1302.24\pm0.27$ is in fair agreement with the energy of 1302.67±0.11 keV for the ground state transition. The sum of the transition energies reported in Ref. 3 differs by about two standard deviations from the energy quoted for the ground state transition. We conclude that a systematic error may be present in these data.

IV. DECAY OF THE CAPTURE STATE AND THE REACTION Q VALUE

In the absence of precise energies of low-lying levels in ^{137}Xe from radioactive decay and because of the large discrepancy in level energies reported in the two studies of the ^{136}Xe(d,p) reaction, we constructed the decay scheme for the capture state primarily from the data obtained in the present study. Guided by intensity arguments and the ex-

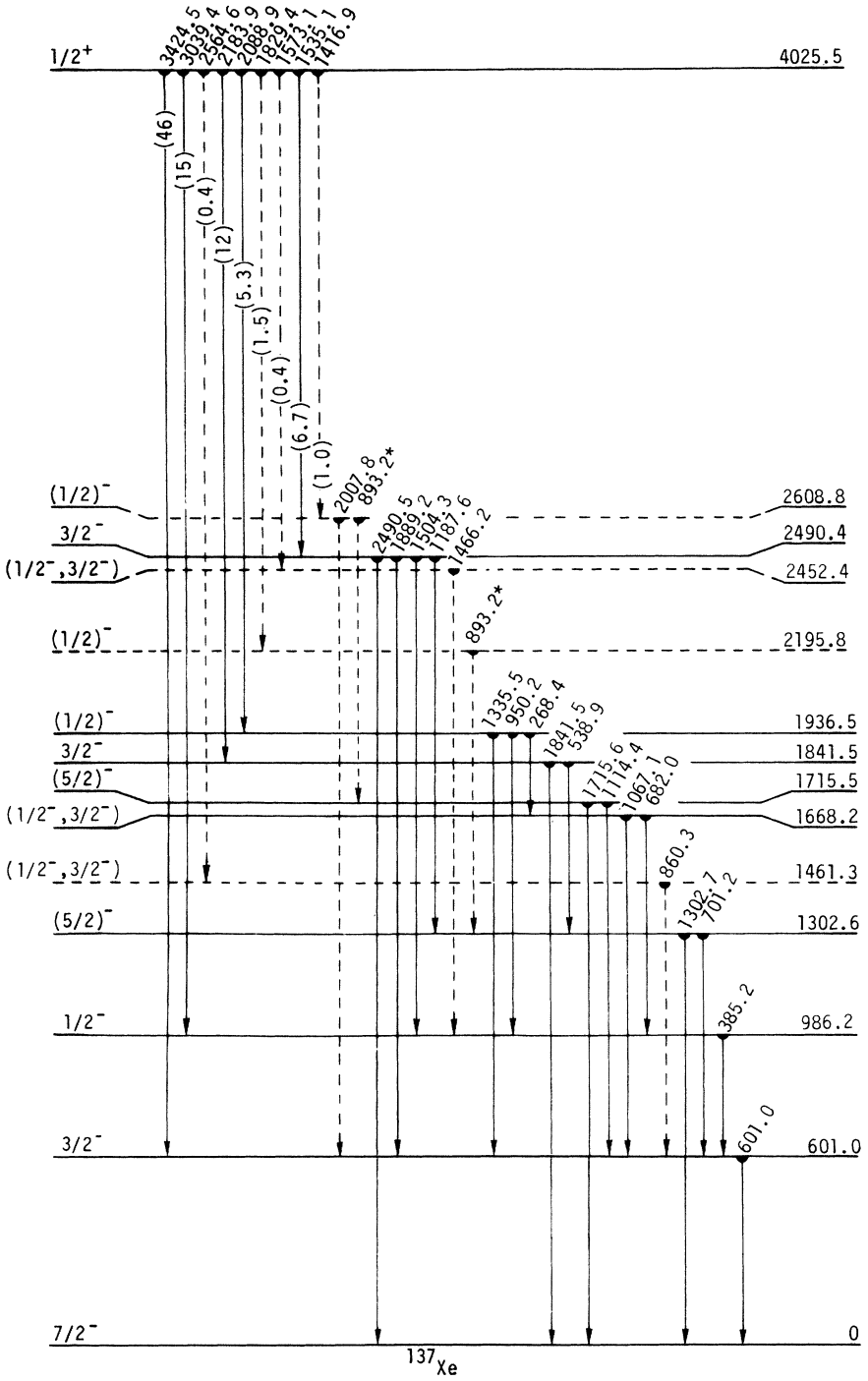

FIG. 2. Decay schemes of the ^{137}Xe capture state. The intensities of the primary transitions are shown in parentheses. Dashed lines indicate that the existence of the level or the placement of the transition is uncertain. The asterisks (*) indicate the two equally probable placements of the 893.2-keV transition.

pectation that the first two excited states should be populated by primary transitions from the capture state, the levels at 601.0 and 986.2 keV were defined. Then, using sum-difference relations between γ-ray energies and the capture-state energy estimated from the above, other levels were defined. The proposed decay scheme obtained with this procedure is shown in Fig. 2 and Table II.

TABLE II. ^{137}Xe-level energies and Q values.

E_{ex} (keV)[a]	E_γ (keV)[b]	$Q(n,\gamma)$ (keV)
0		
601.01(0.11)	3424.60(0.11)	4025.61(0.16)
986.17(0.15)	3039.41(0.11)	4025.58(0.19)
1302.61(0.15)		
1461.28(0.18)		
1668.15(0.14)		
1715.48(0.19)		
1041.51(0.11)	2183.90(0.10)	4025.41(0.15)
1936.45(0.11)	2088.95(0.12)	4025.40(0.16)
(2195.8)		
(2452.4)		
2490.38(0.10)	1535.09(0.12)	4025.47(0.16)
(2608.8)		
$\bar{Q} = 4025.49 \pm 0.07$[c]		

[a] Level energies are derived from transitions that are placed in the level scheme with a high degree of certainty.

[b] Transitions with $E_\gamma > 2$ MeV have been corrected for nuclear recoil.

[c] Statistical error only; see text for discussion of systematic errors.

Based on the energy sums of γ rays in cascade with the five primary transitions shown as definitely arising from decay of the capture state, the Q value for the reaction is calculated to be 4025.49 ±0.07 keV. The value obtained from the nine primary transitions shown in Fig. 2 is 4025.50 ±0.21 keV. In attempting to assess possible systematic errors, we have examined the data used to define the nonlinearity corrections that we believe contain the largest source of uncertainty. A maximum systematic error of ±0.2 keV could be attributed to this source, and we therefore believe the value $Q(n,\gamma) = 4025.5 \pm 0.3$ keV to have a conservative error estimate. This result is in very good agreement with the Q value derived from the data of Schneid and Rosner[7] (4045 ± 60 keV) but differs substantially from that obtained by Moore *et al.*[6] (3862 ± 20 keV). The level energies from our work are also in better agreement with the results in Ref. 7.

As a result of the high background from neutron capture in the cryostat, many weaker transitions that followed the decay of the capture state were undetected. Hence, with the exception of the excited states at 601.0 and 986.2 keV, we used the criterion that a level is considered defined if at least three transitions are associated with its population and decay. We further require that no substantial intensity imbalance result from its placement in the scheme. The levels at 1461.3, 2195.8, and 2452.4 keV are considered tentative even though both intensity balance and population by primary transitions suggest their presence. The level at 2608.8 keV is also considered tentative because of the uncertain placement of the 893.2 keV transition in the decay scheme. The only intensity imbalance present in the scheme is associated with the level at 2490.4 keV where the intensity of the 1535.1-keV transition is slightly greater (~13%) than the sum of the intensities of the transitions shown in the decay of this level. We nevertheless consider the level well established since it is defined by five transitions.

V. LEVEL SCHEME OF ^{137}Xe

Spins and parities of levels were obtained primarily by comparing the level scheme in Fig. 2 with those obtained from reaction studies. As in the case of other $N = 83$ even-Z nuclides, the low-lying levels of ^{137}Xe are expected to arise from $f_{7/2}$, $p_{3/2}$, $p_{1/2}$, and $f_{5/2}$ neutron single-particle orbitals. The γ decay of the $\frac{1}{2}^+$ state formed by thermal neutron capture should occur predominantly by emission of $E1$ radiation and should selectively populate levels excited by $l = 1$ transfers in the ^{136}Xe(d,p) and ^{136}Xe(p,p_0) reactions. Figure 3 shows the levels defined in this study, along with a summary of the relevant reaction data for levels below 3.0 MeV in ^{137}Xe. We have excellent agreement between the level energies from the (p,p_0) study and those from our (n,γ) measurements. With the exception of the tentative level at 1461.3 keV, a one-to-one correspondence is firmly established between the levels populated by primary transitions from the capture state and those excited by $l = 1$ transfers. In addition, the energies of the low-lying levels at 1302.6 and 1715.5 keV for which primary transitions could not be found agree well with those at 1300 and 1740 keV that were excited by $l = 3$ transfers. Similar agreement with the (d,p) data of Moore *et al.*[6] is found after accounting for systematic energy errors.

The spins and parities of the ground state ($\frac{7}{2}^-$) and levels at 601.0 ($\frac{3}{2}^-$), 986.2 ($\frac{1}{2}^-$), and 1302.6 keV ($\frac{5}{2}^-$) have been previously assigned by analogy with results obtained by Veeser, Ellis, and Haeberli[20] from polarization measurements of proton elastic scattering at analog resonances in ^{139}La. Consistent with these assignments are the population of the first two levels by primary transitions from the capture state and the absence of a ground state transition in decay of the level at 986.2 keV. While we cannot rule out a spin assignment of $\frac{7}{2}$, the absence of a transition from the capture state to the level at 1302.5 keV is consistent with the assigned spin and parity of ($\frac{5}{2}^-$).

The pairs of levels at 1860 and 1940 keV and at 2500 and 2590 keV were observed as closely spaced

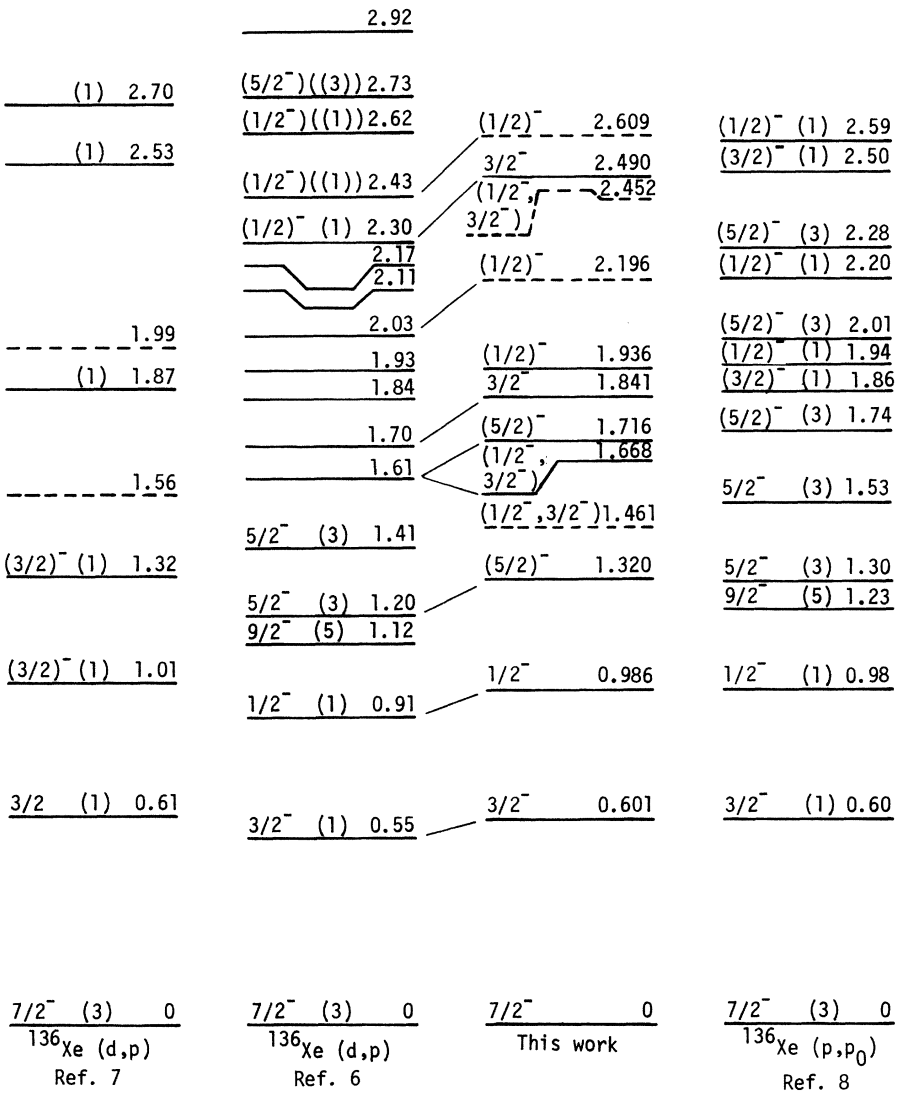

FIG. 3. Comparison of the ^{137}Xe-level properties. The results of the present study are compared with data from the (d,p) and (p,p_0) reactions. The l-transfer values derived from the charged particle reaction studies are indicated in parentheses at the level centers.

resonances in the (p,p_0) measurements. The spins assigned to these levels were suggested by the best fit of theoretical calculations to the elastic scattering data. All four members of the pairs appear to be populated by primary transitions from the capture state. Definite assignments of spin $\frac{3}{2}$ to the levels at 1841.5 and 2490.4 keV can be made on the basis of the strong ground-state transitions observed in decay of these levels. Some support to the assignment of spin $\frac{1}{2}$ to each of the remaining members of the pairs is gained by the absence of ground-state transitions in their decay. Finally, the tentative assignment of spin $\frac{1}{2}$ to the level at 2195.8 keV was made on the basis of sum-rule arguments,[6] but our data are insufficient to provide additional information.

Besides the levels of spin $\frac{1}{2}$ and $\frac{3}{2}$ seen in the reaction studies, we have placed tentative levels at 1461.3 and 2452.4 keV, both of which appear populated by primary transitions from the capture state and therefore have probable spin and parity assignments $(\frac{1}{2}^-, \frac{3}{2}^-)$. Our data also define a definite level at 1668.2 keV for which no primary transition was observed. If the residual intensity out of this level were balanced by a primary transition, it would lie near the limit of sensitivity of our measurements. Based on the observed decay to levels of spin $\frac{1}{2}$ and $\frac{3}{2}$ and the absence of decay to the ground state, we favor a spin assignment of $\frac{1}{2}$, although a spin of $\frac{3}{2}$ cannot be ruled out.

The only other level defined in the (n,γ) study is the one at 1715.5 keV for which a primary transition from the capture state should have been observed, if present. This level can be identified with that seen at 1740 keV in the (p,p_0) reaction for which a tentative spin assignment of $\frac{5}{2}$ was made by analogy with levels in ^{139}Ba.[8] Our data are consistent with this assignment.

VI. CORRELATIONS BETWEEN REDUCED TRANSITION RATES FROM DECAY OF THE CAPTURE STATE AND $l=1$ SPECTROSCOPIC FACTORS FROM REACTION STUDIES

The decay scheme for the capture state defined in this study shows population of all levels below 3.0 MeV in ^{137}Xe that have been excited by $l=1$ transitions in the (d,p) and (p,p_0) reactions on ^{136}Xe. The 83-neutron isotone ^{139}Ba has been studied by Moragues *et al.*[21] through thermal neutron capture of ^{138}Ba. A strong correlation was observed between six reduced $E1$-transition probabilities measured in the capture state decay and the spectroscopic factors for $l=1$ transfers observed in the ^{138}Ba(d,p) reaction. On the assumption that a similar correlation might also exist for ^{137}Xe, we have compared our data with spectroscopic factors derived from the (d,p) and (p,p_0) reactions on ^{136}Xe. The relevant data are summarized in Table III.

The spectroscopic factors from the two (d,p) studies show considerable variation and, as noted in Ref. 8, the values for the $l=1$ states at 601 and 986 keV are increased somewhat if the optical model parameters used to fit the elastic proton scattering data are applied to the (d,p) data of Ref. 6. The spectroscopic factors from the (p,p_0) experiment, while considerably less certain, show no worse agreement with the (d,p) spectroscopic factors than between the two sets of (d,p) results themselves. Therefore, we have chosen to use an unweighted average of the various measurements in order to obtain the set of $G(d,p)$ values given in Table II. An arbitrary error of $\pm 30\%$ was assumed for $\bar{S}$.

As an estimate of the extent of correlation, we have calculated the ratios $G(n,\gamma)/G(d,p)$ shown in the last column of Table III. This ratio should be constant if the initial and final states have a common unique parent.[21] With the exception of the $l=1$ levels at 2.196 and 2.490 MeV, the calculated ratios overlap within the estimated errors. It appears, however, that the ratios show a systematic increase with increasing excitation energy of the final state. As a second measure, we have calculated the correlation coefficient[21]:

TABLE III. Comparison of reduced $E1$-transition probabilities from the ^{136}Xe(n,γ) reaction with spectroscopic factors from the (d,p) and (p,p_0) reactions on ^{136}Xe.

		$S(d,p)$		$S(p,p_0)$				
E (MeV)	$G(n,\gamma)$[a]	Ref. 7	Ref. 6	Ref. 8	l_n	J_f	$G(d,p)$[b]	$G(n,\gamma)/G(d,p)$[c]
0.000		0.58	0.68	0.73	3	$\frac{7}{2}$		
0.601	100 ± 11	0.37	0.49	0.40	1	$\frac{3}{2}$	1.68 ± 0.52	60 ± 18
0.986	47 ± 6	0.13	0.34	0.27	1	$\frac{1}{2}$	0.60 ± 0.20	78 ± 30
1.219			0.31		5	$(\frac{9}{2})$		
1.320		0.16	0.24	0.26	3	$(\frac{5}{2})$		
1.716				(0.11)	3	$(\frac{5}{2})$		
1.841	100 ± 8	0.30		(0.18)	1	$\frac{3}{2}$	0.96 ± 0.28	104 ± 31
1.936	51 ± 5			(0.20)	1	$(\frac{1}{2})$	0.40 ± 0.14	127 ± 42
2.196	21 ± 3			(0.06)	1	$(\frac{1}{2})$	0.12 ± 0.04	175 ± 64
2.490	162 ± 17	0.13	0.18[d]	(0.15)	1	$\frac{3}{2}$	0.60 ± 0.16	270 ± 78
2.609	31 ± 3	0.09	0.22	(0.08)	1	$\frac{1}{2}$	0.26 ± 0.08	119 ± 51

[a] $G(n,\gamma) \propto (I_\gamma / E_\gamma^3)$. $G(n,\gamma)$ values are in arbitrary units.

[b] If $\bar{S}$ represents an unweighted average of the spectroscopic factors in columns 3 and 4, then $G(d,p) = (2J_f+1)\bar{S}$. An error of $\pm 30\%$ was assumed for the mean values $\bar{S}$.

[c] Arbitrary units.

[d] Assuming $J_f = \frac{3}{2}$.

$$\rho = \frac{\sum_i [G_i(n,\gamma) - \bar{G}(n,\gamma)][G_i(d,p) - \bar{G}(d,p)]}{\left(\sum_i [G_i(n,\gamma) - \bar{G}(n,\gamma)]^2 \sum_i [G_i(d,p) - \bar{G}(d,p)]^2\right)^{1/2}} .$$

Using all seven levels, we obtain the value $\rho = 0.53$. If we exclude the level at 2.490 MeV from the calculation, the value $\rho = 0.85$ is obtained. The latter admits a less than 2% chance that no correlation exists. Taking account of experimental uncertainties, we conclude that our data are consistent with a strong correlation between the $E1$ decay probabilities from the capture state and the spectroscopic factor of $l = 1$ final states in ^{137}Xe.

VII. SUMMARY AND CONCLUSIONS

The value obtained in this study for the neutron binding energy in ^{137}Xe, 4025.5 ± 0.3 keV, is appreciably higher than that previously adopted and indicates that the γ rays near 3.9 MeV observed by Nuh *et al.*[3] do not compete with delayed neutron emission. When coupled with the energies of neutron transitions from the decay of ^{137}I, the new value of B_n will establish precise energies of levels above the neutron binding energy in ^{137}Xe that are populated by β^- decay of ^{137}I.

The levels populated strongly by primary transitions in decay of the capture state in ^{137}Xe correlate well with those excited by $l = 1$ transfers in the ^{136}Xe(d,p) and ^{136}Xe(p,p_0) reactions. Only two of the low-lying levels excited by $l = 3$ transfers could be identified in this study. Since levels with spin greater than $\frac{3}{2}$ are not expected to be directly populated by decay of the capture state and because of the high background due to neutron capture in the cryostat, levels populated by low intensity transitions from excited states could not be observed. We note in this regard that the identity of higher spin states in ^{137}Xe should be obtained from study of β^- decay of ^{137}I($\frac{7}{2}^-$). In comparing the data reported by Nuh *et al.*[3] the γ rays found in both the β^- decay and (n,γ) studies are associated with the levels at 1302.6 and 1715.5 keV, both of which have been assigned probable spins of $\frac{5}{2}$. Furthermore, the most intense line seen in the β^- decay at 1218.6 keV probably deexcites the level at 1.23 MeV excited by an $l = 5$ transition in the reaction studies. Clearly, more complete studies of the β decay of ^{137}I and of the ^{136}Xe(n,γ) γ-ray spectrum would provide a detailed knowledge of the low-lying level structure of ^{137}Xe.

Even with the large uncertainties in the spectroscopic factors for $l = 1$ levels excited in the (d,p) and (p,p_0) reactions on ^{136}Xe, comparison with the reduced transition probabilities of primary transitions from the capture state in ^{137}Xe suggests a strong correlation comparable to that observed for the $N = 83$ isotone ^{139}Ba.

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