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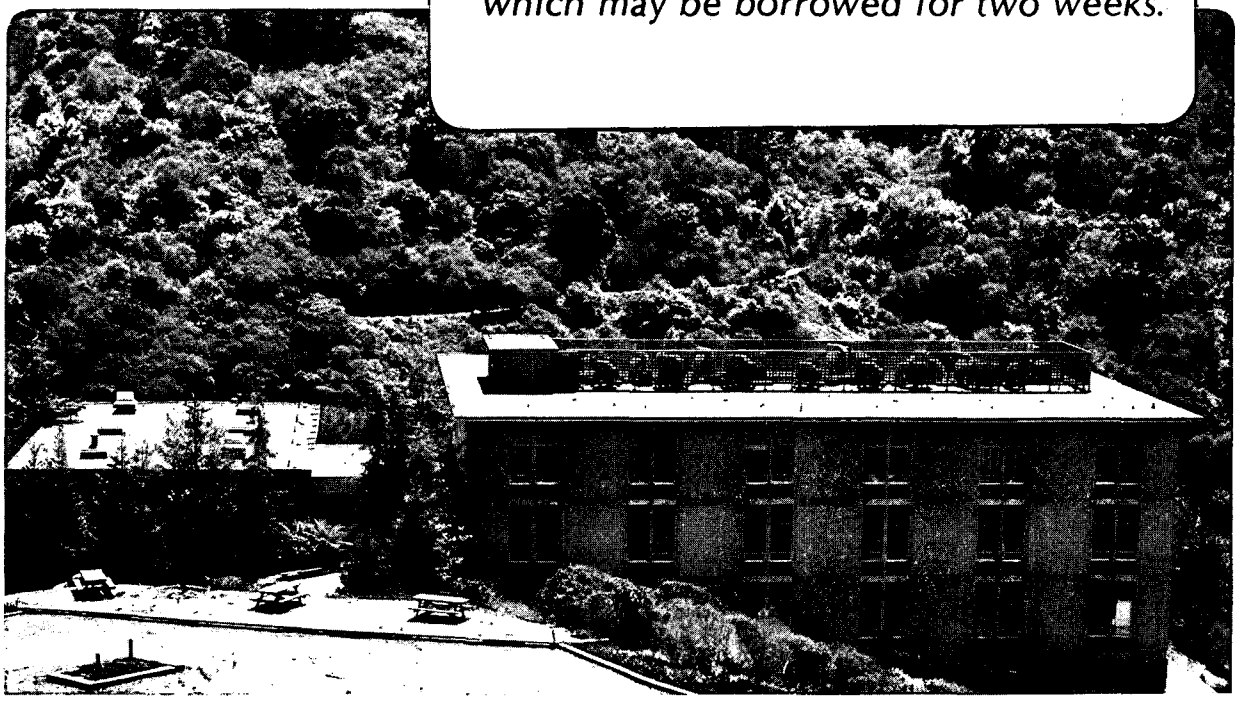

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Revisions and Additions to the Energy Levels of Neutral Curium, ^{244}Cm I.

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ABSTRACT

New spectroscopic data obtained using isotopically different samples have led to revisions and additions to the energy levels of neutral curium, ^{244}Cm I. There are now 491 odd and 432 even energy levels with J-values. Almost all the levels have isotope shift and many have g-values and configuration designations. Ten odd configurations and nine (one tentative) even configurations have been identified.

INTRODUCTION

Since the publication of the energy levels of neutral curium [1] (Cm I) in 1976, new experimental data have been obtained that enable us to extend the analysis and to correct some levels. Other reports on the curium emission spectrum may be found in Refs. 2 through 11. Isotope shift data on 97 lines reported by Lobikov et. al. [12] and the much more extensive measurements (6000 lines) at Lawrence Livermore National laboratory (LLNL) [13] have been the most important contribution. The isotope shift measures by the two groups are in good agreement. The infrared Fourier transform spectra (FTS) recorded at Laboratoire Aimé Cotton (LAC) [5] and visible Fourier transform spectra taken at the National Solar Observatory, Kitt Peak, Arizona (KPNO) have been used to improve the accuracy of many levels. A preliminary discussion of the results given here was the subject of a poster presentation at the 1986 EGAS meeting.[14]

OBSERVATIONS

The isotope shift spectra were photographed using the Argonne National Laboratory (ANL) 9.15m Paschen-Runge spectrograph and electrodeless lamps with the isotope compositions given in Table 1. The experimental conditions were essentially the same as reported in Ref. 1. The electrodeless lamps were quartz tubes 3 or 4 mm I.D. (5 to 6 mm O.D.) and 20 to 25 mm long containing 50 to 200 micrograms of curium as anhydrous iodide. The lamps were excited in a 25.4 mm diameter microwave cavity using 40 to 100 watts of 2450 MHz microwave power. The plates were read with a semi-automatic comparator. Shifts for over 6000 lines were observed in the photographic range, 2400-11200 Å.

The spectrum of curium has recently been recorded by Fourier transform spectroscopy at the KPNO between 3730 and 11780 Å. Because the electrodeless discharge lamp was operated at high metal-atom pressure, the spectrum of Cm I is predominant and a number of lines are self-reversed. In the range 4250-10000 Å, this spectrum is much richer than the spectrum photographed at ANL. Unfortunatly, it also contains all the strong transitions of ^{240}Pu (^{244}Cm alpha decays with 18.1 year half life to ^{240}Pu) and Ti I and a number of Ca I

and II lines, as well as the persistent lines of the neutral atoms Li, Na, Mg, Al, K, Zr, La, Ce, Pr, and Nd.

Fig. 1 shows a 1.5 Ångstrom portion of the spectrum obtained using the ANL spectrograph and lamps with compositions given in Table 1. It is a reproduction of Fig. 2 from Ref. 10 shown here to exhibit how spectra from the lamps with three different isotopic compositions appear. The advantages in measurement are obvious. The two spectra with three isotopes were always read if possible and the spectrum with ^{244}Cm and ^{246}Cm read if one or both the other spectra were blended. The data were handled by a computer program to print out all measured values and to average the two measured ^{246}Cm - ^{244}Cm shifts. The final value of ^{246}Cm - ^{244}Cm isotope shift for well resolved lines included averaging an additional value obtained from the the measured ^{248}Cm - ^{244}Cm shift divided by the relative isotope shift (RIS) value of 1.954. The RIS values derived for Cm and a discussion of the accuracy of the isotope shifts are reported in Ref. 10.

RESULTS

All the levels published in 1976 [1,5] have been checked with respect to energies, isotope shifts, J, and g-values. We have confirmed the validity of 311 of the 335 odd levels reported in Ref. 1 and all six new odd levels added in Ref. 5. The J value of a level at 23633 cm^{-1} had already been corrected in Ref. 5 and that of a level at 35407 cm^{-1} has been increased by one unit. Of the 348 even levels reported in Ref. 1, 16 have been rejected. The 10 new levels added in Ref. 5 were confirmed, but for three of the levels the J value was increased by one unit.

Over the last few years, the extensive unpublished isotope shift studies [13] have led to the discovery of many new levels and to the determination of the isotope shifts for all but 31 of the 923 known Cm I levels. The energies of nearly all the Cm I levels have now been derived from Fourier transform spectra. The level interval consistency is ±-0.001 cm^{-1} for all levels below 25000 cm^{-1} and +-0.003 cm^{-1} for higher levels given to three places after the decimal point. However, some 40 high levels with values given to two places in Tables 2 and 3 have only transitions in the ultraviolet and were observed only on the photographic plates. As a result

their energies have internal consistencies of only +-0.02 cm^{-1}.

A special effort has been devoted to the interpretation of the Cm I levels, particulary the identification of levels belonging to configurations with 8s, 8p, and 7d electrons. These levels lie at high energy and are subject to broadening by fields present in the electrodeless lamps. Several wide lines remained unclassified in the infrared and a number of them had been omitted from the list given in Ref. 5. Searches with the frequencies of these lines as a basis led to new identifications. More details are given below in the discussions of the configurations containing these electrons.

The energy levels of neutral curium are listed in Table 2 (odd levels) and Table 3 (even levels). These tables contain the 174 new odd levels and 90 new even levels that have been added to the earlier level lists of Refs. 1 and 5. Column 1 lists the value of the energy level in wave numbers. Columns 2 and 3 give the J and g values. Column 4 is the isotope shift in wave numbers. The isotope shifts are ^{246}Cm - ^{244}Cm relative to the $5f^7 6d7s^2\ ^9D^o_2$ ground state as zero shift. An asterisk indicates an approximate value or a shift derived from only one line. Column 5 gives the configuration designation followed by the term, usually in LS-coupling notation. In some cases the J_1j-coupling notation is used. In general we followed the designations used in Atomic Energy Levels--The Rare Earths.[15]

Figure 2 shows the range of isotope shifts for levels assigned to identified configurations of Cm I. Note that there is considerable overlap of observed shift for a number of configurations (9 of 17). In these cases, theory, Landé g-values, transition intensities and other factors are important for assigning the level to the appropriate configuration. As seen in Fig. 2, we report the shifts relative to the ground state as X. The largest isotope shifts, relative to the ground state, are about -0.81 cm^{-1}. Therefore a good estimate for X is +0.85 cm^{-1}. For the shifts in Tables 2 and 3, X is zero. In heavy elements the largest shifts are found for levels belonging to configurations with the largest number of penetrating s electrons and the smallest number of shielding f and d electrons. The smallest isotope shifts are for levels of configurations with no penetrating electrons. Thus, in the case of Cm I, levels of the

configuration $5f^8 7p^2$ and the still unidentified $5f^8 6d^2$ configuration are expected to have a shifts close to zero.

ODD CONFIGURATIONS

The $5f^7 6d7s^2$ configuration.

The ten low levels based on the ^8S core of the configuration $5f^7$ 6d $7s^2$ were known.[1] A number of levels built on the core terms $^6P^o$, $^6D^o$ and $^6I^o$ have now been found above 17280 cm^{-1}. This configuration contains the ground level of curium with isotope shift set to zero (X = 0) so that the values of the shifts of these levels given in Table 2 are all small (+0.03 to -0.10).

The $5f^7 6d^2 7s$ configuration.

Many levels have been assigned to this configuration but since it overlaps the $5f^8 7s7p$ configuration that has isotope shifts of the same magnitude, some identifications are only tentative.

The $5f^8 7s$ 7p configuration.

A number of levels have been identified by the intensity of transitions between this configuration and $5f^8 7s^2$, $5f^8 6d7s$ and $5f^8 7s8s$, with those involving $5f^8 7s8s$ characterized by looking "fuzzy" or being much wider than other lines in the same spectral range.

The $5f^8 6d7p$ configuration.

This configuration begins at 32876 cm^{-1} with a $^9H^o_8$ level (X-0.720 cm^{-1} and unknown g) and several levels with shifts of the same magnitude have been assigned to this configuration.

The $5f^7(^8S^o_{7/2})7s^2 8s$ configuration.

The $^9S^o_4$ and $^7S^o_3$ levels, expected around 30000 cm^{-1}, should have a large isotope shift and strongly combine with the $5f^7(^8S^o)7s^2 7p$ and $5f^7(^8S^o)7s^2 8p$ levels. The level J=3

at 29673 cm^{-1} with a shift +0.155 cm^{-1} and g=1.801, has been easily identified with $^7S^o_3$, although it is perturbed by a neighboring level at 29794 cm^{-1} that shows the same type of transitions. The lower level, $^9S^o_4$, at 28635 cm^{-1} (X-0.128 $cm^{-1}$and g=1.731), was more difficult to identify because of its perturbation by two $^9P^o_4$ levels at 28989 and 29452 cm^{-1}.

The $5f^7 7s7p^2$ configuration.

Another J=4 level at 31167 cm^{-1} (X-0.180 cm^{-1} and g=1.759) also combines strongly with the $5f^7 7s^2 7p$ levels and levels of $5f^7 6d7s7p$. It has been tentatively identified as $5f^7 7s7p^2\ ^{11}P^o_4$.

The $5f^7 6d^3$ configuration.

The only identified levels of this configuration belong to the $^{11}F^o$ term. This term lies considerably higher than reported earlier .[1] It starts at 30443 cm^{-1} with the three levels $^{11}F^o_{2,3,4}$ that had previously been identified in Ref. 1 as $^9D^o_{2,3,4}$. Except for the $^{11}F^o_5$ level that has dubious identification, all the levels of this term are known and their expected transitions with the $5f^7 6d^2 7p$ levels have been observed in the infrared.

The $5f^7 6d7s8s$ configuration.

Most of the earlier identifications [1] have been confirmed and a few more levels have been found that belong to this configuration.

The $5f^7 7d7s^2$ configuration.

All the levels of the lowest term, $^9D^o$ of this configuration have been identified. The term starts with the J=2 level at 36481 cm^{-1} (isotope shift of X+0.103 cm^{-1} and g=2.373) that had previously been assigned to the second $^9D^o$

term of $5f^7 6d7s8s$. The $^9D^o_5$ and $^9D^o_6$ levels at 37792 and 39742 cm^{-1} have shifts X-0.143 and X-0.227 cm^{-1} respectively. Shifts of these two levels are slightly smaller than expected for this configuration because of pertubations by neighboring levels.

The $5f^8 7s8p$ configuration.

Eight levels above 38000 cm^{-1} have been assigned to this configuration because of their strong transitions to levels of the $5f^8 6d7s$ and $5f^8 7s8s$ configurations.

EVEN CONFIGIRATIONS

The $5f^8 7s^2$ configuration.

A parametric study [16] of this configuration was made before the more complete isotope shift data were available. Except for the levels of the lowest multiplet ^7F, with purity of about 70%, all the other levels have a very low purity. The four levels expected between 14000 and 20000 cm^{-1} have been identified. Because their shift is now known, the levels at 23532 and 27667 cm^{-1} that were identified in 1980 as belonging to $5f^8 7s^2$, are now assigned to $5f^8 6d7s$. The configuration designation of the level at 25848 cm^{-1} is not obvious and no designation is indicated in Table 3. The isotope shift of -0.429 cm^{-1} makes the identification of this level as $5f^8 6s^2$ in Ref. 16 unlikely since an isotope shift of -0.10 to -0.35 cm^{-1} is expected for levels of this configuration.

The $5f^7 7s^2 7p$ configuration.

All the levels based on the $^8S^o$ core of $5f^7$ that belong to this configuration have been confirmed and improved isotope shifts have been obtained. Several levels of this configuration based on the $5f^7$ $^6P^o$ and $^6D^o$ cores have now been identified above 26905 cm^{-1}.

The $5f^7 6d7s7p$ configuration.

The designations of the levels lying below 26000 cm^{-1} that were assigned to this configuration have been confirmed. The term identifications of the higher levels of this huge configuration are only tentative.

The $5f^8 6d7s$ configuration.

Below 25000 cm^{-1} only the $^7F_1$ and $^7F_0$ levels are still missing. Most of the levels of the ^9H term which begins with a J=9 level at 21416 cm^{-1}, and of the ^7G term which starts with a J=7 level at 22615 cm^{-1} have been found. The ^7H term is complete.

The $5f^8 7s8s$ configuration.

The four lowest levels of this configuration based on the $5f^8\ ^7F_6$ core, were already known and a number of levels of the $5f^8(^7F_{5-0})7s8s(^3S_1)$ have been found between 36869 and 40206 cm^{-1}.

The $5f^7(^8S^o_{7/2})7s^2 8p$ sub-configuration.

Five out of the six expected levels have been identified between 35540 and 36315 cm^{-1}.

The $5f^7 6d^2 7p$ configuration.

As pointed out in Ref. 1, the isotope shift of this configuration is of the order of X-0.6 cm^{-1} and, according to Brewer [17], the lowest level $^{11}G_1$ is expected around 36000 +-4000 cm^{-1}. The ^{11}G term is perturbed by surrounding configurations and it has not been possible to detect its lowest levels. The levels at 34290 and 35838 cm^{-1} could be the $^{11}G_5$ and $^{11}G_6$ levels and are tentativly identified as such. The three highest levels of this term $^{11}G_{7,8,9}$ are respectivly at 37181, 39071 and 42464 cm^{-1}. All the levels

of the ^{11}F term have been identified and lie between 36128 and 44788 cm^{-1}.

The $5f^8 7p^2$ configuration.

Before its very small shift, X-0.813 cm^{-1} had been determined from many lines, and because it had strong transitions with the $5f^8 7s7p$ levels, the level at 37631 cm^{-1} (g=1.48) was assigned as $5f^8 7s8s\ ^7F_6$. The expected shift of which is X-0.46 cm^{-1}. This level is now identified as $5f^8 7p^2\ ^9G_6$ in good agreement with Brewer's prediction.[17] The $^9G_7$ and $^9G_8$ levels have been found at 38043 cm^{-1} (X-0.817 cm^{-1}) and 38622 cm^{-1} (X-0.799 cm^{-1}).

The $5f^7 7s^2 9p$ configuration.

It is not easy to identify the configuration of the three levels that show a very large shift (X+0.17 cm^{-1}), around 41200 cm^{-1}. We have tentatively identified the two lowest levels as $^7P_3$ and $^7P_2$ of $5f^7 7s^2 9p$.

SUMMARY

Table 4 lists the lowest level of each of the identified configurations of Cm I along with their designations, g-values and isotope shifts. We have identified levels belonging to eighteen configurations, including the eleven configurations predicted by Brewer [17] below 40000 +-7000 cm^{-1} and six configurations involving 8s, 8p or 7d electrons. Only the lowest level of the $5f^7 7s7p^2$ configuration has been identified and no level could be assigned to the $5f^8 6d^2$ configuration expected to start at 41000 +-7000 cm^{-1}. A tentative identification has been made of two levels of $5f^7 7s^2 9p$ configuration.

Because the configurations involved in Cm I are very large, from 295 levels for $5f^8 7s^2$ to 78822 levels in $5f^7 6d^2 7p$, the theoretical studies made so far have given satisfactory

results for only the lowest levels of the $5f^7 6d 7s^2$, $5f^8 7s^2$, and $5f^7 7s^2 7p$ configurations.[1,16]

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CAPTIONS

Table 1. Isotopic composition of curium samples.

Table 2. Odd energy levels of neutral curium, ^{244}Cm I.

Table 3. Even energy levels of neutral curium, ^{244}Cm I.

Table 4. Lowest levels of identified configurations in ^{244}Cm I.

Figure 1. A 1.5 Å ngstrom region of the curium spectrum showing the isotope shift for four isotopes. Spectra of three isotopically different samples are shown.

Figure 2. Range of observed isotope shifts for seventeen electronic configurations of Cm I. The value of X is about 0.85 cm^{-1} (see text).

Table 1. Isotopic Composition of Curium Samples.

Sample	Composition >1%			
	244	245	246	248
1	95	1.5	3	
2	27		16	55
3	55	23	21	

Table 2. Odd energy levels of neutral Curium, ^{244}Cm I.

Energy Level (cm^{-1})	J odd	g odd	I.S. (cm^{-1})	Configuration Designation	
0.000	2	2.563	.000	$5f^7 6d7s^2$	$^9D^o$
302.153	3	2.000	+.001	$5f^7 6d7s^2$	$^9D^o$
815.655	4	1.777	+.002	$5f^7 6d7s^2$	$^9D^o$
1764.268	5	1.671	+.005	$5f^7 6d7s^2$	$^9D^o$
3809.355	6	1.624	+.013	$5f^7 6d7s^2$	$^9D^o$
8958.447	4	1.605	+.014	$5f^7 6d7s^2$	$^7D^o$
9064.880	5	1.573	+.011	$5f^7 6d7s^2$	$^7D^o$
9458.053	3	1.705	+.012	$5f^7 6d7s^2$	$^7D^o$
9671.692	2	1.953	+.008	$5f^7 6d7s^2$	$^7D^o$
10133.857	1	2.840	+.011	$5f^7 6d7s^2$	$^7D^o$
10144.927	2	2.873	-.339	$5f^7 6d^2 7s$	$^{11}F^o$
10484.864	3	2.175	-.341	$5f^7 6d^2 7s$	$^{11}F^o$
10971.171	4	1.893	-.347	$5f^7 6d^2 7s$	$^{11}F^o$
11641.681	5	1.757	-.344	$5f^7 6d^2 7s$	$^{11}F^o$
12534.983	6	1.676	-.342	$5f^7 6d^2 7s$	$^{11}F^o$
13720.282	7	1.630	-.335	$5f^7 6d^2 7s$	$^{11}F^o$
15110.020	8	1.60	-.325	$5f^7 6d^2 7s$	$^{11}F^o$
15300.447	1	3.303	-.390	$5f^7 6d^2 7s$	$^9F^o$
15546.648	2	2.068	-.400	$5f^7 6d^2 7s$	$^9F^o$
15719.057	4	2.13	-.331	$5f^7 6d^2 7s$	$^{11}P^o$
15924.578	3	1.754	-.393	$5f^7 6d^2 7s$	$^9F^o$
16516.296	4	1.62	-.385	$5f^7 6d^2 7s$	$^9F^o$
16915.929	5		-.340	$5f^7 6d^2 7s$	$^{11}P^o$
17047.491	6	1.681	-.399	$5f^7 6d^2 7s$	$^{11}P^o$
17280.020	4		+.009	$5f^7(^6P)6d7s^2$	7/2,3/2
17463.053	5	1.622	-.390	$5f^7 6d^2 7s$	$^9F^o$
17656.659	6	1.621	-.453	$5f^8(^7F)7s7p$	$6, {}^3P^o_0$
17971.433	3		+.003	$5f^7(^6P)6d7s^2$	7/2,3/2
18009.483	7	1.48	-.519	$5f^8 7s7p$	$6, {}^3P^o_1$
18866.555	2		+.027*	$5f^7(^6P)6d7s^2$	7/2,3/2

Table 2 continued.

19059.388	6	1.550	-.390	$5f^7 6d^2 7s$	$^9F^o$
19089.348	5	1.310	-.130	$5f^7(^6P)6d7s^2$	7/2,3/2
19741.312	5	1.44	-.382	$5f^8 7s7p$	$6,^3P^o_1$
20144.461	4				
20197.523	6	1.40	-.541	$5f^8 7s7p$	$6,^3P^o_1$
20435.165	3		-.367	$5f^7 6d^2 7s$	
20673.891	4	1.604	-.456	$5f^8 7s7p$	$4,^3P^o_0$
20688.516	3		+.002	$5f^7(^6P)6d7s^2$	5/2,3/2
20762.088	7	1.50	-.385	$5f^7 6d^2 7s$	$^9F^o$
20830.015	2		+.020	$5f^7(^6P)6d7s2$	5/2,3/2
20832.199	4		+.020	$5f^7(^6P)6d7s^2$	5/2,3/2
20912.803	5	1.547	-.455	$5f^8 7s7p$	$5,^3P^o_0$
21087.069	1		-.001	$5f^7(^6P)6d7s^2$	5/2,3/2
21560.537	3	1.744	-.403	$5f^8 7s7p$	$4,^3P^o_1$
21688.716	4	1.740	-.348	$5f^7 6d^2 7s$	$^9P^o$
21788.790	4		-.023	$5f^7 6d7s^2$	
21822.755	2		-.383	$5f^7 6d^2 7s$	$^9F^o$
21828.992	5	1.599	-.428	$5f^7 6d^2 7s$	$^9P^o$
22100.309	1		-.374	$5f^7 6d^2 7s$	$^9F^o$
22129.083	6	1.47	-.465	$5f^8 7s7p$	$5,^3P^o_1$
22268.518	4	1.566P	-.425	$5f^8 7s7p$	$4,^3P^o_1$
22297.603	5	1.545	-.454	$5f^8 7s7p$	$5,^3P^o_1$
22334.183	3	P	-.403	$5f^8 7s7p$	
22341.234	4	1.617	-.399	$5f^7 6d^2 7s$	$^9F^o$
22455.427	6	1.319	-.009	$5f^7 6d7s^2$	
22461.750	0				
22557.753	2	1.769	-.381	$5f^7 6d^2 7s$	
22640.068	5	0.98	-.026	$5f^7(^6I)6d7s^2$	7/2,3/2
22660.750	1		-.390	$5f^7 6d^2 7s$	
22660.803	8	1.47	-.543	$5f^8 7s7p$	$6,^3P^o_2$
22751.903	3	1.675	-.432	$5f^8 7s7p$	$3,^3P^o_0$
22799.239	5	1.585	-.437	$5f^7 6d^2 7s$	$5,^3P^o_1$

Table 2 continued.

22907.611	7	1.47	-.540	$5f^8 7s7p$	$6, {}^3P^o_2$
23067.277	2		+.010	$5f^7 6d7s^2$	
23089.647	3		+.028	$5f^7 6d7s^2$	
23136.514	6	1.567	-.382	$5f^7 6d^2 7s$	${}^9F^o$
23146.241	4	1.42	-.430	$5f^8 7s7p$	$5, {}^3P^o_1$
23282.607	4	1.176	-.034	$5f^7({}^6I)6d7s^2$	7/2,3/2
23299.456	5	0.968	-.022	$5f^7({}^6I)6d7s^2$	9/2,3/2
23377.831	2	1.771	-.399	$5f^8 7s7p$	$2, {}^3P^o_0$
23419.316	5	1.509	-.344	$5f^7 6d^2 7s$	
23561.014	2	2.08	-.384	$5f^7 6d^2 7s$	${}^9D^o$
23633.638	6	1.46	-.543	$5f^8 7s7p$	$6, {}^3P^o_2$
23683.898	3	1.881	-.393	$5f^7 6d^2 7s$	${}^9D^o$
23730.897	4	1.631	-.430	$5f^8 7s7p$	$6, {}^3P^o_2$
23775.535	5	1.42	-.507	$5f^8 7s7p$	
23814.567	1		-.434	$5f^8 7s7p$	
23889.998	3	1.51	-.444	$5f^8 7s7p$	$3, {}^3P^o_1$
24129.740	2				
24270.432	4	1.51	-.442	$5f^8 7s7p$	$3, {}^3P^o_1$
24357.510	4	1.44	-.424		
24451.730	6	1.16	-.075	$5f^7({}^6I)6d7s^2$	9/2,3/2
24501.356	5	1.45	-.435	$5f^8 7s7p$	$6, {}^3P^o_2$
24646.279	5	1.41	-.241		
24665.284	2	1.839	-.466	$5f^8 7s7p$	$3, {}^3P^o_1$
24670.976	3	1.010	+.013Q		
24749.326	6	1.42	-.287		
24900.564	3	1.54	-.280		
24951.328	7	1.50	-.405	$5f^7 6d^2 7s$	${}^9F^o$
25057.185	5	1.45	-.340	$5f^7 6d^2 7s$	
25077.809	3	1.366	-.250		
25267.593	1	2.904	-.497	$5f^8 7s7p$	
25273.171	3	1.45	-.355		
25320.325	4		-.061	$5f^7 6d7s^2$	
25381.100	2	1.239	-.163		
25455.486	2	1.713	-.391	$5f^7 6d^2 7s$	${}^7D^o$
25518.802	6	1.51	-.465	$5f^8 7s7p$	$4, {}^3P^o_2$
25529.393	4	1.736	-.340		

Table 2 continued.

25724.913	1	2.339	-.384	$5f^7 6d^2 7s$	$^7D^o$
25826.625	2	1.296	-.308		
25836.816	4	1.39	-.386		
25844.771	3	1.63	-.370	$5f^7 6d^2 7s$	$^7D^o$
25878.134	5	1.49	-.387		
25897.365	6	0.942	+.010	$5f^7(^6I)6d7s^2$	11/2,3/2
25998.908	1	0.355	-.437	$5f^8 7s7p$	
26010.234	7	1.48	-.442	$5f^8 7s7p$	$5,\ ^3P^o_2$
26014.858	2		-.451		
26103.080	3	2.094	-.380	$5f^7 6d^2 7s$	$^9P^o$
26106.481	5	1.283	-.150		
26255.810	4		-.115		
26428.852	6	1.41	-.342	$5f^8 7s7p$	$6,\ ^1P^o_1$
26465.372	4	1.636	-.357	$5f^7 6d^2 7s$	$^7D^o$
26531.932	6	1.452	-.329		
26554.929	5	1.48	-.348		
26578.502	4		-.337		
26609.213	7	1.39	-.375	$5f^8 7s7p$	$6,\ ^1P^o_1$
26755.000	4	1.41	-.260*		
26790.162	5	1.230	-.076	$5f^7 6d7s^2$	
26814.729	3	1.46	-.407		
26935.503	8		-.358	$5f^7 6d^2 7s$	$^9G^o$
26943.258	5	1.40	-.260*	$5f^7 6d^2 7s$	
27090.458	4		+.021	$5f^7 6d7s^2$	
27097.152	3	1.768	-.332		
27131.102	5	1.350	-.111		
27264.795	6	1.290	-.152		
27320.061	2		-.383		
27349.285	3	1.423	-.026	$5f^7 6d7s^2$	
27349.626	6	1.48	-.426		
27410.123	7	1.301	-.499		
27446.42	7	1.07	-.577		
27485.657	5	1.38	-.140		
27522.392	4	1.46	-.485		
27562.438	2	1.47	-.422		
27586.158	5	1.45	-.246		
27704.537	1	1.02	-.598	$5f^8 7s7p$	
27728.671	7	1.48	-.443	$5f^8 7s7p$	
27752.639	1	0.905	-.260*		
27759.019	3	1.50 Q	-.085	$5f^7 6d7s^2$	
27763.130	4	1.368	-.397		
27780.863	5	1.40	-.351	$5f^8 7s7p$	$4,\ ^1P^o_1$

Table 2 continued.

27888.478	6	1.386	-.501	$5f^8 7s7p$	$5, {}^3P^o_2$
27922.720	3	1.201	-.127		
28036.411	3	1.315	-.421	$5f^8 7s7p$	$4, {}^1P^o_1$
28164.867	5		-.245		
28174.666	4	1.45	-.360	$5f^8 7s7p$	$4, {}^1P^o_1$
28246.244	3	1.40	-.385		
28406.425	2		-.452	$5f^8 7s7p$	
28487.425	4	1.328	-.200	$5f^8 7s7p$	
28635.021	4	1.731	-.128	$5f^7 7s^2 8s$	${}^9S^o$
28724.797	2	1.243	-.250*		
28744.071	3	1.229	-.109		
28838.170	4		-.122		
28880.047	5	1.46	-.412		
28893.313	2	1.376	-.237		
28989.090	4	1.648	-.303	$5f^7 6d^2 7s$	${}^9P^o$
29019.028	1	0.00	-.473	$5f^8 7s7p$	
29064.397	4	1.232	-.030	$5f^7 6d7s^2$	
29065.935	6	1.40	-.355		
29153.757	5	1.38	-.335*		
29183.683	6	1.247	-.020	$5f^7 6d7s^2$	
29270.946	2	1.413	-.460	$5f^8 7s7p$	
29403.684	3	1.380	-.401		
29406.786	7		-.041	$5f^7 6d7s^2$	
29452.531	4	1.671	-.264	$5f^7 6d7s^2$	${}^9P^o$
29471.629	1		+.017	$5f^7 6d7s^2$	
29506.738	3		-.487		
29617.550	3	1.46	-.339		
29652.096	4		-.345		
29673.766	3	1.801	+.155	$5f^7 7s^2 8s$	${}^7S^o$
29794.541	3	1.318	+.040	$5f^7 6d7s^2$	
29815.052	2	1.567	-.402		
29830.196	4	1.23	-.200*		
29861.094	3	1.514	-.450		
29921.678	7	1.31	-.220*		
30044.331	1		-.433		
30121.545	5	1.242	-.163		
30168.658	2	1.984	-.525		
30238.931	4	1.299	-.378		
30431.746	5	1.351	-.332		
30433.775	1	1.962	-.425		
30443.915	2	2.53	-.620	$5f^7 6d^3$	${}^{11}F^o$
30483.367	6	1.347	-.250		
30536.495	2	1.286	-.179		
30606.740	3	1.206	-.245*		

Table 2 continued.

30651.616	5	1.219	-.181		
30674.086	3	1.190	-.143		
30737.719	2	2.032	-.436		
30762.522	3	1.494P	-.212		
30766.875	4	1.37 P	-.377		
30834.756	5	1.35	-.231		
30840.559	1		-.144		
30860.129	3	1.84	-.544	$5f^7 6d^3$	$^{11}F^o$
30922.257	1	1.756	-.494		
31075.505	5	1.39	-.270*		
31104.821	4	1.487P	-.417		
31106.271	3	P	-.387		
31167.969	4	1.759P	-.180	$5f^7 7s7p^2$	$^{11}P^0$
31169.353	3	1.18 P	+.080*		
31204.048	2	1.129	-.129		
31219.632	6	1.305	-.115		
31299.069	4	1.065	-.024	$5f^7 6d7s^2$	
31370.765	4	1.50	-.420	$5f^8(^5D)7s7p$	
31411.647	4	1.803	-.659	$5f^7 6d^3$	$^{11}F^o$
31464.053	7	1.315	-.120		
31523.817	6	1.37	-.230*		
31542.176	2	1.206	-.350		
31589.714	6		-.321		
31597.016	2	1.177	+.250*		
31599.330	3	1.586	-.308		
31662.743	5	1.329	-.258		
31712.322	4	1.46	-.377		
31712.829	3	1.39	-.345		
31950.099	5	1.40	-.438	$5f^8(^5D)7s7p$	
31978.068	4	1.355	-.155*		
32010.115	6	1.228	-.131		
32037.767	6	1.252	-.422		
32092.428	3	1.267	-.379		
32188.121	5	1.55	-.536	$5f^8(^5D)7s7p$	
32247.323	5	1.55	-.532	$5f^7 6d^3$	$^{11}F^o$?
32299.235	2	1.180	-.161		
32362.860	7	1.103	+.021Q	$5f^7 6d7s^2$	
32370.610	4	1.163	-.042	$5f^7 6d7s^2$	
32447.082	4	1.40	-.326		
32452.960	5	1.28	-.141		
32453.625	6	1.289	-.155		
32523.771	2	1.222	-.120		
32597.791	3				
32651.367	3	1.40	-.200*		
32686.900	2	0.762	-.426		
32735.347	5	1.057	-.226		
32754.74	1	1.949	-.260*		
32775.742	7		-.455		

Table 2 continued.

32796.537	4	1.362	-.065	$5f^7 6d7s^2$	
32865.385	4	1.256	-.210*		
32876.853	8		-.720	$5f^8 6d7p$	$^9H^o$
32882.948	3	1.45	-.300*		
32917.213	5	1.776	-.215		
33001.084	1	2.132	-.280*		
33030.131	3	1.329	-.280*		
33041.34	2	0.97	-.290		
33064.748	5	1.144	-.025	$5f^7 6d7s^2$	
33082.558	4	1.237	-.357		
33088.917	6	1.246	-.085	$5f^7 6d7s^2$	
33127.022	2	1.119	-.250*		
33148.226	3	1.017	-.061	$5f^7 6d7s^2$	
33173.326	6		-.732	$5f^7 6d^3$	$^{11}F^o$
33194.354	7		+.002	$5f^7 6d7s^2$	
33362.424	6	1.135	-.060	$5f^7 6d7s^2$	
33466.511	5		-.281		
33475.911	4	1.250	-.298		
33484.58	2	1.46	-.190		
33498.334	3	1.330	-.260		
33554.531	4	1.45	-.275		
33576.024	6		-.069	$5f^7 6d7s^2$	
33614.06	1	1.61 a	-.210		
33675.367	5	1.173	-.300*		
33758.655	4	1.516	-.093	$5f^7 6d7s^2$	
33857.906	2	1.998	-.353		
33868.535	6	1.14	-.352		
33877.167	3		-.398		
33890.963	5	1.196	-.064	$5f^7 6d7s^2$	
34012.555	1	1.740	-.159		
34030.794	4	0.957	-.250*		
34058.508	5	1.176	-.038	$5f^7 6d7s^2$	
34147.959	4	1.081	-.200*		
34191.367	7		-.730	$5f^7 6d^3$	$^{11}F^o$
34210.532	3	1.335	-.250*		
34255.175	3	2.064	-.206	$5f^7 6d7s8s$	$^{11}D^o$
34263.359	4	1.623b	-.341		
34314.550	3	1.184	-.067		
34337.136	3		-.251		
34354.034	6		-.391		
34456.76	2	1.526	-.260*		
34463.27	1	2.12	-.320*		
34483.879	5	1.32	-.025	$5f^7 6d7s^2$	
34544.649	6		-.002	$5f^7 6d7s^2$	
34583.932	4	1.206	-.008	$5f^7 6d7s^2$	

Table 2 continued.

34592.564	3	1.35	-.300		
34698.974	4	2.028	-.184	$5f^7 6d7s8s$	$^{11}D^o$
34909.149	1	0.985	-.260*		
34920.553	4	1.173	-.065	$5f^7 6d7s^2$	
34934.492	5	1.112	-.327		
35036.699	3	1.778	-.277		
35053.436	6	1.291	-.403		
35091.870	4	1.160	-.028	$5f^7 6d7s^2$	
35100.041	2	2.324	-.125	$5f^7 6d7s8s$	$^9D^o$
35112.065	3	1.415	-.119		
35126.975	2		-.320*		
35151.691	5	1.265	-.018	$5f^7 6d7s^2$	
35163.221	8		-.744	$5f^7 6d^3$	$^{11}F^o$
35166.732	4	1.093	-.425		
35195.544	6	1.229	-.105		
35211.177	2	1.52	-.370		
35214.024	3	1.42	-.239		
35236.035	7		-.051	$5f^7 6d7s^2$	
35310.635	3	1.45	-.139		
35336.724	5	1.80	-.200	$5f^7 6d7s8s$	$^{11}D^o$
35367.461	3	1.768	-.077	$5f^7 6d7s8s$	$^9D^o$
35400.182	3	1.46	-.137		
35401.959	4		-.330		
35407.924	5		-.368		
35533.483	4	1.83 P	-.290		
35534.885	5	P	-.460		
35570.240	3	1.570	-.200*		
35594.99	2	1.207	-.350		
35604.984	8		-.336		
35612.624	5	1.25	-.029	$5f^7 6d7s^2$	
35651.398	3	1.24	-.077	$5f^7 6d7s^2$	
35694.697	7	1.358	-.677	$5f^8 6d7p$	$^9H^o$
35738.60	1	2.134	-.300		
35768.337	4	1.182	-.230*		
35815.691	2	1.349			
35816.331	4	1.85	-.153	$5f^7 6d7s8s$	$^9D^o$
35859.865	6		-.558		
35896.341	4	1.430	+.017	$5f^7 6d7s^2$	
35903.551	5		-.268		
35904.807	3	1.51	+.020	$5f^7 6d7s^2$	
35930.816	5	1.27	-.059	$5f^7 6d7s^2$	
35944.50	1	0.386	-.330*		
35980.264	5	1.421	-.270		
36035.833	2	1.381	-.210*		
36114.452	6	1.156	+.005	$5f^7 6d7s^2$	

Table 2 continued.

36152.071	6	1.537	-.029	$5f^7 6d7s^2$	
36158.657	4	1.192	-.090	$5f^7 6d7s^2$	
36184.419	4	1.19	-.358		
36197.282	1	1.587	-.088	$5f^7 6d7s^2$	
36228.447	6	1.366	-.209		
36279.506	2	1.660	+.064	$5f^7 6d7s^2$	
36308.864	6		+.011		
36311.537	5		-.262		
36311.708	7		-.315*		
36325.671	4	1.91	-.425		
36333.448	3	1.600c	-.031	$5f^7 6d7s^2$	
36349.717	7	1.32	-.008	$5f^7 6d7s^2$	
36378.675	5	1.460	-.294		
36391.931	3	1.16	-.373		
36398.666	1	2.075	+.026	$5f^7 6d7s^2$	
36406.457	5		-.383		
36478.169	5				
36481.440	2	2.373	+.103	$5f^7 7d7s^2$	$^9D^o$
36515.137	4	1.46 *	-.343		
36552.904	5	1.80 Q	-.240	$5f^7 6d7s8s$	$^9D^o$
36554.994	6	1.70	-.140	$5f^7 6d7s8s$	$^{11}D^o$
36561.898	2	1.79	+.035		
36605.235	6		-.550*		
36607.967	4	1.244	-.048		
36613.083	3	1.95	+.064	$5f^7 7d7s^2$	$^9D^o$
36702.582	4	1.45 *	-.055		
36734.277	3	1.127	-.064		
36765.454	1	1.017	-.325*		
36788.927	5	1.307	-.353		
36832.732	3	1.335	-.330*		
36856.144	5	1.271	-.168		
36867.252	4		-.435*		
36922.911	3		-.305		
36934.315	4	1.767	-.044	$5f^7 7d7s^2$	$^9D^o$
36993.38	5				
37004.97	2	1.155	-.084		
37006.552	5		-.364		
37079.181	7		-.357	$5f^8 7s7p$	
37143.490	8		-.629	$5f^8 6d7p$	$^9G^o$
37167.467	4		-.260*		
37187.570	5	1.314	+.035*		
37238.374	4		-.424		
37285.945	4		-.260*		
37290.357	6		-.404	$5f^8 7s7p$	
37344.249	3		-.036		
37367.599	8		-.580*		

Table 2 continued.

37376.863	5		-.371		
37385.310	7				
37440.439	2	1.345	+.023		
37505.186	5		-.365		
37530.102	6	1.34	-.169		
37589.094	8		-.372	$5f^8 7s7p$	
37614.640	5	1.345	-.064		
37661.903	6		-.529		
37687.591	4		-.481		
37701.062	5		-.218		
37740.381	4		-.067		
37792.931	5	1.64 *	-.143	$5f^7 7d7s^2$	$^9D^o$
37824.355	5		-.266		
37848.305	1	1.773	-.154		
37857.755	3		-.560		
37927.625	6		-.260*		
37946.650	4		-.357		
37971.538	7		-.294		
37977.872	5		-.404		
38021.450	5		-.358		
38030.719	7		-.643	$5f^8 6d7p$	
38067.602	3		-.275*		
38092.623	6	1.47	-.435	$5f^8(^7F)7s8p$	$6,\ ^3P^o_0$
38119.030	2	1.015	-.202		
38120.312	5	1.45 Q	-.160		
38125.871	7		-.449	$5f^8 7s8p$	$6,\ ^3P^o_1$
38143.828	2	1.109	-.250*		
38162.761	4		-.325*		
38162.899	3	1.29 P	-.186		
38168.031	5		-.287		
38295.962	4		-.227		
38357.394	5		-.417		
38380.870	4		-.328		
38421.701	5		-.432		
38438.254	3		-.260*		
38446.132	1		-.415		
38471.775	6		-.580*		
38496.602	5		-.250*		
38554.564	3		-.500		
38566.318	4		-.445		
38596.162	3		-.335		
38599.583	7	1.655	-.272	$5f^7 6d7s8s$	$^{11}D^o$
38612.876	2		-.444		
38633.681	7		-.301		
38744.373	3	1.46	-.288		
38799.929	2		-.255*		
38834.169	3		-.285*		
38870.75	5	1.42Q	-.047		
38888.476	2		-.209	$5f^7 6d7s8s$	

Table 2 continued.

38895.919	6			$5f^8 6d7p$	
38940.708	3		-.270*	$5f^7 6d7s8s$	
38982.955	5		-.506		
39008.858	2		-.290*		
39013.424	3		-.033		
39028.163	5	1.242d	-.149		
39119.654	1		-.251	$5f^7 6d7s8s$	$^7D^o$
39171.538	7		-.294		
39186.425	3	1.46	-.279		
39189.941	8		-.495	$5f^8 7s8p$	$6,^3P^o_2$
39215.266	3		-.335		
39249.087	6		-.470	$5f^8 7s8p$	
39310.969	2		-.258	$5f^7 6d7s8s$	$^7D^o$
39314.755	4		-.465		
39418.873	5		-.335*	$5f^8 7s8p$	
39477.374	4		-.136		
39516.15	1	0.736	-.220*		
39516.718	2		-.260*		
39573.771	7	1.555Q	-.563		
39600.368	6		-.560*	$5f^8 7s8p$	
39621.793	4		-.339		
39643.19	2		-.023		
39653,497	6	1.418e	-.524		
39670.411	8		-.527		
39742.725	6	1.59 f	-.227	$5f^7 7d7s^2$	$^9D^o$
39743.699	3		-.360*		
39753.419	3	1.60 *	-.340*		
39758.754	5		-.515	$5f^8 7s8p$	
39811.903	3		-.350*		
39860.689	4		-.411		
40035.337	7		-.403		
40055.354	4		-.056		
40090.699	6				
40126.703	3	1.46 *	-.353		
40132.563	4		-.285*		
40204.56	2		-.220*		
40376.144	4				
40444.339	6	1.37	-.463		
40451.652	7		-.772	$5f^8 6d7p$	
40491.247	4		-.336		
40491.505	6		-.280*		
40523.662	4		-.512		
40551.677	3	1.54	-.365		
40555.336	4		-.336		
40570.872	9	1.332	-.575*		
40620.130	6		-.140		
40656.303	2				
40669.190	3	1.709	-.423		

Table 2 continued.

40738.324	8		-.771	$5f^8 6d7p$
40790.490	6		-.549	
40803.443	4	1.214	-.344	
40811.788	3		-.332	
40850.220	4		-.265	
40850.988	5	1.336	-.464	
40868.422	4		-.270*	
40900.579	3		-.260*	
40934.123	4		-.300*	
40956.454	5,4		-.300	
40958.875	7		-.391	
41040.798	3		-.260*	
41060.12	1		-.093	
41074.260	5			
41135.102	2		-.270	
41183.820	5	1.496	-.392	
41281.392	2		-.251	
41314.903	5		-.361	
41324.232	6			
41340.192	8		-.677	$5f^8 6d7p$
41356.140	5	1.502	-.368	
41821.796	5		-.223	
41940.383	6		-.115	
42622.344	7		-.307	
42747.832	9		-.430*	
42891.47	5	1.224	-.240*	

Q Some question about the value.
* Approximate value.
P Paschen Back effect.
a Possibly, g=1.31
b Possibly, g=1.277
c Possibly, g=1.330
d Possibly, g=1.658
e Possibly, g=1.518
f Possibly, g=1.61

Table 3. Even energy levels of neutral Curium, ^{244}Cm I.

Energy Level (cm^{-1})	J even	g even	I.S. (cm^{-1})	Configuration Designation	
1214.203	6	1.452	-.275	$5f^8 7s^2$	^7F
4877.610	4	1.450	-.263	$5f^8 7s^2$	^7F
5136.519	5	1.463	-.262	$5f^8 7s^2$	^7F
7208.827	3	1.465	-.251	$5f^8 7s^2$	^7F
7521.122	2	1.457	-.257	$5f^8 7s^2$	^7F
8696.688	1	1.463	-.262	$5f^8 7s^2$	^7F
8887.265	0		-.260	$5f^8 7s^2$	^7F
9263.374	3	2.112	+.118	$5f^7 7s^2 7p$	(7/2,1/2)
9784.543	4	1.796	+.122	$5f^7 7s^2 7p$	(7/2,1/2)
14521.027	4	1.424	-.236	$5f^8 7s^2$	^7F +$^5D3$
15252.710	2	2.835	-.274	$5f^7 6d7s7p$	^{11}F
15302.542	6	1.14 Q	-.256	$5f^8 7s^2$	^7F +$^3H9$
15677.750	3	2.127	-.266	$5f^7 6d7s7p$	^{11}F
15721.679	5	1.755	+.080	$5f^7 7s^2 7p$	(7/2,3/2)
16314.782	4	1.842	-.226	$5f^7 6d7s7p$	^{11}F
16480.938	4	1.787	+.021	$5f^7 7s^2 7p$	(7/2,3/2)
16645.953	3	1.923	+.081	$5f^7 7s^2 7p$	(7/2,3/2)
16932.750	7	1.466	-.587	$5f^8 6d7s$	^9G
16998.505	2	2.217	+.080	$5f^7 7s^2 7p$	(7/2,3/2)
17036.200	6	1.535	-.575	$5f^8 6d7s$	^9G
17315.732	5	1.703	-.288	$5f^7 6d7s7p$	^{11}F
17656.157	8	1.459	-.576	$5f^8 6d7s$	^9G
18060.131	5	1.594	-.567	$5f^8 6d7s$	^9G
18491.582	4		-.250	$5f^8 7s^2$	$^5H1$ +$^5G2$
18865.049	6	1.63	-.305	$5f^7 6d7s7p$	^{11}F
18945.130	2		-.230*	$5f^8 7s^2$	^7F +$^3P3$
19296.028	6	1.468	-.582	$5f^8 6d7s$	^9F
19584.139	5		-.278	$5f^8 7s^2$	$^5H2$ +$^5G1$
19658.813	3	2.375	-.257	$5f^7 6d7s7p$	^{11}D
19755.816	4	1.56	-.579	$5f^8 6d7s$	^9G
19824.405	5		-.565	$5f^8 6d7s$	^9F

Table 3 continued.

19992.572	1	3.147	-.323	$5f^7 6d7s7p$	^9F
20140.640	2	1.991	-.322	$5f^7 6d7s7p$	^9F
20180.710	4	1.984	-.262	$5f^7 6d7s7p$	^{11}D
20290.550	3	1.668	-.416	$5f^7 6d7s7p$	^9F
20594.001	7	1.428	-.594	$5f^8 6d7s$	^9F
20727.743	3	1.648	-.477	$5f^8 6d7s$	^9G
20813.955	4	1.584	-.541	$5f^8 6d7s$	^9F
20853.664	5	1.544	-.505	$5f^8 6d7s$	^7F
21010.257	4	1.594	-.349	$5f^7 6d7s7p$	^9F
21020.945	5	1.72	-.352	$5f^7 6d7s7p$	^{11}D
21348.015	6	1.468	-.578	$5f^8 6d7s$	^7F
21416.352	9		-.575*	$5f^8 6d7s$	^9H
21565.178	2	1.607	-.566	$5f^8 6d7s$	^9G
21747.000	7	1.60	-.302	$5f^7 6d7s7p$	^{11}F
21786.392	6	1.71	-.291	$5f^7 6d7s7p$	^{11}D
22013.913	5	1.546	-.324	$5f^7 6d7s7p$	^9F
22099.841	3	1.727	-.558	$5f^8 6d7s$	^9F
22155.608	1	1.630	-.567	$5f^8 6d7s$	^9G
22273.180	4	1.553	-.585	$5f^8 6d7s$	^7F
22538.555	8		-.584	$5f^8 6d7s$	^9H
22615.429	7		-.606	$5f^8 6d7s$	^7G
22792.054	2	2.554	-.308	$5f^7 6d7s7p$	^9D
22806.822	6		-.570	$5f^8 6d7s$	^9D
22954.725	5	1.332	-.379	$5f^8 7s^2$	$^5F2$
23057.310	5	1.541	-.463	$5f^8 6d7s$	^9D
23083.822	3	1.985	-.325	$5f^7 6d7s7p$	^9D
23125.882	2	2.058	-.557	$5f^8 6d7s$	^9F
23215.187	5	1.435	-.509	$5f^8 6d7s$	^5F
23292.503	5	1.74	-.350	$5f^7 6d7s7p$	^9D
23306.985	4	1.866	-.327	$5f^7 6d7s7p$	^9D
23377.841	6	1.69	-.323	$5f^7 6d7s7p$	^9D
23532.585	3	1.423 P	-.587	$5f^8 6d7s$	^7F
23535.116	4	1.49 P	-.577	$5f^8 6d7s$	
23710.616	7			$5f^8 6d7s$	^9H
23833.626	6	1.428	-.558	$5f^8 6d7s$	^7G
23973.893	1	3.021	-.539	$5f^8 6d7s$	^9F

Table 3 continued.

24079.930	4	1.576	-.536	$5f^8 6d7s$	^9D
24318.835	2	1.311	-.577	$5f^8 6d7s$	
24374.710	3	1.487	-.571	$5f^8 6d7s$	
24387.558	6		-.546	$5f^8 6d7s$	^9H
24472.957	4	1.991	-.316	$5f^7 6d7s7p$	^{11}P
24572.026	5		-.578	$5f^8 6d7s$	^7G
24700.194	7	1.62	-.300	$5f^7 6d7s7p$	^{11}D
24725.952	7		-.235	$5f^8 7s^2$	^5L +$^5H2$
24748.797	3	1.758	-.542	$5f^8 6d7s$	^9D
24991.573	7		-.599	$5f^8 6d7s$	
24996.962	4	1.70	-.312	$5f^7 6d7s7p$	^7D
25001.545	5	1.37	-.572	$5f^8 6d7s$	^9H
25023.578	3	1.821	-.326	$5f^7 6d7s7p$	^7D
25029.460	2	2.235	-.535	$5f^8 6d7s$	^9D
25228.368	5	1.663	-.349	$5f^7 6d7s7p$	^{11}P
25233.937	6	1.50	-.414	$5f^7 6d7s7p$	^9F
25237.898	4	1.383	-.575	$5f^8 6d7s$	^7G
25287.770	2	1.982	-.353	$5f^7 6d7s7p$	^7D
25316.440	5	1.18	-.238	$5f^8 7s^2$	$^5H1$ +$^5I2$
25472.336	7		-.591	$5f^8 6d7s$	
25545.503	2	1.514	-.370	$5f^7 6d7s7p$	
25559.668	8	1.524	-.375	$5f^7 6d7s7p$	^{11}F
25581.306	5	1.642	-.447	$5f^7 6d7s7p$	
25608.265	1	2.93	-.357	$5f^7 6d7s7p$	^7D
25615.259	6	1.439	-.495	$5f^8 6d7s$	
25688.472	8	1.454	-.488	$5f^8 6d7s$	^7H
25704.358	4	1.362	-.558	$5f^8 6d7s$	^9H
25820.722	3	1.11	-.567	$5f^8 6d7s$	^7G
25838.365	5	1.61	-.397	$5f^7 6d7s7p$	^7D
25848.549	2	1.463	-.429*		
26107.218	3			$5f^8 7s^2$	$^5D1$ +^5P
26171.876	5		-.585	$5f^8 6d7s$	
26216.209			-.567	$5f^8 6d7s$	
26305.608	2	0.768	-.560	$5f^8 6d7s$	^7G
26388.700	7		-.609	$5f^8 6d7s$	
26447.750	3	1.901	-.311	$5f^7 6d7s7p$	^9D

Table 3 continued.

26526.894	4	1.559Q	-.208		
26599.205	5	1.296	-.572	$5f^8 6d7s$	
26625.496	6	1.476	-.610	$5f^8 6d7s$	
26730.227	4	0.883	-.234	$5f^8 7s^2$	$^5I2$
26779.400	2	2.216	-.336	$5f^7 6d7s7p$	^9D
26782.813	4	1.628	-.315	$5f^7 6d7s7p$	^9D
26905.110	3	1.460	-.150	$5f^7(^6P)7s^2 7p$	^{5}
26971.967	4			$5f^7(^6P)7s^2 7p$	
27030.022	3	1.518	-.506	$5f^8 6d7s$	
27124.748	6	1.66	-.313	$5f^7 6d7s7p$	^{11}P
27263.194	2	1.279	-.285	$5f^8 7s^2$	$^5F2$
27266.199	2	1.573	-.405	$5f^7 6d7s7p$	
27288.240	4	1.595	-.483	$5f^7 6d7s7p$	
27399.447	5	1.46	-.584	$5f^8 6d7s$	
27442.258	1	1.902	-.430	$5f^7 6d7s7p$	
27538.031	4	1.549	-.579	$5f^8 6d7s$	
27624.837	3	1.759	-.332	$5f^7 6d7s7p$	^7P
27667.740	6	1.295	-.503	$5f^8 6d7s$	
27780.979	4	1.330	-.552	$5f^8 6d7s$	
27834.174	3	1.485	-.500	$5f^8 6d7s$	
27843.945	5	1.58	-.337	$5f^7 6d7s7p$	^9D
27857.236	2	1.525	-.420		
27909.047	0		-.438	$5f^7 6d7s7p$	
28035.604	1	2.104	-.481	$5f^7 6d7s7p$	
28097.914	3	1.786	-.359	$5f^7 6d7s7p$	
28259.506	7	1.354	-.533	$5f^8 6d7s$	^7H
28381.976	1	3.046	-.433	$5f^7 6d7s7p$	^9F
28464.320	3	0.980	-.242	$5f^8 7s^2$	$^5F2$
28479.622	2	2.013	-.405	$5f^7 6d7s7p$	^9F
28495.840	7	1.50	-.351	$5f^7 6d7s7p$	^9F
28515.968	4	1.555	-.500	$5f^8 6d7s$	
28526.244	4	1.623	-.388	$5f^7 6d7s7p$	
28580.748	4	1.622	-.394	$5f^7 6d7s7p$	
28629.204	3	1.006	-.267	$5f^8 7s^2$	$^5H1$
28639.631	5	1.296	-.562	$5f^8 6d7s$	
28663.328	3	1.676	-.395	$5f^7 6d7s7p$	^9F

Table 3 continued.

28777.262	6	1.40	-.580	$5f^8 6d7s$	
28833.541	3	1.394	-.516	$5f^8 6d7s$	
28886.192	5	1.630	-.356	$5f^7 6d7s7p$	^9P
28982.651	2	0.581			
28992.823	4	1.502	-.510	$5f^8 6d7s$	
29064.195	6	1.27	-.555	$5f^8 6d7s$	
29229.382	4	1.601	-.422	$5f^7 6d7s7p$	^9F
29291.973	5	1.331	-.597	$5f^8 6d7s$	
29346.581	3	1.622	-.495	$5f^8 6d7s$	
29456.858	3	1.760	-.522	$5f^8 6d7s$	
29484.146	5	1.400	-.565	$5f^8 6d7s$	
29559.567	6	1.56	-.340	$5f^7 6d7s7p$	
29721.331	2	1.845	-.100	$5f^7 7s^2 7p$	
29830.066	6	1.54	-.368	$5f^7 6d7s7p$	^9D
29936.581	4	1.35* P	-.551	$5f^8 6d7s$	
29937.102	3	1.39* P	-.537	$5f^8 6d7s$	
29948.918	5	1.523	-.393	$5f^7 6d7s7p$	^9F
29967.270	2	1.561	-.389	$5f^7 6d7s7p$	
30026.435	2	2.181	-.334	$5f^7 6d7s7p$	^7P
30103.238	3	1.575	-.215	$5f^7 7s^2 7p$	
30216.144	2	1.834	-.435	$5f^7 6d7s7p$	
30263.310	3	1.588	-.281	$5f^7 6d7s7p$	
30373.520	3	1.604	-.467	$5f^7 6d7s7p$	
30439.897	4	1.545	-.425	$5f^7 6d7s7p$	
30573.145	5	1.454	-.395	$5f^7 6d7s7p$	
30610.456	6	1.275	-.595	$5f^8 6d7s$	^7H
30693.289	4	1.503	-.510	$5f^8 6d7s$	
30882.019	1	2.11	-.292	$5f^8 7s^2$	^5P
30886.403	2	1.810	-.448	$5f^7 6d7s7p$	
30916.690	5	1.299	-.494	$5f^8 6d7s$	
30922.380	3	1.827	-.334	$5f^7 6d7s7p$	^7P
31036.080	3	1.514	-.490	$5f^7 6d7s7p$	
31080.216	2	1.738	-.405	$5f^7 6d7s7p$	
31162.346	5	1.67	-.297	$5f^7 6d7s7p$	
31185.822	3	1.319	-.430	$5f^7 6d7s7p$	
31264.290	1	1.968	-.380	$5f^7 6d7s7p$	

Table 3 continued.

31413.242	2	1.258	-.480		
31427.145	5	1.63	-.364	$5f^7 6d7s7p$	
31446.365	3	1.86	-.347	$5f^7 6d7s7p$	
31468.066	4	1.536	-.379	$5f^7 6d7s7p$	
31493.406	3	0.915	.0*	$5f^7 7s^2 7p$	
31574.145	2	1.154	-.503		
31580.761	5	1.24	-.592	$5f^8 6d7s$	^7H
31582.247	4	0.961	+.008	$5f^7 7s^2 7p$	
31655.785	3	1.308	-.198	$5f^8 7s^2$	^5P
31721.565	4	1.415	-.455	$5f^7 6d7s7p$	
31730.560	1	2.221	-.440	$5f^7 6d7s7p$	^5P
31730.976	4	1.198	-.460	$5f^7 6d7s7p$	
31750.187	2	1.360	-.521		
31763.813	3	1.85	-.336	$5f^7 6d7s7p$	
31954.420	4	1.51	-.430	$5f^7 6d7s7p$	
31957.228	1	2.526	-.066	$5f^7 7s^2 7p$	
31975.645	1	1.537	-.526		
31982.845	2	1.445	-.288	$5f^8 7s^2$	^5P
32032.836	6	1.194	-.577	$5f^8 6d7s$	
32078.886	2	1.769	-.474	$5f^7 6d7s7p$	^5P
32189.832	4	1.78	-.218	$5f^7 7s^2 7p$	
32237.997	5		-.536	$5f^8 6d7s$	
32239.115	6	1.547	-.335	$5f^7 6d7s7p$	^9F
32275.166	3	1.563	-.503		
32287.516	3	1.698	-.477	$5f^7 6d7s7p$	
32317.117	4	1.139	-.149	$5f^8 7s^2$	$^5G2$
32441.099	4	1.302	-.488	$5f^7 6d7s7p$	
32539.889	1	1.298	-.540		
32581.072	2	2.043	-.528		
32669.447	5		-.455	$5f^7 6d7s7p$	
32698.525	3	1.423	-.498		
32715.468	5		.0*	$5f^7 7s^2 7p$	
32762.036	6	1.58	-.349	$5f^7 6d7s7p$	
32770.516	4	1.548	-.397	$5f^7 6d7s7p$	
32787.885	4	1.28	-.520	$5f^8 6d7s$	^7H
32798.878	3	1.604	-.452	$5f^7 6d7s7p$	^5P
32957.965	3		-.536		
33013.038	7	1.54	-.460	$5f^8(^7F)7s8s$	$6,^3S_1$

Table 3 continued.

33030.796	4		-.040	$5f^7 7s^2 7p$	
33121.760	5	1.457	-.251		
33166.997	3		-.375	$5f^7 6d7s7p$	
33259.502	3	1.096	-.535	$5f^8 6d7s$	^7H
33350.543	4	1.335	-.119		
33391.146	3	1.473	-.465	$5f^7 6d7s7p$	
33433.144	7	1.54	-.363	$5f^7 6d7s7p$	^9F
33439.281	2	1.758	-.501		
33467.965	1	2.022	-.395	$5f^7 6d7s7p$	
33518.274	4	1.488	-.379	$5f^7 6d7s7p$	
33522.390	3	1.474	-.561		
33621.640	1	2.421	-.407	$5f^7 6d7s7p$	
33630.995	5	1.419	-.035	$5f^7 7s^2 7p$	
33656.768	3		-.141		
33734.652	6	1.59	-.457	$5f^8 7s8s$	$6,^3S_1$
33846.109	6		-.539	$5f^8 6d7s$	
33860.109	3	1.40	-.417		
33914.828	2	0.60	-.540	$5f^8 6d7s$	^7H
33950.094	4		-.397		
33994.860	5	1.59	-.233		
34077.411	4	1.235	-.254		
34255.866	4	1.396	-.339		
34262.055	2	1.520	-.402		
34290.497	5	1.466	-.526	$5f^7 6d^2 7p$	^{11}G?
34317.240	5	1.407	-.545		
34321.111	3	1.257	-.262		
34414.181	3	1.366	-.240		
34520.337	4	1.573	-.335	$5f^7 6d7s7p$	
34526.179	5	1.498	-.296	$5f^7 6d7s7p$	
34616.958	7		-.568	$5f^8 6d7s$	
34624.467	2	1.525	+.010	$5f^7 7s^2 7p$	
34845.707	6	1.521	-.466	$5f^7 6d7s7p$	
34854.957	4	P	-.333	$5f^7 6d7s7p$	
34858.388	5	1.38 P	-.343	$5f^7 6d7s7p$	
34944.366	1	2.224	-.487		
34960.036	2	2.10	-.312		
35092.719	7	1.247	-.551		
35097.890	5	1.40	-.466	$5f^8 7s8s$	$6,^3S_1$
35139.545	5	1.230	-.470		
35144.887	6	1.15	-.396		
35285.157	3	1.153	-.319		
35335.354	7	1.525	-.376	$5f^7 6d7s7p$	

Table 3 continued.

35459.796	6	1.56	-.381		
35461.448	4	1.33	-.245		
35463.05	3		-.163		
35540.697	3	2.00	+.140	$5f^7 7s^2 8p$	(7/2,1/2)
35591.160	6	1.45	-.468	$5f^8 7s8s$	$6, {}^1S_0$
35596.599	4		-.020	$5f^7 7s^2 8p$	(7/2,1/2)
35656.708	5		-.181		
35746.242	4		-.165		
35838.784	6	1.423	-.543	$5f^7 6d^2 7p$	${}^{11}G$?
35906.598	4		-.150		
35943.297	6	1.345	-.500		
36043.622	5		-.286	$5f^7 6d7s7p$	
36064.69	3		-.154		
36074.166	5		-.292		
36128.775	2	2.733	-.630	$5f^7 6d^2 7p$	${}^{11}F$
36157.108	3	1.48	-.239		
36162.039	4		-.030	$5f^7 7s^2 8p$	(7/2,3/2)
36256.910	3		-.010*	$5f^7 7s^2 8p$	(7/2,3/2)
36314.097	5	1.62*	-.190	$5f^7 7s^2 8p$	(7/2,3/2)
36333.832	3		-.360		
36381.26	4		-.487Q		
36390.781	4	1.58	-.229		
36439.710	2		-.275		
36505.373	3	1.931	-.546	$5f^7 6d^2 7p$	${}^{11}F$
36516.760	3	1.545	-.231		
36637.250	2,3				
36696.128	4	1.236	-.381		
36764.934	5		-.522		
36776.731	4	1.351	-.246		
36782.294	3	1.35	-.395		
36822.674	6	1.30	-.321		
36825.778	1	1.609	-.445		
36842.840	3	1.575	-.271		
36869.950	5	1.53	-.445	$5f^8 7s8s$	$4, {}^3S_1$
36888.798	4	1.71	-.263		
36936.015	3				
36972.302	3		-.245	$5f^8 7s^2$	
37003.906	2	1.31	-.220Q		
37112.019	2	1.304	-.431		
37127.972	6		-.525		
37134.820	0		-.406		
37181.675	7	1.542	-.665	$5f^7 6d^2 7p$	${}^{11}G$
37207.150	3	1.55	-.375		
37233.173	1	1.44	-.530		
37288.977	6	1.51	-.468	$5f^8 7s8s$	$5, {}^3S_1$

Table 3 continued.

37309.665	4	1.457	-.486		
37353.280	4		-.448	$5f^8 7s8s$	$4,{}^3S_1$
37381.047	1	1.139	-.509		
37408.967	4	1.578	-.546	$5f^7 6d^2 7p$	${}^{11}F$
37469.132	5		-.288	$5f^8 7s^2$	
37560.925	4	P	-.331		
37561.848	5	1.66 P	-.187		
37631.966	6	1.48	-.813	$5f^8 7p^2$	${}^9G$ or (6,0)
37906.378	3				
37986.154	5		-.505	$5f^8 7s8s$	$5,{}^3S_1$
38012.626	2	2.038	-.430	$5f^7 6d7s7p$	
38018.743	4		-.267		
38021.152	3	1.36	-.346		
38043.687	7		-.817	$5f^8 7p^2$	(6,1)
38110.940	3	1.52	-.299		
38129.260	5	1.34	-.643		
38151.183	3		-.289		
38201.153	7		-.580*		
38205.349	5	1.465	-.651	$5f^7 6d^2 7p$	
38208.978	4	1.36	-.430		
38272.743	3		-.429	$5f^8 7s8s$	$4,{}^3S_1$
38301.545	5	1.57	-.589	$5f^7 6d^2 7p$	${}^{11}F$
38302.724	4	1.15	-.155		
38342.599	2	1.294	-.522		
38373.257	4	1.400	-.468		
38413.650	7		-.590*		
38417.244	3	1.472	-.376		
38433.241	4	1.325	-.581		
38492.676	3	1.21	-.415		
38512.607	4	1.546	-.549		
38556.377	6,5		-.540*		
38563.043	5	1.337	-.433		
38599.366	3	1.387	-.398		
38622.375	8		-.799	$5f^8 7p^2$	(6,2)
38654.118	0		-.340*		
38667.384	2	1.44 P	-.460		
38676.405	5	1.340	-.491		
38680.458	1	1.444 P	-.473		
38680.515	4		-.394	$5f^8 7s8s$	$5,{}^3S_1$
38725.339	5	1.036	-.181		
38799.895	4	1.385	-.479		
38815.956	3	1.532	-.355		
38856.112	4	1.209	-.310		
38887.933	3	1.379	-.477		
38898.151	4	1.322	-.379		
38973.816	6	1.49	-.563		

Table 3 continued.

39071.507	8	1.529	-.705	$5f^7 6d^2 7p$	^{11}G
39117.339	3	1.696	-.463		
39160.598	4	1.361	-.522		
39187.625	5	1.348	-.265		
39202.873	2	1.662	-.423		
39288.895	4	1.507	-.522		
39303.802	6	1.46	-.625		
39318.713	7		-.512		
39331.590	1	2.779	-.502	$5f^7 6d^2 7p$	^9F
39344.782	6	1.41	-.540		
39360.577	5	1.435	-.311		
39373.648	4	1.42*	-.464	$5f^8 7s8s$	$3,^3S_1$
39379.610	6		-.535		
39422.933	7		-.530*		
39435.397	6	1.63	-.616	$5f^7 6d^2 7p$	^{11}F
39449.530	8	1.429	-.530*		
39474.495	2		-.512		
39476.241	3		-.425	$5f^8 7s8s$	$3,^3S_1$
39542.600	7	1.61	-.473		
39660.600	2		-.291		
39665.624	2		-.257		
39699.230	0			$5f^8 7s8s$	$1,^3S_1$
39704.977	4		-.291		
39737.141	8		-.537		
39764.464	5		-.435		
39849.573	3	2.13	-.526		
39857.618	7		-.550		
39975.839	4	1.640	-.378		
39995.022	5	1.477	-.515		
39999.680	6		-.318		
40026.02	4	1.173	-.205		
40029.750	3	1.989	-.485		
40038.578	5	1.450	-.467		
40043.28	3		-.296		
40118.222	2	1.76	-.483		
40160.505	4	1.59	-.520		
40186.625	4	1.52	-.481		
40205.194	1	2.317	-.452	$5f^8 7s8s$	$0,^3S_1$
40228.361	7		-.481		
40263.761	3	1.32	-.303		
40287.35	3	1.153	-.285		
40288.014	7	1.269	-.340		
40335.864	1		-.422		
40370.79	2	1.48	-.350		
40440.742	4	1.70	-.396	$5f^7 6d7s7p$	
40446.678	6	1.533	-.562		
40521.99	1	1.62	-.297		
40548.722	4		-.482		

Table 3 continued.

40570.41	1	0.75	-.285		
40582.239	1,2				
40603.671	4	1.57	-.479		
40634.889	5	1.46	-.388		
40663.886	7	1.36	-.614	$5f^7 6d^2 7p$	
40672.61	4		-.480		
40687.745	7	1.353	-.613	$5f^7 6d^2 7p$	
40731.190	3		-.416		
40772.800	5	1.25	-.449		
40782.621	4	1.62	-.351		
40794.82	3		-.297		
40984.99	3		-.261		
41026.165	6		-.489		
41063.373	3	1.91	-.193		
41112.570	6		-.470		
41241.23	3		+.170	$5f^7 7s^2 9p$?	(7/2,3/2)?
41252.51	2		+.185	$5f^7 7s^2 9p$?	(7/2,3/2)?
41266.103	1	1.48	+.158		
41298.34	3		-.358		
41405.895	5	1.713	-.570		
41408.539	8	1.63 Q	-.620*		
41479.26	6	1.534	-.594		
41683.747	8	1.38	-.665	$5f^7 6d^2 7p$	
41703.57	7		-.490*		
41729.542	8	1.236	-.563		
41759.291	7		-.500*		
41826.610	7	1.57*	-.585	$5f^7 6d^2 7p$	^{11}F
41832.479	8	1.301	-.415*		
41950.759	8	1.37	-.690	$5f^7 6d^2 7p$	
42104.385	3	1.87	-.340*		
42255.938	6		-.663	$5f^7 6d^2 7p$	
42264.04	9	1.527	-.714	$5f^7 6d^2 7p$	^{11}G
42357.283	6		-.680	$5f^7 6d^2 7p$	
42408.38	5		-.380*		
42454.025	5		-.330*		
42645.18	2		-.290		
42921.180	7	1.37	-.517		
44788.725	8	1.53	-.534	$5f^7 6d^2 7p$	^{11}F

Q doubtful value.
* approximate value.
P Paschen-Back effect.
? Uncertain configuration and designation.

Table 4. Lowest Levels of Identified Configurations in ^{244}Cm I.

Energy Level (cm^{-1})	g value	Isotope Shift (cm^{-1})	Configuration	Designation
ODD				
0.000	2.563	X	$5f^7 6d 7s^2$	$^9D^o_2$
10144.927	2.873	X-0.339	$5f^7 6d^2 7s$	$^{11}F^o_2$
17656.659	1.621	X-0.453	$5f^8 7s 7p$	$(6,0)_6$
28635.021	1.731	X-0.128	$5f^7 7s^2 8s$	$^9S^o_4$
30443.915	2.53	X-0.620	$5f^7 6d^3$	$^{11}F^o_2$
31167.969	1.759	X-0.180	$5f^7 7s 7p^2$	$^{11}P^o_4$
32876.853	---	X-0.720	$5f^8 6d 7p$	$^9H^o_8$
34255.175	2.064	X-0.206	$5f^7 6d 7s 8s$	$^{11}D^o_3$
36481.440	2.373	X+0.103	$5f^7 7d 7s^2$	$^9D^o_2$
38092.623	1.47	X-0.435	$5f^8 7s 8p$	$(6,0)_6$
EVEN				
1214.203	1.452	X-0.275	$5f^8 7s^2$	$^7F_6$
9263.374	2.112	X+0.118	$5f^7 7s^2 7p$	$(7/2,1/2)_3$
15252.710	2.835	X-0.274	$5f^7 6d 7s 7p$	$^{11}F_2$
16932.750	1.466	X-0.587	$5f^8 6d 7s$	$^9G_7$
33013.038	1.54	X-0.460	$5f^8 7s 8s$	$(6,1)_7$
34290.497	1.466	X-0.526	$5f^7 6d^2 7p$	$^{11}G_5$
35540.697	2.00	X+0.140	$5f^7 7s^2 8p$	$(7/2,1/2)_3$
37631.966	1.48	X-0.813	$5f^8 7p^2$	$(6,0)_6$
41241.23	---	X+0.170	$5f^7 7s^2 9p$?	$(7/2,3/2)_3$?

?, Uncertain Configuration and designation.

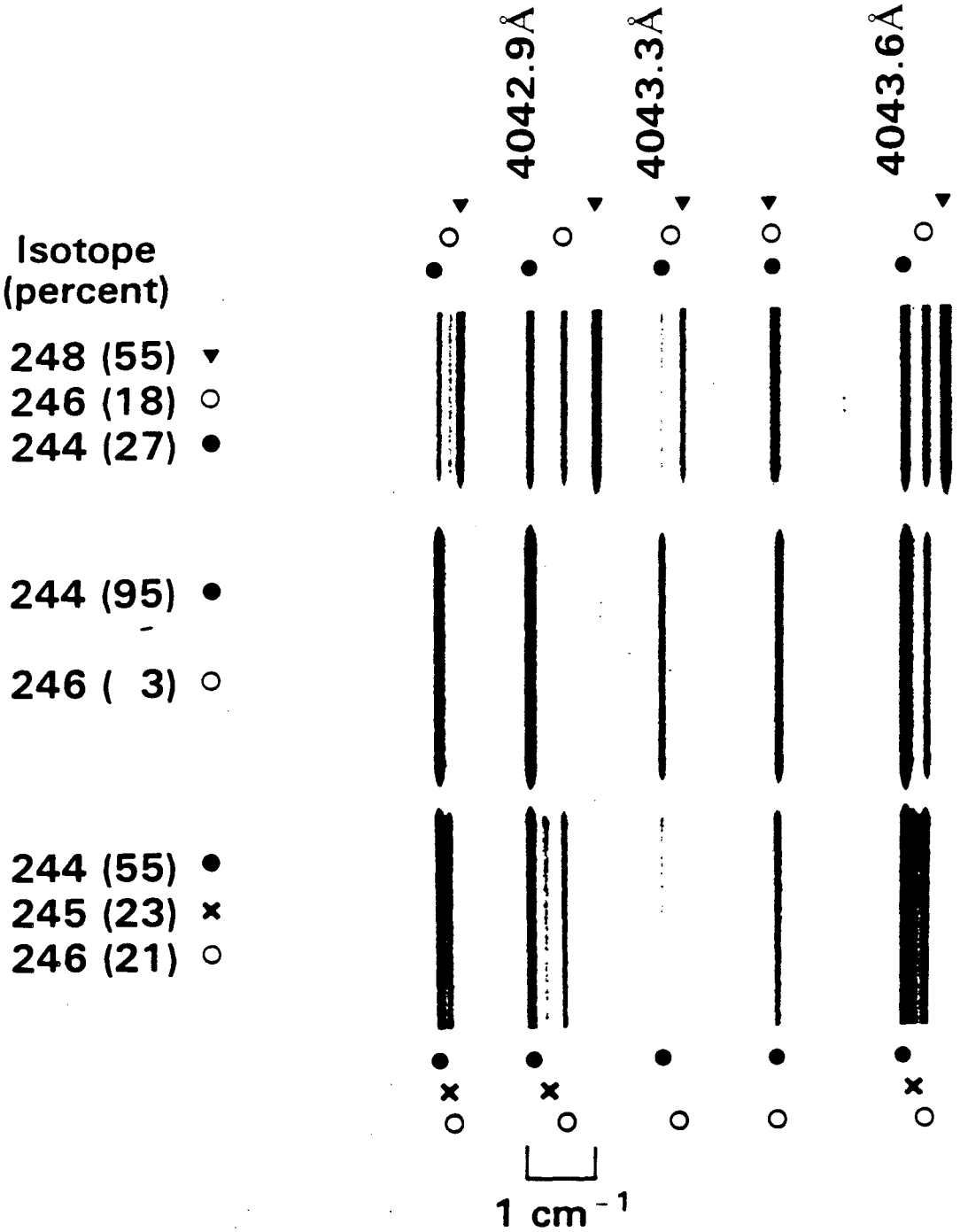

FIGURE 1: A 1.5 Å region of the curium spectrum showing the isotope shift for four isotopes. Spectra of three isotopically different samples are shown. Photographed on the ANL 9.15 m spectrograph.

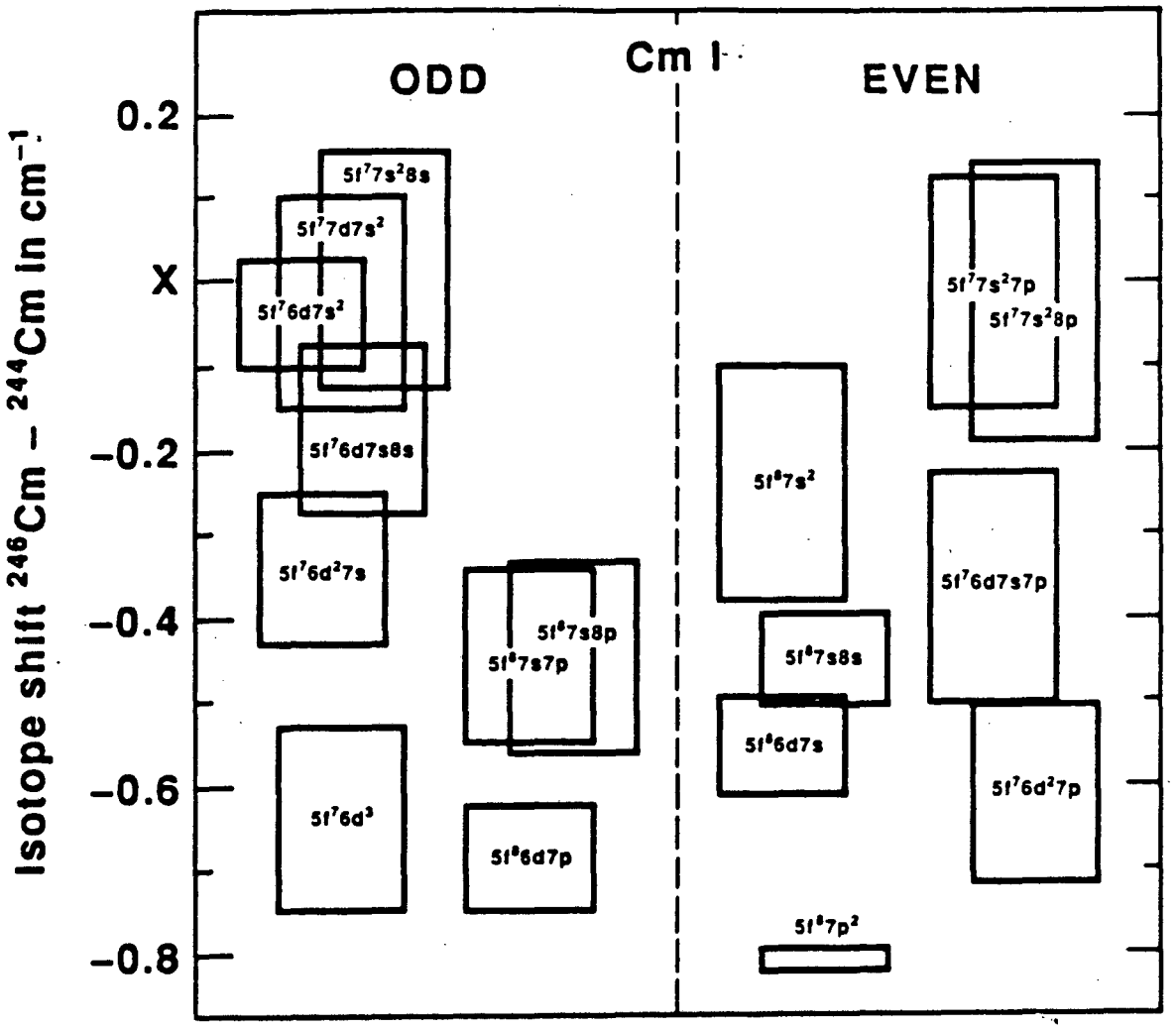

FIGURE 2. Range of observed isotope shifts for seventeen electronic configurations of Cm I. The value of X is about 0.85 cm^{-1} (see text).

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