Compton,[6]

$$R_c = Z^2 f^2 + Z(1-f^2), \quad (9)$$

where f is the common value of the structure factor for all of the electrons. This is no longer identical with the first two terms of Eq. (3), and is found[8] to be in somewhat less satisfactory agreement with the experiments.

Though we are accustomed to think of the Schrödinger ψ_n functions as distributed continuously throughout space, these functions are strictly speaking in $3n$-dimensional space. The apparent overlapping of the functions is merely a convenient 3-dimensional approximation. Thus the discreteness of the electrons in the classical theory corresponds on the wave-mechanics theory to equally discrete ψ_n functions, which are completely separated by being in different dimensions.

The closest classical analog to the wave-mechanical atom is thus one composed of discrete electrons, each of which has its own characteristic probability $\psi_n \psi_n^* d\tau$ of occurring within a given volume element.[9] It is accordingly proper not only to speak of electrons occurring within the atom, but also to distinguish each individual electron by the name of the corresponding quantum state. That is, K electrons are distinguishable from L electrons, etc. Thus for treatment of scattering problems, individual electrons grouped within the atom form the most nearly adequate classical picture corresponding to the continuous de Broglie waves of the wave-mechanics atom.

[8] G. Herzog, Zeits. f. Physik **69**, 207 (1931); E. O. Wollan, Rev. Mod. Phys. **4**, 241 (1932).

[9] Cf. A. H. Compton, Phys. Rev. **35**, 931 (1930), and Tech. Rev. Mass. Inst. **33**, 19 (1930). The conclusion there drawn was that the observed presence of incoherent scattering indicated that the discrete electron interpretation of $\psi\psi^*$ was necessary to bring agreement between theory and experiment. This argument was criticized by G. Herzog (reference 8), because of a supposed lack of agreement between the classical and quantum formulas, and because the concept of discrete electrons does not enter into the quantum theory of scattering. The statement that the best *classical* interpretation of $\psi\psi^*$ is the probability of occurrence of discrete electrons seems to be the legitimate conclusion from the considerations here advanced.

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The Arc Spectrum of Samarium and Gadolinium. Normal Electron Configurations of the Rare Earths

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A partial analysis which includes most of the low temperature lines is presented for Sa I and Gd I: 453 lines, 175 levels for Sa I; 71 lines, 35 levels for Gd I. The normal configuration and lowest state of Sa I is $4f^6 6s^2\ ^7F$; for Gd I is $4f^7 5d 6s^2\ ^9D$. It is also shown that the normal configuration for Tm I is probably $4f^{13} 6s^2$. There exists in the rare earth group the same type of variation of relative binding between the $4f$ and $5d$ electrons as exists between the s and d electrons in the long periods. In the rare earth group the $5d$ electron is most tightly bound at the beginning and middle of the group and has a minimum just before the middle and at the end of the group.

INTRODUCTION

THE region of the periodic table least investigated by spectroscopists is that occupied by the fourteen elements from cerium to lutecium, inclusive,—the so-called rare earths. With the exception of thulium, ytterbium and lutecium, the arc and spark spectra of the rare earths are of extreme complexity. Indeed, the number of lines obtained appears to depend only on the amount of exposure given. Even if one adheres to the strictest selection rules for L, S, J and parent terms, a fundamental electron transition in neutral gadolinium can yield more than 20,000 lines, and if only the J selection rule is retained, there is a possibility of more than 18,000,000 lines, whereas the identical electron jump in

caesium gives two lines. These figures indicate the apparent futility of an attempt by any worker to push the observation of a rare earth spectrum to its limit.

With the exception of the three elements mentioned above, by far the greater number of the intense lines of an arc exposure belong to the ionized rare earth atom. The work of King[1] on the furnace spectra of the rare earths has shown that the spectrum of the neutral atom is very poorly developed in an arc source. Many neutral lines that are comparatively well developed in the furnace appear so faint in the arc that they have not been measured, while a large number more are masked in the arc by the more intense ionized lines. It is practically impossible to analyze the spectrum of the neutral atom with only the use of arc and spark exposure data. Additional data from the furnace or from absorption measurements must be added.

The most characteristic rare earth spectra are shown by the end-group, thulium, ytterbium and lutecium, and by europium, which precedes the middle. Many of the lutecium and ytterbium lines have already been explained by Meggers and Scribner[2] and by Meggers and Russell[3] as resulting from transitions involving s, p and d electrons. The $4f$ shell is completely filled and contributes nothing to the term types. The europium spectrum is quite complex, but it does have a special character due to a small group of lines of outstanding intensity. These lines have been explained by the writer[4] and by Russell and King.[5] They result from transitions involving s, p and d electrons and configurations built on the parent term $4f^7\ {}^8S$, which does not contribute to the L value of the resulting terms. Thus, although the most intense rare earth lines have been classified, no terms have been found for which the $4f$ electrons contribute to the L value.

[1] Numerous articles in Astrophys. J., Spectroscopic bibliography, R. C. Gibbs, Rev. Mod. Phys. **4**, 278 (1932).
[2] W. F. Meggers and B. F. Scribner, Bur. Standards J. Research **5**, 73 (1930).
[3] W. F. Meggers and H. N. Russell, unpublished material. C. E. Moore, *Term Designations for Excitation Potentials*, Princeton Observatory and Carnegie Institute at Mt. Wilson.
[4] W. E. Albertson, Phys. Rev. **45**, 499 (1934).
[5] H. N. Russell and A. S. King, Phys. Rev. **46**, 1023 (1934).

Analysis of the Arc Spectrum of Samarium

Experimental Data

Following the above-mentioned elements, the next most characteristic spectra are those of samarium, gadolinium, dysprosium and holmium. An extensive temperature classification of samarium has recently been completed by King.[6] The author is greatly indebted to Dr. King, who was generous enough to send a duplicate list of the neutral lines prior to publication. The list contains 422 Class I and II lines, many of which are comparatively intense in the arc and reversed in the furnace, and more than 1200 Class III, IV and V lines. The latter classes appear in two distinct wavelength regions; one from the long waves to about 5100A, the other, from 3900A to short waves. King's data have been supplemented with absorption data recorded by Paul.[7] These data for 337 lines extend from 7755A to 3527A. Although absorption lines were found out to 8700A, none of them belonged to samarium. Nearly all the Class I and the strong Class II lines in this region and strong Class III lines of wavelength less than 3900A appear in absorption.

Results

The results of the analysis of the data are given in Tables I and II. Table I contains all the classified lines (453) that involve levels which are probably real. Over 200 lines are omitted from the list as they involve levels that do not show enough combinations to be accepted with confidence as being real. Most of these levels are no doubt real but they are all omitted as at present there is no way of telling which ones are spurious. Table I also contains all unclassified Class I lines of wavelength less than 7756A. Column 1 gives the wavelength from King's data; Column 2 the arc intensity; Column 3 the furnace intensity with temperature class; Column 4, absorption intensity; Column 5, the wave number in vacuum; Column 6, term combinations. The absorption intensities can be compared only over a small wavelength range. Table II contains the level number, energy of level in cm^{-1} and tentative J value.

[6] A. S. King, unpublished material.
[7] F. W. Paul, M.Sc. Thesis, M. I. T. (1934).

As is seen from Table II, the analysis has yielded a set of seven low levels, each having a different J value, increasing in order. A systematic search has shown that there are no other levels below 12,000 cm^{-1} that combine readily with the middle and high levels already found. This is quite in agreement with the fact that only a few absorption lines remain to be explained.

At the present time all books on the subject state that the normal electron configuration for a rare earth is $4f^n5d6s^2$ where n increases progressively from 1 for cerium to 14 for lutecium. If such were the fact, then the normal configuration for samarium should be $4f^55d6s^2$. $4f^5$ gives rise to the following terms:

$^2PDFGHIKLMNO \quad ^4SPDFGHIKLM \quad ^6PDH.$

Most of the quartet and doublet terms appear several times for each value of L. Let us consider just the ^6H multiplet, since it will be the lowest and most important. The addition of the $5d$ electron to ^6H gives rise to a pentad of septet and quintet multiplets, all expected to be fairly low in Sa I. Since only a single septet multiplet accounts for nearly all the low temperature lines and no other low levels could be found, the normal configuration of Sa I is obviously not $4f^55d6s^2$. Another configuration likely to be found low is $4f^66s^2$. This configuration yields only one septet multiplet, ^7F. Furthermore it is known that when a d shell lacks a single electron of being half filled, i.e., d^4, there is but a single multiplet of highest multiplicity, and it lies far below all other levels from the same configuration. These facts suggest quite strongly that the normal configuration of Sa I is $4f^66s^2$.

The chief electron configurations and transitions of Sa I are expected to be

(1) $4f^66s^2 - 4f^66s6p$,
(2) $4f^66s^2 - 4f^55d6s^2$,
(3) $4f^55d6s^2 - 4f^55d6s6p$,
(4) $4f^66s6p - 4f^55d6s6p$.

In (1) the chief multiplets will be built on the ^7F parent term. The upper configuration will yield the triads $^7F6s6p$(^{9}, ^7DFG, ^{7}, ^5DFG). Although the identification is uncertain, it is believed that most of the nonet and septet levels have been found. They occur at energy values quite near those for the corresponding multiplets built on ^8S of Eu I[5]. Table III gives a typical multiplet ^7FG, the first complete septet multiplet yet found.

The configurations involving the $5d$ electron will yield an enormous number of multiplets. Most of the middle and high levels in Table II, probably belong to $4f^55d6s^2$.

Numerous recurring frequency differences among the intense long wavelength Class III and IV lines have been found with the aid of the mechanical interval sorter.[8] Thus far they have defied attempts to link them together. These intervals probably belong to the configurations involving a $5d$ electron.

The Normal Electron Configuration for the Rare Earths

The normal configuration of Eu I has already been shown by Russell and King[5] to be $4f^76s^2$ instead of the previously supposed $4f^65d6s^2$. This result, with that of Sa I, suggested that the normal configuration of Gd I is $4f^86s^2$ giving identical multiplets with Sa I but inverted. King's data for gadolinium[9] is not complete (4680–3840A) but it does cover the most important region of the spectrum. The results of an analysis of these data are presented in Tables IV and V. Table IV contains all the Class I and II lines and Table V the energy values of the levels with tentative J values. It is seen that nearly all of King's lines result from transitions between middle levels and a low regular multiplet of five levels. The low multiplet eliminates $4f^86s^2$ and answers quite well for ^9D, the expected normal state from $4f^75d6s^2$.

The unpublished data of King for Tm I[10] indicate an extremely simple structure for the low levels. Only a few lines appear, most of which are strong and reversed. The two most probable configurations are $4f^{12}5d6s^2$ and $4f^{13}6s^2$. The former configuration yields 107 levels and the latter only 2. The experimental data, although they have thus far defied analysis favor $4f^{13}6s^2$.

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[8] G. R. Harrison, R. S. I. **4**, 581 (1933).
[9] A. S. King, Astrophys. J. **72**, 221 (1930).
[10] A. S. King, unpublished material; Phys. Rev. **38**, 583 (1931).

TABLE I. *Classified lines of* Sa I.

I.A.	Int. and Temp. Class Arc	Fur.	Abs.	ν(vac)	Designation
8027.5	1	− 15 IIA		12,453.8	6 − 15
7907.48	5	40 IA		12,642.78	5 − 11
7787.02	8	60 IA		12,838.35	7 − 20
7755.32	?	80 IA	1	12,890.83	4 − 9
7686.70	8	60 IA	1	13,005.91	6 − 17
7580.91	5	60 IA	2	13,187.40	3 − 8
7554.14	8	60 IA	2	13,234.14	5 − 13
7513.3	2	8 IIA		13,306.1	5 − 15
7446.2	1	− 5 IIA		13,426.0	4 − 11
7403.30	8	60 IA	3	13,503.78	$^7F - {}^9G$
7378.04	5	60 IA	2	13,550.01	4 − 12
7367.9	1	− 4 IIA		13,568.6	3 − 9
7332.65	60	100 I	2	13,633.88	7 − 27
7279.25	80	100 I	4	13,733.90	6 − 20
7262.69	3	20 IIA		13,765.21	6 − 21
7213.82	80	100 I	10	13,858.47	5 − 17
7172.67	40	30 I	1	13,937.88	5 − 18
7141.13	30	100 I	10	13,999.53	1 − 8
7131.80	100	150 I	12	14,017.84	4 − 13
7114.50	10	80 I	3	14,051.93	3 − 10
7106.23	100	150 I	10	14,068.29	$^7F - {}^9G$
7104.54	150	200 I	10	14,071.63	$^7F - {}^9G$
7101.46	10	50 I	1	14,077.74	4 − 14
7096.33	100	150 I	12	14,087.91	2 − 9
7095.50	150	200 I	15	14,089.56	4 − 15
7091.16	100	150 I	4	14,098.19	$^7F - {}^9G$
7088.30	150	250 I	20	14,103.87	3 − 11
7056.55	40	40 I		14,167.33	
7026.62	100	200 IA	12	14,227.67	3 − 12
7002.03	2	60 IA		14,277.64	7 − 34
6912.79	3	100 IIA	1	14,461.96	6 − 26
6880.86	20	200 II	3	14,529.07	6 − 27
6860.93	300	300 I	15	14,571.27	2 − 10
6853.92	15	150 IIA	2	14,586.17	5 − 20
6839.23	10	100 IIA	1	14,617.50	5 − 21
6827.81	40	150 IA	2	14,641.95	4 − 17
6802.96	50	150 IA	2	14,695.43	3 − 13
6790.88	30	60 IA	1	14,721.57	4 − 18
6779.16	100	200 IA	5	14,747.03	2 − 12
6775.30	60	150 IA	3	14,755.43	3 − 14
6759.25	60	15 III		14,790.46	7 − 41
6725.88	300	200 I	10	14,863.85	1 − 10
6671.51	800	400 I	3	14,984.98	
6588.91	500	300 I	4	15,172.83	6 − 34
6580.53	50	200 IA	2	15,192.16	
6566.36	80	100 I	2	15,224.94	6 − 36
6563.52	150	200 I	2	15,231.53	5 − 24
6562.64	10	80 IA		15,233.57	7 − 48
6558.18	8	50 IA	1	15,243.95	7 − 49
6551.80	200	300 I	3	15,258.77	
6544.95	40	150 IA	3	15,274.75	2 − 14
6536.83	30	150 IA	3	15,293.72	5 − 25
6533.96	200	300 I	5	15,300.44	
6532.25	200	300 I	5	15,304.44	
6528.02	200	250 I	4	15,314.36	5 − 26
6509.44	50	300 IA	6	15,358.07	2 − 16
6501.00	25	100 IA		15,378.01	6 − 39
6492.05	5	25 IIA		15,399.11	3 − 18
6491.28	15	100 IA		15,401.03	4 − 21
6425.90	200	250 I	2	15,557.73	5 − 29
6387.79	4	100 IA		15,650.55	1 − 16
6373.50	10	100 IIA		15,685.64	6 − 41
6373.29	4	60 IIA		15,686.16	5 − 30
6371.01	150	150 I	2	15,691.77	7 − 52
6367.41	250	250 I	5	15,700.64	4 − 22
6295.97	15	80 IIA		15,878.80	2 − 19
6273.29	15	100 IA	2	15,936.20	5 − 32
6258.94	4	30 IIA		15,972.74	4 − 23
6242.39	60	200 IA	2	16,015.08	4 − 24
6229.07	3	20 IIA		16,049.33	6 − 45
6226.70	100	20 II		16,055.44	5 − 35
6222.55	15	30 IA		16,066.15	6 − 46
6218.23	50	150 IA	1	16,077.31	5 − 36 4 − 25
6198.37	30	125 IA	2	16,128.82	6 − 48
6196.83	2	25 IIA		16,132.83	7 − 56
6194.39	200	200 I	3	16,139.18	6 − 49
6174.45	150	150 I	2	16,191.30	
6159.56	150	200 I	2	16,230.45	5 − 39
6117.79	40	150 IA	2	16,341.26	4 − 29
6103.95	3	15 IIA		16,378.31	3 − 22
6099.90	40	200 IA	3	16,389.19	
6096.55	6	80 IA	1	16,398.19	2 − 19
6084.12	400	250 I	4	16,431.69	
6070.06	300	200 I	4	16,469.75	4 − 30
6045.00	300	150 I	3	16,538.03	5 − 41
6027.52	40	100 IA		16,585.99	4 − 31
6027.16	150	150 I	2	16,586.98	6 − 52
6004.18	200	200 I	5	16,650.46	3 − 23
5995.09	125	100 I	2	16,675.71	5 − 42
5989.68	50	150 IA	2	16,690.77	1 − 19
5979.38	200	200 I	4	16,719.52	4 − 32
5936.92	2	8 IIA		16,839.10	4 − 35
5927.89	20	60 IIA		16,864.75	6 − 54
5916.36	80	150 IA	3	16,897.61	2 − 22
5914.91	12	40 IA		16,901.76	5 − 45
5909.04	80	40 I	1	16,918.54	5 − 46
5906.05	50	40 I	1	16,927.11	4 − 37
5902.60	80	40 I	1	16,937.00	5 − 47
5895.35	4	20 IA		16,957.83	3 − 28
5883.68	10	50 IIA	1	16,991.47	5 − 49
5875.92	40	100 IA	1	17,013.91	4 − 39
5874.21	200	150 I	3	17,018.86	3 − 29
5871.06	150	125 I	2	17,027.99	6 − 56
5868.61	200	125 I	2	17,035.10	7 − 63
5867.79	250	80 II	2	17,037.48	6 − 57
5866.23	1	− 20 III		17,042.01	7 − 64
5860.78	4	40 IIA		17,057.86	6 − 58
5822.61	5	40 IA		17,169.68	2 − 23
5802.84	300	100 I	4	17,228.17	5 − 50
5790.91	8	50 IA		17,263.67	3 − 31
5798.38	200	80 I	3	17,271.21	6 − 59
5779.24	200	100 I	3	17,298.53	4 − 40
5746.50	5	50 IIA		17,397.08	3 − 32
5741.19	3	4 I		17,413.18	3 − 33
5732.95	300	150 II	2	17,438.20	7 − 68
5726.06	3	10 IIA		17,459.18	4 − 42
5720.19	125	60 II	2	17,477.10	2 − 28
5711.45	40	60 II	1	17,503.84	5 − 53
5707.22	3	25 IA		17,516.82	3 − 35
5706.75	80	80 I	1	17,518.26	
5706.20	300	100 rII	2	17,519.95	4 − 44
5686.98	20	20 I		17,579.16	7 − 69
5678.74	3	15 IIA		17,604.67	3 − 37
5659.86	400	200 rII	3	17,663.39	3 − 38
5652.84	30	40 I	2	17,685.33	4 − 45
5642.67	6	20 IIA		17,717.20	5 − 54
5641.59	8	10 II		17,720.59	4 − 47
5626.01	250	150 rII	3	17,769.67	1 − 28
5621.79	200	100 I	3	17,783.00	2 − 31
5591.17	20	40 IA	1	17,880.39	5 − 56
5588.20	100	30 II	1	17,889.90	5 − 57
5581.83	10	20 II		17,910.31	5 − 58
5575.59	15	20 I		17,930.36	6 − 63
5574.89	80	30 II	2	17,932.61	2 − 33
5573.42	100	60 II	2	17,937.34	6 − 64
5561.37	50	20 II		17,976.20	3 − 40
5550.40	300	200 rII	4	18,011.73	4 − 50
5548.95	150	125 I	3	18,016.44	
5517.87	1	− 4 III		18,117.91	6 − 66
5516.09	500d	300 rII	4	18,123.76	5 − 59 2 − 37
5512.10	200	100 I	4	18,136.88	3 − 42
5511.09	60	40 I	1	18,140.18	5 − 60
5500.90	10	25 IIA		18,173.81	3 − 43
5498.21	200	150 rII	3	18,182.70	2 − 38
5493.72	300	200 rII	3	18,197.56	3 − 44
5485.42	150	100 rII	2	18,225.09	1 − 33
5466.72	250	125 rII	3	18,287.44	4 − 53
5453.00	300	150 rII	3	18,333.45	6 − 68
5433.82	30	20 II	2	18,398.16	3 − 47
5421.57	80	30 I	2	18,439.73	5 − 61
5411.39	100	50 II	1	18,474.42	6 − 69
5411.15	10	40 IIA	1	18,475.24	1 − 38
5405.23	200	125 rII	3	18,495.47	2 − 40
5403.70	200	80 I	3	18,500.71	4 − 54
5368.352	150	80 II	2	18,622.52	7 − 76
5353.701	1	5 IIA		18,673.49	4 − 57
5349.116	15	40 IA	2	18,689.49	3 − 50
5348.067	10	30 IA	2	18,693.16	2 − 43
5341.265	100	50 I	3	18,716.96	2 − 44
5320.575	100	100 I	4	18,789.75	5 − 64
5299.21	4	15 IA		18,865.50	3 − 51
5282.891	100	50 I	2	18,923.78	4 − 60
5271.388	200	125 I	3	18,965.07	3 − 53
5269.96	5	10 IA	1	18,970.21	5 − 66
5265.646	20	25 I	2	18,985.75	1 − 43
5251.912	150	100 I	5	19,035.40	5 − 67
5210.738	10	10 I		19,185.81	5 − 68
5200.592	200	100 I	3	19,223.24	4 − 61
5187.131	10	15 I	2	19,273.13	4 − 62
5185.550	2	6 IA	1	19,279.00	3 − 55
5175.443	150	80 I	3	19,316.65	
5172.750	80	40 I	2	19,326.71	5 − 69
5157.260	20	30 I	2	19,384.75	2 − 51
5145.834	10	12 I	1	19,427.80	5 − 70
5122.159	125	60 I	3	19,517.60	6 − 76
5117.188	100	80 I	2	19,536.56	
5088.347	20	30 I	1	19,657.29	
5071.205	100	60 I	3	19,713.70	
5060.916	15	30 IIA	2	19,753.78	4 − 66
5049.503	10	30 IA	2	19,798.42	2 − 55
5044.275	80	40 I	2	19,818.95	4 − 67
5010.88	3	10 IA		19,951.02	3 − 62
4975.949	60	60 I	4	20,091.08	1 − 55
4946.305	40	60 II	2	20,211.49	4 − 70
4924.044	30	30 II		20,302.86	7 − 98
4918.994	125	100 I	2	20,323.71	4 − 71
4910.400	150	100 II	2	20,359.27	5 − 75
4907.81	2	2 III		20,370.02	5 − 76
4904.963	80	80 II	3	20,381.84	3 − 65
4883.971	200	100 II	4	20,469.44	6 − 87
4883.763	100	100 II	4	20,470.31	2 − 62
4848.309	100	100 I	2	20,620.01	5 − 78
4841.701	400	150 I	2	20,648.15	7 − 102
4789.977	50	50 II	1	20,871.11	6 − 93
4785.884	150	125 I	3	20,888.96	3 − 70
4783.125	300	200 I	3	20,901.01	2 − 65
4770.20	30	20 I	2	20,957.64	5 − 82
4760.291	300	150 rI	5	21,001.27	3 − 71
4760.033	50	60 II		21,002.40	4 − 74
4750.725	60	50 II	1	21,043.55	5 − 84
4728.433	300	100 I	2	21,142.76	4 − 75
4718.641	40	30 I	1	21,186.63	6 − 97
4717.071	150	125 I	1	21,193.68	1 − 65
4716.097	250	80 I	2	21,198.07	6 − 98
4688.733	150	100 I	2	21,321.78	5 − 87
4684.196	1	4 IIA		21,342.43	6 − 100
4681.551	50	40 II	1	21,354.48	4 − 77
4678.084	3	4 I		21,370.31	7 − 108
4670.834	60	80 I	3	21,403.48	4 − 78
4670.747	50	60 I	2	21,403.88	4 − 79
4664.509	2	10 IIA		21,432.50	7 − 109
4663.556	100	80 rI	1	21,436.86	5 − 89
4649.491	100	80 rI	3	21,501.73	3 − 73
4648.078	40	40 I	1	21,508.27	6 − 101
4645.405	100	100 rI	3	21,520.64	2 − 71
4640.518	3	8 IA		21,543.31	6 − 102
4632.770	1	8 IA		21,579.33	5 − 91
4629.430	5	20 IA	2	21,594.90	7 − 111
4618.228	2	10 IIA		21,647.28	6 − 103
4616.615	1	12 IIA		21,654.84	7 − 113
4611.248	20	50 IA	3	21,680.05	3 − 74
4602.024	1	10 IA		21,723.50	5 − 93
4598.285	4	8 IA	1	21,741.17	4 − 82
4596.743	60	100 rI	2	21,748.46	
4581.729	150	80 I	2	21,819.73	7 − 114
4581.581	100	100 rI	3	21,820.43	3 − 75
4580.188	1	12 IIA		21,827.07	4 − 84
4569.579	6	20 IA	2	21,877.74	5 − 95
4566.767	12	25 IA	1	21,891.21	4 − 85
4556.628	4	40 IA	2	21,939.92	6 − 106
4550.032	8	20 IA	2	21,971.73	5 − 96
4539.830	1	− 5 IIA		22,021.06	2 − 73
4537.570	2	10 IA	1	22,032.07	3 − 77
4536.161	1	20 IA	1	22,038.91	5 − 97
4534.869	1	20 IA		22,045.19	7 − 117
4533.799	50	50 I	1	22,050.39	5 − 98
4532.444	8	40 IA	3	22,056.99	4 − 86
4527.418	5	15 IA	2	22,081.47	3 − 79
4523.182	30	30 I	2	22,102.15	3 − 80
4522.546	20	30 I	2	22,105.26	4 − 87
4511.327	40	40 I	2	22,160.23	7 − 137
4504.321	1	− 6 IIA		22,194.70	5 − 100
4503.378	80	125 rI	3	22,199.35	2 − 74
4499.108	100	150 RI	3	22,220.42	4 − 89
4490.758	1	− 10 IIA		22,261.73	6 − 107
4490.019	4	30 IIA	1	22,265.40	6 − 108
4480.316	30	60 IA	2	22,313.61	1 − 73
4477.505	6	15 IA	1	22,327.62	6 − 109
4471.504	1	8 IIA		22,357.59	4 − 90
4470.886	100	100 rI	2	22,360.68	5 − 101
4470.475	1	4 IIA		22,362.73	4 − 91
4463.897	3	15 IIA	1	22,395.69	5 − 102
4459.290	80	60 I	1	22,418.82	3 − 82
4456.708	3	40 IA	2	22,431.81	3 − 83
4452.953	60	50 I	2	22,450.72	7 − 120
4445.153	80	125 rI	2	22,490.12	6 − 111
4443.270	6	15 IA	2	22,499.65	5 − 103
4442.276	80	100 rI	1	22,504.68	3 − 84
4441.812	100	150 RI	1	22,506.94	4 − 93
4433.344	3	50 IIA		22,550.03	6 − 113
4433.076	15	30 IA	1	22,551.39	2 − 77
4429.664	60	80 rI	2	22,568.76	3 − 85
4423.383	10	20 IA	1	22,600.81	2 − 79
4419.332	80	150 RIA	2	22,621.52	2 − 80
4411.585	30	60 rIA	2	22,661.25	4 − 95
4405.224	1	8		22,693.97	5 − 104
4403.116	100	150 RI	2	22,704.83	5 − 105
4401.174	100	60 I	2	22,714.85	6 − 114

TABLE I—(*Continued.*)

I.A.	Int. and Temp. Class Arc	Fur.	Abs.	ν(vac)	Designation
4397.341	60	60 I	2	22,734.65	3 −86
4393.354	60	30 II	1	22,755.28	4 −96
4393.170	1	20 IIA		22,756.23	7 −122
4386.219	40	60 I	2	22,792.30	5 −106
4381.257	1	8 IIA		22,818.11	3 −88
4380.423	100	100 rI	2	22,822.45	4 −97
4365.954	4	25 IA	1	22,893.09	3 −89
4362.912	150	150 RI	2	22,914.05	1 −80
4357.896	2	40 IIA	1	22,940.42	6 −117
4355.835	2	40 IA	2	22,951.28	2 −83
4350.815	6	50 IA	2	22,977.76	4 −99
4339.924	5	20 IIA	2	23,035.42	3 −90
4338.965	25	60 IA	3	23,040.52	3 −91
4336.137	150	125 RI	2	23,055.54	6 −137
4331.447	40	50 I	3	23,080.51	
4330.016	125	150 RI	3	23,088.13	2 −85
4326.145	4	30 IIA		23,108.79	7 −124
4325.163	2	30 IIA	2	23,114.07	5 −107
4324.460	60	60 rI	1	23,117.80	5 −108
4319.530	100	100 rI	2	23,144.18	4 −101
4313.871	3	30 IIA	2	23,174.54	3 −92
4312.854	60	30 I	2	23,180.00	5 −109
4301.275	8	15 IIA	1	23,242.41	3 −94
4299.141	20	40 IA	2	23,253.94	2 −86
4296.743	300	300 RI	2	23,266.92	$^7F-{}^7G$
4293.743	4	15 IIA	1	23,283.18	4 −103
4290.832	1 −	8 IIA		23,298.97	5 −110
4283.772	5	8 I		23,337.37	2 −88
4283.500	80	80 rI	2	23,338.85	3 −95
4282.833	80	80 rI	1	23,342.49	5 −111
4282.208	100	100 rI	2	23,345.89	6 −120
4274.011	2	12 IIA		23,390.66	5 −112
4271.862	40	40 I	2	23,402.43	5 −113
4266.309	30	20 I	2	23,432.89	3 −96
4258.168	1	6	1	23,477.69	4 −104
4256.209	2	12	1	23,488.50	4 −105
4244.246	3	12 IA	1	23,554.70	2 −90
4240.450	6	40 IA	1	23,575.79	4 −106
4230.727	4	10 IA	1	23,629.97	1 −88
4226.858	2	10 IIA		23,651.60	6 −122
4226.178	50	60 rI	5	23,655.30	3 −99
4219.306	8	40 IA	2	23,693.93	2 −92
4207.250	1	6 IIA		23,761.72	2 −94
4205.779	40	40 I	4	23,770.13	
4201.766	1	4		23,792.83	5 −117
4183.333	60	50 rI	4	23,897.67	4 −107
4164.790	1	8 IIA		24,004.07	6 −124
4151.213	4	8 IA		24,082.58	4 −110
4151.135	1	5 IA		24,083.03	
4147.974	1	6 IA	1	24,101.38	
4146.636	1	4 IA	1	24,109.16	5 −119
4145.594	1	6 IA		24,115.22	
4145.239	20	30 I	3	24,117.28	
4142.969	1	4 IIA		24,130.50	6 −125
4138.734	3	12 IIA	1	24,155.19	3 −104
4135.505	10	20 IA	3	24,174.05	4 −112
4106.284	1	8 IIA		24,346.07	5 −121
4087.505	1	10 IIA		24,457.92	6 −128
4079.834	20	40 IIA	2	24,503.91	5 −122
4069.751	1	8 IIA		24,564.62	4 −116
4062.320	15	40 IIA	2	24,609.55	6 −131
4051.822	1	6 IIA		24,673.31	7 −136
4016.111	2	4 IIA		24,892.70	4 −119
4001.612	1	5 IIA		24,982.89	5 −125
3998.350	40	15 I	1	25,003.27	
3991.019	30	15 I	1	25,049.20	
3990.025	300	50 rI	2	25,055.44	6 −132
3978.244	5	10 IA	1	25,129.64	4 −121
3974.665	150	80 RI	3	25,152.27	5 −127
3972.272	1	8 IIA	1	25,167.42	3 −115
3962.136	20	12 I	1	25,231.80	
3960.501	1	8 IIA	1	25,242.21	3 −116
3951.887	100	60 rI	3	25,297.23	
3949.849	4	10 IA	1	25,310.29	5 −128
3945.252	1	8 IIA		25,339.78	6 −134
3926.325	20	20 II	1	25,461.92	5 −131
3925.216	400	60 rI	2	25,469.12	3 −118
3909.946	50	12 I	1	25,568.58	6 −136
3901.046	3	4		25,626.92	6 −138
3891.955	8	8 II	1	25,686.78	2 −115
3877.486	200	?II	2	25,782.62	7 −142
3858.737	200	100 r?II	4	25,907.90	5 −132
3858.517	80	40 ?II	1	25,909.37	4 −126
3854.556	150	?II	2	25,936.00	4 −127
3853.295	200	50 r?II	1	25,944.49	6 −139
3846.761	30	15 II	2	25,988.56	2 −118
3834.945	5	8		26,068.63	7 −144
3834.476	300	80 rII	3	26,071.81	7 −145
3832.808	150	20 III	3	26,083.16	5 −133
3824.811	8	8 III	1	26,137.69	4 −129
3822.972	100	15 ?III	3	26,150.27	3 −123
3818.363	80	20 III	3	26,181.83	4 −130
3816.846	8	8 III		26,192.23	5 −134
3813.827	150	30 III	3	26,212.97	7 −147
3809.954	100	30 III	4	26,239.61	6 −140
3806.467	60	20 III	1	26,263.68	7 −148
3803.942	300	100 RII	4	26,281.09	1 −118
3783.804	30	20 III	1	26,420.95	5 −136
3775.459	10	15 III		26,479.35	5 −138
3773.331	150	80 rII	3	26,494.28	
3766.923	20	20 III	1	26,539.35	7 −150
3760.169	60	15 III	2	26,587.02	3 −126
3756.411	600	100 RII	3	26,613.62	3 −127
3748.521	100	80 rII	3	26,669.64	2 −123
3747.360	20	15 III		26,677.90	6 −142
3745.465	100	80 rII	3	26,691.40	4 −132
3730.737	100	25 III	2	26,796.76	5 −139
3728.162	50	20 III	2	26,815.27	3 −129
3722.026	60	40 III	3	26,859.48	3 −130
3721.028	150	50 III	3	26,866.68	4 −133
3707.850	150	40 III	4	26,962.16	1 −123
3707.629	10	12 III		26,963.77	6 −144
3707.167	100	30 III	3	26,967.13	6 −145
3705.995	1	10 IIIA		26,975.66	4 −134
3690.084	300	50 III	2	27,091.98	5 −140
3688.129	30	10 III	2	27,106.33	2 −126
3687.878	200	20 III	1	27,108.17	6 −147
3680.983	100	15 III	2	27,158.95	6 −148
3668.887	20	10 III	2	27,248.49	7 −158
3666.972	2	6 IIIA		27,262.82	4 −138
3657.312	100	15 III	2	27,334.73	2 −129
3651.825	4	8 III		27,375.80	5 −141
3643.997	30	15 III	1	27,434.61	6 −150
3636.106	30	8 III		27,494.14	6 −151
3629.480	80	40 III	3	27,544.33	3 −133
3604.714	4	8 III		27,733 57	7 −161
3594.508	2	4 III		27,812.31	6 −155
3594.004	20	12 III		27,816.21	5 −144
3592.894	10	8 III		27,824.80	3 −135
3586.360	80	40 III	3	27,875.40	4 −140
3562.224	15	15 II	1	28,064.36	5 −149
3552.206	8	10 III		28,143.51	6 −158
3550.216	50	40 II	1	28,159.29	4 −141
3530.07	1	4		28,319.98	7 −164
3527.066	15	12 III		28,344.11	2 −135
3526.779	15	15 III	1	28,346.41	5 −151
3524.108	2	6 III		28,367.89	6 −159
3510.15	1	4		28,480.70	5 −152
3491.995	2	6 III		28,628.76	6 −161
3491.040	6	8 III		28,636.59	1 −135
3490.705	2	6 III		28,639.34	4 −146
3487.612	4	8 III		28,664.74	5 −155
3481.523	4	10 III		28,714.87	7 −166
3466.796	30	20 III		28,836.85	3 −141
3465.466	60	30 III		28,847.92	4 −149
3457.788	1	2		28,911.47	5 −156
3447.790	20	15 III		28,995.81	5 −158
3446.58	1	4		29,005.99	3 −143
3431.890	20	20 III		29,130.14	4 −151
3427.855	2	6		29,164.44	6 −163
3421.903	1	5		29,215.16	6 −164
3421.304	5	8 III		29,220.27	5 −159
3416.198	20	12 III		29,263.94	4 −152
3411.22	1	5		29,306.65	4 −153
3410.037	20	12 III		29,316.82	3 −146
3408.049	4	6 III		29,333.92	4 −154
3394.815	5	6		29,448.26	4 −155
3391.024	3	5 III		29,418.18	5 −161
3385.970	8	12 III		29,525.19	2 −143
3376.246	1	2		29,610.22	6 −166
3366.522	1	4		29,695.75	4 −156
3352.727	6	8		29,817.93	1 −143
3350.664	12	10 III		29,836.28	2 −146
3338.864	8	8		29,941.72	3 −152
3334.119	3	2		29,984.34	3 −153
3331.935	4	4		30,003.98	4 −159
3331.074	6	6		30,011.75	3 −154
3330.508	4	4		30,016.85	5 −163
3324.872	2	4		30,067.73	5 −164
3309.885	1	3		30,203.87	7 −171
3307.346	1	3		30,227.05	4 −160
3291.429	15	10 III		30,373.22	3 −156
3287.693	2	3		30,407.73	3 −157
3283.728	2	3		30,444.45	4 −162
3281.775	5	4		30,462.57	5 −166
3277.354	5	6 III		30,503.66	2 −153
3274.430	1	4		30,530.90	2 −154
3245.802	30	10		30,800.17	4 −163
3234.850	1	3		30,904.45	3 −160
3232.489	6	6		30,927.01	2 −157
3218.260	2	2		31,063.75	6 −170
3217.706	1	2		31,069.10	4 −165
3214.613	2	4		31,098.99	6 −171
3212.224	1	3		31,122.12	3 −162
3205.636	6	1		31,186.92	6 −172
3202.201	3	4		31,219.53	1 −157
3181.386	2	2		31,423.78	2 −160
3177.748	3	3		31,459.76	5 −169
3159.497	1	2		31,641.48	2 −162
3157.688	1	1		31,659.61	7 −174
3149.027	1	2		31,746.67	3 −165
3135.985	2	2		31,878.70	6 −173
3132.751	10	5		31,911.61	7 −175
3132.288	1	1		31,916.32	5 −170
3128.864	1	2		31,951.25	5 −171
3120.254	2	2		32,039.41	5 −172
3118.862	2	2		32,053.71	3 −167
3102.867	2	2		32,218.94	3 −168
3100.500	1	1		32,243.54	4 −169
3098.328	1	1		32,266.14	2 −165
3070.874	3	3		32,554.59	6 −174
3069.144	1	1		32,572.94	2 −167
3057.229	2	2		32,699.88	4 −170
3054.313	2	2		32,731.10	5 −173
3053.634	6	5		32,738.37	2 −168
3047.254	2	2		32,806.91	6 −175
3045.759	2	2		32,823.02	4 −172
3041.817	3	2		32,865.55	1 −167
3036.682	3	2		32,921.13	3 −169
3026.588	3	3		33,030.92	1 −168
2992.521	3	2		33,406.93	5 −174
2982.897	2	1		33,514.71	4 −173
2970.098	12	2		33,659.13	5 −175

The present knowledge of the normal configurations, either definite or indicated, for the rare earths is presented in Table VI.

The data presented in Table VI show the same type of variation of relative binding between the $4f$ and $5d$ electrons as exists between the d and s electrons[11] in the long periods. In the rare earth group the $5d$ electron is most tightly bound at the beginning and middle of the group and has a minimum just before the middle and at the end of the group.

[11] R. C. Gibbs and H. E. White, Proc. Nat. Acad. Sci. **14**, 559 (1928); W. E. Albertson, Phys. Rev. **45**, 304 (1934).

TABLE II. *Energy levels of* Sa I.

Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J
1	0.00	0	30	17,959.28	4	59	20,396.67	4, 5	90	23,847.25	2	118	26,281.09	1	148	30,284.37	6
2	292.58	1	31	18,075.57	2	60	20,413.30	3, 4	91	23,852.43	3	119	26,382.25	3, 4	149	30,337.45	3, 4
3	811.92	2	32	18,209.04	3	61	20,712.80	3, 4	92	23,986.48	1, 2	120	26,471.36	6	150	30,560.04	6
4	1,489.55	3	33	18,225.13	1	62	20,762.84	2	93	23,996.55	4	121	26,619.18	3, 4	151	30,619.60	4
5	2,273.09	4	34	18,298.29	6	63	21,055.79	6	94	24,054.32	1, 2	122	26,776.98	5	152	30,754.57	3
6	3,125.46	5	35	18,328.64	3	64	21,062.82	5	95	24,150.80	3	123	26,962.19	1	153	30,796.23	2
7	4,020.66	6	36	18,350.40	4, 5	65	21,193.68	1	96	24,244.82	3	124	27,129.49	6	154	30,823.54	2
8	13,999.43	1	37	18,416.62	2	66	21,243.27	4	97	24,312.03	4	125	27,255.97	4, 5	155	30,937.80	4
9	14,380.44	2	38	18,475.28	1	67	21,308.50	3, 4	98	24,323.51	5	126	27,398.92	2	156	31,185.17	3
10	14,863.85	1	39	18,503.49	4	68	21,458.89	5	99	24,467.27	2, 3	127	27,425.54	3	157	31,219.59	1
11	14,915.83	3	40	18,788.08	2	69	21,599.84	5	100	24,467.84	4, 5	128	27,583.38	4, 5	158	31,269.01	5
12	15,039.59	2	41	18,811.11	5	70	21,700.89	3	101	24,633.74	4	129	27,627.25	2	159	31,493.41	4
13	15,507.35	3	42	18,948.80	3	71	21,813.22	2	102	24,668.79	5	130	27,671.39	2, 3	160	31,716.41	2
14	15,567.32	2	43	18,985.74	1	73	22,313.63	1	103	24,772.74	4	131	27,735.01	6	161	31,754.24	5
15	15,579.11	4	44	19,009.52	2	74	22,491.94	2	104	24,967.14	3	132	28,180.95	5	162	31,934.03	2
16	15,650.55	1	45	19,174.84	4	75	22,632.34	3	105	24,977.99	3, 4	133	28,356.24	4	163	32,289.85	4
17	16,131.53	4	46	19,161.62	4, 5	76	22,643.12	5	106	25,065.37	4	134	28,465.26	4	164	32,340.69	5
18	16,211.04	3	47	19,210.10	3	77	22,844.00	2	107	25,387.19	4	135	28,636.67	1	165	32,558.65	2
19	16,690.76	1	48	19,254.29	6	78	22,893.07	3, 4	108	25,390.91	5	136	28,694.02	5	166	32,735.62	5
20	16,859.31	5	49	19,264.60	5	79	22,893.40	2	109	25,453.11	5	138	28,752.40	4	167	32,865.57	1
21	16,890.59	4	50	19,501.27	3	80	22,914.07	1	110	25,572.10	3, 4	139	29,069.90	4, 5	168	33,030.91	1
22	17,190.19	2	51	19,677.38	1, 2	82	23,230.73	3	111	25,615.57	5	140	29,365.03	4	169	33,733.00	3
23	17,462.31	2	52	19,712.44	6	83	23,243.80	1, 2	112	25,663.67	3, 4	141	29,648.83	3	170	34,189.35	4
24	17,504.63	3, 4	53	19,776.97	3	84	23,316.62	3	113	25,675.50	5	142	29,803.32	6	171	34,224.44	5
25	17,566.84	3, 4	54	19,990.25	4	85	23,380.72	2	114	25,840.31	6	143	29,817.92	1	172	34,312.48	4
26	17,587.44	5	55	20,091.03	1	86	23,546.54	2	115	25,979.35	1, 2	144	30,089.27	5	173	35,004.21	4
27	17,654.03	6	56	20,153.47	5	87	23,594.86	4	116	26,054.15	2, 3	145	30,092.53	6	174	35,680.11	5
28	17,769.68	1	57	20,162.99	4	88	23,629.98	1	117	26,065.88	5	146	30,128.83	2	175	35,932.29	5
29	17,830.80	3	58	20,183.36	4, 5	89	23,709.98	3	137	26,181.95	6	147	30,233.63	6			

TABLE III. *Typical* ^7FG *multiplet in samarium.*

^7F / ^7G	0 0.00	1 292.58	2 811.92	3 1,489.55	4 2,273,09	5 3,125.46	6 4,020.66
1 22,914.07	22,914.05 150 2 150 RI 4362.912	22,621.52 80 2 150 RIA 4419.332	22,102.15 30 2 30 I 4523.182				Wave number Arc abs. Fur. Wavelength
2 23,380.72		23,088.13 125 3 150 RI 4330.016	22,568.76 60 2 80 rI 4429.664	21,891.21 12 1 25 IA 4566.767			
3 24,150.80			23,338.85 80 2 80 rI 4283.500	22,661.25 30 2 60 rIA 4411.585	21,877.74 6 2 20 IA 4569.579		
4 24,633.74				23,144.18 100 2 100 rI 4319.530	22,360.68 100 2 100 rI 4470.886	21,508.27 40 1 40 I 4648.078	
5 25,615.57					32,342.49 80 1 80 rI 4282.833	22,490.12 80 2 125 rI 4445.153	21,594.90 5 2 20 IA 4629.430
6 26,471.36						23,345.89 100 2 100 rI 4282.208	22,450.72 60 2 50 I 4452.953
7 27,287.58							23,266.92 300 2 300 RI 4296.743

TABLE IV. *Classified lines of* Gd I.

I.A.	Int. and Temp. Class Arc	Fur.	(vac)	Designation
4680.04	40	150 II	21,361.38	
4658.60	6	40 IIA	21,459.69	
4654.765	4	20 IIIA	21,477.39	5 −12
4647.650	30	50 II	21,510.25	5 −14
4608.583	8	30 IIIA	21,692.59	3 −6
4602.932	40	60 II	21,719.22	4 −9
4581.294	100	100 II	21,821.80	4 −10
4542.034	125	100 II	22,010.42	2 −6
4537.820	200	150 I	22,030.86	3 −8
4519.661	200	150 I	22,119.37	2 −7
4506.226	200	125 I	22,185.32	3 −9
4503.803	8	30 IIA	22,197.25	4 −12
4497.133	150	100 I	22,230.17	4 −14
4486.908	125	100 II	22,280.83	5 −17
4485.484	8	30 IIA	22,287.90	3 −10
4476.144	300	150 I	22,334.41	1 −7
4473.282	20	40 IIA	22,348.70	2 −8
4430.631	300	150 I	22,563.83	1 −8
4422.409	300	150 I	22,605.78	2 −10
4414.741	200	100 I	22,645.04	4 −16
4411.160	150	80 I	22,663.43	3 −12
4401.849	300	150 I	22,711.33	5 −18
4373.831	300	150 I	22,856.85	3 −15
4346.624	200	150 I	22,999.92	2 −13
4346.460	400	250 I	23,000.78	4 −17
4327.106	250	200 I	23,103.66	1 −11
4325.691	200	200 I	23,111.21	3 −16
4321.202	100	100 II	23,135.23	5 −22
4313.851	200	200 I	23,174.65	2 −15
4306.348	200	150 I	23,215.02	1 −13
4286.127	100	60 II	23,324.55	5 −23
4274.167	40	60 II	23,389.81	1 −15
4267.010	80	80 II	23,429.04	2 −16
4266.601	125	100 II	23,431.29	4 −18
4260.123	125	100 II	23,466.92	3 −17
4225.846	300	300 rI	23,657.26	5 −25
4225.028	20	50 IIA	23,661.84	5 −26
4191.628	125	100 I	23,850.38	4 −21
4190.779	200	200 I	23,855.21	4 −22
4175.539	200	150 I	23,942.28	5 −28
4167.271	12	30 IIA	23,989.78	4 −32
4157.781	15	50 IIA	24,044.53	4 −23
4148.864	20	40 IIA	24,096.21	
4134.169	100	100 I	24,181.81	3 −20
4127.3	2	4 IIIA	24,221.0	5 −30
4111.251	2	3 IIIA	24,316.66	3 −21
4100.269	60	50 I	24,381.79	4 −26
4092.718	100	80 ?I	24,426.77	5 −31
4091.966	2	3 III	24,431.26	5 −33
4090.418	40	30 I	24,440.55	2 −19
4087.847	2	10 IIIA	24,455.87	3 −32
4080.534	15	30 IIA	24,499.70	2 −20
4078.705	300	200 I	24,510.69	3 −23
4058.222	250	200 I	24,634.40	2 −21
4054.731	80	75 I	24,655.61	1 −19
4053.643	200	150 I	24,662.23	4 −28
4045.013	60	100 I	24,714.84	1 −20
4035.396	20	60 IIA	24,773.74	2 −32
4027.613	12	50 IIIA	24,821.61	4 −29
4023.355	60	100 I	24,847.88	3 −26
4023.154	80	100 I	24,849.12	
4019.739	12	40 IIA	24,870.23	3 −27
4015.592	6	10 III	24,895.92	5 −35
4008.339	25	50 IIA	24,940.96	4 −30
4006.975	6	30 IIIA	24,949.46	2 −34
3992.696	20	40 IIA	25,038.67	
3987.840	50	50 II	25,069.17	
3979.346	60	80 IIA	25,122.68	2 −24
3974.819	30	40 II	25,151.29	4 −33
3972.713	30	40 I	25,164.62	1 −34
3969.004	60	50 I	25,188.14	2 −27
3966.279	60	60 II	25,205.44	
3953.372	80	40 I	25,287.73	3 −29
3945.548	150	100 I	25,337.88	1 −24
3943.244	30	20 II	25,352.68	
3942.643	60	30 I	25,356.55	
3941.802	40	25 II	25,361.95	
3935.393	40	30 II	25,403.25	1 −27
3934.790	200	50 I	25,407.18	3 −30
3905.653	30	25 II	25,596.69	
3904.293	20	25 II	25,605.60	2 −29
3902.718	30	25 II	25,615.94	4 −35
3874.476	8	6 II	25,802.66	
3867.62	8	6 ?II	25,848.40	
3811.989	30	15 ?I	25,852.61	
3843.275	40	10 I	26,012.13	
3840.264	6	5 II	26,032.52	

TABLE V. *Energy levels of* Gd I.

Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J	Symbol	Level	J
1	0.00	2	7	22,334.40	2	13	23,215.03	2	19	24,655.64	2	34	25,164.60		29	25,820.73	4
2	215.12	3	8	22,563.83	3	14	23,229.32	6	20	24,714.82	3	24	25,337.89	2	30	25,940.14	5
3	532.99	4	9	22,718.33	3	15	23,389.81	3	21	24,849.52	4	25	25,376.37	7	31	26,145.86	
4	999.14	5	10	22,820.91	4	16	23,644.18	4	22	24,854.34	6	26	25,380.93	5	33	26,150.43	
5	1,719.09	6	11	23,103.66	1	17	23,999.92	5	32	24,988.88		27	25,403.24	3	35	26,615.05	
6	22,225.57	2	12	23,196.43	5	18	24,430.42	6	23	25,043.67	5	28	25,661.37	6			

TABLE VI. *Normal configurations of spectra in the rare earths.*

Atomic number	Element	Normal configuration
62	Samarium	$4f^6 6s^2$
63	Europium	$4f^7 6s^2$
64	Gadolinium	$4f^7 5d 6s^2$
69	Thulium	$4f^{13} 6s^2$
70	Ytterbium	$4f^{14} 6s^2$
71	Lutecium	$4f^{14} 5d 6s^2$

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