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Spectrum and Energy Levels of Triply Ionized Ytterbium

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Spectra of Yb IV produced with a low voltage sliding spark discharge were photographed in the range of 700–2200 Å with a 10.7 m normal incidence spectrograph. Wavelengths for 944 spectral lines identified as Yb IV were measured. Of these, 535 were classified as transitions between 95 even and 51 odd energy levels of the $4f^{13}$, $4f^{12}5d$, $4f^{12}6s$, and $4f^{12}6p$ configurations. Values for the interaction parameters were derived by a least squares fit to the known levels.

Key words: Energy levels; parametric calculations; resonance lines; spectrum analysis; ytterbium.

1. Introduction

The present work was carried out in connection with the interpretation of isoelectronic sequences related to various ionization states of tungsten and neighboring refractory elements. The sixth and seventh spectra of tungsten have been interpreted. [1] In the case of W VIII the $4f^{14}5p^5$ and $4f^{13}5p^6$ configurations compete for the ground state and it has not been established which configuration provides the lowest level. The highest analyzed member of this sequence is now Yb IV.

Interpreting the fourth spectra of the rare earths has become relatively straightforward. Transition arrays occur in compact groups at predictable wavelength regions. Accurate calculations of relative energy levels may be made, using highly predictable values for the interaction parameters. The challenge now lies in deducing enough levels to clarify the structure of these complicated configurations.

An initial analysis of Yb IV was given in which nineteen pairs of lines having the $4f^{13}$ ^2F ground term interval were identified. [2] The upper levels were designated only as belonging to the $4f^{12}5d$ configuration. The present analysis now provides 77 levels of $4f^{12}5d$, 18 of $4f^{12}6s$, and 49 of $4f^{12}6p$. Nearly all levels built on the four lowest $4f^{12}$ parent terms (^{3}H, ^{3}F, ^{1}G, ^{1}D) were found. In addition, levels built on the ^{1}I$_6$ were determined but their connection with the rest of the system is based on only two lines because of the weakness of inter-parent transitions stemming from the high purity of this parent state. Stronger exposures are needed to confirm this connection.

The many known levels permitted us to make an empirical evaluation of all the Slater and spin-orbit single configuration radial intergrals as well as the two-body effective configuration interaction parameters. Explicit configuration interaction between $4f^{12}5d$ and $4f^{12}6s$ was included in the calculation.

The results of this work were provided for inclusion in a compilation of rare earth energy levels [3] in advance of publication. We subsequently established 36 additional levels of the three excited configurations.

[1] Figures in brackets indicate literature references at the end of this paper.

2. Experimental Procedures

The light source for this work was the low voltage sliding spark originally described by one of us [4] as a modification of the Bockasten high voltage sliding spark. [5] It has been used to obtain the second through fifth spectra of rare earths by varying the peak spark current from 6-500 A, with a resulting sharp distinction among the spectra. For the measurements of Yb IV we used exposures made at 200 A. The spark repetition rate was about 30/s with exposure times of two to five min. This produced relatively light exposures but clear groupings of transition arrays and easily measured plates.

All observations were made with the NBS 10.7 m normal incidence spectrograph in the range of observation of 700–2200 Å. A few dozen lines at longer wavelength were reported by Bryant. [6] Some of these fit the known energy level structure but none provided new levels.

For reference wavelengths we used Cu II and Ge II obtained with a copper hollow cathode discharge operated at 0.5 A with a helium pressure of 2 torr.

3. Wavelengths and Energy Levels

Table I contains all the spectrum lines identified as Yb IV in the region we observed. The accuracy is estimated to be ± 0.005 Å. Wavelengths in air are given above 2000 Å. Intensities are visually estimated relative plate blackening. Line classifications are indicated by listing the two energy levels responsible for the transition, with subscripted J-values.

The energy levels of the $4f^{12}5d$ configuration deduced earlier [2] from resonance lines were of little help initially in the new analysis. These transitions are governed by LS selection rules because of the 100 percent purity of the ^2F ground state. For this reason they do not involve the lowest levels of $4f^{12}5d$, which are predominantly of quartet character. Furthermore they have no correlation with J_1 j-coupling, the dominant coupling scheme of the $4f^{12}6p$ configuration with which $4f^{12}5d$ combines.

The first regularities were found among the $4f^N6s$-$4f^N6p$ transitions (here $N=12$) because the coupling is clearly J_1j in both cases, the lines are strong, relatively few, and confined to a small wavelength region. Also the energy intervals of these configurations may be calculated with great accuracy due to the small electrostatic effects and well defined spin-orbit parameters in the $4f^N$ shell.

With the discovery of the low structure of these configurations, we proceeded to find the low levels of $4f^{12}5d$, and finally to tie them in with the levels from reference [2]. Predictions for missing levels were continually improved by fitting the calculations to the known levels.

The search for levels ended without producing those based primarily on the ^1S, or ^3P parent states of $4f^{12}$. Because of the impurity of the eigenvectors of $4f^{12}5d$ in J_1j-coupling, substantial components of the ^3P parent occurs in several known levels. The ^1I group were particularly intriguing because of their high J-values that lead to the classification of strong lines. An interval of 11.6 cm^{-1} was found among several pairs of strong unclassified lines. This matched almost exactly the predicted spacing between the pair of levels of $4f^{12}(^1I_6)6s$. With this interpretation, the resulting $4f^{12}(^1I_6)6p$ levels closely match their predicted values. However, the connection between these levels and the main system was elusive. Initially one level of the $4f^{12}(^1I)$ group of $4f^{12}5d$, the level at 120633.01 cm^{-1} with $J=9/2$, was found because it mixes strongly with a low-lying $4f^{12}6s$ level at 121008.13 cm^{-1}. This enabled us to calculate the position of the entire $4f^{12}(^1I)$ parent system very accurately. This group of levels was then nearly completely established, but its connection with the rest of the levels is based only on two observed transitions. These connect the $4f^{12}6p$ level $(^1I_6, 1/2)_{13/2}$ with the $4f^{12}5d$ levels $(^3H_6, 5/2)_{15/2}$ and $(^3H_5, 5/2)_{15/2}$. Though this is rather weak evidence our confidence in it is based on the discovery of similar lines of the isoelectronic ion, Lu V.

Table II contains all the experimentally deduced levels of Yb IV. The uncertainty in their values of $\pm$ 0.1 cm^{-1} is derived from a least squares adjustment to the observed lines. A few levels are given to one decimal place. These are determined only by short wavelength lines and have an uncertainty of $\pm$ 0.5 cm^{-1}. A column is included that gives the number of lines classified by each level.

The levels are designated, with the exception of the ^2F of $4f^{13}$, in J_1j -coupling, which is the scheme of highest purity. For the $4f^{12}5d$ configuration, J_1j-coupling is only slightly better than LS and many levels are highly mixed in both schemes.

Some levels of $4f^{12}6s$ gave rise to resonance lines. This of course is due to mixing with the $4f^{12}5d$ configuration. In a few cases the foreign configuration shows up as the second largest component of the eigenvector.

4. Calculations

Energy matrices were calculated for the $4f^{12}5d$ and $4f^{12}6s$ configurations with interaction, and the $4f^{12}6p$ configuration. The effective electrostatic interactions for equivalent and inequivalent electrons were included. A brief description of the matrix calculations is given in reference [7]. These matrices were diagonalized initially with interpolated values of the parameters, which then were adjusted by a least squares fitting to the experimental energy levels.

Table III contains the fitted values for the parameters. Of the four "effective" electrostatic parameters of $4f^{12}5d$ for inequivalent electrons, D^1, D^3, X^2, and X^4, only D^3 did not achieve a significant fitted value. The same result was found for $4f^{13}5d$ in Lu IV [7]. In the case of $4f^{12}6p$ the two parameters D^1 and X^3 are allowed. Here only D^1 is significant, as was true for $4f^{13}6p$ of Lu IV. The effective parameters α, β, and γ of the $4f^{12}$ core entered the Hamiltonian in the expression $\alpha L(L+1) + \beta Q + \gamma\, 12G(G_2)$ where Q is the seniority operator and $G(G_2)$ is Casimer's operator for the group G_2. The fixed value of -1000 cm^{-1} for β is estimated from the work of Goldschmit [9] on Ce III.

Configuration interaction between $4f^{12}5d$ and $4f^{12}6s$ is very weak. Only for very close levels is there any mixing. Two parameters are allowed but only the exchange parameter $R^3(fd, sf)$ is significant in the least squares fit.

Table IV and V contain the results of the calculation. The calculated levels are compared with the observed and the leading components of the eigenvectors are given in percent (squared components of eigenvector). The purity of the $4f^{12}5d$ configuration in both LS and J_1-j-coupling is rather low; the average of the highest percentages for all levels is 56 percent in J_1j-coupling and 50 percent in LS. The *rms* deviation for the $4f^{12}(5d+6s)$ calculation is 58 cm^{-1} while for $4f^{12}6p$ it is 20 cm^{-1}.

5. Conclusion

Further progress will require the measurement of a stronger set of exposures. This should provide more connecting lines with the $4f^{12}(^1I_6)$nl system and allow for an extension of the analysis to include higher-lying configurations. The ionization energy is now determined by an interpolated value for the position of the $4f^{12}7s$ configuration. [8] Some candidates were found for this and for $4f^{12}6d$ but there was not sufficient certainty to report them here.

We wish to thank Dr. H. M. Crosswhite for his calculation of the $4f^{12}5d$ configuration which led us to the $4f^{12}(^1I_6)$ connection.

6. References

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Table 1. *Classified spectral lines of* Yb IV.

Wavelengths longer than 2000 Å are values in air.

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification	Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
2187.166	150	45706.97	$123710_{5/2} - 169417^{\circ}_{7/2}$	2036.870	10	49079.16	
2183.324	4000	45787.39	$106801_{11/2} - 152589^{\circ}_{11/2}$	2014.236	3	49630.58	$112189_{9/2} - 161820^{\circ}_{9/2}$
2182.622	2	45802.11	$130676_{9/2} - 176478^{\circ}_{9/2}$	2004.472	8	49872.30	$112189_{9/2} - 162061^{\circ}_{11/2}$
2180.558	2	45845.46	$115974_{9/2} - 161820^{\circ}_{9/2}$	1948.027	3	51333.99	
2177.528	3000	45909.25	$115910_{11/2} - 161820^{\circ}_{9/2}$	1945.254	80	51407.16	
2175.365	80	45954.89	$130524_{7/2} - 176478^{\circ}_{9/2}$	1918.639	20	52120.27	
2174.316	2	45977.06		1917.987	50	52137.99	$106801_{11/2} - 158939^{\circ}_{9/2}$
2172.158	2000	46022.73	$123710_{5/2} - 169733^{\circ}_{3/2}$	1915.155	1	52215.09	
2169.780	5	46073.17		1892.778	1	52832.39	$123710_{5/2} - 176542^{\circ}_{7/2}$
2169.116	3000	46087.27	$115974_{9/2} - 162061^{\circ}_{11/2}$	1892.405	10	52842.81	
2167.448	8	46122.73		1886.073	15	53020.21	
2166.119	1000	46151.03	$115910_{11/2} - 162061^{\circ}_{11/2}$	1876.558	3	53289.05	$122476_{5/2} - 175765^{\circ}_{5/2}$
2165.548	2500	46163.19	$112772_{7/2} - 158935^{\circ}_{7/2}$	1872.438	10	53406.30	
2164.382	800	46188.06	$121008_{9/2} - 167196^{\circ}_{9/2}$	1872.260	10	53411.38	
2163.878	600	46198.82		1857.656	40	53831.27	$130524_{7/2} - 184355^{\circ}_{5/2}$
2155.198	2	46384.86		1841.034	500	54317.30	$145128_{11/2} - 199446^{\circ}_{9/2}$
2154.249	200	46405.29	$121008_{9/2} - 167413^{\circ}_{7/2}$	1840.736	10	54326.09	$123710_{5/2} - 178036^{\circ}_{7/2}$
2154.183	15000	46406.71	$106801_{11/2} - 153208^{\circ}_{13/2}$	1837.438	200	54423.60	$112772_{7/2} - 167196^{\circ}_{9/2}$
2153.453	400	46422.44	$120773_{9/2} - 167196^{\circ}_{9/2}$	1833.584	150	54537.99	
2150.206	5	46492.54	$122787_{3/2} - 169279^{\circ}_{5/2}$	1831.184	1500	54609.47	$145117_{13/2} - 199726^{\circ}_{15/2}$
2148.928	150	46520.18		1829.480	3	54660.34	
2148.516	3000	46529.11	$120667_{7/2} - 167196^{\circ}_{9/2}$	1828.395	5	54692.77	$122650_{7/2} - 177343^{\circ}_{9/2}$
2148.096	4000	46538.20	$145128_{11/2} - 191666^{\circ}_{13/2}$	1827.021	10	54733.90	$112679_{5/2} - 167413^{\circ}_{7/2}$
2147.562	1000	46549.77	$145117_{13/2} - 191666^{\circ}_{13/2}$	1825.713	10	54773.12	
2145.560	1000	46593.20	$137762_{3/2} - 184355^{\circ}_{5/2}$	1824.219	2000	54817.97	$112772_{7/2} - 167590^{\circ}_{5/2}$
2144.769	20000	46610.38	$105978_{13/2} - 152589^{\circ}_{11/2}$	1824.130	10	54820.65	
2143.892	3000	46629.45	$122650_{7/2} - 169279^{\circ}_{5/2}$	1821.101	60	54911.83	$112679_{5/2} - 167590^{\circ}_{5/2}$
2143.425	3000	46639.61	$120773_{9/2} - 167413^{\circ}_{7/2}$				$137762_{3/2} - 192674^{\circ}_{5/2}$
2142.195	2000	46666.38	$130676_{9/2} - 177343^{\circ}_{9/2}$	1820.936	1	54916.81	
2141.570	40	46680.00	$145128_{11/2} - 191808^{\circ}_{11/2}$	1819.024	3000	54974.53	$123710_{5/2} - 178684^{\circ}_{5/2}$
2141.040	4000	46691.55	$145117_{13/2} - 191808^{\circ}_{11/2}$	1818.140	50	55001.26	$97587_{11/2} - 152589^{\circ}_{11/2}$
2140.421	200	46705.06	$137762_{3/2} - 184467^{\circ}_{3/2}$	1817.583	2500	55018.12	$106801_{11/2} - 161820^{\circ}_{9/2}$
2139.987	8000	46714.53		1817.225	10	55028.95	
2138.532	2000	46746.31	$120667_{7/2} - 167413^{\circ}_{7/2}$	1817.106	20	55032.56	
			$112189_{9/2} - 158935^{\circ}_{7/2}$	1816.972	2	55036.62	
2138.354	5000	46750.20	$112189_{9/2} - 158939^{\circ}_{9/2}$	1816.762	20	55042.98	$113049_{11/2} - 168092^{\circ}_{9/2}$
2137.715	30	46764.17		1816.071	4000	55063.92	$115910_{11/2} - 170974^{\circ}_{13/2}$
2137.575	3000	46767.23	$122650_{7/2} - 169417^{\circ}_{7/2}$	1814.953	1000	55097.84	$120667_{7/2} - 175765^{\circ}_{5/2}$
2135.923	1500	46803.40	$122476_{5/2} - 169279^{\circ}_{5/2}$	1813.997	1000	55126.88	$121008_{9/2} - 176135^{\circ}_{11/2}$
2135.280	100	46817.49		1813.843	6000	55131.56	$105978_{13/2} - 161110^{\circ}_{15/2}$
2135.207	5000	46819.09	$130524_{7/2} - 177343^{\circ}_{9/2}$	1813.369	2	55145.97	$122650_{7/2} - 177796^{\circ}_{7/2}$
2133.626	1500	46853.78	$137501_{5/2} - 184355^{\circ}_{5/2}$	1812.499	80	55172.44	$137501_{5/2} - 192674^{\circ}_{5/2}$
2130.520	2	46922.08		1810.602	1500	55230.24	$130676_{9/2} - 185907^{\circ}_{11/2}$
2129.651	2000	46941.22	$122476_{5/2} - 169417^{\circ}_{7/2}$	1810.263	20	55240.59	
2129.434	800	46946.01	$122787_{3/2} - 169733^{\circ}_{3/2}$	1809.626	2500	55260.03	$106801_{11/2} - 162061^{\circ}_{11/2}$
2128.840	1500	46959.10	$123710_{5/2} - 170669^{\circ}_{5/2}$	1809.549	100	55262.38	$106557_{11/2} - 161820^{\circ}_{9/2}$
2128.537	1500	46965.79	$137501_{5/2} - 184467^{\circ}_{3/2}$				$122787_{3/2} - 178049^{\circ}_{5/2}$
2126.207	1500	47017.25	$115974_{9/2} - 162991^{\circ}_{9/2}$	1809.140	4	55274.88	
2125.723	6000	47027.96	$115974_{9/2} - 163002^{\circ}_{11/2}$	1808.469	25	55295.39	$130676_{9/2} - 185972^{\circ}_{7/2}$
2123.324	8000	47081.08	$115910_{11/2} - 162991^{\circ}_{9/2}$	1807.917	15	55312.27	$112812_{9/2} - 168124^{\circ}_{7/2}$
2122.844	2500	47091.73	$115910_{11/2} - 163002^{\circ}_{11/2}$	1807.665	20	55319.98	$122476_{5/2} - 177796^{\circ}_{7/2}$
2121.592	2000	47119.51	$130676_{9/2} - 177796^{\circ}_{7/2}$				$112772_{7/2} - 168092^{\circ}_{9/2}$
2120.910	800	47134.66		1806.843	800	55345.15	$130524_{7/2} - 185869^{\circ}_{5/2}$
2116.647	9000	47229.58	$105978_{13/2} - 153208^{\circ}_{13/2}$	1806.618	1000	55352.04	$112772_{7/2} - 168124^{\circ}_{7/2}$
2115.423	250	47256.91	$122476_{5/2} - 169733^{\circ}_{3/2}$	1806.557	1500	55353.91	
2114.733	200	47272.32	$130524_{7/2} - 177796^{\circ}_{7/2}$	1806.318	1000	55361.23	$120773_{9/2} - 176135^{\circ}_{11/2}$
2114.562	2	47276.15		1805.500	200	55386.31	$122650_{7/2} - 178036^{\circ}_{7/2}$
2112.642	200	47319.11	$120773_{9/2} - 168092^{\circ}_{9/2}$	1805.067	20	55399.60	$122650_{7/2} - 178049^{\circ}_{5/2}$
2111.231	250	47350.73	$120773_{9/2} - 168124^{\circ}_{7/2}$	1804.914	20	55404.30	
2111.144	1	47352.68		1803.486	600	55448.17	$130524_{7/2} - 185972^{\circ}_{7/2}$
2110.862	100	47359.00		1802.752	80	55470.74	$121008_{9/2} - 176478^{\circ}_{9/2}$
2110.829	100	47359.74	$130676_{9/2} - 178036^{\circ}_{7/2}$	1802.326	50	55483.85	
2110.610	1	47364.66		1801.735	8	55502.05	$120633_{9/2} - 176135^{\circ}_{11/2}$
2108.228	5	47418.17		1801.668	2000	55504.12	$106557_{11/2} - 162061^{\circ}_{11/2}$
2106.484	3000	47457.42	$120667_{7/2} - 168124^{\circ}_{7/2}$	1800.679	1	55534.60	$121008_{9/2} - 176542^{\circ}_{7/2}$
2099.844	1	47607.47		1800.205	10	55549.22	
2091.929	1	47787.57		1799.844	100	55560.37	$122476_{5/2} - 178036^{\circ}_{7/2}$
2088.984	2	47854.93		1799.415	200	55573.61	$122476_{5/2} - 178049^{\circ}_{5/2}$
2087.788	1000	47882.35	$122787_{3/2} - 170669^{\circ}_{5/2}$	1798.725	800	55594.93	$123710_{5/2} - 179305^{\circ}_{7/2}$
2086.616	3	47909.24	$131395_{7/2} - 179305^{\circ}_{7/2}$	1798.645	20	55597.40	
2081.832	10	48019.32	$122650_{7/2} - 170669^{\circ}_{5/2}$	1795.169	80	55705.06	$120773_{9/2} - 176478^{\circ}_{9/2}$
2063.010	4	48457.37		1794.998	1	55710.36	
2056.424	2	48612.54	$120667_{7/2} - 169279^{\circ}_{5/2}$	1793.113	2	55768.93	$120773_{9/2} - 176542^{\circ}_{7/2}$
2046.004	30	48860.08	$122650_{7/2} - 171510^{\circ}_{7/2}$	1792.582	600	55785.45	$130676_{9/2} - 186462^{\circ}_{9/2}$

TABLE 1. *Classified spectral lines of* Yb IV.

Wavelengths longer than 2000 Å are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1791.736	400	55811.79	$120667_{7/2} - 176478^{\circ}_{9/2}$
1791.301	1	55825.34	
1791.085	6000	55832.07	$112189_{9/2} - 168021^{\circ}_{11/2}$
1791.045	2000	55833.32	$106801_{11/2} - 162635^{\circ}_{13/2}$
1790.249	400	55858.15	
1790.178	1500	55860.36	
1789.720	2000	55874.66	$122650_{7/2} - 178524^{\circ}_{9/2}$
1789.700	1000	55875.28	$120667_{7/2} - 176542^{\circ}_{7/2}$
1788.993	40	55897.36	$122787_{3/2} - 178684^{\circ}_{5/2}$
1788.800	500	55903.39	$112189_{9/2} - 168092^{\circ}_{9/2}$
1788.740	150	55905.27	
1788.644	600	55908.27	$137501_{5/2} - 193409^{\circ}_{7/2}$
1788.130	250	55924.34	
1787.687	200	55938.20	$130524_{7/2} - 186462^{\circ}_{9/2}$
1787.466	85	55945.12	
1785.476	200	56007.47	
1784.616	50	56034.46	$122650_{7/2} - 178684^{\circ}_{5/2}$
1784.568	80	56035.97	
1783.071	200	56083.01	$105978_{13/2} - 162061^{\circ}_{11/2}$
1782.880	200	56089.02	$102850_{11/2} - 158939^{\circ}_{9/2}$
1779.676	600	56190.00	$106801_{11/2} - 162991^{\circ}_{9/2}$
1779.335	2000	56200.77	$106801_{11/2} - 163002^{\circ}_{11/2}$
1778.201	2000	56236.61	$115974_{9/2} - 172211^{\circ}_{11/2}$
1776.185	2000	56300.44	$115910_{11/2} - 172211^{\circ}_{11/2}$
1775.094	2	56335.04	$121008_{9/2} - 177343^{\circ}_{9/2}$
1772.824	20	56407.17	
1767.740	2	56569.40	$120773_{9/2} - 177343^{\circ}_{9/2}$
1765.381	60	56644.99	$112772_{7/2} - 169417^{\circ}_{7/2}$
1765.026	4000	56656.38	$105978_{13/2} - 162635^{\circ}_{13/2}$
1764.783	20	56664.19	
1764.412	3	56676.10	$120667_{7/2} - 177343^{\circ}_{9/2}$
1761.670	500	56764.32	$145128_{11/2} - 201893^{\circ}_{11/2}$
1761.310	2	56775.92	$145117_{13/2} - 201189^{\circ}_{11/2}$
1759.659	15	56829.19	$122476_{5/2} - 179305^{\circ}_{7/2}$
1754.892	8	56983.56	
1753.658	60	57023.66	$105987_{13/2} - 163002^{\circ}_{11/2}$
1753.029	10	57044.12	
1750.141	50	57138.25	
1749.161	40	57170.26	$145128_{11/2} - 202299^{\circ}_{13/2}$
1748.807	800	57181.83	$145117_{13/2} - 202299^{\circ}_{13/2}$
1748.366	40	57196.26	
1744.281	6	57330.21	
1744.029	1	57338.49	
1740.702	50	57448.08	
1731.569	5	57751.09	$120773_{9/2} - 178524^{\circ}_{9/2}$
1729.480	1	57820.84	
1727.200	300	57897.17	$112772_{7/2} - 170669^{\circ}_{5/2}$
1723.616	15	58017.56	$120667_{7/2} - 178684^{\circ}_{5/2}$
1721.681	1	58082.76	
1717.217	1	58233.75	
1709.021	2	58513.03	
1706.228	15	58608.81	$110808_{7/2} - 169417^{\circ}_{7/2}$
1705.367	10	58638.40	$120667_{7/2} - 179305^{\circ}_{7/2}$
1700.755	5	58797.41	
1695.592	10	58976.45	$120328_{5/2} - 179305^{\circ}_{7/2}$
1685.294	10	59336.82	
1680.201	3	59516.68	$117026_{5/2} - 176542^{\circ}_{7/2}$
1674.059	3	59735.05	
1670.539	2	59860.91	$110808_{7/2} - 170669^{\circ}_{5/2}$
1653.413	1	60480.95	
1651.310	2	60557.98	$115984_{7/2} - 176542^{\circ}_{7/2}$
1645.542	100	60770.25	$117026_{5/2} - 177796^{\circ}_{7/2}$
1644.426	1	60811.49	$130855_{15/2} - 191666^{\circ}_{13/2}$
1643.071	1	60861.64	
1641.874	2	60906.01	
1641.623	2	60915.32	
1640.948	1	60940.38	
1639.060	2	61010.57	$117026_{5/2} - 178036^{\circ}_{7/2}$
1637.952	1	61051.85	
1637.809	500	61057.18	
1637.627	6	61063.96	
1637.525	30	61067.77	
1636.479	10	61106.80	
1635.607	150	61139.38	
1633.465	1	61219.55	$106801_{11/2} - 168021^{\circ}_{11/2}$
1631.941	100	61276.72	$91931_{13/2} - 153208^{\circ}_{13/2}$
1631.578	1	61290.35	
1631.458	20	61294.86	
1629.371	2	61373.37	$106039_{7/2} - 167413^{\circ}_{7/2}$
1629.107	4	61383.32	
1627.458	8	61445.51	
1624.851	20	61544.10	$107873_{5/2} - 169417^{\circ}_{7/2}$
1621.833	4	61658.62	$117026_{5/2} - 178684^{\circ}_{5/2}$
1620.006	100	61728.16	$105685_{7/2} - 167413^{\circ}_{7/2}$
1619.303	200	61754.96	$90834_{11/2} - 152589^{\circ}_{11/2}$
1619.094	20	61762.93	
1617.795	250	61812.52	
1615.967	2	61882.45	
1615.369	1	61905.36	
1615.349	1	61906.12	$105685_{7/2} - 167590^{\circ}_{5/2}$
1615.197	20	61911.95	
1614.917	6	61922.68	
1614.886	2	61923.87	
1612.910	1	61999.73	
1612.535	80	62014.15	$131395_{7/2} - 193409^{\circ}_{7/2}$
1612.119	6	62030.16	
1611.795	8	62042.62	$105978_{13/2} - 168021^{\circ}_{11/2}$
1610.946	4	62075.32	
1610.772	60	62082.03	
1610.660	50	62086.34	
1610.024	100	62110.87	
1609.806	250	62119.28	
1608.647	1	62164.04	
1608.529	1	62168.60	
1605.673	30	62279.18	$117026_{5/2} - 179305^{\circ}_{7/2}$
1605.439	1	62288.25	
1604.163	20	62337.80	
1603.682	2	62356.50	
1603.226	250	62374.23	$90834_{11/2} - 153208^{\circ}_{13/2}$
1602.919	30	62386.18	
1602.454	2	62404.28	
1601.556	10	62439.27	$105685_{7/2} - 168124^{\circ}_{7/2}$
1600.294	40	62488.51	
1600.055	6	62497.85	
1600.022	15	62499.14	
1599.376	20	62524.38	
1598.967	100	62540.37	$115984_{7/2} - 178524^{\circ}_{9/2}$
1598.562	20	62556.22	
1598.390	150	62562.95	
1598.077	600	62575.20	
1597.892	1	62582.45	
1597.694	80	62590.20	
1597.455	50	62599.57	
1596.640	30	62631.52	
1595.819	30	62663.74	
1595.024	40	62694.98	
1594.963	1	62697.37	
1594.569	800	62712.87	
1594.005	300	62735.06	
1592.721	80	62785.63	
1592.670	10	62787.64	
1592.456	200	62796.08	$107873_{5/2} - 170669^{\circ}_{5/2}$
1592.074	400	62811.15	
1591.390	100	62838.14	
1591.112	1	62849.12	
1591.025	80	62852.56	
1590.641	60	62867.73	
1590.501	8	62873.27	
1590.155	80	62886.95	
1589.913	50	62896.52	$99165_{13/2} - 162061^{\circ}_{11/2}$
1589.455	60	62914.64	
1589.067	80	62930.00	
1588.888	1	62937.09	
1588.516	1	62951.83	
1588.381	30	62957.18	
1588.072	60	62969.43	
1587.100	600	63008.00	
1586.538	1	63030.32	

TABLE 1. *Classified spectral lines of* Yb IV.

Wavelengths longer than 2000 Å are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1585.606	2	63067.37	
1585.230	800	63082.32	$122787_{3/2} - 185869^{\circ}_{5/2}$
1585.200	1	63083.52	
1584.926	80	63094.42	
1584.882	1	63096.18	
1584.824	10	63098.48	
1584.496	100	63111.55	
1584.371	150	63116.53	
1583.181	100	63163.97	
1582.729	8	63182.01	
1582.438	60	63193.62	
1581.901	90	63215.08	
1581.856	80	63216.87	
1581.760	100	63220.71	
1581.403	400	63234.98	
1581.212	1	63242.62	
1581.107	2	63246.82	
1581.006	1	63250.86	
1580.934	300	63253.74	
1580.723	10	63262.19	
1580.333	500	63277.80	$106001_{3/2} - 169279^{\circ}_{5/2}$
1579.589	150	63307.60	
1579.324	80	63318.22	
1578.934	500	63333.86	
1578.856	100	63336.99	
1578.714	1	63342.69	
1578.600	100	63347.26	
1578.541	40	63349.63	
1578.123	150	63366.41	
1578.051	400	63369.30	
1577.860	300	63376.97	
1577.453	10	63393.33	
1577.203	100	63403.37	
1576.891	2	63415.92	
1576.757	40	63421.31	
1576.587	50	63428.15	
1576.564	200	63429.07	$113049_{11/2} - 176478^{\circ}_{9/2}$
1576.032	50	63450.48	
1575.767	30	63461.15	
1574.974	2000	63493.11	
1574.892	8	63496.41	
1574.715	150	63503.55	
1574.571	200	63509.36	
1574.301	10	63520.25	
1573.839	200	63538.90	
1573.569	60	63549.80	
1573.379	30	63557.47	
1573.205	50	63564.50	
1572.882	1	63577.56	
1572.688	1	63585.40	
1572.463	100	63594.50	$105685_{7/2} - 169279^{\circ}_{5/2}$
1571.534	40	63632.09	
1571.410	10	63637.11	$107873_{5/2} - 171510^{\circ}_{7/2}$
1571.270	20	63642.78	
1571.069	10	63650.92	
1570.944	30	63655.99	
1570.827	20	63660.73	
1570.574	150	63670.98	
1570.288	20	63682.58	
1570.104	10	63690.04	
1569.068	100	63732.10	$106001_{3/2} - 169733^{\circ}_{3/2}$
1568.742	30	63745.34	
1568.296	20	63763.47	
1567.745	4	63785.88	$89422_{13/2} - 153208^{\circ}_{13/2}$
1567.452	1	63797.80	
1567.192	300	63808.39	
1566.494	10	63836.82	
1565.888	60	63861.52	$95078_{11/2} - 158939^{\circ}_{9/2}$
1565.755	1	63866.95	$104225_{7/2} - 168092^{\circ}_{9/2}$
1564.246	1	63928.56	
1564.059	100	63936.20	
1563.481	2	63959.84	
1562.906	1	63983.37	
1562.642	80	63994.18	

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1561.851	2	64026.59	$120328_{5/2} - 184355^{\circ}_{5/2}$
1561.432	8	64043.77	
1561.339	100	64047.58	
1559.751	20	64112.79	
1558.960	30	64145.32	
1556.967	20	64227.43	$97592_{9/2} - 161820^{\circ}_{9/2}$
1555.372	2	64293.30	$113049_{11/2} - 177343^{\circ}_{9/2}$
1556.717	200	64237.75	
1555.222	40	64299.50	
1554.484	4	64330.02	
1554.169	10	64343.06	
1553.928	2	64353.04	$112189_{9/2} - 176542^{\circ}_{7/2}$
1553.377	6	64375.87	
1552.462	10	64413.81	$88175_{11/2} - 152589^{\circ}_{11/2}$
1551.899	50	64437.18	$94498_{5/2} - 158935^{\circ}_{7/2}$
1551.576	10	64450.59	
1551.126	20	64469.29	$97592_{9/2} - 162061^{\circ}_{11/2}$
1550.774	25	64483.92	
1550.256	80	64505.47	
1549.876	40	64521.29	
1548.896	10	64562.11	
1548.201	150	64591.09	
1547.465	600	64621.81	$127045_{13/2} - 191666^{\circ}_{13/2}$
1547.283	100	64629.41	$106039_{7/2} - 170669^{\circ}_{5/2}$
1546.703	1	64653.65	$102542_{7/2} - 167196^{\circ}_{9/2}$
1544.552	1	64743.69	
1544.079	250	64763.52	$127045_{13/2} - 191808^{\circ}_{11/2}$
1543.117	8	64803.90	$104613_{9/2} - 169417^{\circ}_{7/2}$
1542.767	10	64818.60	
1541.525	200	64870.82	$102542_{7/2} - 167413^{\circ}_{7/2}$
1538.968	18	64978.60	
1537.676	20	65033.20	$88175_{11/2} - 153208^{\circ}_{13/2}$
1535.698	40	65116.96	$112679_{5/2} - 177796^{\circ}_{7/2}$
1532.442	10	65255.32	$102158_{5/2} - 167413^{\circ}_{7/2}$
1532.160	20	65267.33	
1530.050	30	65357.34	$112679_{5/2} - 178036^{\circ}_{7/2}$
1529.739	1	65370.62	$112679_{5/2} - 178049^{\circ}_{5/2}$
1529.273	1	65390.54	
1529.078	150	65398.88	$97592_{9/2} - 162991^{\circ}_{9/2}$
1529.009	5	65401.83	
1528.952	1	65404.27	$97587_{11/2} - 162991^{\circ}_{9/2}$
1528.826	2	65409.66	$\left\{\begin{array}{l} 106801_{11/2} - 172211^{\circ}_{11/2} \\ 97592_{9/2} - 163002^{\circ}_{11/2} \end{array}\right.$
1528.620	35	65418.48	
1528.528	2	65422.41	
1527.961	8	65446.69	$101966_{9/2} - 167413^{\circ}_{7/2}$
1527.410	10	65470.30	$106039_{7/2} - 171510^{\circ}_{7/2}$
1524.804	2	65582.19	$102542_{7/2} - 168124^{\circ}_{7/2}$
1524.607	40	65590.67	
1523.518	80	65637.55	$118717_{7/2} - 184355^{\circ}_{5/2}$
1523.351	40	65644.75	
1523.234	20	65649.79	
1521.468	15	65725.99	
1521.346	100	65731.26	
1519.908	30	65793.45	$95316_{13/2} - 161110^{\circ}_{15/2}$
1519.785	60	65798.78	
1519.558	1	65808.60	
1510.980	2	66182.21	$105685_{7/2} - 171867^{\circ}_{9/2}$
1509.466	10	66248.59	
1505.035	50	66443.63	$104225_{7/2} - 170669^{\circ}_{5/2}$
1502.975	20	66534.70	$110808_{7/2} - 177343^{\circ}_{9/2}$
1499.165	20	66703.79	
1498.409	10	66737.45	$102542_{7/2} - 169279^{\circ}_{5/2}$
1498.242	10	66744.89	$95316_{13/2} - 162061^{\circ}_{11/2}$
1497.742	80	66767.17	$102512_{3/2} - 169279^{\circ}_{5/2}$
1497.684	80	66769.75	$124897_{11/2} - 191666^{\circ}_{13/2}$
1495.323	80	66875.18	$102542_{7/2} - 169417^{\circ}_{7/2}$
1494.830	2	66897.23	$104613_{9/2} - 171510^{\circ}_{7/2}$
1494.506	500	66911.74	$124897_{11/2} - 191808^{\circ}_{11/2}$
1494.029	100	66933.10	
1492.894	500	66983.99	$95078_{11/2} - 162061^{\circ}_{11/2}$
1492.811	300	66987.71	$110808_{7/2} - 177796^{\circ}_{7/2}$
1491.566	3000	67043.63	$85545_{13/2} - 152589^{\circ}_{11/2}$
1489.827	60	67121.88	$102158_{5/2} - 169279^{\circ}_{5/2}$

TABLE 1. *Classified spectral lines of* Yb IV.

Wavelengths longer than 2000 Å are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1489.163	1	67151.81	$118717_{7/2} - 185869^{\circ}_{5/2}$
1487.693	50	67218.16	
1487.640	15	67220.56	$102512_{3/2} - 169733^{\circ}_{3/2}$
1487.473	30	67228.11	$110808_{7/2} - 178036^{\circ}_{7/2}$
1487.196	2	67240.63	$100350_{7/2} - 167590^{\circ}_{5/2}$
1486.906	20	67253.74	$104613_{9/2} - 171867^{\circ}_{9/2}$
1486.883	40	67254.78	$118717_{7/2} - 185972^{\circ}_{7/2}$
1486.777	15	67259.58	$102158_{5/2} - 169417^{\circ}_{7/2}$
1485.483	600	67318.17	$95316_{13/2} - 162635^{\circ}_{13/2}$
1485.238	100	67329.27	$117026_{5/2} - 184355^{\circ}_{5/2}$
1484.285	3	67372.50	
1483.755	1	67396.57	
1483.605	2	67403.38	$91532_{7/2} - 158935^{\circ}_{7/2}$
1482.553	400	67451.21	$101966_{9/2} - 169417^{\circ}_{7/2}$
1482.506	300	67453.35	{ $91482_{5/2} - 158935^{\circ}_{7/2}$
			{ $109025_{9/2} - 176478^{\circ}_{9/2}$
1477.916	4000	67662.84	$85545_{13/2} - 153208^{\circ}_{13/2}$
1474.744	1500	67808.37	
1474.513	800	67819.00	
1472.457	800	67913.69	$95078_{11/2} - 162991^{\circ}_{9/2}$
1472.228	1000	67924.26	$95078_{11/2} - 163002^{\circ}_{11/2}$
1471.420	2	67961.56	$101318_{5/2} - 169279^{\circ}_{5/2}$
1469.109	200	68068.46	$99344_{5/2} - 167413^{\circ}_{7/2}$
1468.321	1000	68104.99	$90834_{11/2} - 158939^{\circ}_{9/2}$
1466.508	400	68189.19	
1465.752	800	68224.36	$98971_{9/2} - 167196^{\circ}_{9/2}$
1465.244	3	68248.01	
1463.744	800	68317.95	$109025_{9/2} - 177343^{\circ}_{9/2}$
1462.624	150	68370.27	$115984_{7/2} - 184355^{\circ}_{5/2}$
1462.357	200	68382.75	$109413_{5/2} - 177796^{\circ}_{7/2}$
1461.848	100	68406.56	
1461.103	600	68441.44	$98971_{9/2} - 167413^{\circ}_{7/2}$
1459.614	20	68511.26	$102158_{5/2} - 170669^{\circ}_{5/2}$
1457.236	3	68623.06	$109413_{5/2} - 178036^{\circ}_{7/2}$
1457.049	150	68631.87	
1455.526	4	68703.68	
1454.778	3	68739.01	$93081_{11/2} - 161820^{\circ}_{9/2}$
1454.100	100	68771.06	$109025_{9/2} - 177796^{\circ}_{7/2}$
1453.913	100	68779.90	$99344_{5/2} - 168124^{\circ}_{7/2}$
1452.310	4	68855.82	$99165_{13/2} - 168021^{\circ}_{11/2}$
1451.990	300	68870.99	$130855_{15/2} - 199726^{\circ}_{15/2}$
1451.593	1000	68889.83	$90045_{9/2} - 158935^{\circ}_{7/2}$
1451.144	80	68911.14	$98502_{7/2} - 167413^{\circ}_{7/2}$
1451.118	80	68912.38	{ $99180_{11/2} - 168092^{\circ}_{9/2}$
			{ $107566_{9/2} - 176478^{\circ}_{9/2}$
1450.841	800	68925.54	
1449.679	3	68980.78	$93081_{11/2} - 162061^{\circ}_{11/2}$
1449.036	2	69011.39	$109025_{9/2} - 178036^{\circ}_{7/2}$
1445.290	30	69190.26	$98222_{5/2} - 167413^{\circ}_{7/2}$
1442.732	6	69312.94	
1441.933	50	69351.35	$101318_{5/2} - 170669^{\circ}_{5/2}$
1441.735	4	69360.87	$102850_{11/2} - 172211^{\circ}_{11/2}$
1440.862	50	69402.89	
1440.609	2000	69415.08	$89520_{7/2} - 158935^{\circ}_{7/2}$
1440.391	20	69425.59	
1439.867	30	69450.85	
1437.943	800	69543.78	$101966_{9/2} - 171510^{\circ}_{7/2}$
1437.364	20	69571.79	
1436.691	100	69604.39	
1436.621	1000	69607.78	$97587_{11/2} - 167196^{\circ}_{9/2}$
1434.913	1	69690.63	
1432.894	100	69788.83	
1430.935	2	69884.37	$115984_{7/2} - 185869^{\circ}_{5/2}$
1430.609	1500	69900.30	$101966_{9/2} - 171867^{\circ}_{9/2}$
1430.391	30	69910.95	$93081_{11/2} - 162991^{\circ}_{9/2}$
1430.294	3000	69915.69	$82673_{11/2} - 152589^{\circ}_{11/2}$
1429.900	500	69934.96	$99344_{5/2} - 169279^{\circ}_{5/2}$
1427.868	80	70034.48	
1427.094	30	70072.46	$99344_{5/2} - 169417^{\circ}_{7/2}$
1426.258	10	70113.54	
1425.925	800	70129.91	$91931_{13/2} - 162061^{\circ}_{11/2}$
1424.662	60	70192.08	$101318_{5/2} - 171510^{\circ}_{7/2}$
1423.991	2000	70225.16	
1423.894	80	70229.94	$107566_{9/2} - 177796^{\circ}_{7/2}$
1423.275	20	70260.49	
1422.871	40	70280.43	$109025_{9/2} - 179305^{\circ}_{7/2}$
1422.088	800	70319.13	$100350_{7/2} - 170669^{\circ}_{5/2}$
1421.627	1	70341.93	
1421.383	1	70354.01	
1420.885	150	70378.67	
1420.688	200	70388.43	$99344_{5/2} - 169733^{\circ}_{3/2}$
1419.669	50	70438.95	$106039_{7/2} - 176478^{\circ}_{9/2}$
1419.633	60	70440.74	
1419.530	250	70445.85	$98971_{9/2} - 169417^{\circ}_{7/2}$
1419.261	2	70459.20	
1418.386	50	70502.66	$106039_{7/2} - 176542^{\circ}_{7/2}$
1417.962	1	70523.75	
1417.761	350	70533.74	
1417.719	4000	70535.84	$82673_{11/2} - 153208^{\circ}_{13/2}$
1417.617	250	70540.91	$106801_{11/2} - 177343^{\circ}_{9/2}$
1417.111	6	70566.10	
1416.814	30	70580.89	
1416.386	1	70602.22	
1416.219	8	70610.54	
1416.153	4000	70613.83	$88322_{5/2} - 158935^{\circ}_{7/2}$
1416.108	200	70616.08	
1415.642	1	70639.32	
1414.358	300	70703.45	$91931_{13/2} - 162635^{\circ}_{13/2}$
1413.645	1	70739.11	
1413.144	3000	70764.19	$88175_{11/2} - 158939^{\circ}_{9/2}$
1412.881	600	70777.36	$98502_{7/2} - 169279^{\circ}_{5/2}$
1412.708	200	70786.03	$106557_{11/2} - 177343^{\circ}_{9/2}$
1412.200	500	70811.49	$107873_{5/2} - 178684^{\circ}_{5/2}$
1412.003	1000	70821.37	$88118_{9/2} - 158939^{\circ}_{9/2}$
1411.599	40	70841.64	
1410.814	20	70881.06	
1410.458	300	70898.95	
1410.252	1	70909.31	
1410.133	2	70915.29	$98502_{7/2} - 169417^{\circ}_{7/2}$
1409.421	1	70951.12	
1408.799	2	70982.44	
1408.733	800	70985.77	$90834_{11/2} - 161820^{\circ}_{9/2}$
1408.579	60	70993.53	
1408.374	80	71003.86	$130889_{13/2} - 201893^{\circ}_{11/2}$
1408.248	1	71010.22	
1407.325	200	71056.79	$98222_{5/2} - 169279^{\circ}_{5/2}$
1407.256	80	71060.27	
1407.049	4000	71070.73	$91931_{13/2} - 163002^{\circ}_{11/2}$
1406.550	3	71095.94	
1406.206	10	71113.33	
1405.278	4	71160.29	$100350_{7/2} - 171510^{\circ}_{7/2}$
1404.778	200	71185.62	
1404.589	100	71195.20	$98222_{5/2} - 169417^{\circ}_{7/2}$
1404.116	80	71219.18	$95977_{7/2} - 167196^{\circ}_{9/2}$
1403.950	1000	71227.60	$90834_{11/2} - 162061^{\circ}_{11/2}$
1403.717	300	71239.43	
1402.452	5	71303.68	
1402.033	60	71324.99	$99344_{5/2} - 170669^{\circ}_{5/2}$
1401.919	10	71330.79	
1401.650	800	71344.48	
1401.087	1	71373.15	
1400.419	300	71407.19	
1400.365	250	71409.95	$130889_{13/2} - 202299^{\circ}_{13/2}$
1399.846	600	71436.43	$95977_{7/2} - 167413^{\circ}_{7/2}$
1399.702	300	71443.77	$130855_{15/2} - 202299^{\circ}_{13/2}$
1398.819	17	71488.87	
1398.773	3500	71491.22	
1398.393	2	71510.65	$98222_{5/2} - 169733^{\circ}_{3/2}$
1398.323	1	71514.23	
1398.298	15	71515.51	
1397.837	30	71539.09	$104225_{7/2} - 175765^{\circ}_{5/2}$
1396.518	1	71606.66	
1396.375	1	71614.00	$95977_{7/2} - 167590^{\circ}_{5/2}$
1395.159	2	71676.41	$112679_{5/2} - 184355^{\circ}_{5/2}$
1394.934	30	71687.97	$89422_{13/2} - 161110^{\circ}_{15/2}$
1394.577	10	71706.33	
1394.075	4	71732.15	
1393.931	2500	71739.56	$107566_{9/2} - 179305^{\circ}_{7/2}$

TABLE 1. *Classified spectral lines of* Yb IV.

Wavelengths longer than 2000 Å are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification	Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1393.874	600	71742.49		1364.203	30	73302.87	$95977_{7/2} - 169279^{\circ}_{5/2}$
1393.526	250	71760.41		1363.053	2	73364.71	$98502_{7/2} - 171867^{\circ}_{9/2}$
1393.332	2	71770.40		1361.966	800	73423.27	$104613_{9/2} - 178036^{\circ}_{7/2}$
1392.981	40	71788.48	$112679_{5/2} - 184467^{\circ}_{3/2}$	1361.746	2000	73435.13	$118231_{15/2} - 191666^{\circ}_{13/2}$
1392.954	1	71789.88		1361.647	100	73440.47	$95977_{7/2} - 169417^{\circ}_{7/2}$
1392.883	400	71793.53	$99180_{11/2} - 170974^{\circ}_{13/2}$	1360.965	40	73477.27	
1392.727	4	71801.58		1359.833	800	73538.44	
1392.646	200	71805.75		1359.680	1	73546.71	$110808_{7/2} - 184355^{\circ}_{5/2}$
1392.619	1500	71807.14		1359.064	1	73580.05	$89422_{13/2} - 163002_{11/2}$
1392.580	1000	71809.15	$99165_{13/2} - 170974^{\circ}_{13/2}$	1358.656	80	73602.14	
1392.404	60	71818.23		1358.628	1000	73603.66	$102875_{9/2} - 176478^{\circ}_{9/2}$
1391.728	1	71853.12		1358.318	1	73620.46	$105685_{7/2} - 179305^{\circ}_{7/2}$
1391.483	2	71865.77	$104613_{9/2} - 176478^{\circ}_{9/2}$	1358.175	200	73628.21	$102850_{11/2} - 176478^{\circ}_{9/2}$
1390.248	10	71929.61	$104613_{9/2} - 176542^{\circ}_{7/2}$	1357.783	250	73649.47	$112812_{9/2} - 186462^{\circ}_{9/2}$
1388.948	10	71996.93	$106039_{7/2} - 178036^{\circ}_{7/2}$	1357.472	200	73666.34	
1388.629	100	72013.47		1357.156	30	73683.49	
1387.957	450	72048.34	$106001_{3/2} - 178049^{\circ}_{5/2}$	1357.057	500	73688.87	$112772_{7/2} - 186462^{\circ}_{9/2}$
1387.714	200	72060.95		1356.818	1000	73701.85	$88118_{9/2} - 161820^{\circ}_{9/2}$
1387.385	40	72078.04		1356.146	4000	73738.37	$94386_{9/2} - 168124^{\circ}_{7/2}$
1387.334	800	72080.69		1354.811	800	73811.03	$104225_{7/2} - 178036^{\circ}_{7/2}$
1385.913	60	72154.60		1354.697	30	73817.24	
1385.847	20	72158.03	$90834_{11/2} - 162991^{\circ}_{9/2}$	1354.578	10	73823.72	$104225_{7/2} - 178049^{\circ}_{5/2}$
1385.678	2	72166.83	$98502_{7/2} - 170669^{\circ}_{5/2}$	1353.428	2000	73886.45	$88175_{11/2} - 162061^{\circ}_{11/2}$
1385.643	30	72168.66	$90834_{11/2} - 163002^{\circ}_{11/2}$	1352.973	80	73911.30	$104613_{9/2} - 178524^{\circ}_{9/2}$
1385.349	30	72183.97		1352.383	1000	73943.55	$88118_{9/2} - 162061^{\circ}_{11/2}$
1385.067	30	72198.67		1352.149	200	73956.34	$118717_{7/2} - 192674^{\circ}_{5/2}$
1384.406	2000	72233.14	$88877_{15/2} - 161110^{\circ}_{15/2}$	1350.264	9000	74059.59	$78529_{9/2} - 152589^{\circ}_{11/2}$
1384.189	30	72244.47		1350.176	20	74064.41	
1382.852	20	72314.31		1349.829	1500	74083.45	
1382.801	50	72316.98	$104225_{7/2} - 176542^{\circ}_{7/2}$	1348.925	1000	74133.10	$10214^{\circ}_{5/2} - 84347_{7/2}$
1382.519	1000	72331.73		1348.658	2	74147.78	
1382.255	40	72345.55	$120328_{5/2} - 192674^{\circ}_{5/2}$	1347.668	300	74202.25	$95215_{9/2} - 169417^{\circ}_{7/2}$
1381.930	80	72362.56	$94834_{7/2} - 167196^{\circ}_{9/2}$	1346.939	600	74242.41	
1381.881	60	72365.13	$105685_{7/2} - 178049^{\circ}_{5/2}$	1345.815	4	74304.41	
1381.500	50	72385.08		1345.675	100	74312.14	$103484_{5/2} - 177796^{\circ}_{7/2}$
1381.179	150	72401.91		1345.558	20	74318.60	$111550_{7/2} - 185869^{\circ}_{5/2}$
1380.372	150	72444.23		1345.362	3000	74329.43	
1379.985	100	72464.55		1344.574	1000	74372.99	
1379.287	1	72501.22		1344.467	1000	74378.91	
1379.017	100	72515.42		1344.365	250	74384.56	$102158_{5/2} - 176542^{\circ}_{7/2}$
1378.877	80	72522.78		1343.694	600	74421.70	$111550_{7/2} - 185972^{\circ}_{7/2}$
1376.826	1000	72630.81		1343.242	150	74446.74	$101318_{5/2} - 175765^{\circ}_{5/2}$
1376.722	1000	72636.30	$120773_{9/2} - 193409^{\circ}_{7/2}$	1343.047	1000	74457.55	
1376.664	3000	72639.36	$89422_{13/2} - 162061^{\circ}_{11/2}$	1343.008	800	74459.72	$88175_{11/2} - 162635^{\circ}_{13/2}$
1376.556	80	72645.06	$106039_{7/2} - 178684^{\circ}_{5/2}$	1342.866	40	74467.59	$102875_{9/2} - 177343^{\circ}_{9/2}$
1375.838	400	72682.97	$106001_{3/2} - 178684^{\circ}_{5/2}$	1342.693	1	74477.18	
1375.417	4000	72705.22	$95316_{13/2} - 168021^{\circ}_{11/2}$	1342.188	300	74505.21	
1375.022	30	72726.10		1341.329	50	74552.92	$103484_{5/2} - 178036^{\circ}_{7/2}$
1374.438	600	72757.01	$94834_{7/2} - 167590^{\circ}_{5/2}$	1341.102	600	74565.54	$103484_{5/2} - 178049^{\circ}_{5/2}$
1373.524	40	72805.42	$95215_{9/2} - 168021^{\circ}_{11/2}$	1340.930	1000	74575.10	
1373.448	800	72809.45	$94386_{9/2} - 167196^{\circ}_{9/2}$	1340.188	1	74616.39	
1372.706	20	72848.81		1340.150	200	74618.51	$97592_{9/2} - 172211^{\circ}_{11/2}$
1371.820	2	72895.86	$98971_{9/2} - 171867^{\circ}_{9/2}$	1340.055	2000	74623.80	$97587_{11/2} - 172211^{\circ}_{11/2}$
1371.450	600	72915.52	$94498_{5/2} - 167413^{\circ}_{7/2}$	1338.834	60	74691.85	$104613_{9/2} - 179305^{\circ}_{7/2}$ $118717_{7/2} - 193409^{\circ}_{7/2}$
1370.166	400	72983.85					
1369.884	200	72998.88		1337.235	2	74781.17	$94498_{5/2} - 169279^{\circ}_{5/2}$
1369.871	800	72999.57	$105685_{7/2} - 178684^{\circ}_{5/2}$	1336.414	1000	74827.11	$88175_{11/2} - 163002^{\circ}_{11/2}$
1369.717	3000	73007.78	$98502_{7/2} - 171510^{\circ}_{7/2}$	1336.044	2	74847.83	$127045_{13/2} - 201893^{\circ}_{11/2}$
1369.579	200	73015.13	$95078_{11/2} - 168092^{\circ}_{9/2}$	1335.390	450	74884.49	$88118_{9/2} - 163002^{\circ}_{11/2}$
1369.282	30	73030.97	$99180_{11/2} - 172211^{\circ}_{11/2}$	1334.921	600	74910.79	$111550_{7/2} - 186462^{\circ}_{9/2}$
1368.129	600	73092.52	$94498_{5/2} - 167590^{\circ}_{5/2}$	1334.775	1	74918.99	$94498_{5/2} - 169417^{\circ}_{7/2}$
1367.682	300	73116.41		1334.389	1000	74940.66	$93081_{11/2} - 168021^{\circ}_{11/2}$
1367.307	3	73136.46		1333.341	3	74999.56	
1366.874	400	73159.63	$112812_{9/2} - 185972^{\circ}_{7/2}$	1333.119	1000	75012.05	$93081_{11/2} - 168092^{\circ}_{9/2}$
1366.436	80	73183.08	$104613_{9/2} - 177796^{\circ}_{7/2}$	1332.796	20	75030.23	$94386_{9/2} - 169417^{\circ}_{7/2}$
1366.304	100	73190.15	$112679_{5/2} - 185869^{\circ}_{5/2}$	1331.926	80	75079.24	$104225_{7/2} - 179305^{\circ}_{7/2}$
1366.227	150	73194.27	$112675_{3/2} - 185869^{\circ}_{5/2}$	1329.780	1	75200.40	$103484_{5/2} - 178684^{\circ}_{5/2}$
1365.885	3000	73212.60	$89422_{13/2} - 162635^{\circ}_{13/2}$	1329.357	80	75224.33	$101318_{5/2} - 176542^{\circ}_{7/2}$
1365.696	30	73222.73	$102542_{7/2} - 175765^{\circ}_{5/2}$	1329.173	20	75234.75	$94498_{5/2} - 169733^{\circ}_{3/2}$
1365.331	1	73242.31		1328.965	80	75246.52	
1365.139	200	73252.61	$102512_{3/2} - 175765^{\circ}_{5/2}$	1328.835	15	75253.88	$102542_{7/2} - 177796^{\circ}_{7/2}$ $127045_{13/2} - 202299^{\circ}_{13/2}$
1365.005	600	73259.80	$102875_{9/2} - 176135^{\circ}_{11/2}$				
1364.484	600	73287.77	$98222_{5/2} - 171510^{\circ}_{7/2}$	1326.362	8000	75394.19	$95580_{15/2} - 170974^{\circ}_{13/2}$
1364.399	1500	73292.34		1326.319	2000	75396.64	

TABLE 1. *Classified spectral lines of* Yb IV.
Wavelengths longer than 2000 Å are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1324.608	20	75494.03	$102542_{7/2} - 178036^{\circ}_{7/2}$
1324.375	100	75507.31	$102542_{7/2} - 178049^{\circ}_{5/2}$
1323.921	300	75533.20	$95977_{7/2} - 171510^{\circ}_{7/2}$
1323.855	1	75536.97	$102512_{3/2} - 178049^{\circ}_{5/2}$
1323.366	150	75564.88	$85545_{13/2} - 161110^{\circ}_{15/2}$
1321.886	10	75649.48	$102875_{9/2} - 178524^{\circ}_{9/2}$
1321.668	2	75661.96	
1317.886	6	75879.09	$102158_{5/2} - 178036^{\circ}_{7/2}$
1317.857	20	75880.76	$91532_{7/2} - 167413^{\circ}_{7/2}$
1317.703	100	75889.63	$95977_{7/2} - 171867^{\circ}_{9/2}$
1317.582	20	75896.60	$95078_{11/2} - 170974^{\circ}_{13/2}$
1316.986	800	75930.95	$91482_{5/2} - 167413^{\circ}_{7/2}$
1316.040	9000	75985.53	$85124_{17/2} - 161110^{\circ}_{15/2}$
1314.794	150	76057.54	$91532_{7/2} - 167590^{\circ}_{5/2}$
1314.240	1	76089.60	$91931_{13/2} - 168021^{\circ}_{11/2}$
1313.920	100	76108.13	$91482_{5/2} - 167590^{\circ}_{5/2}$
1313.568	20	76128.52	$100350_{7/2} - 176478^{\circ}_{9/2}$
1312.469	150	76192.27	$100350_{7/2} - 176542^{\circ}_{7/2}$
1311.883	1	76226.31	
1311.195	100	76266.30	$82673_{11/2} - 158939^{\circ}_{9/2}$
1308.548	100	76420.58	$99344_{5/2} - 175765^{\circ}_{5/2}$
1307.943	10	76455.93	$109413_{5/2} - 185869^{\circ}_{5/2}$
1307.712	800	76469.43	
1306.919	600	76515.83	$85545_{13/2} - 162061^{\circ}_{11/2}$
1306.740	1	76526.31	$102158_{5/2} - 178684^{\circ}_{5/2}$
1306.192	800	76558.42	$\{101966_{9/2} - 178524^{\circ}_{9/2}$
			$109413_{5/2} - 185972^{\circ}_{7/2}$
1305.584	2000	76594.07	$107873_{5/2} - 184467^{\circ}_{3/2}$
1304.733	250	76644.03	
1303.965	2	76689.17	$115984_{7/2} - 192674^{\circ}_{5/2}$
1302.815	60	76756.86	
1302.712	20	76762.93	$102542_{7/2} - 179305^{\circ}_{7/2}$
1301.916	1	76809.87	
1300.692	1	76882.15	$109025_{9/2} - 185907^{\circ}_{11/2}$
1300.491	2	76894.03	$95316_{13/2} - 172211^{\circ}_{11/2}$
1299.591	20	76947.28	$109025_{9/2} - 185972^{\circ}_{7/2}$
1298.500	20	77011.93	$94498_{5/2} - 171510^{\circ}_{7/2}$
1298.236	50	77027.59	
1298.155	100	77032.40	$94834_{7/2} - 171867^{\circ}_{9/2}$
1297.192	300	77089.59	$85545_{13/2} - 162635^{\circ}_{13/2}$
1296.461	40	77133.05	$95078_{11/2} - 172211^{\circ}_{11/2}$
1296.166	20	77150.61	$90045_{9/2} - 167196^{\circ}_{9/2}$
1295.936	500	77164.30	
1295.551	400	77187.23	$90834_{11/2} - 168021^{\circ}_{11/2}$
1294.355	20	77258.55	$90834_{11/2} - 168092^{\circ}_{9/2}$
1294.290	150	77262.43	$98502_{7/2} - 175765^{\circ}_{5/2}$
1292.725	400	77355.97	
1291.957	25	77401.95	$124897_{11/2} - 202299^{\circ}_{13/2}$
1291.762	400	77413.64	
1291.572	25	77425.02	$115984_{7/2} - 193409^{\circ}_{7/2}$
1291.227	200	77445.71	$100350_{7/2} - 177796^{\circ}_{7/2}$
1290.245	2000	77504.66	$122222_{17/2} - 199726^{\circ}_{15/2}$
1289.619	1	77542.28	$98222_{5/2} - 175765^{\circ}_{5/2}$
1289.130	400	77571.69	$98971_{9/2} - 176542^{\circ}_{7/2}$
1287.402	4	77675.81	$89520_{7/2} - 167196^{\circ}_{9/2}$
1287.009	1	77699.53	$100350_{7/2} - 178049^{\circ}_{5/2}$
1285.378	15	77798.12	
1281.388	6	78040.37	$98502_{7/2} - 176542^{\circ}_{7/2}$
1280.897	2	78070.28	$89520_{7/2} - 167590^{\circ}_{5/2}$
1280.758	1	78078.76	$90045_{9/2} - 168124^{\circ}_{7/2}$
1280.284	1500	78107.67	$10214^{\circ}_{5/2} - 88322_{5/2}$
1276.580	2	78334.29	$100350_{7/2} - 178684^{\circ}_{5/2}$
1276.202	4	78357.50	
1273.121	6	78547.12	$97687_{11/2} - 176135^{\circ}_{11/2}$
1272.794	2	78567.30	
1272.284	400	78598.80	$89422_{13/2} - 168021^{\circ}_{11/2}$
1269.209	3	78789.22	
1269.048	10	78799.22	
1267.570	80	78891.10	$97587_{11/2} - 176478^{\circ}_{9/2}$
1267.028	300	78924.85	$82185_{15/2} - 161110^{\circ}_{15/2}$
1265.993	1	78989.37	
1265.134	20	79043.01	$91931_{13/2} - 170974^{\circ}_{13/2}$
1263.593	15	79139.40	
1263.141	80	79167.72	
1261.531	400	79268.76	$88322_{5/2} - 167590^{\circ}_{5/2}$
1261.218	100	79288.43	
1260.332	60	79344.17	$99180_{11/2} - 178524^{\circ}_{9/2}$
1259.889	1	79372.07	$90045_{9/2} - 169417^{\circ}_{7/2}$
1259.625	20	79388.70	$82673_{11/2} - 162061^{\circ}_{11/2}$
1253.100	2	79802.09	$88322_{5/2} - 168124^{\circ}_{7/2}$
1252.403	60	79846.50	$88175_{11/2} - 168021^{\circ}_{11/2}$
1251.511	50	79903.41	$88118_{9/2} - 168021^{\circ}_{11/2}$
1251.286	15	79917.78	$88175_{11/2} - 168092^{\circ}_{9/2}$
1250.595	1000	79961.93	$82673_{11/2} - 162635^{\circ}_{13/2}$
1250.362	40	79976.83	$91532_{7/2} - 171510^{\circ}_{7/2}$
1249.660	100	80021.76	$98502_{7/2} - 178524^{\circ}_{9/2}$
1249.561	80	80028.10	$91482_{5/2} - 171510^{\circ}_{7/2}$
1245.945	1	80260.36	
1245.649	200	80279.43	$91931_{13/2} - 172211^{\circ}_{11/2}$
1244.803	30	80333.99	$\{98971_{9/2} - 179305^{\circ}_{7/2}$
			$91532_{7/2} - 171867^{\circ}_{9/2}$
1244.180	100	80374.22	
1243.619	60	80410.47	$78529_{9/2} - 158939^{\circ}_{9/2}$
1243.015	600	80449.55	$82185_{15/2} - 162635^{\circ}_{13/2}$
1242.207	1	80501.88	$95977_{7/2} - 176478^{\circ}_{9/2}$
1237.976	3	80777.01	$105685_{7/2} - 186462^{\circ}_{9/2}$
1237.830	6	80786.53	
1237.571	1	80803.44	$98502_{7/2} - 179305^{\circ}_{7/2}$
1234.839	300	80982.21	
1233.115	2	81095.43	$88322_{5/2} - 169417^{\circ}_{7/2}$
1230.491	500	81268.37	$10214^{\circ}_{5/2} - 91482_{5/2}$
1229.732	1000	81318.53	$10214^{\circ}_{5/2} - 91532_{7/2}$
1228.328	1	81411.47	$88322_{5/2} - 169733^{\circ}_{3/2}$
1228.064	1	81428.98	
1226.207	1	81552.29	$89422_{13/2} - 170974^{\circ}_{13/2}$
1224.818	1	81644.78	$94834_{7/2} - 176478^{\circ}_{9/2}$
1221.087	4	81894.24	
1216.579	2	82197.70	$102158_{5/2} - 184355^{\circ}_{5/2}$
1212.479	200	82475.65	$85545_{13/2} - 168021^{\circ}_{11/2}$
1211.421	3	82547.68	$95977_{7/2} - 178524^{\circ}_{9/2}$
1210.452	3	82613.76	
1207.513	20	82814.84	
1207.016	20	82848.94	$84347_{7/2} - 167196^{\circ}_{9/2}$
1201.695	20	83215.79	$94834_{7/2} - 178049^{\circ}_{5/2}$
1200.336	1	83310.00	
1197.133	250	83532.90	$78529_{9/2} - 162061^{\circ}_{11/2}$
1193.637	2	83777.56	$84347_{7/2} - 168124^{\circ}_{7/2}$
1189.156	1	84093.25	$88118_{9/2} - 172211^{\circ}_{11/2}$
1186.454	5	84284.76	$10214^{\circ}_{5/2} - 94498_{5/2}$
1185.579	6000	84346.97	$0^{\circ}_{7/2} - 84347_{7/2}$
1183.807	10	84473.22	$78529_{9/2} - 163002^{\circ}_{11/2}$
1181.751	1000	84620.19	$10214^{\circ}_{5/2} - 94834_{7/2}$
1166.012	500	85762.41	$10214^{\circ}_{5/2} - 95977_{7/2}$
1162.278	5	86037.93	
1155.330	3	86555.35	
1136.237	300	88009.80	$10214^{\circ}_{5/2} - 98222_{5/2}$
1134.426	5000	88150.30	
1128.894	20	88582.27	
1122.529	60	89084.55	
1121.943	20	89131.08	$10214^{\circ}_{5/2} - 99344_{5/2}$
1117.064	100	89520.38	$0^{\circ}_{7/2} - 89520_{7/2}$
1110.548	200	90045.63	$0^{\circ}_{7/2} - 90045_{9/2}$
1109.431	100	90136.29	$10214^{\circ}_{5/2} - 100350_{7/2}$
1107.680	5	90278.78	
1097.643	100	91104.30	$10214^{\circ}_{5/2} - 101318_{5/2}$
1093.109	50	91482.18	$0^{\circ}_{7/2} - 91482_{5/2}$
1092.510	400	91532.34	$0^{\circ}_{7/2} - 91532_{7/2}$
1087.621	50	91943.79	$10214^{\circ}_{5/2} - 102158_{5/2}$
1083.441	50	92298.52	$10214^{\circ}_{5/2} - 102512_{3/2}$
1083.088	2	92328.60	$10214^{\circ}_{5/2} - 102542_{7/2}$
1072.155	20	93270.09	$10214^{\circ}_{5/2} - 103484_{5/2}$
1063.694	40	94011.99	$10214^{\circ}_{5/2} - 104225_{7/2}$
1059.468	100	94386.99	$0^{\circ}_{7/2} - 94386_{9/2}$
1058.223	50	94498.03	$0^{\circ}_{7/2} - 94498_{5/2}$
1054.463	1000	94835.00	$0^{\circ}_{7/2} - 94834_{7/2}$
1050.245	1000	95215.87	$0^{\circ}_{7/2} - 95215_{9/2}$
1047.433	3	95471.50	$10214^{\circ}_{5/2} - 105685_{7/2}$
1043.558	40	95826.01	$10214^{\circ}_{5/2} - 106039_{7/2}$

TABLE 1. *Classified spectral lines of* Yb IV.
Wavelengths longer than 2000 A are values in air—continued

Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification	Wavelength (Å)	Intensity	Wavenumber (cm^{-1})	Classification
1041.917	1	95976.93	$0^{\circ}_{7/2} - 95977_{7/2}$	908.141	10	110115.05	$10214^{\circ}_{5/2} - 120328_{5/2}$
1040.732	50	96086.21	$95580_{15/2} - 191666^{\circ}_{13/2}$	905.234	1	110468.67	
1033.426	3	96765.51		904.495	10	110558.93	
1024.323	100	97625.45		902.456	300	110808.72	$0^{\circ}_{7/2} - 110808_{7/2}$
1018.089	30	98223.23	$0^{\circ}_{7/2} - 98222_{5/2}$	896.455	40	111550.49	$0^{\circ}_{7/2} - 111550_{7/2}$
1015.206	10	98502.17	$0^{\circ}_{7/2} - 98502_{7/2}$	891.095	2	112221.47	
1010.391	50	98971.58	$0^{\circ}_{7/2} - 98971_{9/2}$	887.474	5	112679.35	$0^{\circ}_{7/2} - 112679_{5/2}$
1008.066	40	99199.85	$10214^{\circ}_{5/2} - 109413_{5/2}$	886.429	20	112812.19	$0^{\circ}_{7/2} - 112812_{9/2}$
1006.592	5	99345.11	$0^{\circ}_{7/2} - 99344_{5/2}$	875.159	20	114264.95	
996.503	20	100350.92	$0^{\circ}_{7/2} - 100350_{7/2}$	871.646	20	114725.47	$10214^{\circ}_{5/2} - 124939_{5/2}$
994.081	100	100595.42	$10214^{\circ}_{5/2} - 110808_{7/2}$	871.076	1	114800.54	
986.983	50	101318.86	$0^{\circ}_{7/2} - 101318_{5/2}$	870.352	200	114896.04	$10214^{\circ}_{5/2} - 125110_{7/2}$
986.808	10	101336.83	$10214^{\circ}_{5/2} - 111550_{7/2}$	860.694	2	116185.31	$10214^{\circ}_{5/2} - 126399_{5/2}$
980.708	50	101967.14	$0^{\circ}_{7/2} - 101966_{9/2}$	857.243	10	116653.03	$10214^{\circ}_{5/2} - 126867_{7/2}$
978.879	30	102157.67	$0^{\circ}_{7/2} - 102157_{5/2}$	854.513	40	117025.72	$0^{\circ}_{7/2} - 117026_{5/2}$
975.979	100	102461.22	$10214^{\circ}_{5/2} - 112675_{3/2}$	842.548	10	118687.60	$10214^{\circ}_{5/2} - 128901_{7/2}$
975.944	100	102464.89	$10214^{\circ}_{5/2} - 112679_{5/2}$	842.336	5	118717.47	$0^{\circ}_{7/2} - 118717_{7/2}$
975.206	200	102542.43	$0^{\circ}_{7/2} - 102542_{7/2}$	841.480	1	118838.23	
972.859	40	102789.81	$88877_{15/2} - 191666^{\circ}_{13/2}$	835.305	2	119716.75	
966.332	4	103484.10	$0_{7/2} - 103484_{5/2}$	831.056	40	120328.83	$0^{\circ}_{7/2} - 120328_{5/2}$
959.454	100	104225.94	$0_{7/2} - 104255_{7/2}$	828.957	200	120633.51	$0^{\circ}_{7/2} - 120633_{9/2}$
955.907	10	104612.68	$0_{7/2} - 104613_{9/2}$	827.994	20	120773.82	$0^{\circ}_{7/2} - 120773_{9/2}$
946.781	20	105621.04		826.391	40	121008.09	$0^{\circ}_{7/2} - 121008_{9/2}$
946.205	400	105685.34	$0^{\circ}_{7/2} - 105685_{7/2}$	823.426	30	121443.82	
945.440	10	105770.85	$10214^{\circ}_{5/2} - 115984_{7/2}$	819.641	3	122004.63	
943.039	400	106040.15	$0^{\circ}_{7/2} - 106039_{7/2}$	818.816	20	122127.55	
936.221	300	106812.38	$10214^{\circ}_{5/2} - 117026_{5/2}$	816.515	100	122471.72	
932.529	1	107235.27		816.485	2	122476.22	$0^{\circ}_{7/2} - 122476_{5/2}$
929.660	50	107566.20	$0^{\circ}_{7/2} - 107566_{9/2}$	800.386	40	124939.71	$0^{\circ}_{7/2} - 124939_{5/2}$
927.719	2	107791.26		791.143	10	126399.39	$0^{\circ}_{7/2} - 126399_{5/2}$
927.013	300	107873.35	$0^{\circ}_{7/2} - 107873_{5/2}$	788.225	25	126867.32	$0^{\circ}_{7/2} - 126867_{7/2}$
918.740	1	108844.72		775.787	300	128901.35	$0^{\circ}_{7/2} - 128901_{7/2}$
917.221	2	109024.97	$0^{\circ}_{7/2} - 109025_{9/2}$	761.059	15	131395.86	$0^{\circ}_{7/2} - 131395_{7/2}$
913.338	1	109488.49					

TABLE II. *Observed energy levels of triply ionized ytterbium in units of* cm^{-1}.
Term assignments are generally obtained from the major component of the eigenvector.

Configuration	Term	J	Energy Level	Number of Transitions[a]
$4f^{13}$	$^2F^{\circ}$	7/2	0.00	41
		5/2	10214.00	30
$4f^{12}(^3H_6)5d$	(6,3/2)	9/2	78529.35	4
		15/2	82185.66	2
		11/2	82673.22	5
		13/2	85545.79	6
$4f^{12}(^3H_6)5d$	(6,5/2)	7/2	84347.10	4
		17/2	85124.97	1
		9/2	88118.23	6
		11/2	88175.39	8
		15/2	88877.36	2
		13/2	89422.61	6
$4f^{12}(^3F_4)5d$	(4,3/2)	5/2	88322.02	6
		7/2	89520.58	4
		9/2	90045.75	5
		11/2	90834.28	9
$4f^{12}(^3H_5)5d$	(5,5/2)	5/2	91482.45	6
		15/2	95580.51	2
		7/2	95977.01	11
		9/2	97592.82	5
		13/2	99165.53	3
		11/2	99180.70	4
$4f^{12}(^3H_5)5d$	(5,3/2)	7/2	91532.82	7
		13/2	91931.84	7
		11/2	95078.12	7
		9/2	95215.74	3
$4f^{12}(^3F_4)5d$	(4,5/2)	11/2	93081.00	5
		9/2	94386.78	4
		7/2	94834.11	7
		13/2	95316.96	5
		5/2	98222.84	8
$4f^{12}(^3H_4)5d$	(4,3/2)	5/2	94498.44	9
		11/2	97587.91	6
		9/2	98971.58	7
		7/2	102542.46	12
$4f^{12}(^3F_3)5d$	(3,3/2)	7/2	98502.45	11
		9/2	101966.58	6
		5/2	102158.00	10
		3/2	102512.64	5
$4f^{12}(^3F_2)5d$	(2,3/2)	5/2	99344.81	9
		7/2	100350.37	10
$4f^{12}(^3H_4)5d$	(4,5/2)	5/2	101318.32	7
		11/2	102850.63	3
		9/2	102875.36	4
		7/2	106039.98	9
$4f^{12}(^3F_3)5d$	(3,5/2)	5/2	103484.12	6
		7/2	104225.95	9
		9/2	104613.33	10
		11/2	106557.74	3
$4f^{12}(^3F_2)5d$	(2,5/2)	7/2	105685.06	11
		3/2	106001.61	4
		9/2	107566.26	4
		5/2	107873.37	6
$4f^{12}(^3H_6)6s$	(6,1/2)	13/2	105978.91	7
		11/2	106801.87	11
$4f^{12}(^1G_4)5d$	(4,3/2)	9/2	109025.19	8
		5/2	109413.60	5
		7/2	110808.64	8
$4f^{12}(^1G_4)5d$	(4,5/2)	7/2	111550.79	5
		3/2	112675.11	2
		9/2	112812.41	4
		11/2	113049.88	3
		5/2	117026.11	8
$4f^{12}(^3F_4)6s$	(4,1/2)	9/2	112189.53	7
		7/2	112772.68	8
$4f^{12}(^1D_2)5d$	(2,3/2)	5/2	112679.21	10
		7/2	115984.86	7
$4f^{12}(^3H_5)6s$	(5,1/2)	11/2	115910.86	6
		9/2	115974.66	5
$4f^{12}(^1I_6)5d$	(6,3/2)	15/2	118231.82	1
		9/2	120633.01	2
		11/2	124897.10	3
		13/2	127045.18	4
$4f^{12}(^1D_2)5d$	(2,5/2)	7/2	118717.47	6
		5/2	120328.83	5
		9/2	120773.79	11
$4f^{12}(^3H_4)6s$	(4,1/2)	7/2	120667.16	10
		9/2	121008.13	7
$4f^{12}(^1I_6)5d$	(6,5/2)	17/2	122222.00	1
		7/2	125110.0	1 R
		15/2	130855.44	3
		13/2	130889.13	2
$4f^{12}(^3F_3)6s$	(3,1/2)	5/2	122476.28	9
		7/2	122650.29	10
$4f^{12}(^3F_2)6s$	(2,1/2)	3/2	122787.25	6
		5/2	123710.47	7
$4f^{12}(^3P_0)5d$	(0,5/2)	5/2	124939.6	2 R
$4f^{12}(^3P_1)5d$	(1,3/2)	5/2	126399.3	2 R
$4f^{12}(^3P_2)5d$	(2,3/2)	7/2	126867.2	2 R
$4f^{12}(^3P_1)5d$	(1,5/2)	7/2	128901.4	2 R
$4f^{12}(^1G_4)6s$	(4,1/2)	7/2	130524.02	7
		9/2	130676.79	7
$4f^{12}(^3P_2)5d$	(2,5/2)	7/2	131395.86	3
$4f^{12}(^1D_2)6s$	(2,1/2)	5/2	137501.58	4
		3/2	137762.23	3
$4f^{12}(^1I_6)6s$	(6,1/2)	13/2	145117.18	5
		11/2	145128.74	5
$4f^{12}(^3H_6)6p$	$(6,1/2)^{\circ}$	11/2	152589.23	8
		13/2	153208.58	8
$4f^{12}(^3F_4)6p$	$(4,1/2)^{\circ}$	7/2	158935.83	8
		9/2	158939.69	9
$4f^{12}(^3H_6)6p$	$(6,3/2)^{\circ}$	15/2	161110.51	7
		9/2	161820.11	9
		11/2	162061.91	19
		13/2	162635.23	9
$4f^{12}(^3H_5)6p$	$(5,1/2)^{\circ}$	9/2	162991.93	8
		11/2	163002.61	11
$4f^{12}(^3H_4)6p$	$(4,1/2)^{\circ}$	9/2	167196.22	13

[a] An R next to the number of transitions indicates that this level is derived solely from resonance transition(s).

TABLE II. *Observed energy levels of triply ionized ytterbium in units of* cm^{-1}.
Term assignments are generally obtained from the major component of the eigenvector—continued

		7/2	167413.37	17
$4f^{12}(^3F_4)6p$	$(4,3/2)°$	5/2	167590.90	11
		11/2	168021.55	13
		9/2	168092.91	10
		7/2	168124.60	11
$4f^{12}(^3F_3)6p$	$(3,1/2)°$	5/2	169279.75	14
		7/2	169417.53	20
$4f^{12}(^3F_2)6p$	$(2,1/2)°$	3/2	169733.24	8
		5/2	170669.58	13
$4f^{12}(^3H_5)6p$	$(5,3/2)°$	13/2	170974.70	7
		7/2	171510.39	13
		9/2	171867.02	8
		11/2	172211.38	11
$4f^{12}(^3H_4)6p$	$(4,3/2)°$	5/2	175765.16	9
		11/2	176135.05	5
		9/2	176478.90	16
		7/2	176542.74	15
$4f^{12}(^1G_4)6p$	$(4,1/2)°$	9/2	177343.17	12
		7/2	177796.30	14
$4f^{12}(^3F_3)6p$	$(3,3/2)°$	7/2	178036.66	15
		5/2	178049.82	11
		9/2	178524.89	9
$4f^{12}(^3F_2)6p$	$(2,3/2)°$	5/2	178684.75	11
		7/2	179305.45	13
$4f^{12}(^1D_2)6p$	$(2,1/2)°$	5/2	184355.37	10
		3/2	184467.36	4
$4f^{12}(^1G_4)6p$	$(4,3/2)°$	5/2	185869.34	8
		11/2	185907.11	2
		7/2	185972.22	7
		9/2	186462.00	6
$4f^{12}(^1I_6)6p$	$(6,1/2)°$	13/2	191666.95	8
		11/2	191808.74	4
$4f^{12}(^1D_2)6p$	$(2,3/2)°$	5/2	192674.06	5
		7/2	193409.82	4
$4f^{12}(^1I_6)6p$	$(6,3/2)°$	9/2	199446.04	1
		15/2	199726.66	3
		11/2	201893.08	4
		13/2	202299.01	6

TABLE III. *Fitted values for radial parameters of the* $4f^{12}5d$, $4f^{12}6s$, *and* $4f^{12}6p$ *configurations of* Yb IV. *Units are* cm^{-1}.

Parameter	$4f^{12}5d$	$4f^{12}6s$	$4f^{12}6p$
A	108872 ± 110	121758 ± 40	176104 ± 38
$E^1(f^{12})$	7684 ± 21	7771 ± 66	7806 ± 17
$E^2(f^{12})$	36.83 ± .18	37.73 ± .37	37.99 ± .09
$E^3(f^{12})$	758.9 ± 1.9	752.7 ± 7.9	752.0 ± 1.9
$\alpha(f^{12})$	21.6 ± 1.4	18.5 ± 2.5	17.3 ± .7
$\beta(f^{12})$	−1000(fixed)	−1000(fixed)	−1000(fixed)
$\gamma(f^{12})$	−52.7 ± 6.2	−57(fixed)	−59.0 ± 2.3
$\zeta(4f)$	3079.6 ± 5.3	3065.1 ± 8.7	3065.7 ± 2.1
$F^2(fd)$	24434 ± 110		
$F^4(fd)$	16545 ± 280		
$G^1(fd)$	8454 ± 34		
$G^3(fd)$	9760 ± 260		
$G^5(fd)$	6465 ± 240		
$D^1(fd)$	−868 ± 100		
$D^3(fd)$	0(fixed)		
$X^2(fd)$	−2677 ± 220		
$X^4(fd)$	−2770 ± 340		
$\zeta(5d)$	1752.3 ± 8.5		
$F^2(fp)$			7891 ± 39
$G^2(fp)$			2443 ± 31
$G^4(fp)$			2235 ± 87
$D^1(fp)$			220 ± 32
$X^3(fp)$			0(fixed)
$\zeta(6p)$			5843.9 ± 51
$G^3(fs)$		3161 ± 170	
$R^2(fd,fs)$[a]		0(fixed)	
$R^3(fd,sf)$[a]		−3175 ± 670	

[a] Configuration interaction parameters between $4f^{12}5d$ and $4f^{12}6s$.

TABLE IV. *Calculated energies and compositions of the levels of the* $4f^{12}(5d+6s)$ *configuration of triply ionized ytterbium. Units are* cm^{-1}.

J	Levels calc	Levels obs	o-c	Composition in J_1j coupling			
1/2	100817			$(^3F_2)3/2$	58%,	$(^3F_3)5/2$	23%
	105642			$(^3F_2)5/2$	51%,	$(^3F_2)3/2$	13%
	106622			$(^3F_3)5/2$	60%,	$(^3F_2)5/2$	21%
	114974			$(^3P_2)3/2$	33%,	$(^1D_2)3/2$	28%
	120886			$(^3P_2)5/2$	23%,	$(^1D_2)5/2$	22%
	124212			$(^3P_1)3/2$	52%,	$(^1D_2)5/2$	22%
	130023			$(^3P_2)3/2$	58%,	$(^1D_2)3/2$	33%
	135674			$(^3P_2)5/2$	60%,	$(^1D_2)5/2$	32%
	145466			$(^3P_0)\,s$	84%,	$(^3P_1)\,s$	9%
	147770			$(^3P_1)\,s$	90%,	$(^3P_0)\,s$	8%
	187172			$(^1S_0)\,s$	92%,	$(^3P_0)\,s$	7%
3/2	92990			$(^3H_4)5/2$	28%,	$(^1G_4)5/2$	27%
	96662			$(^3F_3)3/2$	35%,	$(^3F_4)5/2$	32%
	99944			$(^3F_2)3/2$	28%,	$(^3F_3)3/2$	22%
	102468[a]	102512	44	$(^3H_4)5/2$	34%,	$(^3F_3)3/2$	35%
	105155			$(^3F_3)5/2$	43%,	$(^3F_2)5/2$	30%
	106162	106001	−161	$(^3F_2)5/2$	38%,	$(^3F_3)5/2$	31%
	112706	112675	−31	$(^1G_4)5/2$	47%,	$(^3F_4)5/2$	18%
	116065			$(^3P_2)3/2$	46%,	$(^3F_2)3/2$	18%
	119534			$(^1D_2)5/2$	40%,	$(^3P_2)5/2$	27%
	122823	122787	−36	$(^3F_2)\,s$	75%,	$(^1D_2)\,s$	22%
	124293			$(^3P_0)3/2$	66%,	$(^1D_2)3/2$	9%
	125631			$(^3P_1)3/2$	59%,	$(^3P_0)3/2$	10%
	130224			$(^3P_1)3/2$	31%,	$(^3P_2)3/2$	22%
	132475			$(^3P_1)5/2$	59%,	$(^1D_2)3/2$	16%
	134656			$(^3P_2)5/2$	62%,	$(^1D_2)5/2$	33%
	137789	137762	−27	$(^1D_2)\,s$	42%,	$(^3P_2)\,s$	37%
	146772			$(^3P_1)\,s$	97%,	$(^1D_2)\,s$	1%
	149733			$(^3P_2)\,s$	59%,	$(^1D_2)\,s$	34%
	164996			$(^1S_0)3/2$	90%,	$(^3P_0)3/2$	8%
5/2	88242	88322	80	$(^3F_4)3/2$	45%,	$(^1G_4)3/2$	31%
	91450	91482	32	$(^3H_5)5/2$	39%,	$(^3H_4)3/2$	14%
	94471[a]	94498	27	$(^3F_4)3/2$	26%,	$(^3H_4)3/2$	16%
	98231[a]	98222	−9	$(^3H_5)5/2$	30%,	$(^3F_4)5/2$	21%
	99332	99344	12	$(^3F_2)3/2$	42%,	$(^3H_4)3/2$	15%
	101264	101318	54	$(^3H_4)5/2$	17%,	$(^3F_2)5/2$	17%
	102154	102158	4	$(^3F_3)3/2$	34%,	$(^3H_4)5/2$	30%
	103461	103484	23	$(^3F_3)5/2$	63%,	$(^3H_4)3/2$	10%
	107977	107873	−104	$(^3F_2)5/2$	40%,	$(^3F_4)5/2$	19%
	109318[a]	109413	95	$(^1G_4)5/2$	33%,	$(^1G_4)3/2$	19%
	112678	112679	1	$(^1D_2)3/2$	21%,	$(^3P_2)3/2$	17%
	117064[a]	117026	−38	$(^3F_2)3/2$	18%,	$(^1G_4)5/2$	13%
	120393	120328	−65	$(^1D_2)5/2$	32%,	$(^3P_2)5/2$	27%
	122479	122476	−3	$(^3F_3)\,s$	69%,	$(^3F_2)\,s$	23%
	123645	123710	65	$(^3F_2)\,s$	48%,	$(^3F_3)\,s$	28%
	124864	124939	75	$(^3P_0)5/2$	25%,	$(^3D_2)3/2$	20%
	126361	126399	38	$(^3P_1)3/2$	79%,	$(^3P_2)3/2$	9%
	129052			$(^3P_0)5/2$	28%,	$(^3P_2)5/2$	26%
	131361			$(^3P_0)5/2$	33%,	$(^3P_2)5/2$	30%
	132275			$(^3P_1)5/2$	82%,	$(^3P_2)5/2$	10%
	137479[a]	137501	22	$(^3P_2)\,s$	42%,	$(^1D_2)\,s$	36%
	149013			$(^3P_2)\,s$	55%,	$(^1D_2)\,s$	40%
	168872			$(^1S_0)5/2$	91%,	$(^3P_0)5/2$	7%
7/2	84377	84347	−30	$(^3H_6)5/2$	42%,	$(^3F_4)3/2$	23%
	89575	89520	−55	$(^3F_4)3/2$	37%,	$(^3H_6)5/2$	19%
	91557	91532	−25	$(^3H_5)3/2$	46%,	$(^3H_6)5/2$	22%
	94747	94834	87	$(^3F_4)5/2$	23%,	$(^3H_5)5/2$	19%
	95936	95977	41	$(^3H_5)5/2$	46%,	$(^3H_4)3/2$	12%
	98533	98502	−31	$(^3F_3)3/2$	52%,	$(^3F_4)5/2$	8%
	100287	100350	63	$(^3F_2)3/2$	31%,	$(^3F_4)5/2$	19%
	102561[a]	102542	−19	$(^3F_2)5/2$	21%,	$(^3H_4)3/2$	17%
	104185	104225	40	$(^3F_3)5/2$	38%,	$(^3F_2)3/2$	14%
	105638	105685	47	$(^3F_2)5/2$	28%,	$(^3H_4)3/2$	24%
	106013[a]	106039	26	$(^3F_3)5/2$	23%,	$(^3H_4)5/2$	16%
	110792	110808	16	$(^1G_4)3/2$	34%,	$(^3H_4)3/2$	13%
	111523	111550	27	$(^1G_4)5/2$	33%,	$(^3H_4)5/2$	28%
	112768	112772	4	$(^3F_4)\,s$	56%,	$(^1G_4)\,s$	31%
	116026[a]	115984	−42	$(^3P_2)3/2$	24%,	$(^1D_2)3/2$	14%
	118681[a]	118717	36	$(^3P_2)5/2$	24%,	$(^1D_2)5/2$	17%
	120640	120667	27	$(^3H_4)\,s$	55%,	$(^3F_4)\,s$	29%
	122672	122650	−22	$(^3F_3)\,s$	95%,	$(^3H_4)\,s$	1%
	125064	125110	46	$(^1I_6)5/2$	84%,	$(^3H_4)3/2$	4%
	126801[a]	126867	66	$(^1D_2)5/2$	28%.	$(^3P_2)3/2$	16%
	128963	128901	−62	$(^3P_1)5/2$	38%,	$(^3P_2)3/2$	32%
	130484	130524	40	$(^1G_4)\,s$	53%,	$(^3H_4)\,s$	31%
	131402	131395	−7	$(^3P_2)5/2$	35%,	$(^3P_1)5/2$	32%
9/2	78711	78529	−182	$(^3H_6)3/2$	84%,	$[^3H_6)5/2$	6%
	88118	88118	0	$(^3H_6)5/2$	52%,	$(^3F_4)3/2$	18%
	90067	90045	−22	$(^3F_4)3/2$	44%,	$(^1G_4)3/2$	17%
	94424	94386	−38	$(^3F_4)5/2$	54%,	$(^1G_4)5/2$	25%
	95179	95215	36	$(^3H_5)3/2$	61%,	$(^3F_3)3/2$	15%
	97572	97592	20	$(^3H_5)5/2$	64%,	$(^3H_6)5/2$	9%
	99018	98971	−47	$(^3H_4)3/2$	44%,	$(^3F_4)3/2$	21%
	101932	101966	34	$(^3F_3)3/2$	53%,	$(^3H_5)3/2$	18%
	102787	102875	88	$(^3H_4)5/2$	22%,	$(^3F_2)5/2$	23%
	104632	104613	−19	$(^3F_3)5/2$	58%,	$(^3F_3)3/2$	10%
	107563	107566	3	$(^3F_2)5/2$	46%,	$(^3H_4)5/2$	14%
	109085[a]	109025	−60	$(^3H_4)3/2$	41%,	$(^1G_4)3/2$	40%
	112207	112189	−18	$(^3F_4)\,s$	64%,	$(^1G_4)\,s$	29%
	112854	112812	−42	$(^1G_4)5/2$	42%,	$(^3H_4)5/2$	39%
	115990	115974	−16	$(^3H_5)\,s$	98%,	$(^3H_4)\,s$	1%
	120703	120633	−70	$(^1I_6)3/2$	54%,	$(^3H_4)\,s$	7%
	120836[a]	120773	−63	$(^3P_2)5/2$	28%,	$(^1D_2)5/2$	23%
	120994	121008	14	$(^3H_4)\,s$	31%,	$(^1I_6)3/2$	21%
	127494			$(^1I_6)5/2$	86%,	$(^1I_6)3/2$	11%
	130713	130676	−37	$(^1G_4)\,s$	52%,	$(^3H_4)\,s$	37%
	132682			$(^3P_2)5/2$	52%,	$(^1D_2)5/2$	39%
11/2	82685	82673	−12	$(^3H_6)3/2$	79%,	$(^3H_6)5/2$	15%
	88102	88175	73	$(^3H_6)5/2$	51%,	$(^3F_4)3/2$	27%
	90795[a]	90834	39	$(^3H_6)5/2$	23%,	$(^3F_4)3/2$	20%
	93135	93080	−55	$(^3F_4)5/2$	55%,	$(^1G_4)5/2$	22%
	95052	95078	26	$(^3H_5)3/2$	81%,	$(^3H_6)5/2$	5%
	97620	97587	−33	$(^3H_4)3/2$	49%,	$(^3F_4)3/2$	32%
	99181	99180	−1	$(^3H_5)5/2$	76%,	$(^3F_3)5/2$	18%
	102935	102850	−85	$(^3H_4)5/2$	41%,	$(^1G_4)5/2$	21%
	106513	106557	44	$(^3F_3)5/2$	59%,	$(^3H_5)5/2$	15%
	106852	106801	−51	$(^3H_6)\,s$	85%,	$(^1G_4)3/2$	4%
	107240			$(^1G_4)3/2$	38%,	$(^3H_4)3/2$	22%
	113073	113049	−24	$(^1G_4)5/2$	46%,	$(^3H_4)5/2$	45%
	115912	115910	−2	$(^3H_5)\,s$	99%,	$(^3H_6)\,s$	1%
	124926	124897	−29	$(^1I_6)3/2$	91%,	$(^1I_6)5/2$	6%
	130088			$(^1I_6)5/2$	91%,	$(^1I_6)3/2$	6%
	145129	145128	−1	$(^1I_6)\,s$	99%,	$(^3H_6)\,s$	1%
13/2	85460	85545	85	$(^3H_6)3/2$	92%,	$(^3F_4)5/2$	3%
	89382	89422	40	$(^3H_6)5/2$	63%,	$(^3F_4)5/2$	16%
	91968	91931	−37	$(^3H_5)3/2$	81%,	$(^3H_6)5/2$	10%
	95279	95316	37	$(^3F_4)5/2$	30%,	$(^1G_4)5/2$	29%
	99197	99165	−32	$(^3H_5)5/2$	90%,	$(^1G_4)5/2$	4%
	101832			$(^3H_4)5/2$	53%,	$(^3F_4)5/2$	35%
	105926	105978	52	$(^3H_6)\,s$	99%,	$(^1I_6)\,s$	1%
	111553			$(^1G_4)5/2$	54%,	$(^3H_4)5/2$	31%
	126948	127045	97	$(^1I_6)3/2$	98%,	$(^3H_6)3/2$	1%
	130890	130889	−1	$(^1I_6)5/2$	98%,	$(^3H_6)5/2$	1%
	145117	145117	0	$(^1I_6)\,s$	99%,	$(^3H_6)\,s$	1%
15/2	82207	82185	−22	$(^3H_6)3/2$	97%,	$(^3H_6)5/2$	1%
	88847	88877	30	$(^3H_6)5/2$	97%,	$(^3H_6)3/2$	1%
	95602	95580	−22	$(^3H_5)5/2$	99%,	$(^3H_6)3/2$	1%
	118271	118231	−40	$(^1I_6)3/2$	92%,	$(^1I_6)5/2$	7%
	130905	130855	−50	$(^1I_6)5/2$	92%,	$(^1I_6)3/2$	7%
17/2	85120	85124	4	$(^3H_6)5/2$	99%,	$(^1I_6)5/2$	1%
	122196	122222	26	$(^1I_6)5/2$	99%.	$(^3H_6)5/2$	1%

[a] The smaller of the listed eigenvectors was used in Table II as the level name. This was done in order to give each level a unique designation.

Table V. *Calculated energies and compositions of the levels of the* $4f^{12}6p$ *configuration of the triply ionized ytterbium. Units are* cm^{-1}.

J	Levels calc	Levels obs	o-c	Composition in J_1j coupling			
1/2	178783			$(^3F_2)3/2$	76%,	$(^1D_2)3/2$	20%
	191891			$(^3P_1)1/2$	39%,	$(^3P_0)3/2$	21%
	192860			$(^3P_0)1/2$	69%,	$(^3P_1)1/2$	16%
	194768			$(^3P_1)1/2$	40%,	$(^1D_2)3/2$	24%
	202601			$(^3P_1)3/2$	96%,	$(^3P_1)1/2$	2%
	206344			$(^3P_2)3/2$	56%,	$(^1D_2)3/2$	39%
	234484			$(^1S_0)1/2$	92%,	$(^3P_0)1/2$	7%
3/2	169756	169733	−23	$(^3F_2)1/2$	73%,	$(^1D_2)1/2$	23%
	178178			$(^3F_3)3/2$	59%,	$(^3F_2)3/2$	28%
	178985			$(^3F_2)3/2$	47%,	$(^3F_3)3/2$	37%
	184422[a]	184467	45	$(^3P_2)1/2$	42%,	$(^1D_2)1/2$	33%
	193057			$(^1D_2)3/2$	30%,	$(^3P_2)3/2$	29%
	194541			$(^3P_1)1/2$	74%,	$(^1D_2)3/2$	9%
	196128			$(^3P_2)1/2$	45%,	$(^1D_2)1/2$	41%
	201323			$(^3P_0)3/2$	86%,	$(^1S_0)3/2$	6%
	203431			$(^3P_1)3/2$	89%,	$(^1D_2)3/2$	3%
	205329			$(^3P_2)3/2$	53%,	$(^1D_2)3/2$	32%
	243135			$(^1S_0)3/2$	92%,	$(^3P_0)3/2$	7%
5/2	167568	167590	22	$(^3F_4)3/2$	40%,	$(^1G_4)3/2$	28%
	169284	169279	−5	$(^3F_3)1/2$	83%,	$(^3F_2)1/2$	11%
	170623	170669	46	$(^3F_2)1/2$	50%,	$(^3F_4)3/2$	16%
	175763	175765	2	$(^3H_4)3/2$	56%,	$(^3F_4)3/2$	28%
	178044	178049	5	$(^3F_3)3/2$	66%,	$(^3F_2)3/2$	22%
	178705	178684	−21	$(^3F_2)3/2$	47%,	$(^3F_3)3/2$	32%
	184363	184355	−8	$(^1D_2)1/2$	34%,	$(^3P_2)1/2$	32%
	185862	185869	7	$(^1G_4)3/2$	49%,	$(^3H_4)3/2$	26%
	192698[a]	192674	−24	$(^3P_2)3/2$	42%,	$(^1D_2)3/2$	34%
	196196			$(^3P_2)1/2$	53%,	$(^1D_2)1/2$	40%
	202241			$(^3P_1)3/2$	90%,	$(^1D_2)3/2$	5%
	204317			$(^3P_2)3/2$	51%,	$(^1D_2)3/2$	36%
7/2	158926	158935	9	$(^3F_4)1/2$	61%,	$(^1G_4)1/2$	31%
	167408	167413	5	$(^3H_4)1/2$	47%,	$(^3F_4)1/2$	25%
	168105	168124	19	$(^3F_4)3/2$	45%,	$(^1G_4)3/2$	23%
	169427	169417	−10	$(^3F_3)1/2$	61%,	$(^3F_4)3/2$	15%
	171493	171510	17	$(^3H_5)3/2$	76%,	$(^3F_3)1/2$	20%
	176535	176542	7	$(^3H_4)3/2$	51%,	$(^3F_4)3/2$	27%
	177767	177796	29	$(^1G_4)1/2$	45%,	$(^3H_4)1/2$	31%
	178043	178036	−7	$(^3F_3)3/2$	82%,	$(^1G_4)1/2$	8%
	179287	179305	18	$(^3F_2)3/2$	67%,	$(^1D_2)3/2$	21%
	185986	185972	−14	$(^1G_4)3/2$	53%,	$(^3H_4)3/2$	37%
	193426[a]	193409	−17	$(^3P_2)3/2$	43%,	$(^1D_2)3/2$	36%
	205144			$(^3P_2)3/2$	53%,	$(^1D_2)3/2$	42%
9/2	158957	158939	−18	$(^3F_4)1/2$	56%,	$(^1G_4)1/2$	27%
	161825	161820	−5	$(^3H_6)3/2$	60%,	$(^3H_5)1/2$	29%
	163016	162991	−25	$(^3H_5)1/2$	69%,	$(^3H_6)3/2$	29%
	167181	167196	15	$(^3H_4)1/2$	37%,	$(^3F_4)3/2$	21%
	168134	168092	−42	$(^3F_4)3/2$	43%,	$(^3H_4)1/2$	19%
	171833	171867	34	$(^3H_5)3/2$	96%,	$(^3H_5)1/2$	1%
	176479	176478	−1	$(^3H_4)3/2$	44%,	$(^3F_4)3/2$	19%
	177353	177343	−10	$(^1G_4)1/2$	41%,	$(^3H_4)1/2$	29%
	178534	178524	−10	$(^3F_3)3/2$	93%,	$(^3H_4)3/2$	2%
	186483	186462	−21	$(^1G_4)3/2$	52%,	$(^3H_4)3/2$	38%
	199443	199446	3	$(^1I_6)3/2$	98%,	$(^3H_6)3/2$	1%
11/2	152614	152589	−25	$(^3H_6)1/2$	96%,	$(^3H_6)3/2$	2%
	162058	162061	3	$(^3H_6)3/2$	55%,	$(^3H_5)1/2$	42%
	163011	163002	−9	$(^3H_5)1/2$	57%,	$(^3H_6)3/2$	40%
	168015	168021	6	$(^3F_4)3/2$	59%,	$(^1G_4)3/2$	31%
	172211	172211	−0	$(^3H_5)3/2$	99%,	$(^3H_5)1/2$	1%
	176132	176135	3	$(^3H_4)3/2$	56%,	$(^3F_4)3/2$	29%
	185900	185907	7	$(^1G_4)3/2$	54%,	$(^3H_4)3/2$	35%
	191814	191808	−6	$(^1I_6)1/2$	94%,	$(^1I_6)3/2$	3%
	201895	201893	−2	$(^1I_6)3/2$	96%,	$(^1I_6)1/2$	3%
13/2	153202	153208	6	$(^3H_6)1/2$	99%,	$(^1I_6)1/2$	1%
	162635	162635	0	$(^3H_6)3/2$	99%,	$(^1I_6)3/2$	1%
	170970	170974	4	$(^3H_5)3/2$	100%,		
	191668[a]	191666	−2	$(^1I_6)1/2$	97%,	$(^1I_6)3/2$	2%
	202306	202299	−7	$(^1I_6)3/2$	97%,	$(^1I_6)1/2$	2%
15/2	161099	161110	11	$(^3H_6)3/2$	99%,	$(^1I_6)3/2$	1%
	199710	199726	16	$(^1I_6)3/2$	99%,	$(^3H_6)3/2$	1%

[a] The smaller of the listed eigenvectors was used in Table II as the level name. This was done in order to give each level a unique designation.