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Extension of the Pt III Analysis

Alexander Ryabtsev

Institute of Spectroscopy, Russian Academy of Sciences, Troitsk, 108840 Moscow, Russia; ryabtsev@isan.troitsk.ru

Abstract: Using a sliding spark and a 6.65 m normal incidence vacuum spectrograph, the third spectrum of platinum was analyzed. The transitions involving high-lying levels were studied. A total of 241 Pt III lines of the transitions from the levels of the $5d^76p + 5d^66s6p$ configurations in the region 728–2062 Å were classified, increasing the number of known Pt III lines to more than 1000. Ninety-one energy levels belonging mostly to the $5d^66s6p$ configuration were added to Pt III. The odd Pt III levels were theoretically interpreted by means of multiconfiguration Dirak–Fock calculations and a least-squares fit of the calculated to the observed levels in the framework of the orthogonal parameters technique.

Keywords: platinum; ionic spectrum; vacuum ultraviolet; wavelengths; energy levels; transition probabilities; parametric calculations

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1. Introduction

The spectrum of doubly ionized platinum was first analyzed by Ryabtsev et al. [1]. They classified more than 800 lines in the 893–2022 Å region as transitions between the three lowest configurations, $5d^8$, $5d^76s$ and $5d^76p$, and found 40 even and 93 odd levels. Later, Wyart [2] reported two levels of the $5d^77s$ and five levels of the $5d^76d$ configurations based on 30 lines identified in the region 1300–1750 Å. In a recent paper [3], the photoabsorption spectrum of Pt III was recorded between 98 and 180 Å using the dual laser plasma method. Several unresolved peaks were identified as transitions from the inner subshell $4f^{14}$ broadened by autoionization.

The observation of the spectra of chemically peculiar stars χ *Lup* and κ *Cnc* from the Goddard High Resolution Spectrograph (GHRS) onboard the Hubble Space Telescope (HST) have resulted in the first identification of the Pt III lines in any stellar spectrum [4]. The absorption spectrum of χ *Lup* recorded in the range 1249–2688 Å is so rich in Pt III lines that even the transitions from highly lying known levels of the $5d^76s$ configuration are present [5]. The interest in Pt III was revived in connection with the interpretation of the spectrum of a binary neutron star merger, or a “kilonova”. Platinum is considered as one of the most interesting heavy elements to search for signatures in this spectrum. Recently, several theoretical studies of Pt III were published [6–8] pointing out the need for extended experimental atomic data.

The present investigation was undertaken to find the highly lying levels of Pt III (in particular, those of the $5d^66s6p$ configuration) and to derive transition probabilities from a theoretical study using a formalism of orthogonal operators.

2. Experimental Details

The platinum spectrum was excited in a sliding spark operated with a capacitor of 3.2 μF charged to 0.6–1.2 kV. Auxiliary inductance up to 3 μH and resistance up to 1.5 Ω were introduced in the electric circuit. The spectrum containing high intensity Pt III lines was obtained at a current about 1 kA. Variation of the electric parameters served to distinguish between Pt III lines and platinum lines of the other stages of the ionization.

The spectra in the region 500–2400 Å were obtained on a 6.65 m normal incidence spectrograph with a 1200 L/mm grating and a plate factor of 1.25 Å/mm. The spectra were photographed on Ilford Q2 plates and measured using an automatic microdensitometer. The Pt II lines [9] were used as reference lines in the region above 1178 Å. Impurity lines of O I-III and C II-III were used as standards for the wavelengths below 1178 Å [10]. Some platinum lines were measured in second order against the Pt II lines and used as the secondary standards. The rms deviation of the reference lines from a correction curve was 0.005 Å in the whole measured region. It can be considered as an uncertainty of Pt III wavelength measurements. This uncertainty is generally consistent with the differences between the observed wavelength and the wavelength derived from the final level energies (Ritz wavelength).

The measured line blackening was transformed to intensity using an approximately modeled characteristic curve of the photoplate. The relative line intensities in arbitrary units are given in this work on a linear scale approximately matching the intensities of the lines reported in [1]. The changes with the wavelength of the characteristic curve and sensitivity of the photoplate, as well as the wavelength dependence of the spectrograph response, were not taken into account.

3. Results and Discussion

As mentioned above, 40 Pt III levels were found in the even $5d^8 + 5d^7 6s$ configurations and 93 levels in the odd $5d^7 6p$ configuration [1]. The even levels in [1] were interpreted in a model of the mixed $5d^8 + 5d^7 6s + 5d^6 6s^2$ configurations by means of the Cowan code [11,12], with the 53 cm^{-1} standard deviation of the calculated level energies from the measured ones. Later, the orthogonal parameters technique [13–16] was applied to the calculations of the even energy levels [17]. Wyart et al. [18] performed a systematic study of the $(5d + 6s)^8$ mixed group in the isoelectronic sequence Ir II—Bi VIII by means of a generalized least-squares (GLS) fit. A standard deviation of 27 cm^{-1} of the calculated from the experimental levels was obtained for the whole sequence. Because the orthogonal parameters technique in an application to the odd configurations was not developed at that time, the calculations in [1] were made using the Cowan code. Fitting of the calculated level energies to the experimental ones for the $5d^7 6p + 5d^6 6s6p + 5d^5 6s^2 6p$ mixed group of the configurations resulted in average deviation of 190 cm^{-1}.

In this study, the energy levels of the odd configurations and transition probabilities were calculated by means of the orthogonal parameters technique. The even levels were calculated in an approach adopted in [17] with comparable results.

At the beginning of the analysis, the energy levels of the $5d^6 5s5p$ configuration were predicted using the Cowan code in a model of the $5d^7 6p + 5d^6 6s6p + 5d^5 6s^2 6p + 5d^7 7p + 5d^7 5f$ interacting configurations. The energy parameters for the $5d^7 6p + 5d^6 6s6p + 5d^5 6s^2 6p$ configurations were taken from [1] and estimated for the $5d^7 7p$ and $5d^7 5f$ configurations. The $5d^8 + 5d^7 6s + 5d^6 6s^2$ configurations were treated as in [1]. Thus, calculated energy levels and transition probabilities were used as entries to a program for visual identification of spectral lines and energy levels in optical spectra IDEN2 [19]. After finding enough $5d^6 6s6p$ levels for meaningful fitting of the level energies, the orthogonal parameters technique was applied. As in the Cowan code calculations, the model of five interacting configurations was applied. The energy parameters obtained in the fitting were used for the prediction of the unknown level energies and transition probabilities. Further identification was continued as an iterative process. The results of the identification are collected in Tables 1–3. Newly identified lines in the $(5d^8 + 5d^7 6s) - (5d^7 6p + 5d^6 6s6p)$ transition array of Pt III are listed in Table 1. Table 2 contains the energy of all known levels of the $5d^7 6p + 5d^6 6s6p$ configurations along with the *LS* composition of their wavefunctions, calculated with the final orthogonal energy parameters shown in Table 3.

Table 1. New lines in the ($5d^8$ + $5d^7 6s$) − ($5d^7 6p$ + $5d^6 6s6p$) transition array of Pt III.

					Lower Level			Upper Level			
gA, 10^7 s^{-1}	*Int* [1]	*λ* (Å)	o.-c. [2] (Å)	*ν* (cm^{-1})	*J*	E_{low} [3] (cm^{-1})	Name [4]	*J*	E_{upper} (cm^{-1})	Name [5]	Remark [6]
62	14	728.431	−0.001	137,281.4	3	9751.5 [c]	1|3F2)	2	147,032.6	1|2D1)3D	
184	9	762.099	0.000	131,216.5	4	36,530.1	2|4F3)3F	4	167,746.7	2|1G2G,3F	
313	10	785.423	0.002	127,319.9	3	32,266.6	2|4F3)5F	3	159,586.9	2|5D4D,5F	
163	19	788.233	0.007	126,866.0	4	21,330.5 [c]	1|1G2)	3	148,197.6	1|2D1)1F	
240	50	790.902	0.004	126,437.9	4	21,330.5 [c]	1|1G2)	3	147,769.0	1|2D1)1F	IV
182	13	792.688	0.005	126,153.0	3	43,057.2	2|4F3)3F	3	169,211.0	2|3G2G,1F	
467	15	798.092	−0.001	125,298.8	4	27,888.2	2|4F3)5F	5	153,186.9	2|3H4H,5G	
55	17	798.561	−0.002	125,225.2	2	14,171.9	1|3F2)	1	139,396.9	1|2D1)3D	
515	24	798.625	−0.003	125,215.2	5	42,531.9 [c]	2|2G3)3G	4	167,746.7	2|1G2G,3F	
1296	14	799.584	0.001	125,065.0	6	48,134.2	2|2H3)3H	5	173,199.4	2|3H4H,3G	
107	22	799.709	0.001	125,045.5	5	21,836.7	2|4F3)5F	4	146,882.3	1|2D1)3F	
576	45	804.607	−0.001	124,284.3	4	27,888.2	2|4F3)5F	4	152,172.3	2|5D4D,3F	
617	66	805.445		124,155.0	5	21,836.7	2|4F3)5F	6	145,991.7	2|3G4G,5G	
384	15	806.420	−0.002	124,004.9	3	36,970.2	2|4P3)5P	4	160,974.8	2|3H4H,5H	
360	50	812.623	−0.002	123,058.3	5	21,836.7	2|4F3)5F	5	144,894.7	2|3G4G,5G	
438	50	812.623	−0.010	123,058.3	4	36,530.1	2|4F3)3F	3	159,586.9	2|5D4D,5F	
599	21	813.690		122,896.9	6	48,134.2	2|2H3)3H	7	171,031.1	2|3H2H,3I	
245	22	815.552	0.002	122,616.3	3	36,970.2	2|4P3)5P	3	159,586.9	2|5D4D,5F	
58	7	816.376	−0.005	122,492.6	2	24,540.8 [c]	1|1D2)	2	147,032.6	1|2D1)3D	
655	27	817.606	−0.001	122,308.3	4	45,438.6	2|2G3)3G	4	167,746.7	2|1G2G,3F	
688	55	817.727	0.000	122,290.2	5	21,836.7	2|4F3)5F	5	144,126.9	2|3H4H,5G	
135	10	818.262	0.002	122,210.2	4	45,438.6	2|2G3)3G	3	167,649.2	2|3G4G,3G	
1449	13	821.331	−0.001	121,753.6	5	51,446.0	2|2H3)3H	5	173,199.4	2|3H4H,3G	
23	14	821.406	−0.004	121,742.5	4	0.0	1|3F2)	3	121,741.9	2|5D6D,7F	
988	37	821.818		121,681.4	3	32,266.6	2|4F3)5F	3	153,948.0	2|3F4F,5F	
53	27	822.467	−0.001	121,585.4	4	27,888.2	2|4F3)5F	4	149,473.5	2|3H4H,5G	
329	46	823.827	−0.001	121,384.7	4	27,888.2	2|4F3)5F	3	149,272.7	2|3G4G,5G	
130	24	824.759	−0.002	121,247.5	4	36,530.1	2|4F3)3F	4	157,777.4	2|3F4F,5F	IV
40	6	824.822	0.002	121,238.3	2	14,171.9	1|3F2)	2	135,410.5	2|5D6D,7D	
984	47	826.580		120,980.4	6	48,134.2	2|2H3)3H	6	169,114.6	2|3H4H,3I	
65	12	827.868	0.000	120,792.2	4	36,530.1	2|4F3)3F	5	157,322.3	2|3D4D,5F	
198	17	829.545	−0.008	120,548.0	4	27,888.2	2|4F3)5F	4	148,435.0	2|3F4F,5G	Ry
192	21	831.192	0.002	120,309.1	4	27,888.2	2|4F3)5F	3	148,197.6	1|2D1)1F	
93	35	832.888	−0.003	120,064.2	1	16,781.6	1|3P2)	2	136,845.3	1|2D1)3P	
510	111	833.736	0.000	119,942.0	2	36,291.5	2|4P3)5P	2	156,233.6	2|3F4F,5F	OIII
43	12	833.990	0.001	119,905.5	3	32,266.6	2|4F3)5F	4	152,172.3	2|5D4D,3F	
270	41	834.164	0.002	119,880.5	4	27,888.2	2|4F3)5F	3	147,769.0	1|2D1)1F	
48	22	838.472	−0.008	119,264.6	3	36,970.2	2|4P3)5P	2	156,233.6	2|3F4F,5F	
1063	39	840.696		118,949.1	5	51,446.0	2|2H3)3H	6	170,395.1	2|1I2I,3I	
63	39	842.961	−0.004	118,629.5	1	16,781.6	1|3P2)	2	135,410.5	2|5D6D,7D	
198	48	843.628	0.000	118,535.7	5	21,836.7	2|4F3)5F	5	140,372.4	2|3H4H,5I	
1097	55	844.290	0.001	118,442.7	5	42,531.9 [c]	2|2G3)3G	4	160,974.8	2|3H4H,5H	
787	29	845.939		118,211.8	3	32,266.6	2|4F3)5F	4	150,478.4	2|3F4F,5F	
593	20	847.908	0.005	117,937.3	5	42,531.9 [c]	2|2G3)3G	6	160,469.9	2|3F4F,5G	
64	7	848.198	−0.004	117,897.0	4	36,530.1	2|4F3)3F	4	154,426.5	2|3H4H,5G	
285	29	848.744	−0.005	117,821.2	4	27,888.2	2|4F3)5F	3	145,708.7	2|3G4G,5H	
177	7	849.017	0.002	117,783.3	3	49,963.2 [c]	2|2G3)3G	4	167,746.7	2|1G2G,3F	
431	31	849.347	−0.007	117,737.5	4	27,888.2	2|4F3)5F	4	145,624.8	2|3G4G,5F	
378	79	849.491		117,717.6	4	21,330.5 [c]	1|1G2)	3	139,048.1	1|2D1)3F	
815	27	849.716	−0.003	117,686.4	3	49,963.2 [c]	2|2G3)3G	3	167,649.2	2|3G4G,3G	
486	28	851.381	0.001	117,456.2	3	36,970.2	2|4P3)5P	4	154,426.5	2|3H4H,5G	
478	25	851.482		117,442.3	5	42,531.9 [c]	2|2G3)3G	5	159,974.2	2|3F4F,5F	
252	38	852.688	0.007	117,276.2	4	21,330.5 [c]	1|1G2)	3	138,607.7	2|3D4D,5F	

Table 1. *Cont.*

					Lower Level			Upper Level			
gA, 10^7 s^{-1}	*Int* [1]	λ (Å)	o.-c. [2] (Å)	ν (cm^{-1})	*J*	E_{low} [3] (cm^{-1})	Name [4]	*J*	E_{upper} (cm^{-1})	Name [5]	Remark [6]
159	10	852.752	−0.004	117,267.4	4	36,530.1	2|4F3)3F	5	153,797.0	2|5D4D,5F	
635	57	853.192	0.000	117,206.9	3	32,266.6	2|4F3)5F	4	149,473.5	2|3H4H,5G	
410	21	853.257	−0.004	117,198.0	4	52,013.6	2|2G3)1G	3	169,211.0	2|3G2G,1F	
822	61	854.654	0.001	117,006.4	4	27,888.2	2|4F3)5F	5	144,894.7	2|3G4G,5G	
660	38	855.287		116,919.8	5	42,531.9 [c]	2|2G3)3G	5	159,451.7	2|3H4H,5H	
430	37	856.657		116,732.8	1	40,963.6 [c]	2|4P3)5P	1	157,696.4	2|3F4F,5D	
1149	53	857.213	−0.002	116,657.1	4	36,530.1	2|4F3)3F	5	153,186.9	2|3H4H,5G	
2805	121	857.749	0.001	116,584.2	5	21,836.7	2|4F3)5F	4	138,421.0	2|5D6D,5D	
424	38	858.557		116,474.5	4	45,438.6	2|2G3)3G	4	161,913.1	2|1G2G,3G	
302	119	858.885	−0.007	116,430	3	32,266.6	2|4F3)5F	3	148,695.7	2|5D4D,5D	
2784	119	858.885		116,430.0	5	21,836.7	2|4F3)5F	5	138,266.7	2|5D6D,5F	
344	31	859.862	0.001	116,297.7	3	32,266.6	2|4F3)5F	2	148,564.4	1|2D1)3D	
1404	74	860.299	0.000	116,238.7	4	27,888.2	2|4F3)5F	5	144,126.9	2|3H4H,5G	
425	34	860.825	0.006	116,167.6	3	32,266.6	2|4F3)5F	4	148,435.0	2|3F4F,5G	
246	43	861.124	0.002	116,127.3	4	21,330.5 [c]	1|1G2)	3	137,458.1	2|3F4F,5G	
1286	28	864.059	0.002	115,732.8	4	52,013.6	2|2G3)1G	4	167,746.7	2|1G2G,3F	
540	31	864.737	0.001	115,642.1	4	36,530.1	2|4F3)3F	4	152,172.3	2|5D4D,3F	
353	11	864.784	−0.002	115,635.8	4	52,013.6	2|2G3)1G	3	167,649.2	2|3G4G,3G	
49	11	864.784	0.002	115,635.8	1	16,781.6	1|3P2)	2	132,417.7	2|3F4F,5G	
2646	124	865.207		115,579.3	5	21,836.7	2|4F3)5F	6	137,416.0	2|3H4H,5G	
177	21	865.782	−0.001	115,502.5	3	32,266.6	2|4F3)5F	3	147,769.0	1|2D1)1F	
602	33	867.714	0.001	115,245.3	5	42,531.9 [c]	2|2G3)3G	4	157,777.4	2|3F4F,5F	
604	28	870.575	−0.003	114,866.6	5	42,531.9 [c]	2|2G3)3G	6	157,398.1	2|1I2I,3H	
153	22	870.656	0.001	114,855.9	2	24,540.8 [c]	1|1D2)	1	139,396.9	1|2D1)3D	
694	39	871.149	−0.004	114,790.9	5	42,531.9 [c]	2|2G3)3G	5	157,322.3	2|3D4D,5F	
158	9	871.344	0.006	114,765.2	3	32,266.6	2|4F3)5F	2	147,032.6	1|2D1)3D	
305	23	871.491	0.002	114,745.9	2	33,949.6	2|4F3)5F	3	148,695.7	2|5D4D,5D	
401	11	871.687	0.001	114,720.1	3	43,057.2	2|4F3)3F	4	157,777.4	2|3F4F,5F	
122	10	872.490	0.002	114,614.5	2	33,949.6	2|4F3)5F	2	148,564.4	1|2D1)3D	
94	17	874.330	−0.001	114,373.3	1	34,912.5	2|4F3)5F	0	149,285.7	2|5D4D,3P	
827	36	875.307	0.010	114,245.6	2	36,291.5	2|4P3)5P	3	150,538.4	2|3H4H,5G	
183	37	875.982	−0.004	114,157.6	3	32,266.6	2|4F3)5F	2	146,423.7	2|3F4F,5F	
557	37	875.982		114,157.6	3	54,095.7	2|2D3)3D	3	168,253.3	2|3D2D,1F	
3339	79	876.126		114,138.8	6	48,134.2	2|2H3)3H	6	162,273.0	2|1I2I,3H	
632	61	878.642	0.006	113,812.0	4	27,888.2	2|4F3)5F	4	141,701.0	2|3H4H,5H	
146	12	879.101	0.003	113,752.6	5	42,531.9 [c]	2|2G3)3G	6	156,284.8	2|1I2I,3K	
207	64	880.210		113,609.3	1	16,781.6	1|3P2)	0	130,390.9	1|2D3)3P	
503	8	880.519	−0.009	113,569.4	3	36,970.2	2|4P3)5P	3	150,538.4	2|3H4H,5G	
75	12	881.516	0.009	113,440.9	3	32,266.6	2|4F3)5F	3	145,708.7	2|3G4G,5H	
194	11	882.036	−0.002	113,374.1	6	48,134.2	2|2H3)3H	5	161,508.0	2|3D4D,5F	
24	11	882.153	−0.006	113,359.0	3	32,266.6	2|4F3)5F	4	145,624.8	2|3G4G,5F	
900	78	883.860	0.000	113,140.1	4	27,888.2	2|4F3)5F	3	141,028.3	2|5D4D,3D	
91	19	885.104	0.001	112,981.1	2	36,291.5	2|4P3)5P	3	149,272.7	2|3G4G,5G	
201	27	885.395	−0.004	112,943.9	4	36,530.1	2|4F3)3F	4	149,473.5	2|3H4H,5G	
975	42	886.170		112,845.2	6	48,134.2	2|2H3)3H	7	160,979.4	2|3H4H,3I	
205	58	888.557		112,542.0	5	21,836.7	2|4F3)5F	6	134,378.7	2|3H4H,5H	
47	15	889.013	−0.001	112,484.3	4	27,888.2	2|4F3)5F	5	140,372.4	2|3H4H,5I	
189	18	889.094	0.000	112,474.0	2	33,949.6	2|4F3)5F	2	146,423.7	2|3F4F,5F	
344	45	889.300		112,448.0	5	21,836.7	2|4F3)5F	4	134,284.7	2|3H4H,5I	
80	11	890.185	−0.004	112,336.2	6	48,134.2	2|2H3)3H	6	160,469.9	2|3F4F,5G	
197	68	890.439	0.003	112,304.2	2	24,540.8 [c]	1|1D2)	2	136,845.3	1|2D1)3P	
363	8	891.538	−0.001	112,165.7	4	36,530.1	2|4F3)3F	3	148,695.7	2|5D4D,5D	
857	50	893.485	−0.002	111,921.3	5	42,531.9 [c]	2|2G3)3G	6	154,452.9	2|3H4H,5G	
106	32	893.618	0.002	111,904.6	4	36,530.1	2|4F3)3F	4	148,435.0	2|3F4F,5G	

Table 1. *Cont.*

gA, 10^7 s^{-1}	*Int* [1]	λ (Å)	o.-c. [2] (Å)	ν (cm^{-1})	Lower Level J	E_{low} [3] (cm^{-1})	Name [4]	Upper Level J	E_{upper} (cm^{-1})	Name [5]	Remark [6]
54	10	896.101	−0.003	111,594.6	3	36,970.2	2|4P3)5P	2	148,564.4	1|2D1)3D	
348	62	896.226	−0.004	111,579.0	4	21,330.5 c	1|1G2)	3	132,909.1	1|2P3)3D	
90	12	896.771	0.000	111,511.2	1	34,912.5	2|4F3)5F	2	146,423.7	2|3F4F,5F	
1009	51	896.947	0.002	111,489.3	5	51,446.0	2|2H3)3H	5	162,935.5	2|1I2I,3H	
27	16	898.622	−0.003	111,281.5	3	9751.5 c	1|3F2)	4	121,032.6	2|5D6D,7F	
681	27	898.757	0.003	111,264.8	5	42,531.9 c	2|2G3)3G	5	153,797.0	2|5D4D,5F	
188	12	899.053	−0.006	111,228.1	3	36,970.2	2|4P3)5P	3	148,197.6	1|2D1)1F	
28	6	900.442	−0.001	111,056.6	2	45,177.2	2|4F3)3F	2	156,233.6	2|3F4F,5F	
102	10	902.534	−0.003	110,799.1	3	36,970.2	2|4P3)5P	3	147,769.0	1|2D1)1F	
54	14	903.008	0.001	110,741.0	2	36,291.5	2|4P3)5P	2	147,032.6	1|2D1)3D	
63	15	903.183	0.000	110,719.5	4	27,888.2	2|4F3)5F	3	138,607.7	2|3D4D,5F	
34	23	906.177	0.002	110,353.7	3	32,266.6	2|4F3)5F	3	142,620.6	2|3F4F,5D	Ry
171	40	906.514	−0.001	110,312.7	5	21,836.7	2|4F3)5F	4	132,149.24	1|2F3)3F	
23	28	906.865	0.002	110,270.0	4	0.0	1|3F2)	4	110,270.3	2|5D6D,7D	
275	16	908.581	0.002	110,061.7	5	51,446.0	2|2H3)3H	5	161,508.0	2|3D4D,5F	
93	9	909.890	0.008	109,903.4	1	46,329.2	2|2P3)1P	2	156,233.6	2|3F4F,5F	
18	7	910.985	−0.005	109,771.3	2	14,171.9	1|3F2)	1	123,942.53	2|5D6D,7F	
452	14	913.288	−0.001	109,494.5	4	52,013.6	2|2G3)1G	5	161,508.0	2|3D4D,5F	
113	11	913.554	−0.002	109,462.6	2	33,949.6	2|4F3)5F	3	143,412.0	2|3G4G,5H	
523	28	915.216	0.001	109,263.8	6	48,134.2	2|2H3)3H	6	157,398.1	2|1I2I,3H	
122	9	915.425	0.002	109,238.9	3	58,410.1	2|2F3)3F	3	167,649.2	2|3G4G,3G	
88	30	917.404	0.003	109,003.2	0	14,939.0	1|3P2)	1	123,942.53	2|5D6D,7F	
432	22	917.536	0.003	108,987.5	4	45,438.6	2|2G3)3G	4	154,426.5	2|3H4H,5G	
306	31	917.845		108,950.9	5	42,531.9 c	2|2G3)3G	5	151,482.8	2|3F4F,5G	
122	9	919.438	−0.003	108,762.1	3	32,266.6	2|4F3)5F	3	141,028.3	2|5D4D,3D	
500	38	919.534		108,750.7	6	48,134.2	2|2H3)3H	7	156,885.0	2|1I2I,3K	
70	5	919.645	0.008	108,737.6	3	36,970.2	2|4P3)5P	3	145,708.7	2|3G4G,5H	
51	21	920.238	0.001	108,667.5	2	14,171.9	1|3F2)	2	122,839.5	2|5D6D,7F	
45	7	920.354	0.006	108,653.8	3	36,970.2	2|4P3)5P	4	145,624.8	2|3G4G,5F	
107	17	922.776	−0.004	108,368.7	2	24,540.8 c	1|1D2)	3	132,909.1	1|2P3)3D	
299	7	924.641	0.004	108,150.1	6	48,134.2	2|2H3)3H	6	156,284.8	2|1I2I,3K	
23	10	925.061	0.000	108,101.0	2	14,171.9	1|3F2)	1	122,272.9	2|5D6D,7F	
200	27	926.980	−0.003	107,877.2	2	24,540.8 c	1|1D2)	2	132,417.7	2|3F4F,5G	
179	41	928.091	0.002	107,748.1	4	45,438.6	2|2G3)3G	5	153,186.9	2|3H4H,5G	Ry
58	34	931.673	0.001	107,333.8	0	14,939.0	1|3P2)	1	122,272.9	2|5D6D,7F	
27	8	933.174	−0.002	107,161.2	1	16,781.6	1|3P2)	1	123,942.53	2|5D6D,7F	
138	18	933.530	0.002	107,120.3	2	36,291.5	2|4P3)5P	3	143,412.0	2|3G4G,5H	
18	8	935.090	0.000	106,941.6	5	42,531.9 c	2|2G3)3G	4	149,473.5	2|3H4H,5G	
91	6	940.571	0.003	106,318.4	6	48,134.2	2|2H3)3H	6	154,452.9	2|3H4H,5G	
352	35	942.590	−0.001	106,090.7	4	36,530.1	2|4F3)3F	3	142,620.6	2|3F4F,5D	
126	9	943.824	0.001	105,952.0	5	51,446.0	2|2H3)3H	6	157,398.1	2|1I2I,3H	
11	11	947.950	0.005	105,490.8	1	16,781.6	1|3P2)	1	122,272.9	2|5D6D,7F	
124	37	948.860	0.001	105,389.6	5	21,836.7	2|4F3)5F	4	127,226.4	2|5D4D,3F	
195	11	949.592	0.003	105,308.4	4	52,013.6	2|2G3)1G	5	157,322.3	2|3D4D,5F	
16	25	951.861	−0.007	105,057.4	3	9751.5 c	1|3F2)	3	114,808.1	2|5D6D,7D	
79	31	952.443	0.001	104,993.2	2	14,171.9	1|3F2)	1	119,165.21	2|5D6D,7D	
374	26	953.838	−0.007	104,839.6	5	51,446.0	2|2H3)3H	6	156,284.8	2|1I2I,3K	
70	12	954.823	−0.006	104,731.5	3	36,970.2	2|4P3)5P	4	141,701.0	2|3H4H,5H	
153	43	957.677		104,419.3	5	21,836.7	2|4F3)5F	5	126,256.0	2|5D6D,7D	
39	35	959.456	0.004	104,225.7	0	14,939.0	1|3P2)	1	119,165.21	2|5D6D,7D	
72	51	960.590		104,102.7	4	36,530.1	2|4F3)3F	4	140,632.8	2|3H4H,5I	
114	8	961.004	0.002	104,057.8	3	36,970.2	2|4P3)5P	3	141,028.3	2|5D4D,3D	
98	6	961.219	0.003	104,034.6	4	45,438.6	2|2G3)3G	4	149,473.5	2|3H4H,5G	
113	31	964.767		103,652.0	0	14,939.0	1|3P2)	1	118,591.0	2|5D6D,7D	
62	8	966.103	−0.001	103,508.6	2	33,949.6	2|4F3)5F	3	137,458.1	2|3F4F,5G	

Table 1. *Cont.*

					Lower Level			Upper Level			
gA, 10^7 s^{-1}	*Int* [1]	λ (Å)	o.-c. [2] (Å)	ν (cm^{-1})	*J*	E_{low} [3] (cm^{-1})	Name [4]	*J*	E_{upper} (cm^{-1})	Name [5]	Remark [6]
25	5	969.521	0.002	103,143.7	3	32,266.6	2|4F3)5F	2	135,410.5	2|5D6D,7D	
40	6	971.284	0.000	102,956.5	1	46,329.2	2|2P3)1P	0	149,285.7	2|5D4D,3P	
11	7	971.875	−0.001	102,893.9	4	60,041.7 [c]	2|2H3)3H	5	162,935.5	2|1I2I,3H	
42	16	973.752	0.001	102,695.6	2	24,540.8 [c]	1|1D2)	3	127,236.5	2|5D4D,5D	
65	5	974.159	−0.011	102,652.6	3	43,057.2	2|4F3)3F	3	145,708.7	2|3G4G,5H	
39	12	979.648	0.001	102,077.5	4	36,530.1	2|4F3)3F	3	138,607.7	2|3D4D,5F	
236	35	981.963		101,836.8	6	48,134.2	2|2H3)3H	7	149,971.0	2|3H4H,5H	
84	21	983.893	0.004	101,637.1	3	36,970.2	2|4P3)5P	3	138,607.7	2|3D4D,5F	Ry
138	20	985.699	0.000	101,450.8	3	36,970.2	2|4P3)5P	4	138,421.0	2|5D6D,5D	
9	13	995.894	−0.009	100,412.3	4	21,330.5 [c]	1|1G2)	3	121,741.9	2|5D6D,7F	
17	10	1002.982	−0.006	99,702.7	4	21,330.5 [c]	1|1G2)	4	121,032.6	2|5D6D,7F	
80	34	1006.559	−0.001	99,348.4	4	27,888.2	2|4F3)5F	3	127,236.5	2|5D4D,5D	Ry
43	23	1006.654	−0.008	99,339.0	4	27,888.2	2|4F3)5F	4	127,226.4	2|5D4D,3F	
56	38	1008.104	−0.002	99,196.1	5	21,836.7	2|4F3)5F	4	121,032.6	2|5D6D,7F	
53	96	1025.588	0.002	97,505.0	1	34,912.5	2|4F3)5F	2	132,417.7	2|3F4F,5G	Ry
18	12	1031.788	0.000	96,919.1	3	49,963.2 [c]	2|2G3)3G	4	146,882.3	1|2D1)3F	
26	11	1045.355	0.003	95,661.3	3	49,963.2 [c]	2|2G3)3G	4	145,624.8	2|3G4G,5F	
19	12	1050.646	−0.005	95,179.5	3	36,970.2	2|4P3)5P	4	132,149.24	1|2F3)3F	
15	18	1051.757	−0.002	95,079.0	1	16,781.6	1|3P2)	0	111,860.43	1|4F3)5D	
31	9	1053.083	0.006	94,959.3	3	32,266.6	2|4F3)5F	4	127,226.4	2|5D4D,3F	
5	10	1056.809	−0.001	94,624.5	2	24,540.8 [c]	1|1D2)	1	119,165.21	2|5D6D,7D	
63	29	1065.480	−0.008	93,854.4	4	27,888.2	2|4F3)5F	3	121,741.9	2|5D6D,7F	
32	10	1104.078	−0.005	90,573.3	3	32,266.6	2|4F3)5F	2	122,839.5	2|5D6D,7F	
9	21	1111.622	0.001	89,958.6	2	5293.1	1|1D2)	1	95,251.80	1|4F3)5F	Ch
6	9	1115.849	−0.006	89,617.9	5	42,531.9 [c]	2|2G3)3G	4	132,149.24	1|2F3)3F	
9	9	1155.204	0.001	86,564.8	4	45,438.6	2|2G3)3G	5	132,003.4	2|3G4G,5H	
29	13	1170.270	0.000	85,450.4	2	36,291.5	2|4P3)5P	3	121,741.9	2|5D6D,7F	
51	16	1179.640	0.001	84,771.6	3	36,970.2	2|4P3)5P	3	121,741.9	2|5D6D,7F	
26	11	1189.592	0.000	84,062.4	3	36,970.2	2|4P3)5P	4	121,032.6	2|5D6D,7F	
16	24	1192.341	0.009	83,868.6	6	48,134.2	2|2H3)3H	5	132,003.4	2|3G4G,5H	
21	130	1213.852	−0.004	82,382.4	4	27,888.2	2|4F3)5F	4	110,270.3	2|5D6D,7D	IV
12	9	1239.110	0.002	80,703.1	5	51,446.0	2|2H3)3H	4	132,149.24	1|2F3)3F	
6	19	1240.057	0.010	80,641.5	2	14,171.9	1|3F2)	2	94,813.99	1|4F3)5G	Ch
18	26	1241.351	0.001	80,557.4	5	51,446.0	2|2H3)3H	5	132,003.4	2|3G4G,5H	
6	75	1245.125	−0.007	80,313.2	0	14,939.0	1|3P2)	1	95,251.80	1|4F3)5F	
19	8	1247.880	−0.004	80,135.9	4	52,013.6	2|2G3)1G	4	132,149.24	1|2F3)3F	
3	15	1274.375	0.006	78,469.8	1	16,781.6	1|3P2)	1	95,251.80	1|4F3)5F	Ch
15	11	1281.175	0.003	78,053.3	3	54,095.7	2|2D3)3D	4	132,149.24	1|2F3)3F	
17	11	1284.721	0.000	77,837.9	3	36,970.2	2|4P3)5P	3	114,808.1	2|5D6D,7D	
30	15	1288.439	0.001	77,613.3	1	46,329.2	2|2P3)1P	1	123,942.53	2|5D6D,7F	
26	23	1299.575	−0.005	76,948.2	1	34,912.5	2|4F3)5F	0	111,860.43	1|4F3)5D	
10	13	1316.649	−0.003	75,950.4	2	46,322.7	2|4P3)3P	1	122,272.9	2|5D6D,7F	
20	12	1328.617	0.006	75,266.2	0	52,119.22	2|4P3)3P	1	127,385.80	1|2F3)3D	Ry
56	85	1364.258	0.003	73,299.9	3	36,970.2	2|4P3)5P	4	110,270.3	2|5D6D,7D	
26	37	1372.182	−0.006	72,876.6	3	49,963.2 [c]	2|2G3)3G	2	122,839.5	2|5D6D,7F	
41	43	1390.683	−0.006	71,907.1	3	66,700.9	2|2F3)1F	3	138,607.7	2|3D4D,5F	
60	48	1410.502	0.002	70,896.7	1	40,963.6 [c]	2|4P3)5P	0	111,860.43	1|4F3)5D	
7	18	1414.215	0.008	70,710.6	2	24,540.8 [c]	1|1D2)	1	95,251.80	1|4F3)5F	Ch
81	26	1415.006	0.003	70,671.1	5	61,332.20	2|2H3)1H	5	132,003.4	2|3G4G,5H	
60	23	1440.118	0.002	69,438.8	1	54,503.7	2|4P3)3P	1	123,942.53	2|5D6D,7F	
13	20	1441.558	0.003	69,369.4	4	45,438.6	2|2G3)3G	3	114,808.1	2|5D6D,7D	
60	10	1455.961	−0.004	68,683.2	4	64,226.1	2|2F3)3F	3	132,909.1	1|2P3)3D	

Table 1. *Cont.*

gA, 10^7 s^{-1}	*Int* [1]	λ (Å)	o.-c. [2] (Å)	ν (cm^{-1})	Lower Level J	E_{low} [3] (cm^{-1})	Name [4]	Upper Level J	E_{upper} (cm^{-1})	Name [5]	Remark [6]
153	42	1472.248	−0.004	67,923.3	4	64,226.1	2∣2F3)3F	4	132,149.24	1∣2F3)3F	
163	20	1475.410	−0.009	67,777.8	4	64,226.1	2∣2F3)3F	5	132,003.4	2∣3G4G,5H	
119	17	1478.107	−0.013	67,654.1	0	61,022.8	2∣4P3)3P	1	128,676.30	1∣2P3)3S	
384	71	1493.651	0.007	66,950.0	2	65,958.7	2∣2D3)1D	3	132,909.1	1∣2P3)3D	Ry
80	23	1493.949	0.005	66,936.7	3	54,095.7	2∣2D3)3D	4	121,032.6	2∣5D6D,7F	
30	12	1516.746	0.007	65,930.6	2	56,908.6	2∣2F3)3F	2	122,839.5	2∣5D6D,7F	
14	13	1525.993	0.003	65,531.1	1	46,329.2	2∣2P3)1P	0	111,860.43	1∣4F3)5D	
128	31	1527.932	0.009	65,447.9	3	66,700.9	2∣2F3)1F	4	132,149.24	1∣2F3)3F	
57	71	1546.516	0.001	64,661.5	1	54,503.7	2∣4P3)3P	1	119,165.21	2∣5D6D,7D	IV
37	14	1563.251	0.008	63,969.3	2	57,772.3	2∣2F3)3F	3	121,741.9	2∣5D6D,7F	
11	26	1598.777	−0.011	62,547.81	3	32,266.6	2∣4F3)5F	2	94,813.99	1∣4F3)5G	
46	46	1606.254	−0.001	62,256.65	2	56,908.6	2∣2F3)3F	1	119,165.21	2∣5D6D,7D	
59	40	1608.561	−0.002	62,167.37	0	52,119.22	2∣4P3)3P	1	114,286.50	1∣4P3)3P	
63	26	1616.181	−0.002	61,874.26	0	61,022.8	2∣4P3)3P	1	122,897.00	1∣2D3)1P	
5	11	1631.255	−0.008	61,302.49	2	33,949.6	2∣4F3)5F	1	95,251.80	1∣4F3)5F	Ch
56	98	1642.992	−0.005	60,864.57	2	33,949.6	2∣4F3)5F	2	94,813.99	1∣4F3)5G	
50	120	1657.275	−0.020	60,340.0	1	34,912.5	2∣4F3)5F	1	95,251.80	1∣4F3)5F	Ch
37	33	1666.938	−0.001	59,990.23	0	521,19.22	2∣4P3)3P	1	112,109.40	1∣2P3)3D	
118	136	1669.401	−0.007	59,901.73	1	34,912.5	2∣4F3)5F	2	94,813.99	1∣4F3)5G	Ch
53	71	1696.059	0.003	58,960.21	2	36,291.5	2∣4P3)5P	1	95,251.80	1∣4F3)5F	Ch
94	103	1708.753	0.008	58,522.21	2	36,291.5	2∣4P3)5P	2	94,813.99	1∣4F3)5G	Ch
18	7	1719.914	−0.001	58,142.44	0	61,022.8	2∣4P3)3P	1	119,165.21	2∣5D6D,7D	
4	29	1728.787	−0.007	57,844.03	3	36,970.2	2∣4P3)5P	2	94,813.99	1∣4F3)5G	
36	12	1750.332	0.012	57,132.02	0	61,022.8	2∣4P3)3P	1	118,155.20	1∣4P3)3S	
48	89	1842.023	0.002	54,288.14	1	40,963.6 [c]	2∣4P3)5P	1	95,251.80	1∣4F3)5F	Ch
29	58	1856.995	−0.002	53,850.44	1	40,963.6 [c]	2∣4P3)5P	2	94,813.99	1∣4F3)5G	
22	39	1997.020	0.000	50,074.61	2	45,177.2	2∣4F3)3F	1	95,251.80	1∣4F3)5F	Ch
36	86	2013.992	0.008	49,636.60	2	45,177.2	2∣4F3)3F	2	94,813.99	1∣4F3)5G	
10	22	2043.120	0.002	48,929.05	2	46,322.7	2∣4P3)3P	1	95,251.80	1∣4F3)5F	
9	27	2061.578	0.011	48,491.03	2	46,322.7	2∣4P3)3P	2	94,813.99	1∣4F3)5G	

[1] Relative intensity in arbitrary units. [2] Difference between the observed wavelength and the wavelength derived from the final level energies (Ritz wavelength). A blank value indicates that the upper level is derived only from that line. [3] The level values are from [1]. The values marked by "c" are corrected in this work. [4] The number preceding the "∣" symbol has the following meaning: 1 stands for $5d^8$ and 2 stands for $5d^7 6s$. [5] The number preceding the "∣" symbol has the following meaning: 1 stands for $5d^7 6p$ and 2 stands for $5d^6 6s6p$. [6] IV—identified also as Pt IV [20]; OIII—blended by strong O III line, Ritz wavelength and wavenumber are listed; Ry—belongs also to the $(5d^8 + 5d^7 s)$—$5d^7 6p$ transition array [1]; Ch—identification in [1] is changed.

Table 2. Observed and calculated using the orthogonal parameters technique energy levels (cm^{-1}) of the $5d^7 6p + 5d^6 6s6p$ configurations of Pt III.

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
$J = 0$							
149,285.7	0.4		149,349	−63	26% 2∣5D4D,3P	+14% 2∣5D6D,5D	+12% 2∣3P4P,5D
			147,317		25% 2∣5D4D,5D	+19% 2∣1S2S,3P	+11% 2∣3P4P,5D
			146,374		60% 1∣2D1)3P	+6% 2∣3P4P,5D	+5% 2∣3P4P,5D
			143,134		26% 2∣3D4D,5D	+23% 2∣3P4P,5D	+17% 2∣1S2S,3P
			133,880		23% 2∣5D4D,5D	+13% 2∣5D6D,5D	+13% 2∣3D4D,5D
130,390.9	0.7	1	130,452	−61	51% 1∣2D3)3P	+10% 1∣2D1)3P	+10% 1∣2P3)1S
123,702.4			123,734	−32	53% 1∣4P3)3P	+24% 1∣2P3)1S	+6% 1∣4F3)5D
			122,331		71% 2∣5D6D,7F	+12% 2∣3P4P,5D	+4% 2∣5D6D,5D
111,860.43	0.16	4	111,901	−41	41% 1∣4F3)5D	+16% 1∣4P3)5D	+15% 1∣2P3)1S
110,739.0			110,706	33	59% 1∣2P3)3P	+14% 1∣4F3)5D	+13% 1∣4P3)5D
			102,848		33% 1∣2P3)1S	+23% 1∣4P3)3P	+ 20% 1∣2D3)3P

Table 2. *Cont.*

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
95,833.6			95,829	5	53% 1 | 4P3)5D	+24% 1 | 2P3)3P	+13% 1 | 4F3)5D
***J* = 1**							
157,696.4	0.7	1	157,735	−39	41% 2 | 3F4F,5D	+8% 2 | 3D4D,5D	+8% 2 | 3F4F,5F
			155,885		11% 2 | 5D6D,5D	+10% 2 | 3G4G,5F	+10% 2 | 5D4D,5D
			155,097		16% 2 | 3G4G,5F	+13% 2 | 3D2D,3D	+7% 2 | 3D2D,1P
			154,597		13% 2 | 3D4D,5P	+12% 2 | 1S2S,3P	+9% 2 | 5D6D,5D
			153,183		35% 2 | 3P4P,5D	+13% 2 | 3P4P,5D	+6% 2 | 3P4P,3P
			152,810		15% 1 | 2D1)1P	+9% 2 | 3D4D,5P	+9% 2 | 5D4D,3D
			152,767		22% 1 | 2D1)1P	+9% 2 | 3P4P,5P	+6% 1 | 2D1)3D
			151,301		18% 2 | 5D4D,3D	+13% 1 | 2D1)1P	+6% 2 | 5D4D,3P
			149,758		22% 2 | 3D4D,5F	+12% 2 | 3F4F,5F	+10% 2 | 5D4D,5F
			146,578		25% 1 | 2D1)3P	+21% 2 | 5D6D,5P	+12% 1 | 2D1)3D
			145,546		13% 2 | 5D6D,5P	+11% 1 | 2D1)3P	+8% 1 | 2D1)3D
			145,413		10% 2 | 3P2P,3S	+8% 2 | 3F4F,5F	+6% 2 | 3D4D,5D
			144,108		11% 1 | 2D1)3P	+8% 2 | 5D4D,3P	+8% 2 | 3F4F,5D
			142,425		18% 2 | 3F4F,5F	+18% 2 | 3D4D,5F	+7% 2 | 5D4D,5D
			140,355		17% 2 | 3D4D,5D	+14% 2 | 3P4P,5D	+13% 2 | 3D4D,5F
139,396.9	0.5	2	139,504	−107	37% 1 | 2D1)3D	+14% 1 | 2D1)3P	+12% 1 | 2D1)1P
			136,376		19% 2 | 5D4D,5F	+16% 2 | 3D4D,5F	+11% 2 | 5D6D,5F
133,752.0			133,832	−80	18% 1 | 2D3)3D	+18% 1 | 2P3)1P	+8% 1 | 2D1)1P
			132,855		16% 2 | 5D4D,5D	+8% 2 | 5D6D,5D	+7% 1 | 2D3)3P
128,676.3	0.6	1	128,704	−27	32% 1 | 2P3)3S	+10% 1 | 4P3)3P	+9% 1 | 4P3)3D
127,385.8	0.3	1	127,252	134	48% 1 | 2F3)3D	+15% 1 | 2D3)1P	+7% 1 | 2P3)1P
123,942.53	0.18	5	123,775	167	31% 2 | 5D6D,7F	+14% 1 | 2D3)3P	+12% 1 | 4F3)5D
122,897.0	0.09	1	122,899	−2	28% 1 | 2D3)1P	+12% 1 | 4P3)3D	+11% 1 | 2P3)3P
122,272.9	0.3	4	122,237	36	24% 2 | 5D6D,7F	+18% 1 | 2D3)3P	+10% 2 | 5D6D,7D
119,165.21	0.11	6	119,217	−52	25% 2 | 5D6D,7D	+11% 1 | 2D3)3D	+9% 1 | 4P3)3D
118,591.0	0.5	1	118,668	−77	30% 2 | 5D6D,7D	+14% 1 | 2D3)3D	+8% 2 | 5D6D,7F
118,155.2	0.13	1	118,281	−126	17% 1 | 4P3)3S	+13% 1 | 2P3)3D	+12% 1 | 4F3)3D
114,286.5	0.09	1	114,286	0	22% 1 | 4P3)3P	+19% 1 | 4F3)3D	+14% 1 | 2P3)3P
112,109.4	0.09	1	112,012	98	24% 1 | 2P3)3D	+16% 1 | 4P3)3S	+13% 1 | 4P3)5D
110,136.2			110,152	−15	31% 1 | 4P3)3P	+18% 1 | 2P3)1P	+14% 1 | 4P3)3D
108,594.2			108,521	73	24% 1 | 4F3)3D	+20% 1 | 4P3)3S	+10% 1 | 4P3)5D
107,563.6			107,594	−30	28% 1 | 4F3)5F	+28% 1 | 4P3)5P	+9% 1 | 2D3)3P
104,357.2			104,292	65	36% 1 | 4F3)5D	+17% 1 | 2P3)3D	+9% 1 | 2D3)3P
100,009.8			99,936	74	19% 1 | 4P3)5D	+16% 1 | 4P3)5P	+11% 1 | 4F3)5F
95,251.80	0.08	10	95,269	−17	27% 1 | 4F3)5F	+26% 1 | 4P3)5D	+10% 1 | 4F3)3D
88,207.8			88,260	−53	20% 1 | 2P3)3P	+13% 1 | 2D3)3D	+10% 1 | 4P3)5D
***J* = 2**							
156,233.6	0.5	4	156,112	121	15% 2 | 3F4F,5F	+8% 2 | 3D4D,5D	+8% 2 | 1D2D,3P
			155,772		20% 2 | 5D6D,5D	+ 10% 2 | 5D4D,5F	+9% 2 | 5D4D,5D
			154,420		14% 2 | 5D4D,3F	+10% 2 | 3F4F,5D	+10% 2 | 3G4G,5F
			153,809		13% 2 | 3D4D,5P	+9% 2 | 3F4F,5F	+8% 2 | 3D4D,5F
			153,236		18% 2 | 3P4P,5D	+15% 2 | 3H4H,5G	+10% 2 | 3D4D,5F
			150,933		13% 2 | 5D4D,3D	+11% 2 | 3H4H,5G	+7% 2 | 5D6D,5P
			150,302		15% 2 | 3H4H,5G	+7% 1 | 2D1)1D	+6% 2 | 5D4D,3D
			149,714		28% 1 | 2D1)1D	+7% 1 | 2D3)1D	+6% 1 | 2D1)3P
148,564.4	0.4	4	148,636	−71	19% 1 | 2D1)3D	+12% 2 | 5D4D,3F	+4% 1 | 2D1)1D
147,032.6	0.5	4	147,028	5	29% 1 | 2D1)3D	+7% 2 | 3D4D,5F	+7% 2 | 3F4F,5D
146,423.7	0.4	3	146,499	−75	8% 2 | 3F4F,5F	+7% 2 | 5D6D,5F	+6% 2 | 5D6D,5P
			146,037		10% 2 | 3D4D,5F	+8% 2 | 5D6D,5F	+7% 2 | 5D4D,3D
			145,832		29% 2 | 5D4D,3P	+13% 2 | 3G4G,5G	+5% 2 | 3P4P,5D
			143,113		10% 2 | 3P4P,5S	+10% 2 | 5D4D,3D	+6% 2 | 3F4F,5D
			142,544		19% 2 | 5D6D,5P	+9% 2 | 5D4D,5P	+7% 2 | 3G4G,5G
			140,507		15% 2 | 3D4D,5F	+14% 2 | 3F4F,5G	+8% 2 | 5D4D,5F
			139,096		35% 2 | 3F4F,5G	+12% 2 | 3D4D,5F	+6% 2 | 3F4F,5F
			137,347		18% 2 | 5D6D,7P	+13% 1 | 2D1)3P	+7% 2 | 5D4D,5D

Table 2. *Cont.*

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
136,845.3	0.6	2	136,596	249	17% 1∣2D1)3P	+15% 1∣2D1)3F	+ 14% 2∣5D6D,7P
			136,444		27% 1∣2D1)3F	+22% 2∣5D6D,7P	+6% 2∣5D4D,5F
135,410.5	0.4	3	135,509	−98	17% 2∣5D6D,7D	+13% 2∣5D6D,7P	+9% 1∣2D1)3P
133,233.6			133,225	8	14% 1∣2F3)3D	+14% 1∣2F3)1D	+13% 1∣2D3)3D
132,417.7	0.4	3	132,649	−231	12% 2∣3F4F,5G	+9% 2∣5D4D,5F	+8% 1∣2D1)3F
			129,491		13% 2∣5D4D,5D	+8% 2∣3P4P,5S	+8% 2∣5D6D,7F
129,160.1			129,077	84	13% 1∣2F3)3D	+11% 1∣2P3)3P	+10% 1∣2F3)1D
127,875.4			127,899	−24	23% 1∣2P3)1D	+13% 1∣2F3)3F	+10% 1∣2D3)1D
125,841.1			125,812	29	12% 1∣2F3)3F	+9% 1∣2D1)3P	+9% 1∣2F3)3D
124,596.7			124,566	31	29% 1∣2P3)3D	+ 10% 1∣2D3)1D	+9% 1∣2G3)3F
122,839.5	0.2	4	122,763	76	37% 2∣5D6D,7F	+11% 2∣5D6D,7D	+5% 2∣3P4P,5D
121,453.7			121,428	26	11% 1∣4P3)3D	+10% 1∣2D3)3P	+10% 1∣2F3)3D
119,574.4			119,513	61	25% 1∣2G3)3F	+12% 1∣2D3)3F	+10% 1∣2P3)3P
117,247.1			117,287	−40	16% 1∣2P3)3D	+13% 1∣4P3)3D	+9% 1∣4F3)3F
			116,104		51% 2∣5D6D,7D	+16% 2∣5D6D,7F	+6% 2∣3P4P,5P
115,421.4			115,375	46	13% 1∣2F3)1D	+13% 1∣2D3)3P	+12% 1∣4F3)3D
113,020.4			113,023	−3	19% 1∣4P3)5P	+14% 1∣4P3)5D	+9% 1∣2P3)1D
112,195.4			112,269	−74	23% 1∣2F3)3F	+15% 1∣4F3)3D	+13% 1∣2F3)1D
110,120.4			110,101	19	19% 1∣4P3)3P	+15% 1∣4F3)3F	+12% 1∣4P3)5P
108,482.2			108,519	−36	16% 1∣4P3)3D	+12% 1∣4F3)5F	+10% 1∣2D3)3F
107,247.0			107,341	−94	17% 1∣4F3)5F	+15% 1∣4F3)5G	+12% 1∣4P3)5D
105,352.8			105,295	58	12% 1∣4F3)5G	+11% 1∣4F3)3D	+11% 1∣2P3)1D
103,891.0			103,862	29	16% 1∣4F3)3F	+14% 1∣4P3)3P	+12% 1∣4F3)5F
102,608.9			102,580	29	23% 1∣4F3)5D	+17% 1∣2P3)3P	+15% 1∣2D3)3D
94,813.99	0.10	9	94,763	51	36% 1∣4F3)5G	+17% 1∣4P3)5D	+12% 1∣2D3)3F
92,944.1			92,999	−55	33% 1∣4P3)5S	+20% 1∣4F3)5F	+10% 1∣4P3)5P
89,707.2			89,752	−44	13% 1∣4P3)5D	+12% 1∣4F3)5F	+10% 1∣2P3)3D
88,420.3			88,467	−47	21% 1∣4P3)5S	+9% 1∣2P3)3P	+9% 1∣2P3)3D
***J* = 3**							
169,211.0	0.7	2	169,209	2	12% 2∣3G2G,1F	+10% 2∣3G2G,3F	+6% 4∣4F3)3D
			168,430		10% 2∣3F2F,3F	+10% 2∣3F4F,5G	+9% 2∣1G2G,3F
168,253.3	0.8	1	168,193	60	13% 2∣3D2D,1F	+10% 2∣3D4D,3D	+6% 2∣3D2D,3D
167,649.2	0.4	4	167,697	−47	10% 2∣3G4G,3G	+8% 2∣3G2G,1F	+7% 2∣3G2G,3G
			167,251		19% 2∣1G2G,3G	+14% 2∣3G4G,3F	+4% 4∣4F3)3D
			165,979		7% 2∣3P4P,5D	+7% 2∣1D2D,3F	+6% 2∣3G2G,1F
			164,989		15% 2∣3F4F,5D	+9% 2∣3F2F,3G	+7% 2∣3G4G,5F
			163,914		10% 2∣3D4D,3D	+9% 2∣3D4D,3F	+7% 2∣3D2D,3D
			162,629		18% 2∣3H4H,5G	+7% 2∣3F4F,3D	+6% 2∣3H2H,3G
			161,633		17% 2∣3D4D,5D	+8% 2∣3F4F,5D	+6% 2∣3P4P,5P
			161,492		8% 2∣1F2F,3G	+7% 2∣3G4G,5G	+6% 2∣3P4P,5D
			160,392		13% 2∣3H4H,3G	+13% 2∣3H2H,3G	+8% 2∣3F2F,3D
159,586.9	0.6	3	159,693	−106	12% 2∣5D4D,5F	+11% 2∣5D4D,5P	+8% 2∣3D4D,5D
			158,999		20% 2∣5D4D,5F	+7% 2∣5D4D,5D	+6% 2∣3P2P,3D
			158,372		15% 2∣3F4F,5F	+6% 2∣1F2F,3D	+5% 2∣3G2G,3F
			157,279		10% 2∣3D2D,3F	+7% 2∣5D6D,5P	+6% 2∣1F2F,3G
			156,755		13% 2∣3F2F,3G	+9% 2∣3G4G,5F	+8% 2∣3D4D,5D
			155,965		12% 2∣3D4D,5P	+7% 2∣3G2G,3G	+7% 2∣5D6D,5P
			155,352		9% 2∣1F2F,3D	+9% 2∣3G4G,5H	+8% 2∣3D2D,3F
			155,018		5% 2∣1F2F,3G	+5% 2∣3P4P,5D	+5% 2∣5D6D,5P
153,948.0	0.7	1	153,944	4	9% 2∣3F4F,5F	+9% 2∣1F2F,3G	+8% 2∣3G4G,5F
			152,496		18% 2∣3H4H,5H	+8% 1∣2D1)3D	+8% 2∣3F2F,3G
			151,989		12% 2∣5D6D,5D	+11% 2∣5D4D,5D	+10% 2∣5D4D,5P
			151,519		26% 1∣2D1)3D	+14% 1∣2D1)1F	+6% 1∣2D3)3D
150,538.4	1.0	2	150,768	−230	13% 2∣3H4H,5G	+11% 2∣3D4D,5P	+9% 2∣5D6D,5P
149,272.7	0.5	2	149,636	−363	22% 2∣3G4G,5G	+6% 2∣3G4G,5F	+6% 2∣3F2F,3G
148,695.7	0.5	3	148,536	160	11% 2∣5D4D,5D	+9% 2∣3H4H,5G	+8% 2∣5D4D,3D
148,197.6	0.6	3	148,294	−96	13% 1∣2D1)1F	+10% 2∣5D4D,3F	+9% 1∣2D1)3F

Table 2. *Cont.*

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
147,769.0	0.4	4	147,826	−57	22% 1∣2D1)1F	+17% 1∣2D1)3F	+9% 2∣3D4D,5P
145,708.7	0.6	4	145,580	128	19% 2∣3G4G,5H	+18% 2∣3F4F,5G	+9% 2∣5D4D,3F
			144,601		15% 2∣5D4D,3F	+7% 2∣3P4P,5P	+6% 2∣3F4F,5G
143,412.0	0.4	2	143,366	46	19% 2∣3G4G,5H	+8% 2∣3F4F,5F	+8% 2∣5D6D,5F
142,620.6	0.4	2	142,771	−150	18% 2∣3F4F,5D	+17% 2∣3D4D,5D	+14% 2∣5D4D,3D
141,028.3	0.4	3	141,194	−166	12% 2∣5D4D,3D	+10% 2∣5D6D,5P	+8% 2∣5D6D,5D
139,048.1	0.7	1	139,115	−67	18% 1∣2D1)3F	+11% 1∣2D1)1F	+7% 2∣5D6D,7F
138,607.7	0.3	5	138,746	−138	8% 2∣3D4D,5F	+7% 2∣5D6D,5P	+6% 1∣2F3)1F
137,458.1	0.4	2	137,510	−52	19% 2∣3F4F,5G	+15% 2∣5D6D,7F	+8% 1∣2D1)3F
135,434.8			135,416	19	55% 1∣2F3)1F	+12% 1∣2F3)3D	+5% 1∣2G3)3G
			134,798		15% 2∣3H4H,5H	+11% 2∣3G4G,5G	+8% 2∣5D4D,5P
			134,002		45% 2∣5D6D,7P	+10% 2∣5D6D,7D	+3% 1∣2D3)3F
132,909.1	0.2	4	132,875	34	14% 1∣2P3)3D	+13% 1∣2D3)3F	+12% 1∣2D3)1F
			132,330		11% 2∣5D6D,7P	+9% 2∣5D4D,5F	+9% 2∣5D6D,7D
129,079.0			129,062	16	34% 1∣2H3)3G	+19% 1∣2G3)1F	+10% 1∣2F3)3F
127,236.5	0.4	2	127,330	−93	14% 2∣5D4D,5D	+9% 2∣5D4D,5P	+5% 2∣5D4D,3D
125,699.3			125,650	49	16% 1∣2F3)3D	+16% 1∣2F3)3F	+11% 1∣2F3)1F
122,430.1			122,404	26	23% 1∣2F3)3F	+11% 2∣5D6D,7F	+10% 1∣2D3)3D
121,741.9	0.2	6	121,649	93	29% 2∣5D6D,7F	+6% 1∣2D3)1F	+5% 2∣5D6D,7P
121,054.8			121,046	8	14% 1∣2G3)1F	+13% 1∣2G3)3F	+ 11% 1∣2H3)3G
119,568.8			119,598	−29	14% 1∣2P3)3D	+11% 1∣4P3)5D	+8% 1∣4F3)5G
118,315.5			118,248	68	42% 1∣2G3)3G	+14% 1∣2F3)3D	+8% 1∣2G3)3F
114,964.3			114,971	−7	27% 1∣2G3)3F	+11% 1∣2H3)3G	+8% 1∣2F3)3G
114,808.1	0.2	3	114,761	47	55% 2∣5D6D,7D	+15% 2∣5D6D,7F	+10% 2∣5D6D,7P
111,973.8			111,955	19	27% 1∣4P3)3D	+23% 1∣2F3)3G	+10% 1∣4F3)3G
110,867.0			110,941	−74	12% 1∣2F3)3D	+12% 1∣4F3)3G	+9% 1∣2G3)1F
110,652.3			110,730	−78	33% 1∣4P3)5P	+10% 1∣4P3)3D	+9% 1∣4F3)3F
108,804.8			108,804	0	18% 1∣4P3)5D	+17% 1∣4F3)5G	+9% 1∣4F3)3G
107,420.1			107,397	24	20% 1∣4F3)3F	+13% 1∣2D3)3D	+11% 1∣2F3)3G
105,326.6			105,352	−26	18% 1∣2G3)3G	+13% 1∣4F3)3D	+10% 1∣4F3)3F
103,517.5			103,525	−7	19% 1∣4F3)3G	+19% 1∣2P3)3D	+14% 1∣4P3)5P
102,813.0			102,779	34	38% 1∣4F3)5D	+13% 1∣4P3)3D	+12% 1∣4F3)5F
98,104.7			98,109	−4	55% 1∣4F3)3D	+9% 1∣2G3)3F	+6% 1∣4F3)5G
97,138.5			97,098	41	26% 1∣4P3)5D	+20% 1∣4F3)5G	+10% 1∣4F3)3F
90,415.7			90,376	40	28% 1∣4F3)5G	+16% 1∣4F3)5F	+6% 1∣4P3)5D
88,294.4			88,310	−16	37% 1∣4F3)5D	+28% 1∣4F3)5F	+10% 1∣4P3)5D
$J = 4$							
167,746.7	0.4	5	167,633	114	17% 2∣1G2G,3F	+8% 2∣3F4F,5D	+7% 2∣3G4G,3G
			166,986		12% 2∣3D4D,3F	+11% 2∣3D2D,3F	+10% 2∣3F4F,5F
			166,932		15% 2∣3G2G,3G	+10% 4∣4F3)5D	+10% 2∣3G4G,3H
			165,871		13% 2∣3H2H,1G	+13% 2∣3F2F,1G	10% 2∣3F4F,5D
			164,825		22% 4∣4F3)5D	+11% 4∣4F3)3F	+ 10% 4∣4F3)5F
			163,402		10% 2∣1G2G,3F	+7% 2∣3D4D,3F	+6% 2∣3F4F,5D
			162,763		20% 2∣3D4D,5D	+15% 2∣3D4D,5F	+5% 2∣3F4F,3G
161,913.1	0.7	1	161,991	−78	11% 2∣1G2G,3G	+9% 2∣3G4G,5G	+6% 2∣1G2G,3H
160,974.8	0.5	2	161,023	−48	11% 2∣3H4H,5H	+7% 2∣3F4F,3F	+6% 2∣3F4F,3F
			160,693		15% 2∣1G2G,3H	+15% 2∣1I2I,3H	+12% 2∣3F2F,1G
			160,086		37% 2∣5D4D,5F	+10% 2∣5D6D,5F	+7% 2∣3F2F,3G
			159,688		11% 2∣3D4D,5D	+7% 2∣3F4F,5D	+7% 2∣3F4F,5G
			158,217		10% 2∣3G4G,5F	+9% 2∣3G2G,1G	+8% 2∣3D4D,5F
157,777.4	0.4	3	157,844	−66	13% 2∣3F4F,5F	+7% 2∣3H2H,3G	+6% 2∣3G2G,3H
			157,075		17% 2∣1F2F,3G	+14% 2∣3F4F,5G	+7% 2∣1F2F,3F
			154,694		11% 2∣3F4F,5G	+9% 2∣3G2G,3H	+9% 2∣1I2I,3H
154,426.5	0.4	3	154,517	−91	15% 2∣3H4H,5G	+9% 2∣3D4D,5F	+8% 2∣3G2G,3G
152,172.3	0.4	3	152,171	1	14% 2∣5D4D,3F	+14% 2∣3G4G,5F	+8% 2∣3H4H,5H
			150,975		12% 2∣5D6D,5F	+12% 2∣3P4P,5D	+12% 2∣5D4D,5D
			150,844		14% 2∣5D4D,5D	+ 10% 2∣3H4H,5I	+7% 2∣3F2F,3G
150,478.4	0.7	1	150,360	118	14% 2∣3F4F,5F	+8% 2∣3F4F,5F	+8% 2∣5D6D,5D

Table 2. *Cont.*

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
149,473.5	0.3	5	149,266	208	14% 2 | 3H4H,5G	+13% 2 | 3G4G,5G	+8% 2 | 3H2H,1G
148,435.0	0.6	3	148,172	263	21% 2 | 3F4F,5G	+13% 2 | 3G4G,5G	+7% 2 | 3F4F,5D
146,882.3	0.4	2	146,893	−10	36% 1 | 2D1)3F	+11% 2 | 3G4G,5H	+7% 1 | 2D3)3F
			145,904		14% 2 | 3G4G,5H	+14% 1 | 2D1)3F	+11% 2 | 3D4D,5F
145,624.8	0.4	4	145,498	127	14% 2 | 3G4G,5F	+11% 2 | 3H4H,5H	+9% 2 | 3D4D,5F
141,701.0	0.7	2	141,719	−18	20% 2 | 3H4H,5H	+12% 2 | 5D6D,5F	+12% 2 | 3H4H,5G
140,632.8	0.5	1	140,555	79	13% 2 | 3H4H,5I	+9% 2 | 3G4G,5G	+7% 2 | 5D6D,5F
			140,379		21% 2 | 5D4D,3F	+12% 2 | 3F4F,5G	+7% 2 | 5D6D,5F
138,421.0	0.4	2	138,378	43	24% 2 | 5D6D,5D	+12% 2 | 5D4D,5D	+10% 2 | 3H4H,5I
134,284.7	0.6	1	134,196	88	22% 2 | 3H4H,5I	+10% 2 | 5D6D,5D	+9% 2 | 3G4G,5H
132,149.24	0.17	8	132,047	103	16% 1 | 2F3)3F	+7% 2 | 5D4D,5D	+6% 2 | 3G4G,5G
131,370.1			131,381	−11	29% 1 | 2F3)3F	+6% 1 | 2G3)3G	+6% 2 | 5D4D,3F
			129,878		34% 2 | 5D6D,7P	+30% 2 | 5D6D,7D	+14% 2 | 5D6D,7F
128,317.2			128,306	11	41% 1 | 2H3)3H	+18% 1 | 2H3)3G	+6% 1 | 2G3)1G
127,226.4	0.4	3	127,103	123	9% 2 | 5D4D,3F	+9% 2 | 5D4D,5D	+7% 2 | 5D6D,7D
125,228.1			125,202	27	40% 1 | 2F3)1G	+23% 1 | 2F3)3G	+8% 1 | 2H3)3H
123,222.7			123,196	27	41% 1 | 2H3)1G	+29% 1 | 2G3)1G	+10% 1 | 2F3)1G
122,004.8			122,025	−20	38% 1 | 2D3)3F	+8% 1 | 2D1)3F	+8% 1 | 4F3)5G
121,032.6	0.2	5	120,932	100	36% 2 | 5D6D,7F	+22% 2 | 5D6D,7P	+8% 2 | 5D6D,5F
119,420.3			119,486	−66	20% 1 | 2H3)1G	+12% 1 | 2F3)3G	+11% 1 | 2F3)1G
117,094.5			117,124	−29	43% 1 | 2G3)3G	+15% 1 | 2G3)3H	+12% 1 | 2F3)3F
115,528.1			115,493	35	38% 1 | 2H3)3G	+17% 1 | 2F3)3G	+13% 1 | 2G3)3H
111,395.5			111,326	69	24% 1 | 2G3)3F	+18% 1 | 2G3)1G	+15% 1 | 2H3)3H
110,270.3	0.2	3	110,338	−68	37% 2 | 5D6D,7D	+19% 2 | 5D6D,7P	+8% 2 | 5D6D,7F
108,036.9			108,084	−47	39% 1 | 4P3)5D	+20% 1 | 4F3)3G	+16% 1 | 4F3)5G
104,963.8			104,970	−6	32% 1 | 2G3)3H	+14% 1 | 4F3)3F	+7% 1 | 2G3)1G
103,950.5			103,960	−9	23% 1 | 4P3)5D	+18% 1 | 2G3)3H	+ 3% 1 | 4F3)5G
102,449.2			102,448	2	25% 1 | 4F3)3G	+21% 1 | 4F3)3F	+16% 1 | 4F3)5F
100,462.2			100,475	−13	35% 1 | 4F3)5F	+16% 1 | 2G3)3F	+9% 1 | 4F3)5G
94,771.1			94,766	5	30% 1 | 4F3)5D	+28% 1 | 4F3)3F	+13% 1 | 2G3)1G
90,510.5			90,465	46	43% 1 | 4F3)5G	+19% 1 | 4F3)3G	+17% 1 | 4F3)5F
79,260.8			79,312	−51	43% 1 | 4F3)5D	+21% 1 | 4F3)5F	+12% 1 | 2G3)3F
$J = 5$							
173,199.4	0.6	2	173,112	87	14% 2 | 3H4H,3G	+12% 2 | 1I2I,3I	+10% 2 | 1I2I,3H
			172,717		16% 2 | 3F4F,3G	+15% 2 | 3F4F,5F	+9% 2 | 1F2F,3G
			171,098		15% 2 | 3G2G,1H	+13% 2 | 3G2G,3G	+8% 2 | 3H4H,3H
			170,491		15% 2 | 3G2G,1H	+5% 2 | 3H2H,1H	+5% 2 | 1G2G,3H
			168,505		32% 2 | 1F2F,3G	+24% 2 | 3F4F,5G	+6% 2 | 1I2I,3I
			168,044		45% 4 | 4F3)5F	+16% 4 | 4F3)3G	+8% 4 | 2G3)3G
			166,948		11% 2 | 3G2G,3G	+9% 2 | 3G2G,3H	+7% 2 | 3F4F,3G
			165,927		11% 2 | 3F2F,3G	+10% 2 | 3G4G,3H	+8% 2 | 3G4G,3G
			164,341		13% 4 | 4F3)3G	+9% 4 | 4F3)5F	+8% 2 | 3G4G,3H
			163,316		18% 4 | 4F3)3G	+13% 2 | 3H2H,3G	+11% 2 | 1I2I,3I
162,935.5	0.4	2	162,949	−14	31% 2 | 1I2I,3H	+14% 2 | 3H2H,1H	+6% 2 | 3F4F,5F
161,508.0	0.4	3	161,497	11	33% 2 | 3D4D,5F	+7% 2 | 3H2H,1H	+7% 2 | 1I2I,3H
159,974.2	0.7	1	160,028	−54	15% 2 | 3F4F,5F	+10% 2 | 1G2G,3G	+7% 2 | 3H4H,3I
159,451.7	0.7	1	159,509	−58	10% 2 | 3H4H,5H	+8% 2 | 3G4G,5F	+6% 2 | 3G4G,3G
			158,982		16% 2 | 1I2I,3I	+12% 2 | 3F4F,5G	+11% 2 | 3H2H,3G
157,322.3	0.4	3	157,292	31	15% 2 | 3D4D,5F	+15% 2 | 3G2G,1H	+9% 2 | 3H2H,1H
			155,140		17% 2 | 3G2G,3H	+11% 2 | 5D4D,5F	+6% 2 | 3F4F,5G
153,797.0	0.5	2	153,665	132	32% 2 | 5D4D,5F	+7% 2 | 3F4F,3G	+6% 2 | 3D4D,5F
153,186.9	0.4	3	153,096	91	15% 2 | 3H4H,5G	+10% 2 | 3H2H,3G	+8% 2 | 1I2I,3I
151,482.8	0.6	1	151,478	4	22% 2 | 3F4F,5G	+18% 2 | 3H4H,5H	+8% 2 | 5D4D,5F
			149,308		14% 2 | 3H2H,3I	+12% 2 | 3F4F,5F	+10% 2 | 3G4G,5F
			146,994		29% 2 | 3G4G,5H	+13% 2 | 3H4H,5H	+9% 2 | 3H4H,5I
144,894.7	0.6	2	144,974	−80	24% 2 | 3G4G,5G	+13% 2 | 3H4H,5G	+9% 2 | 3H2H,3I
144,126.9	0.5	2	144,169	−42	18% 2 | 3H4H,5G	+12% 2 | 3G4G,5F	+10% 2 | 3H2H,3G
140,372.4	0.5	2	140,357	15	31% 2 | 3H4H,5I	+16% 2 | 3G4G,5F	+6% 2 | 3G4G,5G

Table 2. *Cont.*

E_{obs}	Unc. [a]	N [b]	E_{calc}	o.-c. [c]	Composition [d]		
138,266.7	0.7	1	138,316	−49	22% 2 ∣ 5D6D,5F	+21% 2 ∣ 3H4H,5G	+7% 2 ∣ 3G4G,5F
			134,343		32% 2 ∣ 5D6D,7F	+22% 2 ∣ 5D6D,5F	+12% 2 ∣ 3G4G,5F
132,003.4	0.2	5	131,933	71	14% 2 ∣ 3G4G,5H	+14% 2 ∣ 3H4H,5I	+11% 2 ∣ 3G4G,5G
131,684.0			131,727	−43	37% 1 ∣ 2F3)3G	+8% 1 ∣ 2G3)1H	+6% 1 ∣ 2H3)3H
129,523.3			129,559	−36	34% 1 ∣ 2H3)1H	+19% 1 ∣ 2F3)3G	+16% 1 ∣ 2H3)3H
126,256.0	0.6	1	126,264	−8	35% 2 ∣ 5D6D,7D	+30% 2 ∣ 5D6D,7F	+12% 2 ∣ 5D6D,5F
120,721.9			120,671	50	37% 1 ∣ 2H3)1H	+29% 1 ∣ 2H3)3H	+16% 1 ∣ 2H3)3G
118,078.2			118,070	9	41% 1 ∣ 2G3)1H	+27% 1 ∣ 2G3)3H	+15% 1 ∣ 2F3)3G
115,106.1			115,064	42	37% 1 ∣ 2H3)3I	+21% 1 ∣ 2G3)3H	+19% 1 ∣ 2H3)3H
112,273.2			112,319	−46	44% 1 ∣ 2G3)3G	+20% 1 ∣ 2H3)3I	+6% 2 ∣ 5D6D,7D
			111,983		48% 2 ∣ 5D6D,7D	+18% 2 ∣ 5D6D,7F	+7% 2 ∣ 5D6D,5F
106,212.1			106,251	−39	68% 1 ∣ 2H3)3G	+10% 1 ∣ 2H3)3H	+7% 1 ∣ 2H3)1H
102,752.2			102,806	−54	67% 1 ∣ 4F3)5G	+18% 1 ∣ 4F3)3G	+5% 1 ∣ 4F3)5F
99,330.4			99,304	26	24% 1 ∣ 2G3)3H	+22% 1 ∣ 2H3)3I	+14% 1 ∣ 2G3)3G
92,592.2			92,584	8	50% 1 ∣ 4F3)5F	+28% 1 ∣ 4F3)3G	+6% 1 ∣ 2G3)1H
81,371.7			81,342	30	33% 1 ∣ 4F3)5F	+29% 1 ∣ 4F3)3G	+21% 1 ∣ 4F3)5G
***J* = 6**							
170,395.1	0.7	1	170,377	18	48% 2 ∣ 1I2I,3I	+26% 2 ∣ 3H4H,3H	+6% 2 ∣ 1I2I,3K
169,114.6	0.7	1	169,124	−9	22% 2 ∣ 3H4H,3I	+17% 2 ∣ 3G2G,3H	+15% 2 ∣ 3H2H,3I
			168,230		79% 4 ∣ 4F3)5G	+18% 4 ∣ 2G3)3H	+1% 4 ∣ 2H3)3I
			164,785		21% 2 ∣ 3H2H,1I	+17% 2 ∣ 3G4G,3H	+9% 2 ∣ 1I2I,3I
162,273.0	0.7	1	162,198	75	17% 2 ∣ 1I2I,3H	+13% 2 ∣ 3H2H,3H	+10% 2 ∣ 1G2G,3H
160,469.9	0.6	2	160,391	79	28% 2 ∣ 3F4F,5G	+18% 2 ∣ 3H4H,3I	+13% 2 ∣ 3H2H,1I
157,398.1	0.4	3	157,504	−106	28% 2 ∣ 1I2I,3H	+22% 2 ∣ 3G4G,5H	+13% 2 ∣ 1I2I,3K
156,284.8	0.5	3	156,348	−63	33% 2 ∣ 1I2I,3K	+16% 2 ∣ 3H2H,3I	+10% 2 ∣ 3H2H,1I
154,452.9	0.5	2	154,230	223	19% 2 ∣ 3H4H,5G	+18% 2 ∣ 1I2I,3I	+12% 2 ∣ 1I2I,3H
			150,650		39% 2 ∣ 3H4H,5H	+13% 2 ∣ 1I2I,3K	+13% 2 ∣ 3G4G,5H
			149,363		24% 2 ∣ 3H4H,5I	+14% 2 ∣ 3G4G,5G	+13% 2 ∣ 3H2H,1I
145,991.7	0.8	1	146,034	−42	19% 2 ∣ 3G4G,5G	+13% 2 ∣ 3F4F,5G	+11% 2 ∣ 1G2G,3H
			142,218		19% 2 ∣ 1I2I,3K	+15% 2 ∣ 3H2H,3I	+12% 2 ∣ 3G4G,5G
137,416.0	0.7	1	137,647	−231	49% 2 ∣ 3H4H,5G	+14% 2 ∣ 3G4G,5G	+9% 2 ∣ 3G4G,5H
134,378.7	0.6	1	134,349	30	26% 2 ∣ 3H4H,5H	+24% 2 ∣ 3H4H,5I	+13% 2 ∣ 3H4H,5G
126,331.9			126,357	−25	34% 1 ∣ 2H3)3I	+ 33% 1 ∣ 2H3)1I	+26% 1 ∣ 2G3)3H
			124,783		84% 2 ∣ 5D6D,7F	+8% 2 ∣ 3F4F,5G	+5% 2 ∣ 3F4F,5G
119,120.9			119,159	−38	78% 1 ∣ 2H3)3H	+11% 1 ∣ 2H3)1I	+7% 1 ∣ 2H3)3I
110,820.4			110,832	−12	54% 1 ∣ 2G3)3H	+20% 1 ∣ 2H3)1I	+15% 1 ∣ 4F3)5G
104,831.9			104,815	17	48% 1 ∣ 2H3)3I	+32% 1 ∣ 2H3)1I	+17% 1 ∣ 2H3)3H
93,150.2			93,150	1	81% 1 ∣ 4F3)5G	+16% 1 ∣ 2G3)3H	+1% 1 ∣ 2H3)3I
***J* = 7**							
171,031.1	0.8	1	171,106	−75	46% 2 ∣ 3H2H,3I	+24% 2 ∣ 1I2I,3I	+13% 2 ∣ 1I2I,1K
			168,108		41% 2 ∣ 1I2I,3I	+19% 2 ∣ 1I2I,3K	+11% 2 ∣ 3H4H,3I
160,979.4	0.6	1	161,011	−32	35% 2 ∣ 3H4H,3I	+29% 2 ∣ 3G4G,5H	+17% 2 ∣ 3H4H,5I
156,885.0	0.6	1	156,885	−0	50% 2 ∣ 1I2I,3K	+20% 2 ∣ 1I2I,3I	+13% 2 ∣ 3H4H,5I
149,971.0	0.5	1	150,015	−44	49% 2 ∣ 3H4H,5H	+15% 2 ∣ 3H4H,5I	+14% 2 ∣ 1I2I,3K
			148,862		54% 2 ∣ 3G4G,5H	+19% 2 ∣ 3H4H,5I	+10% 2 ∣ 3H4H,3I
			137,395		36% 2 ∣ 3H4H,5I	+34% 2 ∣ 3H4H,5H	+13% 2 ∣ 3H4H,3I
116,060.0			116,056	4	98% 1 ∣ 2H3)3I	+1% 2 ∣ 3H4H,3I	+0% 2 ∣ 3H2H,3I

[a] Uncertainty of new or changed energy level. Blanks correspond to previously known levels [1]. Their uncertainties were estimated [1] as better than 0.8 cm^{-1}. [b] Number of lines used to identify new or changed energy level; blank corresponds to previously [1] known level. [c] Difference between the observed and calculated energy level. [d] *LS*-composition of the level. The number preceding the "∣" symbol has the following meaning: 1 stands for $5d^7 6p$, 2 stands for $5d^6 6s6p$, and 4 stands for $5d^7 7p$.

Table 3. Fitted and calculated parameter values (cm^{-1}) in the $5d^7 6p$ + $5d^6 6s6p$ + $5d^5 6s^2 6p$ + $5d^7 7p$ + $5d^7 5f$ system of Pt III.

Parameter Name [a]	Fitted Value	Error [b]	MCDF [c]	Fitted/MCDF	Parameter Status [d]
$5d^7 6p$					
E_{av}	116,976	51	117,340.0	0.9969	1
O_2	6481	19	7755.3	0.836	r1
$O_{2'}$	3933	37	5295.2	0.743	r2
E_a	69	(9)			0
E_b	25	(15)			0
T_1	−0.2	(0.6)			0
T_2	0.6	(0.5)			0
ζ_{5d}	4895.9	12	4619.7	1.0598	1
A_c	41.6	(7.3)	45.7	0.91	r3
A_3	6.9		7.6	0.91	r3
A_4	8.2		9.1	0.91	r3
A_5	10.7		11.8	0.91	r3
A_6	17.7		19.4	0.91	r3
A_1	−6.4		−7.0	0.91	r3
A_2	5.3		5.8	0.91	r3
A_0	−5.7		−6.3	0.91	r3
C_1	2272	30	2577	0.881	r4
C_2	2018	26	2497	0.808	r5
C_3	1015	25	1350	0.752	r6
S_1	204	(8)			1
S_2	−87	(13)			1
ζ_{6p}	8235.3	21	7205.5	1.1429	1
$S_d.L_p$	−97.4	(6.2)	−132.6	0.73	r7
$S_p.L_d$	−18.5		−25.2	0.73	r7
$Z^2(pp)$	−47.8		−65.0	0.73	r7
$Z^2(dd)$	28.5		38.9	0.73	r7
$Z^1(pp)$	151.7		206.5	0.73	r7
$Z^1(dd)$	−16.9		−23.1	0.73	r7
$Z^3(pp)$	44.2		60.2	0.73	r7
$Z^3(dd)$	−12.4		−16.9	0.73	r7
SS_{02}	−13.6		−18.5	0.73	r7
SS_{20}	−2.1		−3.0	0.73	r7
t_{16}	−6.7	(11)			0
t_{17}	2.8	(9)			0
t_{18}	1.6	(9)			0
t_{19}	−2.9	(11)			0
t_{20}	−41.9	(24)			0
t_{21}	−6.2	(8)			0
t_{22}	0.9	(12)			0
t_{23}	−12.7	(10)			0
t_{24}	−17.7	(11)			0
t_{25}	0.5	(9)			0
t_{26}	−50.0	(18)			0
t_{27}	0.4	(10)			0
t_{28}	31.7	(14)			0
t_{29}	19.0	(10)			0
t_{30}	63.1	(13)			0
t_{31}	−16.9	(10)			0
t_{32}	4.7	(10)			0
t_{33}	12.3	(12)			0
t_{34}	1.5	(10)			0
t_{35}	18.7	(12)			0

Table 3. *Cont.*

Parameter Name [a]	Fitted Value	Error [b]	MCDF [c]	Fitted/MCDF	Parameter Status [d]
5d^{6}6s6p					
E_{av}	166,361	39	168,123	0.9905	1
O_2	6574	26	7964	0.825	1
$O_{2'}$	3756	83	5418	0.693	1
E_a	53	28	68	0.768	1
E_b	24	0	24	1.000	0
ζ_{5d}	5173	23	4888	1.058	1
T_1	0.2	1			1
T_2	3.6	1.1			1
A_c	55	19	45.7	1.20	r8
A_3	8.6		7.1	1.20	r8
A_4	14.8		12.3	1.20	r8
A_5	17.4		14.4	1.20	r8
A_6	22.3		18.5	1.20	r8
A_1	−6.1		−5.1	1.20	r8
A_2	9.3		7.8	1.20	r8
A_0	−4.5		−3.7	1.20	r8
C_{ds}	2999	38	3626	0.827	1
$A_{mso}(ds)$	87	16	69	1.298	1
Ass	−12	0	−12	1	0
C_1	2545	35	2790	0.912	1
C_2	1937	28	2618	0.749	1
C_3	1223	27	1395	0.886	1
S_1	111	19	204	0.557	1
S_2	−38	34	−80	0.487	1
ζ_{6p}	9017	84	8450	1.067	1
$S_d.L_p$	−113	11	−138	0.821	r9
$S_p.L_d$	−20.2		−24.6	0.821	r9
$Z^2(pp)$	−48.4		−58.9	0.821	r9
$Z^2(dd)$	41.6		50.6	0.821	r9
$Z^1(pp)$	174.3		211.8	0.821	r9
$Z^1(dd)$	−12.9		−15.8	0.821	r9
$Z^3(pp)$	54.2		65.9	0.821	r9
$Z^3(dd)$	−11.9		−14.4	0.821	r9
C_{sp}	9451	83	12,840	0.736	1
$A_{mso}(sp)$	−732	202	−744	0.985	1
$R^2(dd;ds)12$	−22,716	450	−26,035	0.872	1
$R^2(dp;sp)12$	−19,009	605	−21,469	0.885	1
$R^1(dp;ps)12$	−16,699	434	−19,620	0.851	1
5d^{5}6s^{2}6p					
E_{av}	236,401		236,401	1	0
O_2	6824		8166	0.836	r1
$O_{2'}$	4113		5538	0.743	r2
$\zeta(5d)$	5449		5141	1.060	0
C_1	2642		2996	0.881	r4
C_2	2219		2746	0.808	r5
C_3	1074		1428	0.752	r6
ζ_{6p}	11,210		9842	1.14	0
$R^2(dd;ss)13$	19,692		23,167	0.85	0
$R^2(dd;ds)23$	−22,181		−26,096	0.85	0
$R^2(dp;sp)23$	−18,835		−22,159	0.85	0
$R^1(dp;ps)23$	−17,138		−201,62	0.85	0
5d^{7}7p					
E_{av}	194,872		194,872	1	0
O_2	6584		7876	0.836	r1
$O_{2'}$	3984		5365	0.743	r2
ζ_{5d}	5734		5410	1.060	0

Table 3. *Cont.*

Parameter Name [a]	Fitted Value	Error [b]	MCDF [c]	Fitted/MCDF	Parameter Status [d]
C_1	733		832	0.881	r4
C_2	466		577	0.808	r5
C_3	214		285	0.752	r6
ζ_{7p}	2651		2316	1.14	0
5d⁷5f					
E_{av}	204,702		204,702	1	0
O_2	6584		7881	0.836	r1
$O_{2'}$	3988		5368	0.743	r2
ζ_{5d}	5405		5098	1.060	0
C_1	594		699	0.85	0
C_2	−22		−26	0.85	0
C_3	476		560	0.85	0
C_4	373		439	0.85	0
C_5	647		762	0.85	0
ζ_{5f}	10		10	1	0
$R^2(dp;dp)14$	7738		9104	0.85	0
$R^1(dp;pd)14$	3981		4684	0.85	0
$R^3(dp;pd)14$	3462		4073	0.85	0
$R^2(dp;df)15$	−9561		−11,248	0.85	0
$R^4(dp;df)15$	−4276		−5030	0.85	0
$R^1(dp;fd)15$	−4375		−5147	0.85	0
$R^3(dp;fd)15$	−2974		−3499	0.85	0
$R^2(sp;dp)24$	−5877		−6915	0.85	0
$R^1(sp;pd)24$	−5709		−6717	0.85	0
$R^2(sp;df)25$	9791		11,519	0.85	0
$R^3(sp;fd)25$	5946		6995	0.85	0
$R^2(dp;df)45$	−1408		−1657	0.85	0
$R^4(dp;df)45$	−1474		−1734	0.85	0
$R^1(dp;fd)45$	−1971		−2319	0.85	0
$R^3(dp;fd)45$	−1410		−1659	0.85	0

[a] Trailing digits *xy* in the *R*-integral labels denote interaction between configurations *x* and *y*, where 1 stands for $5d^7 6p$, 2 stands for $5d^6 6s6p$, 3 stands for $5d^5 6s^2 6p$, 4 stands for $5d^7 7p$, and 5 stands for $5d^7 5f$. [b] Errors in parentheses refer to the values obtained from the fitting of only $5d^7 6p$ levels (see the text). [c] *Ab initio* value (cm^{-1}) of the parameter. It was obtained from the calculations using the multiconfiguration Dirak–Fock (MCDF) code GRASP92 [21]. The average energies and the values of the *R*-integrals for configuration interactions were obtained from the calculations using the Cowan code [11,12]. [d] Parameter status: 0—parameter is fixed; 1—parameter is varied; r1, r2—parameter is linked at the MCDF ratio to O_2, $O_{2'}$, respectively, in the $5d^7 6p$ configuration; r3—parameter is linked at the MCDF ratio to A_c; r4–r6—parameter is linked at the MCDF ratio to C_1–C_3, respectively, in the $5d^7 6p$ configuration; r7 — parameter is linked at the MCDF ratio to $S_d.L_p$; r8—parameter is linked at the MCDF ratio to A_c in the $5d^6 6s6p$ configuration; r9—parameter is linked at the MCDF ratio to $S_d.L_p$ in the $5d^6 6s6p$ configuration.

Table 1 contains 241 lines; 3 of them were doubly classified. It was found that two levels at 94,814.1 and 95,251.9 cm^{-1} were incorrectly classified in [1] as $5d^7(^4F)6p\ ^5F_1$ and $5d^7(^4F)6p\ ^5G_2$, respectively. The classification of these two levels should be interchanged: the level $5d^7(^4F)6p\ ^5G_2$ should be at 94,814.1 cm^{-1}, whereas the energy 95,251.9 cm^{-1} should belong to the $5d^7(^4F)6p\ ^5F_1$ level. The identification of the corresponding lines was changed. The questionable odd level at 127,385.8 cm^{-1} ($J = 1$) was confirmed, but it was not possible to confirm the level at 118,956.1 cm^{-1} ($J = 1$). Instead, this level was found at 118,591.0 cm^{-1}.

The differences between the observed wavelength and the wavelength derived from the final level energies (Ritz wavelength) are also shown in Table 1. These differences are not higher than 0.010 Å for 235 lines. The wavelengths of five lines deviate from the corresponding Ritz values by 0.011–0.013 Å, and that of one line (1657.275 Å) deviates by 0.020 Å. Thus, the majority of the differences are located in the limit of two standard deviation of the measured wavelength uncertainty (0.005 Å).

As it is seen in Table 2, the wavefunction composition of many new levels consists of a mixture of the $5d^7 6p$ and $5d^6 6s6p$ configurations. In many cases, the leading percentages are low, and the level names in Table 1 have little physical meaning. Therefore, the J values and the energy values are also listed in Table 1 for unambiguous identification of the transitions. The "forbidden" transitions from some of the levels of the $5d^6 6s6p$ configuration to the $5d^8$ one were found as a consequence of the configuration mixing of the upper levels.

The energies of the new levels were obtained using the program LOPT for least-squares optimization of energy levels [22]. It was observed, in the course of the identification using the IDEN2 program, that the most of the $5d^7 6s$ level energies agree with an uncertainty of 0.1 cm^{-1} with those reported in [1]. Several level energies deviating by 0.2–0.5 cm^{-1} were corrected. They are marked by "c" in Table 1. Two new J = 0 levels of the $5d^7 6s$ configuration were found close to positions predicted by Wyart et al. [18]: 52,119.1 cm^{-1} (43% (^{4}P)^{3}P + 28% (^{2}P)^{2}P) and 61,022.8 cm^{-1} (46% (^{4}P)^{3}P + 43% (^{2}P)^{2}P). All level energies of the $5d^7 6s$ configuration established in [1] and corrected in this work were fixed at the optimization of the $5d^7 6p$ + $5d^6 6s6p$ levels. Ninety-one new odd levels are collected in Table 2. Their uncertainty varies from 0.1 to 1.0 cm^{-1}, depending mostly on the number of lines available for the optimization. Table 2 also contains calculated energy levels truncated above the highest observed level in the matrixes of each J.

In comparison with the conventional Slater–Condon approach implemented in the Cowan code, the orthogonal operators technique permits small higher-order magnetic and electrostatic effects to be introduced in the fitting procedure. The energy parameters, representing these effects, used in the fitting of the odd levels, are shown in Table 3. The meaning of these parameters can be found in [15,16] and in the references therein. Ab initio values of these parameters were obtained by fitting the energy levels calculated using the Parpia et al. MCDF program [21]. Some of them were varied collectively keeping the ratios of the corresponding ab initio values. Table 3 gives a comparison of the fitted energy parameters of the odd system with ab initio calculated values. Only for the average energies (E_{av}) and configuration interaction integrals, the ab initio values are from Cowan's Hartree–Fock program. In all other cases, they are obtained by fitting the results returned by the MCDF code [21].

The fitting of the $5d^7 6p$ + $5d^6 6s6p$ levels was carried out in two steps. In the first step, the energy parameters of the $5d^7 6p$ configuration were varied, keeping the parameters of the $5d^6 6s6p$ configuration fixed on predetermined values. Twenty-one strongly mixed levels were excluded from the fitting. The mean deviation of the fitting was 48 cm^{-1}. It should be noted that the fitting using Cowan's code in [1] resulted in an average deviation of 190 cm^{-1} for the $5d^7 6p$ levels. In the final step, all energy levels were fitted. Most of the energy parameters describing the levels of the $5d^7 6p$ configuration were fixed on the values obtained in the first step. The mean deviation of the final fitting was 89 cm^{-1}.

Radial integrals for transitions between the levels of the odd and even configurations used for the calculation of the weighted transition probabilities gA in Table 1 were taken from the Cowan code. As was mentioned above, the observed relative line intensities should only be considered as rough qualitative estimates due to neglect of the wavelength dependence of the spectrograph efficiency and the sensitivity of the photographic plates, as well as due to the non-linearity of their response. Nevertheless, the relative line intensities follow the branching ratios represented by the calculated gA values, which was sufficient for the identification of the spectrum.

4. Conclusions

This study of the vacuum spark spectrum of twice-ionized platinum results in the identification of 241 new spectral lines in the range 728–2062 Å. New lines belong mostly to the $5d^7 6s - (5d^7 6p - 5d^6 6s6p)$ transitions. The number of known Pt III lines was increased to more than 1000. Ninety-one new high-lying levels of the odd configurations were found. The levels of the $5d^6 6s6p$ configuration strongly interact with the levels of the upper part of the $5d^7 6p$ configuration, resulting in a mixture of their wavefunctions. The upper levels of the *5d*^{6}*6s6p* configuration also overlap with those of the *5d*^{7}*7p* and *5d*^{7}*5f* configurations. Accurate predictions of their interaction, along with observations in the visible part of the spectrum, are needed for further extension of the Pt III analysis.

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