

NEW SPECTROSCOPIC RESULTS IN Xe II, Xe III AND Xe IV

J.G. REYNA ALMANDOS, M. GALLARDO and M. GARAVAGLIA
Centro de Investigaciones Ópticas (CONICET-UNLP-CIC)
 1900 La Plata (Argentina)

ABSTRACT

New results obtained in spontaneous xenon spectrum employing a conventional pulsed gaseous laser tube as light source, are presented in this work. A total of 626 spectral lines has been ionically assigned as follows: 50 to Xe II spectrum, 103 to Xe III spectrum, and 222 to Xe IV spectrum.

30 Lines previously assigned to Xe II were reassigned as belonging to Xe III, 94 lines were assigned with some doubts to Xe II-III spectrum, and 84 lines to Xe III-IV spectrum. Also there were classified 43 lines of Xe II.

RESUMEN

Nuevos resultados obtenidos en el espectro del xenón espontáneo logrado mediante la utilización de un tubo de láser gaseoso pulsado convencional como fuente de luz son presentados en este trabajo.

Han sido estudiadas en total 626 líneas espectrales las que fueron asignadas iónicamente de la siguiente manera: 50 al espectro del Xe II, 103 al de Xe III y 222 al de Xe IV.

30 Líneas asignadas anteriormente al Xe II fueron reasignadas como pertenecientes al Xe III. 94 Líneas fueron asignadas con cierta duda al espectro del Xe II-III y 84 líneas al de Xe III-IV. Fueron clasificadas además 43 líneas del Xe II.

1. INTRODUCTION

Several authors have studied xenon spectra since it was discovered in 1898 by W. Ramsay and M.W. Travers (1-8), employing different types of spectral sources.

The experimental material previously obtained was recently analyzed taking as a basis the calculations by the Hartree-Fock method for evaluating the parameters which permit the definition of transitions between the excited levels of Xe III. As a result of this spectral analysis it has been revised and extended the identification of levels $5s^2 5p^3 ({}^4S)6s$, $7s$, $6p$, $5d$ and $4f$, and many spectral lines have been classified as combinations between levels of the system $({}^4S)nl$ (9).

In the course of the present research it has been studied the spectra of xenon several times ionized in the range between 2000 and 6900 Å, making the ionic assignment of the observed lines according with the results summarized in Table I.

TABLE I

New lines assigned to Xenon Spectra

<u>Spectrum</u>	<u>Quantity</u>
Xe II	50
Xe III	103
Xe IV	222
Xe II - III	94
Xe III - IV	84
Re-assigned lines	30
Classified Xe II lines	43

2. EXPERIMENTAL EQUIPMENT

The light source employed in these experiments was made with a Pyrex tube ended in quartz windows, 3 mm internal diameter and 80 cm between electrodes. The tube had two cold electrodes made with tungsten wire covered with indium. Conventional vacuum systems were used for evacuating and filling up the tube with spectroscopically pure xenon. Its working pressure was of the order of 10 mTorr.

The excitation and ionization of xenon was produced by discharging between electrodes a capacitor bank with a capacitance varying from 1 to 20 nF, charged up to 20 kV.

Light radiation was axially analyzed, focusing the beam on the spectrograph entrance slit.

In the short wavelength region, it was used a Jarrell-Ash vacuum spectrograph, Robin mounting, with 3 m focal length and a concave diffraction grating of 1180 lines/mm blazed at 1500 Å. The spectra were photographed on the first diffraction order, and a reciprocal dispersion of 2.8 Å/mm was achieved.

To photograph the remaining spectral regions it was used an Ebert mounting spectrograph with 3.4 m focal length and plane diffraction grating of 600 lines/mm blazed at 5000 Å. In this case, spectra were photographed in the third diffraction order with a reciprocal dispersion of 1.5 Å/mm.

Ilford Q-2, Kodak 103 a-0, and Kodak 103 a-F plates were used to record spectra in the various regions they were divided, associated with properly selected filters.

The wavelengths of xenon spectral lines observed with the Ebert mounting spectrograph were determined comparing them with Th^{232} spectra interferometrically measured by Valero et al (10). The position of spectral lines on the plates were determined with a rotating prism photoelectric automatic Grant comparator, whose precision is 1 μm . The error in determining wavelengths by this procedure is estimated in ± 0.01 Å.

In the photographic records made with the Robin mounting spectrograph there were employed, as a first approach, internal standard lines for the identification and measure of wavelengths. The plates were measured with the above mentioned comparator. After that, all lines were recalculated employing as standard lines those belonging to the Xe II spectrum which were obtained from the energy levels calculated by W. Persson (11). Then, the estimated error in wavelength determination is ± 0.05 Å.

3. RESULTS

Ionic assignment of most spectral lines was made varying the capacity of the capacitor bank and observing their behaviour in line intensity. In this way there were assigned lines corresponding to Xe II, Xe III and Xe IV spectra. In some cases it was difficult to distinguish some lines corresponding to spectra of these ions and they were assigned as Xe II-III and Xe III-IV, respectively.

In Tables II, III and IV are listed the values in wavelength and wavenumber corresponding to observed new spectral lines in Xe II, Xe III and Xe IV spectra, respectively. Tables V and VI list the wavelength and wavenumber values of the new lines with doubtful assignment corresponding to the Xe II-III and Xe III-IV, respectively.

The first and second column in these tables give the wavelength in air, in Angstrom, and the wavenumber in cm^{-1} . The relative intensity of each spectral line is given in the third column, in a scale that ranges from 0 to 5. The fourth column remarks the type of spectral line: W, wide; B, blended; A, asymmetric; and H, hazy. Those without any mark are sharp, clear and well defined spectral lines. Besides, previous spontaneous observations made by Humphreys (5), Bloch, Bloch and Déjardin (2), and Baly (1) are marked with an asterisk on columns five, six and seven, respectively.

In Table VII are included lines assigned to Xe II spectra by C.J. Humphreys (4), which has now been re-assigned as corresponding to Xe III.

In Table VIII, 43 spectral lines belonging to Xe II are listed with their proposed classifications, based on unpublished data (11) related with the energy levels between which those transitions are produced.

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TABLE II

$\lambda_{\text{air}}(\text{\AA})$	$\sigma(\text{cm}^{-1})$	I	R	H	BBD	B
2053.71	48676.82	3				
2174.78	45967.30	2				
2241.56	44597.99	1				
2247.17	44486.66	1				
2254.74	44337.32	1				
2274.96	43943.28	3	A			
2292.01	43616.42	2	B			
2316.27	43159.64	2				
2444.89	40889.28	2	W			
2497.72	40024.33	1				
2572.87	38855.50	1				
2615.02	38229.25	3				
2623.17	38110.48	2			*	*
2625.93	38070.43	0		*		*
2629.05	38025.25	1				
2633.72	37957.83	2		*	*	*
2636.51	37917.67	0				
2646.35	37776.68	1	A			
2667.72	37474.09	1	B			
2668.22	37466.93	0			*	*
2680.68	37292.93	1	W			
2691.74	37139.70	4	W		*	*
2704.86	36959.56	1				*
2740.22	36482.53	0				
2786.67	35874.58	1				
2797.49	35735.83	1		*	*	*
2805.61	35632.41	1			*	*
2828.86	35339.56	0				
2830.08	35324.33	1	H			*
2954.49	33836.93	0	B			
2974.70	33607.06	1				
3049.22	32785.66	1	H		*	*
3061.64	32652.77	0			*	*
3073.41	32527.73	1		*	*	*
3090.25	32349.43	0	B			*
3092.75	32324.33	0			*	*
3144.20	31795.41	0				
3369.12	29672.76	1				
3369.29	29671.35	1				*
3621.86	27602.28	1				
3649.57	27392.71	2		*		*
4180.29	23915.07	1			*	*
4242.21	23022.77	0			*	*
4361.54	22921.26	1		*		*
4395.05	22798.28	1			*	*
4414.66	22645.48	1	B			
4536.78	22035.91	2				
4571.52	21868.41	0	A			
4571.80	21771.88	1				
4690.49	21272.97	0		*		

TABLE III

λ_{air} (Å)	σ (cm ⁻¹)	I	R	H	BBD	B
2568.81	38916.91	1			*	*
2573.94	38839.35	1	w		*	*
2575.75	38812.06	0				
2579.87	38765.71	1			*	*
2591.24	38580.06	0		*	*	*
2600.16	38447.72	2		*	*	*
2610.20	38299.84	0				
2613.98	38244.46	1		*	*	*
2629.71	38030.17	1	A			
2631.17	37994.61	1				
2636.15	37879.70	0				
2640.16	37865.25	1	A			
2643.41	37819.60	0		*	*	*
2647.67	37815.55	0			*	*
2652.34	37777.17	1			*	*
2657.21	37620.98	0			*	*
2696.96	37069.29	1	w		*	*
2706.92	36931.44	1			*	*
2708.45	36910.58	1		*	*	*
2714.90	36822.80	1		*	*	*
2732.52	36595.33	1			*	*
2733.25	36494.25	2			*	*
2741.90	36435.59	1			*	*
2754.98	36289.52	1		*	*	*
2761.95	36196.55	1		*	*	*
2763.79	36171.55	1			*	*
2755.95	36143.29	0			*	*
2774.44	36032.71	0		*	*	*
2779.82	35962.97	0			*	*
2781.05	35935.44	0			*	*
2784.34	35914.52	0			*	*
2789.76	35834.84	0	H		*	*
2795.36	35763.00	0			*	*
2797.87	35739.98	1		*	*	*
2806.24	35624.41	1			*	*
2809.52	35582.69	0		*	*	*
2819.84	35452.60	0	B		*	*
2825.22	35385.00	0			*	*
2827.74	35353.56	0			*	*
2832.83	35290.04	0			*	*
2862.55	34923.67	0			*	*
2866.51	34875.42	0			*	*
2877.67	34740.19	0		*	*	*
2895.04	34531.75	1			*	*
2897.99	34496.00	0			*	*
2949.40	44450.47	1		*	*	*
2964.97	33764.13	0			*	*
2976.75	33592.91	1		*	*	*
2980.00	33546.27	1		*	*	*
2984.27	33286.70	0		*	*	*

TABLE III (Cont.)

2994.95	33379.84	1		*	*	*
3004.65	33272.08	1			*	*
3013.36	33175.91	0		*	*	*
3015.77	33149.40	0			*	*
3029.74	32996.56	1		*	*	*
3051.21	32764.39	0			*	*
3106.47	32181.57	1			*	*
3108.50	32160.56	0			*	*
3132.80	31911.11	2	A	*	*	*
3143.02	31807.35	0				
3179.27	31444.70	3		*		*
3231.70	30934.57	4	W	*	*	*
3244.13	30816.04	2		*	*	*
3248.02	30779.14	1	B		*	*
3301.22	30283.14	1				
3320.07	30111.21	1		*	*	*
3334.75	29978.66	1				
3399.87	29404.48	1		*	*	*
3587.67	27865.32	3		*	*	*
3663.89	27285.72	3	R	*	*	*
3751.44	26648.88	1				
3801.71	26296.51	2		*	*	*
3816.79	26192.62	2		*	*	*
3895.05	25666.36	4		*	*	*
3905.92	25594.87	2	R	*	*	*
3958.35	25255.93	3		*		*
3976.32	25141.79	2			*	*
3979.21	25123.53	2		*		*
3981.55	25108.77	4		*	*	*
3994.42	25027.87	2				*
4049.34	24688.43	2		*		
4053.04	24665.89	3		*		
4053.56	24662.73	3		*		*
4068.11	24574.52	3	B	*		*
4070.12	24562.33	4	B	*	*	*
4094.88	24413.87	3			*	*
4106.10	24347.17	4			*	*
4111.26	24316.57	3		*	*	*
4132.94	24189.06	4	R	*	*	*
4155.57	24057.34	3		*		*
4179.99	23916.79	4	W		*	*
4196.71	23821.51	3		*	*	*
4226.97	23650.97	2		*	*	*
4204.99	23222.31	4		*		
4365.32	22901.37	4		*		
4440.80	22512.18	2				
4601.60	21725.47	0		*		
4614.82	21663.19	0				
4671.81	21399.01	0			*	*
4830.85	20694.53	1				
6780.40	14744.34	4	A	*	*	
6847.82	14599.14	0				
6851.79	14590.74	0	U	*		

TABLE IV

λ_{air} (Å)	σ (cm ⁻¹)	I	R	H	BBD	B
2612.63	38264.22	1				*
2615.59	38220.22	0		*	*	*
2619.79	38160.96	0		*	*	*
2652.17	37622.79	0		*	*	*
2652.89	37684.84	0		*	*	*
2654.26	37662.69	0				
2665.12	37510.59	0		*	*	*
2679.99	37322.53	0		*	*	*
2689.51	37170.49	0				
2695.97	37082.91	1		*		*
2699.59	37132.95	1			*	*
2706.72	36924.83	1		*	*	*
2712.22	36861.26	1				*
2721.49	36731.17	2				
2721.99	36728.29	0				
2722.55	36719.42	0				
2725.31	36682.24	0		*	*	*
2733.92	36566.73	2				*
2759.82	36092.67	1			*	*
2779.26	36095.77	1		*	*	*
2771.51	36079.8	2		*		
2787.51	35862.77	2				
2796.17	35752.76	2				
2798.27	35725.87	0				
2801.72	35681.89	0				
2813.81	35528.57	2				
2828.21	35346.44	0			*	*
2835.92	35252.71	0				*
2833.47	35219.32	2		*		*
2848.42	35086.78	2				*
2869.95	34823.62	1			*	*
2891.12	34578.57	0				*
2907.62	34358.72	0				*
2914.95	33768.76	1				*
2914.22	33168.65	1	R			
3024.86	32349.79	1				
3027.21	32017.59	0			*	*
3059.52	32675.49	0				*
3066.92	32597.62	1				*
3071.75	32545.31	1				*
3077.71	32482.29	4		*		*
3096.67	32284.14	1				*
3097.52	32274.55	1				*
3107.45	32171.42	0				*
3112.99	32118.49	3				*
3137.22	31869.19	2				*
3142.87	31808.87	0				*
3142.11	31745.94	2	A		*	*
3156.12	31575.19	1				*
3181.56	31432.14	2				*

TABLE IV (Cont.)

3187.54	31363.12	3			*
3188.72	31351.51	2			*
3195.03	31289.59	2			*
3199.32	31247.64	1		*	*
3207.79	31165.13	2			
3227.53	30974.53	1	A	*	*
3229.51	30955.54	0			
3238.65	30969.19	1			
3241.12	30844.66	1		*	*
3241.45	30841.52	0		*	*
3244.82	30809.40	0			
3255.34	30709.93	3			
3261.46	30652.31	0			
3267.88	30592.89	0			
3268.22	30598.91	3		*	*
3276.59	30510.77	0		*	*
3287.00	30414.14	0			
3287.08	30413.41	0	A		
3287.47	30409.80	2	A		
3294.45	30345.37	0			
3295.56	30335.15	3		*	*
3297.51	30317.21	2			
3299.80	30226.17	1			
3309.11	30210.94	1			*
3312.92	30176.20	5			*
3313.90	30167.27	2			
3318.61	30124.46	2			*
3320.82	30104.41	1			
3323.45	30080.50	1			
3326.86	30049.76	1			
3332.01	30003.31	0			*
3333.57	29989.27	1			*
3344.57	29990.65	2			*
3355.11	29796.75	2			*
3356.17	29787.34	1	A		*
3364.69	29712.00	1			*
3367.50	29687.12	2	B		*
3367.54	29686.77	2	B		*
3381.64	29562.99	1			*
3382.59	29554.69	0	B		
3470.66	28804.74	3		*	*
3474.76	28770.76	3			
3483.25	28700.63	4			*
3490.97	28637.16	2			
3490.31	28568.92	3			
3544.46	28208.10	3			
3556.00	28105.72	2			
3565.01	28025.35	1			
3573.10	27978.22	2			
3582.71	27903.80	2			

TABLE IV (Cont.)

3590.22	27844.67	1			
3593.74	27818.25	0	R	*	*
3605.07	27730.83	3			
3610.74	27687.28	0			
3620.88	27609.75	1			
3640.62	27459.97	2			
3648.90	27397.74	2			
3658.80	27323.61	1		*	*
3664.99	27284.16	2		*	*
3676.21	27195.69	1			
3712.74	26926.65	2			
3718.55	26884.58	1			
3720.91	26867.52	1	R	*	*
3721.02	26866.66	0			
3731.59	26799.62	2			*
3762.45	26570.90	2	A	*	*
3812.26	26285.80	4			
3812.55	26221.75	1			
3817.38	26188.57	0			
3828.92	26105.57	2			
3837.71	26045.84	2			*
3842.95	26014.22	0	H		
3845.22	25979.25	1			
3855.72	25929.12	1			
3872.51	25869.09	1			
3870.17	25771.42	1			*
3917.12	25521.76	2			*
3923.41	25489.84	3	D	*	*
3973.11	25162.74	4			
3986.74	25076.02	1			
4017.62	24882.29	2			
4052.22	24628.29	1			
4070.26	24561.54	2	D	*	*
4133.67	24184.74	1	H		
4254.42	23469.24	2			
4264.21	23442.88	2	A		
4264.98	23424.15	1			
4279.55	23369.40	2	A	*	*
4299.66	23197.20	1		*	*
4316.82	22159.72	1			
4322.24	23120.74	1		*	*
4322.92	22124.47	1	A		
4343.81	23014.92	0			
4344.95	23008.57	0			
4356.26	22949.21	2			
4360.96	22924.22	1		*	*
4361.97	22919.01	0			
4366.69	22904.67	0	H		
4376.44	22842.19	2			*
4382.91	22829.29	1			

TABLE IV (Cont.)

4391.19	22766.50	0	
4393.65	22753.75	2	
4394.24	22750.66	1	
4399.17	22725.16	1	
4400.40	22718.85	2	
4401.41	22713.65	0	
4407.01	22694.74	1	
4409.97	22669.55	4	
4422.08	22607.47	3	
4424.49	22595.11	1	
4427.93	22578.27	2	
4434.27	22544.82	1	
4435.11	22541.56	2	
4435.29	22536.49	0	
4439.44	22524.12	2	
4441.15	22511.30	1	
4442.49	22499.51	2	
4462.71	22401.65	1	
4474.17	22344.27	2	
4517.16	22121.63	1	
4517.22	22120.79	0	
4522.06	22113.25	1	
4531.25	22067.19	2	11
4531.98	22059.26	2	
4543.60	22002.80	0	
4546.35	21989.40	0	
4550.99	21967.11	2	
4557.25	21936.65	1	
4560.29	21921.59	1	
4575.74	21849.20	0	
4587.78	21792.64	1	A
4634.49	21571.20	2	
4650.85	21495.45	4	B
4659.79	21454.22	2	
4668.22	21414.53	1	B
4675.58	21381.72	1	
4686.74	21320.85	1	
4692.92	21271.23	1	A
4710.21	21269.72	0	B
4711.24	21267.29	0	
4735.65	21112.51	0	
4737.49	21102.21	0	
4744.53	21071.00	0	
4749.27	21051.60	1	B
4754.46	21019.45	0	
4761.92	20994.45	1	
4767.76	20969.27	1	
4768.67	20964.27	2	
4775.88	20932.72	0	A
4790.14	20914.22	2	B

TABLE IV (Cont.)

4877.17	20826.76	1	W
4876.71	20799.46	3	
4827.26	21700.89	0	A
4830.06	20697.91	0	
4832.78	21686.27	0	H
4833.57	20682.80	1	
4843.90	20638.74	1	H
4849.30	20615.80	1	
5082.40	19670.25	0	
5150.08	19377.82	3	
5256.37	19010.24	1	
5284.73	18917.20	0	
5211.00	18826.96	1	
5274.87	18588.60	0	
5521.60	19105.66	0	
5614.03	17807.50	0	
5705.76	17521.28	0	
5955.67	16786.07	0	A
6281.22	15916.07	0	H
6460.86	15472.32	0	H
6489.32	15405.67	1	
6870.44	14551.11	0	H

TABLE V

$\lambda_{\text{air}} (\text{\AA})$	$\sigma (\text{cm}^{-1})$	I	R	H	BBD
2045.06	48882.68	0	A		
2052.74	48699.82	0			
2066.62	48372.79	1			
2108.24	47417.95	0	A		
2110.69	47362.91	2			
2113.80	47293.24	1			
2142.25	46665.23	0	A		
2146.31	46576.97	0	A		
2155.17	46385.51	0			
2159.33	46296.16	0	A		
2171.40	46060.06	1			
2192.78	45590.00	0			
2196.80	45506.59	1			
2197.81	45485.68	1			
2202.04	45398.31	0	A		
2205.74	45322.16	1			
2211.12	45232.36	1			
2211.35	45207.20	0	w		
2214.28	45106.65	1			
2231.79	44793.21	0	A		
2232.51	44778.76	1			
2237.04	44688.10	1			
2243.98	44549.90	1			
2244.84	44532.84	1			
2245.83	44513.21	1			
2253.07	44370.18	0			
2254.19	44269.59	0	A		
2261.33	44208.12	0			
2271.07	44018.55	0			
2271.39	44012.34	1			
2271.62	44007.89	0			
2273.18	43977.69	1			
2275.93	43924.56	0	A		
2282.60	43796.22	0	A		
2288.56	43682.17	0	A		
2289.18	43670.24	0	A		
2295.27	43554.48	0			
2311.72	43451.32	0	w		
2310.84	43449.35	0	w		
2311.40	43438.48	0	w		
2312.81	43411.89	1			
2312.75	43225.32	0			
2313.44	43212.43	2	A		
2317.55	43135.60	0	P		
2321.54	43061.67	0			
2323.48	43025.72	0			
2325.31	42991.86	0	A		
2331.28	42881.79	1			
2332.26	42863.76	0	A		
2333.80	42835.48	0			

TABLE V (Cont.)

2335.07	42812.18	0	B
2340.60	42711.04	1	A
2346.28	42607.65	1	
2347.86	42578.98	1	
2348.48	42567.74	0	
2349.41	42550.89	0	
2354.45	42459.81	0	
2354.97	42450.44	1	
2362.90	42307.99	0	B
2364.15	42285.62	0	
2364.63	42277.04	0	
2365.42	42262.92	0	
2374.68	42098.13	0	A
2379.11	42019.74	C	
2380.45	41996.09	C	A
2382.09	41967.18	C	B
2382.34	41962.78	C	B
2383.24	41946.93	0	
2386.78	41884.73	1	A
2388.58	41853.16	0	
2391.10	41809.06	2	
2394.10	41756.67	1	
2395.33	41735.23	1	W
2395.90	41725.30	1	A
2399.95	41654.89	1	
2404.27	41580.06	0	A
2413.76	41416.59	1	
2414.39	41405.78	C	B
2415.42	41387.96	C	A
2419.50	41318.34	C	
2419.77	41313.73	C	
2429.75	41144.05	0	A
2430.27	41135.25	0	A
2439.48	40979.96	0	
2439.78	40974.92	0	
2447.07	40852.86	C	
2459.02	40654.35	0	A
2463.58	40579.10	0	
2479.89	40312.23	0	
2485.01	40229.18	C	
2504.87	39910.24	0	W
2507.16	39873.79	1	
2524.00	39607.78	0	
2548.98	39219.65	0	

TABLE VI

λ_{air} (Å)	σ (cm ⁻¹)	I	R	H	BBD	B
2637.23	37907.31	0		*	*	
2638.89	37883.47	0		*	*	
2664.68	37516.83	0		*	*	*
2685.22	37229.88	2		*		*
2701.50	37005.53	0		*		
2701.71	37002.66	0		*	*	*
2704.41	36965.71	0		*		*
2710.13	36887.70	1		*	*	
2713.21	36845.83	2		*	*	*
2716.42	36802.15	1			*	*
2722.00	36714.71	0		*		*
2742.55	36438.39	1		*	*	*
2755.26	36282.53	1			*	*
2782.22	35620.62	0		*	*	*
2800.33	35585.23	1		*	*	*
2822.19	35423.21	0		*		*
2855.72	35007.07	0		*		*
2855.80	35006.21	0		*		*
2873.29	34793.13	0		*		*
2896.07	34519.47	0		*		*
2910.10	34252.17	0		*		
2918.52	34253.65	0		*		*
2996.04	33357.67	0				*
2998.04	33335.43	2	B	*	*	*
3055.00	32723.74	1			*	*
3060.82	32661.41	0		*		
3074.49	32516.41	0		*		
3076.16	32498.65	0				
3097.69	32272.78	1				
3118.42	32058.26	1				
3125.76	31982.99	2		*		*
3134.72	31891.56	2		*	*	*
3159.52	31651.26	0				
3159.67	31649.76	0				
3159.88	31647.66	0				
3260.46	30661.71	0				*
3270.17	30570.67	0				
3296.48	30326.49	0		*	*	*
3312.20	30182.75	0	B	*	*	*
3312.25	30172.29	0		*	*	*
3325.06	29957.80	1				
3334.17	29893.88	3	A	*		*
3336.49	29863.03	2		*		
3338.61	29844.80	0			*	*
3345.49	29822.42	4		*	*	*
3348.97	29851.37	1				
3353.56	29810.70	1		*		
3360.04	29753.02	1	A			*
3360.22	29751.43	1				*
3360.36	29750.21	2				*

TABLE VI (Cont.)

3247.19	29689.85	1			*	
3271.13	29655.15	0			*	*
3271.66	29650.49	0	A	*		
3277.70	29506.69	1				
3479.72	28729.75	1			*	*
3518.82	28410.52	0			*	*
3527.07	28344.07	1				*
3587.88	27863.69	0			*	*
3589.78	27848.94	0		*		*
3643.92	27435.11	1			*	*
3739.60	26733.25	0		*		
3739.76	26732.11	1				
3742.10	26715.39	0		*	*	
3768.86	26525.71	4	A	*		
3840.40	26030.58	0				
3961.51	25080.20	1			*	*
4051.18	24677.22	0		*		*
4082.72	24486.52	2	B	*	*	*
4082.80	24485.51	2		*		*
4128.27	24215.84	4	A			
4129.64	24208.20	2		*		
4171.26	23966.80	1			*	*
4173.27	23954.72	1				
4201.15	23796.22	1		*	*	*
4246.28	23542.86	0				
4327.80	23089.40	2		*		
4341.01	23029.63	2				
4359.76	22635.80	0				
4400.69	22717.32	4		*		
4416.97	22622.62	5	H	*		
4661.62	21445.74	4	W	*		
4678.60	21367.52	0	H			
4779.31	20917.70	0		*	*	*
4842.85	20642.22	1				

TABLE VII

$\lambda_{\text{air}} (\text{\AA})$	$\sigma (\text{cm}^{-1})$	I	R
2757.82	36249.71	0	
2757.92	36248.40	0	
2799.77	35706.73	1	W
2810.95	35462.54	1	A
2964.15	33726.67	0	
2976.44	33587.41	5	
3048.12	32797.49	1	
3048.66	32789.64	1	
3128.37	31957.32	0	A
3164.47	31591.75	2	
3175.25	31434.50	5	
3192.72	31202.43	1	
3211.59	31129.26	1	A
3247.60	30792.26	5	W
3274.71	30528.29	0	W
3274.80	30526.51	1	
3537.41	28261.22	4	
3727.21	24821.43	5	
3810.52	25512.21	2	
4027.04	24810.69	4	
4044.74	24716.51	1	
4057.27	24639.57	4	A
4061.12	24616.82	4	
4113.26	24304.74	3	
4127.69	23815.95	1	
4251.42	23514.92	2	B
4210.59	23192.26	2	
4415.07	22628.75	2	
4415.02	16248.51	0	
4224.37	15099.80	0	W

TABLE VIII

$\lambda_{\text{observed}}$	σ_{observed}	l	R	$\sigma_{\text{calculated}}[11]$	Classification
2026.16	48597.32	0	A	49095.28	(3P_0) 5d[2] $_{5/2}$ - (1D_2) 4f[3] $_{7/2}$
2040.42	48993.83	0		48993.51	(3P_1) 5d[3] $_{7/2}$ - (1D_2) 4f[4] $_{9/2}$
2043.46	48920.95	0	A	48920.39	(3P_0) 5d[2] $_{3/2}$ - (1D_2) 4f[2] $_{3/2}$
2065.55	48397.64	0		48397.63	(3P_1) 5d[1] $_{3/2}$ - (1D_2) 4f[2] $_{3/2}$
2068.33	48332.80	0	A	48331.30	(3P_1) 5d[1] $_{3/2}$ - (1D_2) 4f[2] $_{5/2}$
2069.95	48294.97	0		48294.85	(3P_0) 5d[2] $_{5/2}$ - (1D_2) 4f[2] $_{3/2}$
2076.32	48146.83	1		48146.98	(3P_2) 5d[4] $_{7/2}$ - (3P) 4f[3] $_{7/2}$
2102.84	47539.78	0		47539.42	(1D_2) 6s[2] $_{5/2}$ - (1D_2) 4f[3] $_{7/2}$
2117.21	47217.07	1		47217.62	(3P_0) 6s[0] $_{1/2}$ - (3P_1) 4f[2] $_{3/2}$
2120.61	47141.38	1		47141.55	(3P_2) 6s[2] $_{5/2}$ - (3P_1) 4f[2] $_{5/2}$
2124.73	47049.98	2		47050.22	(3P_2) 5d[4] $_{7/2}$ - (3P_1) 4f[4] $_{9/2}$
2128.73	46961.58	1		46961.55	(3P_2) 6s[0] $_{5/2}$ - (3P_2) 4f[4] $_{7/2}$
2138.85	46738.41	1		46738.99	(1D_2) 6s[2] $_{5/2}$ - (1D_2) 4f[2] $_{3/2}$
2153.08	46430.54	0	A	46430.02	(3P_2) 6s[2] $_{5/2}$ - (3P_2) 4f[2] $_{3/2}$
2166.05	46152.55	1		46152.73	(3P_1) 6s[1] $_{3/2}$ - (3P_1) 4f[2] $_{5/2}$
2167.84	46114.44	1		46114.14	(3P_2) 6s[2] $_{5/2}$ - (3P_2) 4f[3] $_{5/2}$
2176.22	45936.67	2		45936.83	(3P_2) 6s[2] $_{5/2}$ - (3P_2) 4f[3] $_{7/2}$
2178.25	45894.08	0		45894.05	(3P_1) 5d[2] $_{3/2}$ - (1D_2) 4f[3] $_{5/2}$
2193.48	45575.46	1		45576.03	(3P_1) 6s[1] $_{3/2}$ - (3P_1) 4f[2] $_{3/2}$
2209.24	45270.86	2		45270.71	(3P_2) 6s[2] $_{3/2}$ - (3P_1) 4f[1] $_{3/2}$
2214.27	45145.55	3		45145.61	(3P_2) 6s[2] $_{3/2}$ - (3P_2) 4f[2] $_{5/2}$
2215.58	45120.99	2		45121.29	(3P_2) 6s[2] $_{3/2}$ - (3P_2) 4f[1] $_{1/2}$
2222.76	44975.16	3		44975.17	(3P_1) 5d[2] $_{3/2}$ - (1D_2) 4f[2] $_{3/2}$
2224.59	44938.17	2		44938.35	(3P_2) 5d[2] $_{5/2}$ - (3P_2) 4f[1] $_{3/2}$
2225.99	44908.91	2		44908.84	(3P_1) 5d[2] $_{3/2}$ - (1D_2) 4f[2] $_{5/2}$

TABLE VIII (cont.)

2232.83	44772.25	2		44772.32	(³ P ₂) 5d[3] _{7/2} -	(³ P ₂) 4f[2] _{5/2}
2234.99	44729.08	1		44728.99	(³ P ₁) 5d[2] _{5/2} -	(¹ D ₂) 4f[4] _{7/2}
2235.52	44718.47	2		44718.64	(³ P ₁) 6s[1] _{3/2} -	(³ P ₀) 4f[3] _{5/2}
2239.79	44633.23	1		44633.25	(³ P ₂) 5d[2] _{5/2} -	(³ P ₂) 4f[4] _{7/2}
2248.22	44465.89	1		44465.96	(³ P ₂) 5d[3] _{7/2} -	(³ P ₁) 4f[5] _{9/2}
2256.82	44296.40	2		44296.19	(¹ D ₂) 6s[2] _{3/2} -	(¹ D ₂) 4f[3] _{5/2}
2283.14	43785.84	5		43785.84	(³ P ₂) 5d[2] _{5/2} -	(³ P ₂) 4f[3] _{5/2}
2303.15	43311.40	2		43310.96	(¹ D ₂) 6s[2] _{3/2} -	(¹ D ₂) 4f[2] _{5/2}
2350.10	42538.40	0	A	42538.57	(¹ D ₂) 6s[2] _{3/2} -	(¹ D ₂) 4f[1] _{3/2}
2357.70	42527.54	0		42527.48	(¹ D ₂) 5d[4] _{9/2} -	(¹ D ₂) 4f[4] _{7/2}
2352.06	42502.60	1		42502.60	(¹ D ₂) 5d[4] _{7/2} -	(¹ D ₂) 4f[4] _{9/2}
2404.84	41570.20	1		41570.06	(³ P ₀) 5d[2] _{3/2} -	(³ P ₁) 4f[2] _{5/2}
2420.87	41294.96	2	B	41296.69	(¹ D ₂) 5d[4] _{9/2} -	(¹ D ₂) 4f[5] _{9/2}
2446.79	40857.54	0		40857.33	(³ P ₁) 5d[3] _{7/2} -	(³ P ₁) 4f[4] _{7/2}
2517.06	39716.98	1		39717.26	(¹ D ₂) 6s[2] _{5/2} -	(³ P ₁) 4f[4] _{7/2}
2523.67	39612.95	0		39613.21	(³ P ₁) 5d[1] _{3/2} -	(³ P ₀) 4f[3] _{5/2}
2553.79	39145.78	0		39146.03	(³ P ₁) 5d[3] _{7/2} -	(³ P ₀) 4f[3] _{7/2}
2781.92	35935.83	0		35935.61	(³ P ₁) 6s[1] _{1/2} -	(³ P ₁) 4f[1] _{1/2}

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