Atlas of Atomic Spectral Lines of Neptunium Emitted by an Inductively Coupled Plasma

by

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ABSTRACT

Optical emission spectra from high-purity Np-237 were generated with a glovebox-enclosed inductively coupled plasma (ICP) source. Spectra covering the 230 - 700 nm wavelength range are presented along with general commentary on the methodology used in collecting the data.

INTRODUCTION

The Ames Laboratory Nuclear Safeguards and Security Program has been charged with the task of developing optical spectroscopic methods to analyze the composition of spent nuclear fuels. Such materials are highly radioactive even after prolonged "cooling" and are chemically complex. Neptunium (Np) is a highly toxic by-product of nuclear power generation and is found, in low abundance, in spent nuclear fuels. This atlas of the optical emission spectrum of Np, as produced by an inductively coupled plasma (ICP) spectroscopic source, is part of a general survey of the ICP emission spectra of the actinide elements.

The ICP emission spectrum of the actinides originates almost exclusively from the electronic relaxation of excited, singly ionized species. Spectral data on the Np ion emission spectrum (i.e., the Np II spectrum) have been reported by Tomkins and Fred [1] and Haaland [2]. Tomkins and Fred excited the Np II spectrum with a Cu spark discharge and identified 114 Np lines in the 265.5 - 436.3 nm spectral range. Haaland, who corrected some spectral line misidentifications in the work of Tomkins and Fred, utilized an enclosed Au spark discharge to excite the Np II spectrum and reported 203 Np lines within the 265.4 - 461.0 nm wavelength range.

Fred, Tomkins, Blaise, Camus, and Verges [3] published a comprehensive listing of the atomic spectrum of Np (i.e., the Np I spectrum) in the 257.5 - 2630 nm wavelength range excited by an electrodeless discharge, and Bovey and Steers [4], who also used an electrodeless discharge tube to excite the Np I spectrum, recorded the Np spectrum over the 890 - 2240 nm range.

To our knowledge, a comprehensive listing of the Np spectral emission lines produced by an ICP excitation source has not been reported in the literature. Work has been done at various laboratories to determine the most sensitive Np emission lines from an ICP source. During an early stage of this work, one of the authors obtained information [5] about the detection limits of several intense Np lines emitted by an ICP source operated at Rockwell Hanford Operations, Richland, WA.

APPARATUS and PROCEDURES

Apparatus: The data presented herein were collected with an ICP apparatus specially adapted for glovebox operation [6,7]. The ICP operating conditions are listed in Table 1.

TABLE 1. ICP OPERATING CONDITIONS	
Forward R.F. Power	900W
Reflected Power	<5W
Argon Flow Rates	
Outer Gas	17 l/min
Intermediate Gas	For ignition only
Nebulizer Gas	0.95 l/min
Sample Uptake Rate	0.25 ml/min
Observation Height	15 mm above load coil
Integration Time	see text below

Some of the operating conditions were dictated by the limitations of glovebox operation rather than by spectroscopic considerations. For example, the power applied at the ICP torch was restricted to 900W forward power to minimize the heat input to a nearby air filtration device, and the torch-to-slit distance was set at ~1.7 m to permit the further isolation of the

enclosed ICP in a separately ventilated room. A concentric nebulizer with a nominal solution uptake rate of ~0.3 to 0.5 ml/minute was chosen for this work. A peristaltic pump was used to further limit the solution uptake rate to 0.25 ml/min and thereby to reduce the amount of liquid waste generated during ICP operation.

The instrumentation used is described in Table 2. A schematic diagram of the experimental lay-out is included here as Fig. 1. The imaging optics resulted in an image demagnification at the entrance slit of ~3X.

TABLE 2. INSTRUMENTATION

A. POWER and NEBULIZER SYSTEM

Generator	Type HFS 3000D (Plasma-Therm)
Nebulizer	TR-50-CO.5 (Meinhard)
Torch	T 1.5 (Plasma-Therm)
Spray Chamber	- (Plasma-Therm)
Peristaltic Pump	Minipuls 2 (Gilson Med. Elec)
Mass Flow Controllers	(3-channel) (MKS)

B. SPECTROMETER

Grating	1.50 m, f/14 THR1500 (Jobin-Yvon)
	2400 groove/mm (Jobin-Yvon)
	(Master holographic grating)
Entrance Slit	0.015 mm
Filter	Schott #GG 400 for 500-700nm

C. SIGNAL DETECTION ELECTRONICS

OMA	Model 1450 (EG&G/PAR)
PDA Detector	Model 1453 (EG&G/PAR)

D. COMPUTER SYSTEM

CPU	11/73 (Digital Equipment)
Graphics Terminal	Model 550 (Visual Technology)
Operating System	RT-11 V.5.2 (Digital Equipment)
Software	Ames Laboratory
Plotter	Model 9872S (Hewlett Packard)

Fig. 1. Experimental lay-out. GB = stainless steel glovebox, S = ICP source, W1-W4 = fused silica windows, L1-L3 = 25 mm diameter fused silica lenses, LS = He-Ne alignment laser, M1-M2 = monochromators, BS = fused silica beamsplitter (R = ~8%), PMT1-2 = photomultipliers, OMAD = optical multichannel analyzer detector. A more complete equipment specification is provided in Table 2.

Reagents: High purity $^{237}\text{NpO}_2$, obtained from Oak Ridge National Laboratory, was dissolved in HNO_3 to prepare a 0.4 mg/ml ^{237}Np solution. This solution was introduced into the ICP torch to generate the emission spectra contained in this report.

Analysis of the starting material by spark source mass spectroscopy at Oak Ridge National Laboratory indicated that the Np sample contained less than 65 ppm total impurities (see Table 3).

TABLE 3. Np-237 IMPURITY ANALYSIS

Boron	0.1 ppm
Calcium	2 ppm
Chlorine	10 ppm
Chromium	0.3 ppm
Iron	3 ppm
Potassium	0.3 ppm
Sodium	2 ppm
Phosphorus	0.4 ppm
Plutonium	<3 ppm
Sulfur	3 ppm
Silicon	3 ppm
Thorium	<3 ppm
Uranium	5 ppm
Zinc	0.3 ppm
Zirconium	0.2 ppm

Even though the radioactive decay of the Np-237 atom is primarily through alpha-particle emission and Np-237 has a relatively long half life of 2×10^6 years and hence has a low specific activity, it was found that our sample emitted gamma radiation. This was from Pa-233, a short-lived daughter product

of Np-237, that was in secular equilibrium with the parent nucleus. To reduce operator exposure to the penetrating gamma-radiation, the bottle containing the Np stock solution was placed into a Pb covering. Laboratory personnel were also issued dosimeter badges to monitor exposure to gamma radiation. The gamma radiation dose rate in the immediate vicinity of the glovebox was measured by Health Physics personnel and was not deemed to be a health hazard (see Table 4).

TABLE 4. ALPHA FACILITY RADIATION SURVEY

ISOTOPE; Np-237/Pa-233

INSTRUMENT; FUG

ROOM BACKGROUND;	.02 MR/H
BOX WINDOW- CENTER AT 4" FROM BOT;	.30 MR/H
LEFT GLOVE PORT AT SURFACE;	.20 MR/H
BOX BET L AND M PORT AT SURFACE;	.18 MR/H
CENTER GLOVE PORT AT SURFACE	.43 MR/H
CENTER GLOVE PORT AT 3" IN;	.80 MR/H
BOX BET M AND R PORT AT SURFACE;	.30 MR/H
RIGHT GLOVE PORT AT SURFACE;	.27 MR/H
BOX TOP AT SURFACE;	.04 MR/H
EXHAUST FILTER AT SURFACE;	.14 MR/H
2ND EXHAUST FILTER AT SURFACE;	.02 MR/H
LOWER REAR OF BOX AT SURFACE;	.15 MR/H

Procedures: A photodiode array, optical multichannel analyzer (PDA-OMA) was used to record the optical emission of Np from 230 to 700 nm. This device was mounted on the photographic exit port of the THR1500 monochromator and, because this port was located perpendicular to the usual optical path, a

mirror was used to divert the dispersed radiation to the PDA. The monochromator was used in the "single-pass" mode. In this mode, with a 2400 grooves/mm grating, the resolution of the system was ~6 pm (at 300 nm) and the spectral coverage was ~ 6 nm. The maximum useful integration time per measurement was determined to be 1 second; the photodiode detector saturated for integration times greater than 1 s. The final OMA spectra were prepared by summing a number of individual 1 second PDA exposures for each wavelength range recorded. The exposure conditions used for the various wavelength ranges are collected in Table 5. Two lens positions were used to focus the image of the plasma source onto the spectrometer entrance slit, one for the visible spectrum and the other for the ultraviolet spectrum. Spectral line intensities were relatively insensitive to changes in the lens position.

TABLE 5. OMA EXPOSURE CONDITIONS

Wavelength range (nm)	Number of One-Second Integrations	Slit Width (μ)	Lens Focus	Optical Filter
230-300	320	50	UV	none
300-400	160	25	UV	none
400-500	160	25	visible	none
500-700	160	25	visible	GG400

To remove second order spectral lines, a sharp cut optical filter was used for the higher wavelength exposures. The filter had a transmission of less than 1% for wavelengths below 370 nm and more than 95% for wavelength greater than 500 nm.

Software was written to link the OMA to a laboratory computer and the OMA spectra were transferred to computer memory after acquisition. The OMA output to the computer was in tabular form listing pixel number (from 0 to 1023) versus intensity as 'counts'. The counts were linearly related to the diode photocurrent. These spectra were then permanently stored on flexible 5-1/4" diskettes.

Three aspects of the OMA spectral data presented here should be noted. First, the PDA sensitivity varied with wavelength and was at a maximum near 600 nm [8]. No attempt was made to compensate for this sensitivity variation. Second, the 1024 channel photodiode array consists of alternating p- and n-silicon regions, both of which are light sensitive. A signal resulting from light falling on an n-region is divided between the adjacent p-regions. Therefore, even for situations where the spectral bandpass approximated the diode spacing of the detector, as was the case for this work, the Gaussian-like spectral line profile covered portions of several diodes. Thus the measured intensity of a line depended on the position of the line profile relative the p- and n-regions. No attempt was made to compensate for this spectral line-to-diode registry effect, which has been shown to result in intensity errors of as much as 30% [9]. Finally, the first ~175 photodiodes (on the low wavelength side of the PDA) were noted to be less light sensitive than were the remainder of the diodes. This loss of sensitivity was due to a small degree of vignetting in the spectrometer. Usually there was sufficient spectral overlap between successive Np spectral segments so that intensity information could be collected from lines isolated on the unvignetted portion of the diode array.

Spectral calibration: Haaland's Np line list [2], which includes all of the verified lines from the list of Tomkins and Fred, proved to be useful for calibrating the Np ICP spectrum. For spectral ranges that included lines reported in Haaland's study, those lines were taken as wavelength standards. If available, three lines were used to calibrate each diode array spectral segment. A quadratic fitting function was used in the calibration calculation. When three identified Np lines were not available, a single line was used in conjunction with spectrometer dispersion values obtained during the preparation of U and Pu atlases [10,11]. For spectral segments that did not include any of Haaland's identified lines, the spectral overlap of adjacent segments was used to provide wavelength markers that could be used for the calibration. Inaccuracies in wavelength assignments were thus passed on to the adjacent segment to compound the margin of error for that segment.

Many of the ^{237}Np lines show a substantial amount of hyperfine splitting, in some cases more than 0.05 nm (see Fig. 2). It is not clear whether the wavelengths of such lines listed by Haaland represent the strongest line component, or the centroid of the plate blackening. For this atlas, we have assigned Haaland's wavelength to the strongest component, or to the OMA pixel with the highest intensity when hyperfine splitting was not resolved. This uncertainty could introduce a bias in our wavelength assignments of up to 0.05 nm.

Calibration of Np wavelengths greater than 440 nm, beyond the range of the published reference spectra, was accomplished by measuring the spectrum of a mixture of 300 μg $^{237}\text{Np}/\text{ml}$ and 160 μg $^{242}\text{Pu}/\text{ml}$. These spectra were calibrated using the previously identified Pu lines and lines of H, O, and Ar [11]. The stronger Np lines were thus assigned wavelength values, which were subsequently used to calibrate the Np spectral segments. Again, any

Fig. 2. Np-237 line at approximately 3829.1Å showing hyperfine splitting of nearly 0.5Å. This figure was obtained by scanning the spectrometer, in double pass mode, while monitoring the exit slit with a photomultiplier.

inaccuracies in the Pu wavelengths would be transferred to the Np lines. However, the Pu wavelengths are believed to be accurate to within 5 pm, although instances of greater inaccuracy are possible.

Np wavelengths below 265 nm were not previously reported, so calibration of the regions from 230 to 265 nm was carried out by using the monochromator dispersion (known from previous atlas work [11]), and the central wavelength as indicated by the wavelength counter. For this 35 nm region, the wavelength calibrations are probably accurate to within 0.2 nm.

RESULTS AND DISCUSSION

Appendix I consists of 115 wavelength-vs-intensity plots of the ^{237}Np OMA data, corrected for detector dark current. These plots cover the spectral region extending from 228 to 700 nm.

Tabular data on the pages facing the wavelength-vs-intensity plots list the stronger lines, which are marked on the plots with either a dot or an element symbol (for lines not due to Np emission). The first column of the tables gives the line wavelength in Angstrom units (i.e., 1 Angstrom unit = 0.1 nm). The line positions are generally accurate to within 0.05 nm for the Np lines. The second column lists the spectral line intensities, in counts. These values have been corrected for detector dark current, but have not been corrected to account for the variation of instrument sensitivity to spectral wavelength. An attempt was made to estimate this variation by recording the spectrum of a quartz-halogen lamp over the 250-700 nm range and dividing the resulting spectrum by the expected "black-body" emission intensity from this

source. The results are shown in Fig. 3, which must be understood to represent only an approximation of the actual instrument response function.

Few Np lines were found in the spectral region from 198 to 248 nm, possibly because of the poor response of the spectroscopic apparatus at those wavelengths. To compensate for the poor sensitivity, the entrance slit of the monochromator was opened to 0.050 mm, and the number of one-second integrations was doubled to 320.

The spectral regions above 637 nm were smoothed with a running three point averaging procedure to increase their signal-to-noise ratio. This also reduced the apparent maximum intensity of the spectral lines, especially for the sharp lines. The intensity values in the accompanying tables were measured prior to the smoothing procedure, and consequently, the tabular intensities for the regions from 637 to 700 nm may not agree with the spectral intensities shown in the smoothed plots.

The detection limits of the most prominent Np lines found in this atlas have been measured with a photomultiplier detector and with the spectrometer in the double pass mode. This was done previously to determine the detection limits of several prominent Pu lines [12]. Table 6 lists the 3σ detection limits for the strongest ICP emission lines of Np.

Table 6. Np-237 ICP DETECTION LIMITS

Wavelength (nm)	Detection Limit ($\mu\text{g/l}$)
382.91	25
430.77	37
429.08	48
456.04	52
416.44	60
386.52	75
410.84	77
302.66	120
405.10	120

Fig. 3. Approximate variation of monochromator-OMA sensitivity with wavelength. Measured using a 1000W quartz-halogen source (Model FEL, [Q1000/4CL], General Electric) operated at 8A, with a specified color temperature of 3200K. Curve shown is the average of measurements with two different lamps.

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APPENDIX I

FIGURES 1-115

ICP-OVA spectra of a ^{~0.5}~~0.4~~ mg/ml Np-237 solution. The spectra are corrected for OVA detector dark current contributions, are unsmoothed, and represent the summation of 160 one-second integrations (see text for special recording conditions for spectra in the 230 - 300 and the 637 - 700 nm regions). Please note that the wavelength axis of these figures is labelled in Angstrom units, and that 1A = 0.1 nm.

$\lambda(\text{\AA})$	I
2292.7612	1869.
2300.3940	2400.
2325.6621	3370.
2340.6211	1668.
2362.1445	2596.
2366.2129	2540.
2367.5254	3023.
2369.4939	2484.
2371.5938	3059.
2372.2500	5043.
2375.2686	2490.
2378.4839	2872.

$\lambda(\text{\AA})$	I
2387.8926	2233.
2402.4224	2510.
2405.5640	2524.
2413.7451	2383.
2416.8213	2467.
2417.2141	3652.
2419.7012	2192.
2420.6174	2453.
2422.1882	2762.
2422.7773	2387.
2424.0864	2263.
2427.5552	2336.
2429.1260	2441.
2429.9114	2157.
2431.1550	2401.
2437.4570	4049.
2442.2239	2149.
2442.8770	3811.
2446.7949	2264.
2447.0562	2825.
2447.5784	2209.
2451.9536	2704.
2453.3901	3529.
2460.0508	2414.
2462.3362	2493.
2462.9893	2744.
2464.4912	3569.
2464.8176	2076.
2468.2786	2049.
2469.3232	3647.
2475.0044	2111.
2475.3311	2597.
2476.0493	2291.
2476.7676	2686.
2478.2695	2885.
2479.1836	2901.

$\lambda(\text{\AA})$	I
2484.0356	2948.
2484.8821	4781.
2490.4807	2973.
2492.7590	8510.
2498.6831	2846.
2500.4409	3766.
2500.7664	7465.
2504.5422	3411.
2506.1047	13680.
2507.2114	2938.
2507.9924	2868.
2508.6436	5066.
2515.1536	9431.
2515.6091	3363.
2520.2964	6045.
2521.8589	2738.
2523.8770	2444.
2526.0903	2468.
2526.3508	3588.
2529.2151	5532.
2529.6057	3026.

$\lambda(\text{\AA})$	I
2533.5701	6146.
2535.1301	5015.
2536.8201	6142.
2537.1450	3634.
2538.9651	13805.
2542.0852	6183.
2546.4402	5350.
2547.4150	6895.
2551.5100	3502.
2558.0100	4749.
2558.9202	4527.
2560.8701	8682.
2565.6802	5685.
2566.9802	5177.
2573.0251	3575.
2575.6902	4203.
2577.2500	4521.
2581.2151	4207.
2581.1328	5831.
2583.1416	6289.
2585.6689	4631.
2589.2329	5177.
2593.3801	5862.
2595.3889	6479.
2598.3049	9137.
2598.9529	4998.
2603.9426	5446.
2605.3682	5182.
2605.6272	19744.
2606.9233	24544.
2607.3770	5359.
2609.0618	4899.
2613.9216	15827.
2615.6064	9877.
2620.9202	5110.
2622.1514	6329.
2623.1882	5073.
2623.8362	5842.
2624.2898	14020.
2628.5664	4690.
2628.7610	5064.
2629.0200	19610.

$\lambda(\text{\AA})$	I
2633.2202	8263.
2635.6104	6336.
2637.3545	16611.
2638.8403	12019.
2639.4216	7534.
2641.0366	7764.
2641.4890	9428.
2643.1685	6732.
2646.2049	8293.
2647.3030	6153.
2651.7603	15310.
2652.8584	12908.
2654.9902	79438.
2656.7346	6150.
2662.6130	6092.
2666.8120	7149.
2669.7837	40111.
2671.5925	12755.
2675.8562	8755.
2678.3110	41947.
2679.4092	21725.
2680.0552	6749.
2680.8303	7701.
2680.5269	9828.
2684.2124	17233.
2688.9299	10952.
2691.6709	10381.
2693.4937	9842.
2697.3877	9634.
2700.9424	20295.
2704.4192	14764.
2709.4812	16543.
2710.0562	11419.
2711.3323	10957.
2712.3518	19065.
2714.5146	17647.
2715.0864	10344.
2715.4673	11268.
2716.4187	12934.
2717.2424	49496.
2722.1687	16935.
2727.1294	13390.
2728.4434	10231.
2728.7559	10040.

$\lambda(\text{\AA})$	I
2730.3635	10819.
2733.0620	16054.
2734.6040	36235.
2739.8081	13163.
2740.1936	12836.
2741.4146	10409.
2748.2893	33956.
2748.8674	36302.
2750.7307	98406.
2751.6301	10830.
2754.0076	13361.
2755.8064	11417.
2758.6335	10650.
2758.8904	13255.
2760.6252	15261.
2762.9382	11175.
2771.2266	12056.
2773.0898	20631.
2774.8887	13739.
2777.1375	11608.
2780.9282	10241.
2780.7803	12486.
2783.2783	12509.
2785.3279	42416.
2787.1853	41812.
2789.1709	11340.
2790.0037	18363.
2790.6440	15181.
2792.5015	17131.
2796.0242	11641.
2796.6648	13753.
2798.1379	13430.
2798.7783	34784.
2800.7000	47623.
2803.5823	13995.
2804.2866	11158.
2816.9045	20152.
2820.3633	10589.
2822.3489	12072.
2824.0142	13496.
2825.2312	28126.

$\lambda(\text{\AA})$	I
2830.1172	13211.
2833.5012	13081.
2838.0347	12833.
2841.1633	39150.
2841.6741	15000.
2843.9727	23359.
2844.2920	46787.
2847.8677	17236.
2852.6562	13344.
2853.6140	20042.
2859.6799	28317.
2860.6377	14486.
2861.4038	11893.
2861.7231	13151.
2863.4470	13545.
2866.0649	62989.
2867.0227	17147.
2867.6611	21257.
2869.4490	17516.
2870.4705	26685.
2873.4075	14783.
2874.0461	13429.
2874.6208	11734.
2877.8132	12922.
2881.5085	20875.
2884.1838	23619.
2887.8149	52929.
2889.2163	22105.
2891.0635	20875.
2893.7390	49523.
2898.9624	34186.
2899.9177	29129.
2900.6187	30081.
2901.0007	53328.
2902.7844	35815.
2904.2495	76003.
2904.5679	28112.
2905.5872	22699.
2913.4224	68277.
2916.6709	23617.
2918.6458	25304.
2920.4292	23511.
2923.0410	20668.
2925.2068	58442.
2926.7993	36120.
2927.5000	31597.
2928.9651	35887.
2929.4109	73561.
2930.1753	20714.
2931.3857	80247.

$\lambda(\text{\AA})$	I
2931.2676	78037.
2937.8081	47444.
2938.1255	84514.
2939.5862	28609.
2944.0310	41146.
2947.5872	68587.
2950.8257	64248.
2953.6196	58617.
2956.6040	183513.
2957.1121	37738.
2958.0012	43353.
2960.5410	48054.
2961.0491	31360.
2962.6367	33867.
2964.4780	35797.
2967.2085	37336.
2968.3516	38980.
2971.2727	67298.
2974.3206	128859.
2975.0825	79615.
2978.0671	29214.
2983.6125	44976.
2986.9673	29939.
2988.1067	35359.
2992.4744	67399.
2993.5505	35214.
2993.8669	40192.
2995.4495	35397.
2997.6650	37448.
2998.2981	146252.
2999.7539	29734.
3001.3364	53539.
3002.7290	49704.
3012.6038	43418.
3015.0725	58484.
3017.2249	46422.
3025.2639	32862.
3025.6436	35473.
3026.0234	27266.
3026.6565	156358.
3027.5427	28366.
3029.2517	49216.

$\lambda(\text{\AA})$	I
2982.7263	8555.
2983.6125	11872.
2986.9673	7102.
2988.1067	8270.
2991.7148	6847.
2992.4744	15652.
2993.5505	8345.
2993.8669	9341.
2995.4495	8998.
2997.6650	10586.
2998.2981	33399.
2999.7539	6795.
3001.3364	14606.
3002.7290	13763.
3006.7803	7108.
3012.6038	11265.
3015.1357	14019.
3017.2249	11135.
3017.5413	6723.
3025.2639	7741.
3025.6436	8350.
3026.5933	40139.
3029.2517	11607.
3033.6140	10955.
3034.1824	6990.
3037.8450	7000.
3044.6021	5748.
3046.6860	6836.
3048.4543	5681.
3052.1169	19063.
3052.6853	7747.
3053.4431	8218.
3054.8323	6550.
3055.9690	6101.
3056.4111	7654.
3057.6741	27402.
3059.4424	5779.
3063.7366	6010.
3064.1785	4837.
3066.5151	13913.
3067.3362	5617.
3068.1570	9200.
3070.3672	18788.
3073.1460	5876.
3073.9668	5687.
3078.0085	9442.
3079.7766	8443.

$\lambda(\text{\AA})$	I
3084.8865	9284.
3089.7336	11530.
3090.5520	20231.
3092.3777	8844.
3092.7554	9275.
3095.3362	8722.
3095.9028	18788.
3098.2949	8616.
3098.5466	7734.
3099.4280	8944.
3102.1348	9648.
3105.6599	7747.
3106.0376	10502.
3106.5413	8310.
3107.8633	8745.
3108.0520	11446.
3112.0181	14882.
3117.2429	9088.
3117.6833	50646.
3117.9353	7814.
3122.5935	8372.
3126.9370	10242.
3128.7627	9841.
3131.4338	6079.
3133.1907	6147.
3134.3203	8005.
3135.3870	6486.
3139.1479	20644.
3142.4150	4754.
3143.7954	4903.
3144.9250	7455.
3149.8196	5658.
3151.6392	15304.
3152.7688	13267.
3154.2747	5451.
3154.5256	4712.
3158.5417	4792.
3158.8555	4710.
3160.0476	6169.
3162.6204	4671.
3163.7500	9911.
3164.3147	5616.
3165.0049	7972.
3167.3267	4843.
3170.3386	10102.
3177.2412	6747.

$\lambda(\text{\AA})$	I
3185.3010	11726.
3185.9268	23825.
3187.6162	7694.
3189.1179	7462.
3189.4809	7264.
3193.9358	4191.
3194.9368	8255.
3196.8140	4918.
3197.1267	4257.
3200.8811	7106.
3203.5090	13477.
3204.3850	4214.
3208.5771	5126.
3208.9526	5898.
3212.2061	4545.
3213.2073	4418.
3215.3347	4676.
3215.8977	5002.
3223.4063	11680.
3224.3447	4232.
3225.8464	16553.
3230.1011	7508.
3230.1204	6532.
3235.9558	3964.
3237.3833	5004.
3239.1208	3426.
3241.4785	8101.
3243.6497	3700.
3244.0837	5592.
3246.3784	8059.
3252.4543	5791.
3252.7644	3912.
3255.2434	10602.
3255.5532	3447.
3256.6685	6998.
3259.8901	4853.
3261.3149	5744.
3263.1729	6158.
3264.8450	3825.
3265.5879	5493.
3268.1882	3771.
3268.9312	6596.
3271.5308	7186.
3275.6765	4128.
3276.9758	3474.
3279.6973	8047.

$\lambda(\text{\AA})$	I
3281.4353	9036.
3283.9214	13292.
3285.0415	7959.
3287.7837	11513.
3290.0940	5723.
3290.6565	8358.
3293.7859	8165.
3294.9768	10836.
3297.4250	8411.
3298.9336	6709.
3301.7036	6876.
3303.2373	7840.
3307.2607	6791.
3308.4001	10837.
3311.2524	10183.
3311.6333	5624.
3313.6658	6237.
3314.9377	8224.
3316.0195	4968.
3318.9514	23051.
3319.5256	12898.
3324.8972	5911.
3326.2432	7442.
3326.6279	9992.
3331.3696	6790.
3332.9182	9599.
3333.1660	8135.
3335.9539	21424.
3337.0688	35977.
3339.2373	4665.
3340.6001	6719.
3341.4055	5813.
3343.3879	11853.
3344.0073	8477.
3344.8748	9352.
3346.4854	4568.
3355.4063	9665.
3358.3796	6482.
3359.6187	5788.
3361.6631	4999.
3368.2297	6546.
3368.8494	4654.
3371.2034	8021.
3374.9204	8834.
3379.9382	7769.

$\lambda(\text{\AA})$	I
3383.5142	7399.
3386.0461	5435.
3389.6892	10962.
3391.3564	4832.
3392.4063	5622.
3393.3325	19524.
3402.6567	59115.
3403.4595	9466.
3404.6328	10263.
3407.3499	4538.
3408.4612	9063.
3409.5728	5060.
3411.1782	11075.
3412.4751	7849.
3415.9331	4447.
3416.1182	4512.
3416.6741	6404.
3417.0444	12583.
3417.4768	6222.
3417.8472	7399.
3426.0601	10354.
3428.8389	6846.
3429.6416	4505.
3433.0781	5539.
3433.6936	7595.
3434.3706	5104.
3434.6169	6219.
3436.7712	5802.
3437.1404	6320.
3439.4177	6087.
3440.2180	5364.
3441.6951	11749.
3446.1267	5176.
3446.4346	5648.
3450.4968	5023.
3453.2666	18759.
3455.3591	5647.
3459.5447	9189.
3464.0994	9695.
3464.8994	6730.
3466.4382	4985.
3470.7468	9092.
3471.4854	4929.
3474.0088	8742.
3479.7332	6041.
3480.2871	6988.

$\lambda(\text{\AA})$	I
3480.2119	7369.
3482.3591	11831.
3483.2180	6036.
3484.6904	15156.
3486.8376	6236.
3488.1873	9712.
3488.8008	11481.
3489.2915	13789.
3491.5615	9155.
3498.4329	6470.
3501.6843	19021.
3504.9358	7293.
3507.3286	7164.
3507.8193	10892.
3510.8867	6237.
3511.3162	7790.
3512.8501	12811.
3514.8745	29727.
3516.1628	17699.
3517.3286	7318.
3518.7397	11176.
3522.2366	6480.
3522.4207	6877.
3522.9114	9340.
3524.6292	8398.
3525.4880	6095.
3531.0054	5842.
3532.7700	18020.
3533.3176	6752.
3535.3865	16995.
3539.3411	5755.
3542.1394	5398.
3542.8694	32406.
3543.7820	6209.
3544.0859	8719.
3545.4241	9243.
3547.7354	8924.
3550.5938	5729.
3551.3843	10520.
3551.9314	6357.
3555.2151	6635.
3556.7957	6650.
3557.0999	5353.
3558.1941	16816.
3559.5923	14897.
3562.5103	5826.
3565.3062	6585.
3567.7981	5279.
3570.0464	5502.
3572.1125	35685.
3572.8418	5685.

$\lambda(\text{\AA})$	I
3581.0027	9076.
3589.1633	47425.
3590.1987	11403.
3591.2949	110141.
3592.8174	9810.
3593.4873	22522.
3594.3398	44546.
3595.1316	13367.
3596.9585	8660.
3597.6284	10504.
3600.6733	7427.
3603.4138	8510.
3605.3628	7975.
3606.5808	49392.
3610.2957	8713.
3611.2700	9932.
3612.6099	8451.
3614.8022	7519.
3616.3247	9099.
3617.6646	7808.
3618.8826	11450.
3619.7351	16105.
3627.4084	8290.
3627.9565	13498.
3628.8093	10813.
3630.5996	11514.
3632.4207	15202.
3635.5771	7974.
3637.8339	11374.
3639.8867	11397.
3640.3118	8743.
3640.7366	7617.
3643.0432	18326.
3645.8354	17518.
3646.7458	8056.
3647.7778	7346.
3650.8127	11888.
3651.3391	11257.
3653.1194	14585.
3655.6687	19719.
3658.7039	9469.
3659.3716	6933.
3661.8601	10639.
3664.6523	23656.
3665.6235	35299.
3665.7449	40647.
3668.1729	7078.
3678.7954	19208.

$\lambda(\text{\AA})$	I
3480.4995	17429.
3483.1594	14351.
3486.4841	32338.
3486.8469	16277.
3487.7537	15441.
3493.2546	10513.
3493.8591	20312.
3496.4585	9542.
3498.3323	21484.
3700.4482	38746.
3703.7124	11555.
3707.6416	10704.
3708.2461	135109.
3711.6313	38442.
3714.6538	16834.
3716.1047	38513.
3718.8230	17539.
3720.0339	11386.
3720.2756	10697.
3722.2102	31129.
3723.4192	10196.
3725.8975	10014.
3727.1670	16571.
3729.3433	12950.
3730.6179	35129.
3733.2087	21877.
3736.8237	13678.
3737.9685	12673.
3740.0168	10592.
3741.3423	11584.
3742.3667	14715.
3743.0896	20652.
3744.6563	34810.
3749.2954	17428.
3750.8618	10646.
3752.6091	10072.
3755.6216	15219.
3757.3086	14817.
3759.5378	11560.
3762.9119	17156.
3765.9243	11240.
3768.8164	24020.
3770.8047	12319.
3773.6365	14439.
3775.9861	19675.
3776.5166	14491.

$\lambda(\text{\AA})$	I
3780.4980	17950.
3784.0044	18460.
3789.6748	14273.
3791.5361	13138.
3793.1689	42204.
3794.9224	21582.
3796.7974	24837.
3798.8540	21095.
3800.8572	16379.
3802.3928	19166.
3808.0310	13305.
3808.4482	34880.
3815.0337	26896.
3816.7795	14096.
3817.9858	38223.
3818.7710	36274.
3822.2837	13224.
3822.6479	20454.
3823.1946	14471.
3829.1118	394933.
3829.2344	359454.

$\lambda(\text{\AA})$	I
3829.1121	292684.
3829.2893	275531.
3830.3530	11061.
3831.1807	10745.
3831.4170	24987.
3832.4221	57450.
3832.9541	9075.
3834.0774	8688.
3835.9705	8495.
3838.1003	11360.
3843.0139	9157.
3846.9238	44233.
3848.5833	11478.
3850.0652	17906.
3853.2080	76994.
3858.9040	13105.
3861.2800	33666.
3861.3987	27498.
3862.0520	11997.
3865.2009	150496.
3869.0647	11369.
3870.7893	33856.
3871.3245	9330.
3874.4182	16965.

$\lambda(\text{\AA})$	I
3882.7944	76503.
3882.9136	65765.
3887.4392	9308.
3888.1538	87497.
3891.3101	28518.
3891.9651	24123.
3892.7393	10725.
3894.7043	11469.
3896.4314	16866.
3902.2078	11710.
3904.8875	13094.
3906.1975	16303.
3909.3538	17742.
3910.6042	9509.
3910.7830	9184.
3913.1648	18726.
3918.4053	11099.
3918.5840	11539.
3918.7625	9321.
3919.8940	14407.
3922.9907	18741.
3923.7053	17445.
3927.1592	14226.
3932.0564	20635.
3932.5901	11242.
3933.6575	10964.
3935.6145	20255.
3936.2668	11222.
3937.0969	18975.
3940.0620	13169.
3941.0107	11013.
3941.2480	19192.
3946.2886	14206.
3948.7197	24109.
3949.6094	16304.
3950.9138	53637.
3954.2939	26168.
3959.3345	15946.
3963.8413	17951.
3965.8574	13215.
3966.4504	12476.
3967.4585	33935.
3967.6958	12043.
3968.0515	15810.
3978.4290	41738.
3978.6069	46243.

$\lambda(\text{\AA})$	I
3980.6851	30035.
3984.4644	13274.
3985.2910	14817.
3986.8264	15548.
3989.7197	21233.
3991.0779	11433.
3991.7275	19314.
3996.3335	10466.
3996.5696	119090.
3996.7468	97803.
3996.8647	86246.
3998.5183	9713.
3999.4041	11805.
4000.2898	28599.
4002.2383	9793.
4004.1279	42012.
4007.6709	10229.
4016.9419	21149.
4018.3000	22833.
4022.1973	14376.
4024.0869	28374.
4024.7363	9777.
4025.9766	18962.
4029.0471	72199.
4028.7021	107226.
4029.2327	20873.
4030.5881	19520.
4033.7114	19631.
4034.8313	50448.
4035.0671	55836.
4037.3655	54708.
4043.4335	36950.
4046.5002	16262.
4047.0305	29381.
4049.7417	132544.
4049.8594	105418.
4050.0364	101678.
4050.1541	93001.
4051.0381	172398.
4051.5686	26542.
4052.3347	25076.
4055.2224	16047.
4060.1729	16846.
4065.6538	23475.
4073.5510	82112.

$\lambda(\text{\AA})$	I
4074.0500	24302.
4075.5737	48027.
4077.2732	18732.
4079.3828	14782.
4080.1445	17830.
4081.4924	17593.
4081.9026	19058.
4085.2427	24823.
4087.0593	23136.
4092.8608	30587.
4095.6736	30652.
4098.7207	141941.
4100.2441	20764.
4101.1821	28721.
4102.0610	19900.
4103.4673	14836.
4103.6431	115793.
4103.8188	15306.
4104.1704	29056.
4105.0498	21831.
4108.3896	181038.
4109.7964	14805.
4121.0356	47154.
4123.9673	21164.
4125.3169	13210.
4128.7231	19914.
4132.0747	15870.
4133.3696	21630.
4136.8452	38630.
4137.4937	16513.
4139.2041	40160.
4143.6919	26096.
4145.9385	38578.
4147.1907	24694.
4150.3779	18030.
4152.4521	21784.
4156.7246	40406.
4157.3184	17184.
4159.1602	33320.
4160.1113	28473.
4160.4683	53728.
4160.5869	51182.
4160.7656	50145.

$\lambda(\text{\AA})$	I
4164.3838	394503.
4164.8008	31173.
4165.2769	101675.
4166.4658	19564.
4168.0674	37081.
4168.6006	23252.
4171.9097	114203.
4172.0273	101164.
4172.1455	88500.
4172.2632	85789.
4172.5576	20429.
4180.6401	30026.
4182.1523	134563.
4186.0347	19389.
4192.8774	64830.
4197.1548	37060.
4199.7080	49670.
4200.7832	40036.
4206.6938	66655.
4207.3662	29189.
4208.4985	18119.
4209.6675	21865.
4211.7676	14234.
4212.9321	18491.
4216.3574	16513.
4217.6313	24611.
4221.3833	20283.
4224.2002	14702.
4227.5220	74350.
4229.8047	19289.
4234.6914	89976.
4235.9365	18345.
4236.3887	14372.
4237.2925	31032.
4237.9697	50800.
4238.1392	39399.
4243.5908	16012.
4245.1572	15205.
4247.8911	31809.
4250.8374	20401.
4251.5029	13315.

$\lambda(\text{\AA})$	I
4256.6108	142098.
4258.0537	105711.
4258.6304	13929.
4259.3804	15877.
4261.5137	35439.
4265.6611	15715.
4269.0557	23383.
4269.7461	51342.
4272.1602	19202.
4273.1367	122961.
4273.8262	22954.
4274.6299	16717.
4276.1226	17658.
4277.4995	21250.
4279.4497	67771.
4282.3154	40080.
4282.5444	40702.
4286.4380	52623.
4287.8682	25593.
4289.5835	105352.
4290.7837	469546.
4293.2402	13669.
4295.9805	93702.
4301.6870	13659.
4302.9478	30252.
4304.6665	25734.
4307.1865	12670.
4307.7017	438684.
4307.9878	12774.
4311.1357	27980.
4311.5361	15945.
4313.1377	17228.
4314.2817	23403.
4316.4541	31381.
4318.1113	40898.
4319.6543	59949.
4321.1963	26905.
4322.7383	23109.
4325.8774	13650.
4327.5322	13878.
4332.0937	11769.
4333.5757	34762.
4336.4810	134701.

$\lambda(\text{\AA})$	I
4348.8491	17854.
4350.7949	12918.
4351.0234	14455.
4351.9946	35759.
4352.9087	22200.
4354.7910	11551.
4358.7749	11082.
4360.7622	59525.
4361.4995	15416.
4362.9165	11260.
4363.7656	131998.
4370.3711	10696.
4373.3521	54259.
4373.5205	52430.
4373.6328	46713.
4373.7451	45290.
4374.1382	10269.
4375.9897	52519.
4378.3979	15953.
4378.9014	24466.
4385.4834	14267.
4386.3179	28576.
4387.3735	21708.
4386.5630	32850.
4387.5864	24863.
4390.5986	36833.
4394.2925	32766.
4395.3154	14114.
4398.2695	14327.
4403.2686	15099.
4405.4268	68488.
4411.6729	18848.
4413.4897	33420.
4414.8521	13576.
4415.5332	274879.
4417.2930	50926.
4417.9741	19633.
4420.2441	40579.
4424.5566	12142.
4424.7271	13724.
4424.8975	15641.
4425.1812	22668.
4426.7129	15455.
4429.3789	28586.

$\lambda(\text{\AA})$	I
4432.4175	11126.
4433.5498	31281.
4434.6816	10180.
4436.8892	14343.
4437.5117	9735.
4441.3037	19562.
4444.3604	10300.
4445.4922	8578.
4447.6431	8289.
4449.2847	13951.
4452.3975	9588.
4452.7935	19167.
4455.7935	33002.
4456.3594	19963.
4457.5483	41861.
4457.8311	12373.
4459.6421	65386.
4460.3779	10669.
4463.6045	36526.
4466.2080	34389.
4472.6602	9279.
4474.8110	22260.
4478.0869	40268.
4479.4438	8519.
4487.2290	21866.
4488.5239	10869.
4488.8052	46296.
4490.7734	15338.
4492.2349	14511.
4493.1333	9154.
4493.9194	16937.
4496.8921	8539.
4497.3965	94560.
4500.9243	10714.
4504.6694	8566.
4505.6187	92503.
4506.9580	32703.
4509.6895	8250.
4509.9683	18198.
4510.5249	132206.
4517.2524	11225.
4518.2515	10214.
4522.0210	30992.

$\lambda(\text{\AA})$	I
4522.0190	35379.
4522.7534	12688.
4527.0474	35953.
4529.0249	16470.
4531.3979	25608.
4532.3018	14212.
4532.6411	31447.
4539.0820	10133.
4539.5903	53150.
4541.5679	21697.
4547.4438	10492.
4555.9756	24708.
4556.2012	21629.
4557.6138	20806.
4559.0264	15263.
4560.0435	11147.
4560.4390	436155.
4561.5122	13839.
4565.0718	10561.
4565.7500	95498.
4566.4844	11535.
4569.1191	115275.
4570.4634	26047.
4570.9111	10868.
4571.0791	11939.
4571.5273	15014.
4575.3911	43909.
4577.1270	10190.
4578.1353	16137.
4578.5830	44875.
4579.8711	9487.
4583.8472	10674.
4587.7671	10929.
4590.5112	154902.
4592.4150	11981.
4593.7031	10051.
4595.8311	54655.
4597.5112	9621.
4603.3350	33584.
4606.7510	45161.
4607.3672	10503.
4609.5513	21292.

$\lambda(\text{\AA})$	I
4614.0537	20060.
4614.6685	15117.
4616.7368	34845.
4619.6436	18177.
4622.5503	21089.
4626.0161	9627.
4635.2397	29450.
4635.3516	27838.
4636.0225	14663.
4637.8672	9300.
4640.7739	43801.
4645.9165	20295.
4646.1401	15007.
4649.2148	33272.
4649.4941	35032.
4649.7178	29465.
4649.8857	24112.
4655.4756	9126.
4655.6992	8089.
4656.4258	18432.
4656.7056	30907.
4657.4321	10530.
4660.8682	13249.
4661.1465	13381.
4664.4888	47249.
4664.8228	33563.
4665.5469	14995.
4665.8252	12970.
4666.5493	11420.
4667.8862	22629.
4668.3320	22829.
4668.6660	31385.
4675.0161	12043.
4680.6416	16485.
4681.5327	13533.
4682.1455	8235.
4684.3179	10143.
4701.6406	25227.

$\lambda(\text{\AA})$	I
4701.0503	14771.
4702.6553	6377.
4705.4785	4511.
4706.6963	5641.
4707.1387	5228.
4708.6885	4313.
4709.2974	7454.
4709.5742	5826.
4709.8511	4944.
4710.0723	4039.
4710.2383	4554.
4711.8438	4122.
4714.5005	4600.
4717.1572	25337.
4717.4341	6092.
4717.6553	6033.
4718.8179	7184.
4721.4189	4815.
4722.0835	4289.
4722.6367	11238.
4730.4966	7706.
4731.6035	5467.
4732.2676	5124.
4732.7661	5881.
4734.7583	7313.
4739.6846	4121.
4742.0093	13613.
4743.0610	4301.
4746.6914	5343.
4749.3335	39183.
4751.5908	90454.
4756.2148	6547.
4757.9766	8401.
4758.1968	4297.
4758.4170	5331.
4761.4448	4974.
4766.7295	7720.
4767.2251	3913.
4769.1519	3954.
4769.4819	4426.
4769.9775	4979.
4770.8032	4296.
4772.6748	10925.
4773.4458	8704.
4774.3262	5836.
4774.4365	6703.
4774.9868	33777.
4776.4731	9637.
4779.8315	5174.
4780.2720	3902.
4780.8774	10914.
4781.0977	4145.
4782.0884	7756.
4788.8047	3894.
4789.5200	4342.

$\lambda(\text{\AA})$	I
4792.2349	11645.
4793.9321	4022.
4795.4106	8705.
4796.5605	4155.
4796.9438	5250.
4797.2173	4169.
4797.4365	4002.
4800.7212	3942.
4801.2139	39132.
4801.5972	4159.
4801.9805	7018.
4802.7471	5773.
4804.8823	4895.
4805.3203	4001.
4810.3574	4207.
4810.6860	9028.
4812.1094	10621.
4816.2705	7074.
4818.1865	4337.
4820.1577	4204.
4820.6504	23358.
4822.5117	3560.
4823.7710	5205.
4824.8115	3665.
4833.2427	3955.
4834.2285	3525.
4834.9946	4181.
4836.1934	9694.
4840.3862	20240.
4840.9307	6927.
4842.7817	4500.
4843.0542	6578.
4843.2720	6288.
4843.4351	7729.
4848.6079	5934.
4849.1523	6808.
4851.5483	22076.
4851.6572	18971.
4855.5229	8094.
4857.2109	6674.
4860.0425	6814.
4860.3691	8882.
4860.5327	8108.
4860.8047	11932.
4861.3491	17695.
4861.8394	19243.
4865.1064	19664.
4865.3242	4126.
4866.2500	4569.
4867.0122	7294.
4868.2100	4249.
4869.6802	4463.
4869.9526	7744.
4873.8730	4168.
4878.3921	45658.

$\lambda(\text{\AA})$	I
4883.0640	5345.
4884.2012	10501.
4891.7822	6576.
4898.7134	39892.
4901.1499	5761.
4901.7998	4084.
4901.9624	3832.
4902.2329	4246.
4903.9658	4142.
4906.2402	4419.
4912.3047	3748.
4914.8501	6331.
4915.3916	5996.
4918.3799	8175.
4921.1104	5160.
4922.6699	6503.
4923.1602	25704.
4924.6304	11745.
4925.4199	9846.
4924.2676	7004.
4925.0210	6856.
4928.0337	4299.
4933.4136	3461.
4934.7588	6136.
4937.8252	5430.
4938.8472	10077.
4939.6543	4543.
4940.0308	5216.
4940.1924	5094.
4941.4297	4355.
4949.1768	3288.
4949.6611	9679.
4950.6836	8066.
4953.2656	3662.
4954.1265	5238.
4955.2026	4375.
4956.6553	3763.
4957.8926	3404.
4958.2153	5443.
4960.3135	5815.
4964.5640	3504.
4966.7158	17398.
4966.9849	18805.
4967.5767	4268.
4969.0293	8840.

$\lambda(\text{\AA})$	I
4977.9292	2971.
4978.0898	3009.
4978.6245	4896.
4981.0854	4369.
4981.6206	12779.
4986.0078	11554.
4988.7363	3761.
4991.6787	3116.
4992.4277	4717.
4992.9629	5887.
4993.6582	2932.
4995.7983	3579.
4997.9380	3591.
4998.0986	3491.
4999.0083	3068.
5000.5596	11618.
5002.9136	4204.
5003.6626	7752.
5004.7861	3259.
5005.1069	2842.
5006.9795	5464.
5010.0293	5024.
5012.0088	2885.
5013.7744	6247.
5013.9883	2949.
5014.5767	3661.
5014.9512	3477.
5015.8174	11407.
5024.2764	7695.
5024.3828	9625.
5024.4888	8135.
5024.6484	10911.
5024.8081	4325.
5026.0850	3457.
5026.2979	3479.
5026.5107	4912.
5030.6602	5051.
5031.5112	10633.
5032.0435	13625.
5036.4590	3479.
5039.1191	3438.
5039.7573	3804.
5040.0767	4125.
5040.2896	4136.
5040.8745	3791.
5041.7788	3424.
5043.8008	8065.
5043.9072	9925.
5044.0664	5271.
5044.2793	7172.
5046.8330	3447.
5048.6948	4560.
5054.4937	8142.
5054.6001	8174.
5055.5044	4224.

$\lambda(\text{\AA})$	I
5070.0654	3159.
5072.6553	3600.
5075.9321	13750.
5076.0903	11481.
5081.8511	3215.
5082.0098	3188.
5082.4326	3567.
5084.4409	5830.
5087.5059	5562.
5087.6118	6199.
5088.1401	3475.
5088.9331	3158.
5091.0469	6461.
5091.2583	4783.
5091.8926	4998.
5092.1567	4526.
5093.8481	3565.
5096.1206	5588.
5096.8604	7184.
5098.1289	3436.
5098.4458	3533.
5098.6045	3912.
5099.8203	6371.
5102.5684	4437.
5104.4180	5332.
5104.6821	3255.
5105.7920	3190.
5105.9507	5722.
5105.3008	3748.
5105.8789	4516.
5112.7632	3795.
5117.0195	4191.
5120.1201	8050.
5120.3301	8730.
5120.4878	7864.
5125.4277	7192.
5130.2622	5478.
5131.6284	3656.
5133.8882	12031.
5138.5127	5457.
5139.1958	3698.
5139.3535	4134.
5140.0889	55191.
5140.2993	49518.
5142.5063	3518.
5144.3457	4003.
5145.3965	9152.
5145.6069	8709.
5145.7646	10347.
5148.9702	3669.
5149.3906	4044.
5150.1260	4779.

$\lambda(\text{\AA})$	I
5150.4648	3509.
5154.3799	4082.
5154.5884	3715.
5160.4873	9440.
5161.4268	3522.
5162.1577	5220.
5162.4185	3408.
5167.0645	3542.
5167.2212	3162.
5168.3174	3058.
5172.9106	14641.
5174.2158	3651.
5175.7295	13429.
5175.8340	16066.
5175.9907	15330.
5176.3560	3455.
5178.0786	22301.
5178.2354	25262.
5178.3394	22937.
5178.4438	20277.
5184.1338	3245.
5188.0488	4812.
5191.5986	4817.
5195.1479	10523.
5194.8652	6788.
5200.2627	14945.
5200.5225	16832.
5201.7158	13278.
5201.9233	4450.
5209.2412	4152.
5216.4038	2886.
5218.7393	3199.
5219.6216	5544.
5221.5938	4036.
5222.0605	5363.
5222.2163	6119.
5222.4761	7105.
5222.6836	7741.
5223.8252	6499.
5227.5620	3333.
5228.1328	4299.
5229.3784	2858.
5232.4409	10734.
5232.7002	2927.
5232.8560	3019.
5233.2710	4917.
5234.2056	3289.
5235.8662	7972.
5236.0737	6173.
5238.2017	27540.
5238.4092	23570.
5238.8242	4732.

$\lambda(\text{\AA})$	I
5242.7646	3098.
5248.6416	4365.
5253.1777	2675.
5256.0132	2131.
5258.0234	3835.
5260.7041	2164.
5260.9106	2706.
5265.2407	3575.
5269.0039	2915.
5272.3545	5449.
5273.3857	4052.
5276.1177	2441.
5276.6333	2357.
5276.9424	2573.
5277.3032	3915.
5279.4683	2748.
5281.8398	2363.
5283.9019	5473.
5284.0566	6044.
5284.2627	5303.
5284.7266	2216.
5284.9326	2438.
5285.1904	2771.
5286.1875	2621.
5288.3916	19479.
5290.9028	20982.
5291.0054	20868.
5295.9253	2502.
5296.8477	5490.
5298.0776	16014.
5298.2314	13375.
5298.3340	12263.
5301.9727	2685.
5302.7925	5834.
5303.3052	2841.
5308.5327	2933.
5308.7891	4111.
5308.9941	4746.
5309.1987	6821.
5310.5313	2430.
5311.3516	2665.
5314.0679	2743.
5314.2217	2603.
5314.4775	2451.
5327.7002	4701.
5328.4688	2639.

$\lambda(\text{\AA})$	I
5330.3062	2050.
5331.0698	3613.
5331.2222	1926.
5331.4258	1929.
5332.2915	2120.
5340.0791	1994.
5340.4863	5022.
5343.3877	2646.
5343.5400	3823.
5346.2886	2651.
5346.4922	2616.
5346.6450	2131.
5346.7979	2132.
5350.5137	2443.
5350.8696	6653.
5352.2949	2428.
5357.5884	1984.
5358.4028	1988.
5359.8789	2267.
5360.1846	1959.
5361.5078	2269.
5365.1216	3158.
5367.7178	1914.
5368.4810	8098.
5373.1133	1930.
5373.4185	1955.
5373.6221	2360.
5380.8760	27650.
5380.9771	36150.
5381.0781	44438.
5381.9375	6719.
5386.6895	15326.
5391.6431	4185.
5396.2432	29870.
5401.8545	3046.
5402.1069	3126.
5402.4102	3417.
5405.6963	3011.
5405.9487	3746.
5407.0103	24324.
5407.7183	4613.
5408.9312	8971.
5411.3579	3440.
5417.1709	7175.
5417.5249	3246.
5417.8281	4640.
5418.0303	6337.
5418.2324	6488.
5418.4854	4832.
5418.7383	3026.
5419.0415	3272.

$\lambda(\text{\AA})$	I
5418.1958	3548.
5418.4468	2651.
5423.5220	2395.
5423.7734	2698.
5426.8389	2419.
5427.1401	2523.
5430.8589	4100.
5435.2305	5610.
5436.1851	2766.
5441.9639	4787.
5443.0190	2383.
5443.2202	2626.
5443.4712	3085.
5445.3306	2885.
5446.6372	2489.
5447.5415	2574.
5452.2148	3262.
5452.5166	4313.
5452.9687	4748.
5453.2197	6297.
5460.6567	8643.
5461.1592	2368.
5461.7124	3602.
5461.9634	2970.
5468.9287	1961.
5471.6235	1542.
5472.5215	2165.
5473.3701	1808.
5475.5654	1601.
5477.1621	1616.
5481.1543	1628.
5481.5034	2231.
5484.9468	2143.
5487.1924	1556.
5488.7393	1535.
5490.4355	3849.
5491.0845	3321.
5491.9824	1517.
5492.1323	1601.
5492.3320	2272.
5494.4277	1631.
5496.0742	8049.
5497.7212	1718.
5499.2183	1503.
5502.2119	2108.
5502.5117	2831.
5502.9106	10343.
5505.5054	2836.
5505.7549	1743.
5506.4536	2596.
5508.2500	2528.

$\lambda(\text{\AA})$	I
5520.3569	2434.
5520.5054	2993.
5520.7036	2883.
5521.0010	2544.
5521.8433	1652.
5523.9741	1171.
5524.7671	1166.
5525.1138	3393.
5526.7983	1446.
5530.4155	1155.
5530.9111	1479.
5533.4380	1323.
5533.7354	1182.
5533.9834	1565.
5535.4697	1231.
5536.4111	1553.
5536.6094	1403.
5536.9067	4435.
5537.4023	3839.
5538.8389	2294.
5539.7310	11969.
5540.5732	1789.
5540.8213	1235.
5544.1904	1952.
5545.1816	1194.
5548.4517	5223.
5549.4922	23627.
5552.6138	1993.
5556.0850	2483.
5558.2969	4583.
5558.6406	5360.
5559.6240	3455.
5560.1152	1757.
5564.5879	10270.
5566.6523	2547.
5568.5693	5411.
5568.7168	7771.
5568.9131	10378.
5569.1592	11622.
5569.4048	10156.
5572.5010	2702.
5573.8774	1969.
5577.4653	2605.
5582.5771	10460.
5583.2651	2015.
5584.2480	10719.
5586.4106	15581.
5589.8018	1802.
5589.9492	1710.
5590.0967	2165.
5594.0288	6458.
5594.2256	2008.
5596.4863	2589.
5597.7642	2682.

$\lambda(\text{\AA})$	I
5598.9878	1087.
5599.2319	1046.
5599.3784	1097.
5606.2661	1029.
5606.7061	14123.
5610.2231	2073.
5615.8896	1016.
5616.0850	3287.
5617.1108	1231.
5618.1367	1341.
5619.5049	1265.
5622.5820	1193.
5622.8755	1256.
5623.0708	1529.
5628.1514	1174.
5630.2515	2255.
5632.4009	5934.
5632.4990	6179.
5632.6943	8873.
5632.8896	11342.
5635.8208	1015.
5636.8467	1100.
5644.0913	1014.
5646.0313	1622.
5648.8442	1559.
5650.1055	1192.
5650.7842	7092.
5656.9922	1770.
5657.2349	1540.
5657.3804	1507.
5658.1562	966.
5659.2720	1740.
5660.7271	974.
5670.3784	1029.
5670.5723	960.
5672.5122	2478.
5672.7549	2593.
5673.0459	2784.
5673.3853	3796.
5676.4893	2058.
5682.0669	9576.

$\lambda(\text{\AA})$	I
5689.8008	1657.
5690.5229	874.
5695.9644	961.
5700.2495	822.
5700.5386	1393.
5700.7310	857.
5700.9233	1078.
5706.0757	2116.
5709.2534	988.
5710.3608	1059.
5712.2871	832.
5712.8164	922.
5713.8276	4706.
5714.4536	983.
5714.9351	1033.
5715.2241	888.
5718.6909	1948.
5722.6392	849.
5728.3691	920.
5738.5815	1147.
5739.7275	5820.
5740.3960	1884.
5744.4072	1413.
5744.6460	1224.
5744.8369	1129.
5744.9800	1025.
5745.1235	966.
5745.4575	1028.
5745.6963	974.
5754.6255	1146.
5757.1562	1402.
5757.5386	1124.
5758.7319	1450.
5772.5317	2242.
5776.0654	2440.

$\lambda(\text{\AA})$	I
5781.2573	2299.
5783.6177	1013.
5785.4233	1933.
5786.8589	4177.
5790.1035	1226.
5790.4282	1725.
5790.6602	2319.
5793.6294	1258.
5796.3691	1039.
5801.9014	1972.
5803.6694	1787.
5806.8359	1622.
5808.8398	1321.
5808.9795	1410.
5809.1660	1544.
5809.3994	1832.
5818.3145	2447.
5818.7354	1173.
5819.0156	1075.
5819.2026	2018.
5821.6812	1036.
5821.8682	1186.
5825.1177	666.
5825.5879	2895.
5827.4209	1381.
5829.3008	662.
5833.2490	794.
5834.2827	3387.
5836.7739	891.
5838.9829	2117.
5840.2520	747.
5840.9097	667.
5842.3198	4866.
5844.9990	708.
5845.4688	869.
5845.6567	794.
5847.6309	1418.
5848.0537	1082.
5848.3359	1463.
5852.8008	721.
5856.9370	784.
5857.8301	1591.
5860.5088	2132.
5864.3628	623.
5866.5718	2154.

$\lambda(\text{\AA})$	I
5869.4380	1264.
5875.8691	1144.
5877.9658	1330.
5882.5796	3303.
5883.3252	956.
5883.4648	1034.
5888.6372	9663.
5890.4082	1173.
5897.7710	1081.
5898.0972	1158.
5900.2876	2334.
5903.5493	989.
5904.6680	1532.
5908.6289	1130.
5910.3530	1060.
5912.4033	6999.
5912.2041	3061.
5916.5005	852.
5918.3486	1141.
5922.7837	1558.
5923.0610	882.
5925.6021	1068.
5927.2651	991.
5929.0205	4639.
5934.9341	960.
5936.3667	1305.
5941.0327	1294.
5942.1875	964.
5942.9731	1920.
5945.1445	3187.
5947.6392	959.
5948.1938	4991.
5952.7212	1361.

$\lambda(\text{\AA})$	I
5964.6841	1059.
5967.0200	1230.
5967.2490	1317.
5967.5239	1271.
5967.7988	1357.
5968.1650	1937.
5968.5313	2070.
5971.7373	1963.
5973.8442	1602.
5975.9966	1114.
5976.3174	1156.
5987.4927	3017.
5988.4546	1016.
5988.6377	1089.
5991.3398	1399.
5996.4692	1855.
5999.2632	1898.
5984.6606	1119.
5987.3965	4110.
5988.3545	1367.
5989.0381	1032.
5990.8623	1367.
5991.1357	1981.
5996.2886	2638.
5999.0249	2522.
6002.3081	1155.
6002.9009	1109.
6003.2656	1298.
6005.2720	1482.
6006.0015	2059.
6013.0239	1907.
6013.9814	1899.
6019.0889	1065.
6019.2710	1019.
6021.9614	2191.

$\lambda(\text{\AA})$	I
6022.8857	2265.
6023.2031	1687.
6023.4297	1407.
6023.6108	1145.
6025.1509	4375.
6032.1270	49236.
6041.3682	1280.
6043.3613	20067.
6046.6685	1480.
6051.6060	1265.
6051.7871	1662.
6052.0137	1494.
6052.3311	1646.
6052.6479	2153.
6052.9199	3965.
6056.5894	2219.
6056.0020	1267.
6056.3618	2024.
6059.3735	7345.
6064.9023	1739.
6074.2520	2313.
6076.8140	1301.
6077.3984	1990.
6082.4775	1052.
6082.7021	1450.
6082.9722	1605.
6083.3315	1647.
6091.1528	1901.

$\lambda(\text{\AA})$	I
6090.7837	1862.
6098.8564	3127.
6101.2202	1440.
6102.3350	5464.
6104.2974	1187.
6104.6543	1654.
6105.6802	7571.
6106.4829	1065.
6106.7505	1051.
6107.5532	1134.
6111.3442	7231.
6112.9946	1800.
6113.6187	1125.
6120.5767	2155.
6123.2969	1066.
6123.6538	1134.
6123.7876	1372.
6123.9214	1162.
6124.2783	1212.
6124.9028	1228.
6127.4790	1089.
6128.8066	1034.
6129.1162	1407.
6132.5679	1344.
6139.0728	1189.
6139.3823	1387.
6145.6216	6363.
6155.5337	2157.
6156.2417	3312.
6157.0381	5070.
6158.4985	7056.

$\lambda(\text{\AA})$	I
6163.5278	1227.
6163.6592	1120.
6165.0640	1283.
6167.5664	1248.
6170.1567	4265.
6172.2637	1099.
6172.6587	1202.
6173.0981	5374.
6191.0967	1214.
6191.5361	1265.
6194.2578	1136.
6194.7847	2337.
6194.9600	1114.
6206.5542	982.
6207.2075	844.
6211.7363	930.
6212.4331	5072.
6213.8271	1025.
6214.0884	1029.
6215.8735	4385.
6218.9658	1070.
6222.6675	957.
6226.1953	888.

$\lambda(\text{\AA})$	I
6231.2085	845.
6232.2437	1072.
6236.3433	862.
6236.6885	852.
6238.4575	1695.
6243.7217	738.
6244.0669	751.
6248.6841	1202.
6249.4175	1447.
6257.3574	1976.
6263.4414	827.
6263.8296	733.
6264.0884	727.
6269.9971	915.
6273.0889	1006.
6273.3008	866.
6275.9687	1992.
6276.5615	1234.
6279.3564	856.
6286.3867	1339.
6288.8008	1984.
6290.5371	955.
6297.1436	5615.

$\lambda(\text{\AA})$	I
6307.6597	7567.
6309.0591	1332.
6309.5254	911.
6313.2988	1098.
6314.0195	813.
6316.4790	1301.
6316.9878	1372.
6317.4116	801.
6317.6660	956.
6317.8779	940.
6321.0581	1275.
6323.2632	796.
6329.6230	782.
6329.9624	1256.
6333.9902	873.
6334.4565	916.
6334.9653	848.
6334.1304	967.
6334.6343	937.
6337.4482	1641.
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6364.8320	1645.
6369.5781	3337.

$\lambda(\text{\AA})$	I
6375.9014	869.
6377.0654	1029.
6384.6782	5472.
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6408.0161	574.
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6423.4023	740.
6424.3931	974.
6424.6812	1178.
6424.9697	1126.
6430.1680	807.
6431.6934	1384.
6433.3022	646.

$\lambda(\text{\AA})$	I
6440.1270	567.
6440.4141	792.
6444.3857	977.
6449.7505	507.
6449.9146	580.
6453.6001	1092.
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6466.7036	956.
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6499.6392	416.
6500.0439	467.
6507.6270	397.
6509.2896	548.

$\lambda(\text{\AA})$	I
6508.8477	445.
6513.7925	497.
6515.7222	405.
6515.9634	394.
6517.4102	462.
6520.7471	402.
6521.2695	1697.
6530.3145	564.
6531.5210	453.
6538.1138	2361.
6540.2036	441.
6538.0737	2425.
6558.9019	1048.
6559.8989	1123.
6562.8521	226941.
6566.0840	1211.
6568.7173	1019.

$\lambda(\text{\AA})$	I
6569.3384	381.
6569.4966	370.
6570.8804	407.
6571.4731	367.
6572.0669	385.
6585.0000	370.
6590.2202	410.
6592.0005	633.
6593.9775	525.
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6596.3105	500.
6598.8174	572.
6602.6191	459.
6604.8936	4360.
6605.7168	467.
6606.1475	508.
6612.9292	959.
6618.8877	635.
6626.9233	702.

$\lambda(\text{\AA})$	I
6632.3159	545.
6637.3213	1109.
6637.5933	881.
6638.3301	467.
6638.6401	462.
6638.7959	505.
6646.3228	530.
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6649.3101	612.
6651.2114	472.
6653.3848	481.
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6658.0796	478.
6658.2729	544.
6660.7090	2199.
6661.1318	541.
6664.0542	2413.
6669.4756	1060.
6677.2813	9716.
6678.7808	506.
6678.9346	538.
6684.9321	654.
6686.2017	583.

$\lambda(\text{\AA})$	I
6689.3438	1369.
6690.7148	1927.
6694.2202	2466.
6699.0977	1066.
6699.8213	1082.
6704.5073	806.
6710.0698	580.
6711.2896	617.
6715.2139	632.
6719.4971	1576.
6721.0444	2244.
6730.3311	1243.
6738.8252	777.
6739.0894	733.
6746.8276	611.
6747.9980	611.

$\lambda(\text{\AA})$	I
6749.6182	1963.
6752.8345	11589.
6756.2007	1781.
6766.6729	1322.
6782.2227	3149.
6787.0688	1937.
6790.5845	1414.
6791.8057	2440.
6794.8765	1075.
6796.2085	1361.
6797.9102	1021.
6806.1240	906.

$\lambda(\text{\AA})$	I
6810.3433	2050.
6817.9561	1814.
6827.3262	1358.
6842.9810	872.
6852.4653	1429.
6857.9316	1352.
6864.3760	1647.
6867.9951	12714.

$\lambda(\text{\AA})$	I
6867.7461	9593.
6868.1035	7566.
6869.3896	6052.
6871.3257	7891.
6879.5952	1005.
6887.1489	1118.
6888.2231	1620.
6895.8481	1321.
6887.1030	518.
6888.1699	932.
6895.7065	657.
6900.6479	988.
6908.3267	843.
6912.9482	986.

$\lambda(\text{\AA})$	I
6917.2793	428.
6921.0396	590.
6922.2002	566.
6927.5776	738.
6930.4253	710.
6932.5342	937.
6937.6655	3526.
6941.1460	925.
6941.6382	821.
6942.0244	724.
6944.5557	1252.
6944.9067	1480.
6946.9453	791.
6951.5850	771.
6952.9028	792.
6956.0952	954.
6960.3286	817.
6965.4644	205742.
6972.3350	1636.
6972.5088	1842.

$\lambda(\text{\AA})$	I
6980.5142	305.
6980.7197	370.
6980.9941	438.
6981.3721	494.
6981.7827	655.
6982.7095	313.
6984.4590	303.
6990.5298	480.
6991.6963	329.
6991.9355	366.
6992.5190	450.
6995.1943	667.
7000.3735	336.
7000.6143	302.
7002.5688	747.
7003.0835	331.
7003.3574	351.
7003.7012	361.
7004.0435	344.
7004.5239	344.
7006.0337	307.
7006.5479	447.
7006.7192	564.
7006.8906	765.

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