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Second spectrum of chromium (Cr II), Part III: Radiative lifetimes and transition probabilities from highly excited $3d^45s$ levels

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In this study we have extended our previous investigations of Cr II spectrum to levels of the $3d^45s$ configuration. Once again an overall good agreement is observed for these levels between experimental oscillator strength values and our calculated data using two different approaches, namely the oscillator strength parameterization and the HFR+CPOL methods. Recurring to the latter model we have computed radiative lifetime values for 20 $3d^45s$ levels, confirming the well founded basis of recent experimental data, given in literature. From the use of the former method and with the help of a least squares fitting procedure to available experimental gf-values we have taken advantage of extracting for the first time the transition radial integral value for $3d^44p-3d^45s$, $\langle 4p|r^1|5s\rangle = 1.962\pm0.005$, which is confirmed favorably by *ab initio* results, obtained by the HFR method scaled by a factor 0.92 or directly by the HFR+CPOL approach. Finally a long list of semi-empirical oscillator strength, transition probability and branching fraction values is generated for around 500 Cr II transitions depopulating the $3d^45s$ levels. Our new gf data are compared successfully with those given by Kurucz.

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Contents

1. Introduction

For many years we have performed atomic structure calculations in order to provide astrophysicists with new or improved radiative data in different ions. Such data play a key role in the investigation and the interpretation of the observed spectra produced by any type of celestial objects. This spectroscopic analysis, with the help of reliable radiative parameters, can be used to derive many properties of distant stars and galaxies, such as their chemical composition, temperature, density, mass, distance and luminosity, for example. Previously we have successfully studied the electronic structure of many different complex atomic systems. The present work is devoted to the calculation of oscillator strengths and transition probabilities in singly ionized chromium, paying a particular attention to transitions depopulating highly excited $3d^45s$ levels. This paper is the third part of a detailed and systematic analysis of the Cr II spectrum. As a reminder, in the first part [1] we have studied the fine structure in order to obtain level eigenvector to transform into actual intermediate coupling the transition matrix beforehand obtained in pure LS coupling with help of Racah algebra while, in the second part [2], our efforts were mainly focused on radiative transitions depopulating low-lying $3d^44p$ levels. For Cr II the most recent compilation of energy levels is due to Sugar & Corliss [3], based on the analysis of Kiess [4] who succeeded in classifying 1843 lines linking 138 even-parity levels of $3d^5$, $3d^44s$ and $3d^34s^2$ configurations to 139 $3d^44p$ odd-parity levels. Johansson [5] extended the Kiess study, particularly in near-infrared region and analyzed 450 additional levels. Sansonetti et al. [6–8] reported in turn new observations of Cr II some years later, in the near-ultraviolet region 1140–3400 Å, and also up to the infrared region: 2850–37 900 Å, using 10.7 m normal incidence vacuum spectrograph and FT700 vacuum ultraviolet Fourier transform spectrometer. In our recent study of the fine structure in Cr II [1], we notably revised the assignments of some levels wrongly classified in earlier lists of energy levels. We also shifted the positions of some quartets like $3d^45d\ ^4F_J$ for instance and we predicted the positions of still missing levels. Nevertheless we have to point out that $3d^45s$ levels were correctly assigned in previous studies and we have not changed any label of these levels. To compute oscillator strength values we used two different approaches, namely the HFR+CPOL model [9,10] and oscillator strength parameterization (OSP) method [11,12]. For the latter we need experimental data since transition radial integrals are treated as free parameters in the least squares fit to experimental gf values. Here we take advantage of the experimental work of a Swedish team from Lund University [13] which reported lifetime measurements of five $3d^45s\ ^6D$ levels at energy around 83 000 cm^{-1} and log gf values for 38 transitions from these levels. The lifetimes were obtained using time-resolved laser-induced fluorescence and gf-values were deduced by combining the experimental lifetimes with relative intensities, i.e. branching fractions.

2. Oscillator strength determination

The reader is invited to read one of our previous papers, for instance [2,14,15], in which the formulas and the approaches we have used to achieve our calculations are presented in detail. Usually before performing OSP calculations, we first have to select the strongest lines, not blended, and preferably those corresponding to transitions between levels with a limited number of leading components. In the present work we have not selected beforehand some lines but we have considered the complete set of experimental gf-values for the thirty eight transitions involving $3d^45s$ levels listed in [13]. The compositions of the eigenvectors obtained in the present work for these levels are displayed in Table 1. For odd-parity levels the compositions were already given in our previous paper [1]. When comparing our fitted data to the experimental oscillator strengths, a very satisfactory agreement is observed on the whole except for the lines whose wavelengths are: λ_{air} = 2787.914, 2899.195, 2945.277, 2967.410, 3013.455 and 3194.200 Å. Moreover, our OSP results are in close agreement with those obtained using our HFR+CPOL model, as described in [2], and with those reported by Kurucz [16]. Such comparisons can be found in Table 2. So we suggest that the experimental gf values of lines whose wavelengths are here above mentioned should be re-examined. From our semi-empirical fitting process, we have extracted the main transition radial integral value with a very good accuracy: $\langle 4p|r^1|5s\rangle = 1.962 \pm 0.005$, which corresponds to the HFR+CPOL value (1.969) or the HFR value computed by classical Cowan code [17], i.e. 2.139, scaled by a factor 0.92. This confirms the trends we already highlighted in [15] for several singly ionized ions.

3. Lifetime considerations

Some years ago Engman et al. [18] and Pinnington et al. [19] have used the beam-foil technique to measure radiative lifetimes of low-lying levels of Cr II $3d^4(^5D)4p$ configuration. Later Schade et al. [20], Pinnington et al. [21], Bergeson and Lawler [22] and Nilsson et al. [23] have extended these experimental data using time-resolved laser-induced fluorescence method (TR-LIF) on ions produced in a fast ion beam in a hollow cathode from laser-procured plasma but unfortunately for levels belonging to the same $3d^44p$ configuration. It is only in 2014 that Engström et al. [13] have reported for the first time lifetime measurements of five levels in the $3d^45s$ configuration, all of them belonging to the same ^6D multiplet located around 83 000 cm^{-1}. These data are gathered in Table 3 and compared to HFR+CPOL radiative lifetimes. We could expect some discrepancies between our calculated data and those given in [13] since we have observed for few transitions some divergences between our calculated gf and those given in [13] which were extracted from a combination of lifetimes and branching fractions. As seen from Table 3 a good agreement is observed, the mean ratio $\tau_{exp}/\tau_{HFR+CPOL}$ being found equal to 0.91. We can then conclude that the discrepancies mentioned in Section II for some gf-values are rather due to branching fractions; Engström et al. have corrected the effects of missing branches on their measurements using the unpublished theoretical values computed by Raassen & Uylings reported in their paper [13].

4. Transition probabilities and branching fractions

Finally, in Table 4, we give the oscillator strengths, transition probabilities and branching fractions computed in the present work using the HFR+CPOL method for about 500 Cr II spectral lines involving available experimental energy levels with calculated log gf values greater than −4. This table covers a wide range of wavelengths, from 1750 to 8700 Å for $3d^44p - 3d^45s$ transitions. We have taken this opportunity to compare our semi-empirical data with those given by Kurucz [16]. We note a good agreement between these different sets of results. To derive branching fraction values we have taken experimental lifetime values for levels whose energies are: 82 692, 82 763, 82 881, 83 041 and 83 240 cm^{-1}. Unfortunately for the other $3d^45s$ levels no experimental lifetime values are available in literature and then we have replaced these missing values by those computed by means of HFR+CPOL model (see Table 1).

5. Conclusion

After studying radiative parameters of low-lying Cr II $3d^44p$ levels [2], we have investigated those of higher excited $3d^45s$ levels with the same success. Using the oscillator strength parameterization method, we have fitted the computed gf-values to available experimental data, confirming in the whole their well founded basis. We have taken this opportunity to extract for the first time the $\langle 4p|r^1|5s\rangle$ transition radial integral value with a very good accuracy. Using the HFR+CPOL approach, we have calculated the radiative lifetimes of $3d^45s$ levels and compared them to the few available experimental ones. In addition, a list of oscillator strength, transition probability and branching fraction values of about 500 transitions involving $3d^45s$ levels was generated. These new computed radiative decay rates agree very well with those obtained by Kurucz [16], so supplying an even more solid basis to all the spectroscopic parameters determined until now in singly ionized chromium. These very encouraging results incite us to extend the present work to Cr II transitions involving $3d^44d$, $3d^4nf$ ($n = 4, 5$) and highly excited $3d^44p$ levels.

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Explanation of Tables

Table 1.	**Eigenvalue components of even-parity Cr II levels of interest in this study, more detailed than in our previous paper [1].**	
	Level:	Configuration to which belongs the even-parity level involved in the studied transitions and the designation of this level in LS coupling.
	J:	Total angular momentum.
	Energy:	Experimental energy level (cm^{-1}).
	$3d^5$:	Contribution in LS coupling of $3d^5$ configuration (in %) to the total composition of the level.
	$3d^44s$:	Contribution in LS coupling of $3d^44s$ configuration (in %) to the total composition of the level.
	$3d^44d$:	Contribution in LS coupling of $3d^44d$ configuration (in %) to the total composition of the level.
	$3d^45s$:	Contribution in LS coupling of $3d^45s$ configuration (in %) to the total composition of the level.
	$3d^46s$:	Contribution in LS coupling of $3d^46s$ configuration (in %) to the total composition of the level.
	$3d^45d$:	Contribution in LS coupling of $3d^45d$ configuration (in %) to the total composition of the level.
	$3d^46d$:	Contribution in LS coupling of $3d^46d$ configuration (in %) to the total composition of the level.
	Others:	Total contribution in LS coupling of other configurations (in %) to the total composition of the level.
Table 2.	**Comparison between experimental and calculated oscillator strength values**	
	λ_{air}:	Wavelength in the air of the spectral line (Å) deduced from observed energy levels taken from [13].
	Upper level:	Depopulated upper level [13] (cm^{-1}) in emission transition.
	J_U:	Total angular momentum of the upper level.
	Lower level:	Populated lower level [13] (cm^{-1}) in emission transition.
	J_L:	Total angular momentum of the lower level.
	gf_{exp}:	Measured weighted oscillator strength value taken from [13] (dimensionless).
	Δgf_{exp}:	Experimental uncertainty (%) for measured weighted oscillator strength value from [13].
	gf_{calc}:	OSP weighted oscillator strength obtained in this work with help of least squares fitting procedure to experimental gf [11] (dimensionless).
	$log(gf_{calc})$:	Weighted oscillator strength in logarithmic scale from this work (OSP)
Table 3.	**Comparison between HFR+CPOL radiative lifetimes (in ns) and available experimental data for low-lying $3d^45s$ energy levels of Cr II.**	
	Level:	Designation of the state in LSJ coupling within the configuration and where J represents the total angular momentum.
	Energy:	Observed (experimental) energy level value in cm^{-1} [13].
	τ_{Exp}:	Measured lifetimes (ns) obtained by TR-LIF technique [13].
	$\tau_{HFR+CPOL}$:	Computed lifetime (ns) using Hartree–Fock method with relativistic corrections (HFR) implemented in the code developed by Cowan [17] and including core polarization (CPOL).
Table 4.	**Semi-empirical radiative data in Cr II**	
	Wavelength:	Wavelength in Å of experimentally observed spectral lines.
	E(lower):	Energy in cm^{-1} of lower level of the transition.
	Parity (lower):	Parity of lower level of the transition. 'e' and 'o' stand respectively for even and odd.
	J(lower):	Total angular momentum of the lower level of the transition.
	E(upper):	Energy in cm^{-1} of upper level of the transition.
	Parity (upper):	Parity of upper level of the transition. 'e' and 'o' stand respectively for even and odd.
	J(upper):	Total angular momentum of the upper level of the transition.
	$log(gf)$(HFR+CPOL):	HFR+CPOL weighted oscillator strength in logarithmic scale.
	gA(HFR+CPOL):	HFR+CPOL weighted transition probability (s^{-1}).
	BF (HFR+CPOL):	HFR+CPOL branching fraction.
	$log(gf)$(Kurucz):	Weighted oscillator strength in the logarithmic scale from the Kurucz database [14].

Table 1
Eigenvalue components of even-parity Cr II levels of interest in this study, more detailed than in our previous paper [1].

Level	J	Energy (cm^{-1})	$3d^5$ (%)	$3d^44s$ (%)	$3d^44d$ (%)	$3d^45s$ (%)	$3d^46s$ (%)	$3d^45d$ (%)	$3d^46d$ (%)	Others (%)
e^6D	1/2	82692.011		0.03	0.09	99.76	0.08			0.02
e^6D	3/2	82763.665		0.03	0.09	99.76	0.08			0.02
e^6D	5/2	82881.097		0.03	0.09	99.76	0.08			0.02
e^6D	7/2	83041.319		0.03	0.10	99.75	0.08			0.02
e^6D	9/2	83240.419		0.03	0.10	99.75	0.08			0.02
e^4D	1/2	84209.784	0.03	0.09	0.02	99.85				
e^4D	3/2	84320.138	0.03	0.09	0.02	99.85				
e^4D	5/2	84495.613	0.03	0.09	0.02	99.85				
e^4D	7/2	84726.677	0.03	0.09	0.02	99.85				
f^4P	1/2	99677.828	0.01			99.90	0.05			0.01
f^4P	3/2	100040.168	0.01			99.89	0.05			0.01
e^4H	7/2	100068.856			0.02	99.89	0.06			0.01
e^4H	9/2	100135.778			0.02	99.89	0.06			0.01
e^4H	11/2	100221.595			0.02	99.89	0.06			0.01
e^4H	13/2	100322.077			0.02	99.89	0.06			0.01
f^4P	5/2	100650.462	0.01			99.90	0.05			0.01
e^2P	1/2	100782.820	0.02	0.04	0.09	99.85				
f^4F	3/2	101245.003			0.05	99.86	0.05			0.01
f^4F	5/2	101276.5471			0.05	99.86	0.05			0.01
f^4F	7/2	101321.812			0.05	99.86	0.05			0.01
e^2P	3/2	101492.822	0.02	0.04	0.10	99.83				
g^2G	7/2	104543.110	0.03	0.03	3.04	96.83		0.07	0.01	
g^2G	9/2	104666.357	0.01	0.03	1.34	98.57		0.03		

Table 2
Comparison between experimental and calculated oscillator strength values.

λ_{air} (Å)	Upper level (cm^{-1})	J_U	Lower level (cm^{-1})	J_L	gf_{exp}	$log(gf_{exp})$	Δgf_{exp} (%)	gf_{calc}	$log(gf_{calc})$
2039.073	82763.664	3/2	48749.277	1/2	0.0590	-1.230	19	0.0454	-1.343
2787.123	82692.008	1/2	46823.305	1/2	0.2360	-0.627	15	0.2377	-0.624
2787.914	82763.664	3/2	46905.137	3/2	0.5020	-0.299	11	0.3496	-0.456
2789.292	82881.094	5/2	47040.273	5/2	0.3620	-0.441	12	0.4311	-0.365
2791.373	83041.320	7/2	47227.219	7/2	0.5260	-0.279	12	0.4278	-0.369
2793.497	82692.008	1/2	46905.137	3/2	0.2070	-0.684	17	0.1867	-0.729
2794.357	83240.422	9/2	47464.559	9/2	0.4500	-0.347	13	0.3001	-0.523
2798.461	82763.664	3/2	47040.273	5/2	0.2790	-0.554	11	0.4288	-0.368
2803.918	82881.094	5/2	47227.219	7/2	0.6930	-0.159	10	0.7640	-0.117
2809.996	83041.320	7/2	47464.559	9/2	0.9720	-0.012	9	1.2173	0.085
2816.959	83240.422	9/2	47751.602	11/2	1.3210	0.121	9	1.8215	0.260
2888.628	83240.422	9/2	48632.059	7/2	1.1590	0.064	9	1.0098	0.004
2893.486	83041.320	7/2	48491.059	5/2	0.6190	-0.208	9	0.5436	-0.265
2899.191	82881.094	5/2	48398.871	3/2	0.5180	-0.286	10	0.2138	-0.670
2905.344	83041.320	7/2	48632.059	7/2	0.3210	-0.493	11	0.2510	-0.600
2906.967	82881.094	5/2	48491.059	5/2	0.3720	-0.429	10	0.3217	-0.492
2909.105	82763.664	3/2	48398.871	3/2	0.3420	-0.466	11	0.2574	-0.589
2915.182	82692.008	1/2	48398.871	3/2	0.2110	-0.676	12	0.1599	-0.796
2916.928	82763.664	3/2	48491.059	5/2	0.1100	-0.959	16	0.0926	-1.034
2939.073	82763.664	3/2	48749.277	1/2	0.0590	-1.230	19	0.0454	-1.343
2945.275	82692.008	1/2	48749.277	1/2	0.0510	-1.290	21	0.0131	-1.883
2951.144	82881.094	5/2	49005.848	3/2	0.0790	-1.102	17	0.0443	-1.353
2967.409	83041.320	7/2	49351.734	5/2	0.2680	-0.571	11	0.0775	-1.110
2967.728	82692.008	1/2	49005.848	3/2	0.0930	-1.032	13	0.0929	-1.032
2975.801	83240.422	9/2	49645.805	7/2	0.2840	-0.547	10	0.1868	-0.729
2981.590	82881.094	5/2	49351.734	5/2	0.1800	-0.745	11	0.0944	-1.025
2992.070	82763.664	3/2	49351.734	5/2	0.2930	-0.533	10	0.1661	-0.780
2992.956	83240.422	9/2	49838.379	9/2	1.5380	0.187	9	0.9442	-0.025
2993.541	83041.320	7/2	49645.805	7/2	0.5360	-0.271	9	0.4334	-0.363
2998.970	83041.320	7/2	49706.262	5/2	0.1850	-0.733	10	0.1861	-0.730
3000.630	82881.094	5/2	49564.504	3/2	0.3160	-0.500	10	0.2089	-0.680
3004.748	82763.664	3/2	49492.711	1/2	0.1630	-0.788	10	0.1394	-0.856
3007.973	82881.094	5/2	49645.805	7/2	0.2810	-0.551	10	0.3302	-0.481
3010.904	83041.320	7/2	49838.379	9/2	0.3300	-0.481	10	0.2402	-0.619
3011.237	82692.008	1/2	49492.711	1/2	0.0390	-1.409	18	0.0407	-1.391
3013.471	82881.094	5/2	49706.262	5/2	0.0316	-1.500	19	0.0944	-1.025
3017.780	82692.008	1/2	49564.504	3/2	0.1580	-0.801	12	0.1281	-0.893
3024.160	82763.664	3/2	49706.262	5/2	0.0600	-1.220	11	0.1505	-0.823
3194.194	83240.422	9/2	51942.664	9/2	0.0520	-1.284	21	0.0117	-1.933

Table 3
Comparison between HFR+CPOL radiative lifetimes (in ns) and available experimental data for low-lying $3d^45s$ energy levels of Cr II.

Level	Energy (cm^{-1})	τ_{Exp} (ns)	$\tau_{HFR+CPOL}$ (ns)
$e^6D_{1/2}$	82692.011	2.5±0.2	2.8
$e^6D_{3/2}$	82763.665	2.5±0.2	2.8
$e^6D_{5/2}$	82881.097	2.5±0.2	2.8
$e^6D_{7/2}$	83041.319	2.6±0.2	2.8
$e^6D_{9/2}$	83240.419	2.6±0.2	2.8
$e^4D_{1/2}$	84209.784		2.9
$e^4D_{3/2}$	84320.138		2.9
$e^4D_{5/2}$	84495.613		2.9
$e^4D_{7/2}$	84726.677		2.9
$f^4P_{1/2}$	99677.828		2.7
$f^4P_{3/2}$	100040.168		2.7
$e^4H_{7/2}$	100068.856		2.8
$f^4P_{5/2}$	100650.462		2.7
$f^2P_{1/2}$	100782.820		2.8
$f^4F_{3/2}$	101245.003		2.7
$f^4F_{5/2}$	101276.547		2.7
$f^4F_{7/2}$	101321.812		2.7
$e^2P_{3/2}$	101492.822		2.8
$g^2G_{7/2}$	104543.110		2.3
$g^2G_{9/2}$	104666.357		2.6

Table 4
Semi-empirical radiative data in Cr II.

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	log(gf)(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	log(gf) (Kurucz)
1788.363	48749	(o)	0.5	104666	(e)	0.5	-3.12	1.61E+06	2.09E−03	
1796.607	49006	(o)	1.5	104666	(e)	0.5	-3.67	4.48E+05	5.82E−04	
1812.460	49493	(o)	0.5	104666	(e)	0.5	-3.67	4.34E+05	5.64E−04	
1936.311	49006	(o)	1.5	100650	(e)	2.5	-2.70	3.52E+06	1.58E−03	-2.595
1949.366	49352	(o)	2.5	100650	(e)	2.5	-2.48	5.80E+06	2.61E−03	-2.252
1949.664	48749	(o)	0.5	100040	(e)	1.5	-2.68	3.65E+06	2.46E−03	-2.597
1957.485	49565	(o)	1.5	100650	(e)	2.5	-3.12	1.34E+06	6.03E−04	-2.964
1959.466	49006	(o)	1.5	100040	(e)	1.5	-3.24	9.98E+05	6.74E−04	-3.107
1962.932	49706	(o)	2.5	100650	(e)	2.5	-2.51	5.39E+06	2.43E−03	-2.492
1963.534	48749	(o)	0.5	99678	(e)	0.5	-3.34	7.96E+05	1.07E−03	-3.296
1972.837	49352	(o)	2.5	100040	(e)	1.5	-2.79	2.79E+06	1.88E−03	-2.619
1973.476	49006	(o)	1.5	99678	(e)	0.5	-2.68	3.58E+06	4.83E−03	-2.611
1978.339	49493	(o)	0.5	100040	(e)	1.5	-3.22	1.03E+06	6.95E−04	-3.003
1981.153	49565	(o)	1.5	100040	(e)	1.5	-3.64	3.86E+05	2.61E−04	-3.489
1986.732	49706	(o)	2.5	100040	(e)	1.5	-2.83	2.52E+06	1.70E−03	-2.778
1992.622	49493	(o)	0.5	99678	(e)	0.5	-3.88	2.23E+05	3.01E−04	-3.654
1995.476	49565	(o)	1.5	99678	(e)	0.5	-3.10	1.35E+06	1.82E−03	-2.912
2011.728	51584	(o)	1.5	101277	(e)	2.5	-3.21	1.03E+06	4.64E−04	-3.003
2013.006	51584	(o)	1.5	101245	(e)	1.5	-2.44	5.99E+06	4.04E−03	-2.262
2013.351	51669	(o)	2.5	101322	(e)	3.5	-3.13	1.22E+06	4.12E−04	-2.926
2015.188	51669	(o)	2.5	101277	(e)	2.5	-2.30	8.36E+06	3.76E−03	-2.129
2016.470	51669	(o)	2.5	101245	(e)	1.5	-3.11	1.28E+06	8.64E−04	-2.878
2020.051	51789	(o)	3.5	101277	(e)	2.5	-2.99	1.67E+06	7.52E−04	-2.751
2172.058	54626	(o)	2.5	100650	(e)	2.5	-3.24	8.18E+05	3.68E−04	-2.977
2179.581	54784	(o)	3.5	100650	(e)	2.5	-2.76	2.43E+06	1.09E−03	-2.422
2191.230	54418	(o)	0.5	100040	(e)	1.5	-3.89	1.78E+05	1.20E−04	-3.702
2195.153	54499	(o)	1.5	100040	(e)	1.5	-3.18	9.17E+05	6.19E−04	-2.935
2201.249	54626	(o)	2.5	100040	(e)	1.5	-3.07	1.17E+06	7.90E−04	-2.72
2208.773	54418	(o)	0.5	99678	(e)	0.5	-3.30	6.88E+05	9.29E−04	-3.053
2212.760	54499	(o)	1.5	99678	(e)	0.5	-3.46	4.77E+05	6.44E−04	-3.106
2446.365	63802	(o)	0.5	104666	(e)	0.5	-1.93	1.33E+07	1.73E−02	
2462.027	64062	(o)	1.5	104666	(e)	0.5	-2.00	1.12E+07	1.46E−02	
2493.364	64449	(o)	2.5	104543	(e)	3.5	-2.03	1.01E+07	2.90E−03	-2.181
2522.136	65029	(o)	0.5	104666	(e)	0.5	-0.85	1.48E+08	1.92E−01	
2602.718	66256	(o)	0.5	104666	(e)	0.5	-1.20	6.30E+07	8.19E−02	
2609.398	66355	(o)	1.5	104666	(e)	0.5	-2.60	2.51E+06	3.26E−03	
2629.622	66649	(o)	1.5	104666	(e)	0.5	-0.68	2.03E+08	2.64E−01	
2643.573	66727	(o)	2.5	104543	(e)	3.5	-2.30	4.83E+06	1.39E−03	-2.596
2645.099	66872	(o)	0.5	104666	(e)	0.5	-0.41	3.77E+08	4.90E−01	
2652.359	63802	(o)	0.5	101493	(e)	1.5	-3.60	2.37E+05	1.66E−04	-3.786
2653.442	63601	(o)	3.5	101277	(e)	2.5	-2.01	9.28E+06	4.18E−03	-2.214
2659.073	67070	(o)	1.5	104666	(e)	0.5	-3.61	2.35E+05	3.06E−04	
2663.669	67012	(o)	2.5	104543	(e)	3.5	-2.74	1.72E+06	4.95E−04	-2.408
2669.053	47040	(o)	2.5	84496	(e)	2.5	-3.35	4.21E+05	2.03E−04	-3.308
2669.914	63802	(o)	0.5	101245	(e)	1.5	-1.43	3.47E+07	2.34E−02	-1.6
2670.779	64062	(o)	1.5	101493	(e)	1.5	-2.83	1.40E+06	9.80E−04	-2.76
2671.930	46905	(o)	1.5	84320	(e)	1.5	-3.85	1.32E+05	9.57E−05	-3.882
2679.835	46905	(o)	1.5	84210	(e)	0.5	-3.08	7.81E+05	1.13E−03	-2.896
2681.100	67379	(o)	1.5	104666	(e)	0.5	-1.45	3.32E+07	4.32E−02	
2681.617	47040	(o)	2.5	84320	(e)	1.5	-2.58	2.45E+06	1.78E−03	-2.417
2682.442	47227	(o)	3.5	84496	(e)	2.5	-2.31	4.53E+06	2.19E−03	-2.152
2686.301	64062	(o)	1.5	101277	(e)	2.5	-1.18	6.15E+07	2.77E−02	-1.317
2687.439	67344	(o)	2.5	104543	(e)	3.5	-1.95	1.04E+07	2.99E−03	-2.09
2688.580	64062	(o)	1.5	101245	(e)	1.5	-1.84	1.34E+07	9.05E−03	-2.02
2690.555	67387	(o)	2.5	104543	(e)	3.5	-3.87	1.24E+05	3.57E−05	-3.369
2698.687	64449	(o)	2.5	101493	(e)	1.5	-1.83	1.37E+07	9.59E−03	-1.71
2711.203	64449	(o)	2.5	101322	(e)	3.5	-0.93	1.09E+08	3.68E−02	-1.027
2714.536	64449	(o)	2.5	101277	(e)	2.5	-1.68	1.91E+07	8.60E−03	-1.841
2716.086	67860	(o)	0.5	104666	(e)	0.5	-2.79	1.47E+06	1.91E−03	
2716.863	64449	(o)	2.5	101245	(e)	1.5	-2.93	1.06E+06	7.16E−04	-3.118
2716.872	67870	(o)	1.5	104666	(e)	0.5	-3.81	1.41E+05	1.83E−04	
2722.421	64062	(o)	1.5	100783	(e)	0.5	-2.00	9.04E+06	1.27E−02	-1.923
2725.822	67868	(o)	2.5	104543	(e)	3.5	-1.47	3.02E+07	8.68E−03	-3.563
2732.270	64062	(o)	1.5	100650	(e)	2.5	-1.76	1.57E+07	7.07E−03	-1.659
2741.659	65029	(o)	0.5	101493	(e)	1.5	-1.07	7.62E+07	5.33E−02	-1.043

(continued on next page)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	$log(gf)$(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	$log(gf)$ (Kurucz)
2749.403	68306	(o)	1.5	104666	(e)	0.5	-3.19	5.76E+05	7.49E−04	
2750.061	64924	(o)	3.5	101277	(e)	2.5	-3.11	6.85E+05	3.08E−04	-3.287
2758.687	63802	(o)	0.5	100040	(e)	1.5	-1.45	3.12E+07	2.11E−02	-1.411
2760.420	65029	(o)	0.5	101245	(e)	1.5	-3.42	3.33E+05	2.25E−04	-3.849
2761.485	64449	(o)	2.5	100650	(e)	2.5	-0.74	1.61E+08	7.25E−02	-0.681
2764.263	65156	(o)	2.5	101322	(e)	3.5	-1.99	8.87E+06	2.99E−03	-1.879
2767.728	65156	(o)	2.5	101277	(e)	2.5	-0.84	1.26E+08	5.67E−02	-0.856
2769.515	48399	(o)	1.5	84496	(e)	2.5	-2.79	1.42E+06	6.86E−04	-2.044
2770.147	65156	(o)	2.5	101245	(e)	1.5	-0.27	4.66E+08	3.15E−01	-0.288
2775.440	65257	(o)	3.5	101277	(e)	2.5	-0.44	3.10E+08	1.40E−01	-0.389
2776.607	48491	(o)	2.5	84496	(e)	2.5	-3.05	7.86E+05	3.80E−04	-2.361
2776.878	47040	(o)	2.5	83041	(e)	3.5	-1.29	4.47E+07	1.12E−02	-1.257
2778.619	64062	(o)	1.5	100040	(e)	1.5	-0.59	2.26E+08	1.53E−01	-0.582
2778.814	46905	(o)	1.5	82881	(e)	2.5	-1.14	6.22E+07	2.07E−02	-1.132
2780.063	68583	(o)	2.5	104543	(e)	3.5	-0.21	5.28E+08	1.52E−01	-1.414
2781.566	46823	(o)	0.5	82764	(e)	1.5	-1.18	5.74E+07	2.87E−02	-1.182
2783.045	48399	(o)	1.5	84320	(e)	1.5	-3.00	8.75E+05	6.34E−04	-2.215
2786.549	63802	(o)	0.5	99678	(e)	0.5	-0.64	1.98E+08	2.67E−01	-0.669
2787.123	46823	(o)	0.5	82692	(e)	0.5	-0.63	2.00E+08	2.00E−01	-0.657
2787.914	46905	(o)	1.5	82764	(e)	1.5	-0.47	2.92E+08	1.46E−01	-0.486
2789.292	47040	(o)	2.5	82881	(e)	2.5	-0.38	3.57E+08	1.19E−01	-0.39
2790.206	48491	(o)	2.5	84320	(e)	1.5	-3.86	1.21E+05	8.77E−05	-3.194
2791.622	48399	(o)	1.5	84210	(e)	0.5	-3.76	1.52E+05	2.20E−04	-2.967
2793.497	46905	(o)	1.5	82692	(e)	0.5	-0.73	1.58E+08	1.58E−01	-0.769
2796.106	65029	(o)	0.5	100783	(e)	0.5	-0.84	1.25E+08	1.75E−01	-0.903
2797.658	65543	(o)	3.5	101277	(e)	2.5	-0.51	2.61E+08	1.17E−01	-0.649
2798.257	64924	(o)	3.5	100650	(e)	2.5	-0.02	8.15E+08	3.67E−01	-0.043
2798.461	47040	(o)	2.5	82764	(e)	1.5	-0.37	3.63E+08	1.82E−01	-0.409
2803.918	47227	(o)	3.5	82881	(e)	2.5	-0.12	6.43E+08	2.14E−01	-0.158
2806.887	64062	(o)	1.5	99678	(e)	0.5	-0.63	1.98E+08	2.67E−01	-0.698
2808.838	64449	(o)	2.5	100040	(e)	1.5	-0.25	4.76E+08	3.21E−01	-0.307
2810.462	48749	(o)	0.5	84320	(e)	1.5	-0.97	9.04E+07	6.55E−02	-1.006
2816.884	49006	(o)	1.5	84496	(e)	2.5	-0.61	2.06E+08	9.96E−02	-0.643
2819.209	48749	(o)	0.5	84210	(e)	0.5	-0.93	9.88E+07	1.43E−01	-0.96
2824.538	65257	(o)	3.5	100650	(e)	2.5	-3.53	2.44E+05	1.10E−04	
2830.569	69348	(o)	1.5	104666	(e)	0.5	-0.73	1.60E+08	2.08E−01	
2830.882	49006	(o)	1.5	84320	(e)	1.5	-0.83	1.24E+08	8.99E−02	-0.856
2837.142	66256	(o)	0.5	101493	(e)	1.5	-2.04	7.56E+06	5.29E−03	-1.814
2839.756	49006	(o)	1.5	84210	(e)	0.5	-1.61	2.02E+07	2.93E−02	-1.635
2844.609	49352	(o)	2.5	84496	(e)	2.5	-0.97	8.80E+07	4.25E−02	-0.917
2845.080	66355	(o)	1.5	101493	(e)	1.5	-3.59	2.15E+05	1.51E−04	-2.06
2847.553	65543	(o)	3.5	100650	(e)	2.5	-3.27	4.37E+05	1.97E−04	-3.612
2850.992	69478	(o)	2.5	104543	(e)	3.5	-1.74	1.49E+07	4.28E−03	-2.579
2854.041	69639	(o)	1.5	104666	(e)	0.5	-2.29	4.19E+06	5.45E−03	
2855.420	65029	(o)	0.5	100040	(e)	1.5	-1.37	3.47E+07	2.34E−02	-1.428
2858.885	49352	(o)	2.5	84320	(e)	1.5	-1.99	8.39E+06	6.08E−03	-1.889
2861.937	49565	(o)	1.5	84496	(e)	2.5	-0.98	8.45E+07	4.08E−02	-1.041
2862.701	66355	(o)	1.5	101277	(e)	2.5	-2.72	1.57E+06	7.07E−04	-3.097
2863.474	65156	(o)	2.5	100069	(e)	3.5	-1.24	4.56E+07	1.60E−02	-1.373
2868.614	49646	(o)	3.5	84496	(e)	2.5	-2.68	1.70E+06	8.22E−04	-2.738
2869.139	66649	(o)	1.5	101493	(e)	1.5	-0.84	1.16E+08	8.12E−02	-0.591
2870.458	49493	(o)	0.5	84320	(e)	1.5	-1.48	2.70E+07	1.96E−02	-1.486
2873.599	49706	(o)	2.5	84496	(e)	2.5	-1.17	5.52E+07	2.67E−02	-1.395
2875.527	66727	(o)	2.5	101493	(e)	1.5	-2.21	4.96E+06	3.47E−03	-2.392
2876.387	49565	(o)	1.5	84320	(e)	1.5	-1.32	3.83E+07	2.78E−02	-1.398
2879.582	49493	(o)	0.5	84210	(e)	0.5	-1.49	2.58E+07	3.74E−02	-1.513
2885.280	65029	(o)	0.5	99678	(e)	0.5	-2.15	5.72E+06	7.72E−03	-2.131
2885.550	49565	(o)	1.5	84210	(e)	0.5	-2.05	7.14E+06	1.04E−02	-2.138
2887.060	66649	(o)	1.5	101277	(e)	2.5	-2.43	2.98E+06	1.34E−03	-2.696
2887.574	66872	(o)	0.5	101493	(e)	1.5	-0.73	1.49E+08	1.04E−01	-0.803
2888.168	49706	(o)	2.5	84320	(e)	1.5	-1.90	9.99E+06	7.24E−03	-2.099
2889.693	66649	(o)	1.5	101245	(e)	1.5	-1.63	1.89E+07	1.28E−02	-1.842
2889.741	66727	(o)	2.5	101322	(e)	3.5	-2.02	7.78E+06	2.63E−03	-2.377
2890.240	69954	(o)	2.5	104543	(e)	3.5	-2.36	3.53E+06	1.01E−03	-2.927
2893.486	48491	(o)	2.5	83041	(e)	3.5	-0.28	4.26E+08	1.07E−01	-0.239
2895.488	66256	(o)	0.5	100783	(e)	0.5	-1.41	3.13E+07	4.38E−02	-1.585

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	*E*(lower) (cm^{-1})	Parity (lower)	*J*(lower)	*E*(upper) (cm^{-1})	Parity (upper)	*J*(upper)	*log*(*gf*)(HFR+CPOL)	*gA* (HFR+CPOL) (s^{-1})	*BF* (HFR+CPOL)	*log*(*gf*) (Kurucz)
2896.172	66727	(o)	2.5	101245	(e)	1.5	-3.79	1.30E+05	8.78E−05	-3.48
2899.195	48399	(o)	1.5	82881	(e)	2.5	-0.70	1.59E+08	5.30E−02	-0.638
2899.320	67012	(o)	2.5	101493	(e)	1.5	-1.20	5.02E+07	3.51E−02	-1.326
2903.756	66355	(o)	1.5	100783	(e)	0.5	-2.83	1.17E+06	1.64E−03	-2.659
2904.236	67070	(o)	1.5	101493	(e)	1.5	-0.65	1.79E+08	1.25E−01	-0.901
2906.967	48491	(o)	2.5	82881	(e)	2.5	-0.45	2.84E+08	9.47E−02	-0.512
2908.394	66872	(o)	0.5	101245	(e)	1.5	-2.48	2.66E+06	1.80E−03	-2.522
2909.103	48399	(o)	1.5	82764	(e)	1.5	-0.56	2.20E+08	1.10E−01	-0.593
2913.771	67012	(o)	2.5	101322	(e)	3.5	-1.01	7.57E+07	2.55E−02	-0.845
2914.964	66355	(o)	1.5	100650	(e)	2.5	-0.78	1.32E+08	5.94E−02	-0.638
2915.181	48399	(o)	1.5	82692	(e)	0.5	-0.72	1.51E+08	1.51E−01	-0.832
2916.928	48491	(o)	2.5	82764	(e)	1.5	-0.95	8.99E+07	4.50E−02	-1.102
2917.621	67012	(o)	2.5	101277	(e)	2.5	-0.77	1.33E+08	5.99E−02	-0.8
2918.935	48632	(o)	3.5	82881	(e)	2.5	-1.33	3.70E+07	1.23E−02	-1.52
2920.309	67012	(o)	2.5	101245	(e)	1.5	-0.86	1.07E+08	7.22E−02	-1.159
2920.875	70317	(o)	2.5	104543	(e)	3.5	-1.76	1.37E+07	3.94E−03	-2.366
2922.599	67070	(o)	1.5	101277	(e)	2.5	-1.18	5.20E+07	2.34E−02	-1.114
2925.297	67070	(o)	1.5	101245	(e)	1.5	-0.97	8.35E+07	5.64E−02	-0.97
2927.503	67344	(o)	2.5	101493	(e)	1.5	-1.87	1.07E+07	7.49E−03	
2928.822	66649	(o)	1.5	100783	(e)	0.5	-0.67	1.64E+08	2.30E−01	-0.801
2930.531	67379	(o)	1.5	101493	(e)	1.5	-1.25	4.36E+07	3.05E−02	-1.513
2931.201	67387	(o)	2.5	101493	(e)	1.5	-1.08	6.55E+07	4.59E−02	-1.163
2939.073	48749	(o)	0.5	82764	(e)	1.5	-1.31	3.77E+07	1.89E−02	-1.334
2940.224	66649	(o)	1.5	100650	(e)	2.5	-1.44	2.77E+07	1.25E−02	-1.839
2942.237	67344	(o)	2.5	101322	(e)	3.5	-2.04	7.15E+06	2.41E−03	-2.358
2943.891	70584	(o)	2.5	104543	(e)	3.5	-0.87	1.05E+08	3.02E−02	-0.49
2945.274	67334	(o)	3.5	101277	(e)	2.5	-0.36	3.39E+08	1.53E−01	-0.88
2945.277	48749	(o)	0.5	82692	(e)	0.5	-1.86	1.06E+07	1.06E−02	-1.861
2945.973	67387	(o)	2.5	101322	(e)	3.5	-1.12	5.91E+07	1.99E−02	-1.024
2946.162	67344	(o)	2.5	101277	(e)	2.5	-1.36	3.39E+07	1.53E−02	-1.341
2946.932	66727	(o)	2.5	100650	(e)	2.5	-0.21	4.77E+08	2.15E−01	-0.261
2948.035	66872	(o)	0.5	100783	(e)	0.5	-1.00	7.65E+07	1.07E−01	-0.918
2948.904	67344	(o)	2.5	101245	(e)	1.5	-0.98	8.10E+07	5.47E−02	-0.963
2949.230	67379	(o)	1.5	101277	(e)	2.5	-1.19	4.98E+07	2.24E−02	-1.108
2949.908	67387	(o)	2.5	101277	(e)	2.5	-0.47	2.59E+08	1.17E−01	-0.58
2950.462	67393	(o)	3.5	101277	(e)	2.5	-1.87	1.04E+07	4.68E−03	-0.568
2951.145	49006	(o)	1.5	82881	(e)	2.5	-1.13	5.68E+07	1.89E−02	-1.473
2951.977	67379	(o)	1.5	101245	(e)	1.5	-0.49	2.48E+08	1.67E−01	-0.553
2952.656	67387	(o)	2.5	101245	(e)	1.5	-1.18	5.13E+07	3.46E−02	-1.002
2959.140	66256	(o)	0.5	100040	(e)	1.5	-0.66	1.69E+08	1.14E−01	-0.691
2961.412	49006	(o)	1.5	82764	(e)	1.5	-2.21	4.71E+06	2.36E−03	-1.713
2965.403	67070	(o)	1.5	100783	(e)	0.5	-2.69	1.54E+06	2.16E−03	-3.655
2967.410	49352	(o)	2.5	83041	(e)	3.5	-0.86	1.04E+08	2.60E−02	-1.383
2967.711	49006	(o)	1.5	82692	(e)	0.5	-1.12	5.68E+07	5.68E−02	-1.01
2967.777	66355	(o)	1.5	100040	(e)	1.5	-0.85	1.09E+08	7.36E−02	-1.087
2971.927	67012	(o)	2.5	100650	(e)	2.5	-1.50	2.36E+07	1.06E−02	-1.379
2972.379	67860	(o)	0.5	101493	(e)	1.5	-2.76	1.31E+06	9.17E−04	-2.831
2973.107	67868	(o)	2.5	101493	(e)	1.5	-1.81	1.17E+07	8.19E−03	-1.7
2973.321	67870	(o)	1.5	101493	(e)	1.5	-1.31	3.74E+07	2.62E−02	-1.623
2977.093	67070	(o)	1.5	100650	(e)	2.5	-1.82	1.15E+07	5.18E−03	-3.143
2981.590	49352	(o)	2.5	82881	(e)	2.5	-1.07	6.41E+07	2.14E−02	-1.056
2988.305	67868	(o)	2.5	101322	(e)	3.5	-0.23	4.37E+08	1.47E−01	-0.27
2991.222	66256	(o)	0.5	99678	(e)	0.5	-1.46	2.62E+07	3.54E−02	-1.441
2992.070	49352	(o)	2.5	82764	(e)	1.5	-0.76	1.29E+08	6.45E−02	-0.842
2992.354	67868	(o)	2.5	101277	(e)	2.5	-0.79	1.21E+08	5.45E−02	-0.652
2992.571	67870	(o)	1.5	101277	(e)	2.5	-3.17	5.09E+05	2.29E−04	-0.466
2992.823	67379	(o)	1.5	100783	(e)	0.5	-1.63	1.75E+07	2.45E−02	-1.621
2993.034	67875	(o)	3.5	101277	(e)	2.5	-2.18	4.86E+06	2.19E−03	-1.648
2993.966	66649	(o)	1.5	100040	(e)	1.5	-3.85	1.05E+05	7.09E−05	-1.851
2994.444	67860	(o)	0.5	101245	(e)	1.5	-0.57	1.99E+08	1.34E−01	-0.56
2995.182	67868	(o)	2.5	101245	(e)	1.5	-2.09	6.01E+06	4.06E−03	-1.733
2995.400	67870	(o)	1.5	101245	(e)	1.5	-3.01	7.35E+05	4.96E−04	-0.889
2998.970	49706	(o)	2.5	83041	(e)	3.5	-0.69	1.52E+08	3.80E−02	-0.676
3000.047	66355	(o)	1.5	99678	(e)	0.5	-0.53	2.19E+08	2.96E−01	-0.617
3000.625	67334	(o)	3.5	100650	(e)	2.5	-3.38	3.13E+05	1.41E−04	-3.282
3000.632	49565	(o)	1.5	82881	(e)	2.5	-0.61	1.82E+08	6.07E−02	-0.656

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	$log(gf)$(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	$log(gf)$ (Kurucz)
3000.921	66727	(o)	2.5	100040	(e)	1.5	-0.59	1.91E+08	1.29E−01	-0.579
3001.546	67344	(o)	2.5	100650	(e)	2.5	-2.35	3.33E+06	1.50E−03	-4.481
3004.730	67379	(o)	1.5	100650	(e)	2.5	-2.44	2.71E+06	1.22E−03	-3.257
3004.749	49493	(o)	0.5	82764	(e)	1.5	-0.78	1.22E+08	6.10E−02	-0.826
3005.434	67387	(o)	2.5	100650	(e)	2.5	-2.05	6.66E+06	3.00E−03	-2.256
3006.009	67393	(o)	3.5	100650	(e)	2.5	-2.50	2.33E+06	1.05E−03	-1.874
3007.973	49646	(o)	3.5	82881	(e)	2.5	-0.45	2.63E+08	8.77E−02	-0.43
3011.234	49493	(o)	0.5	82692	(e)	0.5	-1.33	3.47E+07	3.47E−02	-1.353
3011.247	49565	(o)	1.5	82764	(e)	1.5	-2.51	2.27E+06	1.14E−03	-2.453
3012.326	68306	(o)	1.5	101493	(e)	1.5	-2.01	7.27E+06	5.09E−03	-1.57
3013.455	49706	(o)	2.5	82881	(e)	2.5	-1.21	4.56E+07	1.52E−02	-1.1
3014.045	66872	(o)	0.5	100040	(e)	1.5	-3.15	5.19E+05	3.50E−04	
3017.760	49565	(o)	1.5	82692	(e)	0.5	-0.83	1.08E+08	1.08E−01	-0.817
3024.160	49706	(o)	2.5	82764	(e)	1.5	-0.79	1.19E+08	5.95E−02	-0.672
3024.217	67012	(o)	2.5	100069	(e)	3.5	-1.24	4.14E+07	1.45E−02	-2.615
3026.811	66649	(o)	1.5	99678	(e)	0.5	-3.21	4.43E+05	5.98E−04	-1.684
3026.844	67012	(o)	2.5	100040	(e)	1.5	-3.95	8.04E+04	5.43E−05	-3.786
3032.086	68306	(o)	1.5	101277	(e)	2.5	-0.39	3.04E+08	1.37E−01	-1.307
3032.202	67070	(o)	1.5	100040	(e)	1.5	-1.65	1.64E+07	1.11E−02	-1.619
3034.990	68306	(o)	1.5	101245	(e)	1.5	-0.93	8.69E+07	5.87E−02	-1.661
3036.482	67860	(o)	0.5	100783	(e)	0.5	-2.64	1.63E+06	2.28E−03	-2.655
3037.465	67870	(o)	1.5	100783	(e)	0.5	-1.93	8.47E+06	1.19E−02	-3.727
3037.566	51584	(o)	1.5	84496	(e)	2.5	-2.02	6.94E+06	3.35E−03	-2.068
3037.752	68583	(o)	2.5	101493	(e)	1.5	-1.60	1.81E+07	1.27E−02	-1.991
3045.460	51669	(o)	2.5	84496	(e)	2.5	-0.69	1.50E+08	7.25E−02	-0.725
3047.335	66872	(o)	0.5	99678	(e)	0.5	-2.56	1.98E+06	2.67E−03	-2.778
3049.505	67868	(o)	2.5	100650	(e)	2.5	-1.25	4.02E+07	1.81E−02	-1.421
3049.731	67870	(o)	1.5	100650	(e)	2.5	-0.39	2.89E+08	1.30E−01	-1.679
3050.211	67875	(o)	3.5	100650	(e)	2.5	-0.66	1.56E+08	7.02E−02	-0.708
3053.620	68583	(o)	2.5	101322	(e)	3.5	-1.83	1.06E+07	3.58E−03	-1.797
3053.849	51584	(o)	1.5	84320	(e)	1.5	-0.78	1.20E+08	8.70E−02	-0.813
3054.893	67344	(o)	2.5	100069	(e)	3.5	-0.19	4.66E+08	1.63E−01	-0.118
3056.580	51789	(o)	3.5	84496	(e)	2.5	0.05	8.06E+08	3.90E−01	0.018
3057.848	68583	(o)	2.5	101277	(e)	2.5	-2.91	8.65E+05	3.89E−04	-2.654
3058.921	67387	(o)	2.5	100069	(e)	3.5	-1.91	8.78E+06	3.07E−03	-2.438
3060.801	68583	(o)	2.5	101245	(e)	1.5	-3.06	6.14E+05	4.14E−04	-3.385
3060.877	67379	(o)	1.5	100040	(e)	1.5	-2.15	5.06E+06	3.42E−03	-2.491
3061.608	67387	(o)	2.5	100040	(e)	1.5	-3.90	9.04E+04	6.10E−05	-3.323
3061.828	51669	(o)	2.5	84320	(e)	1.5	-0.13	5.31E+08	3.85E−01	-0.162
3064.179	51584	(o)	1.5	84210	(e)	0.5	-0.34	3.28E+08	4.76E−01	-0.37
3065.896	67070	(o)	1.5	99678	(e)	0.5	-2.81	1.09E+06	1.47E−03	-2.554
3074.445	68760	(o)	3.5	101277	(e)	2.5	-2.76	1.22E+06	5.49E−04	-3.059
3078.183	68306	(o)	1.5	100783	(e)	0.5	-2.79	1.16E+06	1.62E−03	-1.831
3082.358	68843	(o)	3.5	101277	(e)	2.5	-3.06	6.10E+05	2.75E−04	-2.627
3090.780	68306	(o)	1.5	100650	(e)	2.5	-2.44	2.58E+06	1.16E−03	-0.482
3095.215	67379	(o)	1.5	99678	(e)	0.5	-3.54	2.00E+05	2.70E−04	-3.415
3104.586	67868	(o)	2.5	100069	(e)	3.5	-3.92	8.11E+04	2.84E−05	-3.21
3106.560	67860	(o)	0.5	100040	(e)	1.5	-2.16	4.69E+06	3.17E−03	-2.265
3107.354	67868	(o)	2.5	100040	(e)	1.5	-1.18	4.53E+07	3.06E−02	-1.182
3107.589	67870	(o)	1.5	100040	(e)	1.5	-0.84	9.88E+07	6.67E−02	-0.999
3110.033	69348	(o)	1.5	101493	(e)	1.5	-1.00	6.92E+07	4.84E−02	-1.01
3117.553	68583	(o)	2.5	100650	(e)	2.5	-2.67	1.46E+06	6.57E−04	-2.759
3122.638	69478	(o)	2.5	101493	(e)	1.5	-0.23	4.02E+08	2.81E−01	-0.204
3131.100	69348	(o)	1.5	101277	(e)	2.5	-2.81	1.08E+06	4.86E−04	-2.617
3134.197	69348	(o)	1.5	101245	(e)	1.5	-2.39	2.80E+06	1.89E−03	-2.725
3138.391	69639	(o)	1.5	101493	(e)	1.5	-2.31	3.33E+06	2.33E−03	-2.389
3139.408	69478	(o)	2.5	101322	(e)	3.5	-3.08	5.60E+05	1.89E−04	-2.51
3141.936	67860	(o)	0.5	99678	(e)	0.5	-1.60	1.70E+07	2.30E−02	-1.619
3142.988	67870	(o)	1.5	99678	(e)	0.5	-1.24	3.92E+07	5.29E−02	-2.673
3143.033	68843	(o)	3.5	100650	(e)	2.5	-2.17	4.54E+06	2.04E−03	
3143.877	69478	(o)	2.5	101277	(e)	2.5	-2.50	2.14E+06	9.63E−04	-2.989
3146.664	69506	(o)	3.5	101277	(e)	2.5	-1.62	1.60E+07	7.20E−03	-1.652
3146.999	69478	(o)	2.5	101245	(e)	1.5	-2.35	2.97E+06	2.00E−03	-2.566
3150.221	68306	(o)	1.5	100040	(e)	1.5	-1.34	3.10E+07	2.09E−02	-0.973
3159.846	69639	(o)	1.5	101277	(e)	2.5	-2.97	7.16E+05	3.22E−04	-2.89
3162.999	69639	(o)	1.5	101245	(e)	1.5	-2.10	5.21E+06	3.52E−03	-2.39

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	$log(gf)$(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	$log(gf)$ (Kurucz)
3169.784	69954	(o)	2.5	101493	(e)	1.5	-0.78	1.11E+08	7.77E−02	-0.853
3175.142	68583	(o)	2.5	100069	(e)	3.5	-1.98	6.82E+06	2.39E−03	-1.919
3178.038	68583	(o)	2.5	100040	(e)	1.5	-2.58	1.71E+06	1.15E−03	-2.579
3180.280	69348	(o)	1.5	100783	(e)	0.5	-0.44	2.42E+08	3.39E−01	-0.417
3186.526	69903	(o)	3.5	101277	(e)	2.5	-2.81	1.01E+06	4.55E−04	-3.448
3186.604	68306	(o)	1.5	99678	(e)	0.5	-1.69	1.37E+07	1.85E−02	-1.004
3186.643	51669	(o)	2.5	83041	(e)	3.5	-3.10	5.31E+05	1.33E−04	-3.105
3187.065	69954	(o)	2.5	101322	(e)	3.5	-3.09	5.37E+05	1.81E−04	-2.9
3191.671	69954	(o)	2.5	101277	(e)	2.5	-2.29	3.39E+06	1.53E−03	-2.698
3193.729	69348	(o)	1.5	100650	(e)	2.5	-3.25	3.71E+05	1.67E−04	-3.228
3194.271	51584	(o)	1.5	82881	(e)	2.5	-3.58	1.73E+05	5.77E−05	-3.557
3194.888	69954	(o)	2.5	101245	(e)	1.5	-2.04	6.04E+06	4.08E−03	-2.025
3203.002	51669	(o)	2.5	82881	(e)	2.5	-2.67	1.41E+06	4.70E−04	-2.59
3206.302	51584	(o)	1.5	82764	(e)	1.5	-3.27	3.52E+05	1.76E−04	-3.176
3206.669	70317	(o)	2.5	101493	(e)	1.5	-3.39	2.62E+05	1.83E−04	
3207.023	69478	(o)	2.5	100650	(e)	2.5	-2.62	1.54E+06	6.93E−04	-2.403
3209.924	69506	(o)	3.5	100650	(e)	2.5	-2.95	7.10E+05	3.20E−04	-3.28
3209.940	69639	(o)	1.5	100783	(e)	0.5	-1.68	1.33E+07	1.86E−02	-1.76
3213.688	51584	(o)	1.5	82692	(e)	0.5	-3.86	8.92E+04	8.92E−05	-3.71
3213.784	73436	(o)	2.5	104543	(e)	3.5	-3.53	1.85E+05	5.32E−05	-3.277
3215.099	51669	(o)	2.5	82764	(e)	1.5	-3.35	2.93E+05	1.47E−04	-3.162
3215.303	51789	(o)	3.5	82881	(e)	2.5	-3.21	3.99E+05	1.33E−04	-2.993
3224.356	70317	(o)	2.5	101322	(e)	3.5	-3.22	3.91E+05	1.32E−04	-3.506
3229.071	70317	(o)	2.5	101277	(e)	2.5	-2.21	3.92E+06	1.76E−03	-2.359
3232.364	70317	(o)	2.5	101245	(e)	1.5	-1.36	2.81E+07	1.90E−02	-1.296
3234.430	70584	(o)	2.5	101493	(e)	1.5	-2.86	8.74E+05	6.12E−04	-3.448
3240.603	70427	(o)	3.5	101277	(e)	2.5	-1.18	4.17E+07	1.88E−02	-1.122
3252.425	70584	(o)	2.5	101322	(e)	3.5	-3.94	7.24E+04	2.44E−05	-3.299
3256.771	69954	(o)	2.5	100650	(e)	2.5	-2.71	1.23E+06	5.54E−04	-2.766
3257.222	70584	(o)	2.5	101277	(e)	2.5	-3.48	2.10E+05	9.45E−05	
3257.236	69348	(o)	1.5	100040	(e)	1.5	-2.50	2.01E+06	1.36E−03	-2.332
3260.573	70584	(o)	2.5	101245	(e)	1.5	-2.37	2.72E+06	1.84E−03	-3.826
3267.998	69478	(o)	2.5	100069	(e)	3.5	-2.47	2.12E+06	7.42E−04	-2.519
3271.065	69478	(o)	2.5	100040	(e)	1.5	-2.17	4.22E+06	2.85E−03	-1.948
3285.891	70852	(o)	3.5	101277	(e)	2.5	-3.25	3.52E+05	1.58E−04	-4.186
3288.356	69639	(o)	1.5	100040	(e)	1.5	-3.17	4.16E+05	2.81E−04	-3.257
3296.148	69348	(o)	1.5	99678	(e)	0.5	-2.19	4.01E+06	5.41E−03	-2.078
3307.647	74319	(o)	2.5	104543	(e)	3.5	-2.80	9.57E+05	2.75E−04	-2.323
3319.671	69954	(o)	2.5	100069	(e)	3.5	-2.45	2.18E+06	7.63E−04	-2.225
3320.531	74436	(o)	2.5	104543	(e)	3.5	-2.55	1.69E+06	4.86E−04	-1.798
3322.836	69954	(o)	2.5	100040	(e)	1.5	-2.28	3.18E+06	2.15E−03	-2.308
3325.811	74484	(o)	2.5	104543	(e)	3.5	-1.06	5.06E+07	1.45E−02	-2.715
3328.020	69639	(o)	1.5	99678	(e)	0.5	-3.03	5.58E+05	7.53E−04	-3.11
3332.806	54499	(o)	1.5	84496	(e)	2.5	-0.60	1.53E+08	7.40E−02	-0.615
3338.074	74718	(o)	1.5	104666	(e)	0.5	-3.43	2.25E+05	2.93E−04	
3343.276	54418	(o)	0.5	84320	(e)	1.5	-0.76	1.04E+08	7.54E−02	-0.781
3346.876	54626	(o)	2.5	84496	(e)	2.5	-0.23	3.54E+08	1.71E−01	-0.246
3352.418	54499	(o)	1.5	84320	(e)	1.5	-0.57	1.61E+08	1.17E−01	-0.586
3353.336	74854	(o)	0.5	104666	(e)	0.5	-3.38	2.49E+05	3.24E−04	
3355.661	54418	(o)	0.5	84210	(e)	0.5	-0.78	9.82E+07	1.42E−01	-0.802
3360.149	70317	(o)	2.5	100069	(e)	3.5	-0.85	8.22E+07	2.88E−02	-0.941
3360.837	74920	(o)	0.5	104666	(e)	0.5	-2.75	1.01E+06	1.31E−03	
3364.772	54784	(o)	3.5	84496	(e)	2.5	-0.78	9.71E+07	4.69E−02	-0.817
3364.870	54499	(o)	1.5	84210	(e)	0.5	-0.82	9.03E+07	1.31E−01	-0.841
3366.655	54626	(o)	2.5	84320	(e)	1.5	-0.68	1.22E+08	8.85E−02	-0.713
3368.118	74985	(o)	1.5	104666	(e)	0.5	-2.75	1.02E+06	1.33E−03	
3390.643	70584	(o)	2.5	100069	(e)	3.5	-2.08	4.84E+06	1.69E−03	-3.89
3518.172	54626	(o)	2.5	83041	(e)	3.5	-3.27	2.88E+05	7.20E−05	-3.109
3522.401	54499	(o)	1.5	82881	(e)	2.5	-3.55	1.50E+05	5.00E−05	-3.496
3538.122	54626	(o)	2.5	82881	(e)	2.5	-3.80	8.40E+04	2.80E−05	-4.13
3546.027	54499	(o)	1.5	82692	(e)	0.5	-3.73	9.82E+04	9.82E−05	-3.599
3552.889	54626	(o)	2.5	82764	(e)	1.5	-3.34	2.40E+05	1.20E−04	-3.245
3558.127	54784	(o)	3.5	82881	(e)	2.5	-3.36	2.29E+05	7.63E−05	-3.284
3585.046	73436	(o)	2.5	101322	(e)	3.5	-2.91	6.24E+05	2.11E−04	-4.289
3591.173	73407	(o)	0.5	101245	(e)	1.5	-3.43	1.89E+05	1.28E−04	
3591.817	73412	(o)	1.5	101245	(e)	1.5	-3.56	1.40E+05	9.45E−05	

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	log(gf)(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	log(gf) (Kurucz)
3628.010	76988	(o)	2.5	104543	(e)	3.5	-1.34	2.28E+07	6.56E−03	-1.424
3670.219	73412	(o)	1.5	100650	(e)	2.5	-3.59	1.23E+05	5.54E−05	-3.547
3673.489	73436	(o)	2.5	100650	(e)	2.5	-2.86	6.61E+05	2.97E−04	-2.699
3680.180	73486	(o)	3.5	100650	(e)	2.5	-2.87	6.48E+05	2.92E−04	-2.619
3701.428	74484	(o)	2.5	101493	(e)	1.5	-3.34	2.17E+05	1.52E−04	-4.223
3706.540	74273	(o)	1.5	101245	(e)	1.5	-3.48	1.57E+05	1.06E−04	-4.124
3709.098	77713	(o)	1.5	104666	(e)	0.5	-3.07	4.05E+05	5.27E−04	
3717.930	77777	(o)	0.5	104666	(e)	0.5	-1.78	7.71E+06	1.00E−02	
3733.729	74718	(o)	1.5	101493	(e)	1.5	-3.52	1.44E+05	1.01E−04	-3.584
3752.833	74854	(o)	0.5	101493	(e)	1.5	-3.88	6.29E+04	4.40E−05	-4.396
3753.634	73407	(o)	0.5	100040	(e)	1.5	-3.88	6.00E+04	4.05E−05	-3.767
3754.338	73412	(o)	1.5	100040	(e)	1.5	-3.32	2.18E+05	1.47E−04	-3.141
3757.213	77935	(o)	2.5	104543	(e)	3.5	-3.42	1.78E+05	5.12E−05	-2.901
3757.759	73436	(o)	2.5	100040	(e)	1.5	-3.77	7.83E+04	5.29E−05	-3.535
3764.434	78109	(o)	1.5	104666	(e)	0.5	-1.64	1.06E+07	1.38E−02	
3796.638	74319	(o)	2.5	100650	(e)	2.5	-2.04	4.16E+06	1.87E−03	-2.316
3805.404	73407	(o)	0.5	99678	(e)	0.5	-3.78	7.31E+04	9.87E−05	-3.564
3813.623	74436	(o)	2.5	100650	(e)	2.5	-2.61	1.12E+06	5.04E−04	
3835.436	74718	(o)	1.5	100783	(e)	0.5	-3.91	5.55E+04	7.77E−05	-3.745
3855.012	74718	(o)	1.5	100650	(e)	2.5	-2.30	2.23E+06	1.00E−03	-2.393
3865.517	74920	(o)	0.5	100783	(e)	0.5	-3.88	5.62E+04	7.87E−05	
3875.152	74985	(o)	1.5	100783	(e)	0.5	-3.58	1.11E+05	1.55E−04	-3.933
3886.723	74319	(o)	2.5	100040	(e)	1.5	-2.45	1.54E+06	1.04E−03	-2.921
3904.524	74436	(o)	2.5	100040	(e)	1.5	-2.75	7.63E+05	5.15E−04	
3947.922	74718	(o)	1.5	100040	(e)	1.5	-3.05	3.78E+05	2.55E−04	-3.028
3969.287	74854	(o)	0.5	100040	(e)	1.5	-2.43	1.56E+06	1.05E−03	-4.419
4005.231	74718	(o)	1.5	99678	(e)	0.5	-2.44	1.52E+06	2.05E−03	-2.403
4027.222	74854	(o)	0.5	99678	(e)	0.5	-3.10	3.23E+05	4.36E−04	
4100.849	80288	(o)	1.5	104666	(e)	0.5	-2.11	3.27E+06	4.25E−03	
4204.110	77713	(o)	1.5	101493	(e)	1.5	-1.92	4.45E+06	3.12E−03	-2.046
4215.460	77777	(o)	0.5	101493	(e)	1.5	-2.11	2.78E+06	1.95E−03	-2.044
4243.716	77935	(o)	2.5	101493	(e)	1.5	-2.60	9.36E+05	6.55E−04	-2.51
4275.343	78109	(o)	1.5	101493	(e)	1.5	-1.68	7.43E+06	5.20E−03	-1.56
4288.755	81233	(o)	2.5	104543	(e)	3.5	-1.62	9.46E+06	2.72E−03	-1.526
4333.501	77713	(o)	1.5	100783	(e)	0.5	-2.26	1.91E+06	2.67E−03	-2.183
4345.561	77777	(o)	0.5	100783	(e)	0.5	-1.90	4.24E+06	5.94E−03	-1.851
4409.225	78109	(o)	1.5	100783	(e)	0.5	-2.32	1.59E+06	2.23E−03	-2.218
4477.646	77713	(o)	1.5	100040	(e)	1.5	-3.63	7.52E+04	5.08E−05	-3.74
4490.523	77777	(o)	0.5	100040	(e)	1.5	-3.67	6.79E+04	4.58E−05	-3.583
4551.509	77713	(o)	1.5	99678	(e)	0.5	-3.83	4.64E+04	6.26E−05	-3.614
4558.539	78109	(o)	1.5	100040	(e)	1.5	-3.43	1.17E+05	7.90E−05	-3.246
4564.815	77777	(o)	0.5	99678	(e)	0.5	-3.77	5.22E+04	7.05E−05	-3.932
4635.118	78109	(o)	1.5	99678	(e)	0.5	-3.72	5.72E+04	7.72E−05	-3.418
4714.594	80288	(o)	1.5	101493	(e)	1.5	-2.00	3.20E+06	2.24E−03	-2.041
4744.159	80420	(o)	2.5	101493	(e)	1.5	-1.33	1.49E+07	1.04E−02	-1.351
4872.316	63802	(o)	0.5	84320	(e)	1.5	-3.18	1.89E+05	1.37E−04	-3.042
4877.924	80288	(o)	1.5	100783	(e)	0.5	-1.65	6.76E+06	9.46E−03	-1.651
4892.456	64062	(o)	1.5	84496	(e)	2.5	-3.23	1.67E+05	8.07E−05	-2.947
4898.663	63802	(o)	0.5	84210	(e)	0.5	-2.92	3.34E+05	4.84E−04	-2.954
4934.471	81233	(o)	2.5	101493	(e)	1.5	-3.33	1.39E+05	9.73E−05	-2.614
4934.834	64062	(o)	1.5	84320	(e)	1.5	-2.69	5.65E+05	4.10E−04	-2.777
4961.864	64062	(o)	1.5	84210	(e)	0.5	-3.08	2.26E+05	3.28E−04	-3.016
4986.920	64449	(o)	2.5	84496	(e)	2.5	-2.45	9.70E+05	4.69E−04	-2.51
5014.032	84605	(o)	2.5	104543	(e)	3.5	-2.60	7.06E+05	2.03E−04	-2.143
5030.958	64449	(o)	2.5	84320	(e)	1.5	-3.08	2.23E+05	1.62E−04	-2.93
5061.329	80288	(o)	1.5	100040	(e)	1.5	-3.55	7.96E+04	5.37E−05	-3.512
5095.417	80420	(o)	2.5	100040	(e)	1.5	-2.92	3.29E+05	2.22E−04	-2.932
5108.138	64924	(o)	3.5	84496	(e)	2.5	-3.43	9.73E+04	4.70E−05	-3.101
5155.906	80288	(o)	1.5	99678	(e)	0.5	-3.29	1.39E+05	1.88E−04	-3.317
5182.374	65029	(o)	0.5	84320	(e)	1.5	-3.12	1.88E+05	1.36E−04	-3.176
5196.392	65257	(o)	3.5	84496	(e)	2.5	-3.14	1.77E+05	8.56E−05	-3.231
5212.191	65029	(o)	0.5	84210	(e)	0.5	-3.15	1.76E+05	2.55E−04	-3.248
5216.761	65156	(o)	2.5	84320	(e)	1.5	-3.67	5.17E+04	3.75E−05	-3.784
5239.683	85587	(o)	1.5	104666	(e)	0.5	-3.72	4.62E+04	6.01E−05	
5327.741	85779	(o)	2.5	104543	(e)	3.5	-3.33	1.07E+05	3.08E−05	-3.942
5363.625	82854	(o)	0.5	101493	(e)	1.5	-3.50	7.84E+04	5.49E−05	-3.514

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	$log(gf)$(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	$log(gf)$ (Kurucz)
5382.689	82920	(o)	1.5	101493	(e)	1.5	-2.75	4.28E+05	3.00E−04	-2.831
5510.888	66355	(o)	1.5	84496	(e)	2.5	-1.66	4.87E+06	2.35E−03	-1.645
5534.428	66256	(o)	0.5	84320	(e)	1.5	-2.07	1.89E+06	1.37E−03	-2.073
5542.991	86507	(o)	2.5	104543	(e)	3.5	-3.96	2.42E+04	6.96E−06	-4.173
5561.226	86566	(o)	2.5	104543	(e)	3.5	-3.50	6.86E+04	1.97E−05	-3.802
5564.716	66355	(o)	1.5	84320	(e)	1.5	-1.95	2.46E+06	1.78E−03	-1.91
5568.447	66256	(o)	0.5	84210	(e)	0.5	-2.09	1.79E+06	2.60E−03	-2.066
5576.032	82854	(o)	0.5	100783	(e)	0.5	-2.97	2.44E+05	3.42E−04	-3.049
5596.638	82920	(o)	1.5	100783	(e)	0.5	-3.75	3.95E+04	5.53E−05	
5599.109	66355	(o)	1.5	84210	(e)	0.5	-2.84	3.13E+05	4.54E−04	-2.765
5601.872	66649	(o)	1.5	84496	(e)	2.5	-2.87	2.84E+05	1.37E−04	-4.449
5626.270	66727	(o)	2.5	84496	(e)	2.5	-1.99	2.21E+06	1.07E−03	-1.958
5633.086	86919	(o)	1.5	104666	(e)	0.5	-3.79	3.44E+04	4.47E−05	
5682.387	66727	(o)	2.5	84320	(e)	1.5	-3.17	1.42E+05	1.03E−04	-3.197
5693.054	66649	(o)	1.5	84210	(e)	0.5	-2.68	4.32E+05	6.26E−04	-3.171
5718.080	67012	(o)	2.5	84496	(e)	2.5	-2.55	5.69E+05	2.75E−04	-2.556
5729.625	66872	(o)	0.5	84320	(e)	1.5	-3.94	2.37E+04	1.72E−05	-4.26
5737.232	67070	(o)	1.5	84496	(e)	2.5	-3.96	2.24E+04	1.08E−05	-3.086
5766.094	66872	(o)	0.5	84210	(e)	0.5	-3.43	7.58E+04	1.10E−04	-4.063
5776.052	67012	(o)	2.5	84320	(e)	1.5	-1.80	3.14E+06	2.28E−03	-1.839
5795.595	67070	(o)	1.5	84320	(e)	1.5	-2.48	6.57E+05	4.76E−04	-2.693
5825.267	67334	(o)	3.5	84496	(e)	2.5	-1.73	3.74E+06	1.81E−03	-2.959
5832.912	67070	(o)	1.5	84210	(e)	0.5	-2.28	1.04E+06	1.51E−03	-2.182
5840.759	67379	(o)	1.5	84496	(e)	2.5	-3.44	7.17E+04	3.47E−05	-3.641
5843.420	67387	(o)	2.5	84496	(e)	2.5	-2.09	1.61E+06	7.78E−04	-2.089
5845.593	67393	(o)	3.5	84496	(e)	2.5	-1.52	5.97E+06	2.89E−03	-1.349
5888.992	67344	(o)	2.5	84320	(e)	1.5	-3.43	7.20E+04	5.22E−05	-3.545
5901.258	67379	(o)	1.5	84320	(e)	1.5	-2.27	1.05E+06	7.61E−04	-2.225
5903.975	67387	(o)	2.5	84320	(e)	1.5	-1.79	3.08E+06	2.23E−03	-1.79
5939.953	67379	(o)	1.5	84210	(e)	0.5	-1.88	2.49E+06	3.61E−03	-1.903
6012.350	67868	(o)	2.5	84496	(e)	2.5	-3.59	4.71E+04	2.28E−05	-3.739
6013.227	67870	(o)	1.5	84496	(e)	2.5	-3.34	8.44E+04	4.08E−05	-3.522
6015.093	67875	(o)	3.5	84496	(e)	2.5	-2.45	6.43E+05	3.11E−04	-2.182
6073.439	67860	(o)	0.5	84320	(e)	1.5	-3.38	7.45E+04	5.40E−05	-3.416
6076.476	67868	(o)	2.5	84320	(e)	1.5	-2.62	4.29E+05	3.11E−04	-2.406
6077.372	67870	(o)	1.5	84320	(e)	1.5	-3.66	3.99E+04	2.89E−05	-3.846
6114.432	67860	(o)	0.5	84210	(e)	0.5	-3.59	4.53E+04	6.57E−05	-3.486
6174.920	68306	(o)	1.5	84496	(e)	2.5	-3.20	1.16E+05	5.61E−05	-3.753
6192.783	68583	(o)	2.5	84727	(e)	3.5	-3.54	4.77E+04	1.73E−05	-4.275
6224.119	88604	(o)	1.5	104666	(e)	0.5	-2.96	1.89E+05	2.46E−04	
6242.581	68306	(o)	1.5	84320	(e)	1.5	-3.95	2.00E+04	1.45E−05	
6285.896	68306	(o)	1.5	84210	(e)	0.5	-3.00	1.77E+05	2.57E−04	-3.724
6343.890	85486	(o)	0.5	101245	(e)	1.5	-2.76	2.79E+05	1.88E−04	-2.579
6384.550	85587	(o)	1.5	101245	(e)	1.5	-3.17	1.08E+05	7.29E−05	-2.982
6556.092	69478	(o)	2.5	84727	(e)	3.5	-3.72	2.87E+04	1.04E−05	-4.488
6636.539	85587	(o)	1.5	100650	(e)	2.5	-3.79	2.40E+04	1.08E−05	-3.587
6656.965	69478	(o)	2.5	84496	(e)	2.5	-2.77	2.51E+05	1.21E−04	-2.887
6669.473	69506	(o)	3.5	84496	(e)	2.5	-1.69	3.00E+06	1.45E−03	-1.653
6671.276	86507	(o)	2.5	101493	(e)	1.5	-2.33	7.01E+05	4.91E−04	-2.423
6677.293	69348	(o)	1.5	84320	(e)	1.5	-3.61	3.81E+04	2.76E−05	-3.71
6722.277	85779	(o)	2.5	100650	(e)	2.5	-2.83	2.13E+05	9.59E−05	-2.625
6726.875	69348	(o)	1.5	84210	(e)	0.5	-3.52	4.56E+04	6.61E−05	-3.45
6728.966	69639	(o)	1.5	84496	(e)	2.5	-3.49	4.75E+04	2.30E−05	-3.485
6735.669	69478	(o)	2.5	84320	(e)	1.5	-2.54	4.18E+05	3.03E−04	-2.552
6809.392	69639	(o)	1.5	84320	(e)	1.5	-2.42	5.31E+05	3.85E−04	-2.393
6810.785	86566	(o)	2.5	101245	(e)	1.5	-3.66	3.22E+04	2.17E−05	-2.955
6851.119	69903	(o)	3.5	84496	(e)	2.5	-3.36	6.19E+04	2.99E−05	-3.595
6859.728	86919	(o)	1.5	101493	(e)	1.5	-3.16	9.96E+04	6.97E−05	-3.331
6860.753	86079	(o)	3.5	100650	(e)	2.5	-2.18	9.04E+05	4.07E−04	-1.977
6860.963	69639	(o)	1.5	84210	(e)	0.5	-2.03	1.29E+06	1.87E−03	-1.998
6869.064	85486	(o)	0.5	100040	(e)	1.5	-3.56	3.77E+04	2.54E−05	-3.365
6874.944	69954	(o)	2.5	84496	(e)	2.5	-2.47	4.94E+05	2.39E−04	-2.434
6916.760	85587	(o)	1.5	100040	(e)	1.5	-2.75	2.42E+05	1.63E−04	-2.55
6940.497	90262	(o)	1.5	104666	(e)	0.5	-3.91	1.74E+04	2.26E−05	
6958.919	69954	(o)	2.5	84320	(e)	1.5	-1.94	1.61E+06	1.17E−03	-1.923
7009.942	85779	(o)	2.5	100040	(e)	1.5	-2.44	4.76E+05	3.21E−04	-2.246

(*continued on next page*)

Table 4 (*continued*)

Wavelength (Å)	E(lower) (cm^{-1})	Parity (lower)	J(lower)	E(upper) (cm^{-1})	Parity (upper)	J(upper)	$log(gf)$(HFR+CPOL)	gA (HFR+CPOL) (s^{-1})	BF (HFR+CPOL)	$log(gf)$ (Kurucz)
7044.435	85486	(o)	0.5	99678	(e)	0.5	-2.85	1.85E+05	2.50E−04	-2.653
7094.607	85587	(o)	1.5	99678	(e)	0.5	-2.83	1.90E+05	2.57E−04	-2.633
7106.057	70427	(o)	3.5	84496	(e)	2.5	-3.12	9.93E+04	4.80E−05	-2.903
7139.197	70317	(o)	2.5	84320	(e)	1.5	-3.78	2.16E+04	1.57E−05	-3.186
7211.034	86919	(o)	1.5	100783	(e)	0.5	-2.59	3.34E+05	4.68E−04	-2.707
7278.269	70584	(o)	2.5	84320	(e)	1.5	-3.40	5.09E+04	3.69E−05	-3.387
7327.505	70852	(o)	3.5	84496	(e)	2.5	-3.49	4.07E+04	1.97E−05	-3.354
7387.392	86507	(o)	2.5	100040	(e)	1.5	-3.73	2.29E+04	1.55E−05	-3.653
7404.052	86566	(o)	2.5	100069	(e)	3.5	-2.27	6.48E+05	2.27E−04	-2.165
7756.678	88604	(o)	1.5	101493	(e)	1.5	-3.33	5.17E+04	3.62E−05	-2.969
9345.279	93969	(o)	0.5	104666	(e)	0.5	-3.84	1.19E+04	1.55E−05	
9603.253	94256	(o)	1.5	104666	(e)	0.5	-3.32	3.51E+04	4.56E−05	
11871.802	96245	(o)	0.5	104666	(e)	0.5	-2.30	2.23E+05	2.90E−04	