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Energy Levels and gf-values for Fe XIV

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I. Introduction

Of the first fifteen stages of ionization of iron in which the ground states have one or more electrons in the M shell, the spectrum of Fe XIV has the fewest identified levels (Reader and Sugar, 1975). This spectrum in the Al I isoelectronic sequence is essentially a three-electron spectrum, but unlike the similar B I isoelectronic sequence the configurations degenerate in the hydrogenic limit for large Z include d electrons as well as s and p electrons. Consequently there are far more low-lying, interacting configurations at high stages of ionization in the Al I sequence than the B I sequence, and the analysis of the spectrum is more difficult.

In a recent study (Froese Fischer, 1978) of transitions between excited states in the Al I sequence, namely 4s - 4p transitions, the energy of $3s^2\ 4p\ ^2P$ was found to be too <u>low</u> relative to the $3s^2\ ^1S$ ionization limit. The observed level was derived from the work of Fawcett, Cowan, Kononov, and Hayes (1972) who identified the $3s^2\ 3d - 3s^2\ 4p$ transition. Their calculated wavelength of 91.672 Å agreed reasonably well with the observed value of 91.273 Å.

In the Al I sequence at low degrees of ionization, $3s^2\ 4p$ is a lower lying configuration than $3p\ 3d^2$ but as the degree of ionization increases the $3p\ 3d^2$ configuration comes "plunging" down and in precisely Fe XIV the $3s^2\ 4p\ ^2P$ and $3p\ 3d^2$ (LS) ^2P levels begin to cross with $3p\ 3d^2\ (^1S,\ ^1D)$ <u>below</u> $3s\ ^24p$ but $3p\ 3d^2\ (^3P)$ <u>above</u> $3s^2\ 4p\ ^2P$. Often $\Delta n = 0$ transitions have a larger gf value than $\Delta n = 1$ transitions. In order to check whether a line in the 91 Å

region could be due to some other transition, calculations were performed for the odd and even states of the $n = 3$ complex. From these wavefunctions, gf-values were computed for all dipole transitions between states in the two groups. No line with a significant gf value was found in the region of 91 Å.

II. Method of computations

Two types of interactions are important in Fe XIV - electrostatic and spin-orbit interaction. Since nearly all configurations of a given parity are connected either directly or indirectly by these two interactions, the configurations with three electrons in the M-shell were divided into two groups, the odd and the even group. These are listed in Table 1.

For each group and each J value ($J = 1/2$ to $11/2$) an interaction matrix was computed that included electrostatic and spin-orbit interaction. The diagonal energies also included certain relativistic effects which shift the energy of one configuration relative to another, namely the mass-velocity effect, Darwin term, and a contribution from the spin-contact term as defined by Hartman and Clementi (1964).

A common orbital basis was used for all configurations. The radial functions were determined in a Hartree-Fock like manner, but from an energy expression for the average energy of two configurations, namely

$$W = (1/2)\ \{E_{av}\ (3s^2\ 3p) + E_{av}\ (3p^2\ 3d)\}$$

where $E_{av}\ (\gamma)$ is a statistically weighted average energy of all the

terms associated with the configuration γ. The values of the resulting spin-orbit parameters were $\zeta_{3p} = 12022\ cm^{-1}$ and $\zeta_{3d} = 1171.5\ cm^{-1}$.

In Hartree-Fock calculations the radial functions are different for each configuration and each term. To check the sensitivity of the radial functions to the configuration, calculations were also performed for

$$W = (1/5)\ \{E_{av}\ (3s_1^2\ 3d_1) + E_{av}\ (3p_1^2\ 3d_2) + E_{av}\ (3d_3^3) + E_{av}\ (3s_2\ 3d_4^2) + E_{av}\ (3s_2\ 3p_2^2)\}$$

so that all configurations had the same common core. In Table 2, the different mean radii and spin-orbit parameters are compared. Because of the high degree of ionization, the mean radii differ by less than 1%. The 3d spin-orbit (ζ) parameters are relatively more sensitive to the configuration but on an absolute scale the variation is at most 22 cm^{-1} which is fairly small. Even so, the constrained radial basis used for this calculation does not represent $3d^3$ as accurately as the other configurations.

All calculations were entirely *ab initio* without any scaling of the Slater integrals as is usually done in Cowan's calculations (see for example, Fawcett et al., 1972).

Many of the programs required for this calculation are readily available. They include Hibbert's (1971) program for the interaction matrix, a multi-configuration Hartree-Fock program (Froese Fischer, 1978a), Saxena's (1977) spin-orbit interaction program, and programs for oscillator strengths (Froese Fischer and Saxena, 1975).

III. Discussion of results

The various energy levels for the states in Fe XIV considered here are listed in Table 1 in the order of increasing levels. However, instead of tabulating the J-value we tabulated [J] = 2J + 1. Also, in our notation all superscripts have been lowered so that $3s^2.3p$ becomes 3S2.3P and coupling information is given in parentheses as needed.

In theoretical calculations a state is an eigenstate of a set of interacting configuration states. The total wavefunction for the state is then represented as a linear combination of configuration state functions. In Table 3 the states have been labelled according to their dominant component in this representation. Usually different states have different dominant components but it may happen that two differing states are assigned the same label. This is the case for $3p^2$ $(^3P).3d$ ^4D with [J] = 8 which appears twice, once at 995642 cm^{-1} and again at 1011266 cm^{-1}. The composition of the larger components of these two states is given in Table 4. It is now evident that because of the large interaction with two $3p^2$ 3d ^2F configuration states, $3p^2$ (^1D) 3d ^2F never becomes a dominant state though the second state in Table 4 has more ^2F character than ^4D.

In Table 5 the present energy levels are compared with those which have been identified from observed lines (Reader and Sugar, 1975). Generally the theoretical levels are in error by only a few percent. It appears that our spectrum is somewhat too spread out. Even though the energy levels become progressively too high, the energy separation between levels of a given term remains reasonably

accurate. For example, the $3s^2\ 3d\ ^2D$ levels are too high by at least 8200 cm^{-1}, but the theoretical energy level separation of only 2398 cm^{-1} differs from the observed by only 408 cm^{-1}. Certainly the level separation is more accurate than the theoretical energy displacement which is consistent with the observation that the spectrum is too diffuse.

Table 6 presents the gf values of all transitions for which $gf \geq 0.4$, tabulated according to increasing wavelengths for the lines. Both length and velocity gf values are included. All transitions are between an even (left) and an odd (right) state from the group of states considered here. However the reported gf value is for an absorption transition rather than from the left state to the right state.

Table 6 clearly indicates the large number of lines which may appear within a 1 cm^{-1} wavelength region, even if only those with the larger gf values are considered. For example, the region 217.9 - 218.8 Å in Table 6 contains 10 lines. Also there is extensive overlapping of lines of one multiplet with those of another, making identification more difficult.

No lines are reported with a wavelength less than 100 Å. In fact, gf values for such lines were all less than 0.001.

Transitions between low-lying levels are of particular importance both in astrophysics and for the identification of iron emission lines observed in plasmas. For convenience, Table 7 lists all transitions from the various levels from the three lowest configurations - $3s^2\ 3p$, $3s\ 3p^2$, and $3s^2\ 3d$ - with gf values greater than 0.01. Since the level of one of the states entering into these transitions is

frequently known, this table may be useful in determining other levels from observation. The gf value of 4.517 for the $3s^2 3d\ ^2D$ - $3s.3p\ (^1P).3d\ ^2F$ multiplet is unusually large.

In order to ascertain the reliability of the wavelengths reported here, the present values are compared in Table 8 with some derived from Cowan's calculations and those obtained from observation. Cowan (see Fawcett et al., 1972) used a procedure very similar to ours but scaled the Slater integrals and ζ_{3d} by a factor 0.85, and ζ_{3p} by a factor 0.95. In the four cases where Cowan's values are available, the present results are essentially the same as Cowan's or in somewhat better agreement with observation. Generally the wavelengths are in error by only a few angstroms, and never more than four angstroms.

All the levels of Fe XIV determined so far from observation are members of the doublet series. Table 3 shows that the second term above the ground configuration is $3s\ 3p^2\ (^3P)\ ^4P$ but the levels for this term have not been identified. In Table 9 the intercombination lines are listed in order of decreasing gf value. The largest gf values are associated with transitions from levels that have not been identified. Many of these involve terms of the configuration $3s\ 3p\ (^{1,3}P)\ 3d$. The identification of these levels is likely to assist greatly the analysis of the Fe XIV spectrum.

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Table 1. Configurations included in the interaction calculation.

	Even states		Odd states	
1.	$3s^2 \cdot 3d$	^2D	$3s^2 \cdot 3p$	^2P
2.	$3p^2\ (^1S) \cdot 3d$	^2D	$3p^3\ (^2P)$	^2P
3.	$3p^2\ (^3P) \cdot 3d$	^2D	$3p \cdot 3d^2\ (^1S)$	^2P
4.	$3p^2\ (^1D) \cdot 3d$	^2D	$3p \cdot 3d^2\ (^3P)$	^2P
5.	$3d^3\ (^2D_1)$	^2D	$3p \cdot 3d^2\ (^1D)$	^2P
6.	$3d^3\ (^3D_3)$	^2D	$3s \cdot 3p\ (^1P) \cdot 3d$	^2P
7.	$3s \cdot 3d^2\ (^1D)$	^2D	$3s \cdot 3p\ (^3P) \cdot 3d$	^2P
8.	$3s \cdot 3p^2\ (^1D)$	^2D	$3p^3\ (^2D)$	^2D
9.	$3p^2\ (^3P) \cdot 3d$	^2F	$3p \cdot 3d^2\ (^3P)$	^2D
10.	$3p^2\ (^1D) \cdot 3d$	^2F	$3p \cdot 3d^2\ (^1D)$	^2D
11.	$3d^3\ (^2F)$	^2F	$3p \cdot 3d^2\ (^3F)$	^2D
12.	$3p^2\ (^3P) \cdot 3d$	^2P	$3s \cdot 3p\ (^1P) \cdot 3d$	^2D
13.	$3p^2\ (^1D) \cdot 3d$	^2P	$3s \cdot 3p\ (^3P) \cdot 3d$	^2D
14.	$3d^3\ (^2P)$	^2P	$3p^3\ (^4S)$	^4S
15.	$3s \cdot 3d^2\ (^3P)$	^2P	$3p \cdot 3d^2\ (^3P)$	^4S
16.	$3s \cdot 3p^2\ (^3P)$	^2P	$3p \cdot 3d^2\ (^3P)$	^4D
17.	$3p^2\ (^3P) \cdot 3d$	^4F	$3p \cdot 3d^2\ (^3F)$	^4D
18.	$3d^3\ (^4F)$	^4F	$3s \cdot 3p\ (^3P) \cdot 3d$	^4D
19.	$3p^2\ (^3P) \cdot 3d$	^4D	$3p \cdot 3d^2\ (^3P)$	^4P
20.	$3p^2\ (^3P) \cdot 3d$	^4P	$3s \cdot 3p\ (^3P) \cdot 3d$	^4P
21.	$3d^3\ (^4P)$	^4P	$3p \cdot 3d^2\ (^3P)$	^2S
22.	$3s \cdot 3d^2\ (^3P)$	^4P	$3p \cdot 3d^2\ (^1D)$	^2F
23.	$3s \cdot 3p^2\ (^3P)$	^4P	$3p \cdot 3d^2\ (^3F)$	^2F
24.	$3p^2\ (^1D) \cdot 3d$	^2G	$3p \cdot 3d^2\ (^1G)$	^2F
25.	$3d^3\ (^2G)$	^2G	$3s \cdot 3p\ (^1P) \cdot 3d$	^2F
26.	$3p^2\ (^1D) \cdot 3d$	^2S	$3s \cdot 3p\ (^3P) \cdot 3d$	^2F
27.	$3s \cdot 3d^2\ (^1S)$	^2S	$3p \cdot 3d^2\ (^3F)$	^4G
28.	$3s \cdot 3p^2\ (^1S)$	^2S	$3p \cdot 3d^2\ (^3F)$	^4F
29.	$3d^3\ (^2H)$	^2H	$3s \cdot 3p\ (^3P) \cdot 3d$	^4F
30.			$3p \cdot 3d^2\ (^3F)$	^2G
31.			$3p \cdot 3d^2\ (^1G)$	^2G
32.			$3p \cdot 3d^2\ (^1G)$	^2H

Table 2. A comparison of mean radii and spin-orbit parameters for a constrained calculation with an unconstrained calculation where radial functions depend on the configuration.

	Constrained	Unconstrained	Difference
$\langle r_{3s_1} \rangle$	0.7021 au	0.7022 au	0.01%
$\langle r_{3s_2} \rangle$		0.7013	0.11
$\langle r_{3p_1} \rangle$	0.6959	0.6959	0.0
$\langle r_{3p_2} \rangle$		0.6935	0.35
$\langle r_{3d_1} \rangle$	0.6429	0.6424	0.08
$\langle r_{3d_2} \rangle$		0.6434	0.08
$\langle r_{3d_3} \rangle$		0.6487	0.90
$\langle r_{3d_4} \rangle$		0.6457	0.44
ζ_{3p_1}	12022. cm^{-1}	12033. cm^{-1}	0.09
ζ_{3p_2}		12101.	0.66
ζ_{3d_1}	1171.5	1175.2	0.32
ζ_{3d_2}		1161.9	0.82
ζ_{3d_3}		1149.8	1.85
ζ_{3d_4}		1163.5	0.68

Table 3. Energy levels for states in Fe XIV with three electrons in the M shell.

Configuration	LS	[J]	Level (cm^{-1})
3S2.3P	2P	2	0.
3S2.3P	2P	4	17543.
3S.3P2(3P)	4P	2	221664.
3S.3P2(3P)	4P	4	228728.
3S.3P2(3P)	4P	6	237879.
3S.3P2(1D)	2D	4	298497.
3S.3P2(1D)	2D	6	300398.
3S.3P2(1S)	2S	2	368154.
3S.3P2(3P)	2P	2	391908.
3S.3P2(3P)	2P	4	399776.
3S2.3D	2D	4	481406.
3S2.3D	2D	6	483804.
3P3(2D)	2D	4	574048.
3P3(2D)	2D	6	577393.
3P3(4S)	4S	4	587379.
3S.3P(3P).3D	4F	4	642323.
3P3(2P)	2P	2	643532.
3P3(2P)	2P	4	646244.
3S.3P(3P).3D	4F	6	646275.
3S.3P(3P).3D	4F	8	651957.
3S.3P(3P).3D	4F	10	659761.
3S.3P(3P).3D	4P	6	693021.
3S.3P(3P).3D	4D	4	695211.
3S.3P(3P).3D	4D	2	696741.
3S.3P(3P).3D	4P	2	704729.
3S.3P(3P).3D	4P	4	705610.
3S.3P(3P).3D	4D	8	706043.
3S.3P(3P).3D	4D	6	706125.
3S.3P(3P).3D	2D	4	721106.
3S.3P(3P).3D	2D	6	721722.
3S.3P(3P).3D	2F	6	753326.
3S.3P(3P).3D	2F	8	767317.
3S.3P(3P).3D	2P	4	818530.
3S.3P(3P).3D	2P	2	826421.
3S.3P(1P).3D	2F	8	832076.
3S.3P(1P).3D	2F	6	834678.
3S.3P(1P).3D	2P	2	853782.
3S.3P(1P).3D	2D	4	854718.
3S.3P(1P).3D	2D	6	857780.
3S.3P(1P).3D	2P	4	857923.
3P2(3P).3D	4F	4	968776.
3P2(3P).3D	4F	6	973098.
3P2(3P).3D	4F	8	979010.
3P2(3P).3D	4F	10	986217.
3P2(3P).3D	2P	4	986409.
3P2(3P).3D	4D	2	990900.
3P2(1D).3D	2F	6	991376.
3P2(3P).3D	4D	8	995642.
3P2(3P).3D	4D	4	998014.
3P2(3P).3D	4D	6	1000663.
3P2(3P).3D	2P	2	1004681.
3P2(3P).3D	4D	8	1011266.
3P2(1D).3D	2D	6	1039361.
3P2(1D).3D	2D	4	1042493.
3P2(1D).3D	2G	8	1044674.
3P2(1D).3D	2G	10	1047862.
3P2(3P).3D	4P	2	1049885.
3P2(3P).3D	4P	4	1050199.
3P2(3P).3D	4P	6	1050208.
3P2(1D).3D	2P	2	1086090.
3P2(1D).3D	2P	4	1088478.
3P2(1D).3D	2S	2	1097594.
3P2(1S).3D	2D	4	1098146.
3P2(1S).3D	2D	6	1107480.
3P2(3P).3D	2F	6	1140754.
3P2(3P).3D	2F	8	1145068.
3S.3D2(3P)	4P	2	1167791.
3S.3D2(3P)	4P	4	1168420.

Table 3 (continued)

Configuration	LS	[J]	Level (cm^{-1})	Configuration	LS	[J]	Level (cm^{-1})
3S.3D2(3P)	4P	6	1169386.	3P.3D2(1D)	2P	4	1483484.
3P2(3P).3D	2D	6	1172495.	3P.3D2(1D)	2P	2	1490428.
3P2(3P).3D	2D	4	1174704.	3P.3D2(3P)	4S	4	1507397.
3S.3D2(1D)	2D	6	1217474.	3P.3D2(1D)	2F	6	1514842.
3S.3D2(1D)	2D	4	1217485.	3P.3D2(1G)	2F	8	1517431.
3S.3D2(1S)	2S	2	1298440.	3P.3D2(1D)	2D	4	1531378.
3S.3D2(1S)	2S	2	1301504.	3P.3D2(1D)	2D	6	1537197.
3S.3D2(3P)	2P	4	1302263.	3P.3D2(1S)	2P	2	1539271.
3P.3D2(3F)	4G	6	1368178.	3P.3D2(1S)	2P	4	1551329.
3P.3D2(3F)	4G	8	1372933.	3P.3D2(1G)	2F	8	1559474.
3P.3D2(3F)	4G	10	1379060.	3P.3D2(1G)	2F	6	1565888.
3P.3D2(3F)	4G	12	1386854.	3P.3D2(3F)	2G	10	1571278.
3P.3D2(1D)	2F	6	1401791.	3P.3D2(3F)	2G	8	1574427.
3P.3D2(1D)	2D	4	1409463.	3P.3D2(3P)	2D	6	1611236.
3P.3D2(1D)	2F	8	1412017.	3P.3D2(3P)	2D	4	1611784.
3P.3D2(3P)	2D	6	1415116.	3P.3D2(3P)	2P	2	1633687.
3P.3D2(3P)	4D	2	1421986.	3P.3D2(3P)	2P	4	1635603.
3P.3D2(3P)	2S	2	1423950.	3D3(4F3)	4F	4	1860016.
3P.3D2(3P)	4D	4	1426045.	3D3(4F3)	4F	6	1861055.
3P.3D2(3P)	4D	6	1430185.	3D3(4F3)	4F	8	1862447.
3P.3D2(3F)	4F	4	1430482.	3D3(4F3)	4F	10	1864142.
3P.3D2(3F)	4F	8	1431837.	3D3(2G3)	2G	8	1894975.
3P.3D2(3F)	4F	6	1432967.	3D3(4P)	4P	2	1895875.
3P.3D2(3F)	4F	10	1435854.	3D3(2G3)	2G	10	1896137.
3P.3D2(3P)	4D	8	1437239.	3D3(4P)	4P	4	1896296.
3P.3D2(1G)	2G	8	1443531.	3D3(4P)	4P	6	1897427.
3P.3D2(1G)	2G	10	1444741.	3D3(2H3)	2H	10	1903438.
3P.3D2(3P)	4P	4	1445163.	3D3(2H3)	2H	12	1904195.
3P.3D2(3P)	4P	2	1446116.	3D3(2D3)	2D	4	1916443.
3P.3D2(3P)	4P	6	1451550.	3D3(2D3)	2D	6	1919042.
3P.3D2(1G)	2H	10	1464537.	3D3(2P)	2P	2	1920104.
3P.3D2(3F)	4D	8	1470137.	3D3(2P)	2P	4	1922632.
3P.3D2(3F)	4D	6	1470399.	3D3(2F)	2F	8	1940308.
3P.3D2(3F)	4D	4	1470483.	3D3(2F)	2F	6	1940886.
3P.3D2(3F)	4D	2	1470845.	3D3(2D1)	2D	6	1994523.
3P.3D2(1G)	2H	12	1475100.	3D3(2D1)	2D	4	1995089.

Table 4. Composition of the two $3p^2$ (^3P) 3d ^4D states with [J] = 8.

Configuration	State	Weight I	Weight II
$3p^2$ (^3P) • 3d	^2F	-0.4263	0.4463
$3p^2$ (^1D) • 3d	^2F	-0.5550	0.5414
$3p^2$ (^3P) • 3d	^4F	0.0851	0.1547
$3p^2$ (^3P) • 3d	^4D	0.7044	0.6890
$3p^2$ (^1D) • 3d	^2G	-0.0822	0.0944
Energy (cm^{-1})		995642.	1011266.

Table 5. A comparison of theoretical and observed energy levels for Fe XIV.

Configuration	LS	[J]	Level (cm^{-1}) Theory	Observed+	Difference
$3s^2$ • 3p	^2P	2	0.0	0.0	0.0
		4	17543.	18852.5	-1309.5
3s • $3p^2$	^2D	4	298497.	299280.	- 783.
		6	300398.	301460.	-1062.
3s • $3p^2$	^2S	2	368154.	364670.	3484.
3s • $3p^2$	^2P	2	391908.	388490.	3418.
		4	399776.	396510.	3266.
$3s^2$ • 3d	^2D	4	481406.	473210	8196.
		6	483804.	475200	8604.

+Reader and Sugar (1972)

Table 6. Line list for transitions in Fe XIV for which gf (length form) ≥ 0.4. The lines are listed in order of increasing wavelength.

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3P2(3P).3D	2F	-	3P3(2D)	2D	8- 6	1.668	1.290	176.2
3P2(3P).3D	2F	-	3P3(2D)	2D	6- 4	1.162	0.894	176.5
3S.3P2(1D)	2D	-	3S.3P(1P).3D	2F	4- 6	0.908	0.809	186.5
3S.3P2(1D)	2D	-	3S.3P(1P).3D	2F	6- 8	1.284	1.168	188.1
3P2(3P).3D	2D	-	3P3(2P)	2P	4- 2	0.633	0.534	188.3
3P2(1D).3D	2G	-	3P.3D2(3F)	2G	8- 8	0.888	0.541	188.8
3P2(3P).3D	2D	-	3P3(2P)	2P	6- 4	1.062	0.913	190.0
3P2(1D).3D	2F	-	3P.3D2(1D)	2F	6- 6	0.804	0.512	191.0
3P2(1D).3D	2G	-	3P.3D2(3F)	2G	10-10	1.060	0.699	191.1
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.549	0.376	191.6
3D3(2D3)	2D	-	3P.3D2(1D)	2F	4- 6	0.475	0.259	194.3
3D3(2P)	2P	-	3P.3D2(3P)	2D	4- 6	0.575	0.357	197.0
3D3(2D3)	2D	-	3P.3D2(1D)	2F	6- 8	0.713	0.361	197.2
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.690	0.499	197.6
3P2(3P).3D	2P	-	3P.3D2(1D)	2P	4- 4	0.687	0.522	201.2
3S.3D2(1D)	2D	-	3S.3P(3P).3D	2D	4- 4	1.098	0.867	201.5
3S.3D2(1D)	2D	-	3S.3P(3P).3D	2D	6- 6	1.597	1.274	201.7
3D3(4F)	4F	-	3P.3D2(3F)	4G	8-10	0.482	0.253	206.9
3S2.3D	2D	-	3S2.3P	2P	4- 2	0.991	0.887	207.7
3S.3D2(1S)	2S	-	3S.3P(3P).3D	2P	2- 4	0.592	0.328	208.4
3D3(4F)	4F	-	3P.3D2(3F)	4G	10-12	0.546	0.290	209.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	4- 6	0.473	0.456	209.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	4- 4	0.597	0.543	209.7
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4P	6- 6	0.651	0.511	209.9
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4P	4- 6	0.920	0.606	210.3
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	2- 2	0.566	0.526	210.5
3P2(3P).3D	4D	-	3P.3D2(3F)	4D	8- 8	0.790	0.619	210.7
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	2- 4	0.795	0.727	211.2
3P2(3P).3D	4P	-	3P3(2D)	2D	6- 6	0.532	0.474	211.5
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4D	2- 4	0.601	0.396	211.6
3P2(3P).3D	2F	-	3P.3D2(3P)	2D	6- 4	0.736	0.238	212.3
3P2(3P).3D	4D	-	3P.3D2(3F)	4D	6- 6	0.411	0.335	212.9
3P2(1D).3D	2D	-	3P3(2D)	2D	4- 4	0.731	0.662	213.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	6- 6	1.152	1.077	213.6
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	6- 8	2.362	2.297	213.6
3P2(1D).3D	2D	-	3P.3D2(3P)	4S	6- 4	0.645	0.401	213.7
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2F	6- 8	0.944	0.882	214.2
3P2(3P).3D	2F	-	3P.3D2(3P)	2D	8- 6	0.865	0.250	214.5
3S2.3D	2D	-	3S2.3P	2P	6- 4	1.777	1.696	214.5
3D3(4P)	4P	-	3P.3D2(3F)	4F	6- 8	0.445	0.266	214.8
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	4- 6	1.087	1.033	215.4
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4P	6- 4	0.431	0.319	215.6
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4P	4- 2	0.558	0.418	215.7
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4D	6- 8	0.664	0.361	215.8
3S.3D2(3P)	4P	-	3S.3P(3P).3D	4D	6- 6	0.851	0.584	215.9
3P2(3P).3D	2D	-	3P.3D2(3P)	2P	6- 4	1.043	0.528	215.9
3P2(3P).3D	4P	-	3P3(4S)	4S	4- 4	1.128	1.041	216.1
3P2(3P).3D	4P	-	3P3(4S)	4S	6- 4	0.946	0.877	216.1
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2D	2- 4	1.482	1.379	216.1
3P2(3P).3D	4P	-	3P3(4S)	4S	2- 4	0.681	0.628	216.2

Table 6 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3P2(1D).3D	2D	-	3P3(2D)	2D	6- 6	0.658	0.618	216.5
3P2(3P).3D	4F	-	3P.3D2(3F)	4F	4- 4	0.980	0.839	216.6
3D3(2G)	2G	-	3P.3D2(3F)	4F	10-10	0.438	0.299	217.3
3P2(3P).3D	4F	-	3P.3D2(3F)	4F	6- 6	0.745	0.686	217.5
3P2(3P).3D	4D	-	3P.3D2(3F)	4D	8- 8	0.525	0.430	217.9
3P2(3P).3D	2D	-	3P.3D2(3P)	2P	4- 2	0.605	0.324	217.9
3P2(3P).3D	4F	-	3P.3D2(1G)	2G	10-10	0.505	0.418	218.1
3P2(3P).3D	4F	-	3P.3D(3P)	4D	8- 8	0.585	0.555	218.2
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2P	4- 4	0.816	0.726	218.3
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2D	4- 6	2.717	2.590	218.3
3P2(3P).3D	4P	-	3P.3D2(3P)	4S	2- 4	0.464	0.297	218.6
3P2(3P).3D	4P	-	3P.3D2(3P)	4S	4- 4	0.721	0.463	218.7
3P2(3P).3D	4P	-	3P.3D2(3P)	4S	6- 4	0.804	0.518	218.7
3P2(3P).3D	4F	-	3P.3D(3P)	4D	6- 6	0.679	0.530	218.8
3P2(3P).3D	4D	-	3P.3D2(3P)	4P	8- 6	0.512	0.317	219.3
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2F	4- 6	0.607	0.603	219.9
3P2(3P).3D	4F	-	3P.3D2(3F)	4F	8- 6	0.755	0.539	220.3
3P2(3P).3D	4F	-	3P.3D2(3F)	4F	8- 8	1.391	1.170	220.8
3P2(1D).3D	2D	-	3P3(4S)	4S	6- 4	1.034	0.994	221.2
3P2(1D).3D	2F	-	3P.3D2(1G)	2G	6- 8	0.621	0.512	221.2
3D3(2G)	2G	-	3P.3D2(1G)	2G	10-10	1.733	1.239	221.5
3D3(2G)	2G	-	3P.3D2(1G)	2G	8- 8	1.757	1.225	221.5
3P2(1D).3D	2S	-	3P3(2P)	2P	2- 4	0.475	0.390	221.6
3P2(3P).3D	4F	-	3P.3D(3P)	4D	10- 8	0.946	0.635	221.7
3S.3P2(1S)	2S	-	3S.3P(3P).3D	2P	2- 4	1.224	1.108	222.0
3P2(3P).3D	4F	-	3P.3D2(3F)	4F	10-10	2.282	2.055	222.4
3S.3D2(1S)	2S	-	3S.3P(1P).3D	2D	2- 4	0.676	0.363	223.8
3D3(4P)	4P	-	3P.3D2(3P)	4P	6- 6	0.762	0.616	224.3
3S.3D2(1S)	2S	-	3S.3P(1P).3D	2P	2- 2	0.767	0.469	224.9
3P2(3P).3D	4D	-	3P.3D2(3P)	4P	6- 4	0.465	0.311	225.0
3S.3D2(3P)	2P	-	3S.3P(1P).3D	2D	4- 6	0.885	0.468	225.0
3S.3D2(3P)	2P	-	3S.3P(1P).3D	2P	4- 4	1.672	1.200	225.1
3P2(1S).3D	2D	-	3P.3D2(1S)	2P	6- 4	0.928	0.470	225.3
3S.3D2(1S)	2S	-	3S.3P(1P).3D	2P	2- 4	0.402	0.234	225.4
3P2(3P).3D	4D	-	3P.3D2(1G)	2G	6- 8	0.428	0.388	225.8
3P2(1D).3D	2P	-	3P3(2P)	2P	2- 2	0.459	0.401	226.0
3P2(1D).3D	2P	-	3P3(2P)	2P	4- 4	0.422	0.374	226.1
3P2(3P).3D	4D	-	3P.3D2(3P)	4P	8- 6	0.560	0.391	227.1
3P2(3P).3D	4D	-	3P.3D2(3F)	4F	8-10	1.020	0.967	227.2
3D3(2H)	2H	-	3P.3D2(1G)	2H	10-10	1.393	1.171	227.8
3P2(3P).3D	2D	-	3P.3D2(3P)	2D	6- 6	0.545	0.388	227.9
3P2(3P).3D	2P	-	3P.3D2(3P)	2S	4- 2	0.512	0.383	228.5
3D3(2D3)	2D	-	3P.3D2(1D)	2P	6- 4	0.772	0.755	229.6
3D3(2D1)	2D	-	3P.3D2(1G)	2F	6- 8	1.161	0.374	229.9
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2P	2- 2	0.470	0.434	230.1
3P2(3P).3D	2F	-	3P.3D2(3F)	2G	6- 8	2.341	2.315	230.6
3P2(3P).3D	4D	-	3P.3D2(1G)	2G	8-10	1.100	1.044	230.7
3P2(1S).3D	2D	-	3P.3D2(1D)	2D	4- 4	0.644	0.497	230.8
3D3(2D3)	2D	-	3P.3D2(1D)	2P	4- 4	0.536	0.424	231.0
3P2(1D).3D	2D	-	3P.3D2(3F)	4D	6- 8	1.175	1.148	232.1
3D3(4F)	4F	-	3P.3D2(3F)	4F	8- 8	1.143	0.831	232.2
3P2(1S).3D	2D	-	3P.3D2(1D)	2D	6- 6	1.474	1.283	232.7
3D3(4F)	4F	-	3P.3D2(3F)	4F	4- 4	1.184	0.911	232.8
3D3(2H)	2H	-	3P.3D2(1G)	2H	12-12	1.498	1.360	233.0
3D3(2D1)	2D	-	3P.3D2(1G)	2F	4- 6	1.129	0.386	233.0
3D3(4F)	4F	-	3P.3D2(3F)	4F	10-10	2.541	1.934	233.5

Table 6 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3D3(4F)	4F	-	3P.3D2(3F)	4F	6- 6	1.295	1.043	233.6
3D3(4P)	4P	-	3P.3D2(3F)	4D	6- 8	0.988	0.498	234.0
3P2(1D).3D	2G	-	3P.3D2(1G)	2H	10-12	2.403	2.331	234.1
3P2(3P).3D	2F	-	3P.3D2(3F)	2G	8-10	5.677	5.700	234.6
3D3(2F)	2F	-	3P.3D2(1D)	2F	6- 6	1.130	0.843	234.7
3D3(4P)	4P	-	3P.3D2(3F)	4D	4- 6	0.691	0.377	234.8
3D3(4F)	4F	-	3P.3D(3P)	4D	8- 8	1.053	0.863	235.2
3P2(3P).3D	2F	-	3S.3P(3P).3D	2D	8- 6	0.736	0.826	236.2
3D3(2F)	2F	-	3P.3D2(1G)	2F	8- 8	1.630	1.244	236.5
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	4- 4	1.091	1.016	236.6
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	6- 6	1.592	1.501	237.3
3P2(3P).3D	4P	-	3P.3D2(3F)	4D	2- 2	0.568	0.574	237.6
3P2(3P).3D	4P	-	3P.3D2(3F)	4D	2- 4	0.612	0.621	237.8
3P2(3P).3D	4P	-	3P.3D2(3F)	4D	4- 4	0.469	0.478	237.9
3P2(3P).3D	4P	-	3P.3D2(3F)	4D	4- 6	1.170	1.189	238.0
3P2(3P).3D	4P	-	3P.3D2(3F)	4D	6- 8	1.620	1.623	238.1
3P2(1D).3D	2G	-	3P.3D2(1G)	2H	8-10	1.617	1.601	238.2
3P2(3P).3D	2F	-	3S.3P(3P).3D	2D	6- 4	0.477	0.542	238.3
3D3(4F)	4F	-	3P.3D2(1G)	2G	10-10	0.631	0.499	238.4
3P2(3P).3D	2F	-	3P.3D2(1G)	2F	6- 8	1.957	1.919	238.8
3P2(3P).3D	2P	-	3P3(2D)	2D	4- 6	0.517	0.425	244.5
3P2(3P).3D	2D	-	3P.3D2(3F)	2G	6- 8	1.841	2.074	248.8
3P2(3P).3D	4F	-	3P.3D2(3F)	4G	10-12	1.103	1.278	249.6
3P2(3P).3D	4F	-	3P.3D2(3F)	4G	8-10	0.872	1.010	250.0
3P2(3P).3D	4F	-	3P.3D2(3F)	4G	6- 8	0.664	0.768	250.1
3P2(3P).3D	4F	-	3P.3D2(3F)	4G	4- 6	0.492	0.569	250.4
3P2(1D).3D	2G	-	3P.3D2(1G)	2G	8- 8	0.685	0.944	250.7
3P2(1D).3D	2G	-	3P.3D2(1G)	2G	10-10	0.580	0.832	252.0
3D3(4F)	4F	-	3P.3D2(3F)	4D	10- 8	2.585	2.753	253.8
3S.3D2(1D)	2D	-	3P.3D2(3P)	2D	6- 6	0.452	0.434	254.0
3D3(4F)	4F	-	3P.3D2(3F)	4D	8- 6	1.719	1.826	255.1
3P2(3P).3D	2D	-	3P.3D2(1G)	2F	4- 6	2.411	2.816	255.6
3D3(4F)	4F	-	3P.3D2(3F)	4D	6- 4	1.041	1.109	256.0
3D3(4P)	4P	-	3P.3D2(3P)	4S	6- 4	1.290	1.034	256.4
3D3(4F)	4F	-	3P.3D2(3F)	4D	4- 2	0.590	0.635	257.0
3D3(4P)	4P	-	3P.3D2(3P)	4S	4- 4	0.752	0.588	257.1
3P2(3P).3D	2D	-	3P.3D2(1G)	2F	6- 8	1.653	1.990	258.4
3S.3D2(1D)	2D	-	3S.3P(1P).3D	2F	6- 8	0.496	0.127	259.5
3D3(2D3)	2D	-	3P.3D2(1D)	2D	4- 4	0.987	0.643	259.7
3D3(2D1)	2D	-	3P.3D2(3P)	2D	6- 6	0.702	0.410	260.9
3S.3D2(1D)	2D	-	3S.3P(1P).3D	2F	4- 6	0.410	0.118	261.2
3S.3P2(3P)	2P	-	3S2.3P	2P	4- 4	1.449	1.247	261.6
3D3(2D3)	2D	-	3P.3D2(1D)	2D	6- 6	1.890	1.307	261.9
3D3(2G)	2G	-	3P.3D2(1D)	2F	8- 6	0.901	1.048	263.1
3D3(2G)	2G	-	3P.3D2(1G)	2F	10- 8	0.631	0.757	264.1
3S2.3D	2D	-	3S.3P(1P).3D	2P	4- 4	0.470	0.312	265.6
3S.3P2(3P)	2P	-	3S2.3P	2P	2- 4	0.473	0.407	267.1
3S2.3D	2D	-	3S.3P(1P).3D	2P	6- 4	0.952	0.464	267.3
3S2.3D	2D	-	3S.3P(1P).3D	2D	6- 6	1.341	1.090	267.4
3S2.3D	2D	-	3S.3P(1P).3D	2D	4- 4	0.518	0.460	267.9
3P2(1D).3D	2D	-	3P.3D2(1D)	2F	6- 8	0.601	0.725	268.3
3S2.3D	2D	-	3S.3P(1P).3D	2P	4- 2	0.702	0.365	268.5
3S2.3D	2D	-	3S.3P(1P).3D	2D	6- 4	0.422	0.248	269.6
3D3(2F)	2F	-	3P.3D2(3F)	2G	8-10	0.586	0.183	271.0
3S.3D2(1D)	2D	-	3S.3P(1P).3D	2P	4- 2	0.404	0.394	274.9
3D3(2D1)	2D	-	3P.3D2(3P)	2P	4- 2	0.976	0.856	276.7

Table 6 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3S.3D2(1D)	2D	-	3S.3P(1P).3D	2P	6- 4	0.618	0.600	278.1
3D3(2D1)	2D	-	3P.3D2(3P)	2P	6- 4	1.687	1.538	278.6
3S.3P2(3P)	4P	-	3P3(4S)	4S	4- 4	0.591	0.495	278.8
3P2(3P).3D	2D	-	3S.3P(3P).3D	2P	6- 4	1.225	1.382	282.5
3S2.3D	2D	-	3S.3P(1P).3D	2F	4- 6	1.894	2.145	283.1
3P2(3P).3D	4D	-	3S.3P(3P).3D	4F	8-10	0.482	0.253	284.5
3S.3P2(3P)	4P	-	3P3(4S)	4S	6- 4	0.854	0.761	286.1
3P2(3P).3D	4D	-	3S.3P(3P).3D	4F	6- 8	0.505	0.267	286.8
3P2(3P).3D	2D	-	3S.3P(3P).3D	2P	4- 2	0.852	1.007	287.1
3S2.3D	2D	-	3S.3P(1P).3D	2F	6- 8	2.557	3.008	287.1
3S.3P2(1D)	2D	-	3P3(2P)	2P	6- 4	0.505	0.360	289.1
3P2(1S).3D	2D	-	3S.3P(3P).3D	2F	4- 6	0.413	0.166	290.0
3P2(3P).3D	4P	-	3S.3P(3P).3D	4D	6- 8	0.618	0.414	290.6
3P2(3P).3D	4P	-	3S.3P(3P).3D	4D	4- 6	0.506	0.364	290.6
3P2(3P).3D	2D	-	3S.3P(1P).3D	2F	6- 8	0.540	0.321	293.8
3P2(1S).3D	2D	-	3S.3P(3P).3D	2F	6- 8	1.051	0.422	294.0
3P2(3P).3D	2D	-	3S.3P(1P).3D	2F	4- 6	0.493	0.314	294.1
3S.3D2(1S)	2S	-	3P.3D2(3P)	2P	2- 4	0.458	0.374	296.6
3D3(2G)	2G	-	3P.3D2(1G)	2F	10- 8	2.619	3.756	297.0
3P2(3P).3D	4D	-	3S.3P(3P).3D	4F	8-10	0.525	0.305	297.7
3S.3D2(3P)	2P	-	3P.3D2(3P)	2P	4- 4	1.173	0.761	300.0
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	6- 8	0.477	0.340	300.0
3D3(2H)	2H	-	3P.3D2(3F)	2G	12-10	4.700	7.089	300.4
3S.3D2(1S)	2S	-	3P.3D2(3P)	2P	2- 2	0.570	0.439	301.0
3D3(2H)	2H	-	3P.3D2(3F)	2G	10- 8	3.456	5.345	303.9
3D3(2G)	2G	-	3P.3D2(1G)	2F	8- 6	1.513	2.272	303.9
3D3(2F)	2F	-	3P.3D2(3P)	2D	8- 6	1.930	2.536	303.9
3D3(2F)	2F	-	3P.3D2(3P)	2D	6- 4	1.392	1.822	303.9
3P2(3P).3D	4F	-	3S.3P(3P).3D	4F	8- 8	0.990	0.868	305.8
3P2(3P).3D	4F	-	3S.3P(3P).3D	4F	6- 6	0.624	0.554	306.0
3P2(3P).3D	4F	-	3S.3P(3P).3D	4F	10-10	1.783	1.547	306.3
3P2(3P).3D	4F	-	3S.3P(3P).3D	4F	4- 4	0.518	0.459	306.3
3P2(3P).3D	2F	-	3S.3P(3P).3D	2P	6- 4	0.463	0.596	310.3
3S.3D2(1D)	2D	-	3P.3D2(1D)	2D	6- 6	0.528	0.284	312.8
3P2(3P).3D	2D	-	3S.3P(1P).3D	2D	6- 6	0.747	0.687	317.7
3S.3D2(1S)	2S	-	3P.3D2(3P)	2D	2- 4	0.521	0.512	319.1
3P2(3P).3D	2F	-	3S.3P(1P).3D	2F	8- 8	0.948	0.875	319.5
3S.3D2(1S)	2S	-	3P.3D2(3P)	2D	2- 4	0.435	0.427	322.3
3S.3D2(3P)	2P	-	3P.3D2(3P)	2D	4- 6	1.500	1.536	323.7
3P2(3P).3D	2F	-	3S.3P(1P).3D	2F	6- 6	0.511	0.491	326.7
3P2(3P).3D	4D	-	3S.3P(3P).3D	4P	8- 6	0.556	0.564	330.4
3S.3D2(1D)	2D	-	3P.3D2(1G)	2F	6- 8	1.163	1.425	333.4
3S.3D2(1D)	2D	-	3P.3D2(1D)	2F	4- 6	0.720	0.981	336.3
3P2(1D).3D	2G	-	3S.3P(3P).3D	2F	8- 6	0.644	0.722	343.2
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	8- 6	0.607	0.696	345.4
3P2(3P).3D	2F	-	3S.3P(1P).3D	2D	8- 6	1.979	3.258	348.1
3P2(3P).3D	2F	-	3S.3P(1P).3D	2D	6- 4	1.106	1.761	349.6
3S.3D2(3P)	4P	-	3P.3D2(3P)	4P	6- 6	0.556	0.383	354.4
3P2(1D).3D	2G	-	3S.3P(3P).3D	2F	10- 8	0.837	1.006	356.4
3P2(3P).3D	4F	-	3S.3P(3P).3D	4D	10- 8	0.776	0.924	356.9
3S.3D2(3P)	4P	-	3P.3D(3P)	4D	6- 8	0.509	0.477	373.3
3P2(3P).3D	4D	-	3S.3P(3P).3D	2F	8- 8	0.430	0.484	409.9
3P2(1D).3D	2F	-	3S.3P(3P).3D	2F	6- 6	0.529	0.627	420.1
3P2(1D).3D	2G	-	3S.3P(1P).3D	2F	10- 8	1.291	2.394	463.4
3P2(1D).3D	2G	-	3S.3P(1P).3D	2F	8- 6	0.917	1.795	476.2

Table 7. Transitions from levels of $3s^2 \cdot 3p$, $3s \cdot 3p^2$, and $3s^2 \cdot 3d$ with $gf \geq 0.01$, listed according to increasing wavelength.

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3S.3P2(1D)	2D	-	3S.3P(1P).3D	2F	4- 6	0.908	0.809	186.5
3S.3P2(1D)	2D	-	3S.3P(1P).3D	2F	6- 6	0.053	0.048	187.2
3S.3P2(1D)	2D	-	3S.3P(1P).3D	2F	6- 8	1.284	1.168	188.1
3S.3P2(3P)	4P	-	3S.3P(3P).3D	2F	6- 8	0.016	0.012	188.9
3S.3P2(3P)	4P	-	3S.3P(3P).3D	2D	4- 6	0.017	0.014	202.8
3S.3P2(1S)	2S	-	3S.3P(1P).3D	2P	2- 4	0.176	0.152	204.2
3S.3P2(1S)	2S	-	3S.3P(1P).3D	2D	2- 4	0.023	0.022	205.5
3S.3P2(1S)	2S	-	3S.3P(1P).3D	2P	2- 2	0.242	0.195	205.9
3S2.3D	2D	-	3S2.3P	2P	4- 2	0.991	0.887	207.7
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	4- 6	0.473	0.456	209.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	4- 4	0.597	0.543	209.7
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	4- 2	0.398	0.350	210.1
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	2- 2	0.566	0.526	210.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	2- 4	0.795	0.727	211.2
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	6- 6	1.152	1.077	213.6
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	6- 8	2.362	2.297	213.6
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	6- 4	0.339	0.311	213.8
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2F	6- 8	0.944	0.882	214.2
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	4- 4	0.149	0.152	214.4
3S2.3D	2D	-	3S2.3P	2P	6- 4	1.777	1.696	214.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	4- 6	1.087	1.033	215.4
3S2.3D	2D	-	3S2.3P	2P	4- 4	0.236	0.219	215.6
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2D	2- 4	1.482	1.379	216.1
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2P	2- 2	0.112	0.092	216.5
3S.3P2(1S)	2S	-	3S.3P(3P).3D	2P	2- 2	0.209	0.196	218.2
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2P	4- 4	0.816	0.726	218.3
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2D	4- 6	2.717	2.590	218.3
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4D	6- 4	0.038	0.032	218.7
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4P	6- 6	0.143	0.122	219.7
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2D	4- 4	0.159	0.154	219.8
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2F	4- 6	0.607	0.603	219.9
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2P	4- 2	0.151	0.127	220.3
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2F	6- 6	0.110	0.106	220.8
3S.3P2(1S)	2S	-	3S.3P(3P).3D	2P	2- 4	1.224	1.108	222.0
3S.3P2(3P)	2P	-	3S.3P(1P).3D	2F	4- 6	0.023	0.019	229.9
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2P	2- 2	0.470	0.434	230.1
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2P	4- 2	0.087	0.077	234.4
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2P	2- 4	0.021	0.019	234.4
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	4- 6	0.187	0.175	236.3
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	4- 4	1.091	1.016	236.6
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	6- 6	1.592	1.501	237.3
3S.3P2(1D)	2D	-	3S.3P(3P).3D	2D	6- 4	0.099	0.101	237.7
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2P	4- 4	0.396	0.352	238.8
3S.3P2(3P)	4P	-	3P3(2P)	2P	4- 4	0.013	0.009	239.5
3S.3P2(3P)	4P	-	3S.3P(3P).3D	4F	6- 8	0.016	0.020	241.5
3S.3P2(1D)	2D	-	3S.3P(3P).3D	4D	6- 8	0.020	0.024	246.5
3S.3P2(3P)	2P	-	3S2.3P	2P	4- 2	0.302	0.252	250.1
3S.3P2(1D)	2D	-	3S.3P(3P).3D	4D	4- 4	0.015	0.017	252.1

Table 7 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3S.3P2(1D)	2D	-	3S.3P(3P).3D	4P	6- 6	0.051	0.053	254.7
3S.3P2(3P)	2P	-	3S2.3P	2P	2- 2	0.301	0.260	255.2
3S.3P2(3P)	2P	-	3S2.3P	2P	4- 4	1.449	1.247	261.6
3S2.3D	2D	-	3S.3P(1P).3D	2P	4- 4	0.470	0.312	265.6
3S2.3D	2D	-	3S.3P(1P).3D	2D	4- 6	0.021	0.009	265.7
3S.3P2(3P)	2P	-	3S2.3P	2P	2- 4	0.473	0.407	267.1
3S2.3D	2D	-	3S.3P(1P).3D	2P	6- 4	0.952	0.464	267.3
3S2.3D	2D	-	3S.3P(1P).3D	2D	6- 6	1.341	1.090	267.4
3S2.3D	2D	-	3S.3P(1P).3D	2D	4- 4	0.518	0.460	267.9
3S2.3D	2D	-	3S.3P(1P).3D	2P	4- 2	0.702	0.365	268.5
3S2.3D	2D	-	3S.3P(1P).3D	2D	6- 4	0.422	0.248	269.6
3S.3P2(1S)	2S	-	3S2.3P	2P	2- 2	0.393	0.332	271.6
3S.3P2(3P)	4P	-	3P3(4S)	4S	2- 4	0.300	0.242	273.4
3S.3P2(3P)	4P	-	3P3(4S)	4S	4- 4	0.591	0.495	278.8
3S2.3D	2D	-	3S.3P(1P).3D	2F	4- 6	1.894	2.145	283.1
3S.3P2(1S)	2S	-	3S.3P(3P).3D	2D	2- 4	0.013	0.013	283.3
3S2.3D	2D	-	3S.3P(1P).3D	2F	6- 6	0.066	0.079	285.0
3S.3P2(1S)	2S	-	3S2.3P	2P	2- 4	0.038	0.024	285.2
3S.3P2(3P)	4P	-	3P3(4S)	4S	6- 4	0.854	0.761	286.1
3S2.3D	2D	-	3S.3P(1P).3D	2F	6- 8	2.557	3.008	287.1
3S.3P2(1D)	2D	-	3P3(2P)	2P	4- 4	0.067	0.041	287.6
3S.3P2(1D)	2D	-	3P3(2P)	2P	6- 4	0.505	0.360	289.1
3S.3P2(1D)	2D	-	3P3(2P)	2P	4- 2	0.326	0.226	289.8
3S.3P2(1D)	2D	-	3S.3P(3P).3D	4F	6- 4	0.015	0.012	292.5
3S2.3D	2D	-	3S.3P(3P).3D	2P	4- 4	0.027	0.016	296.6
3S.3P2(3P)	4P	-	3P3(2D)	2D	6- 4	0.027	0.023	297.5
3S2.3D	2D	-	3S.3P(3P).3D	2P	6- 4	0.024	0.058	298.8
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2D	2- 4	0.050	0.049	303.8
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2D	4- 6	0.073	0.070	310.6
3S.3P2(3P)	2P	-	3S.3P(3P).3D	2D	4- 4	0.024	0.022	311.2
3S.3P2(1D)	2D	-	3S2.3P	2P	4- 2	0.159	0.133	335.0
3S2.3D	2D	-	3S.3P(3P).3D	2F	6- 8	0.327	0.291	352.7
3S.3P2(1D)	2D	-	3S2.3P	2P	6- 4	0.223	0.203	353.5
3S.3P2(1D)	2D	-	3P3(2D)	2D	4- 6	0.035	0.020	358.6
3S.3P2(1S)	2S	-	3P3(2P)	2P	2- 4	0.147	0.128	359.6
3S.3P2(1D)	2D	-	3P3(2D)	2D	6- 6	0.365	0.288	361.0
3S.3P2(1D)	2D	-	3P3(2D)	2D	4- 4	0.183	0.143	362.9
3S.3P2(1D)	2D	-	3P3(2D)	2D	6- 4	0.072	0.065	365.4
3S2.3D	2D	-	3S.3P(3P).3D	2F	4- 6	0.187	0.180	367.8
3S2.3D	2D	-	3S.3P(3P).3D	2F	6- 6	0.041	0.041	371.0
3S.3P2(3P)	2P	-	3P3(2P)	2P	2- 2	0.160	0.144	397.4
3S.3P2(3P)	2P	-	3P3(2P)	2P	4- 4	0.267	0.209	405.7
3S.3P2(3P)	2P	-	3P3(2P)	2P	4- 2	0.037	0. 30	410.2
3S2.3D	2D	-	3S.3P(3P).3D	2D	4- 6	0.018	0.015	416.1
3S2.3D	2D	-	3S.3P(3P).3D	2D	4- 4	0.049	0.017	417.2
3S2.3D	2D	-	3S.3P(3P).3D	2D	6- 6	0.062	0.019	420.3
3S.3P2(1S)	2S	-	3P3(2D)	2D	2- 4	0.045	0.040	485.7
3S.3P2(3P)	2P	-	3P3(2D)	2D	2- 4	0.088	0.071	549.0
3S.3P2(3P)	2P	-	3P3(2D)	2D	4- 6	0.182	0.167	563.0

Table 8. A comparison of theoretical and observed wavelengths in angstroms.

Configuration			Configuration		[J]-[J°]	Theory Present	Theory Cowan[1]	Observed[2]
$3s^2 \cdot 3d$	^2P	-	$3s^2 \cdot 3p$	^2P	4- 2	207.7	207.5	211.30[1]
					6- 4	214.5	214.6	219.13[1]
$3s \cdot 3p^2$	^2P	-	$3s^2 \cdot 3p$	^2P	4- 2	250.1		252.20
					2- 2	255.2		257.40
					4- 4	261.6		264.79
					4- 2	267.1		270.51
$3s \cdot 3p^2$	^2S	-	$3s^2 \cdot 3p$	^2P	2- 2	271.6		274.23[1]
					2- 4	285.2		289.15[1]
$3s \cdot 3p^2$	^4P	-	$3p^3$	^4S	2- 4	273.4		274.
					4- 4	278.8		280.69
					6- 4	286.1		288.45
$3s \cdot 3p^2$	^2D	-	$3s^2 \cdot 3p$	^2P	6- 4	335.0	331.8	334.13[1]
					4- 2	353.5	351.6	353.82[1]

[1] Fawcett et al. (1972).

[2] Fawcett (1970) except as indicated otherwise.

Table 9. Intercombination lines listed in order of decreasing gf value (length form.

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3P2(1D).3D	2D	-	3P.3D2(3F)	4D	6- 8	1.175	1.148	232.1
3P2(3P).3D	4D	-	3P.3D2(1G)	2G	8-10	1.100	1.044	230.7
3P2(1D).3D	2D	-	3P3(4S)	4S	6- 4	1.034	0.994	221.2
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.690	0.499	197.6
3P2(1D).3D	2D	-	3P.3D2(3P)	4S	6- 4	0.645	0.401	213.7
3D3(4F)	4F	-	3P.3D2(1G)	2G	10-10	0.631	0.499	238.4
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	8- 6	0.607	0.696	345.4
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.549	0.376	191.6
3P2(3P).3D	4P	-	3P3(2D)	2D	6- 6	0.532	0.474	211.5
3P2(3P).3D	4F	-	3P.3D2(1G)	2G	10-10	0.505	0.418	218.1
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	6- 8	0.477	0.340	300.0
3D3(2G)	2G	-	3P.3D2(3F)	4F	10-10	0.438	0.299	217.3
3P2(3P).3D	4D	-	3S.3P(3P).3D	2F	8- 8	0.430	0.484	409.9
3P2(3P).3D	4D	-	3P.3D2(1G)	2G	6- 8	0.428	0.388	225.8
3P2(3P).3D	4D	-	3S.3P(3P).3D	2F	8- 8	0.379	0.484	438.0
3P2(3P).3D	4P	-	3P.3D2(1G)	2F	6- 8	0.375	0.376	214.0
3P2(1D).3D	2D	-	3S.3P(3P).3D	4P	6- 6	0.358	0.291	288.7
3P2(1D).3D	2D	-	3P.3D2(3F)	4D	4- 6	0.342	0.342	233.7
3P2(3P).3D	4D	-	3P.3D2(1D)	2F	6- 6	0.337	0.224	194.5
3P2(3P).3D	4P	-	3P3(2P)	2P	6- 4	0.322	0.344	247.5
3P2(3P).3D	4D	-	3P.3D2(3F)	2G	8-10	0.290	0.142	173.7
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.288	0.134	182.4
3P2(3P).3D	4D	-	3P.3D2(3F)	2G	8-10	0.280	0.146	178.6
3P2(3P).3D	4P	-	3S.3P(3P).3D	2D	6- 6	0.265	0.243	304.4
3P2(1D).3D	2F	-	3P.3D2(3F)	4F	6- 8	0.262	0.237	227.0
3P2(1D).3D	2D	-	3P.3D2(3F)	4D	6- 6	0.250	0.237	232.0
3P2(1D).3D	2D	-	3P.3D2(3P)	4S	4- 4	0.236	0.148	215.1
3P2(3P).3D	4P	-	3P.3D2(1D)	2D	6- 6	0.233	0.161	205.3
3P2(3P).3D	4D	-	3P.3D2(1D)	2P	4- 4	0.229	0.183	206.0
3P2(1D).3D	2D	-	3P3(4S)	4S	4- 4	0.223	0.208	219.7
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	8- 8	0.220	0.091	177.4
3P2(3P).3D	4P	-	3P.3D2(1D)	2F	6- 8	0.217	0.264	276.4
3P2(1D).3D	2D	-	3P.3D2(3F)	4D	4- 4	0.200	0.191	233.6
3P2(1D).3D	2F	-	3P.3D2(3F)	4D	6- 6	0.196	0.151	208.8
3P2(3P).3D	4P	-	3P.3D2(3P)	2D	6- 6	0.190	0.122	178.2
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	4- 6	0.187	0.143	297.3
3P2(3P).3D	2P	-	3P.3D2(3P)	4P	2- 2	0.184	0.128	226.5
3P2(3P).3D	4D	-	3S.3P(3P).3D	2F	6- 6	0.182	0.204	404.3
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	8- 6	0.172	0.212	365.1
3P2(1D).3D	2F	-	3S.3P(3P).3D	4F	6- 8	0.170	0.095	294.6
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	6- 4	0.169	0.210	357.7
3P2(3P).3D	4P	-	3P.3D2(1D)	2F	4- 6	0.158	0.160	215.2
3P2(3P).3D	4D	-	3P.3D2(3P)	2D	8- 6	0.158	0.161	238.4
3P2(1D).3D	2F	-	3P.3D2(3P)	4P	6- 4	0.147	0.093	220.4
3D3(2P)	2P	-	3P.3D(3P)	4D	4- 6	0.121	0.078	203.1
3P2(3P).3D	2P	-	3P.3D2(3F)	4D	4- 4	0.121	0.094	206.6
3P2(3P).3D	4P	-	3P.3D2(3P)	2D	4- 6	0.115	0.135	274.0
3P2(3P).3D	4D	-	3P.3D2(3P)	2S	2- 2	0.111	0.080	230.9
3P2(3P).3D	4D	-	3P.3D2(1G)	2G	8-10	0.109	0.081	222.7
3P2(3P).3D	4D	-	3P3(2D)	2D	2- 4	0.101	0.079	239.9

Table 9 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3P2(3P).3D	4P	-	3P.3D2(1D)	2D	4- 4	0.099	0.069	207.8
3D3(4F)	4F	-	3P.3D2(1G)	2G	8- 8	0.099	0.080	238.7
3P2(1D).3D	2F	-	3S.3P(3P).3D	4D	6- 4	0.099	0.100	337.6
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	6- 4	0.098	0.080	290.6
3P2(1D).3D	2F	-	3P.3D(3P)	4D	6- 8	0.097	0.097	224.3
3P2(3P).3D	4P	-	3S.3P(3P).3D	2D	4- 4	0.095	0.081	303.9
3D3(2F)	2F	-	3P.3D2(3F)	4F	8-10	0.092	0.035	198.2
3D3(4P)	4P	-	3P.3D2(3P)	2D	4- 6	0.091	0.060	207.8
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	4- 4	0.091	0.064	287.9
3P2(3P).3D	4D	-	3S.3P(1P).3D	2D	8- 6	0.089	0.227	651.5
3P2(1D).3D	2F	-	3P.3D2(3F)	4F	6- 6	0.085	0.072	226.5
3P2(3P).3D	4D	-	3P3(2D)	2D	4- 6	0.085	0.066	237.7
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	4- 6	0.083	0.049	361.9
3P2(3P).3D	4D	-	3S.3P(1P).3D	2D	8- 6	0.083	0.274	725.4
3P2(3P).3D	2P	-	3S.3P(3P).3D	4F	2- 4	0.082	0.044	276.0
3P2(3P).3D	4D	-	3P.3D2(3P)	2D	8- 6	0.081	0.101	247.6
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	8- 6	0.080	0.006	184.7
3P2(3P).3D	4P	-	3P.3D2(1G)	2F	6- 8	0.080	0.075	196.4
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	8- 6	0.079	0.006	190.1
3D3(4P)	4P	-	3P.3D2(3P)	2S	4- 2	0.078	0.060	211.7
3P2(3P).3D	4F	-	3P.3D2(1D)	2D	4- 4	0.076	0.061	226.9
3P2(3P).3D	2F	-	3P.3D2(3F)	4F	8-10	0.076	0.192	343.9
3P2(1D).3D	2F	-	3S.3P(3P).3D	4D	6- 6	0.076	0.080	350.6
3P2(1D).3D	2P	-	3P.3D(3P)	4D	4- 6	0.074	0.085	292.6
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	6- 4	0.072	0.070	244.6
3P2(3P).3D	4P	-	3P3(2D)	2D	4- 4	0.071	0.063	210.0
3P2(3P).3D	4P	-	3P.3D2(1D)	2F	6- 6	0.071	0.076	284.4
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	6- 6	0.070	0.028	176.9
3P2(3P).3D	4P	-	3P3(2P)	2P	4- 2	0.070	0.070	245.9
3P2(3P).3D	4F	-	3P.3D2(1G)	2G	8- 8	0.069	0.056	215.3
3P2(3P).3D	2P	-	3S.3P(3P).3D	4F	4- 6	0.069	0.033	294.0
3P2(3P).3D	4P	-	3P3(2D)	2D	6- 4	0.068	0.063	210.0
3P2(1D).3D	2F	-	3S.3P(3P).3D	4F	6- 6	0.067	0.040	289.8
3P2(1D).3D	2F	-	3P.3D2(3F)	4D	6- 4	0.066	0.057	208.7
3S.3D2(1D)	2D	-	3S.3P(3P).3D	4P	6- 6	0.065	0.046	190.7
3P2(3P).3D	4D	-	3P.3D2(1D)	2P	2- 2	0.065	0.048	200.2
3P2(3P).3D	4D	-	3P.3D2(1D)	2F	8- 6	0.065	0.043	246.2
3D3(2P)	2P	-	3P.3D(3P)	4D	2- 4	0.063	0.039	202.4
3D3(4F)	4F	-	3P.3D2(1G)	2G	8-10	0.063	0.051	239.4
3P2(3P).3D	4P	-	3P.3D2(3P)	2D	4- 4	0.062	0.041	178.1
3P2(3P).3D	2P	-	3P.3D(3P)	4D	4- 6	0.062	0.058	225.3
3P2(1D).3D	2G	-	3P.3D2(3F)	4F	10-10	0.062	0.109	257.7
3P2(3P).3D	4P	-	3S.3P(1P).3D	2D	6- 6	0.062	0.016	519.7
3P2(1D).3D	2F	-	3P.3D2(3P)	4P	6- 6	0.059	0.040	217.3
3P2(3P).3D	2P	-	3S.3P(3P).3D	4P	2- 2	0.059	0.060	333.4
3P2(1D).3D	2F	-	3S.3P(3P).3D	4P	6- 4	0.059	0.075	349.9
3D3(4P)	4P	-	3P.3D2(1D)	2F	6- 8	0.057	0.030	206.0
3D3(2P)	2P	-	3P.3D2(3P)	4P	4- 2	0.056	0.050	209.9
3P2(3P).3D	4D	-	3P.3D2(1G)	2H	8-10	0.056	0.046	220.6
3P2(3P).3D	4D	-	3P.3D2(3F)	2G	6- 8	0.055	0.028	174.3
3S.3D2(3P)	4P	-	3S.3P(3P).3D	2D	6- 6	0.055	0.044	223.4
3P2(3P).3D	4P	-	3P.3D2(1D)	2F	6- 6	0.054	0.049	215.2
3P2(3P).3D	4F	-	3P.3D2(3P)	2D	6- 6	0.053	0.041	226.2
3S.3D2(3P)	4P	-	3P.3D2(3P)	2D	6- 6	0.053	0.052	406.9
3P2(3P).3D	2P	-	3P.3D2(3F)	4D	4- 2	0.051	0.040	206.4
3P2(1D).3D	2F	-	3P.3D(3P)	4D	6- 4	0.051	0.045	230.1

Table 9 (continued)

Configuration	LS		Configuration	LS°	[J]-[J°]	gf_ℓ	gf_v	λ (Å)
3P2(3P).3D	2P	-	3P.3D2(3F)	4F	2- 4	0.051	0.055	234.9
3S.3P2(1D)	2D	-	3S.3P(3P).3D	4P	6- 6	0.051	0.053	254.7
3P2(3P).3D	4P	-	3P.3D2(1D)	2P	6- 4	0.050	0.057	230.8
3P2(3P).3D	4F	-	3P.3D2(3P)	2S	4- 2	0.049	0.029	219.7
3P2(3P).3D	2P	-	3S.3P(3P).3D	4P	4- 4	0.049	0.057	356.1
3D3(2G)	2G	-	3P.3D(3P)	4D	8- 8	0.048	0.032	218.5
3P2(3P).3D	4D	-	3P.3D2(3P)	2D	6- 6	0.048	0.056	241.3
3P2(3P).3D	4P	-	3P.3D2(3P)	2D	6- 6	0.048	0.036	274.0
3P2(3P).3D	2P	-	3S.3P(3P).3D	4F	4- 4	0.048	0.027	290.6
3P2(3P).3D	4P	-	3S.3P(3P).3D	2D	6- 4	0.048	0.044	303.9
3P2(3P).3D	4F	-	3P.3D2(1G)	2H	10-12	0.047	0.035	204.5
3P2(3P).3D	4D	-	3P3(2D)	2D	8- 6	0.047	0.030	239.1
3P2(3P).3D	4D	-	3P.3D2(3F)	2G	8- 8	0.046	0.019	177.6
3P2(3P).3D	4D	-	3P.3D2(3F)	2G	8- 8	0.045	0.016	172.8
3S.3D2(3P)	4P	-	3P.3D2(3P)	2S	2- 2	0.044	0.042	390.4
3P2(3P).3D	2P	-	3P.3D2(3F)	4D	4- 6	0.042	0.032	206.6
3P2(1D).3D	2F	-	3P.3D2(3F)	4D	6- 8	0.042	0.033	208.9
3P2(3P).3D	2P	-	3P.3D(3P)	4D	4- 4	0.042	0.029	227.5
3P2(1D).3D	2G	-	3S.3P(3P).3D	4F	10-10	0.042	0.025	257.7
3P2(3P).3D	4D	-	3P.3D2(1G)	2F	6- 8	0.041	0.019	179.0
3P2(3P).3D	4D	-	3P.3D2(1D)	2F	8- 6	0.041	0.027	256.1
3P2(1D).3D	2D	-	3S.3P(3P).3D	4D	4- 2	0.041	0.031	289.2
3D3(4P)	4P	-	3P.3D2(1D)	2F	4- 6	0.040	0.023	202.2
3D3(2G)	2G	-	3P.3D2(3F)	4F	8- 8	0.038	0.026	215.9
3P2(3P).3D	4D	-	3P.3D2(1D)	2P	4- 2	0.037	0.027	203.1
3P2(3P).3D	4P	-	3P3(2D)	2D	4- 6	0.037	0.031	211.5
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	2- 4	0.037	0.034	238.9
3P2(3P).3D	2P	-	3P.3D2(3P)	4P	4- 4	0.036	0.023	218.0
3P2(3P).3D	4D	-	3P3(2D)	2D	4- 4	0.036	0.032	235.9
3P2(1D).3D	2D	-	3P.3D2(3F)	4F	6- 8	0.036	0.044	254.8
3D3(4P)	4P	-	3P.3D2(1D)	2D	2- 4	0.035	0.022	205.6
3D3(2P)	2P	-	3P.3D2(3P)	4P	2- 2	0.035	0.030	211.0
3P2(3P).3D	4F	-	3P.3D2(1D)	2F	10- 8	0.035	0.016	234.9
3P2(3P).3D	4D	-	3P.3D2(3P)	2D	4- 6	0.035	0.034	239.7
3P2(1D).3D	2P	-	3P.3D(3P)	4D	2- 4	0.035	0.041	294.2
3P2(3P).3D	4P	-	3S.3P(3P).3D	2P	6- 4	0.035	0.053	431.6
3D3(4F)	4F	-	3P.3D2(1D)	2D	6- 4	0.034	0.030	221.4
3P2(3P).3D	2P	-	3P.3D(3P)	4D	2- 4	0.034	0.029	237.3
3P2(1D).3D	2G	-	3P.3D2(3F)	4F	8-10	0.034	0.045	255.6
3P2(3P).3D	2P	-	3P.3D2(3F)	4D	2- 2	0.033	0.028	214.5
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	2- 4	0.032	0.025	185.0
3D3(4F)	4F	-	3P.3D2(3P)	2D	8- 6	0.032	0.031	223.5
3S.3D2(3P)	4P	-	3S.3P(3P).3D	2D	4- 6	0.032	0.026	223.9
3P2(3P).3D	4P	-	3S.3P(1P).3D	2P	6- 4	0.032	0.023	520.1
3P2(1S).3D	2D	-	3P.3D(3P)	4D	4- 6	0.031	0.038	301.2
3P2(3P).3D	4D	-	3S.3P(3P).3D	2D	6- 6	0.030	0.045	358.5
3P2(1D).3D	2F	-	3S.3P(3P).3D	4P	6- 6	0.029	0.037	335.2
3P2(3P).3D	4D	-	3P.3D2(1D)	2D	4- 6	0.028	0.023	185.5
3P2(3P).3D	4P	-	3P.3D2(1G)	2F	4- 6	0.028	0.025	193.9
3D3(2G)	2G	-	3P.3D2(3F)	4F	8-10	0.028	0.015	217.8
3P2(3P).3D	2F	-	3S.3P(3P).3D	4P	8- 6	0.028	0.030	221.2
3P2(3P).3D	4D	-	3P3(2D)	2D	8- 6	0.028	0.014	230.5
3P2(3P).3D	4D	-	3P.3D2(1D)	2F	8- 8	0.028	0.082	240.2
3P2(1D).3D	2D	-	3P.3D(3P)	4D	4- 6	0.028	0.032	257.9
3D3(4F)	4F	-	3P.3D2(1D)	2D	4- 4	0.027	0.016	221.9
3P2(3P).3D	4P	-	3P.3D2(1D)	2D	4- 4	0.027	0.021	278.3