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CALCULATED LEVEL ENERGIES, TRANSITION PROBABILITIES, AND LIFETIMES FOR PHOSPHORUS-LIKE IONS OF THE IRON GROUP IN THE $3s3p^4$ AND $3s^23p^23d$ CONFIGURATIONS

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Theoretical excitation energies and lifetimes are presented for the low-lying levels of phosphorus-like ions of the iron group. We apply large-scale multiconfiguration Dirac–Fock wave functions to the calculation of the levels of the two excited $3s3p^4$ and $3s^23p^23d$ configurations for seven selected ions in the atomic range $22 \leq Z \leq 32$. Transition energies and probabilities as well as oscillator strengths for all electric-dipole (E1) allowed transitions to the $3s^23p^3$ ground state configuration are tabulated. For selected data we compare our results with experimental results and with other theoretical calculations.

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CONTENTS

INTRODUCTION

Accurate atomic transition data for (highly) ionized atoms are needed in astrophysics and plasma physics. In the extreme ultraviolet (EUV) part of the solar spectrum, for example, many of the observed lines arise from excited multiply charged ions of the iron group [1]. Even though a number of previously unidentified solar lines can now be assigned from beam-foil measurements [2], theoretical data for such ions remain relevant for further astrophysical precision work in astronomy.

Of particular interest are predictions of oscillator strengths and lifetimes for long-lived levels, because most laboratory light sources which yield precise wavelength data often do not allow lifetime measurements of the excited levels. In beam-foil measurements, however, a series of long-lived lines for various phosphorus-, sulfur-, and chlorine-like ions have recently been observed by Träbert and co-workers [3]. Many of these are intercombination lines which arise from the decay of low-excitation states of the $3s^23p^n3d$ configuration in these sequences. Such lines were found in the spectra of the solar corona and also of low-density tokamak discharges. In the phosphorus sequence, Träbert et al. [4] observed long-lived levels from the $3s^23p^23d\ ^4D$ and ^4F terms of Fe XII. Similar spectra have also been found for phosphorus-like Ni ions at various beam energies between 8.5 and 24 MeV. For a detailed interpretation of such delayed spectra from beam-foil measurements, however, knowledge of lifetimes and transition probabilities is required. The long-lived intercombination lines were often not included in previous compilations on these transition arrays, because the small probabilities are difficult to predict accurately.

Here we present the energy levels and lifetimes associated with the excited $3s3p^4$ and $3s^23p^23d$ configurations for the seven phosphorus-like ions Ti, Cr, Fe, Co, Ni, Zn, and Ge ($22 \le Z \le 32$). We also list all transition probabilities of the electric-dipole (E1) allowed transitions from these excited levels to the $3s^23p^3$ ground state configuration. Both transition probabilities and lifetimes have been found to be sensitive to the inclusion of electron correlation beyond the occupied $3l$ subshells.

Approximations to the atomic wave functions have been generated with the newly published atomic structure package GRASP92 [5]. In this multiconfiguration Dirac–Fock (MCDF) program, an atomic state with parity P and angular momentum quantum numbers J, M is represented in terms of configuration state functions (CSF) of the same symmetry

$$\psi_\alpha(PJM) = \sum_{r=1}^{n_c} c_r(\alpha)\,|\gamma_r PJM\rangle, \qquad (1)$$

where n_c denotes the number of CSF in the expansion. In Eq. (1), each CSF is built from antisymmetrized products of Dirac orbitals whose radial parts are represented by values at a number of grid points. In the standard MCDF model, both the orbitals and the expansion coefficients $\{c_r(\alpha),\ r = 1, \ldots, n_c\}$ are optimized self-consistently with respect to the Dirac–Coulomb Hamiltonian. The relativistic (transverse) Breit interaction is added later to the Hamiltonian matrix as perturbation. Then, from the diagonalization of the Dirac–Coulomb–Breit matrix the wave function expansion is finally obtained.

To generate the wave functions we performed a series of computations. All spectroscopic orbitals were first optimized on the levels of both the $3s^23p^3$ ground state and the excited $3s3p^4$ and $3s^23p^23d$ configurations together. We also optimized the correlation orbitals in such a way as to obtain a common orbital set for the full transition array. Because of the large number of individ-

TABLE A
Number of CSF in Eq. (1) in Different Approximations of the Calculation

Parity	J	$4l$	$5l$
Odd	1/2, 3/2, 5/2	2365	7917
Even	1/2	1889	7891
	3/2	3212	13814
	5/2	3698	16633
	7/2	3343	16169

Note. Different wave function expansions have been used for the lower ($Z \leq 26$) and higher charged ions. For the three elements titanium, chromium, and iron all single and double excitations up to the $5l$ subshells have been included. For the other four elements only single and double excitations up to the $4l$ subshells were taken into account (see text for details).

ual transitions in the two arrays $3s^23p^3-3s3p^4$ and $3s^23p^3-3s^23p^23d$, a separate optimization of the orbital function for each transition in turn is not feasible. However, using this set of orbitals we then carried out independent configuration-interaction (CI) calculations for the different $J = 1/2, 3/2, 5/2$, and $7/2$ states of the excited configurations. Since we restrict this investigation to the electric dipole decay to the ground state configuration, only excited levels with $J \leq 7/2$ need be considered. There are 34 levels which belong to the two excited configurations and which have total angular momenta $J = 1/2, \ldots, 7/2$.

The configuration expansions (1) for the different symmetries have been obtained with the active space method. Within this method, the list of CSF of a given parity and total angular momentum is generated by excitations from one or more reference configurations to an active set of orbitals. In the wave functions below, we include all virtual excitations (up to quadrupole) within the $3l$ subshells as well as single (S) and double (D) excitations into the $4l$ shells. For the three elements with $Z \leq 26$, i.e., phosphorus-like titanium, chromium, and iron, all SD excitations into the $4l$ *and/or* $5l$ layer have been incorporated also. However, since in phosphorus-like ions five electrons have to be treated outside the $1s^22s^22p^6$ core, we were not able to include further core-valence correlations. An active space with SD excitations up to the $5l$ orbitals outside the closed core yields a maximal wave function expansion of 16633 CSF to represent the even-parity $J = 5/2$ states. Table A lists the number of CSF for the different wave function expansions which we applied in the current treatment. Independent calculations have been performed for all the different J values of the $3s3p^4$ and $3s^23p^23d$ configurations. By incorporating virtual excitations into the $4l$ and $5l$ shells a rather satisfying convergence is obtained for most excitation energies and lifetimes.

In Table I, we present the excitation energies of the $3s3p^4$ and $3s^23p^23d$ levels with respect to the $3s^23p^3$ $^4S_{3/2}$ ground state as well as the corresponding lifetimes in length and velocity gauge. Table I also displays the energy splitting in the $3s^23p^3$ ground state configuration. To allow comparison of our results with previous theoretical computations and experimental data, Table B lists level energies for a few levels in different ranges of excitations for the two ions Ti VIII and Fe XII. Overall, a rather satisfying agreement is found with the semiempirical computations by Fawcett [7]. Especially for the higher excited levels, however, the results from our *large-scale* calculations differ quite sizably from MCDF calculations by Huang [6] due to the essentially improved wave function expansions. Moreover, no lifetimes had been given in the previous compilations [6, 7]. In addition to level energies we also calculated all electric-dipole decay rates which connect the $3s3p^4$ and $3s^23p^23d$ configurations with the odd-parity ground state configuration. The calculation of the transition probabilities and lifetimes was done with the OSCL92 component of GRASP92 [5]. From this program we obtained transition energies, probabilities, and oscillator strengths for the electric-dipole allowed transitions to the five levels of the $3s^23p^3$ ground state configuration. In relativistic atomic structure calculations two gauge forms for the coupled radiation field are commonly applied, namely Babushkin and Coulomb gauges. In the nonrelativistic limit, the Babushkin gauge corresponds to the length form of the matrix elements, while the Coulomb gauge tends toward the velocity form. For the convenience of the reader, we use below the terms *length* and *velocity* to display our results.

Table II lists transition energies and probabilities for all electric-dipole allowed transitions. Again, a brief comparison of wavelengths and oscillator strengths (in length gauge) with the work by Fawcett [7] and with experimental results is made in Table C for selected transitions. Only strong lines but no intercombination transitions have been listed by Fawcett and also by Huang [6]. To provide some insight into the overall ''convergence'' of our calculations we present the E1 transition probabilities in Table II in both length and velocity gauges. The results in length gauge are often accepted to be more reliable, while the velocity form is known to be more sensitive to correlations. For accurate wave functions, however, results from both gauge forms should be the same, so that the difference between them gives some hint as to the estimated accuracy. The weighted oscillator strengths are displayed in the length gauge only.

In Tables I and II all excited levels and transitions are shown in ascending order of the energy. We further display the level numbers as well as the total angular momenta and parities of the initial and final atomic states. All excited initial levels are of even parity and all final

TABLE B

Excitation Energies for a Few Selected Levels of the $3s^2 3p^3$, $3s3p^4$, and $3s^2 3p^2 3d$ Configurations for Ti VIII and Fe XII Ions

Level	Designation of states	J^P	Huang *et al.* Ref. [6]	Fawcett Ref. [7]	This work	Experiment
			Ti VIII Levels			
1	$3s^2 3p^3\ ^4S$	3/2 −	0	0	0	0
2	^2D	3/2 −	35937		33023	32191 ± X[a]
3	^2D	5/2 −	37001		34067	33256 ± X[a]
4	^2P	1/2 −	58319		55255	54189 ± X[a]
5	^2P	3/2 −	59704		56656	55634 ± X[a]
6	$3s3p^4\ ^4P$	5/2 +	194369	194179	194299	194475[a]
7	^4P	3/2 +	197977	197611	197880	198098[a]
8	^4P	1/2 +	199661	199407	199698	199954[a]
9	^2D	3/2 +	245728		241718	240972 ± X[a]
10	^2D	5/2 +	246208		242170	241426 ± X[a]
21	$3s^2 3p^2 3d\ ^4D$	5/2 +	328743		322880	
22	^4D	7/2 +	332723		326332	
23	^2G	7/2 +	367533		355481	
24	$3s3p^4\ ^2P$	3/2 +	378295		369108	364082 ± X[a]
25	^2P	1/2 +	382891	368659	373584	368663 ± X[a]
			Fe XII Levels			
1	$3s^2 3p^3\ ^4S$	3/2 −	0	0	0	0
2	^2D	3/2 −	45375		42667	41555 ± 1[b]
3	^2D	5/2 −	49932		47130	46088 ± 1[b]
4	^2P	1/2 −	78297		75532	74108 ± 1[b]
5	^2P	3/2 −	84503		81792	
6	$3s3p^4\ ^4P$	5/2 +	274625	274344	274620	
7	^4P	3/2 +	284157	283556	284131	
8	^4P	1/2 +	288345	287737	288431	
9	^2D	3/2 +	345263		341076	339761 ± 10[b]
10	^2D	5/2 +	347176		342949	
21	$3s^2 3p^2 3d\ ^4D$	5/2 +	460430	453305	454327	
22	^4D	7/2 +	470196		463593	
23	^2G	7/2 +	509637		496836	
24	$3s3p^4\ ^2P$	3/2 +	516954		507969	
25	$3s^2 3p^2 3d\ ^4P$	5/2 +	528771	512530	517607	513708 ± 10[b]

Note. Our results are compared with previous theoretical computations and available experimental data. All energies (in cm^{-1}) are displayed with respect to the $3s^2 3p^3\ ^4S_{3/2}$ ground state level. Level numbers are taken from Table I.

[a] Values are taken from Ref. [10]; ''X'' means a correction constant of unknown magnitude since no observational connection to the $^4S_{3/2}$ ground state level has been established.

[b] Values are taken from Ref. [2].

ones are of odd parity. No attempt has been made to assign spectroscopic *LS* notation since these labels lose significance with an increasing degree of ionization and would only be meaningful for the ions near the neutral end of the isoelectronic sequence.

The overall accuracy of the calculated lifetimes and transition probabilities (Tables I and II) is difficult to estimate. The deviations between the results in length and velocity gauge indicate the shorter lifetimes to be accurate to within about 10%. For other weak but still non-negligible transitions, however, there remain somewhat larger discrepancies between the gauges and, possibly, also with experimental results. For phosphorus-like ions with five valence electrons, however, it seems currently impossible to reach the same accuracy as recently obtained for near closed-shell systems in (mainly) nonrelativistic computations [8, 9]. Compared with such simpler shell structures, we are only able to include the most important valence correlations. A detailed comparison with previous calculations and available experimental data on the $3s^2 3p^3$–$3s3p^4$ and $3s^2 3p^3$–$3s^2 3p^3 3d$ transitions arrays will be presented elsewhere.

Even though we cannot demonstrate the same accuracy as recently obtained on simpler systems, we are now

TABLE C
Comparison of Wavelengths and Weighted Oscillator Strengths for Selected Transitions of the Phosphorus-like Ions Ti VIII and Fe XII

	Transition			Wavelengths (Å)			*gf*	
Element	Levels	J_F^p	J_I^p	Fawcett[a]	This work	Experiment	Fawcett[a]	This work
Ti VIII	1–6	3/2 −	5/2 +	514.989	514.671	514.206[a]	0.180	0.198
	1–7	3/2 −	3/2 +	506.045	505.354	504.801[a]	0.119	0.133
	4–12	1/2 −	1/2 +	442.479	440.129	440.687[a]	0.056	0.055
	5–13	3/2 −	1/2 +	430.253	424.560	426.258[a]	0.193	0.198
	4–13	1/2 −	1/2 +	428.154	422.055	423.649[a]	0.051	0.062
	3–11	5/2 −	3/2 +	407.677	407.408	408.528[a]	0.487	0.381
	2–11	3/2 −	3/2 +	406.136	405.684	406.756[a]	0.051	0.045
	2–12	3/2 −	1/2 +	401.880	400.856	401.739[a]	0.240	0.192
Fe XII	5–10	3/2 −	5/2 +	382.001	382.613	383.446[b]	0.066	0.070
	4–12	1/2 −	1/2 +	314.816	311.339	312.255[b]	0.091	0.088
	5–13	3/2 −	1/2 +	305.932	302.040	303.135[b]	0.184	0.194
	2–11	3/2 −	3/2 +	286.938	286.538	287.226[b]	0.041	0.040
	3–25	5/2 −	5/2 +	213.802	212.480	214.416[b]	0.048	0.056
	5–31	3/2 −	3/2 +		209.259	210.412[b]		0.008
	3–29	5/2 −	3/2 +	207.909	207.213	208.357[b]	0.160	0.154
	4–35	1/2 −	3/2 +	199.378	196.856	198.546[b]	0.491	0.441

Note. Level numbers in the designation of the transitions are taken from Table I.
[a] Values are taken from Ref. [7].
[b] Values are taken from Ref. [2].

able to provide theoretical guidance for further experimental investigations also in the phosphorus sequence where five electrons are outside of a closed core.

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EXPLANATION OF TABLES

TABLE I. Excitation Energies and Lifetimes

Excitation energies of the $3s^2 3p^3$, $3s3p^4$, and $3s^2 3p^2 3d$ excited levels are listed relative to the $3s^2 3p^3$ $J = 3/2$ ground state level. Energies are given as wave numbers (cm^{-1}) in ascending order. Numbers in brackets denote powers of 10. The ion is identified in the upper left corner.

No.	Level number (1 = ground state).
J^P	Total angular momentum and parity.
Energy	Wavenumber (in cm^{-1}) relative to the ground state. Our calculated results (Calc.) are compared here with available experimental data (Exp.). An ''X'' means a correction constant of unknown magnitude because no connection to the $3s^2 3p^3$ $J = 3/2$ ground state level was established by experiment [10, 11].
Lifetime	Theoretical lifetimes (in s) due to an electric-dipole (E1) decay to the levels of the ground state configuration calculated in both length and velocity gauges.

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3$–$3s3p^4$ and $3s^2 3p^3$–$3s^2 3p^2 3d$

Transitions from the $3s3p^4$ and $3s^2 3p^2 3d$ excited levels to the different levels of the $3s^2 3p^3$ ground state configuration are listed in ascending order of the transition energy. Transition energies are given as wavenumbers together with the corresponding wavelengths. To characterize the atomic levels involved in the transition we show the level numbers from Table I and the total angular momenta of the corresponding final and initial atomic states. All final levels are of odd parity and all initial levels are of even parity. The ion is identified in the upper left corner.

Trans.	Level numbers of the lower and upper level from Table I.
J_F	Total angular momentum of the lower $3s^2 3p^3$ J_F odd-parity level.
J_I	Total angular momentum of the upper $3s3p^4$ J_I or $3s^2 3p^2 3d$ J_I excited even-parity level.
Wavenumber	Wavenumber of the transition (in cm^{-1}).
Wavelength	Wavelength of the transition (in Å).
A	Transition probability (in s^{-1}). Values are given for both length and velocity gauge.
gf	Weighted oscillator strength (dimensionless) in length gauge.

TABLE I. Excitation Energies and Lifetimes

See page 154 for Explanation of Tables

Ti VIII Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [10,11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	33023	32191±X		
3	5/2 −	34067	33256±X		
4	1/2 −	55255	54189±X		
5	3/2 −	56656	55634±X		
6	5/2 +	194299	194475	1.20(−9)	1.23(−9)
7	3/2 +	197880	198098	1.15(−9)	1.19(−9)
8	1/2 +	199698	199954	1.12(−9)	1.14(−9)
9	3/2 +	241718	240972±X	5.65(−10)	5.80(−10)
10	5/2 +	242170	241426±X	5.94(−10)	6.09(−10)
11	3/2 +	279521	278038±X	2.11(−10)	2.10(−10)
12	1/2 +	282590	281108±X	2.00(−10)	1.95(−10)
13	1/2 +	292321	290234±X	2.06(−10)	1.98(−10)
14	3/2 +	308616		3.53(−8)	3.41(−8)
15	5/2 +	309966		5.77(−8)	5.69(−8)
16	7/2 +	311924		1.55(−7)	1.60(−7)
17	5/2 +	319279		1.36(−8)	1.36(−8)
18	7/2 +	320740		1.06(−7)	8.60(−8)
19	1/2 +	320744		1.03(−8)	1.01(−8)
20	3/2 +	321376		9.82(−9)	9.65(−9)
21	5/2 +	322880		5.87(−8)	5.69(−8)
22	7/2 +	326332		1.91(−6)	8.20(−7)
23	7/2 +	355481		2.23(−8)	2.21(−8)
24	3/2 +	369108	364082±X	2.12(−11)	2.07(−11)
25	1/2 +	373584	368663±X	2.11(−11)	2.05(−11)
26	5/2 +	375267	371012	1.56(−11)	1.53(−11)
27	3/2 +	377155	372887	1.55(−11)	1.51(−11)
28	1/2 +	378109	373971	1.51(−11)	1.47(−11)
29	3/2 +	382057		1.09(−10)	1.06(−10)
30	5/2 +	386777		8.33(−11)	8.07(−11)
31	5/2 +	404005	399323±X	2.07(−11)	2.04(−11)
32	3/2 +	404685	399772±X	1.85(−11)	1.82(−11)
33	1/2 +	418059	412858±X	1.90(−11)	1.87(−11)
34	3/2 +	420791	415589±X	1.89(−11)	1.87(−11)
35	1/2 +	422468	423834±X	2.01(−11)	1.99(−11)
36	5/2 +	424537	418873±X	1.26(−11)	1.26(−11)
37	7/2 +	425528	419939±X	1.26(−11)	1.26(−11)
38	5/2 +	440855	435049±X	1.41(−11)	1.41(−11)
39	3/2 +	442045	436270±X	1.43(−11)	1.43(−11)

Cr X Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	37989	37103		
3	5/2 −	40299	39450		
4	1/2 −	65061	63935		
5	3/2 −	68214	67157		
6	5/2 +	233971	233890	8.30(−10)	8.36(−10)
7	3/2 +	239999	239987	7.81(−10)	7.94(−10)
8	1/2 +	242925	242922	7.51(−10)	7.65(−10)
9	3/2 +	290700	289637	3.79(−10)	3.85(−10)
10	5/2 +	291665	290606	4.07(−10)	4.12(−10)
11	3/2 +	335266	333412	1.44(−10)	1.42(−10)
12	1/2 +	339432	337370	1.32(−10)	1.30(−10)
13	1/2 +	351069	348760	1.50(−10)	1.46(−10)
14	3/2 +	369094		1.29(−8)	1.23(−8)
15	5/2 +	371408		2.20(−8)	2.13(−8)
16	7/2 +	374779		7.24(−8)	7.23(−8)
17	5/2 +	382209		2.30(−8)	2.23(−8)
18	7/2 +	384800		5.07(−8)	4.26(−9)
19	1/2 +	385086		3.71(−9)	3.61(−9)
20	3/2 +	385791		3.64(−9)	3.54(−9)
21	5/2 +	388390		5.22(−9)	5.10(−9)
22	7/2 +	394206		3.93(−6)	1.24(−6)
23	7/2 +	426109		8.79(−9)	8.57(−9)
24	3/2 +	438467	432830	1.69(−11)	1.64(−11)
25	1/2 +	446040	440870	1.69(−11)	1.63(−11)
26	5/2 +	446685	442010	1.30(−11)	1.25(−11)
27	3/2 +	449633	444960	1.29(−11)	1.25(−11)
28	1/2 +	451512	446710	1.24(−11)	1.20(−11)
29	3/2 +	456043		7.38(−11)	7.08(−11)
30	5/2 +	463586		5.10(−11)	4.88(−11)
31	5/2 +	481630	476680	1.85(−11)	1.81(−11)
32	3/2 +	482195	476820	1.52(−11)	1.48(−11)
33	1/2 +	497214	491650	1.60(−11)	1.56(−11)
34	3/2 +	501950	496430	1.56(−11)	1.52(−11)
35	1/2 +	503824		1.64(−11)	1.62(−11)
36	5/2 +	504559		1.05(−11)	1.03(−11)
37	7/2 +	506758	500880	1.05(−11)	1.03(−11)
38	5/2 +	525506	519280	1.17(−11)	1.16(−11)
39	3/2 +	527011	520820	1.19(−11)	1.18(−11)

TABLE I. Excitation Energies and Lifetimes

See page 154 for Explanation of Tables

Fe XII Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	42667	41566		
3	5/2 −	47130	46075		
4	1/2 −	75532	74109		
5	3/2 −	81792	80515		
6	5/2 +	274620	274373	6.11(−10)	6.17(−10)
7	3/2 +	284131	284005	5.70(−10)	5.78(−10)
8	1/2 +	288431	288307	5.40(−10)	5.49(−10)
9	3/2 +	341076	340020	2.75(−10)	2.78(−10)
10	5/2 +	342949	341703	3.02(−10)	3.05(−10)
11	3/2 +	391660	389706	1.10(−10)	1.08(−10)
12	1/2 +	396725	394120	9.75(−11)	9.48(−11)
13	1/2 +	412875		1.18(−10)	1.14(−10)
14	3/2 +	427998		5.27(−9)	4.97(−9)
15	5/2 +	432138		9.32(−9)	8.84(−9)
16	7/2 +	437629		3.88(−8)	3.72(−8)
17	5/2 +	444461		1.02(−8)	9.77(−9)
18	1/2 +	448620		1.55(−9)	1.48(−9)
19	7/2 +	448714		2.89(−8)	2.41(−8)
20	3/2 +	449684		1.56(−9)	1.49(−9)
21	5/2 +	454327		2.29(−9)	2.20(−9)
22	7/2 +	463593		1.36(−5)	7.28(−5)
23	7/2 +	496836		3.92(−9)	3.77(−9)
24	3/2 +	507969	501800	1.40(−11)	1.34(−11)
25	5/2 +	517607	512510	1.11(−11)	1.08(−11)
26	1/2 +	519685	513850	1.38(−11)	1.32(−11)
27	3/2 +	521616	516740	1.12(−11)	1.06(−11)
28	1/2 +	524750	519770	1.05(−11)	1.01(−11)
29	3/2 +	529723	526120	5.31(−11)	5.03(−11)
30	5/2 +	541101	538040	3.29(−11)	3.15(−11)
31	3/2 +	559669	554030	1.27(−11)	1.22(−11)
32	5/2 +	559753	554610	1.78(−11)	1.74(−11)
33	1/2 +	575735	568940	1.36(−11)	1.30(−11)
34	5/2 +	583339	576740	9.12(−12)	8.95(−12)
35	3/2 +	583519	577740	1.33(−11)	1.26(−11)
36	1/2 +	585712	579630	1.36(−11)	1.32(−11)
37	7/2 +	587646	581180	9.13(−12)	8.96(−12)
38	5/2 +	610608	603930	1.02(−11)	9.98(−12)
39	3/2 +	612019	605480	1.03(−11)	9.88(−12)

Co XIII Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	45284			
3	5/2 −	51225			
4	1/2 −	81491			
5	3/2 −	89980			
6	5/2 +	295717	295160	5.51(−10)	5.40(−10)
7	3/2 +	307475	307030	5.04(−10)	4.98(−10)
8	1/2 +	312564	312110	4.73(−10)	4.68(−10)
9	3/2 +	367592	365530	2.42(−10)	2.41(−10)
10	5/2 +	370221	368250	2.73(−10)	2.70(−10)
11	3/2 +	421348	418480	9.91(−11)	9.68(−11)
12	1/2 +	426855	423290	8.60(−11)	8.27(−11)
13	1/2 +	446179		1.08(−10)	1.02(−10)
14	3/2 +	458742		3.50(−9)	3.29(−9)
15	5/2 +	463389		6.20(−9)	5.88(−9)
16	7/2 +	470240		2.95(−8)	2.90(−8)
17	5/2 +	476754		6.86(−9)	6.56(−9)
18	7/2 +	481939		2.03(−8)	1.72(−8)
19	1/2 +	482164		1.06(−9)	1.03(−9)
20	3/2 +	483387		1.08(−9)	1.04(−9)
21	5/2 +	488725		1.59(−9)	1.53(−9)
22	7/2 +	500264		4.04(−6)	1.38(−6)
23	7/2 +	534889		2.66(−9)	2.56(−9)
24	3/2 +	544807		1.27(−11)	1.22(−11)
25	5/2 +	554963	547890	1.03(−11)	9.83(−12)
26	1/2 +	559038		1.23(−11)	1.19(−11)
27	3/2 +	560022	552880	1.04(−11)	9.95(−12)
28	1/2 +	564213	556820	9.79(−12)	9.40(−12)
29	3/2 +	569464		4.55(−11)	4.32(−11)
30	5/2 +	582788		2.62(−11)	2.48(−11)
31	3/2 +	601545	592830	1.16(−11)	1.12(−11)
32	5/2 +	601995	594200	1.79(−11)	1.74(−11)
33	1/2 +	618199	608870	1.26(−11)	1.24(−11)
34	5/2 +	625861		8.40(−12)	8.17(−12)
35	3/2 +	628034	618880	1.24(−11)	1.20(−11)
36	1/2 +	630255		1.25(−11)	1.23(−11)
37	7/2 +	631677	621710	8.41(−12)	8.18(−12)
38	5/2 +	656923	646890	9.37(−12)	9.14(−12)
39	3/2 +	658328	648390	9.63(−12)	9.43(−12)

TABLE I. Excitation Energies and Lifetimes

See page 154 for Explanation of Tables

Ni XIV Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	47412	45768		
3	5/2 −	55130	53569		
4	1/2 −	87208	85127		
5	3/2 −	98503	96630±X		
6	5/2 +	316964	316343	4.88(−10)	4.86(−10)
7	3/2 +	331333	330837	4.41(−10)	4.42(−10)
8	1/2 +	337264		4.10(−10)	4.11(−10)
9	3/2 +	394070	391916	2.12(−10)	2.13(−10)
10	5/2 +	397634	395567	2.43(−10)	2.43(−10)
11	3/2 +	450740	447765	9.05(−11)	8.90(−11)
12	1/2 +	456577	452850±X	7.63(−11)	7.37(−11)
13	1/2 +	479609		9.92(−11)	9.49(−11)
14	3/2 +	487999		2.33(−9)	2.19(−9)
15	5/2 +	493738		4.14(−9)	3.91(−9)
16	7/2 +	502255		2.27(−8)	2.19(−8)
17	5/2 +	507976		4.88(−9)	4.65(−9)
18	7/2 +	514385		1.63(−8)	1.38(−8)
19	1/2 +	514687		7.26(−10)	7.02(−10)
20	3/2 +	516058		7.50(−10)	7.22(−10)
21	5/2 +	522630		1.10(−9)	1.05(−9)
22	7/2 +	536763		4.30(−7)	8.85(−7)
23	7/2 +	571087		1.86(−9)	1.77(−9)
24	3/2 +	580239		1.17(−11)	1.13(−11)
25	5/2 +	590838	583530	9.63(−12)	9.15(−12)
26	3/2 +	592682	589310	9.86(−12)	9.38(−12)
27	1/2 +	596993	594810	1.10(−11)	1.06(−11)
28	1/2 +	602455		9.33(−12)	8.92(−12)
29	3/2 +	607082		3.92(−11)	3.71(−11)
30	5/2 +	622802		2.16(−11)	2.03(−11)
31	3/2 +	641248	632280	1.07(−11)	1.03(−11)
32	5/2 +	642302	634430	1.84(−11)	1.78(−11)
33	1/2 +	657881	648320	1.20(−11)	1.15(−11)
34	5/2 +	665237		7.88(−12)	7.60(−12)
35	3/2 +	670140	660710±X	1.16(−11)	1.11(−11)
36	1/2 +	672625		1.15(−11)	1.13(−11)
37	7/2 +	672862	662780	7.91(−12)	7.63(−12)
38	5/2 +	700873	690560±X	8.80(−12)	8.51(−12)
39	3/2 +	702038	691930	9.08(−12)	8.82(−12)

Zn XVI Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	51816	50260		
3	5/2 −	63914	62488		
4	1/2 −	99545	97579		
5	3/2 −	118401	116594		
6	5/2 +	361341		3.90(−10)	3.81(−10)
7	3/2 +	382125		3.39(−10)	3.35(−10)
8	1/2 +	389818		3.10(−10)	3.06(−10)
9	3/2 +	449291		1.65(−10)	1.63(−10)
10	5/2 +	455552		1.97(−10)	1.94(−10)
11	3/2 +	511643		7.89(−11)	7.67(−11)
12	1/2 +	518107		6.16(−11)	5.88(−11)
13	3/2 +	546136		1.05(−9)	9.91(−10)
14	1/2 +	550238		8.87(−11)	8.42(−11)
15	5/2 +	554578		1.90(−9)	1.80(−9)
16	7/2 +	567436		1.42(−8)	1.39(−8)
17	5/2 +	570840		2.71(−9)	2.60(−9)
18	7/2 +	580246		1.12(−8)	9.78(−9)
19	1/2 +	581117		3.42(−10)	3.28(−10)
20	3/2 +	582498		3.87(−10)	3.71(−10)
21	5/2 +	592068		5.56(−10)	5.33(−10)
22	7/2 +	612580		3.96(−8)	4.67(−8)
23	7/2 +	644993		9.54(−10)	9.10(−10)
24	3/2 +	652363		1.00(−11)	9.56(−12)
25	5/2 +	663343	656202	8.54(−12)	8.12(−12)
26	3/2 +	670822	663600	8.98(−12)	8.56(−12)
27	1/2 +	673491		8.86(−12)	8.47(−12)
28	1/2 +	682271		8.61(−12)	8.23(−12)
29	3/2 +	683603		2.98(−11)	2.63(−11)
30	5/2 +	704581		1.49(−11)	1.41(−11)
31	3/2 +	722140	713229	9.05(−12)	8.69(−12)
32	5/2 +	724936	717970	2.09(−11)	2.04(−11)
33	1/2 +	737930		1.06(−11)	1.02(−11)
34	5/2 +	744254		7.02(−12)	6.78(−12)
35	3/2 +	756385	747766	1.01(−11)	9.70(−12)
36	7/2 +	756440	746375	7.06(−12)	6.82(−12)
37	1/2 +	759672		9.84(−12)	9.62(−12)
38	5/2 +	790953	780896	7.84(−12)	7.59(−12)
39	3/2 +	791211		8.70(−12)	7.94(−12)

TABLE I. Excitation Energies and Lifetimes

See page 154 for Explanation of Tables

Ge XVIII Levels		Energy (cm^{-1})		Lifetime (s)	
No.	J^P	Calc.	Exp. [11]	Length	Velocity
1	3/2 −	0	0		
2	3/2 −	57519	56117		
3	5/2 −	74931	73646		
4	1/2 −	114172	112334		
5	3/2 −	143725	142132		
6	5/2 +	408560		3.19(−10)	3.12(−10)
7	3/2 +	437594		2.64(−10)	2.61(−10)
8	1/2 +	447054		2.36(−10)	2.32(−10)
9	3/2 +	508227		1.32(−10)	1.31(−10)
10	5/2 +	518651		1.65(−10)	1.62(−10)
11	3/2 +	576340		7.40(−11)	7.18(−11)
12	1/2 +	583609		5.12(−11)	4.88(−11)
13	3/2 +	604662		4.87(−10)	4.60(−10)
14	5/2 +	616469		9.15(−10)	8.66(−10)
15	1/2 +	626516		9.08(−11)	8.58(−11)
16	7/2 +	635471		9.46(−9)	9.24(−9)
17	5/2 +	635584		1.71(−9)	1.63(−9)
18	7/2 +	648724		8.30(−9)	7.37(−9)
19	1/2 +	651771		1.58(−10)	1.51(−10)
20	3/2 +	651837		2.15(−10)	2.06(−10)
21	5/2 +	665139		2.98(−10)	2.85(−10)
22	7/2 +	693769		6.84(−9)	7.09(−9)
23	7/2 +	722993		5.34(−10)	5.08(−10)
24	3/2 +	727613		8.62(−12)	8.21(−12)
25	5/2 +	738637	731502	7.63(−12)	7.24(−12)
26	3/2 +	747835	740598	8.20(−12)	7.79(−12)
27	1/2 +	752293		7.52(−12)	7.18(−12)
28	3/2 +	763702		2.39(−11)	2.27(−11)
29	1/2 +	768554		7.66(−12)	7.32(−12)
30	5/2 +	790316		1.06(−11)	1.01(−11)
31	3/2 +	807359		7.70(−12)	7.37(−12)
32	5/2 +	812485	805800	2.42(−11)	2.36(−11)
33	1/2 +	821021		9.55(−12)	9.13(−12)
34	5/2 +	826608		6.51(−12)	6.26(−12)
35	7/2 +	844178	834392	6.34(−12)	6.11(−12)
36	3/2 +	847905		8.93(−12)	8.51(−12)
37	1/2 +	852491		8.43(−12)	8.21(−12)
38	3/2 +	885503		7.42(−12)	7.90(−12)
39	5/2 +	886757	876810	7.05(−12)	6.80(−12)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ti VIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	137643	726.517	4.82(+5)	5.28(+5)	2.29(–4)
5 – 7	3/2	3/2	E1	141224	708.095	1.30(+6)	1.33(+6)	3.90(–4)
4 – 7	1/2	3/2	E1	142626	701.134	1.03(+4)	7.78(+3)	3.03(–6)
5 – 8	3/2	1/2	E1	142915	699.717	1.65(+5)	2.36(+5)	2.42(–5)
4 – 8	1/2	1/2	E1	144313	692.938	1.08(+6)	1.16(+6)	1.55(–4)
3 – 6	5/2	5/2	E1	160231	624.099	3.27(+6)	3.40(+6)	1.15(–3)
2 – 6	3/2	5/2	E1	161275	620.059	9.22(+5)	9.54(+5)	3.19(–4)
3 – 7	5/2	3/2	E1	163813	610.452	5.15(+5)	5.64(+5)	1.15(–4)
2 – 7	3/2	3/2	E1	164875	606.520	4.07(+5)	4.43(+5)	8.99(–5)
2 – 8	3/2	1/2	E1	166574	600.334	5.07(+5)	4.99(+5)	5.48(–5)
5 – 9	3/2	3/2	E1	185062	540.359	2.75(+4)	7.98(+4)	4.82(–6)
5 – 10	3/2	5/2	E1	185514	539.043	2.35(+8)	2.15(+8)	6.15(–2)
4 – 9	1/2	3/2	E1	186463	536.299	1.44(+8)	1.28(+8)	2.48(–2)
1 – 6	3/2	5/2	E1	194299	514.671	8.29(+8)	8.09(+8)	1.98(–1)
1 – 7	3/2	3/2	E1	197881	505.354	8.66(+8)	8.42(+8)	1.33(–1)
1 – 8	3/2	1/2	E1	199698	500.756	8.91(+8)	8.73(+8)	6.70(–2)
3 – 9	5/2	3/2	E1	207650	481.580	6.98(+7)	6.66(+7)	9.71(–3)
3 – 10	5/2	5/2	E1	208103	480.531	1.40(+9)	1.38(+9)	2.92(–1)
2 – 9	3/2	3/2	E1	208694	479.170	1.56(+9)	1.53(+9)	2.14(–1)
2 – 10	3/2	5/2	E1	209147	478.133	4.20(+7)	4.37(+7)	8.64(–3)
5 – 11	3/2	3/2	E1	222865	448.702	3.31(+8)	3.06(+8)	3.99(–2)
4 – 11	1/2	3/2	E1	224266	445.899	1.28(+8)	1.19(+8)	1.52(–2)
5 – 12	3/2	1/2	E1	225808	442.854	7.28(+7)	6.42(+7)	4.28(–3)
4 – 12	1/2	1/2	E1	227206	440.129	9.50(+8)	9.37(+8)	5.52(–2)
5 – 13	3/2	1/2	E1	235538	424.560	3.67(+9)	3.80(+9)	1.98(–1)
4 – 13	1/2	1/2	E1	236936	422.055	1.16(+9)	1.23(+9)	6.17(–2)
1 – 9	3/2	3/2	E1	241718	413.705	2.83(+4)	2.09(+4)	2.91(–6)
1 – 10	3/2	5/2	E1	242170	412.933	1.33(+6)	1.40(+6)	2.04(–4)
3 – 11	5/2	3/2	E1	245454	407.408	3.83(+9)	3.87(+9)	3.81(–1)
2 – 11	3/2	3/2	E1	246497	405.684	4.52(+8)	4.50(+8)	4.46(–2)
2 – 12	3/2	1/2	E1	249466	400.856	3.98(+9)	4.12(+9)	1.92(–1)
5 – 14	3/2	3/2	E1	251960	396.888	3.90(+5)	3.79(+5)	3.68(–5)
5 – 15	3/2	5/2	E1	253309	394.775	2.27(+6)	2.32(+6)	3.18(–4)
4 – 14	1/2	3/2	E1	253361	394.694	4.31(+6)	4.38(+6)	4.03(–4)
2 – 13	3/2	1/2	E1	259197	385.807	1.37(+7)	1.38(+7)	4.13(–4)
5 – 17	3/2	5/2	E1	262622	380.775	2.09(+6)	2.38(+6)	2.73(–4)
5 – 19	3/2	1/2	E1	263962	378.842	1.12(+7)	1.14(+7)	4.85(–4)
5 – 20	3/2	3/2	E1	264720	377.758	3.74(+6)	3.72(+6)	3.20(–4)
4 – 19	1/2	1/2	E1	265360	376.847	4.01(+6)	4.00(+6)	1.71(–4)
4 – 20	1/2	3/2	E1	266121	375.769	1.98(+5)	2.32(+5)	1.68(–5)
5 – 21	3/2	5/2	E1	266224	375.624	2.31(+4)	6.50(+4)	2.93(–6)
3 – 14	5/2	3/2	E1	274548	364.235	1.58(+5)	1.45(+5)	1.16(–5)
2 – 14	3/2	3/2	E1	275592	362.855	2.27(+7)	2.35(+7)	1.79(–3)
3 – 15	5/2	5/2	E1	275898	362.453	9.45(+6)	9.80(+6)	1.12(–3)
2 – 15	3/2	5/2	E1	276942	361.086	3.73(+6)	3.55(+6)	4.38(–4)
3 – 16	5/2	7/2	E1	277856	359.899	6.43(+6)	6.23(+6)	9.99(–4)
1 – 11	3/2	3/2	E1	279521	357.755	6.08(+6)	5.48(+6)	4.67(–4)
1 – 12	3/2	1/2	E1	282590	353.870	6.23(+5)	8.14(+5)	2.34(–5)
3 – 17	5/2	5/2	E1	285211	350.618	1.31(+5)	6.14(+4)	1.44(–5)
2 – 17	3/2	5/2	E1	286255	349.339	2.20(+4)	1.24(+5)	2.41(–6)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ti VIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 18	5/2	7/2	E1	286672	348.831	9.42(+6)	1.16(+7)	1.37(–3)
3 – 20	5/2	3/2	E1	287309	348.057	4.72(+7)	4.80(+7)	3.43(–3)
2 – 19	3/2	1/2	E1	287620	347.681	6.71(+7)	6.92(+7)	2.43(–3)
2 – 20	3/2	3/2	E1	288352	346.798	6.94(+3)	1.37(+3)	5.01(–7)
3 – 21	5/2	5/2	E1	288812	346.246	1.54(+7)	1.46(+7)	1.66(–3)
2 – 21	3/2	5/2	E1	289856	344.999	2.28(+3)	3.61(+4)	2.44(–7)
3 – 22	5/2	7/2	E1	292265	342.155	5.23(+5)	1.22(+6)	7.35(–5)
1 – 13	3/2	1/2	E1	292321	342.090	1.95(+7)	2.05(+7)	6.83(–4)
1 – 14	3/2	3/2	E1	308616	324.027	8.10(+5)	8.25(+5)	5.10(–5)
1 – 15	3/2	5/2	E1	309966	322.616	1.88(+6)	1.91(+6)	1.76(–4)
5 – 24	3/2	3/2	E1	312452	320.049	3.00(+9)	3.12(+9)	1.84(–1)
4 – 24	1/2	3/2	E1	313853	318.621	7.73(+8)	7.94(+8)	4.71(–2)
5 – 25	3/2	1/2	E1	316802	315.655	5.77(+9)	5.97(+9)	1.72(–1)
4 – 25	1/2	1/2	E1	318200	314.268	3.68(+9)	3.80(+9)	1.09(–1)
5 – 26	3/2	5/2	E1	318611	313.862	4.48(+6)	4.46(+6)	3.97(–4)
1 – 17	3/2	5/2	E1	319279	313.206	1.48(+7)	1.50(+7)	1.31(–3)
5 – 27	3/2	3/2	E1	320499	312.013	6.60(+6)	6.87(+6)	3.85(–4)
1 – 19	3/2	1/2	E1	320744	311.775	1.44(+7)	1.47(+7)	4.19(–4)
5 – 28	3/2	1/2	E1	321326	311.210	3.93(+7)	3.96(+7)	1.14(–3)
1 – 20	3/2	3/2	E1	321376	311.162	5.07(+7)	5.16(+7)	2.95(–3)
3 – 23	5/2	7/2	E1	321414	311.125	4.49(+7)	4.52(+7)	5.21(–3)
4 – 27	1/2	3/2	E1	321901	310.655	1.66(+6)	1.33(+6)	9.60(–5)
4 – 28	1/2	1/2	E1	322724	309.862	4.96(+7)	5.17(+7)	1.43(–3)
1 – 21	3/2	5/2	E1	322880	309.713	5.80(+7)	5.91(+7)	5.01(–3)
5 – 29	3/2	3/2	E1	325401	307.313	7.86(+7)	7.61(+7)	4.45(–3)
4 – 29	1/2	3/2	E1	326803	305.995	3.40(+6)	8.74(+6)	1.91(–4)
5 – 30	3/2	5/2	E1	330121	302.919	3.82(+8)	4.34(+8)	3.15(–2)
3 – 24	5/2	3/2	E1	335040	298.472	3.47(+10)	3.55(+10)	1.85
2 – 24	3/2	3/2	E1	336084	297.545	8.67(+9)	8.88(+9)	4.60(–1)
2 – 25	3/2	1/2	E1	340461	293.719	3.70(+10)	3.81(+10)	9.58(–1)
3 – 26	5/2	5/2	E1	341199	293.084	3.69(+8)	3.82(+8)	2.85(–2)
2 – 26	3/2	5/2	E1	342243	292.190	5.80(+7)	5.99(+7)	4.45(–3)
3 – 27	5/2	3/2	E1	343088	291.470	1.66(+6)	1.75(+6)	8.45(–5)
2 – 27	3/2	3/2	E1	344132	290.586	2.71(+8)	2.80(+8)	1.37(–2)
2 – 28	3/2	1/2	E1	344985	289.868	6.93(+8)	7.15(+8)	1.75(–2)
5 – 31	3/2	5/2	E1	347348	287.896	3.13(+9)	3.27(+9)	2.33(–1)
3 – 29	5/2	3/2	E1	347990	287.365	2.50(+9)	2.56(+9)	1.24(–1)
5 – 32	3/2	3/2	E1	348029	287.332	7.92(+6)	6.84(+6)	3.92(–4)
2 – 29	3/2	3/2	E1	349034	286.505	5.17(+9)	5.36(+9)	2.55(–1)
4 – 32	1/2	3/2	E1	349430	286.180	2.72(+9)	2.83(+9)	1.33(–1)
3 – 30	5/2	5/2	E1	352710	283.519	9.98(+9)	1.03(+10)	7.23(–1)
2 – 30	3/2	5/2	E1	353753	282.683	4.86(+8)	4.91(+8)	3.49(–2)
5 – 33	3/2	1/2	E1	361277	276.796	4.53(+9)	4.64(+9)	1.04(–1)
4 – 33	1/2	1/2	E1	362675	275.729	4.73(+10)	4.80(+10)	1.08
5 – 34	3/2	3/2	E1	364135	274.623	4.18(+10)	4.22(+10)	1.89
4 – 34	1/2	3/2	E1	365537	273.570	1.08(+10)	1.09(+10)	4.84(–1)
5 – 35	3/2	1/2	E1	365686	273.459	4.44(+10)	4.49(+10)	9.95(–1)
4 – 35	1/2	1/2	E1	367084	272.417	3.42(+9)	3.42(+9)	7.61(–2)
5 – 36	3/2	5/2	E1	367881	271.827	3.48(+7)	3.41(+7)	2.31(–3)
1 – 24	3/2	3/2	E1	369108	270.923	4.67(+7)	4.78(+7)	2.06(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ti VIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 31	5/2	5/2	E1	369937	270.316	4.24(+10)	4.30(+10)	2.79
3 – 32	5/2	3/2	E1	370618	269.820	6.21(+9)	6.31(+9)	2.71(–1)
2 – 31	3/2	5/2	E1	370981	269.556	2.62(+9)	2.64(+9)	1.72(–1)
2 – 32	3/2	3/2	E1	371661	269.062	4.50(+10)	4.58(+10)	1.95
1 – 25	3/2	1/2	E1	373584	267.677	8.31(+8)	8.53(+8)	1.79(–2)
1 – 26	3/2	5/2	E1	375267	266.477	6.35(+10)	6.50(+10)	4.06
1 – 27	3/2	3/2	E1	377155	265.143	6.44(+10)	6.58(+10)	2.71
1 – 28	3/2	1/2	E1	378109	264.474	6.56(+10)	6.73(+10)	1.38
1 – 29	3/2	3/2	E1	382057	261.741	1.44(+9)	1.47(+9)	5.91(–2)
5 – 38	3/2	5/2	E1	384198	260.282	6.90(+10)	6.92(+10)	4.21
2 – 33	3/2	1/2	E1	384936	259.783	8.08(+8)	8.30(+8)	1.63(–2)
5 – 39	3/2	3/2	E1	385389	259.478	1.34(+10)	1.33(+10)	5.40(–1)
3 – 34	5/2	3/2	E1	386724	258.582	6.91(+7)	6.43(+7)	2.77(–3)
1 – 30	3/2	5/2	E1	386777	258.547	1.14(+9)	1.16(+9)	6.86(–2)
4 – 39	1/2	3/2	E1	386790	258.538	5.65(+10)	5.65(+10)	2.26
2 – 34	3/2	3/2	E1	387768	257.886	4.07(+8)	4.11(+8)	1.62(–2)
2 – 35	3/2	1/2	E1	389344	256.842	1.97(+9)	1.99(+9)	3.89(–2)
3 – 36	5/2	5/2	E1	390470	256.102	5.22(+9)	5.28(+9)	3.08(–1)
3 – 37	5/2	7/2	E1	391461	255.453	7.92(+10)	7.96(+10)	6.20
2 – 36	3/2	5/2	E1	391513	255.419	7.39(+10)	7.43(+10)	4.34
1 – 31	3/2	5/2	E1	404005	247.522	5.11(+7)	5.10(+7)	2.81(–3)
1 – 32	3/2	3/2	E1	404685	247.106	3.18(+6)	3.22(+6)	1.16(–4)
3 – 38	5/2	5/2	E1	406787	245.829	1.61(+9)	1.54(+9)	8.76(–2)
2 – 38	3/2	5/2	E1	407831	245.200	5.30(+5)	1.03(+5)	2.86(–5)
3 – 39	5/2	3/2	E1	407978	245.111	7.81(+7)	7.23(+7)	2.81(–3)
2 – 39	3/2	3/2	E1	409021	244.486	1.26(+8)	1.08(+8)	4.51(–3)
1 – 33	3/2	1/2	E1	418059	239.201	9.97(+6)	1.03(+7)	1.71(–4)
1 – 34	3/2	3/2	E1	420791	237.648	1.65(+7)	1.59(+7)	5.58(–4)
1 – 35	3/2	1/2	E1	422468	236.704	5.41(+5)	8.21(+5)	9.09(–6)
1 – 36	3/2	5/2	E1	424537	235.551	2.44(+7)	2.41(+7)	1.22(–3)
1 – 38	3/2	5/2	E1	440855	226.832	1.15(+8)	1.12(+8)	5.32(–3)
1 – 39	3/2	3/2	E1	442045	226.221	1.93(+7)	1.89(+7)	5.23(–4)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Cr X Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	165757	603.293	1.16(+6)	1.28(+6)	3.80(–4)
5 – 7	3/2	3/2	E1	171785	582.123	3.93(+6)	4.09(+6)	7.98(–4)
5 – 8	3/2	1/2	E1	174711	572.374	5.38(+5)	7.68(+5)	5.28(–5)
4 – 7	1/2	3/2	E1	174938	571.631	3.69(+4)	2.96(+4)	7.24(–6)
4 – 8	1/2	1/2	E1	177864	562.227	3.42(+6)	3.85(+6)	3.24(–4)
3 – 6	5/2	5/2	E1	193672	516.337	9.08(+6)	9.50(+6)	2.18(–3)
2 – 6	3/2	5/2	E1	195982	510.251	3.70(+6)	3.84(+6)	8.65(–4)
3 – 7	5/2	3/2	E1	199700	500.751	1.53(+6)	1.69(+6)	2.30(–4)
2 – 7	3/2	3/2	E1	202011	495.023	6.35(+5)	7.13(+5)	9.34(–5)
2 – 8	3/2	1/2	E1	204936	487.957	1.67(+6)	1.65(+6)	1.19(–4)
5 – 9	3/2	3/2	E1	222486	449.466	3.95(+6)	5.48(+6)	4.79(–4)
5 – 10	3/2	5/2	E1	223452	447.523	3.72(+8)	3.48(+8)	6.71(–2)
4 – 9	1/2	3/2	E1	225639	443.186	2.08(+8)	1.89(+8)	2.45(–2)
1 – 6	3/2	5/2	E1	233971	427.403	1.20(+9)	1.18(+9)	1.97(–1)
1 – 7	3/2	3/2	E1	239999	416.668	1.27(+9)	1.25(+9)	1.33(–1)
1 – 8	3/2	1/2	E1	242924	411.651	1.33(+9)	1.30(+9)	6.74(–2)
3 – 9	5/2	3/2	E1	250401	399.359	6.68(+7)	6.32(+7)	6.39(–3)
3 – 10	5/2	5/2	E1	251366	397.826	2.04(+9)	2.03(+9)	2.91(–1)
2 – 9	3/2	3/2	E1	252712	395.707	2.36(+9)	2.34(+9)	2.22(–1)
2 – 10	3/2	5/2	E1	253677	394.202	3.86(+7)	4.16(+7)	5.39(–3)
5 – 11	3/2	3/2	E1	267052	374.459	4.62(+8)	4.30(+8)	3.88(–2)
4 – 11	1/2	3/2	E1	270205	370.089	2.19(+8)	2.06(+8)	1.80(–2)
5 – 12	3/2	1/2	E1	271218	368.707	1.96(+7)	1.41(+7)	8.01(–4)
4 – 12	1/2	1/2	E1	274371	364.470	1.97(+9)	1.96(+9)	7.85(–2)
5 – 13	3/2	1/2	E1	282855	353.538	5.39(+9)	5.51(+9)	2.02(–1)
4 – 13	1/2	1/2	E1	286008	349.641	1.09(+9)	1.17(+9)	4.01(–2)
1 – 9	3/2	3/2	E1	290700	343.997	6.04(+5)	5.39(+5)	4.29(–5)
1 – 10	3/2	5/2	E1	291665	342.859	3.48(+6)	3.71(+6)	3.68(–4)
3 – 11	5/2	3/2	E1	294967	339.021	5.59(+9)	5.71(+9)	3.85(–1)
2 – 11	3/2	3/2	E1	297277	336.387	4.65(+8)	4.65(+8)	4.51(–2)
5 – 14	3/2	3/2	E1	300881	332.357	5.83(+5)	5.59(+5)	3.86(–5)
2 – 12	3/2	1/2	E1	301443	331.738	5.59(+9)	5.74(+9)	1.84(–1)
5 – 15	3/2	5/2	E1	303194	329.822	5.05(+6)	5.26(+6)	4.94(–4)
4 – 14	1/2	3/2	E1	304033	328.912	9.53(+6)	9.92(+6)	6.18(–4)
2 – 13	3/2	1/2	E1	313081	319.406	1.35(+8)	1.37(+8)	4.14(–3)
5 – 17	3/2	5/2	E1	313995	318.476	4.05(+6)	4.72(+6)	3.70(–4)
5 – 19	3/2	1/2	E1	316872	315.585	4.55(+7)	4.66(+7)	1.36(–3)
5 – 20	3/2	3/2	E1	317577	314.884	1.02(+7)	1.02(+7)	6.09(–4)
4 – 19	1/2	1/2	E1	320025	312.476	1.23(+7)	1.24(+7)	3.60(–4)
5 – 21	3/2	5/2	E1	320177	312.327	3.62(+5)	5.42(+5)	3.18(–5)
4 – 20	1/2	3/2	E1	320730	311.789	1.40(+6)	1.48(+6)	8.14(–5)
3 – 14	5/2	3/2	E1	328795	304.141	2.50(+3)	7.94(+2)	1.39(–7)
2 – 14	3/2	3/2	E1	331106	302.018	6.34(+7)	6.65(+7)	3.47(–3)
3 – 15	5/2	5/2	E1	331109	302.015	2.24(+7)	2.36(+7)	1.84(–3)
2 – 15	3/2	5/2	E1	333419	299.923	9.45(+6)	9.33(+6)	7.65(–4)
3 – 16	5/2	7/2	E1	334480	298.972	1.38(+7)	1.38(+7)	1.48(–3)
1 – 11	3/2	3/2	E1	335266	298.271	1.76(+7)	1.63(+7)	9.41(–4)
1 – 12	3/2	1/2	E1	339432	294.610	8.99(+6)	1.03(+7)	2.34(–4)
3 – 17	5/2	5/2	E1	341910	292.475	2.73(+5)	1.89(+5)	2.10(–5)
2 – 17	3/2	5/2	E1	344220	290.512	2.86(+5)	7.12(+4)	2.18(–5)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Cr X Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 18	5/2	7/2	E1	344501	290.275	1.97(+7)	2.35(+7)	1.99(–3)
3 – 20	5/2	3/2	E1	345492	289.442	1.34(+8)	1.38(+8)	6.73(–3)
2 – 19	3/2	1/2	E1	347097	288.104	1.77(+8)	1.82(+8)	4.41(–3)
2 – 20	3/2	3/2	E1	347802	287.520	2.49(+4)	4.50(+4)	1.24(–6)
3 – 21	5/2	5/2	E1	348091	287.281	4.06(+7)	3.99(+7)	3.01(–3)
2 – 21	3/2	5/2	E1	350402	285.386	2.64(+5)	8.22(+4)	1.94(–5)
1 – 13	3/2	1/2	E1	351069	284.844	4.46(+7)	4.62(+7)	1.09(–3)
3 – 22	5/2	7/2	E1	353907	282.560	2.55(+5)	8.07(+5)	2.44(–5)
1 – 14	3/2	3/2	E1	369094	270.934	3.97(+6)	6.11(+6)	1.75(–4)
5 – 24	3/2	3/2	E1	370253	270.086	3.48(+9)	3.64(+9)	1.52(–1)
1 – 15	3/2	5/2	E1	371408	269.246	8.53(+6)	8.82(+6)	5.56(–4)
4 – 24	1/2	3/2	E1	373406	267.805	1.04(+9)	1.07(+9)	4.45(–2)
5 – 25	3/2	1/2	E1	377827	264.671	9.74(+9)	1.01(+10)	2.05(–1)
5 – 26	3/2	5/2	E1	378471	264.221	6.60(+6)	6.78(+6)	4.14(–4)
4 – 25	1/2	1/2	E1	380979	262.482	5.35(+9)	5.56(+9)	1.10(–1)
5 – 27	3/2	3/2	E1	381419	262.179	4.05(+7)	4.28(+7)	1.67(–3)
1 – 17	3/2	5/2	E1	382209	261.637	3.89(+7)	4.00(+7)	2.39(–3)
5 – 28	3/2	1/2	E1	383298	260.894	1.67(+8)	1.69(+8)	3.41(–3)
4 – 27	1/2	3/2	E1	384572	260.029	9.29(+5)	6.07(+5)	3.77(–5)
1 – 19	3/2	1/2	E1	385086	259.682	3.44(+7)	3.55(+7)	6.96(–4)
1 – 20	3/2	3/2	E1	385791	259.208	1.29(+8)	1.33(+8)	5.20(–3)
3 – 23	5/2	7/2	E1	385810	259.195	1.14(+8)	1.17(+8)	9.16(–3)
4 – 28	1/2	1/2	E1	386451	258.765	1.58(+8)	1.66(+8)	3.17(–3)
5 – 29	3/2	3/2	E1	387829	257.846	1.64(+8)	1.65(+8)	6.52(–3)
1 – 21	3/2	5/2	E1	388390	257.473	1.50(+8)	1.56(+8)	8.97(–3)
4 – 29	1/2	3/2	E1	390982	255.766	4.22(+6)	9.89(+6)	1.66(–4)
5 – 30	3/2	5/2	E1	395372	252.926	9.49(+8)	1.05(+9)	5.46(–2)
3 – 24	5/2	3/2	E1	398168	251.150	4.14(+10)	4.27(+10)	1.57
2 – 24	3/2	3/2	E1	400478	249.702	1.31(+10)	1.36(+10)	4.92(–1)
3 – 26	5/2	5/2	E1	406386	246.071	7.62(+8)	7.97(+8)	4.15(–2)
2 – 25	3/2	1/2	E1	408052	245.067	4.21(+10)	4.33(+10)	7.57(–1)
2 – 26	3/2	5/2	E1	408696	244.681	1.63(+8)	1.70(+8)	8.76(–3)
3 – 27	5/2	3/2	E1	409334	244.299	3.49(+7)	3.67(+7)	1.25(–3)
2 – 27	3/2	3/2	E1	411644	242.928	4.31(+8)	4.50(+8)	1.52(–2)
5 – 31	3/2	5/2	E1	413416	241.887	4.07(+9)	4.28(+9)	2.14(–1)
2 – 28	3/2	1/2	E1	413524	241.824	1.81(+9)	1.87(+9)	3.17(–2)
5 – 32	3/2	3/2	E1	413981	241.557	1.06(+8)	1.04(+8)	3.72(–3)
3 – 29	5/2	3/2	E1	415744	240.533	4.02(+9)	4.17(+9)	1.39(–1)
4 – 32	1/2	3/2	E1	417134	239.731	4.02(+9)	4.22(+9)	1.39(–1)
2 – 29	3/2	3/2	E1	418054	239.204	6.21(+9)	6.52(+9)	2.13(–1)
3 – 30	5/2	5/2	E1	423287	236.246	1.62(+10)	1.69(+10)	8.12(–1)
2 – 30	3/2	5/2	E1	425579	234.974	6.09(+8)	6.22(+8)	3.03(–2)
5 – 33	3/2	1/2	E1	429000	233.100	4.13(+9)	4.29(+9)	6.72(–2)
4 – 33	1/2	1/2	E1	432153	231.400	5.71(+10)	5.84(+10)	9.16(–1)
5 – 34	3/2	3/2	E1	433737	230.554	4.86(+10)	4.99(+10)	1.55
5 – 35	3/2	1/2	E1	435610	229.563	5.36(+10)	5.44(+10)	8.47(–1)
5 – 36	3/2	5/2	E1	436345	229.176	8.18(+7)	8.13(+7)	3.86(–3)
4 – 34	1/2	3/2	E1	436889	228.891	1.43(+10)	1.47(+10)	4.50(–1)
1 – 24	3/2	3/2	E1	438467	228.067	1.31(+6)	1.45(+6)	4.10(–5)
4 – 35	1/2	1/2	E1	438763	227.913	3.32(+9)	3.29(+9)	5.16(–2)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Cr X Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 31	5/2	5/2	E1	441331	226.587	4.70(+10)	4.81(+10)	2.17
3 – 32	5/2	3/2	E1	441896	226.298	8.05(+9)	8.26(+9)	2.47(–1)
2 – 31	3/2	5/2	E1	443641	225.407	2.78(+9)	2.83(+9)	1.27(–1)
2 – 32	3/2	3/2	E1	444206	225.121	5.37(+10)	5.52(+10)	1.63
1 – 25	3/2	1/2	E1	446040	224.195	2.17(+9)	2.25(+9)	3.28(–2)
1 – 26	3/2	5/2	E1	446685	223.871	7.62(+10)	7.89(+10)	3.44
1 – 27	3/2	3/2	E1	449633	222.404	7.71(+10)	7.97(+10)	2.29
1 – 28	3/2	1/2	E1	451512	221.478	7.87(+10)	8.14(+10)	1.16
1 – 29	3/2	3/2	E1	456043	219.278	3.15(+9)	3.25(+9)	9.10(–2)
5 – 38	3/2	5/2	E1	457293	218.678	8.22(+10)	8.36(+10)	3.54
5 – 39	3/2	3/2	E1	458797	217.961	1.71(+10)	1.73(+10)	4.88(–1)
2 – 33	3/2	1/2	E1	459225	217.758	1.47(+9)	1.54(+9)	2.10(–2)
3 – 34	5/2	3/2	E1	461651	216.614	1.10(+8)	1.17(+8)	3.10(–3)
4 – 39	1/2	3/2	E1	461950	216.474	6.64(+10)	6.74(+10)	1.87
1 – 30	3/2	5/2	E1	463586	215.710	1.90(+9)	1.95(+9)	7.93(–2)
2 – 34	3/2	3/2	E1	463962	215.535	8.72(+8)	8.81(+8)	2.43(–2)
3 – 36	5/2	5/2	E1	464260	215.397	6.08(+9)	6.24(+9)	2.54(–1)
2 – 35	3/2	1/2	E1	465835	214.668	4.17(+9)	4.24(+9)	5.77(–2)
3 – 37	5/2	7/2	E1	466459	214.381	9.50(+10)	9.68(+10)	5.24
2 – 36	3/2	5/2	E1	466570	214.330	8.87(+10)	9.03(+10)	3.67
1 – 31	3/2	5/2	E1	481630	207.628	9.65(+7)	9.72(+7)	3.74(–3)
1 – 32	3/2	3/2	E1	482195	207.385	3.08(+6)	3.17(+6)	7.94(–5)
3 – 38	5/2	5/2	E1	485207	206.098	2.63(+9)	2.59(+9)	1.01(–1)
3 – 39	5/2	3/2	E1	486712	205.460	1.19(+8)	1.14(+8)	3.02(–3)
2 – 38	3/2	5/2	E1	487518	205.121	2.14(+6)	3.60(+6)	8.12(–5)
2 – 39	3/2	3/2	E1	489023	204.489	1.02(+8)	8.77(+7)	2.55(–3)
1 – 33	3/2	1/2	E1	497214	201.121	2.07(+7)	2.16(+7)	2.51(–4)
1 – 34	3/2	3/2	E1	501950	199.223	3.53(+7)	3.46(+7)	8.39(–4)
1 – 35	3/2	1/2	E1	503824	198.482	3.07(+5)	7.84(+5)	3.63(–6)
1 – 36	3/2	5/2	E1	504559	198.193	1.09(+8)	1.09(+8)	3.86(–3)
1 – 38	3/2	5/2	E1	525506	190.293	2.52(+8)	2.49(+8)	8.20(–3)
1 – 39	3/2	3/2	E1	527011	189.749	4.43(+7)	4.41(+7)	9.57(–4)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Fe XII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	193031	518.052	2.23(+6)	2.48(+6)	5.39(–4)
5 – 7	3/2	3/2	E1	202339	494.220	9.66(+6)	1.02(+7)	1.42(–3)
5 – 8	3/2	1/2	E1	206638	483.938	1.60(+6)	2.33(+6)	1.12(–4)
4 – 7	1/2	3/2	E1	208598	479.391	1.10(+5)	8.71(+4)	1.52(–5)
4 – 8	1/2	1/2	E1	212898	469.708	9.44(+6)	1.08(+7)	6.24(–4)
3 – 6	5/2	5/2	E1	227645	439.280	2.14(+7)	2.26(+7)	3.72(–3)
2 – 6	3/2	5/2	E1	232110	430.830	1.25(+7)	1.30(+7)	2.08(–3)
3 – 7	5/2	3/2	E1	237001	421.939	4.69(+6)	4.11(+6)	4.39(–4)
2 – 7	3/2	3/2	E1	241464	414.140	6.49(+5)	7.96(+5)	6.67(–5)
2 – 8	3/2	1/2	E1	245764	406.894	4.86(+6)	4.70(+6)	2.41(–4)
5 – 9	3/2	3/2	E1	259284	385.677	1.94(+7)	2.40(+7)	1.73(–3)
5 – 10	3/2	5/2	E1	261361	382.613	5.30(+8)	4.99(+8)	6.98(–2)
4 – 9	1/2	3/2	E1	265544	376.585	2.67(+8)	2.42(+8)	2.27(–2)
1 – 6	3/2	5/2	E1	274620	364.140	1.60(+9)	1.58(+9)	1.91(–1)
1 – 7	3/2	3/2	E1	284131	351.950	1.74(+9)	1.71(+9)	1.29(–1)
1 – 8	3/2	1/2	E1	288431	346.703	1.84(+9)	1.81(+9)	6.62(–2)
3 – 9	5/2	3/2	E1	293947	340.197	4.41(+7)	3.97(+7)	3.06(–3)
3 – 10	5/2	5/2	E1	295975	337.866	2.74(+9)	2.74(+9)	2.82(–1)
2 – 9	3/2	3/2	E1	298409	335.111	3.29(+9)	3.28(+9)	2.22(–1)
2 – 10	3/2	5/2	E1	300439	332.846	2.80(+7)	3.20(+7)	2.79(–3)
5 – 11	3/2	3/2	E1	309868	322.718	5.51(+8)	5.02(+8)	3.44(–2)
5 – 12	3/2	1/2	E1	314933	317.528	2.59(+6)	5.16(+5)	7.83(–5)
4 – 11	1/2	3/2	E1	316128	316.328	3.25(+8)	3.04(+8)	1.95(–2)
4 – 12	1/2	1/2	E1	321193	311.339	3.04(+9)	3.03(+9)	8.83(–2)
5 – 13	3/2	1/2	E1	331082	302.040	7.08(+9)	7.25(+9)	1.94(–1)
4 – 13	1/2	1/2	E1	337342	296.435	1.04(+9)	1.16(+9)	2.74(–2)
1 – 9	3/2	3/2	E1	341076	293.190	4.25(+6)	3.94(+6)	2.19(–4)
1 – 10	3/2	5/2	E1	342949	291.589	8.09(+6)	8.80(+6)	6.19(–4)
3 – 11	5/2	3/2	E1	344531	290.250	7.33(+9)	7.57(+9)	3.71(–1)
5 – 14	3/2	3/2	E1	346205	288.846	6.25(+5)	5.55(+5)	3.13(–5)
2 – 11	3/2	3/2	E1	348994	286.538	8.15(+8)	8.12(+8)	4.01(–2)
5 – 15	3/2	5/2	E1	350549	285.267	9.48(+6)	1.01(+7)	6.94(–4)
4 – 14	1/2	3/2	E1	352465	283.716	1.68(+7)	1.81(+7)	8.11(–4)
2 – 12	3/2	1/2	E1	354058	282.440	7.17(+9)	7.46(+9)	1.71(–1)
5 – 17	3/2	5/2	E1	362872	275.579	5.99(+6)	7.31(+6)	4.09(–4)
5 – 18	3/2	1/2	E1	366828	272.607	1.48(+8)	1.53(+8)	3.30(–3)
5 – 20	3/2	3/2	E1	367892	271.819	2.27(+7)	2.24(+7)	1.01(–3)
2 – 13	3/2	1/2	E1	370208	270.118	2.67(+8)	2.78(+8)	5.83(–3)
5 – 21	3/2	5/2	E1	372739	268.284	1.99(+6)	2.41(+6)	1.29(–4)
4 – 18	1/2	1/2	E1	373088	268.033	2.79(+7)	2.75(+7)	6.02(–4)
4 – 20	1/2	3/2	E1	374152	267.271	6.18(+6)	6.35(+6)	2.65(–4)
3 – 14	5/2	3/2	E1	380868	262.558	1.61(+6)	1.62(+6)	6.64(–5)
3 – 15	5/2	5/2	E1	385165	259.629	4.61(+7)	4.92(+7)	2.80(–3)
2 – 14	3/2	3/2	E1	385331	259.517	1.55(+8)	1.64(+8)	6.25(–3)
2 – 15	3/2	5/2	E1	389628	256.655	2.04(+7)	2.10(+7)	1.21(–3)
3 – 16	5/2	7/2	E1	390654	255.981	2.58(+7)	2.69(+7)	2.02(–3)
1 – 11	3/2	3/2	E1	391660	255.323	3.95(+7)	3.70(+7)	1.55(–3)
1 – 12	3/2	1/2	E1	396725	252.064	4.59(+7)	5.14(+7)	8.75(–4)
3 – 17	5/2	5/2	E1	397486	251.581	2.83(+5)	2.63(+5)	1.61(–5)
3 – 19	5/2	7/2	E1	401740	248.917	3.46(+7)	4.14(+7)	2.57(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^23p^3-3s3p^4$ and $3s^23p^3-3s^23p^23d$

See page 154 for Explanation of Tables

Fe XII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
2 – 17	3/2	5/2	E1	401951	248.787	1.17(+6)	3.36(+5)	6.51(–5)
3 – 20	5/2	3/2	E1	402554	248.414	3.27(+8)	3.42(+8)	1.21(–2)
2 – 18	3/2	1/2	E1	405953	246.334	4.01(+8)	4.22(+8)	7.30(–3)
2 – 20	3/2	3/2	E1	407017	245.690	1.97(+5)	1.94(+5)	7.15(–6)
3 – 21	5/2	5/2	E1	407353	245.487	9.40(+7)	9.51(+7)	5.09(–3)
2 – 21	3/2	5/2	E1	411818	242.826	2.78(+6)	2.20(+6)	1.47(–4)
1 – 13	3/2	1/2	E1	412875	242.204	8.07(+7)	8.42(+7)	1.42(–3)
3 – 22	5/2	7/2	E1	416618	240.028	7.37(+4)	2.37(+4)	5.09(–6)
5 – 24	3/2	3/2	E1	426177	234.644	3.49(+9)	3.60(+9)	1.15(–1)
1 – 14	3/2	3/2	E1	427998	233.646	1.59(+7)	1.67(+7)	5.19(–4)
1 – 15	3/2	5/2	E1	432138	231.408	3.13(+7)	3.28(+7)	1.51(–3)
4 – 24	1/2	3/2	E1	432436	231.248	1.27(+9)	1.31(+9)	4.08(–2)
5 – 25	3/2	5/2	E1	436019	229.348	8.13(+6)	8.97(+6)	3.85(–4)
5 – 26	3/2	1/2	E1	437893	228.366	1.33(+10)	1.39(+10)	2.08(–1)
5 – 27	3/2	3/2	E1	439824	227.364	1.26(+8)	1.38(+8)	3.89(–3)
5 – 28	3/2	1/2	E1	442957	225.756	1.16(+9)	1.19(+9)	1.77(–2)
4 – 26	1/2	1/2	E1	444153	225.148	6.43(+9)	6.66(+9)	9.78(–2)
1 – 17	3/2	5/2	E1	444461	224.992	9.07(+7)	9.44(+7)	4.13(–3)
4 – 27	1/2	3/2	E1	446084	224.173	6.01(+5)	5.64(+5)	1.81(–5)
5 – 29	3/2	3/2	E1	447934	223.247	2.68(+8)	2.83(+8)	8.00(–3)
1 – 18	3/2	1/2	E1	448620	222.906	6.88(+7)	7.23(+7)	1.02(–3)
4 – 28	1/2	1/2	E1	449217	222.610	7.78(+8)	8.08(+8)	1.16(–2)
1 – 20	3/2	3/2	E1	449684	222.378	2.84(+8)	3.00(+8)	8.43(–3)
3 – 23	5/2	7/2	E1	449862	222.290	2.55(+8)	2.66(+8)	1.51(–2)
4 – 29	1/2	3/2	E1	454194	220.170	2.82(+6)	1.78(+6)	8.21(–6)
1 – 21	3/2	5/2	E1	454327	220.106	3.39(+8)	3.54(+8)	1.48(–2)
5 – 30	3/2	5/2	E1	459512	217.622	1.83(+9)	2.00(+9)	7.81(–2)
3 – 24	5/2	3/2	E1	460839	216.996	4.77(+10)	4.99(+10)	1.35
2 – 24	3/2	3/2	E1	465302	214.914	1.90(+10)	1.99(+10)	5.26(–1)
3 – 25	5/2	5/2	E1	470633	212.480	1.39(+9)	1.45(+9)	5.65(–2)
3 – 27	5/2	3/2	E1	474486	210.754	3.03(+8)	3.27(+8)	8.08(–3)
2 – 25	3/2	5/2	E1	475098	210.483	4.17(+8)	4.38(+8)	1.66(–2)
2 – 26	3/2	1/2	E1	477019	209.635	4.31(+10)	4.51(+10)	5.68(–1)
5 – 31	3/2	3/2	E1	477877	209.259	3.85(+8)	2.94(+8)	7.47(–3)
5 – 32	3/2	5/2	E1	478165	209.133	4.54(+9)	4.75(+9)	1.78(–1)
2 – 27	3/2	3/2	E1	478949	208.790	5.16(+8)	5.44(+8)	1.35(–2)
2 – 28	3/2	1/2	E1	482083	207.433	7.21(+9)	7.53(+9)	9.30(–2)
3 – 29	5/2	3/2	E1	482596	207.213	6.00(+9)	6.32(+9)	1.54(–1)
4 – 31	1/2	3/2	E1	484137	206.553	5.35(+9)	5.62(+9)	1.37(–1)
2 – 29	3/2	3/2	E1	487059	205.314	6.42(+9)	6.85(+9)	1.62(–1)
5 – 33	3/2	1/2	E1	493942	202.453	4.38(+9)	4.61(+9)	5.39(–2)
3 – 30	5/2	5/2	E1	494126	202.378	2.49(+10)	2.59(+10)	9.16(–1)
2 – 30	3/2	5/2	E1	498591	200.565	7.35(+8)	7.50(+8)	2.66(–2)
4 – 33	1/2	1/2	E1	500202	199.919	6.68(+10)	7.00(+10)	8.01(–1)
5 – 35	3/2	3/2	E1	501727	199.312	5.49(+10)	5.77(+10)	1.31
5 – 34	3/2	5/2	E1	501750	199.302	1.80(+8)	1.80(+8)	4.42(–3)
5 – 36	3/2	1/2	E1	503920	198.444	6.26(+10)	6.50(+10)	7.40(–1)
1 – 24	3/2	3/2	E1	507969	196.862	7.16(+7)	6.99(+7)	1.66(–3)
4 – 35	1/2	3/2	E1	507986	196.856	1.90(+10)	1.99(+10)	4.41(–1)
4 – 36	1/2	1/2	E1	510180	196.009	3.66(+9)	3.71(+9)	4.22(–2)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Fe XII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 31	5/2	3/2	E1	512539	195.107	1.03(+10)	1.08(+10)	2.36(–1)
3 – 32	5/2	5/2	E1	512779	195.016	4.83(+10)	4.94(+10)	1.65
2 – 31	3/2	3/2	E1	517002	193.423	6.29(+10)	6.56(+10)	1.41
2 – 32	3/2	5/2	E1	517243	193.333	3.12(+9)	3.17(+9)	1.05(–1)
1 – 25	3/2	5/2	E1	517607	193.197	8.79(+10)	9.10(+10)	2.95
1 – 26	3/2	1/2	E1	519686	192.424	9.85(+9)	1.03(+10)	1.09(–1)
1 – 27	3/2	3/2	E1	521616	191.712	8.87(+10)	9.32(+10)	1.95
1 – 28	3/2	1/2	E1	524750	190.567	8.58(+10)	8.99(+10)	9.34(–1)
5 – 38	3/2	5/2	E1	529020	189.029	9.44(+10)	9.61(+10)	3.03
1 – 29	3/2	3/2	E1	529726	188.777	6.14(+9)	6.43(+9)	1.31(–1)
5 – 39	3/2	3/2	E1	530227	188.598	2.16(+10)	2.24(+10)	4.60(–1)
2 – 33	3/2	1/2	E1	533068	187.593	2.29(+9)	2.55(+9)	2.41(–2)
3 – 34	5/2	5/2	E1	536365	186.440	7.19(+9)	7.35(+9)	2.25(–1)
3 – 35	5/2	3/2	E1	536389	186.432	9.03(+7)	1.25(+8)	1.88(–3)
4 – 39	1/2	3/2	E1	536487	186.398	7.56(+10)	7.85(+10)	1.57
3 – 37	5/2	7/2	E1	540672	184.955	1.10(+11)	1.12(+11)	4.49
2 – 34	3/2	5/2	E1	540829	184.901	1.02(+11)	1.04(+11)	3.13
2 – 35	3/2	3/2	E1	540852	184.893	1.41(+9)	1.44(+9)	2.89(–2)
1 – 30	3/2	5/2	E1	541101	184.808	2.93(+9)	3.00(+9)	9.01(–2)
2 – 36	3/2	1/2	E1	543045	184.147	7.02(+9)	7.36(+9)	7.14(–2)
1 – 31	3/2	3/2	E1	559669	178.677	1.09(+6)	1.20(+6)	2.09(–5)
1 – 32	3/2	5/2	E1	559753	178.650	1.54(+8)	1.55(+8)	4.42(–3)
3 – 38	5/2	5/2	E1	563634	177.420	3.64(+9)	3.64(+9)	1.03(–1)
3 – 39	5/2	3/2	E1	564890	177.026	1.61(+8)	1.66(+8)	3.02(–3)
2 – 38	3/2	5/2	E1	568099	176.026	2.57(+7)	2.95(+7)	7.15(–4)
2 – 39	3/2	3/2	E1	569352	175.638	5.81(+7)	6.12(+7)	1.08(–3)
1 – 33	3/2	1/2	E1	575735	173.691	2.78(+7)	4.09(+7)	3.42(–4)
1 – 34	3/2	5/2	E1	583339	171.427	3.73(+8)	3.72(+8)	9.86(–3)
1 – 35	3/2	3/2	E1	583519	171.374	6.35(+7)	6.43(+7)	1.12(–3)
1 – 36	3/2	1/2	E1	585712	170.732	1.85(+4)	1.26(+4)	1.62(–7)
1 – 35	3/2	5/2	E1	610608	163.771	4.51(+8)	4.43(+8)	1.09(–3)
1 – 39	3/2	3/2	E1	612019	163.394	8.60(+7)	8.75(+7)	1.38(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Co XIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	205736	486.060	2.71(+6)	3.14(+6)	5.77(–4)
5 – 7	3/2	3/2	E1	217494	459.783	1.36(+7)	1.47(+7)	1.72(–3)
5 – 8	3/2	1/2	E1	222583	449.271	2.67(+6)	3.72(+6)	1.61(–4)
4 – 7	1/2	3/2	E1	225984	442.509	1.68(+5)	1.40(+5)	1.97(–5)
4 – 8	1/2	1/2	E1	231073	432.764	1.46(+7)	1.69(+7)	8.21(–4)
3 – 6	5/2	5/2	E1	244492	409.011	3.02(+7)	3.26(+7)	4.55(–3)
2 – 6	3/2	5/2	E1	250433	399.308	2.05(+7)	2.19(+7)	2.94(–3)
3 – 7	5/2	3/2	E1	256250	390.244	6.41(+6)	7.21(+6)	5.86(–4)
2 – 7	3/2	3/2	E1	262191	381.401	5.80(+5)	7.18(+5)	5.06(–5)
2 – 8	3/2	1/2	E1	267280	374.139	7.58(+6)	7.42(+6)	3.18(–4)
5 – 9	3/2	3/2	E1	277611	360.216	2.96(+7)	3.63(+7)	2.30(–3)
5 – 10	3/2	5/2	E1	280241	356.836	5.99(+8)	5.76(+8)	6.86(–2)
4 – 9	1/2	3/2	E1	286101	349.527	2.90(+8)	2.68(+8)	2.12(–2)
1 – 6	3/2	5/2	E1	295717	338.161	1.76(+9)	1.80(+9)	1.81(–1)
1 – 7	3/2	3/2	E1	307475	325.230	1.96(+9)	1.98(+9)	1.25(–1)
1 – 8	3/2	1/2	E1	312564	319.934	2.09(+9)	2.11(+9)	6.41(–2)
3 – 9	5/2	3/2	E1	316367	316.089	2.85(+7)	2.55(+7)	1.71(–3)
3 – 10	5/2	5/2	E1	318997	313.483	3.04(+9)	3.10(+9)	2.69(–1)
2 – 9	3/2	3/2	E1	322308	310.262	3.77(+9)	3.82(+9)	2.18(–1)
2 – 10	3/2	5/2	E1	324938	307.751	2.12(+7)	2.58(+7)	1.81(–3)
5 – 11	3/2	3/2	E1	331367	301.780	6.15(+8)	5.71(+8)	3.36(–2)
5 – 12	3/2	1/2	E1	336874	296.847	2.95(+6)	2.59(+6)	7.80(–5)
4 – 11	1/2	3/2	E1	339857	294.241	4.00(+8)	3.80(+8)	2.07(–2)
4 – 12	1/2	1/2	E1	345364	289.550	3.61(+9)	3.68(+9)	9.06(–2)
5 – 13	3/2	1/2	E1	356199	280.742	7.88(+9)	8.21(+9)	1.86(–1)
4 – 13	1/2	1/2	E1	364688	274.207	1.02(+9)	1.17(+9)	2.30(–2)
1 – 9	3/2	3/2	E1	367592	272.041	9.54(+6)	8.98(+6)	4.23(–4)
5 – 14	3/2	3/2	E1	368761	271.178	7.39(+5)	6.27(+5)	3.26(–5)
3 – 11	5/2	3/2	E1	370123	270.180	8.15(+9)	8.46(+9)	3.57(–1)
1 – 10	3/2	5/2	E1	370221	270.109	1.14(+7)	1.27(+7)	7.51(–4)
5 – 15	3/2	5/2	E1	373408	267.804	1.26(+7)	1.36(+7)	8.12(–4)
2 – 11	3/2	3/2	E1	376064	265.912	8.69(+8)	8.68(+8)	3.69(–2)
4 – 14	1/2	3/2	E1	377251	265.076	2.24(+7)	2.43(+7)	9.45(–4)
2 – 12	3/2	1/2	E1	381571	262.074	7.94(+9)	8.32(+9)	1.64(–1)
5 – 17	3/2	5/2	E1	386774	258.549	7.28(+6)	9.12(+6)	4.38(–4)
5 – 19	3/2	1/2	E1	392184	254.982	2.45(+8)	2.54(+8)	4.78(–3)
5 – 20	3/2	3/2	E1	393407	254.190	3.20(+7)	3.20(+7)	1.24(–3)
5 – 21	3/2	5/2	E1	398744	250.787	4.10(+6)	5.28(+6)	2.32(–4)
4 – 19	1/2	1/2	E1	400673	249.580	3.86(+7)	3.85(+7)	7.20(–4)
2 – 13	3/2	1/2	E1	400895	249.442	2.81(+8)	2.88(+8)	5.25(–3)
4 – 20	1/2	3/2	E1	401896	248.821	1.03(+7)	1.08(+7)	3.84(–4)
3 – 14	5/2	3/2	E1	407517	245.389	5.14(+6)	5.08(+6)	1.86(–4)
3 – 15	5/2	5/2	E1	412164	242.622	6.25(+7)	6.78(+7)	3.31(–3)
2 – 14	3/2	3/2	E1	413458	241.863	2.27(+8)	2.43(+8)	7.96(–3)
2 – 15	3/2	5/2	E1	418105	239.174	2.90(+7)	2.89(+7)	1.49(–3)
3 – 16	5/2	7/2	E1	419015	238.655	3.39(+7)	3.45(+7)	2.32(–3)
1 – 11	3/2	3/2	E1	421348	237.334	6.02(+7)	5.51(+7)	2.03(–3)
3 – 17	5/2	5/2	E1	425530	235.001	6.16(+4)	4.10(+4)	3.06(–6)
1 – 12	3/2	1/2	E1	426855	234.272	8.15(+7)	9.24(+7)	1.34(–3)
3 – 18	5/2	7/2	E1	430714	232.173	4.93(+7)	5.81(+7)	3.19(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Co XIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
2 – 17	3/2	5/2	E1	431471	231.765	9.89(+5)	1.12(+5)	4.77(–5)
3 – 20	5/2	3/2	E1	432162	231.395	4.73(+8)	4.90(+8)	1.52(–2)
2 – 19	3/2	1/2	E1	436880	228.896	5.60(+8)	5.82(+8)	8.80(–3)
3 – 21	5/2	5/2	E1	437500	228.571	1.37(+8)	1.36(+8)	6.42(–3)
2 – 20	3/2	3/2	E1	438103	228.257	9.24(+4)	1.62(+5)	2.89(–6)
2 – 21	3/2	5/2	E1	443441	225.509	6.05(+6)	4.93(+6)	2.77(–4)
1 – 13	3/2	1/2	E1	446179	224.125	1.06(+8)	1.11(+8)	1.59(–3)
3 – 22	5/2	7/2	E1	449040	222.697	2.48(+5)	2.90(+4)	1.47(–5)
5 – 24	3/2	3/2	E1	454826	219.864	3.53(+9)	3.76(+9)	1.02(–1)
1 – 14	3/2	3/2	E1	458742	217.987	3.04(+7)	3.18(+7)	8.65(–4)
4 – 24	1/2	3/2	E1	463315	215.836	1.40(+9)	1.44(+9)	3.90(–2)
1 – 15	3/2	5/2	E1	463389	215.801	5.71(+7)	5.98(+7)	2.39(–3)
5 – 25	3/2	5/2	E1	464983	215.062	8.76(+6)	9.12(+6)	3.64(–4)
5 – 26	3/2	1/2	E1	469057	213.194	1.47(+10)	1.55(+10)	2.00(–1)
5 – 27	3/2	3/2	E1	470041	212.747	2.06(+8)	2.23(+8)	5.58(–3)
5 – 28	3/2	1/2	E1	474232	210.867	2.59(+9)	2.67(+9)	3.45(–2)
1 – 17	3/2	5/2	E1	476754	209.752	1.37(+8)	1.43(+8)	5.44(–3)
4 – 26	1/2	1/2	E1	477547	209.403	6.83(+9)	7.16(+9)	9.98(–2)
4 – 27	1/2	3/2	E1	478531	208.973	1.45(+4)	1.11(+5)	3.80(–7)
5 – 29	3/2	3/2	E1	479484	208.558	2.98(+8)	3.13(+8)	7.76(–3)
1 – 19	3/2	1/2	E1	482164	207.398	9.45(+7)	9.86(+7)	1.22(–3)
4 – 28	1/2	1/2	E1	482722	207.159	1.57(+9)	1.66(+9)	2.02(–2)
1 – 20	3/2	3/2	E1	483387	206.874	4.12(+8)	4.30(+8)	1.06(–2)
3 – 23	5/2	7/2	E1	483664	206.755	3.75(+8)	3.91(+8)	1.92(–2)
4 – 29	1/2	3/2	E1	487973	204.929	3.64(+5)	7.99(+5)	9.17(–6)
1 – 21	3/2	5/2	E1	488725	204.614	4.82(+8)	5.06(+8)	1.82(–2)
5 – 30	3/2	5/2	E1	492808	202.919	2.60(+9)	2.89(+9)	9.61(–2)
3 – 24	5/2	3/2	E1	493582	202.601	5.09(+10)	5.28(+10)	1.25
2 – 24	3/2	3/2	E1	499523	200.191	2.26(+10)	2.36(+10)	5.43(–1)
3 – 25	5/2	5/2	E1	503739	198.516	1.81(+9)	1.92(+9)	6.42(–2)
3 – 27	5/2	3/2	E1	508797	196.542	5.42(+8)	5.70(+8)	1.26(–2)
2 – 25	3/2	5/2	E1	509680	196.202	6.47(+8)	6.85(+8)	2.24(–2)
5 – 31	3/2	3/2	E1	511565	195.479	4.79(+8)	4.82(+8)	1.10(–2)
5 – 32	3/2	5/2	E1	512014	195.307	4.53(+9)	4.80(+9)	1.55(–1)
2 – 26	3/2	1/2	E1	513754	194.646	4.04(+10)	4.17(+10)	4.59(–1)
2 – 27	3/2	3/2	E1	514738	194.274	5.02(+8)	5.35(+8)	1.14(–2)
3 – 29	5/2	3/2	E1	518239	192.961	7.09(+9)	7.43(+9)	1.58(–1)
2 – 28	3/2	1/2	E1	518929	192.705	1.32(+10)	1.37(+10)	1.47(–1)
4 – 31	1/2	3/2	E1	520054	192.288	6.47(+9)	6.86(+9)	1.44(–1)
2 – 29	3/2	3/2	E1	524180	190.774	6.69(+9)	7.19(+9)	1.46(–1)
5 – 33	3/2	1/2	E1	528219	189.315	3.74(+9)	3.98(+9)	4.02(–2)
3 – 30	5/2	5/2	E1	531563	188.124	3.12(+10)	3.29(+10)	9.95(–1)
5 – 34	3/2	5/2	E1	535880	186.609	2.92(+8)	2.95(+8)	9.16(–3)
4 – 33	1/2	1/2	E1	536708	186.321	7.21(+10)	7.42(+10)	7.50(–1)
2 – 30	3/2	5/2	E1	537504	186.045	8.05(+8)	8.20(+8)	2.51(–2)
5 – 35	3/2	3/2	E1	538053	185.855	5.71(+10)	5.91(+10)	1.18
5 – 36	3/2	1/2	E1	540274	185.091	6.81(+10)	6.92(+10)	6.99(–1)
1 – 24	3/2	3/2	E1	544807	183.551	2.08(+8)	2.14(+8)	4.19(–3)
4 – 35	1/2	3/2	E1	546542	182.969	3.16(+10)	2.24(+10)	4.34(–1)
4 – 36	1/2	1/2	E1	548763	182.228	3.21(+9)	3.12(+9)	3.20(–2)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Co XIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 31	5/2	3/2	E1	550320	181.712	1.17(+10)	1.21(+10)	2.31(–1)
3 – 32	5/2	5/2	E1	550770	181.564	4.76(+10)	4.88(+10)	1.41
1 – 25	3/2	5/2	E1	554963	180.192	9.49(+10)	9.91(+10)	2.77
2 – 31	3/2	3/2	E1	556261	179.772	6.74(+10)	6.97(+10)	1.31
2 – 32	3/2	5/2	E1	556711	179.626	3.58(+9)	3.64(+9)	1.04(–1)
1 – 26	3/2	1/2	E1	559038	178.879	1.90(+10)	1.98(+10)	1.83(–1)
1 – 27	3/2	3/2	E1	560022	178.564	9.50(+10)	9.92(+10)	1.82
1 – 28	3/2	1/2	E1	564213	177.238	8.47(+10)	8.84(+10)	7.98(–1)
5 – 38	3/2	5/2	E1	566942	176.385	1.02(+11)	1.05(+11)	2.85
5 – 39	3/2	3/2	E1	568348	175.949	2.40(+10)	2.44(+10)	4.45(–1)
1 – 29	3/2	3/2	E1	569464	175.604	7.90(+9)	8.22(+9)	1.46(–1)
1 – 29	3/2	3/2	E1	569464	175.604	7.90(+9)	8.22(+9)	1.46(–1)
2 – 33	3/2	1/2	E1	572916	174.546	2.43(+9)	2.58(+9)	2.22(–2)
3 – 34	5/2	5/2	E1	574636	174.023	8.18(+9)	8.49(+9)	2.23(–1)
3 – 35	5/2	3/2	E1	576809	173.368	6.49(+7)	7.08(+7)	1.17(–3)
4 – 39	1/2	3/2	E1	576837	173.359	7.96(+10)	8.14(+10)	1.43
3 – 37	5/2	7/2	E1	580452	172.280	1.19(+11)	1.22(+11)	4.23
2 – 34	3/2	5/2	E1	580577	172.242	1.10(+11)	1.13(+11)	2.93
2 – 35	3/2	3/2	E1	582750	171.600	1.89(+9)	1.91(+9)	3.34(–2)
1 – 30	3/2	5/2	E1	582788	171.589	3.59(+9)	3.70(+9)	9.51(–2)
2 – 36	3/2	1/2	E1	584971	170.949	8.87(+9)	9.01(+9)	7.78(–2)
1 – 31	3/2	3/2	E1	601545	166.239	2.19(+4)	2.72(+4)	3.64(–7)
1 – 32	3/2	5/2	E1	601995	166.114	1.76(+8)	1.76(+8)	4.37(–3)
3 – 38	5/2	5/2	E1	605698	165.099	4.17(+9)	4.14(+9)	1.02(–1)
3 – 39	5/2	3/2	E1	607103	164.717	1.76(+8)	1.69(+8)	2.86(–3)
2 – 38	3/2	5/2	E1	611639	163.495	7.71(+7)	8.93(+7)	1.85(–3)
2 – 39	3/2	3/2	E1	613044	163.120	3.15(+7)	2.15(+7)	5.02(–4)
1 – 33	3/2	1/2	E1	618199	161.760	5.63(+7)	6.07(+7)	4.42(–4)
1 – 34	3/2	5/2	E1	625861	159.780	6.44(+8)	6.50(+8)	1.48(–2)
1 – 35	3/2	3/2	E1	628034	159.227	9.58(+7)	9.34(+7)	1.46(–3)
1 – 36	3/2	1/2	E1	630255	158.666	1.24(+6)	1.11(+5)	9.35(–6)
1 – 38	3/2	5/2	E1	656923	152.225	5.78(+8)	5.73(+8)	1.20(–2)
1 – 39	3/2	3/2	E1	658328	151.900	1.18(+8)	1.19(+8)	1.64(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ni XIV Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	218461	457.748	3.38(+6)	3.85(+6)	6.37(–4)
5 – 7	3/2	3/2	E1	232830	429.498	1.94(+7)	2.06(+7)	2.15(–3)
5 – 8	3/2	1/2	E1	238761	418.829	4.27(+6)	5.82(+6)	2.24(–4)
4 – 7	1/2	3/2	E1	244125	409.626	2.70(+5)	2.19(+5)	2.72(–5)
4 – 8	1/2	1/2	E1	250056	399.910	2.31(+7)	2.62(+7)	1.11(–3)
3 – 6	5/2	5/2	E1	261834	381.921	4.30(+7)	4.56(+7)	5.65(–3)
2 – 6	3/2	5/2	E1	269552	370.986	3.46(+7)	3.63(+7)	4.29(–3)
3 – 7	5/2	3/2	E1	276204	362.051	1.01(+7)	1.13(+7)	7.95(–4)
2 – 7	3/2	3/2	E1	283922	352.209	3.94(+5)	5.25(+5)	2.93(–5)
2 – 8	3/2	1/2	E1	289853	345.002	1.23(+7)	1.18(+7)	4.39(–4)
5 – 9	3/2	3/2	E1	295567	338.333	4.25(+7)	5.14(+7)	2.91(–3)
5 – 10	3/2	5/2	E1	299131	334.302	6.82(+8)	6.42(+8)	6.86(–2)
4 – 9	1/2	3/2	E1	306861	325.880	3.12(+8)	2.82(+8)	1.99(–2)
1 – 6	3/2	5/2	E1	316964	315.493	1.97(+9)	1.97(+9)	1.76(–1)
1 – 7	3/2	3/2	E1	331333	301.811	2.24(+9)	2.23(+9)	1.22(–1)
1 – 8	3/2	1/2	E1	337264	296.504	2.40(+9)	2.39(+9)	6.32(–2)
3 – 9	5/2	3/2	E1	338940	295.037	1.36(+7)	1.07(+7)	7.10(–4)
3 – 10	5/2	5/2	E1	342504	291.967	3.40(+9)	3.43(+9)	2.61(–1)
2 – 9	3/2	3/2	E1	346658	288.469	4.33(+9)	4.33(+9)	2.16(–1)
2 – 10	3/2	5/2	E1	350222	285.533	1.50(+7)	1.94(+7)	1.10(–3)
5 – 11	3/2	3/2	E1	352236	283.901	6.53(+8)	5.91(+8)	3.15(–2)
5 – 12	3/2	1/2	E1	358074	279.272	2.28(+6)	2.32(+5)	5.34(–5)
4 – 11	1/2	3/2	E1	363531	275.080	4.71(+8)	4.39(+8)	2.14(–2)
4 – 12	1/2	1/2	E1	369368	270.733	4.15(+9)	4.19(+9)	9.12(–2)
5 – 13	3/2	1/2	E1	381106	262.394	8.61(+9)	8.89(+9)	1.78(–1)
5 – 14	3/2	3/2	E1	389496	256.742	7.98(+5)	6.08(+5)	3.16(–5)
4 – 13	1/2	1/2	E1	392401	254.841	1.05(+9)	1.21(+9)	2.04(–2)
1 – 9	3/2	3/2	E1	394070	253.762	2.00(+7)	1.88(+7)	7.73(–4)
5 – 15	3/2	5/2	E1	395235	253.014	1.61(+7)	1.73(+7)	9.26(–4)
3 – 11	5/2	3/2	E1	395610	252.774	8.98(+9)	9.26(+9)	3.44(–1)
1 – 10	3/2	5/2	E1	397634	251.488	1.65(+7)	1.84(+7)	9.37(–4)
4 – 14	1/2	3/2	E1	400791	249.507	2.72(+7)	2.96(+7)	1.01(–3)
2 – 11	3/2	3/2	E1	403328	247.937	8.71(+8)	8.57(+8)	3.21(–2)
2 – 12	3/2	1/2	E1	409165	244.400	8.80(+9)	9.20(+9)	1.58(–1)
5 – 17	3/2	5/2	E1	409473	244.216	7.54(+6)	9.96(+6)	4.05(–4)
5 – 19	3/2	1/2	E1	416184	240.278	4.10(+8)	4.21(+8)	7.09(–3)
5 – 20	3/2	3/2	E1	417555	239.489	4.39(+7)	4.32(+7)	1.51(–3)
5 – 21	3/2	5/2	E1	424127	235.778	7.18(+6)	8.73(+6)	3.59(–4)
4 – 19	1/2	1/2	E1	427479	233.930	4.96(+7)	4.79(+7)	8.14(–4)
4 – 20	1/2	3/2	E1	428850	233.182	1.79(+7)	1.81(+7)	5.84(–4)
2 – 13	3/2	1/2	E1	432198	231.375	2.89(+8)	2.97(+8)	4.65(–3)
3 – 14	5/2	3/2	E1	432869	231.017	1.41(+7)	1.41(+7)	4.52(–4)
3 – 15	5/2	5/2	E1	438608	227.994	8.43(+7)	9.16(+7)	3.94(–3)
2 – 14	3/2	3/2	E1	440587	226.970	3.31(+8)	3.53(+8)	1.02(–2)
2 – 15	3/2	5/2	E1	446326	224.051	3.96(+7)	4.01(+7)	1.79(–3)
3 – 16	5/2	7/2	E1	447125	223.651	4.41(+7)	4.57(+7)	2.65(–3)
1 – 11	3/2	3/2	E1	450740	221.857	8.21(+7)	7.48(+7)	2.42(–3)
3 – 17	5/2	5/2	E1	452846	220.826	2.42(+5)	2.35(+5)	1.06(–5)
1 – 12	3/2	1/2	E1	456577	219.021	1.47(+8)	1.65(+8)	2.12(–3)
3 – 18	5/2	7/2	E1	459256	217.743	6.15(+7)	7.23(+7)	3.50(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ni XIV Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
2 – 17	3/2	5/2	E1	460564	217.125	1.49(+6)	3.53(+5)	6.32(–5)
3 – 20	5/2	3/2	E1	460929	216.953	6.89(+8)	7.13(+8)	1.94(–2)
2 – 19	3/2	1/2	E1	467275	214.007	7.94(+8)	8.26(+8)	1.09(–2)
3 – 21	5/2	5/2	E1	467500	213.904	1.99(+8)	2.01(+8)	8.19(–3)
2 – 20	3/2	3/2	E1	468647	213.380	2.76(+4)	1.33(+5)	7.54(–7)
2 – 21	3/2	5/2	E1	475218	210.430	1.50(+7)	1.37(+7)	5.96(–4)
1 – 13	3/2	1/2	E1	479609	208.503	1.30(+8)	1.36(+8)	1.70(–3)
3 – 22	5/2	7/2	E1	481634	207.627	2.33(+6)	1.13(+6)	1.20(–4)
5 – 24	3/2	3/2	E1	481736	207.583	3.39(+9)	3.58(+9)	8.76(–2)
1 – 14	3/2	3/2	E1	487999	204.918	5.66(+7)	5.94(+7)	1.42(–3)
5 – 25	3/2	5/2	E1	492335	203.114	8.86(+6)	9.58(+6)	3.29(–4)
4 – 24	1/2	3/2	E1	493031	202.827	1.51(+9)	1.56(+9)	3.74(–2)
1 – 15	3/2	5/2	E1	493738	202.537	1.01(+8)	1.07(+8)	3.74(–3)
5 – 26	3/2	3/2	E1	498179	200.731	3.04(+8)	3.31(+8)	7.35(–3)
5 – 27	3/2	1/2	E1	498490	200.606	1.39(+10)	1.47(+10)	1.68(–1)
5 – 28	3/2	1/2	E1	503952	198.432	5.77(+9)	5.98(+9)	6.81(–2)
1 – 17	3/2	5/2	E1	507976	196.860	1.96(+8)	2.05(+8)	6.83(–3)
5 – 29	3/2	3/2	E1	508583	196.625	3.15(+8)	3.35(+8)	7.30(–3)
4 – 26	1/2	3/2	E1	509474	196.281	8.33(+4)	1.16(+5)	1.92(–6)
4 – 27	1/2	1/2	E1	509785	196.161	6.20(+9)	6.47(+9)	7.15(–2)
1 – 19	3/2	1/2	E1	514687	194.293	1.24(+8)	1.30(+8)	1.41(–3)
4 – 28	1/2	1/2	E1	515246	194.082	3.21(+9)	3.39(+9)	3.63(–2)
3 – 23	5/2	7/2	E1	515957	193.815	5.39(+8)	5.66(+8)	2.43(–2)
1 – 20	3/2	3/2	E1	516058	193.777	5.82(+8)	6.11(+8)	1.31(–2)
4 – 29	1/2	3/2	E1	519878	192.353	1.36(+7)	6.22(+6)	3.01(–4)
1 – 21	3/2	5/2	E1	522630	191.340	6.87(+8)	7.25(+8)	2.26(–2)
5 – 30	3/2	5/2	E1	524299	190.731	3.24(+9)	3.60(+9)	1.06(–1)
3 – 24	5/2	3/2	E1	525110	190.436	5.35(+10)	5.56(+10)	1.16
2 – 24	3/2	3/2	E1	532828	187.678	2.64(+10)	2.77(+10)	5.57(–1)
3 – 25	5/2	5/2	E1	535708	186.669	2.34(+9)	2.49(+9)	7.34(–2)
3 – 26	5/2	3/2	E1	541553	184.654	1.05(+9)	1.12(+9)	2.15(–2)
5 – 31	3/2	3/2	E1	542745	184.249	6.12(+8)	6.18(+8)	1.25(–2)
2 – 25	3/2	5/2	E1	543426	184.018	1.00(+9)	1.07(+9)	3.06(–2)
5 – 32	3/2	5/2	E1	543799	183.891	4.34(+9)	4.62(+9)	1.32(–1)
2 – 26	3/2	3/2	E1	549271	182.059	4.27(+8)	4.59(+8)	8.49(–3)
2 – 27	3/2	1/2	E1	549582	181.956	3.27(+10)	3.38(+10)	3.24(–1)
3 – 29	5/2	3/2	E1	551956	181.174	8.16(+9)	8.59(+9)	1.61(–1)
4 – 31	1/2	3/2	E1	554040	180.492	7.36(+9)	7.82(+9)	1.44(–1)
2 – 28	3/2	1/2	E1	555043	180.166	2.46(+10)	2.56(+10)	2.40(–1)
5 – 33	3/2	1/2	E1	559378	178.770	3.70(+9)	3.95(+9)	3.55(–2)
2 – 29	3/2	3/2	E1	559674	178.675	6.27(+9)	6.80(+9)	1.20(–1)
5 – 34	3/2	5/2	E1	566734	176.450	4.26(+8)	4.36(+8)	1.19(–2)
3 – 30	5/2	5/2	E1	567672	176.158	3.78(+10)	4.00(+10)	1.05
4 – 33	1/2	1/2	E1	570673	175.232	7.69(+10)	7.97(+10)	7.08(–1)
5 – 35	3/2	3/2	E1	571637	174.936	5.94(+10)	6.20(+10)	1.09
5 – 36	3/2	1/2	E1	574122	174.179	7.31(+10)	7.47(+10)	6.65(–1)
2 – 30	3/2	5/2	E1	575390	173.795	9.49(+8)	9.74(+8)	2.58(–2)
1 – 24	3/2	3/2	E1	580239	172.343	5.23(+8)	5.39(+8)	9.31(–3)
4 – 35	1/2	3/2	E1	582931	171.547	2.47(+10)	2.58(+10)	4.37(–1)
4 – 36	1/2	1/2	E1	585417	170.818	3.18(+9)	3.09(+9)	2.79(–2)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ni XIV Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 31	5/2	3/2	E1	586119	170.614	1.33(+10)	1.38(+10)	2.32(–1)
3 – 32	5/2	5/2	E1	587172	170.308	4.55(+10)	4.69(+10)	1.19
1 – 25	3/2	5/2	E1	590838	169.251	1.01(+11)	1.06(+11)	2.59
2 – 31	3/2	3/2	E1	593837	168.396	7.24(+10)	7.52(+10)	1.23
2 – 32	3/2	5/2	E1	594890	168.098	4.34(+9)	4.45(+9)	1.10(–1)
1 – 26	3/2	3/2	E1	596682	167.593	9.97(+10)	1.05(+11)	1.68
1 – 27	3/2	1/2	E1	596993	167.506	3.96(+10)	3.78(+10)	3.18(–1)
5 – 38	3/2	5/2	E1	602370	166.011	1.08(+11)	1.12(+11)	2.68
1 – 28	3/2	1/2	E1	602455	165.988	7.36(+10)	7.72(+10)	6.08(–1)
5 – 39	3/2	3/2	E1	603535	165.690	2.66(+10)	2.74(+10)	4.38(–1)
1 – 29	3/2	3/2	E1	607086	164.721	1.08(+10)	1.13(+10)	1.75(–1)
3 – 34	5/2	5/2	E1	610107	163.906	9.55(+9)	9.96(+9)	2.31(–1)
2 – 33	3/2	1/2	E1	610469	163.808	2.74(+9)	3.00(+9)	2.21(–2)
4 – 39	1/2	3/2	E1	614830	162.647	8.32(+10)	8.57(+10)	1.32
3 – 35	5/2	3/2	E1	615010	162.599	3.75(+7)	4.94(+7)	5.95(–4)
3 – 37	5/2	7/2	E1	617733	161.882	1.26(+11)	1.31(+11)	3.97
2 – 34	3/2	5/2	E1	617825	161.858	1.16(+11)	1.20(+11)	2.73
2 – 35	3/2	3/2	E1	622728	160.584	2.18(+9)	2.21(+9)	3.36(–2)
1 – 30	3/2	5/2	E1	622802	160.565	4.42(+9)	4.59(+9)	1.03(–1)
2 – 36	3/2	1/2	E1	625213	159.945	1.06(+10)	1.09(+10)	8.11(–2)
1 – 31	3/2	3/2	E1	641248	155.946	1.27(+6)	1.16(+6)	1.85(–5)
1 – 32	3/2	5/2	E1	642302	155.690	2.17(+8)	1.18(+8)	4.72(–3)
3 – 38	5/2	5/2	E1	645744	154.860	4.61(+9)	4.65(+9)	9.24(–1)
3 – 35	5/2	3/2	E1	646908	154.581	1.95(+8)	1.90(+8)	2.80(–3)
2 – 38	3/2	5/2	E1	653461	153.031	1.32(+8)	1.49(+8)	2.78(–1)
2 – 39	3/2	3/2	E1	654626	152.759	1.85(+7)	1.22(+7)	2.59(–4)
1 – 33	3/2	1/2	E1	657881	152.003	7.48(+7)	8.23(+7)	5.18(–4)
1 – 34	3/2	5/2	E1	665237	150.322	1.05(+9)	1.07(+9)	2.14(–2)
1 – 35	3/2	3/2	E1	670140	149.223	1.25(+8)	1.23(+8)	1.67(–3)
1 – 36	3/2	1/2	E1	672625	148.671	4.33(+6)	1.47(+6)	2.87(–5)
1 – 38	3/2	5/2	E1	700873	142.679	7.08(+8)	7.10(+8)	1.30(–2)
1 – 39	3/2	3/2	E1	702038	142.442	1.55(+8)	1.56(+8)	1.88(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Zn XVI Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	242939	411.626	4.77(+6)	4.62(+6)	7.28(–4)
5 – 7	3/2	3/2	E1	263724	379.184	3.65(+7)	4.00(+7)	3.15(–3)
5 – 8	3/2	1/2	E1	271417	368.437	9.96(+6)	1.34(+7)	4.05(–4)
4 – 7	1/2	3/2	E1	282580	353.882	6.63(+5)	5.66(+5)	4.99(–5)
4 – 8	1/2	1/2	E1	290274	344.502	5.47(+7)	6.29(+7)	1.93(–3)
3 – 6	5/2	5/2	E1	297426	336.218	8.16(+7)	8.82(+7)	8.30(–3)
2 – 6	3/2	5/2	E1	309525	323.076	9.10(+7)	9.69(+7)	8.53(–3)
3 – 7	5/2	3/2	E1	318211	314.257	2.43(+7)	2.76(+7)	1.44(–3)
2 – 7	3/2	3/2	E1	330309	302.747	2.85(+4)	8.99(+4)	1.57(–6)
5 – 9	3/2	3/2	E1	330890	302.215	6.72(+7)	8.06(+7)	3.68(–3)
5 – 10	3/2	5/2	E1	337151	296.603	8.57(+8)	8.35(+8)	6.78(–2)
2 – 8	3/2	1/2	E1	338002	295.856	3.07(+7)	2.96(+7)	8.05(–4)
4 – 9	1/2	3/2	E1	349746	285.922	3.45(+8)	3.20(+8)	1.69(–2)
1 – 6	3/2	5/2	E1	361341	276.747	2.39(+9)	2.43(+9)	1.64(–1)
1 – 7	3/2	3/2	E1	382125	261.694	2.88(+9)	2.91(+9)	1.18(–1)
3 – 9	5/2	3/2	E1	385377	259.486	5.25(+5)	1.80(+6)	2.12(–5)
1 – 8	3/2	1/2	E1	389818	256.530	3.13(+9)	3.17(+9)	6.18(–2)
3 – 10	5/2	5/2	E1	391638	255.338	4.18(+9)	4.27(+9)	2.45(–1)
5 – 11	3/2	3/2	E1	393242	254.296	7.25(+8)	6.76(+8)	2.81(–2)
2 – 9	3/2	3/2	E1	397475	251.588	5.58(+9)	5.65(+9)	2.12(–1)
5 – 12	3/2	1/2	E1	399706	250.184	6.72(+6)	2.17(+6)	1.26(–4)
2 – 10	3/2	5/2	E1	403736	247.687	4.80(+6)	7.76(+6)	2.65(–4)
4 – 11	1/2	3/2	E1	412098	242.661	6.32(+8)	6.00(+8)	2.23(–2)
4 – 12	1/2	1/2	E1	418562	238.913	5.20(+9)	5.34(+9)	8.90(–2)
5 – 13	3/2	3/2	E1	427735	233.790	1.30(+6)	8.78(+5)	4.26(–5)
5 – 14	3/2	1/2	E1	431837	231.569	9.64(+9)	1.00(+10)	1.55(–1)
5 – 15	3/2	5/2	E1	436177	229.265	2.46(+7)	2.68(+7)	1.16(–3)
4 – 13	1/2	3/2	E1	446591	223.919	3.38(+7)	3.73(+7)	1.02(–3)
3 – 11	5/2	3/2	E1	447729	223.349	1.05(+10)	1.09(+10)	3.13(–1)
1 – 9	3/2	3/2	E1	449291	222.573	7.16(+7)	6.90(+7)	2.13(–3)
4 – 14	1/2	1/2	E1	450693	221.881	1.26(+9)	1.47(+9)	1.87(–2)
5 – 17	3/2	5/2	E1	452439	221.024	6.46(+6)	8.40(+6)	2.84(–4)
1 – 10	3/2	5/2	E1	455552	219.514	3.22(+7)	3.61(+7)	1.40(–3)
2 – 11	3/2	3/2	E1	459827	217.473	7.29(+8)	7.22(+8)	2.07(–2)
5 – 19	3/2	1/2	E1	462716	216.115	1.13(+9)	1.18(+9)	1.58(–2)
5 – 20	3/2	3/2	E1	464097	215.472	7.70(+7)	7.68(+7)	2.14(–3)
2 – 12	3/2	1/2	E1	466291	214.458	1.06(+10)	1.12(+10)	1.47(–1)
5 – 21	3/2	5/2	E1	473666	211.119	1.92(+7)	2.33(+7)	7.71(–4)
4 – 19	1/2	1/2	E1	481572	207.653	5.95(+7)	5.62(+7)	7.70(–4)
3 – 13	5/2	3/2	E1	482222	207.373	7.46(+7)	7.65(+7)	1.92(–3)
4 – 20	1/2	3/2	E1	482954	207.059	4.75(+7)	4.93(+7)	1.22(–3)
3 – 15	5/2	5/2	E1	490664	203.805	1.45(+8)	1.59(+8)	5.42(–3)
2 – 13	3/2	3/2	E1	494320	202.298	6.58(+8)	7.04(+8)	1.61(–2)
2 – 14	3/2	1/2	E1	498422	200.633	1.85(+8)	1.94(+8)	2.23(–3)
2 – 15	3/2	5/2	E1	502762	198.901	6.42(+7)	6.34(+7)	2.28(–3)
3 – 16	5/2	7/2	E1	503522	198.601	7.03(+7)	7.19(+7)	3.33(–3)
3 – 17	5/2	5/2	E1	506926	197.267	7.00(+5)	7.51(+5)	2.45(–5)
1 – 11	3/2	3/2	E1	511643	195.449	1.26(+8)	1.15(+8)	2.90(–3)
3 – 18	5/2	7/2	E1	516332	193.674	8.96(+7)	1.02(+8)	4.03(–3)
1 – 12	3/2	1/2	E1	518107	193.010	4.11(+8)	5.58(+8)	4.59(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Zn XVI Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 20	5/2	3/2	E1	518584	192.833	1.36(+9)	1.42(+9)	3.04(–2)
2 – 17	3/2	5/2	E1	519024	192.669	1.31(+6)	2.18(+5)	4.37(–5)
3 – 21	5/2	5/2	E1	528153	189.339	3.95(+8)	4.00(+8)	1.27(–2)
2 – 19	3/2	1/2	E1	529301	188.928	1.53(+9)	1.61(+9)	1.64(–2)
2 – 20	3/2	3/2	E1	530683	188.436	2.33(+6)	2.14(+6)	4.96(–5)
5 – 24	3/2	3/2	E1	533962	187.279	3.01(+9)	3.21(+9)	6.34(–2)
2 – 21	3/2	5/2	E1	540252	185.099	6.82(+7)	6.71(+7)	2.10(–3)
5 – 25	3/2	5/2	E1	544942	183.506	7.45(+6)	7.92(+6)	2.26(–4)
1 – 13	3/2	3/2	E1	546136	183.105	1.81(+8)	1.90(+8)	3.63(–3)
3 – 22	5/2	7/2	E1	548666	182.260	2.52(+7)	2.14(+7)	1.00(–3)
1 – 14	3/2	1/2	E1	550238	181.740	1.79(+8)	1.87(+8)	1.78(–3)
5 – 26	3/2	3/2	E1	552421	181.021	5.52(+8)	5.97(+8)	1.08(–2)
4 – 24	1/2	3/2	E1	552819	180.891	1.77(+9)	1.83(+9)	3.48(–2)
1 – 15	3/2	5/2	E1	554578	180.317	2.92(+8)	3.06(+8)	8.53(–3)
5 – 27	3/2	1/2	E1	555090	180.151	9.10(+9)	9.79(+9)	8.85(–2)
5 – 28	3/2	1/2	E1	563870	177.346	1.49(+10)	1.56(+10)	1.41(–1)
5 – 29	3/2	3/2	E1	565202	176.928	2.81(+8)	3.04(+8)	5.27(–3)
1 – 17	3/2	5/2	E1	570840	175.180	3.60(+8)	3.76(+8)	9.94(–3)
4 – 26	1/2	3/2	E1	571277	175.046	1.04(+5)	5.20(+4)	1.91(–6)
4 – 27	1/2	1/2	E1	573946	174.232	3.74(+9)	3.89(+9)	3.40(–2)
3 – 23	5/2	7/2	E1	581079	172.094	1.05(+9)	1.10(+9)	3.72(–2)
1 – 19	3/2	1/2	E1	581117	172.082	1.98(+8)	2.07(+8)	1.76(–3)
1 – 20	3/2	3/2	E1	582498	171.674	1.10(+9)	1.15(+9)	1.94(–2)
4 – 28	1/2	1/2	E1	582726	171.607	7.86(+9)	8.29(+9)	6.94(–2)
4 – 29	1/2	3/2	E1	584058	171.216	1.53(+8)	1.28(+8)	2.69(–3)
5 – 30	3/2	5/2	E1	586180	170.596	4.72(+9)	5.21(+9)	1.24(–1)
3 – 24	5/2	3/2	E1	588449	169.938	5.82(+10)	6.08(+10)	1.01
1 – 21	3/2	5/2	E1	592068	168.900	1.31(+9)	1.38(+9)	3.37(–2)
3 – 25	5/2	5/2	E1	599429	166.825	3.72(+9)	3.96(+9)	9.31(–2)
2 – 24	3/2	3/2	E1	600548	166.515	3.47(+10)	3.65(+10)	3.77(–1)
5 – 31	3/2	3/2	E1	603739	165.634	8.19(+8)	8.29(+8)	1.35(–2)
5 – 32	3/2	5/2	E1	606535	164.871	3.33(+9)	3.54(+9)	8.15(–2)
3 – 26	5/2	3/2	E1	606908	164.770	3.03(+9)	3.21(+9)	4.93(–2)
2 – 25	3/2	5/2	E1	611527	163.525	2.27(+9)	2.41(+9)	5.45(–2)
2 – 26	3/2	3/2	E1	619006	161.549	1.08(+8)	1.20(+8)	1.68(–3)
5 – 33	3/2	1/2	E1	619529	161.413	3.65(+9)	3.91(+9)	2.85(–2)
3 – 29	5/2	3/2	E1	619689	161.371	1.01(+10)	1.06(+10)	1.57(–1)
2 – 27	3/2	1/2	E1	621675	160.856	1.36(+10)	1.40(+10)	1.05(–1)
4 – 31	1/2	3/2	E1	622595	160.618	9.30(+9)	9.88(+9)	1.44(–1)
5 – 34	3/2	5/2	E1	625853	159.782	9.28(+8)	9.64(+8)	2.13(–2)
2 – 28	3/2	1/2	E1	630455	158.616	5.31(+10)	5.53(+10)	4.01(–1)
2 – 29	3/2	3/2	E1	631787	158.281	5.15(+9)	5.61(+9)	7.74(–2)
5 – 35	3/2	3/2	E1	637984	156.744	6.32(+10)	6.62(+10)	9.31(–1)
4 – 33	1/2	1/2	E1	638385	156.645	8.69(+10)	9.03(+10)	6.40(–1)
3 – 30	5/2	5/2	E1	640667	156.087	5.41(+10)	5.71(+10)	1.19
5 – 37	3/2	1/2	E1	641271	155.940	8.49(+10)	8.70(+10)	6.19(–1)
1 – 24	3/2	3/2	E1	652363	153.289	2.18(+9)	2.28(+9)	3.08(–2)
2 – 30	3/2	5/2	E1	652765	153.194	1.69(+9)	1.73(+9)	3.57(–2)
4 – 35	1/2	3/2	E1	656840	152.244	3.26(+10)	3.40(+10)	4.53(–1)
3 – 31	5/2	3/2	E1	658226	151.924	1.73(+10)	1.80(+10)	2.40(–1)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Zn XVI Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
4 – 37	1/2	1/2	E1	660127	151.486	2.94(+9)	2.83(+9)	2.03(–2)
3 – 32	5/2	5/2	E1	661022	151.281	3.60(+10)	3.49(+10)	7.41(–1)
1 – 25	3/2	5/2	E1	663343	150.752	1.11(+11)	1.17(+11)	2.27
2 – 31	3/2	3/2	E1	670324	149.182	8.30(+10)	8.63(+10)	1.11
1 – 26	3/2	3/2	E1	670822	149.071	1.08(+11)	1.13(+11)	1.43
5 – 38	3/2	5/2	E1	672552	148.687	1.21(+11)	1.25(+11)	2.40
5 – 39	3/2	3/2	E1	672809	148.631	3.28(+10)	3.37(+10)	4.34(–1)
2 – 32	3/2	5/2	E1	673120	148.562	8.14(+9)	8.35(+9)	1.62(–1)
1 – 27	3/2	1/2	E1	673491	148.480	8.65(+10)	9.05(+10)	5.72(–1)
3 – 34	5/2	5/2	E1	680340	146.985	1.49(+10)	1.55(+10)	2.89(–1)
1 – 28	3/2	1/2	E1	682271	146.569	4.03(+10)	4.23(+10)	2.59(–1)
1 – 29	3/2	3/2	E1	683603	146.284	1.78(+10)	1.86(+10)	2.29(–1)
2 – 33	3/2	1/2	E1	686114	145.748	3.20(+9)	3.51(+9)	2.04(–2)
4 – 39	1/2	3/2	E1	691666	144.578	8.92(+10)	9.18(+10)	1.12
2 – 34	3/2	5/2	E1	692438	144.417	1.24(+11)	1.29(+11)	2.33
3 – 35	5/2	3/2	E1	692471	144.410	1.05(+5)	1.31(+6)	1.32(–6)
3 – 36	5/2	7/2	E1	692526	144.399	1.42(+11)	1.47(+11)	3.54
2 – 35	3/2	3/2	E1	704569	141.931	2.59(+9)	2.64(+9)	3.13(–2)
1 – 30	3/2	5/2	E1	704581	141.928	6.67(+9)	6.90(+9)	1.21(–1)
2 – 37	3/2	1/2	E1	707856	141.272	1.37(+10)	1.41(+10)	8.21(–2)
1 – 31	3/2	3/2	E1	722140	138.477	1.97(+7)	1.96(+7)	2.27(–4)
1 – 32	3/2	5/2	E1	724936	137.943	3.41(+8)	3.41(+8)	5.84(–3)
3 – 38	5/2	5/2	E1	727039	137.544	5.32(+9)	5.36(+9)	9.05(–2)
3 – 39	5/2	3/2	E1	727297	137.495	2.36(+8)	2.28(+8)	2.68(–3)
1 – 33	3/2	1/2	E1	737930	135.514	1.25(+8)	1.40(+8)	6.87(–4)
2 – 38	3/2	5/2	E1	739137	135.293	3.13(+8)	3.40(+8)	5.15(–3)
2 – 39	3/2	3/2	E1	739395	135.246	6.05(+6)	2.42(+6)	6.63(–5)
1 – 34	3/2	5/2	E1	744254	134.363	2.41(+9)	2.46(+9)	3.91(–2)
1 – 35	3/2	3/2	E1	756385	132.208	2.07(+8)	2.06(+8)	1.16(–3)
1 – 37	3/2	1/2	E1	759672	131.636	2.76(+7)	1.80(+7)	1.43(–4)
1 – 38	3/2	5/2	E1	790953	126.430	9.69(+8)	9.68(+8)	1.39(–2)
1 – 39	3/2	3/2	E1	791211	126.389	2.46(+8)	2.49(+8)	2.35(–3)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ge XVIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
5 – 6	3/2	5/2	E1	264835	377.594	5.95(+6)	7.09(+6)	7.63(–4)
5 – 7	3/2	3/2	E1	293869	340.288	6.15(+7)	6.79(+7)	4.27(–3)
5 – 8	3/2	1/2	E1	303329	329.675	2.04(+7)	2.69(+7)	6.66(–4)
4 – 7	1/2	3/2	E1	323422	309.194	1.51(+6)	1.30(+6)	8.68(–5)
4 – 8	1/2	1/2	E1	332881	300.408	1.21(+8)	1.39(+8)	3.28(–3)
3 – 6	5/2	5/2	E1	333630	299.733	1.42(+8)	1.53(+8)	1.15(–2)
2 – 6	3/2	5/2	E1	351041	284.867	2.09(+8)	2.22(+8)	1.53(–2)
3 – 7	5/2	3/2	E1	362664	275.737	5.67(+7)	6.44(+7)	2.59(–3)
5 – 9	3/2	3/2	E1	364501	274.348	7.86(+7)	9.52(+7)	3.55(–3)
5 – 10	3/2	5/2	E1	374926	266.719	1.03(+9)	1.02(+9)	6.62(–2)
2 – 7	3/2	3/2	E1	380075	263.106	9.44(+4)	1.65(+4)	3.92(–6)
2 – 8	3/2	1/2	E1	389535	256.716	6.85(+7)	6.57(+7)	1.35(–3)
4 – 9	1/2	3/2	E1	394054	253.772	3.52(+8)	3.26(+8)	1.36(–2)
1 – 6	3/2	5/2	E1	408560	244.762	2.77(+9)	2.83(+9)	1.49(–1)
5 – 11	3/2	3/2	E1	432615	231.152	7.95(+8)	7.48(+8)	2.55(–2)
3 – 9	5/2	3/2	E1	433296	230.789	4.33(+7)	5.61(+7)	1.38(–3)
1 – 7	3/2	3/2	E1	437594	228.522	3.67(+9)	3.70(+9)	1.15(–1)
5 – 12	3/2	1/2	E1	439884	227.333	2.89(+7)	1.96(+7)	4.48(–4)
3 – 10	5/2	5/2	E1	443720	225.367	4.97(+9)	5.07(+9)	2.27(–1)
1 – 8	3/2	1/2	E1	447054	223.687	4.02(+9)	4.07(+9)	6.04(–2)
2 – 9	3/2	3/2	E1	450708	221.873	6.88(+9)	6.96(+9)	2.03(–1)
5 – 13	3/2	3/2	E1	460936	216.950	4.76(+6)	3.36(+6)	1.34(–4)
2 – 10	3/2	5/2	E1	461132	216.858	4.61(+4)	7.19(+4)	1.95(–6)
4 – 11	1/2	3/2	E1	462168	216.372	7.75(+8)	8.16(+8)	2.29(–2)
4 – 12	1/2	1/2	E1	469437	213.021	6.12(+9)	6.30(+9)	8.33(–2)
5 – 14	3/2	5/2	E1	472744	211.531	3.46(+7)	3.78(+7)	1.39(–3)
5 – 15	3/2	1/2	E1	482791	207.129	9.00(+9)	9.36(+9)	1.16(–1)
4 – 13	1/2	3/2	E1	490489	203.878	2.84(+7)	3.25(+7)	7.09(–4)
5 – 17	3/2	5/2	E1	491858	203.311	3.57(+6)	5.00(+6)	1.33(–4)
3 – 11	5/2	3/2	E1	501410	199.438	1.14(+10)	1.19(+10)	2.71(–1)
5 – 20	3/2	3/2	E1	508112	196.807	1.27(+8)	1.27(+8)	2.96(–3)
1 – 9	3/2	3/2	E1	508226	196.763	1.96(+8)	1.90(+8)	4.55(–3)
5 – 19	3/2	1/2	E1	508805	196.539	3.28(+9)	3.41(+9)	3.81(–2)
4 – 15	1/2	1/2	E1	512344	195.181	1.80(+9)	2.07(+9)	2.06(–2)
1 – 10	3/2	5/2	E1	518651	192.808	5.86(+7)	6.61(+7)	1.96(–3)
2 – 11	3/2	3/2	E1	518822	192.744	3.98(+8)	3.87(+8)	8.86(–3)
5 – 21	3/2	5/2	E1	521414	191.786	4.37(+7)	5.18(+7)	1.44(–3)
2 – 12	3/2	1/2	E1	526091	190.081	1.24(+10)	1.31(+10)	1.34(–1)
3 – 13	5/2	3/2	E1	529731	188.775	3.23(+8)	3.35(+8)	6.90(–3)
4 – 19	1/2	1/2	E1	537598	186.013	1.55(+7)	1.02(+7)	1.61(–4)
4 – 20	1/2	3/2	E1	537665	185.989	1.10(+8)	1.14(+8)	2.28(–3)
3 – 14	5/2	5/2	E1	541538	184.659	2.32(+8)	2.55(+8)	7.10(–3)
2 – 13	3/2	3/2	E1	547143	182.768	1.18(+9)	1.27(+9)	2.37(–2)
2 – 14	3/2	5/2	E1	558950	178.907	8.23(+7)	7.99(+7)	2.37(–3)
3 – 16	5/2	7/2	E1	560541	178.399	1.06(+8)	1.08(+8)	4.04(–3)
3 – 17	5/2	5/2	E1	560653	178.363	6.73(+6)	7.06(+6)	1.93(–4)
2 – 15	3/2	1/2	E1	568998	175.748	1.45(+6)	1.89(+6)	1.34(–5)
3 – 18	5/2	7/2	E1	573794	174.279	1.21(+8)	1.36(+8)	4.39(–3)
1 – 11	3/2	3/2	E1	576340	173.509	1.27(+8)	1.10(+8)	2.28(–3)
3 – 20	5/2	3/2	E1	576907	173.338	2.48(+9)	2.60(+9)	4.48(–2)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ge XVIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
2 – 17	3/2	5/2	E1	578065	172.991	3.42(+5)	4.85(+5)	9.22(–6)
1 – 12	3/2	1/2	E1	583610	171.347	9.73(+8)	1.08(+9)	8.57(–3)
5 – 24	3/2	3/2	E1	583881	171.268	2.63(+9)	2.81(+9)	4.62(–2)
3 – 21	5/2	5/2	E1	590209	169.432	7.30(+8)	7.43(+8)	1.88(–2)
2 – 19	3/2	1/2	E1	594252	168.279	2.73(+9)	2.87(+9)	2.31(–2)
2 – 20	3/2	3/2	E1	594319	168.260	2.95(+7)	2.98(+7)	5.01(–4)
5 – 25	3/2	5/2	E1	594912	168.092	4.22(+6)	4.54(+6)	1.07(–4)
5 – 26	3/2	3/2	E1	604109	165.533	8.29(+8)	8.96(+8)	1.36(–2)
1 – 13	3/2	3/2	E1	604662	165.382	5.14(+8)	5.39(+8)	8.43(–3)
2 – 21	3/2	5/2	E1	607621	164.576	2.41(+8)	2.45(+8)	5.88(–3)
5 – 27	3/2	1/2	E1	608568	164.320	6.13(+9)	6.62(+9)	4.97(–2)
4 – 24	1/2	3/2	E1	613441	163.015	2.08(+9)	2.14(+9)	3.32(–2)
1 – 14	3/2	5/2	E1	616469	162.214	7.44(+8)	7.82(+8)	1.76(–2)
3 – 22	5/2	7/2	E1	618838	161.593	1.46(+8)	1.41(+8)	4.58(–3)
5 – 28	3/2	3/2	E1	619977	161.296	1.83(+8)	2.03(+8)	2.86(–3)
5 – 29	3/2	1/2	E1	624829	160.044	2.11(+10)	2.22(+10)	1.62(–1)
1 – 15	3/2	1/2	E1	626516	159.613	2.12(+8)	2.21(+8)	1.62(–3)
4 – 26	1/2	3/2	E1	633662	157.813	5.10(+5)	2.78(+5)	7.62(–6)
1 – 17	3/2	5/2	E1	635584	157.336	5.75(+8)	5.99(+8)	1.28(–2)
4 – 27	1/2	1/2	E1	638121	156.710	2.40(+9)	2.47(+9)	1.76(–2)
5 – 30	3/2	5/2	E1	646591	154.657	6.11(+9)	6.72(+9)	1.32(–1)
3 – 23	5/2	7/2	E1	648063	154.306	1.87(+9)	1.97(+9)	5.35(–2)
4 – 28	1/2	3/2	E1	649530	153.957	6.25(+8)	5.94(+8)	8.89(–3)
1 – 19	3/2	1/2	E1	651771	153.428	3.07(+8)	3.19(+8)	2.17(–3)
1 – 20	3/2	3/2	E1	651837	153.413	1.90(+9)	1.99(+9)	2.68(–2)
3 – 24	5/2	3/2	E1	652683	153.214	6.17(+10)	6.46(+10)	8.69(–1)
4 – 29	1/2	1/2	E1	654382	152.816	1.17(+10)	1.23(+10)	8.18(–2)
5 – 31	3/2	3/2	E1	663634	150.685	9.18(+8)	9.29(+8)	1.25(–2)
3 – 25	5/2	5/2	E1	663706	150.669	5.61(+9)	5.98(+9)	1.15(–1)
1 – 21	3/2	5/2	E1	665139	150.345	2.34(+9)	2.47(+9)	4.75(–2)
5 – 32	3/2	5/2	E1	668760	149.530	1.45(+9)	1.53(+9)	2.91(–2)
2 – 24	3/2	3/2	E1	670094	149.233	4.28(+10)	4.52(+10)	5.72(–1)
3 – 26	5/2	3/2	E1	672904	148.610	6.80(+9)	7.20(+9)	9.00(–2)
5 – 33	3/2	1/2	E1	677295	147.646	3.53(+9)	3.80(+9)	2.31(–2)
2 – 25	3/2	5/2	E1	681118	146.817	4.62(+9)	4.92(+9)	8.96(–2)
5 – 34	3/2	5/2	E1	682882	146.438	2.09(+9)	2.20(+9)	4.04(–2)
3 – 28	5/2	3/2	E1	688772	145.186	1.12(+10)	1.19(+10)	1.42(–1)
2 – 26	3/2	3/2	E1	690316	144.861	1.22(+8)	1.21(+8)	1.54(–3)
4 – 31	1/2	3/2	E1	693186	144.261	1.14(+10)	1.22(+10)	1.43(–1)
2 – 27	3/2	1/2	E1	694775	143.931	4.42(+9)	4.53(+9)	2.75(–2)
5 – 36	3/2	3/2	E1	704180	142.009	6.58(+10)	6.93(+10)	7.96(–1)
2 – 28	3/2	3/2	E1	706183	141.606	4.01(+9)	4.40(+9)	4.82(–2)
4 – 33	1/2	1/2	E1	706848	141.473	9.75(+10)	1.02(+11)	5.85(–1)
5 – 37	3/2	1/2	E1	708766	141.090	9.98(+10)	1.03(+11)	5.96(–1)
2 – 29	3/2	1/2	E1	711036	140.640	7.52(+10)	7.84(+10)	4.46(–1)
3 – 30	5/2	5/2	E1	715385	139.785	7.28(+10)	7.69(+10)	1.28
1 – 24	3/2	3/2	E1	727613	137.436	6.72(+9)	7.05(+9)	7.61(–2)
3 – 31	5/2	3/2	E1	732428	136.532	2.27(+10)	2.37(+10)	2.54(–1)
2 – 30	3/2	5/2	E1	732797	136.463	4.52(+9)	4.65(+9)	7.58(–2)
4 – 36	1/2	3/2	E1	733733	136.289	4.30(+10)	4.51(+10)	4.79(–1)

TABLE II. Transition Energies, Probabilities, and Oscillator Strengths for $3s^2 3p^3 - 3s 3p^4$ and $3s^2 3p^3 - 3s^2 3p^2 3d$

See page 154 for Explanation of Tables

Ge XVIII Emission Lines				Wavenumber	Wavelength	A (1/s)		
Trans.	J_F	J_I	Type	1/cm	Å	Length	Velocity	gf
3 – 32	5/2	5/2	E1	737555	135.583	1.69(+10)	1.71(+10)	2.79(–1)
4 – 37	1/2	1/2	E1	738319	135.443	2.44(+9)	2.32(+9)	1.34(–2)
1 – 25	3/2	5/2	E1	738637	135.384	1.21(+11)	1.27(+11)	1.99
5 – 38	3/2	3/2	E1	741778	134.811	4.06(+10)	4.20(+10)	4.43(–1)
5 – 39	3/2	5/2	E1	743032	134.584	1.34(+11)	1.39(+11)	2.19
1 – 26	3/2	3/2	E1	747835	133.719	1.14(+11)	1.20(+11)	1.22
2 – 31	3/2	3/2	E1	749840	133.362	9.47(+10)	9.88(+10)	1.01
3 – 34	5/2	5/2	E1	751677	133.036	2.82(+10)	2.93(+10)	4.48(–1)
1 – 27	3/2	1/2	E1	752293	132.927	1.20(+11)	1.26(+11)	6.36(–1)
2 – 32	3/2	5/2	E1	754966	132.456	3.23(+10)	3.30(+10)	3.52(–1)
2 – 33	3/2	1/2	E1	763502	130.975	3.47(+9)	3.86(+9)	1.78(–2)
1 – 28	3/2	3/2	E1	763702	130.941	2.57(+10)	2.69(+10)	2.64(–1)
1 – 29	3/2	1/2	E1	768554	130.114	2.26(+10)	2.38(+10)	1.15(–1)
2 – 34	3/2	5/2	E1	769089	130.024	1.19(+11)	1.24(+11)	1.81
3 – 35	5/2	7/2	E1	769247	129.997	1.58(+11)	1.63(+11)	3.20
4 – 33	1/2	3/2	E1	771331	129.646	9.35(+10)	9.64(+10)	9.42(–1)
3 – 36	5/2	3/2	E1	772975	129.370	4.97(+7)	3.70(+7)	4.99(–4)
1 – 30	3/2	5/2	E1	790316	126.532	1.05(+10)	1.08(+10)	1.51(–1)
2 – 36	3/2	3/2	E1	790387	126.520	2.79(+9)	2.85(+9)	2.68(–2)
2 – 37	3/2	1/2	E1	794973	125.790	1.62(+10)	1.67(+10)	7.68(–2)
1 – 31	3/2	3/2	E1	807359	123.861	8.31(+7)	8.42(+7)	7.65(–4)
3 – 38	5/2	3/2	E1	810573	123.370	2.88(+8)	2.79(+8)	2.63(–3)
3 – 39	5/2	5/2	E1	811827	123.179	5.81(+9)	5.88(+9)	7.93(–2)
1 – 32	3/2	5/2	E1	812485	123.079	7.45(+8)	7.47(+8)	1.02(–2)
1 – 33	3/2	1/2	E1	821020	121.800	1.87(+8)	2.16(+8)	8.30(–4)
1 – 34	3/2	5/2	E1	826806	120.947	4.18(+9)	4.29(+9)	5.50(–2)
2 – 38	3/2	3/2	E1	827984	120.775	4.20(+6)	1.38(+6)	3.67(–5)
2 – 39	3/2	5/2	E1	829238	120.593	6.24(+8)	6.63(+8)	8.17(–3)
1 – 36	3/2	3/2	E1	847905	117.938	3.15(+8)	3.18(+8)	2.63(–3)
1 – 37	3/2	1/2	E1	852491	117.303	1.03(+8)	8.20(+7)	4.25(–4)
1 – 38	3/2	3/2	E1	885503	112.930	3.55(+8)	3.63(+8)	2.72(–3)
1 – 39	3/2	5/2	E1	886757	112.770	1.18(+9)	1.18(+9)	1.35(–2)