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Atomic data for Ne-like ions useful in Plasma Diagnostic

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Abstract: Motivated by the recent measurement of transition lines for Ne-like Hf and W, we have reported atomic data in form of multiconfiguration Dirac-Fock transition energies and wavefunction compositions of 209 levels belonging to the configurations $2s^22p^6$, $2s^22p^5ns$ ($n=3,4,5,6,7$), $2s^22p^5np$ ($n=3,4,5,6,7$), $2s^22p^5nd$ ($n=3,4,5,6,7$), $2s^22p^5nf$ ($n=4,5$), $2s^22p^55g$, $2s2p^6ns$ ($n=3,4,5$), $2s2p^6np$ ($n=3,4,5$), $2s2p^6nd$ ($n=3,4,5$), $2s2p^6nf$ ($n=4,5$) and $2s2p^65g$ of Hf LXIII, Ta LXIV, W LXV and Re LXVI. Radiative rates, oscillator strengths, transition wavelengths and line strengths have been calculated for ground state electric dipole (E1) transition among these levels. These values were obtained using GRASP (general-purpose relativistic atomic structure package) code which includes Breit and QED effects along with Dirac-Fock potential and second order coulomb interaction. We have compared our results with the data compiled using FAC (Flexible Atomic Code) and also with the recent results available in the literature. The accuracy of the data is assessed. We predict new energy levels, oscillator strength and transition probability data, where no other theoretical or experimental results are available, which will form the basis for future experimental work.

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1.Introduction

Atomic physics has played a significant role in the history of plasma physics to understand the plasma energy balance and diagnostic development. The atomic physics of tungsten has become of high importance as tungsten will be a constituent of International Thermonuclear Energy Reactor (ITER) plasma. ITER diagnostics has developed using tungsten radiation. The core imaging X-ray spectrometer (CIXS) is a diagnostic designed to measure ion temperature and bulk plasma motion of ITER's core. It has been designed to focus on the X-ray emission of neon-like tungsten ions which is included in the present work. The Spectrum of neon-like tungsten near 8500 eV has been measured by Beiersdorfer et al. [1] which require the reliable calculations for comparison. This is because the CIXS will provide radial profiles of the ion abundances in ITER and therefore reliable atomic data is required for using the CIXS in this endeavor. Further, the transition lines have also been measured for Ne-like Hf [2]. Therefore, to provide support to experimentalists and to extend the database, we have calculated the reliable atomic data in form of energy level, oscillator strength, transition probability and line strength for Ne-like ions ($Z=72-75$).

Ions of Ne-isoelectronic sequence have been studied both experimentally and theoretically over a wide range of Z . But nevertheless the study of Ne-like ions remains of interest as spectra of these ions are the source of many important diagnostics informations on plasma such as electron temperature, electron density and charge state abundance. Ne-like ions of middle and high atomic number are present in tokamak, laser produced plasma, EBIT, solar atmosphere [3-4]. Also, Ne-like ions are highly useful for the modelling of astrophysical, fusion and laser generated plasma. Further, because of their closed shell structure, we can estimate the importance of the contributions from relativistic, electron correlations and quantum electrodynamics (QED) effects in study of energy values and radiative rates particularly, transitions between levels of $2p^53s$, $3p$ and $3d$ configurations

produce prominent lines in the spectra of high temperature light source in Ne-like ions [5-6]. To obtain laser action the 3s and 3p states have utilized. Also, laser is obtained in lighter elements [7] for Ne-like ions.

Many investigations have been carried out for the Ne-like ions considered in the present work in the last two decades. On the experimental side, many experiments have been performed for the lifetimes of the 3l configurations of Ne-like ions using beam foil method [8-11]. Many authors calculated the transition energies, oscillator strength, lifetimes and transition probabilities using different theoretical methods for many Ne-like ions. [12-17]. Recently, Beiersdorfer et. al.[18] reported radiative rates for transitions in Ne-like ions ($Z=10-110$). Much work has been done on Ne-like W due to its importance in exploring the physical conditions in tokamak plasmas such as ITER. In W LXV, Aglitskii et al. [19] calculated energy levels for Ne-like ions from Kr XXVII to U LXXXIII using semiempirical adjusted relativistic calculations. After this, several x-ray lines were precisely measured using EBIT [20-22]. Recently, Khatri et al. [23] calculated photoionization cross section of Ne-like tungsten using R-matrix method. More recently, Aggarwal and Keenan [24] calculated energy levels and radiative rates for 121 levels of W LXV.

In this work, we have reported transition energies and wavefunction compositions of 209 levels belonging to the configurations $2s^22p^6$, $2p^5ns$ ($n=3,4,5,6,7$), $2p^5np$ ($n=3,4,5,6,7$), $2p^5nd$ ($n=3,4,5,6,7$), $2p^5nf$ ($n=4,5$), $2p^55g$, $2s2p^6ns$ ($n=3,4,5$), $2s2p^6np$ ($n=3,4,5$), $2s2p^6nd$ ($n=3,4,5$), $2s2p^6nf$ ($n=4,5$) and $2s2p^65g$ of Hf LXIII, Ta LXIV, W LXV and Re LXVI. We have also taken into account Breit and QED effects. Radiative rates, oscillator strengths, transition wavelengths and line strengths are also calculated for all electric dipole (E1), magnetic dipole (M1), electric quadrupole (E2) and magnetic quadrupole (M2) transitions among these levels. We have obtained results using the multiconfiguration Dirac-Fock

(MCDF) method employed in the GRASP code of Grant *et al.* [25], revised by Norrington [26]. The calculations are helpful in analyzing new data from many different plasma.

2. Energy Levels

In present paper, we have used extensive configuration interaction employed in General purpose relativistic atomic structure package (GRASP) code. GRASP is a fully relativistic code which include Breit and QED correction. We have used GRASP0 in present calculations, which was originally developed by Grant *et al.* [25] and modified by Norrington [26]. We have used Extended Average Level (EAL) option to optimize the MCDF orbital in present calculations. In these calculations we have taken 64 configurations ($2s^22p^6$, $2s^22p^53l$ ($l=0-2$), $2s^22p^54l$ ($l=0-3$), $2s^22p^55l$ ($l=0-4$), $2s2p^63l$ ($l=0-2$), $2s2p^64l$ ($l=0-3$), $2s2p^65l$ ($l=0-4$), $2s^22p^56l$ ($l=0-2$), $2s^22p^57l$ ($l=0-2$), $2s^22p^43s3p$, $2s^22p^43s3d$, $2s^22p^43p3d$, $2s^22p^43s^2$, $2s^22p^43p^2$, $2s^22p^43d^2$, $2s^22p^43s4s$, $2s^22p^43s4p$, $2s^22p^43s4d$, $2s^22p^43s4f$, $2s^22p^43s5s$, $2s^22p^43s5p$, $2s^22p^43s5d$, $2s^22p^43s5f$, $2s^22p^43s5g$, $2s^22p^43p4s$, $2s^22p^43p4p$, $2s^22p^43p4d$, $2s^22p^43p4f$, $2s^22p^43p5s$, $2s^22p^43p5p$, $2s^22p^43p5d$, $2s^22p^43p5f$, $2s^22p^43p5g$, $2s^22p^43d4s$, $2s^22p^43d4p$, $2s^22p^43d4d$, $2s^22p^43d4f$, $2s^22p^43d5s$, $2s^22p^43d5p$, $2s^22p^43d5d$, $2s^22p^43d5f$, $2s^22p^43d5g$) which generate 3948 fine structure levels, out of which we have presented energy values of 209 fine structure levels belonging to the configurations ($2s^22p^6$, $2p^5ns$ ($n=3,4,5,6,7$), $2p^5np$ ($n=3,4,5,6,7$), $2p^5nd$ ($n=3,4,5,6,7$), $2p^5nf$ ($n=4,5$), $2p^55g$, $2s2p^6ns$ ($n=3,4,5$), $2s2p^6np$ ($n=3,4,5$), $2s2p^6nd$ ($n=3,4,5$), $2s2p^6nf$ ($n=4,5$) and $2s2p^65g$) of Ne like Hf, W, Ta and Re. We have also performed similar calculations using an independent method flexible atomic code (FAC), which is also a fully relativistic code and give the comparable results with GRASP. We have successfully applied GRASP and FAC in past to calculate atomic data for many highly charged ion [27-33]

In table 1-4, we have presented the MCDF energies, lifetimes, and mixing coefficients for Ne like ions ($Z=72-75$). In the mixing coefficients, we first give the percentage of the

basis state corresponding to levels name in LS coupling then the second largest percentage together with the related basis and so on. We would like to mention that mixing in our calculations among the levels is very high, for example, we found that 47.8% of $2s^2 2p^5 7d \ ^3P_2$ level is mixed with 35.6% of $2s^2 2p^5 7d \ ^3D_2$. There are many other levels which are mixed. Therefore, the identification of particular level is not unique, although the Aggarwal [24] and Vilkas et al. [34] have the same labels as in our work for Ne like Tungsten.

In table 1-4, we have also presented the energy values for 209 fine structural levels calculated using GRASP code. We have provided the detailed comparison of our energy values calculated from GRASP with the available data compiled by NIST and calculated values from flexible atomic code (FAC) which is independent and fully relativistic atomic structure code. However, NIST energy values are available only for Ne-like Tungsten. Our calculated results from GRASP and FAC are in close agreement with each other for all ions taken in present work. Difference between two sets (FAC and GRASP) are up to 0.5 Ryd. for most of the levels, except for some level for which discrepancies is slightly larger up to 1 Ryd. However, the ordering are almost identical for both calculations for Ne like Tungsten. We have compared energy values calculated from MCDF and FAC with the recent results of Aggarwal [24] and Vilkas [34]. Aggarwal [24] used the same GRASP0 code which is used in our present calculations. Aggarwal et al. [24] reported energies for 121 fine structural levels and calculated energy value only for 157 level. Vilkas et al [34] calculated energies for 141 levels using relativistic multi-reference-many body Moller–Plesset (MRMP) Perturbation theory. These results are listed in table 3 for comparison. In general, our calculated values using GRASP and FAC is closed to NIST. The energy differs only by 0.6 ryd. with our calculated values of GRASP and FAC. Overall, there is no significant discrepancy between the four independent calculations. However, we have listed energy values for 209 fine structural levels which have been presented for the first time. We have presented results for

many new levels which are not listed in NIST tables and may form the basis of future experimental works.

3. Radiative Rates

Apart from energy levels, calculations have also been made for transition wavelength (λ_{ji}), of oscillator strength (f_{ij}), transition probability (A_{ji}, s^{-1}), line strength (S_{ij} in A.U.) for neon like ions ($Z=72-75$). The transition probability and oscillator strength can be related with line strength as

For the electric dipole (E1) transitions

$$A_{ji} = \frac{2.0261 \times 10^{18}}{w_j \lambda_{ji}^3} s \text{ and } f_{ij} = \frac{303.75}{\lambda_{ji} w_i} \dots\dots\dots(1)$$

For the magnetic dipole (M1) transitions

$$A_{ji} = \frac{2.6974 \times 10^{13}}{w_j \lambda_{ji}^3} s \text{ and } f_{ij} = \frac{4.044 \times 10^{-3}}{\lambda_{ji} w_i} \dots\dots\dots(2)$$

For the electric quadrupole (E2) transitions

$$A_{ji} = \frac{1.1199 \times 10^{18}}{w_j \lambda_{ji}^5} s \text{ and } f_{ij} = \frac{167.89}{\lambda_{ji}^3 w_i} \dots\dots\dots(3)$$

For the magnetic quadrupole (M2) transitions

$$A_{ji} = \frac{1.4910 \times 10^{13}}{w_j \lambda_{ji}^5} s \text{ and } f_{ij} = \frac{2.236 \times 10^{-3}}{\lambda_{ji}^3 w_i} \dots\dots\dots(4)$$

In these equations, ω_i and ω_j are the statistical weights of the lower i and upper j levels respectively.

In table 5-8, we have reported the transition wavelength ($\text{\AA}$), transition probability (A_{ji}, s^{-1}), oscillator strength (f_{ij}) and line strength (S_{ij} , in a.u) for all electric dipole (E1) transitions from ground state among 209 levels of Ne-like ions ($Z=72-75$). We have also

presented the transition wavelength ($\text{\AA}$), transition probability (A_{ji}, s^{-1}), oscillator strength (f_{ij}) and line strength (s_{ij} , in a.u) for the transitions within the ground state of Ne-like W for E2, M1 and M2 in Table 9. We have result of all transitions with us and one can get these results if required. For these calculations, we have used GRASP energies which includes Breit and QED effects. In table 5-8 j and i represent the upper and lower level respectively. We have also reported the ratio of velocity and length forms of the oscillator strength because it gives an indication of the accuracy of the f (or A) values. The good agreement between the two forms is desirable, but not a sufficient condition for accuracy, as different sets of configuration can give same ratio of velocity and length but different result in magnitude. In present calculations one can see from table 5-8, the velocity length ratio is generally within 10% for strong E1 type transitions. However, difference between two forms for some weaker transitions sometimes be large. All such weak transitions, do not affect the overall accuracy of the calculations.

In table-10, we have compared the calculated transition probability (A_{ji}), oscillator strength (f_{ij}) using MCDF method with the earlier calculated results and experimental results [24,34]. One can see from table 10 that our calculated results match well with other results, which shows the accuracy of our calculated results.

4. Lifetimes

The lifetime for a particular level j can be defined as follows

$$\tau_j = \frac{1}{\sum_j A_{ji}} \dots\dots\dots(5)$$

In table 1-4, we have presented our calculated lifetime with the GRASP code, which include A-values contributions from Electric dipole (E1), Magnetic dipole (M1), Electric quadrupole (E2) and magnetic quadrupole (M2) transitions. For comparison, theoretical results Aggarwal and Keenan [24] are available for 121 fine structural levels based on calculations with the

same GRASP0 code. One can see from Table 11 that our calculated lifetime with the GRASP0 code shows excellent agreement with the results of Aggarwal and Keenan [24]. We hope our calculated lifetime will be useful to experimentalist for their future work.

5. Conclusion

In present work, energy levels and radiative rates for E1, E2, M1, M2 transitions calculated with GRASP0 code have been reported for the 209 levels of Ne like ions ($Z=72-75$). We have taken into account the various checks like agreement of calculations by performing similar calculations using FAC code. We have performed accuracy test by comparing our calculated results with the other available results. We have also presented the lifetimes of all excited states. Based on the comparison of several calculations with the two independent codes (GRASP and FAC) and with the other available results, our energy levels are estimated to be accurate to 0.5 Ryd. Also, based on the comparison between velocity and length ratio, we conclude that our radiative rates are accurate to better than 20% for most of strong transitions.

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Table 1: MCDF energies (in Ryd.), lifetimes (in s) and mixing coefficients in Ne-like-Hf

S.No	Label	J	Level (Ryd)	FAC	Lifetimes	Mixing coefficients
1	$2s^2 2p^6 \ ^1S^e$	0	-----	0	-----	100
2	$2s^2 2p^5 3s \ ^3P^o$	2	575.746687	575.8738	2.99E-10	100
3	$2s^2 2p^5 3s \ ^1P^o$	1	576.34331	576.47	7.41E-15	66.26 + 33.76(19)
4	$2s^2 2p^5 3p \ ^3P^e$	1	586.363216	586.3716	1.81E-11	49.28 + 31.7(24)
5	$2s^2 2p^5 3p \ ^3D^e$	2	586.499437	586.5063	1.23E-12	50.27 + 33.18(23) + 16.48(8)
6	$2s^2 2p^5 3p \ ^1P^e$	1	610.844174	610.8702	8.08E-13	55.95 + 35.88 (24)
7	$2s^2 2p^5 3p \ ^3D^e$	3	610.815701	610.8944	7.68E-13	100
8	$2s^2 2p^5 3p \ ^3P^e$	2	611.742975	611.7868	4.64E-13	66.75+ 33.18 (23)
9	$2s^2 2p^5 3p \ ^1S^e$	0	615.870615	615.8376	5.11E-13	61.78 + 38.07 (21)
10	$2s^2 2p^5 3d \ ^3P^o$	0	622.13175	622.1152	1.04E-12	100
11	$2s^2 2p^5 3d \ ^3P^o$	1	622.837977	622.8201	1.54E-14	66.75 + 31.81 (29)
12	$2s^2 2p^5 3d \ ^3F^o$	3	622.926827	622.9091	9.82E-13	54.02 + 39.06 (31)
13	$2s^2 2p^5 3d \ ^3D^o$	2	623.491863	623.4683	9.34E-13	54.61 + 18.23 (28) +17.31 (15)
14	$2s^2 2p^5 3d \ ^3F^o$	4	628.273596	628.2818	7.31E-12	100
15	$2s^2 2p^5 3d \ ^1D^o$	2	628.776936	628.7669	4.19E-12	48.72 + 41.09 (30)
16	$2s^2 2p^5 3d \ ^1D^o$	3	629.497131	629.4815	6.65E-12	70.56+27.35(31)
17	$2s^2 2p^5 3d \ ^1P^o$	1	631.617571	631.5568	4.04E-16	62.88+19.45(29)+17.64(11)
18	$2s^2 2p^5 3s \ ^3P^o$	0	665.501858	665.707	4.53E-11	99.8
19	$2s^2 2p^5 3s \ ^3P^o$	1	665.746963	665.952	3.01E-14	66.1+33.76(3)
20	$2s^2 2p^5 3p \ ^3D^e$	1	675.858759	675.9504	1.84E-11	73.62+22.75(6)
21	$2s^2 2p^5 3p \ ^3P^e$	0	679.339609	679.3984	3.53E-12	61.78+37.95(9)
22	$2s 2p^6 3s \ ^3S^e$	1	698.923001	698.9252	1.19E-13	62.09+19.89(4)
23	$2s^2 2p^5 3p \ ^1D^e$	2	700.888993	701.0201	4.43E-13	49.7+33.52(23)+16.81(8)
24	$2s^2 2p^5 3p \ ^3S^e$	1	702.228474	702.0981	8.52E-14	37.82+30.69(4)+19.18(24)
25	$2s 2p^6 3s \ ^1S^e$	0	702.816187	702.4415	5.95E-14	99.8
26	$2s 2p^6 3p \ ^3P^o$	1	710.791342	710.5377	9.92E-16	64+30.91(33)
27	$2s 2p^6 3p \ ^3P^o$	0	711.101696	710.7513	5.59E-14	99.8
28	$2s^2 2p^5 3d \ ^3F^o$	2	712.6381	712.7137	9.40E-13	74.13+20.43(15)
29	$2s^2 2p^5 3d \ ^3D^o$	1	714.74448	714.6845	1.12E-15	45.97+33.76(17)
30	$2s^2 2p^5 3d \ ^3P^o$	2	718.467536	718.5346	4.04E-12	46.92+36.12(13)
31	$2s^2 2p^5 3d \ ^1F^o$	3	718.716558	718.7858	6.13E-12	43.96+33.52(31)+22.47(16)
32	$2s 2p^6 3p \ ^3P^o$	2	735.687686	735.3904	5.19E-14	99.6
33	$2s 2p^6 3p \ ^1P^o$	1	736.114445	735.814	2.39E-15	67.9+32.04(26)
34	$2s 2p^6 3d \ ^3D^e$	1	747.45884	747.037	5.78E-14	100
35	$2s 2p^6 3d \ ^3D^e$	2	747.840811	747.4183	4.47E-14	71.4+28.52(37)
36	$2s 2p^6 3d \ ^3D^e$	3	753.077877	752.6785	5.72E-14	100
37	$2s 2p^6 3d \ ^1D^e$	2	754.186817	753.7721	3.74E-14	71.4+28.52(35)
38	$2s^2 2p^5 4s \ ^3P^o$	2	804.548061	804.6512	1.67E-14	100
39	$2s^2 2p^5 4s \ ^1P^o$	1	804.748696	804.8524	9.27E-15	66.59+33.41(63)
40	$2s^2 2p^5 4p \ ^3P^e$	1	808.934454	808.9941	1.38E-14	49.7+31.25(70)
41	$2s^2 2p^5 4p \ ^3D^e$	2	808.973978	809.034	1.37E-14	50.13+33.41(71)+16.48(44)
42	$2s^2 2p^5 4p \ ^3D^e$	3	818.974686	819.0525	2.10E-14	100
43	$2s^2 2p^5 4p \ ^1P^e$	1	818.997244	819.0737	2.09E-14	56.4+35.76(70)
44	$2s^2 2p^5 4p \ ^3P^e$	2	819.316808	819.3925	2.11E-14	66.75+33.18(71)
45	$2s^2 2p^5 4p \ ^1S^e$	0	820.721973	820.7369	2.18E-14	65.45+34.46(65)
46	$2s^2 2p^5 4d \ ^3P^o$	0	823.312993	823.366	9.19E-15	100
47	$2s^2 2p^5 4d \ ^3P^o$	1	823.568258	823.6192	7.44E-15	64.8+33.29(77)
48	$2s^2 2p^5 4d \ ^3F^o$	3	823.585955	823.6352	9.23E-15	53.58+39.44(83)
49	$2s^2 2p^5 4d \ ^3D^o$	2	823.791622	823.837	9.28E-15	54.46+18.15(75)+17.89(51)
50	$2s^2 2p^5 4d \ ^3F^o$	4	825.921357	825.9796	8.92E-15	100
51	$2s^2 2p^5 4d \ ^1D^o$	2	826.107648	826.1615	8.92E-15	48.58+40.96(82)
52	$2s^2 2p^5 4d \ ^3D^o$	3	826.365858	826.4155	8.98E-15	70.73+27.14(83)
53	$2s^2 2p^5 4d \ ^1P^o$	1	827.108991	827.1346	9.92E-16	63.84+18.92(47)+17.06(77)

54	$2s^2 2p^5 4f^3 D^e$	1	828.442392	828.5077	4.25E-15	100
55	$2s^2 2p^5 4f^3 G^e$	4	828.465363	828.5308	4.36E-15	52.85+44.22(107)
56	$2s^2 2p^5 4f^3 F^e$	2	828.613355	828.6786	4.30E-15	47.33+47.06(101)
57	$2s^2 2p^5 4f^3 F^e$	3	828.69074	828.756	4.35E-15	50.69+22.75(100)+22.37(60)
58	$2s^2 2p^5 4f^3 G^e$	5	829.550736	829.6162	4.46E-15	100
59	$2s^2 2p^5 4f^3 D^e$	2	829.670818	829.7337	4.35E-15	61+30.8(101)
60	$2s^2 2p^5 4f^3 F^e$	3	829.731299	829.796	4.42E-15	44.22+40.45(106)
61	$2s^2 2p^5 4f^3 F^e$	4	829.800938	829.8662	4.47E-15	72.08+22.47(107)
62	$2s^2 2p^5 4s^3 P^o$	0	894.411874	894.6042	1.65E-14	100
63	$2s^2 2p^5 4s^3 P^o$	1	894.480913	894.6737	1.29E-14	66.42+33.41(39)
64	$2s^2 2p^5 4p^3 D^e$	1	898.694629	898.8433	1.36E-14	73.96+22.37(43)
65	$2s^2 2p^5 4p^3 P^e$	0	899.805267	899.9265	1.41E-14	65.45+34.34(45)
66	$2s^2 2p^5 5s^3 P^o$	2	906.592421	906.7052	2.06E-14	100
67	$2s^2 2p^5 5s^3 P^o$	1	906.686483	906.7979	1.26E-14	66.59+33.41(155)
68	$2s^2 2p^5 5p^3 P^e$	1	908.622957	908.7901	1.88E-14	48.86+30.8(158)
69	$2s^2 2p^5 5p^3 D^e$	2	908.733916	908.876	1.88E-14	49.7+33.29(159)+16.4(74)
70	$2s^2 2p^5 4p^3 S^e$	1	909.071993	909.1448	1.89E-14	49.28+28.62(70)
71	$2s^2 2p^5 4p^3 D^e$	2	909.032035	909.1594	1.87E-14	49.56+33.29(71)+16.65(44)
72	$2s^2 2p^5 5p^3 D^e$	3	913.857016	913.5623	2.47E-14	100
73	$2s^2 2p^5 5p^3 P^e$	1	913.867478	913.9557	2.42E-14	56.4+35.52(158)
74	$2s^2 2p^5 5p^3 P^e$	2	914.024819	913.9652	2.49E-14	66.75+33.18(159)
75	$2s^2 2p^5 4d^3 F^o$	2	913.42024	914.1121	9.24E-15	74.3+20.07(51)
76	$2s^2 2p^5 5p^3 S^e$	0	914.697871	914.1199	2.55E-14	65.77+33.76(157)
77	$2s^2 2p^5 4d^3 D^o$	1	913.982019	914.7537	1.79E-15	48.02+32.72(53)
78	$2s^2 2p^5 5d^3 P^o$	0	915.989087	916.0403	1.23E-14	100
79	$2s^2 2p^5 5d^3 P^o$	1	916.115063	916.08	1.10E-14	63.36+33.99(161)
80	$2s^2 2p^5 5d^3 F^o$	3	916.171237	916.0818	1.17E-14	52.85+38.81(163)
81	$2s^2 2p^5 5d^3 D^o$	2	916.246206	916.2049	1.22E-14	54.32+17.47(160)+16.4(85)
82	$2s^2 2p^5 4d^3 P^o$	2	915.895396	916.3013	9.03E-15	42.12+32.04(49)
83	$2s^2 2p^5 4d^3 F^o$	3	915.976274	916.3422	9.39E-15	43.43+32.95(83)+21.9(52)
84	$2s^2 2p^5 5d^3 F^o$	4	917.326664	917.4218	1.23E-14	100
85	$2s^2 2p^5 5d^3 D^o$	2	917.446362	917.5284	1.22E-14	42.51+37.82(162)
86	$2s^2 2p^5 5d^3 D^o$	3	917.541537	917.6284	1.23E-14	70.56+26.63(163)
87	$2s^2 2p^5 5d^3 P^o$	1	917.954051	918.0174	1.59E-15	61.94+18.92(790)
88	$2s^2 2p^5 5f^3 D^e$	1	918.556013	918.6066	8.12E-15	100
89	$2s^2 2p^5 5f^3 G^e$	4	918.580667	918.6348	8.25E-15	53+43.82(167)
90	$2s^2 2p^5 5f^3 D^e$	2	918.672785	918.657	7.58E-15	47.89+46.51(165)
91	$2s^2 2p^5 5f^3 F^e$	3	918.697069	918.6813	8.02E-15	50.55+22.56(164)+22.18(94)
92	$2s^2 2p^5 5f^3 G^e$	5	919.13546	918.8009	8.48E-15	100
93	$2s^2 2p^5 5f^3 D^e$	2	919.211287	918.8026	8.24E-15	61.62+29.05(90)
94	$2s^2 2p^5 5f^3 F^e$	3	919.196164	919.2365	7.78E-15	43.3+39.82(166)
95	$2s^2 2p^5 5f^3 F^e$	4	919.252662	919.3042	8.16E-15	71.74+22.75(167)
96	$2s^2 2p^5 5g^3 F^o$	2	919.327175	919.3098	1.46E-14	100
97	$2s^2 2p^5 5g^3 H^o$	5	919.333579	919.3559	1.46E-14	52.42+45.83(170)
98	$2s^2 2p^5 5g^3 G^o$	3	919.378871	919.4173	1.46E-14	54.17+37.09(169)
99	$2s^2 2p^5 5g^3 G^o$	4	919.397721	919.4234	1.46E-14	47.61+25.2(168)+24.9(104)
100	$2s^2 2p^5 4f^3 G^e$	3	918.456756	919.4691	4.40E-15	72.25+18.66(60)
101	$2s^2 2p^5 4f^3 D^e$	2	918.508021	919.488	4.46E-15	44.09+32.95(59)+21.9(101)
102	$2s^2 2p^5 5g^3 F^o$	3	919.670309	919.7529	1.48E-14	57.91+37.95(169)
103	$2s^2 2p^5 5g^3 H^o$	6	919.672183	919.7603	1.47E-14	100
104	$2s^2 2p^5 5g^3 G^o$	4	919.719734	919.762	1.48E-14	41.73+39.31(171)+17.39(99)
105	$2s^1 2p^6 5g^3 G^o$	5	919.735118	919.7708	1.47E-14	71.57+20.79(170)
106	$2s^2 2p^5 4f^3 D^e$	3	919.625726	919.81	4.64E-15	54.02+29.7(57)
107	$2s^2 2p^5 4f^3 G^e$	4	919.60262	919.8254	4.56E-15	41.47+33.29(107)+25.1(61)
108	$2s 2p^6 4s^3 S^e$	1	928.931364	928.7493	1.28E-14	99.8
109	$2s 2p^6 4s^3 S^e$	0	929.712771	929.4922	1.29E-14	100
110	$2s 2p^6 4p^3 P^o$	0	933.348591	933.1207	1.11E-14	100
111	$2s 2p^6 4p^3 P^o$	1	933.38058	933.1526	4.62E-15	67.57+32.26(113)
112	$2s 2p^6 4p^3 P^o$	2	943.447317	943.2421	1.54E-14	100
113	$2s 2p^6 4p^3 P^o$	1	943.598646	943.3904	3.60E-15	67.57+32.28(111)
114	$2s 2p^6 4d^3 D^e$	1	947.946498	947.7056	7.92E-15	100
115	$2s 2p^6 4d^3 D^e$	2	948.08087	947.8399	7.88E-15	69.06+30.91(117)
116	$2s 2p^6 4d^3 D^e$	3	950.37505	950.1483	7.69E-15	100
117	$2s 2p^6 4d^3 D^e$	2	950.762333	950.5233	7.61E-15	69.06+30.91(115)
118	$2s 2p^6 4f^3 F^o$	2	952.848097	952.626	4.01E-15	100
119	$2s 2p^6 4f^3 F^o$	3	952.831403	952.637	4.02E-15	60.37+39.69(121)
120	$2s 2p^6 4f^3 F^o$	4	953.910809	953.7059	4.11E-15	100
121	$2s 2p^6 4f^3 F^o$	4	953.993888	953.7822	4.13E-15	60.37+39.69(119)
122	$2s^2 2p^5 6s^3 P^o$	2	960.877736	960.9637	2.91E-14	100
123	$2s^2 2p^5 6s^3 P^o$	1	960.926836	961.0092	2.07E-14	66.59+33.41(191)
124	$2s^2 2p^5 6p^3 P^e$	1	962.133913	962.2063	2.44E-14	49.84+30.91(194)

125	$2s^2 2p^5 6p^3 D^e$	2	962.143661	962.2299	2.42E-14	49.98+33.41(195)+16.56(128)
126	$2s^2 2p^5 6p^3 D^e$	3	965.028542	965.1508	3.41E-14	100
127	$2s^2 2p^5 6p^3 P^e$	1	965.035272	965.1513	3.33E-14	56.4+35.76(194)
128	$2s^2 2p^5 6p^3 P^e$	2	965.117698	965.2267	3.39E-14	66.75+33.18(195)
129	$2s^2 2p^5 6p^3 S^e$	0	965.463606	965.54	3.31E-14	66.42+33.52(193)
130	$2s^2 2p^5 6d^3 P^o$	0	966.235633	966.3449	1.85E-14	100
131	$2s^2 2p^5 6d^3 P^o$	1	966.301831	966.4302	1.61E-14	63.2+34.34(197)
132	$2s^2 2p^5 6d^3 F^o$	3	966.303614	966.4491	1.85E-14	53.44+39.56(199)
133	$2s^2 2p^5 6d^3 D^o$	2	966.357322	966.4835	1.84E-14	54.46+18.23(135)+18.23(196)
134	$2s^2 2p^5 6d^3 F^o$	4	967.006363	967.1704	1.85E-14	100
135	$2s^2 2p^5 6d^3 D^o$	2	967.055448	967.2039	1.84E-14	48.3+40.96(198)
136	$2s^2 2p^5 6d^3 D^o$	3	967.122899	967.2694	1.84E-14	70.9+27.04(199)
137	$2s^2 2p^5 6d^3 P^o$	1	967.312534	967.4521	3.45E-15	64+20.25(131)
138	$2s^2 2p^5 7s^3 P^o$	2	993.005034	993.1369	3.97E-14	100
139	$2s^2 2p^5 7s^3 P^o$	1	993.035591	993.1647	3.02E-14	66.59+33.41(201)
140	$2s^2 2p^5 7p^3 P^e$	1	993.788223	993.9116	3.35E-14	49.98+30.91(204)
141	$2s^2 2p^5 7p^3 D^e$	2	993.793913	993.9256	3.34E-14	49.98+33.41(205)+16.56(144)
142	$2s^2 2p^5 7p^3 P^e$	1	995.599273	995.7497	4.34E-14	56.4+35.76(204)
143	$2s^2 2p^5 7p^3 D^e$	3	995.595808	995.7501	4.54E-14	100
144	$2s^2 2p^5 7p^3 P^e$	2	995.651437	995.7969	4.48E-14	66.75+33.18(205)
145	$2s^2 2p^5 7p^3 S^e$	0	995.839882	995.9653	4.17E-14	66.26+33.41(203)
146	$2s^2 2p^5 7d^3 P^o$	0	996.35125	996.4942	2.53E-14	100
147	$2s^2 2p^5 7d^3 P^o$	1	996.395183	996.5447	2.53E-14	63.2+34.34(207)
148	$2s^2 2p^5 7d^3 F^o$	3	996.387333	996.5568	2.65E-14	53.44+39.56(209)
149	$2s^2 2p^5 7d^3 D^o$	2	996.420383	996.5777	2.64E-14	54.46+18.23(151)+18.23(206)
150	$2s^2 2p^5 7d^3 F^o$	4	996.830733	996.7036	2.71E-14	100
151	$2s^2 2p^5 7d^3 D^o$	2	996.860384	996.7308	2.68E-14	48.44+40.96(208)
152	$2s^2 2p^5 7d^3 D^o$	3	996.902409	997.0121	2.67E-14	70.9+27.04(209)
153	$2s^2 2p^5 7d^3 P^o$	1	997.020636	997.032	6.12E-15	63.52+19.98(147)
154	$2s^2 2p^5 5s^3 P^o$	0	996.497906	997.072	2.15E-14	100
155	$2s^2 2p^5 5s^3 P^o$	1	996.521026	997.1836	1.53E-14	66.1+33.06(67)
156	$2s^2 2p^5 5p^3 D^e$	1	998.656767	1.70E-14	1.70E-14	73.96+22.28(73)
157	$2s^2 2p^5 5p^3 P^e$	0	999.215302	999.3673	1.74E-14	65.77+33.76(76)
158	$2s^2 2p^5 5p^3 S^e$	1	1003.80039	1003.986	2.49E-14	50.13+29.48(158)
159	$2s^2 2p^5 5p^3 D^e$	2	1003.81383	1004	2.46E-14	49.98+33.41(159)+16.65(74)
160	$2s^2 2p^5 5d^3 F^o$	2	1006.00644	1006.185	1.25E-14	74.48+20.07(85)
161	$2s^2 2p^5 5d^3 D^o$	1	1006.31733	1006.481	2.74E-15	49.7+33.64(87)+16.48(79)
162	$2s^2 2p^5 5d^3 P^o$	2	1007.30974	1007.49	1.23E-14	47.89+35.64(81)
163	$2s^2 2p^5 5d^3 F^o$	3	1007.34548	1007.525	1.23E-14	44.36+33.41(163)+22.28(86)
164	$2s^2 2p^5 5f^3 G^e$	3	1008.54655	1008.734	8.24E-15	73.44+19.1(94)
165	$2s^2 2p^5 5f^3 F^e$	2	1008.58831	1008.775	8.08E-15	44.49+33.29(93)+22.18(90)
166	$2s^2 2p^5 5f^3 D^e$	3	1009.12652	1009.313	8.40E-15	54.32+29.81(91)
167	$2s^2 2p^5 5f^3 G^e$	4	1009.12643	1009.314	8.48E-15	41.6+33.29(167)+25(95)
168	$2s^2 2p^5 5g^3 H^o$	4	1009.29895	1009.476	1.46E-14	72.42+18.49(104)
169	$2s^2 2p^5 5g^3 F^o$	3	1009.30672	1009.484	1.45E-14	41.73+33.29(109)+25(169)
170	$2s^2 2p^5 5g^3 H^o$	5	1009.6381	1009.815	1.47E-14	39.94+33.29(170)+26.73(105)
171	$2s^2 2p^5 5g^3 F^o$	4	1009.64375	1009.821	1.47E-14	57.61+26.63(99)
172	$2s2p^6 5s^3 S^e$	1	1030.90309	1030.747	1.47E-14	100
173	$2s2p^6 5s^3 S^e$	0	1031.27821	1031.094	1.46E-14	100
174	$2s^2 2p^5 5d^3 F^o$	0	1033.13273	1032.949	1.28E-14	100
175	$2s^2 2p^5 5d^3 D^o$	1	1033.14713	1032.963	6.76E-15	67.57+32.38(177)
176	$2s^2 2p^5 5d^3 P^o$	2	1038.22163	1038.05	1.68E-14	100
177	$2s^2 2p^5 5d^3 F^o$	1	1038.29202	1038.117	5.55E-15	67.57+32.38(175)
178	$2s2p^6 5d^3 D^e$	1	1040.42399	1040.246	9.96E-15	100
179	$2s2p^6 5d^3 D^e$	2	1040.49232	1040.31	9.89E-15	68.56+31.47(181)
180	$2s2p^6 5d^3 D^e$	3	1041.6795	1041.508	9.90E-15	100
181	$2s2p^6 5d^3 D^e$	2	1041.86173	1041.679	9.79E-15	68.56+31.47(179)
182	$2s2p^6 5f^3 F^o$	2	1042.89009	1042.734	7.11E-15	100
183	$2s2p^6 5f^3 F^o$	3	1042.89078	1042.736	7.09E-15	61.47+38.56(185)
184	$2s2p^6 5f^3 F^o$	4	1043.44049	1043.284	7.27E-15	100
185	$2s2p^6 5f^3 F^o$	3	1043.48686	1043.331	7.31E-15	61.47+38.56(183)
186	$2s2p^6 5g^3 G^e$	3	1043.6219	1043.449	1.16E-14	100
187	$2s2p^6 5g^3 G^e$	4	1043.61044	1043.464	1.16E-14	55.8+44.09(189)
188	$2s2p^6 5g^3 G^e$	5	1043.94899	1043.788	1.17E-14	100
189	$2s2p^6 5g^3 G^e$	4	1043.96002	1043.802	1.17E-14	55.8+44.09(187)
190	$2s^2 2p^5 6s^3 P^o$	0	1050.76549	1051.019	2.90E-14	100

191	$2s^2 2p^5 6s^3 p^0$	1	1050.78136	1051.045	2.54E-14	66.59+33.41(123)
192	$2s^2 2p^5 6p^3 d^e$	1	1051.9925	1052.257	2.42E-14	73.96+22.28(127)
193	$2s^2 2p^5 6p^3 p^e$	0	1052.27448	1052.514	2.42E-14	66.42+33.52(129)
194	$2s^2 2p^5 6p^3 s^e$	1	1054.93577	1055.216	3.41E-14	49.98+29.59(194)
195	$2s^2 2p^5 6p^3 d^e$	2	1054.9409	1055.238	3.38E-14	49.98+33.29(195)+16.65(128)
196	$2s^2 2p^5 6d^3 f^o$	2	1056.17966	1056.497	1.85E-14	74.65+19.98(135)
197	$2s^2 2p^5 6d^3 d^o$	1	1056.347	1056.661	4.93E-15	49.84+33.52(137)+16.56(131)
198	$2s^2 2p^5 6d^3 p^o$	2	1056.93562	1057.26	1.84E-14	47.89+35.64(133)
199	$2s^2 2p^5 6d^3 f^o$	3	1056.95418	1057.285	1.85E-14	44.36+33.29(199)+22.28(136)
200	$2s^2 2p^5 7s^3 p^o$	0	1082.89988	1083.199	3.99E-14	100
201	$2s^2 2p^5 7s^3 p^o$	1	1082.90937	1083.217	3.58E-14	66.59+33.41(139)
202	$2s^2 2p^5 7p^3 d^e$	1	1083.66454	1083.972	3.34E-14	74.13+22.28(142)
203	$2s^2 2p^5 7p^3 p^e$	0	1083.83715	1084.129	3.29E-14	66.59+33.52(145)
204	$2s^2 2p^5 7p^3 s^e$	1	1085.50216	1084.972	4.52E-14	49.98+29.59(204)
205	$2s^2 2p^5 7p^3 d^e$	2	1085.5055	1085.168	4.50E-14	49.98+33.29(205)+16.65(144)
206	$2s^2 2p^5 7d^3 f^o$	2	1086.27443	1085.835	2.68E-14	74.65+19.98(151)
207	$2s^2 2p^5 7d^3 d^o$	1	1086.37728	1085.841	7.94E-15	49.98+33.41(153)+16.65(147)
208	$2s^2 2p^5 7d^3 p^o$	2	1086.75026	1086.25	2.69E-14	47.89+35.64(149)
209	$2s^2 2p^5 7d^3 f^o$	3	1086.76178	1086.259	2.70E-14	44.36+33.29(209)+22.28(152)

Table 2: MCDF energies (in Ryd.), lifetimes (in s) and mixing coefficients in Ne-like-Ta

S.No.	Label	J	Level (Ryd)	FAC	Lifetimes	Mixing coefficients
1	$2s^2 2p^6 1s^e$	0	-----	0	-----	100
2	$2s^2 2p^5 3s^3 p^o$	2	592.5993	592.7375	2.63E-10	100
3	$2s^2 2p^5 3s^3 p^o$	1	593.2078	593.3456	6.93E-15	66.3+33.8(19)
4	$2s^2 2p^5 3p^3 p^e$	1	603.4562	603.4645	1.67E-11	49.4+31.6(25)
5	$2s^2 2p^5 3p^3 d^e$	2	603.5888	603.5956	1.13E-12	50.3+33.2(23)+16.5(8)
6	$2s^2 2p^5 3p^3 p^e$	1	629.5819	629.6086	7.12E-13	56+35.9(25)
7	$2s^2 2p^5 3p^3 d^e$	3	629.5512	629.635	6.79E-13	100
8	$2s^2 2p^5 3p^3 p^e$	2	630.4977	630.5442	4.16E-13	66.7+33.3(23)
9	$2s^2 2p^5 3p^3 s^e$	0	634.7089	634.6779	4.57E-13	61.9+37.9(21)
10	$2s^2 2p^5 3d^3 p^o$	0	641.0699	641.0527	9.21E-13	100
11	$2s^2 2p^5 3d^3 p^o$	1	641.79	641.7715	1.36E-14	66.4+32(29)
12	$2s^2 2p^5 3d^3 f^o$	3	641.8662	641.848	8.75E-13	53.9+39.2(31)
13	$2s^2 2p^5 3d^3 d^o$	2	642.4478	642.4236	8.33E-13	54.5+18.2(28)+17.4(15)
14	$2s^2 2p^5 3d^3 f^o$	4	647.5823	647.5906	6.84E-12	100
15	$2s^2 2p^5 3d^3 d^o$	2	648.0979	648.0881	3.84E-12	48.6+41.1(30)
16	$2s^2 2p^5 3d^3 d^o$	3	648.8295	648.8139	6.24E-12	70.6+27.2(31)
17	$2s^2 2p^5 3d^3 p^o$	1	650.9793	650.9179	3.80E-16	62.9+19.1(29)+18(11)
18	$2s^2 2p^5 3s^3 p^o$	0	688.2345	688.4583	3.78E-11	99.8
19	$2s^2 2p^5 3s^3 p^o$	1	688.4805	688.7043	2.77E-14	66.1+33.8(3)
20	$2s^2 2p^5 3p^3 d^e$	1	698.8145	698.914	1.68E-11	73.6+22.7(6)
21	$2s^2 2p^5 3p^3 p^e$	0	702.3704	702.4376	3.27E-12	61.9+37.7(9)
22	$2s 2p^6 3s^3 s^e$	1	722.7934	722.7092	7.79E-14	75.9
23	$2s^2 2p^5 3p^3 d^e$	2	725.508	725.6499	3.97E-13	49.7+33.5(23)+16.8(1)
24	$2s 2p^6 3s^3 s^e$	0	726.3644	725.9685	5.25E-14	99.8
25	$2s^2 2p^5 3p^3 s^e$	1	726.4693	726.4161	1.01E-13	37.8+24(22)+23(25)
26	$2s 2p^6 3p^3 p^o$	0	734.8333	734.2853	4.94E-14	99.8
27	$2s 2p^6 3p^3 p^o$	1	734.6042	734.4522	1.12E-15	65.1+31.5(33)
28	$2s^2 2p^5 3d^3 f^o$	2	737.4615	737.5445	8.37E-13	74.1+20.4(15)
29	$2s^2 2p^5 3d^3 d^o$	1	739.5	739.4816	8.84E-16	47.1+34.3(12)
30	$2s^2 2p^5 3d^3 p^o$	2	743.6703	743.7452	3.68E-12	46.9+36.1(13)
31	$2s^2 2p^5 3d^3 f^o$	3	743.9205	743.9977	5.67E-12	44+33.5(31)+22.5(16)
32	$2s 2p^6 3p^3 p^o$	2	761.0678	760.7432	4.59E-14	99.6
33	$2s 2p^6 3p^3 p^o$	1	761.5023	761.1745	2.25E-15	67.7+32.1(27)
34	$2s 2p^6 3d^3 d^e$	1	773.0447	772.5914	5.12E-14	100
35	$2s 2p^6 3d^3 d^e$	2	773.4308	772.9768	3.96E-14	70.9+29.1(37)
36	$2s 2p^6 3d^3 d^e$	3	779.0326	778.6028	5.07E-14	100

37	$2s^2p^63d^1D^e$	2	780.1552	779.7101	3.35E-14	70.9+29.1(35)
38	$2s^22p^54s^3P^o$	2	829.1212	829.2306	1.56E-14	100
39	$2s^22p^54s^1P^o$	1	829.3256	829.4356	8.65E-15	66.6+33.4(63)
40	$2s^22p^54p^3P^e$	1	833.6049	833.6663	1.29E-14	49.7+31.2(70)
41	$2s^22p^54p^3D^e$	2	833.6431	833.7049	1.28E-14	50.1+33.4(71)+16.5(44)
42	$2s^22p^54p^3D^e$	3	844.3212	844.402	1.99E-14	100
43	$2s^22p^54p^1P^e$	1	844.3446	844.424	1.98E-14	56.4+35.8(70)
44	$2s^22p^54p^3P^e$	2	844.6705	844.7492	2.00E-14	66.7+33.2(71)
45	$2s^22p^54p^1S^e$	0	846.1021	846.1192	2.07E-14	65.4+34.5(65)
46	$2s^22p^54d^3P^o$	0	848.7364	848.7906	8.65E-15	100
47	$2s^22p^54d^3P^o$	1	848.9964	849.0485	6.93E-15	64.3+33.5(85)
48	$2s^22p^54d^3F^o$	3	849.0097	849.0602	8.69E-15	53.6+ 39.4(103)
49	$2s^22p^54d^3D^o$	2	849.2215	849.2681	8.73E-15	54.5+18.2(80)+18(51)
50	$2s^22p^54d^3F^o$	4	851.5045	851.5643	8.38E-15	100
51	$2s^22p^54d^1D^o$	2	851.6954	851.7508	8.38E-15	48.+41(102)
52	$2s^22p^54d^3D^o$	3	851.958	852.0092	8.43E-15	70.7+27.1(103)
53	$2s^22p^54d^1P^o$	1	852.711	852.7379	9.36E-16	63.8+19.3(47)+16.8(85)
54	$2s^22p^54f^3D^e$	1	854.0658	854.1326	3.99E-15	100
55	$2s^22p^54f^3G^e$	4	854.0864	854.1534	4.09E-15	52.9+44.2(102)
56	$2s^22p^54f^3F^e$	2	854.2393	854.3062	4.03E-15	47.5+46.6(105)
57	$2s^22p^54f^3F^e$	3	854.3171	854.3839	4.08E-15	50.7+22.8(104)+22.4(60)
58	$2s^22p^54f^3G^e$	5	855.2444	855.3115	4.19E-15	100
59	$2s^22p^54f^1D^e$	2	855.3683	855.4328	4.08E-15	60.8+31.1(105)
60	$2s^22p^54f^1F^e$	3	855.4295	855.4958	4.16E-15	44.1+40.4(106)
61	$2s^22p^54f^3F^e$	4	855.4997	855.5665	4.20E-15	71.9+22.5(107)
62	$2s^22p^54s^3P^o$	0	924.8705	925.0771	1.54E-14	100
63	$2s^22p^54s^3P^o$	1	924.9393	925.1465	1.20E-14	66.4+33.4(39)
64	$2s^22p^54p^3D^e$	1	929.2442	929.4027	1.27E-14	74+22.4(43)
65	$2s^22p^54p^3P^e$	0	930.3735	930.505	1.31E-14	65.4+34.2(45)
66	$2s^22p^55s^3P^o$	2	934.5911	934.7091	1.92E-14	100
67	$2s^22p^55s^1P^o$	1	934.6879	934.8045	1.20E-14	66.6+33.4(155)
68	$2s^22p^55p^3P^e$	1	936.8377	936.9296	1.60E-14	49.7+31.1(158)
69	$2s^22p^55p^3D^e$	2	936.8627	936.9541	1.59E-14	50+33.4(151)+16.5(79)
70	$2s^22p^54p^3S^e$	1	940.1295	940.3073	2.00E-14	49.3+28.7(70)
71	$2s^22p^54p^1D^e$	2	940.1822	940.3596	1.97E-14	49.8+33.4(71)+16.7(49)
72	$2s^22p^55p^3D^e$	3	942.2441	942.3463	2.34E-14	100
73	$2s^22p^55p^1P^e$	1	942.2644	942.3644	2.29E-14	55.2+35.3(158)
74	$2s^22p^55p^3P^e$	2	942.4154	942.514	2.35E-14	66.7+33.2(159)
75	$2s^22p^55p^1S^e$	0	943.1085	943.1668	2.41E-14	65.8+33.8(152)
76	$2s^22p^55d^3P^o$	0	944.414	944.5093	1.16E-14	100
77	$2s^22p^55d^3P^o$	1	944.5283	944.6241	7.80E-15	64.6+33.3(161)
78	$2s^22p^55d^3F^o$	3	944.5392	944.6315	1.17E-14	53.4+39.4(163)
79	$2s^22p^55d^3D^o$	2	944.7027	944.7024	1.03E-14	54.2+18.1(160)+18(83)
80	$2s^22p^54d^3F^o$	2	944.6487	944.9086	9.71E-15	60.1+17.1(51)
81	$2s^22p^55d^3F^o$	4	945.8335	945.3114	1.16E-14	100
82	$2s^22p^55d^1P^o$	1	945.1335	945.9316	3.01E-15	32.8+25.5(85)+16.4(53)
83	$2s^22p^55d^1D^o$	2	945.9281	946.0059	1.14E-14	41.1+32.4(162)
84	$2s^22p^55d^3D^o$	3	946.0513	946.1416	1.16E-14	70.7+27.1(163)
85	$2s^22p^54d^3D^o$	1	946.6491	946.6734	1.11E-15	31.5+24.1(85)+17.6(53)
86	$2s^22p^55f^3D^e$	1	947.0832	947.187	7.62E-15	100
87	$2s^22p^55f^3G^e$	4	947.1071	947.2106	7.75E-15	53+43.8(166)
88	$2s^22p^55f^3D^e$	2	947.1733	947.276	7.64E-15	47.6+47.1(165)
89	$2s^22p^55f^3F^e$	3	947.2171	947.3188	7.71E-15	50.8+22.7(164)+22.3(92)
90	$2s^22p^55f^3G^e$	5	947.6986	947.6019	7.96E-15	100
91	$2s^22p^55f^1D^e$	2	947.7756	947.6593	7.75E-15	61.3+30.1(88)
92	$2s^22p^55f^1F^e$	3	947.7831	947.8026	7.89E-15	44.2+40.3(166)
93	$2s^22p^55f^3F^e$	4	947.8279	947.8774	7.95E-15	71.9+22.8(162)
94	$2s^22p^55g^3F^o$	2	947.8952	947.8857	1.37E-14	100
95	$2s^22p^55g^3H^o$	5	947.8998	947.9299	1.37E-14	52.4+45.8(170)
96	$2s^22p^55g^3G^o$	3	947.9468	947.9882	1.37E-14	54.2+37(169)
97	$2s^22p^55g^3G^o$	4	947.9654	947.9925	1.37E-14	47.5+25.2(168)+25(100)
98	$2s^22p^55g^1F^o$	3	948.2646	948.04	1.39E-14	56.6+37(169)
99	$2s^22p^55g^3H^o$	6	948.2606	948.0585	1.38E-14	100
100	$2s^22p^55g^1G^o$	4	948.3096	948.3533	1.39E-14	41.6+39.3(171)+17.5(97)
101	$2s^22p^55g^3G^o$	5	948.3248	948.3557	1.38E-14	71.6+20.9(170)
102	$2s^22p^54d^3P^o$	2	947.4496	948.4028	8.40E-15	47.3+35.6(49)
103	$2s^22p^54d^1F^o$	3	947.5041	948.418	8.43E-15	43.2+32.6(103)+21.7(52)
104	$2s^22p^54f^3G^e$	3	949.9818	950.1468	4.09E-15	73.3+19.1(60)
105	$2s^22p^54f^3D^e$	2	950.0504	950.215	4.02E-15	44.6+33.3(59)+22.1(105)
106	$2s^22p^54f^3D^e$	3	951.1855	951.3421	4.17E-15	54.2+29.8(57)
107	$2s^22p^54f^1G^e$	4	951.1779	951.35	4.20E-15	41.6+33.3(107)+25.1(61)

108	2s2p ⁶ 4s ³ S ^e	1	960.1425	959.9373	1.18E-14	99.8
109	2s2p ⁶ 4s ¹ S ^e	0	960.9429	960.6987	1.19E-14	100
110	2s2p ⁶ 4p ³ P ^o	0	964.6587	964.403	1.03E-14	100
111	2s2p ⁶ 4p ³ P ^o	1	964.6892	964.4335	4.30E-15	67.6+32.4(113)
112	2s2p ⁶ 4p ³ P ^o	2	975.4349	975.2033	1.43E-14	100
113	2s2p ⁶ 4p ¹ P ^o	1	975.5897	975.3549	3.39E-15	67.6+32.4(111)
114	2s2p ⁶ 4d ³ D ^e	1	980.0128	979.7429	7.39E-15	100
115	2s2p ⁶ 4d ³ D ^e	2	980.1481	979.8786	7.34E-15	68.6+31.4(117)
116	2s2p ⁶ 4d ³ D ^e	3	982.6002	982.3453	7.16E-15	100
117	2s2p ⁶ 4d ¹ D ^e	2	982.9937	982.7266	7.08E-15	68.6+31.4(115)
118	2s2p ⁶ 4f ³ F ^o	2	985.1127	984.861	3.75E-15	100
119	2s2p ⁶ 4f ³ F ^o	3	985.0948	984.872	3.76E-15	60.2+39.8(121)
120	2s2p ⁶ 4f ³ F ^o	4	986.2468	986.0134	3.85E-15	100
121	2s2p ⁶ 4f ¹ F ^o	3	986.3313	986.0899	3.86E-15	60.2+39.8(119)
122	2s ² 2p ⁵ 6s ³ P ^o	2	990.6868	990.7681	2.72E-14	100
123	2s ² 2p ⁵ 6s ¹ P ^o	1	990.7364	990.814	1.94E-14	66.6+33.4(191)
124	2s ² 2p ⁵ 6p ³ P ^e	1	991.9697	992.0365	2.28E-14	49.8+30.8(194)
125	2s ² 2p ⁵ 6p ³ D ^e	2	991.9795	992.0607	2.27E-14	50+33.4(195)+16.6(128)
126	2s ² 2p ⁵ 6p ³ D ^e	3	995.059	995.1784	3.23E-14	100
127	2s ² 2p ⁵ 6p ¹ P ^e	1	995.0658	995.1787	3.15E-14	56.4+35.9(194)
128	2s ² 2p ⁵ 6p ³ P ^e	2	995.1499	995.2554	3.21E-14	66.7+33.2(195)
129	2s ² 2p ⁵ 6p ¹ S ^e	0	995.5026	995.5745	3.13E-14	66.4+33.5(193)
130	2s ² 2p ⁵ 6d ³ P ^o	0	996.287	996.3924	1.73E-14	100
131	2s ² 2p ⁵ 6d ³ P ^o	1	996.3544	996.4799	1.51E-14	62.9+34.6(197)
132	2s ² 2p ⁵ 6d ³ F ^o	3	996.3551	996.4985	1.73E-14	53.4+39.6(199)
133	2s ² 2p ⁵ 6d ³ D ^o	2	996.4104	996.5336	1.73E-14	54.3+18.3(133)+18.2(196)
134	2s ² 2p ⁵ 6d ³ F ^o	4	997.1053	997.2682	1.74E-14	100
135	2s ² 2p ⁵ 6d ¹ D ^o	2	997.1557	997.3023	1.73E-14	48.3+41(198)
136	2s ² 2p ⁵ 6d ³ D ^o	3	997.2243	997.3689	1.73E-14	70.9+27(199)
137	2s ² 2p ⁵ 6d ¹ P ^o	1	997.4167	997.5543	3.26E-15	63.8+20.5(131)
138	2s ² 2p ⁵ 7s ³ P ^o	2	1023.881	1024.01	3.71E-14	100
139	2s ² 2p ⁵ 7s ¹ P ^o	1	1023.912	1024.038	2.83E-14	66.6+33.3(201)
140	2s ² 2p ⁵ 7p ³ P ^e	1	1024.681	1024.801	3.13E-14	50+30.9(204)
141	2s ² 2p ⁵ 7p ³ D ^e	2	1024.686	1024.815	3.12E-14	50+33.4(205)+16.6(144)
142	2s ² 2p ⁵ 7p ³ D ^e	3	1026.609	1026.762	4.29E-14	100
143	2s ² 2p ⁵ 7p ¹ P ^e	1	1026.613	1026.762	4.11E-14	56.4+35.8(204)
144	2s ² 2p ⁵ 7p ³ P ^e	2	1026.666	1026.81	4.23E-14	66.7+33.2(205)
145	2s ² 2p ⁵ 7p ¹ S ^e	0	1026.87	1026.991	3.97E-14	66.4+33.4(203)
146	2s ² 2p ⁵ 7d ³ P ^o	0	1027.373	1027.519	2.51E-14	100
147	2s ² 2p ⁵ 7d ³ P ^o	1	1027.414	1027.572	2.20E-14	63+34.5(207)
148	2s ² 2p ⁵ 7d ³ F ^o	3	1027.414	1027.582	2.50E-14	53.4+39.6(209)
149	2s ² 2p ⁵ 7d ³ D ^o	2	1027.448	1027.604	2.48E-14	54.5+18.3(151)+18.2(206)
150	2s ² 2p ⁵ 7d ³ F ^o	4	1027.888	1028.068	2.55E-14	100
151	2s ² 2p ⁵ 7d ¹ D ^o	2	1027.918	1028.089	2.52E-14	48.3+41(208)
152	2s ² 2p ⁵ 7d ³ D ^o	3	1027.961	1028.129	2.51E-14	70.9+27(209)
153	2s ² 2p ⁵ 7d ¹ P ^o	1	1028.076	1028.238	5.49E-15	64+20.3(147)
154	2s ² 2p ⁵ 5s ³ P ^o	0	1030.389	1028.495	1.92E-14	100
155	2s ² 2p ⁵ 5s ³ P ^o	1	1030.421	1028.518	1.68E-14	66.6+33.4(67)
156	2s ² 2p ⁵ 5p ³ D ^e	1	1032.588	1032.776	1.59E-14	74+22.3(73)
157	2s ² 2p ⁵ 5p ³ P ^e	0	1033.148	1033.312	1.62E-14	66.1+33.8(75)
158	2s ² 2p ⁵ 5p ³ S ^e	1	1038.076	1038.272	2.35E-14	50.1+29.5(158)
159	2s ² 2p ⁵ 5p ¹ D ^e	2	1038.089	1038.286	2.33E-14	50+33.4(151)+16.6(74)
160	2s ² 2p ⁵ 5d ³ F ^o	2	1040.319	1040.508	1.17E-14	74.6+20.1(83)
161	2s ² 2p ⁵ 5d ³ D ^o	1	1040.633	1040.808	2.59E-15	49.8+33.6(82)+16.5(77)
162	2s ² 2p ⁵ 5d ³ P ^o	2	1041.707	1041.898	1.15E-14	47.9+35.6(79)
163	2s ² 2p ⁵ 5d ¹ F ^o	3	1041.743	1041.933	1.16E-14	44.4+33.4(163)+22.3(84)
164	2s ² 2p ⁵ 5f ³ G ^e	3	1042.963	1043.161	7.73E-15	73.4+19.1(92)
165	2s ² 2p ⁵ 5f ³ F ^e	2	1043.005	1043.203	7.58E-15	44.5+33.3(91)+22.2(88)
166	2s ² 2p ⁵ 5f ³ D ^e	3	1043.58	1043.778	7.90E-15	54.3+29.8(89)
167	2s ² 2p ⁵ 5f ¹ G ^e	4	1043.58	1043.779	7.97E-15	41.6+33.3(167)+25(93)
168	2s ² 2p ⁵ 5g ³ H ^o	4	1043.755	1043.943	1.37E-14	72.4+18.5(100)
169	2s ² 2p ⁵ 5g ³ F ^o	3	1043.763	1043.952	1.36E-14	41.7+33.3(98)+25(169)
170	2s ² 2p ⁵ 5g ¹ H ^o	5	1044.117	1044.305	1.38E-14	39.9+33.3(170)+26.7(101)
171	2s ² 2p ⁵ 5g ³ F ^o	4	1044.122	1044.311	1.38E-14	57.6+26.6(97)
172	2s2p ⁶ 5s ³ S ^e	1	1065.542	1065.362	1.35E-14	100
173	2s2p ⁶ 5s ¹ S ^e	0	1065.925	1065.717	1.34E-14	100
174	2s2p ⁶ 5p ³ P ^o	0	1067.82	1067.61	1.18E-14	100
175	2s2p ⁶ 5p ³ P ^o	1	1067.834	1067.623	6.28E-15	67.6+32.4(177)
176	2s2p ⁶ 5p ³ P ^o	2	1073.25	1073.053	1.55E-14	100
177	2s2p ⁶ 5p ¹ P ^o	1	1073.322	1073.121	5.22E-15	67.6+32.4(175)
178	2s2p ⁶ 5d ³ D ^e	1	1075.491	1075.286	9.26E-15	100

179	2s2p ⁶ 5d ³ D ^e	2	1075.56	1075.351	9.19E-15	68.2+31.8(181)
180	2s2p ⁶ 5d ³ D ^e	3	1076.828	1076.63	9.20E-15	100
181	2s2p ⁶ 5d ¹ D ^e	2	1077.013	1076.804	9.10E-15	68.2+31.8(179)
182	2s2p ⁶ 5f ³ F ^o	2	1078.058	1077.875	6.62E-15	100
183	2s2p ⁶ 5f ³ F ^o	3	1078.058	1077.877	6.61E-15	61.3+38.7(185)
184	2s2p ⁶ 5f ³ F ^o	4	1078.645	1078.463	6.78E-15	100
185	2s2p ⁶ 5f ¹ F ^o	3	1078.693	1078.511	6.81E-15	61.3+38.7(183)
186	2s2p ⁶ 5g ³ G ^e	3	1078.83	1078.631	1.08E-14	100
187	2s2p ⁶ 5g ³ G ^e	4	1078.818	1078.646	1.07E-14	55.8+44.2(189)
188	2s2p ⁶ 5g ³ G ^e	5	1079.179	1078.991	1.08E-14	100
189	2s2p ⁶ 5g ¹ G ^e	4	1079.19	1079.006	1.09E-14	55.8+44.2(187)
190	2s ² 2p ⁵ 6s ³ P ^o	0	1086.461	1086.721	2.70E-14	100
191	2s ² 2p ⁵ 6s ³ P ^o	1	1086.477	1086.747	2.38E-14	66.6+33.4(123)
192	2s ² 2p ⁵ 6p ³ D ^e	1	1087.713	1087.984	2.26E-14	74+22.3(127)
193	2s ² 2p ⁵ 6p ³ P ^e	0	1088.002	1088.247	2.26E-14	66.4+33.5(129)
194	2s ² 2p ⁵ 6p ³ S ^e	1	1090.853	1091.141	3.22E-14	50+29.6(194)
195	2s ² 2p ⁵ 6p ¹ D ^e	2	1090.858	1091.163	3.19E-14	50+33.3(195)+16.6(128)
196	2s ² 2p ⁵ 6d ³ F ^o	2	1092.118	1092.444	1.74E-14	74.6+20(135)
197	2s ² 2p ⁵ 6d ³ D ^o	1	1092.288	1092.611	4.63E-15	49.8+33.5(137)+16.6(131)
198	2s ² 2p ⁵ 6d ³ P ^o	2	1092.923	1093.256	1.73E-14	47.9+35.6(133)
199	2s ² 2p ⁵ 6d ¹ F ^o	3	1092.942	1093.282	1.74E-14	44.4+33.3(199)+22.3(136)
200	2s ² 2p ⁵ 7s ³ P ^o	0	1119.663	1119.969	3.73E-14	100
201	2s ² 2p ⁵ 7s ³ P ^o	1	1119.672	1119.988	3.35E-14	66.6+33.4(139)
202	2s ² 2p ⁵ 7p ³ D ^e	1	1120.443	1120.758	3.13E-14	74.1+22.3(143)
203	2s ² 2p ⁵ 7p ³ P ^e	0	1120.62	1120.919	3.08E-14	66.6+33.5(145)
204	2s ² 2p ⁵ 7p ³ S ^e	1	1122.404	1121.396	4.28E-14	50+29.6(204)
205	2s ² 2p ⁵ 7p ¹ D ^e	2	1122.407	1121.59	4.26E-14	50+33.3(205)+16.6(144)
206	2s ² 2p ⁵ 7d ³ F ^o	2	1123.189	1122.694	2.52E-14	74.6+20(151)
207	2s ² 2p ⁵ 7d ³ D ^o	1	1123.293	1122.707	7.46E-15	50+33.4(153)+16.6(147)
208	2s ² 2p ⁵ 7d ³ P ^o	2	1123.695	1122.745	2.53E-14	47.9+35.6(149)
209	2s ² 2p ⁵ 7d ¹ F ^o	3	1123.707	1122.745	2.54E-14	44.4+33.3(209)+22.3(152)

Table 3: MCDF energies (in Ryd.), lifetimes (in s) and mixing coefficients in Ne-like-W

S.No	Label	J	Level (Ryd)	FAC	NIST	Ref. [24]	Lifetimes	Mixing coefficients
1	2s ² 2p ⁶ 1S ^e	0	-----	0	0	0.0000	-----	100
2	2s ² 2p ⁵ 3s ³ P ^o	2	609.646919	609.7976		609.6024	2.31E-10	100
3	2s ² 2p ⁵ 3s ¹ P ^o	1	610.267422	610.4177	610.6401	610.2292	6.48E-15	66.26+33.76(19)
4	2s ² 2p ⁵ 3p ³ P ^e	1	620.748586	620.7565		620.6689	1.53E-11	49.42+31.58(25)
5	2s ² 2p ⁵ 3p ³ D ^e	2	620.877261	620.8838		620.7976	1.04E-12	50.27+33.29(24)+16.48(8)
6	2s ² 2p ⁵ 3p ¹ P ^e	1	648.608985	648.636		648.5388	6.28E-13	55.95+36(25)
7	2s ² 2p ⁵ 3p ³ D ^e	3	648.575977	648.6648		648.5082	6.00E-13	100
8	2s ² 2p ⁵ 3p ³ P ^e	2	649.54187	649.591		649.4658	3.72E-13	66.75+33.29(24)
9	2s ² 2p ⁵ 3p ¹ S ^e	0	653.837013	653.808	653.8587	653.7288	4.08E-13	62.25+37.7(21)
10	2s ² 2p ⁵ 3d ³ P ^o	0	660.298438	660.2802		660.2404	8.19E-13	100
11	2s ² 2p ⁵ 3d ³ P ^o	1	661.03207	661.0127	661.507	660.9754	1.21E-14	66.1+23.26(29)
12	2s ² 2p ⁵ 3d ³ F ^o	3	661.09547	661.0764		661.0420	7.79E-13	53.88+39.19(31)
13	2s ² 2p ⁵ 3d ³ D ^o	2	661.693976	661.6689		661.6386	7.43E-13	54.46+18.32(28)+17.56(15)
14	2s ² 2p ⁵ 3d ³ F ^o	4	667.199226	667.2074		667.1448	6.41E-12	100
15	2s ² 2p ⁵ 3d ¹ D ^o	2	667.7274	667.7173		667.6732	3.52E-12	48.44+41.09(30)
16	2s ² 2p ⁵ 3d ³ D ^o	3	668.470303	668.4545		668.4160	5.85E-12	70.56+27.25(31)
17	2s ² 2p ⁵ 3d ¹ P ^o	1	670.649232	670.5868	670.246	670.5722	3.59E-16	62.88+18.75(29)+18.23(11)
18	2s ² 2p ⁵ 3s ³ P ^o	0	711.476523	711.721		711.4577	3.16E-11	99.8
19	2s ² 2p ⁵ 3s ³ P ^o	1	711.723347	711.9678	711.936	711.7088	2.56E-14	66.26+33.76(3)
20	2s ² 2p ⁵ 3p ³ D ^e	1	722.283258	722.3909		722.2374	1.52E-11	73.62+22.66(6)
21	2s ² 2p ⁵ 3p ³ P ^e	0	725.916062	725.9919	726.088	725.8494	3.01E-12	62.25+37.58(9)
22	2s2p ⁶ 3s ³ S ^e	1	747.074015	746.9027		746.8320	5.64E-14	85.01
23	2s2p ⁶ 3s ¹ S ^e	0	750.437584	750.0166		750.0804	4.64E-14	99.8
24	2s ² 2p ⁵ 3p ¹ D ^e	2	750.730625	750.8837		750.6897	3.55E-13	49.7+33.52(24)+16.81(8)
25	2s ² 2p ⁵ 3p ³ S ^e	1	751.427697	751.4487		751.3483	1.27E-13	42.51+25.4(25)
26	2s2p ⁶ 3p ³ P ^o	0	759.093117	758.5398		758.8086	4.37E-14	99.8
27	2s2p ⁶ 3p ³ P ^o	1	758.914026	758.6759	758.302	758.6382	1.22E-15	65.93+31.81(33)
28	2s ² 2p ⁵ 3d ³ F ^o	2	762.889496	762.98		762.8610	7.44E-13	74.3+20.43(15)
29	2s ² 2p ⁵ 3d ³ D ^o	1	764.890545	764.8985	765.027	764.8414	7.53E-16	47.61+34.57(17)
30	2s ² 2p ⁵ 3d ³ P ^o	2	769.496164	769.5792		769.4660	3.36E-12	46.92+36.12(13)

31	$2s^2 2p^5 3d^1 F^o$	3	769.747452	769.8329		769.7196	5.23E-12	43.96+33.52(31)+22.47(16)
32	$2s 2p^6 3p^3 P^o$	2	787.066016	786.7087		786.8023	4.06E-14	99.6
33	$2s 2p^6 3p^1 P^o$	1	787.508545	787.1479	786.651	787.2457	2.13E-15	67.73+32.15(27)
34	$2s 2p^6 3d^3 P^e$	1	799.249757	798.7594		798.9331	4.53E-14	100
35	$2s 2p^6 3d^3 D^e$	2	799.639421	799.1486		799.3305	3.51E-14	70.39+29.48(37)
36	$2s 2p^6 3d^3 D^e$	3	805.624622	805.1589		805.3202	4.49E-14	100
37	$2s 2p^6 3d^1 D^e$	2	806.760841	806.2799		806.4689	3.00E-14	70.39+29.48(35)
38	$2s^2 2p^5 4s^3 P^o$	2	854.054641	854.1707		853.9625	1.45E-14	100
39	$2s^2 2p^5 4s^1 P^o$	1	854.262836	854.3794		854.1708	8.08E-15	66.59+33.41(63)
40	$2s^2 2p^5 4p^3 P^e$	1	858.637158	858.7001		858.5362	1.20E-14	49.7+31.14(74)
41	$2s^2 2p^5 4p^3 D^e$	2	858.674115	858.7374		858.5732	1.19E-14	50.13+33.41(75)+16.48(44)
42	$2s^2 2p^5 4p^3 D^e$	3	870.066369	870.15		869.9708	1.89E-14	100
43	$2s^2 2p^5 4p^1 P^e$	1	870.090721	870.173		869.9943	1.88E-14	56.25+35.88(74)
44	$2s^2 2p^5 4p^3 P^e$	2	870.423072	870.5046		870.3249	1.90E-14	66.75+33.18(75)
45	$2s^2 2p^5 4p^1 S^e$	0	871.881374	871.9004		871.7391	1.96E-14	65.45+34.46(65)
46	$2s^2 2p^5 4d^3 P^o$	0	874.558949	874.6141		874.4582	8.15E-15	100
47	$2s^2 2p^5 4d^3 P^o$	1	874.823461	874.8765		874.7215	6.46E-15	64+33.76(101)
48	$2s^2 2p^5 4d^3 F^o$	3	874.832399	874.884		874.7301	8.18E-15	53.58+39.44(103)
49	$2s^2 2p^5 4d^3 D^o$	2	875.050366	875.098		874.9459	8.22E-15	54.46+18.23(100)+18.06(51)
50	$2s^2 2p^5 4d^3 F^o$	4	877.494508	877.5557		877.3960	7.88E-15	100
51	$2s^2 2p^5 4d^1 D^o$	2	877.690124	877.7469		877.5893	7.88E-15	48.44+40.96(102)
52	$2s^2 2p^5 4d^3 D^o$	3	877.956988	878.0095		877.8536	7.93E-15	70.73+27.04(103)
53	$2s^2 2p^5 4d^1 P^o$	1	878.719929	878.7479		878.6101	8.83E-16	63.68+19.62(47)+16.56(101)
54	$2s^2 2p^5 4f^3 D^e$	1	880.095934	880.1641		880.0130	3.75E-15	100
55	$2s^2 2p^5 4f^3 G^e$	4	880.113961	880.1824		880.0340	3.84E-15	52.85+44.09(107)
56	$2s^2 2p^5 4f^3 F^e$	2	880.271846	880.34			3.79E-15	47.75+46.38(105)
57	$2s^2 2p^5 4f^3 F^e$	3	880.349935	880.4182		880.2681	3.84E-15	50.55+22.75(104)+22.47(60)
58	$2s^2 2p^5 4f^3 G^e$	5	881.348167	881.4167		881.2677	3.94E-15	100
59	$2s^2 2p^5 4f^1 D^e$	2	881.476083	881.5419		881.3954	3.83E-15	60.68+31.47(105)
60	$2s^2 2p^5 4f^1 F^e$	3	881.53782	881.6055		881.4557	3.91E-15	44.09+40.45(106)
61	$2s^2 2p^5 4f^3 F^e$	4	881.608563	881.6768		881.5273	3.95E-15	71.91+22.56(107)
62	$2s^2 2p^5 4s^3 P^o$	0	956.00403	956.2259		955.9575	1.44E-14	100
63	$2s^2 2p^5 4s^3 P^o$	1	956.072409	956.2947		956.0265	1.12E-14	66.42+33.41(39)
64	$2s^2 2p^5 4p^3 D^e$	1	960.469893	960.6384		960.4153	1.19E-14	63.96+22.37(43)
65	$2s^2 2p^5 4p^3 P^e$	0	961.613996	961.7564		961.5413	1.23E-14	65.29+33.99(45)
66	$2s^2 2p^5 5s^3 P^o$	2	963.020297	963.1435		962.9295	1.79E-14	100
67	$2s^2 2p^5 5s^1 P^o$	1	963.119652	963.2415		963.0282	1.13E-14	66.59+33.41(155)
68	$2s^2 2p^5 5p^3 P^e$	1	965.320423	965.4146		965.2246	1.49E-14	49.84+31.14(158)
69	$2s^2 2p^5 5p^3 D^e$	2	965.34129	965.4353		965.2449	1.49E-14	49.98+33.41(159)+16.48(72)
70	$2s^2 2p^5 5p^1 P^e$	1	971.061253	971.1711		970.9703	2.16E-14	56.25+35.28(158)
71	$2s^2 2p^5 5p^3 D^e$	3	971.080881	971.1864		970.9884	2.22E-14	100
72	$2s^2 2p^5 5p^3 P^e$	2	971.255626	971.3576		971.1606	2.23E-14	66.75+33.18(159)
73	$2s^2 2p^5 5p^1 S^e$	0	971.97341	972.0335		971.8575	2.28E-14	65.61+33.64(157)
74	$2s^2 2p^5 4p^3 S^e$	1	972.113217	972.2961		972.0601	1.90E-14	49.84+29.05(74)
75	$2s^2 2p^5 4p^1 D^e$	2	972.126624	972.3156		973.1947	1.86E-14	49.84+33.41(75)+16.73(44)
76	$2s^2 2p^5 5d^3 P^o$	0	973.288641	973.3864		972.0758	1.09E-14	100
77	$2s^2 2p^5 5d^3 P^o$	1	973.413991	973.5094		973.3189	8.91E-15	64+33.87(161)
78	$2s^2 2p^5 5d^3 F^o$	3	973.416114	973.5106		973.3201	1.10E-14	53.44+39.56(163)
79	$2s^2 2p^5 5d^3 D^o$	2	973.51952	973.6106		973.4218	1.10E-14	54.46+18.15(160)+18.06(81)
80	$2s^2 2p^5 5d^3 F^o$	4	974.794167	974.8949		974.7015	1.09E-14	100
81	$2s^2 2p^5 5d^3 D^o$	2	974.878976	974.9769		974.7847	1.08E-14	48.44+40.83(162)
82	$2s^2 2p^5 5d^3 D^o$	3	975.01672	975.1095		974.9196	1.09E-14	70.73+27.05(163)
83	$2s^2 2p^5 5d^3 P^o$	1	975.254656	975.3433		975.1580	3.10E-15	62.41+18.75(77)
84	$2s^2 2p^5 5f^3 D^e$	1	976.064266	976.1707		975.9780	7.16E-15	100
85	$2s^2 2p^5 5f^3 G^e$	4	976.08678	976.1929		976.0023	7.29E-15	53+43.82(167)
86	$2s^2 2p^5 5f^3 F^e$	2	976.156799	976.262		976.0701	7.18E-15	47.33+47.2(165)
87	$2s^2 2p^5 5f^3 F^e$	3	976.199984	976.3043		976.1131	7.24E-15	50.69+22.66(164)+22.37(90)
88	$2s^2 2p^5 5f^3 G^e$	5	976.717308	976.824		976.6329	7.49E-15	100
89	$2s^2 2p^5 5f^1 D^e$	2	976.797146	976.9016		976.7120	7.28E-15	61.15+30.58(165)
90	$2s^2 2p^5 5f^1 F^e$	3	976.805504	976.9068		976.7190	7.43E-15	44.22+40.32(166)
91	$2s^2 2p^5 5f^3 F^e$	4	976.849551	976.9106		976.7631	7.48E-15	71.91+22.85(167)
92	$2s^2 2p^5 5g^3 F^o$	2	976.923821	976.9542		976.8410	1.27E-14	99.8
93	$2s^2 2p^5 5g^3 H^o$	5	976.921396	977.0168		976.8384	1.28E-14	52.56+45.83(170)
94	$2s^2 2p^5 5g^3 G^o$	3	976.970113	977.0294		976.8867	1.29E-14	54.32+36.72(169)
95	$2s^2 2p^5 5g^3 G^o$	4	976.988488	977.066		976.9052	1.28E-14	47.47+25.2(168)+25(98)
96	$2s^2 2p^5 5g^3 F^o$	3	977.304296	977.0843		977.2209	1.30E-14	57.61+38.32(169)
97	$2s^2 2p^5 5g^3 H^o$	6	977.305464	977.3999		977.2225	1.30E-14	100
98	$2s^2 2p^5 5g^3 G^o$	4	977.356095	977.4009		977.2727	1.30E-14	41.6+39.44(171)+17.47(95)
99	$2s^2 2p^5 5g^3 G^o$	5	977.371042	977.452		977.2879	1.30E-14	71.57+20.88(170)
100	$2s^2 2p^5 4d^3 F^o$	2	976.756339	977.4669		976.6994	8.26E-15	74.3+20.07(51)
101	$2s^2 2p^5 4d^3 D^o$	1	977.519699	977.648		977.4548	9.92E-16	48.02+33.29(53)

102	$2s^2 2p^5 4d \ ^3P^o$	2	979.629004	979.794	979.5743	7.87E-15	47.61+35.76(49)
103	$2s^2 2p^5 4d \ ^1F^o$	3	979.70381	979.8675	979.6484	7.91E-15	44.22+33.41(103)+22.28(52)
104	$2s^2 2p^5 4f \ ^3G^e$	3	982.214728	982.3897	982.1811	3.84E-15	73.44+19.1(60)
105	$2s^2 2p^5 4f \ ^3D^e$	2	982.283782	982.4584		3.78E-15	44.62+33.29(59)+22.09(105)
106	$2s^2 2p^5 4f \ ^3D^e$	3	983.494741	983.6619	983.4601	3.92E-15	54.32+29.81(57)
107	$2s^2 2p^5 4f \ ^1G^e$	4	983.487779	983.6692	983.4543	3.95E-15	41.6+33.29(107)+25.1(61)
108	$2s2p^6 4s \ ^3S^e$	1	992.0433	991.8102	991.8033	1.09E-14	99.8
109	$2s2p^6 4s \ ^1S^e$	0	992.862836	992.5901	992.5874	1.09E-14	100
110	$2s2p^6 4p \ ^3P^o$	0	996.659716	996.3708	996.4039	9.45E-15	100
111	$2s2p^6 4p \ ^3P^o$	1	996.68872	996.3998	996.4343	4.00E-15	67.57+32.38(113)
112	$2s2p^6 4p \ ^3P^o$	2	1008.15002	1007.887	1007.9087	1.32E-14	100
113	$2s2p^6 4p \ ^1P^o$	1	1008.30862	1008.042	1008.0598	3.19E-15	67.57+32.38(111)
114	$2s2p^6 4d \ ^3D^e$	1	1012.80724	1012.503	1012.5546	6.89E-15	100
115	$2s2p^6 4d \ ^3D^e$	2	1012.94302	1012.639	1012.6918	6.85E-15	68.23+31.7(117)
116	$2s2p^6 4d \ ^3D^e$	3	1015.5612	1015.273	1015.3183	6.67E-15	100
117	$2s2p^6 4d \ ^1D^e$	2	1015.96123	1015.66	1015.7085	6.60E-15	68.23+31.7(115)
118	$2s2p^6 4f \ ^3F^o$	2	1018.11316	1017.826	1017.8997	3.51E-15	100
119	$2s2p^6 4f \ ^3F^o$	3	1018.09395	1017.836	1017.8808	3.52E-15	60.06+39.94(121)
120	$2s2p^6 4f \ ^3F^o$	4	1019.32221	1019.054	1019.1094	3.60E-15	100
121	$2s2p^6 4f \ ^1F^o$	3	1019.40822	1019.13	1019.1955	3.61E-15	60.06+39.94(119)
122	$2s^2 2p^5 6s \ ^3P^o$	2	1020.96254	1021.039		2.54E-14	100
123	$2s^2 2p^5 6s \ ^1P^o$	1	1021.01233	1021.085		1.82E-14	66.59+33.41(191)
124	$2s^2 2p^5 6p \ ^3P^e$	1	1022.27224	1022.333		2.13E-14	49.84+30.8(194)
125	$2s^2 2p^5 6p \ ^3D^e$	2	1022.28233	1022.358		2.12E-14	49.98+33.41(195)+16.56(128)
126	$2s^2 2p^5 6p \ ^1P^e$	1	1025.57363	1025.683		2.99E-14	56.25+35.88(194)
127	$2s^2 2p^5 6p \ ^3D^e$	3	1025.56699	1025.683		3.06E-14	100
128	$2s^2 2p^5 6p \ ^3P^e$	2	1025.65942	1025.761		3.04E-14	66.74+33.18(195)
129	$2s^2 2p^5 6p \ ^1S^e$	0	1026.01886	1026.086		2.95E-14	66.42+33.52(193)
130	$2s^2 2p^5 6d \ ^3P^o$	0	1026.81572	1026.917		1.63E-14	100
131	$2s^2 2p^5 6d \ ^3P^o$	1	1026.88419	1027.007		1.41E-14	62.57+34.69(197)
132	$2s^2 2p^5 6d \ ^3F^o$	3	1026.88383	1027.025		1.63E-14	53.44+39.56(199)
133	$2s^2 2p^5 6d \ ^3D^o$	2	1026.94072	1027.061		1.63E-14	54.32+18.4(135)+18.23(196)
134	$2s^2 2p^5 6d \ ^3F^o$	4	1027.68395	1027.845		1.63E-14	100
135	$2s^2 2p^5 6d \ ^1D^o$	2	1027.7356	1027.88		1.63E-14	48.16+41.09(198)
136	$2s^2 2p^5 6d \ ^3D^o$	3	1027.80544	1027.948		1.63E-14	70.9+27.04(199)
137	$2s^2 2p^5 6d \ ^1P^o$	1	1028.0006	1028.136		3.07E-15	63.84+20.79(131)
138	$2s^2 2p^5 7s \ ^3P^o$	2	1055.24314	1055.369		3.48E-14	100
139	$2s^2 2p^5 7s \ ^1P^o$	1	1055.27514	1055.398		2.66E-14	66.59+33.29(201)
140	$2s^2 2p^5 7p \ ^3P^e$	1	1056.06027	1056.176		2.94E-14	49.98+30.8(204)
141	$2s^2 2p^5 7p \ ^3D^e$	2	1056.0654	1056.191		2.93E-14	49.98+33.41(205)+16.56(144)
142	$2s^2 2p^5 7p \ ^3D^e$	3	1058.11679	1058.267		4.06E-14	100
143	$2s^2 2p^5 7p \ ^1P^e$	1	1058.12109	1058.267		3.90E-14	56.4+35.88(204)
144	$2s^2 2p^5 7p \ ^3P^e$	2	1058.17486	1058.316		4.01E-14	66.75+33.18(205)
145	$2s^2 2p^5 7p \ ^1S^e$	0	1058.38657	1058.504		3.77E-14	66.42+33.41(203)
146	$2s^2 2p^5 7d \ ^3P^o$	0	1058.89328	1059.037		2.36E-14	100
147	$2s^2 2p^5 7d \ ^3P^o$	1	1058.93537	1059.091		2.06E-14	62.73+34.69(207)
148	$2s^2 2p^5 7d \ ^3F^o$	3	1058.93476	1059.101		2.35E-14	53.44+39.69(209)
149	$2s^2 2p^5 7d \ ^3D^o$	2	1058.96984	1059.123		2.34E-14	54.32+18.4(151)+18.23(206)
150	$2s^2 2p^5 7d \ ^3F^o$	4	1059.43945	1059.619		2.40E-14	100
151	$2s^2 2p^5 7d \ ^1D^o$	2	1059.47086	1059.64		2.37E-14	48.3+41.09(208)
152	$2s^2 2p^5 7d \ ^3D^o$	3	1059.51416	1059.681		2.36E-14	70.9+27.04(209)
153	$2s^2 2p^5 7d \ ^1P^o$	1	1059.63188	1059.792		5.17E-15	63.84+20.7(147)
154	$2s^2 2p^5 5s \ ^3P^o$	0	1065.02071	1060.053		1.79E-14	100
155	$2s^2 2p^5 5s \ ^3P^o$	1	1065.05207	1060.076		1.54E-14	66.59+33.41(67)
156	$2s^2 2p^5 5p \ ^3D^e$	1	1067.26502	1067.464		1.49E-14	73.96+22.28(70)
157	$2s^2 2p^5 5p \ ^3P^e$	0	1067.83295	1068.009		1.51E-14	66.1+33.76(73)
158	$2s^2 2p^5 5p \ ^3S^e$	1	1073.11563	1073.324		2.23E-14	50.13+29.48(158)
159	$2s^2 2p^5 5p \ ^1D^e$	2	1073.12818	1073.337		2.20E-14	49.98+33.41(159)+16.65(72)
160	$2s^2 2p^5 5d \ ^3F^o$	2	1075.39643	1075.597		1.10E-14	74.65+20.07(81)
161	$2s^2 2p^5 5d \ ^3D^o$	1	1075.71349	1075.899		2.45E-15	49.84+33.64(83)+16.48(77)
162	$2s^2 2p^5 5d \ ^3P^o$	2	1076.87223	1077.075		1.08E-14	47.89+35.64(79)
163	$2s^2 2p^5 5d \ ^1F^o$	3	1076.90822	1077.11		1.09E-14	44.36+33.41(163)+22.28(82)
164	$2s^2 2p^5 5f \ ^3G^e$	3	1078.14744	1078.357		7.27E-15	73.44+19.1(90)
165	$2s^2 2p^5 5f \ ^3D^e$	2	1078.1903	1078.399		7.12E-15	44.49+33.29(89)+22.18(165)
166	$2s^2 2p^5 5f \ ^3D^e$	3	1078.80466	1079.013		7.43E-15	54.32+29.81(87)
167	$2s^2 2p^5 5f \ ^1G^e$	4	1078.80431	1079.014		7.50E-15	41.6+33.29(167)+25(91)
168	$2s^2 2p^5 5g \ ^3H^o$	4	1078.98218	1079.181		1.28E-14	72.42+18.49(98)
169	$2s^2 2p^5 5g \ ^3F^o$	3	1078.99025	1079.19		1.28E-14	41.73+33.29(96)+25(169)
170	$2s^2 2p^5 5g \ ^1H^o$	5	1079.36669	1079.566		1.30E-14	39.94+33.29(170)+26.73(99)
171	$2s^2 2p^5 5g \ ^3F^o$	4	1079.37255	1079.572		1.29E-14	57.61+26.63(95)
172	$2s2p^6 5s \ ^3S^e$	1	1100.9399	1100.731		1.24E-14	100

173	2s2p ⁶ 5s ¹ 5 ^e	0	1101.33244	1101.094	1.24E-14	100
174	2s2p ⁶ 5p ³ p ^o	0	1103.26766	1103.025	1.09E-14	100
175	2s2p ⁶ 5p ³ p ^o	1	1103.28033	1103.038	5.84E-15	67.57+32.49(177)
176	2s2p ⁶ 5p ³ p ^o	2	1109.05738	1108.829	1.44E-14	100
177	2s2p ⁶ 5p ¹ p ^o	1	1109.13028	1108.899	4.91E-15	67.57+32.49(175)
178	2s2p ⁶ 5d ³ d ^e	1	1111.33642	1111.1	8.62E-15	100
179	2s2p ⁶ 5d ³ d ^e	2	1111.40589	1111.165	8.55E-15	67.73+32.15(181)
180	2s2p ⁶ 5d ³ d ^e	3	1112.7597	1112.53	8.55E-15	100
181	2s2p ⁶ 5d ¹ d ^e	2	1112.94781	1112.707	8.46E-15	67.73+32.15(179)
182	2s2p ⁶ 5f ³ f ^o	2	1114.00972	1113.794	6.17E-15	100
183	2s2p ⁶ 5f ³ f ^o	3	1114.00895	1113.797	6.16E-15	61+38.94(185)
184	2s2p ⁶ 5f ³ f ^o	4	1114.63499	1114.421	6.32E-15	100
185	2s2p ⁶ 5f ¹ f ^o	3	1114.68342	1114.47	6.36E-15	61+38.94(183)
186	2s2p ⁶ 5g ³ g ^e	3	1114.82296	1114.591	9.99E-15	100
187	2s2p ⁶ 5g ³ g ^e	4	1114.81033	1114.607	9.93E-15	55.8+44.22(189)
188	2s2p ⁶ 5g ³ g ^e	5	1115.1943	1114.975	1.00E-14	100
189	2s2p ⁶ 5g ¹ g ^e	4	1115.20628	1114.99	1.01E-14	55.8+44.22(187)
190	2s ² 2p ⁵ 6s ³ p ^o	0	1122.93735	1123.204	2.53E-14	100
191	2s ² 2p ⁵ 6s ³ p ^o	1	1122.95313	1123.23	2.22E-14	66.59+33.41(123)
192	2s ² 2p ⁵ 6p ³ d ^e	1	1124.21573	1124.493	2.11E-14	73.96+22.28(126)
193	2s ² 2p ⁵ 6p ³ p ^e	0	1124.51121	1124.761	2.12E-14	66.42+33.52(129)
194	2s ² 2p ⁵ 6p ³ s ^e	1	1127.56301	1127.858	3.05E-14	49.98+29.59(194)
195	2s ² 2p ⁵ 6p ¹ d ^e	2	1127.56736	1127.881	3.02E-14	49.98+33.29(195)+16.65(128)
196	2s ² 2p ⁵ 6d ³ f ^o	2	1128.84881	1129.183	1.64E-14	74.65+19.98(135)
197	2s ² 2p ⁵ 6d ³ d ^o	1	1129.02081	1129.353	4.35E-15	49.84+33.52(137)+16.56(131)
198	2s ² 2p ⁵ 6d ³ p ^o	2	1129.70477	1130.047	1.63E-14	47.89+35.64(133)
199	2s ² 2p ⁵ 6d ¹ f ^o	3	1129.72338	1130.074	1.63E-14	44.36+33.29(199)+22.28(136)
200	2s ² 2p ⁵ 7s ³ p ^o	0	1157.22746	1157.541	3.49E-14	100
201	2s ² 2p ⁵ 7s ³ p ^o	1	1157.23689	1157.561	3.14E-14	66.59+33.41(139)
202	2s ² 2p ⁵ 7p ³ d ^e	1	1158.02382	1158.343	2.93E-14	74.13+22.28(143)
203	2s ² 2p ⁵ 7p ³ p ^e	0	1158.20465	1158.509	2.89E-14	66.59+33.52(145)
204	2s ² 2p ⁵ 7p ³ s ^e	1	1160.11335	1158.609	4.05E-14	49.98+29.59(204)
205	2s ² 2p ⁵ 7p ¹ d ^e	2	1160.1162	1158.803	4.03E-14	49.98+33.29(205)+16.65(144)
206	2s ² 2p ⁵ 7d ³ f ^o	2	1160.91151	1159.928	2.37E-14	74.65+19.98(151)
207	2s ² 2p ⁵ 7d ³ d ^o	1	1161.01728	1159.941	7.01E-15	49.98+33.41(153)+16.65(147)
208	2s ² 2p ⁵ 7d ³ p ^o	2	1161.45028	1160.461	2.39E-14	47.89+35.64(149)
209	2s ² 2p ⁵ 7d ¹ f ^o	3	1161.46181	1160.464	2.39E-14	44.36+33.29(209)+22.28(152)

Table 4: MCDF energies (in Ryd.), lifetimes (in s) and mixing coefficients in Ne-like-Re

S.No.	Label	J	Level (Ryd)	FAC	Lifetimes	Mixing coefficients
1	2s ² 2p ⁶ 1s ⁵ e	0		0		100
2	2s ² 2p ⁵ 3s ¹ 3p ^o	2	626.8857	627.0489	2.03911E-10	100
3	2s ² 2p ⁵ 3s ¹ 1p ^o	1	627.5184	627.6812	6.06722E-15	66.3+33.6(4)
4	2s ² 2p ⁵ 3p ¹ 3p ^e	1	638.2366	638.2437	9.23808E-13	49.4+31.5(17)
5	2s ² 2p ⁵ 3p ¹ 3p ^e	2	638.3612	638.3671	9.55771E-13	50.3+33.3(15)+16.5(8)
6	2s ² 2p ⁵ 3p ¹ 1p ^e	1	667.9257	667.9529	5.53778E-13	56+36(17)
7	2s ² 2p ⁵ 3p ¹ 3d ^e	3	667.8903	667.9841	5.29884E-13	100
8	2s ² 2p ⁵ 3p ¹ 3p ^e	2	668.8759	668.9274	3.33524E-13	66.7+33.3(15)
9	2s ² 2p ⁵ 3p ¹ 1s ^e	0	673.2555	673.2283	3.64834E-13	62.4+37.5(16)
10	2s ² 2p ⁵ 3d ¹ 3p ^o	0	679.8178	679.7983	7.27856E-13	100
11	2s ² 2p ⁵ 3d ¹ 3p ^o	1	680.5647	680.544	1.07775E-14	65.6+32.6(9)
12	2s ² 2p ⁵ 3d ¹ 3f ^o	3	680.615	680.5948	6.94131E-13	53.9+39.2(3)
13	2s ² 2p ⁵ 3d ¹ 3p ^o	2	681.2308	681.2044	6.62026E-13	54.3+18.3(10)+17.6(117)
14	2s ² 2p ⁵ 3d ¹ 3f ^o	4	687.1255	687.133	5.99405E-12	100
15	2s ² 2p ⁵ 3d ¹ 1d ^o	2	687.6663	687.6557	3.22224E-12	48.4+41.2(116)
16	2s ² 2p ⁵ 3d ¹ 3d ^o	3	688.4206	688.4042	5.4829E-12	70.6+27.2(3)
17	2s ² 2p ⁵ 3d ¹ 1p ^o	1	690.6284	690.5645	3.38737E-16	62.9+18.6(12)+18.5(9)
18	2s ² 2p ⁵ 3s ¹ 3p ^o	0	735.2385	735.5043	2.64685E-11	99.8
19	2s ² 2p ⁵ 3s ¹ 3p ^o	1	735.486	735.7518	2.37235E-14	66.3+33.6(11)
20	2s ² 2p ⁵ 3p ¹ 3d ^e	1	746.2757	746.3916	1.37571E-11	73.6+22.7(21)
21	2s ² 2p ⁵ 3p ¹ 3p ^e	0	749.9872	750.0719	2.77195E-12	62.4+37.3(23)
22	2s ¹ 2p ⁶ 3s ¹ 1s ^e	1	771.8	771.5597	4.45168E-14	90.3
23	2s ¹ 2p ⁶ 3s ¹ 1s ^e	0	775.0469	774.5994	4.09517E-14	99.8

24	$2s^1 2p^5 3p^{11} D^e$	2	776.5715	776.7361	3.17953E-13	49.7+33.5(15)+16.8(8)
25	$2s^2 2p^5 3p^{13} S^e$	1	777.094	777.1704	1.56339E-13	45.3+26.8(17)
26	$2s^1 2p^6 3p^{13} P^o$	0	783.8923	783.322	3.8701E-14	99.8
27	$2s^1 2p^6 3p^{13} P^o$	1	783.7456	783.4371	1.27288E-15	66.3+31.9(167)
28	$2s^2 2p^5 3d^{13} F^o$	2	788.9369	789.0352	6.62079E-13	74.3+20.3(117)
29	$2s^2 2p^5 3d^{13} D^o$	1	790.9173	790.944	6.66626E-16	48+34.7(121)
30	$2s^2 2p^5 3d^{13} P^o$	2	795.9605	796.0518	3.07266E-12	47.1+36.1(14)
31	$2s^2 2p^5 3d^{13} F^o$	3	796.2127	796.3066	4.81625E-12	44+33.5(19)+22.5(5)
32	$2s^1 2p^6 3p^{13} P^o$	2	813.6977	813.3061	3.59341E-14	99.6
33	$2s^1 2p^6 3p^{13} P^o$	1	814.1484	813.7534	2.00932E-15	67.7+32.3(160)
34	$2s^1 2p^6 3d^{13} D^e$	1	826.0893	825.5601	4.01052E-14	100
35	$2s^1 2p^6 3d^{13} D^e$	2	826.4821	825.9526	3.11414E-14	70.1+29.9(136)
36	$2s^1 2p^6 3d^{13} D^e$	3	832.8699	832.3665	3.97477E-14	100
37	$2s^1 2p^6 3d^{13} D^e$	2	834.0198	833.5013	2.69074E-14	70.1+29.9(137)
38	$2s^2 2p^5 4s^{13} P^o$	2	879.3475	879.47	1.35729E-14	100
39	$2s^2 2p^5 4s^{13} P^o$	1	879.5595	879.6826	7.55659E-15	66.6+33.4(24)
40	$2s^2 2p^5 4p^{13} P^e$	1	884.0304	884.0945	1.124E-14	49.7+31(28)
41	$2s^2 2p^5 4p^{13} D^e$	2	884.066	884.1305	1.11539E-14	50.1+33.4(123)+16.5(125)
42	$2s^2 2p^5 4p^{13} D^e$	3	896.2112	896.2973	1.79119E-14	100
43	$2s^2 2p^5 4p^{13} P^e$	1	896.2364	896.3213	1.78223E-14	56.3+35.9(28)
44	$2s^2 2p^5 4p^{13} P^e$	2	896.5753	896.6593	1.79821E-14	66.7+33.2(123)
45	$2s^2 2p^5 4p^{13} S^e$	0	898.0605	898.0812	1.85584E-14	65.6+34.3(37)
46	$2s^2 2p^5 4d^{13} P^o$	0	900.7814	900.8371	7.69049E-15	100
47	$2s^2 2p^5 4d^{13} P^o$	1	901.0504	901.1041	6.03592E-15	63.7+34(42)
48	$2s^2 2p^5 4d^{13} F^o$	3	901.0548	901.1071	7.71813E-15	53.6+39.6(41)
49	$2s^2 2p^5 4d^{13} D^o$	2	901.2791	901.3274	7.75333E-15	54.3+18.2(53)+18.1(47)
50	$2s^2 2p^5 4d^{13} F^o$	4	903.8924	903.9546	7.41994E-15	100
51	$2s^2 2p^5 4d^{13} D^o$	2	904.0928	904.1506	7.41808E-15	48.3+41.1(43)
52	$2s^2 2p^5 4d^{13} D^o$	3	904.364	904.4175	7.46398E-15	70.7+27(41)
53	$2s^2 2p^5 4d^{13} P^o$	1	905.137	905.1656	8.34712E-16	63.7+19.9(49)+16.3(42)
54	$2s^2 2p^5 4f^{13} D^e$	1	906.5339	906.603	3.52285E-15	100
55	$2s^2 2p^5 4f^{13} G^e$	4	906.5491	906.6185	3.61295E-15	53+44.1(59)
56	$2s^2 2p^5 4f^{13} F^e$	2	906.7121	906.7813	3.56113E-15	47.9+46(29)
57	$2s^2 2p^5 4f^{13} F^e$	3	906.7905	906.8597	3.60818E-15	50.6+22.8(54)+22.6(56)
58	$2s^2 2p^5 4f^{13} G^e$	5	907.8632	907.9327	3.70932E-15	100
59	$2s^2 2p^5 4f^{13} D^e$	2	907.9953	908.0621	3.60296E-15	60.5+31.8(29)
60	$2s^2 2p^5 4f^{13} F^e$	3	908.0575	908.1262	3.67812E-15	44+40.4(61)
61	$2s^2 2p^5 4f^{13} F^e$	4	908.1287	908.198	3.71949E-15	71.9+22.6(59)
62	$2s^2 2p^5 4s^{13} P^o$	0	987.8259	988.0634	1.05282E-14	100
63	$2s^2 2p^5 4s^{13} P^o$	1	987.893	988.131	1.05289E-14	66.4+33.4(22)
64	$2s^2 2p^5 5s^{13} P^o$	2	991.88	992.0083	1.6748E-14	100
65	$2s^2 2p^5 5s^{13} P^o$	1	991.9826	992.1094	1.06064E-14	66.4+33.4(75)
66	$2s^2 2p^5 4p^{13} D^e$	1	992.3851	992.564	1.10869E-14	74+22.4(30)
67	$2s^2 2p^5 5p^{13} P^e$	1	994.2316	993.6892	1.39622E-14	49.8+31(81)
68	$2s^2 2p^5 5p^{13} P^e$	2	994.2504	994.328	1.39266E-14	50+33.4(79)+16.5(72)
69	$2s^2 2p^5 4p^{13} P^e$	0	993.5349	994.3467	1.14749E-14	65+33.8(33)
70	$2s^2 2p^5 5p^{13} P^e$	1	1000.372	1000.477	2.06199E-14	56.4+35.6(81)
71	$2s^2 2p^5 5p^{13} D^e$	3	1000.368	1000.48	2.101E-14	100
72	$2s^2 2p^5 5p^{13} P^e$	2	1000.547	1000.652	2.10976E-14	66.7+33.2(79)
73	$2s^2 2p^5 5p^{13} S^e$	0	1001.299	1001.36	2.1482E-14	65.1+33.5(80)
74	$2s^2 2p^5 5d^{13} P^o$	0	1002.614	1002.714	1.02762E-14	100
75	$2s^2 2p^5 5d^{13} P^o$	1	1002.742	1002.839	8.48864E-15	63.5+34.1(92)
76	$2s^2 2p^5 5d^{13} F^o$	3	1002.742	1002.84	1.03626E-14	53.4+39.6(93)
77	$2s^2 2p^5 5d^{13} D^o$	2	1002.849	1002.942	1.03915E-14	54.5+18.2(101)+18.1(35)
78	$2s^2 2p^5 5d^{13} F^o$	4	1004.21	1004.313	1.02377E-14	100
79	$2s^2 2p^5 5d^{13} D^o$	2	1004.301	1004.401	1.01978E-14	48.3+41(38)
80	$2s^2 2p^5 5d^{13} D^o$	3	1004.437	1004.532	1.02533E-14	70.7+27(93)
81	$2s^2 2p^5 5d^{13} P^o$	1	1004.753	1004.833	2.0346E-15	63.7+19.7(102)
82	$2s^2 2p^5 5f^{13} D^e$	1	1005.503	1004.963	6.74192E-15	98.6
83	$2s^2 2p^5 5f^{13} G^e$	4	1005.521	1004.996	6.85281E-15	53.1+43.8(109)
84	$2s^2 2p^5 5f^{13} D^e$	2	1005.599	1005.61	6.76387E-15	47.2+45.6(46)

85	$2s^2 2p^5 5f^{13} F^e$	3	1005.637	1005.63	6.81417E-15	50.7+22.7(114)+22.5(106)
86	$2s^2 2p^5 4p^{11} D^e$	2	1004.763	1005.704	1.78863E-14	49.4+28.4(28)
87	$2s^2 2p^5 5f^{13} G^e$	4	1004.788	1005.744	1.75276E-14	46.6+31.2(123)
88	$2s^2 2p^5 5f^{13} G^e$	5	1006.193	1006.302	6.78296E-15	100
89	$2s^2 2p^5 5f^{11} D^e$	2	1006.284	1006.385	6.85681E-15	58.2+30.7(50)
90	$2s^2 2p^5 5f^{11} F^e$	3	1006.284	1006.391	6.99484E-15	44.1+40.3(111)
91	$2s^2 2p^5 5f^{13} F^e$	4	1006.328	1006.435	7.03991E-15	71.9+22.8(109)
92	$2s^2 2p^5 5g^{13} F^o$	3	1006.397	1006.495	1.21066E-14	100
93	$2s^2 2p^5 5g^{13} H^o$	5	1006.4	1006.498	1.20553E-14	52.6+45.7(57)
94	$2s^2 2p^5 5g^{13} G^o$	3	1006.45	1006.548	1.20888E-14	54.3+36.5(130)
95	$2s^2 2p^5 5g^{13} G^o$	4	1006.468	1006.567	1.20659E-14	47.5+25.2(126)+25.1(129)
96	$2s^2 2p^5 5g^{11} F^o$	3	1006.809	1006.906	1.22703E-14	57.6+38.6(130)
97	$2s^2 2p^5 5g^{13} H^o$	6	1006.808	1006.907	1.22067E-14	100
98	$2s^2 2p^5 5g^{11} G^o$	4	1006.86	1006.959	1.22371E-14	41.6+39.4(131)+17.6(127)
99	$2s^2 2p^5 5g^{13} G^o$	5	1006.875	1006.973	1.22194E-14	71.6+21(57)
100	$2s^1 2p^6 4d^{13} F^o$	2	1009.514	1009.684	7.72721E-15	74.5+20.2(47)
101	$2s^2 2p^5 4d^{13} D^o$	1	1010.205	1010.354	1.08509E-15	49.1+33.9(44)+16.2(49)
102	$2s^1 2p^5 4d^{13} P^o$	2	1012.559	1012.734	7.40903E-15	47.6+35.8(51)
103	$2s^1 2p^6 4d^{11} F^o$	3	1012.635	1012.809	7.44265E-15	44.2+33.4(41)+22.3(34)
104	$2s^2 2p^5 4f^{13} G^e$	3	1015.185	1015.37	3.60904E-15	73.4+19.1(56)
105	$2s^2 2p^5 4f^{13} D^e$	2	1015.255	1015.44	3.55303E-15	44.6+33.3(66)+22.1(29)
106	$2s^2 2p^5 4f^{13} D^e$	3	1016.545	1016.723	3.68986E-15	54.3+29.8(64)
107	$2s^2 2p^5 4f^{11} G^e$	4	1016.538	1016.73	3.71828E-15	41.6+33.3(59)+25.1(62)
108	$2s^1 2p^6 4s^{13} S^e$	1	1024.648	1024.385	9.98655E-15	99.8
109	$2s^1 2p^6 4s^{11} S^e$	0	1025.487	1025.184	1.00719E-14	100
110	$2s^1 2p^6 4p^{13} P^o$	0	1029.366	1029.042	8.71687E-15	100
111	$2s^1 2p^6 4p^{13} P^o$	1	1029.393	1029.069	3.7232E-15	67.4+32.5(183)
112	$2s^1 2p^6 4p^{13} P^o$	2	1041.608	1041.312	1.22735E-14	99.8
113	$2s^1 2p^6 4p^{11} P^o$	1	1041.771	1041.471	2.99884E-15	67.6+32.5(171)
114	$2s^1 2p^6 4d^{13} D^e$	1	1046.346	1046.004	6.43442E-15	100
115	$2s^1 2p^6 4d^{13} D^e$	2	1046.481	1046.141	6.38217E-15	67.9+32(172)
116	$2s^1 2p^6 4d^{13} D^e$	3	1049.274	1048.949	6.21943E-15	99.8
117	$2s^1 2p^6 4d^{11} D^e$	2	1049.681	1049.344	6.1474E-15	67.9+32(177)
118	$2s^2 2p^5 6s^{13} P^o$	2	1051.706	1051.54	2.38246E-14	100
119	$2s^2 2p^5 6s^{11} P^o$	1	1051.755	1051.549	1.70684E-14	66.6+33.4(73)
120	$2s^2 2p^5 6p^{13} P^e$	1	1053.042	1051.777	1.99187E-14	49.8+30.7(108)
121	$2s^2 2p^5 6p^{13} D^e$	2	1053.053	1051.822	1.98729E-14	50+33.4(83)+16.6(100)
122	$2s^1 2p^6 4f^{13} F^o$	2	1051.866	1052.848	3.28496E-15	100
123	$2s^1 2p^6 4f^{13} F^o$	3	1051.845	1052.922	3.28959E-15	59.9+40.1(184)
124	$2s^1 2p^6 4f^{11} F^o$	4	1053.153	1053.096	3.37137E-15	100
125	$2s^1 2p^6 4f^{11} F^o$	3	1053.241	1053.123	3.38436E-15	59.9+40.1(182)
126	$2s^2 2p^5 6p^{11} P^e$	1	1056.56	1056.665	2.83002E-14	56.3+36(108)
127	$2s^2 2p^5 6p^{13} D^e$	3	1056.554	1056.666	2.89775E-14	99.8
128	$2s^2 2p^5 6p^{13} P^e$	2	1056.647	1056.745	2.87797E-14	66.7+33.2(100)
129	$2s^2 2p^5 6p^{11} S^e$	0	1057.014	1057.075	2.79655E-14	66.4+33.5(107)
130	$2s^2 2p^5 6d^{13} P^o$	0	1057.823	1057.919	1.53827E-14	100
131	$2s^2 2p^5 6d^{13} P^o$	1	1057.892	1058.011	1.32699E-14	62.3+34.9(146)
132	$2s^2 2p^5 6d^{13} F^o$	3	1057.891	1058.029	1.53689E-14	53.4+39.6(143)
133	$2s^2 2p^5 6d^{13} D^o$	2	1057.95	1058.066	1.53425E-14	54.3+18.5(147)+18.2(142)
134	$2s^2 2p^5 6d^{13} F^o$	4	1058.743	1058.903	1.53841E-14	100
135	$2s^2 2p^5 6d^{11} D^o$	2	1058.796	1058.938	1.53102E-14	48.2+41.1(149)
136	$2s^2 2p^5 6d^{13} D^o$	3	1058.867	1059.007	1.5321E-14	70.9+27(143)
137	$2s^2 2p^5 6d^{11} P^o$	1	1059.065	1059.198	2.9064E-15	63.7+21.1(148)
138	$2s^2 2p^5 7s^{13} P^o$	2	1087.093	1087.216	3.25733E-14	100
139	$2s^2 2p^5 7s^{11} P^o$	1	1087.126	1087.245	2.49368E-14	66.6+33.3(152)
140	$2s^2 2p^5 7p^{13} P^e$	1	1087.928	1088.04	2.75105E-14	50+30.8(168)
141	$2s^2 2p^5 7p^{13} D^e$	2	1087.933	1088.054	2.74228E-14	50+33.4(159)+16.6(161)
142	$2s^2 2p^5 7p^{13} D^e$	3	1090.119	1090.267	3.84874E-14	100
143	$2s^2 2p^5 7p^{11} P^e$	1	1090.124	1090.267	3.69642E-14	56.4+35.9(168)
144	$2s^2 2p^5 7p^{13} P^e$	2	1090.178	1090.316	3.79865E-14	66.7+33.2(159)

145	$2s^2 2p^5 7p^{11} s^e$	0	1090.396	1090.51	3.57154E-14	66.4+33.4(176)
146	$2s^2 2p^5 7d^{13} p^o$	0	1090.909	1091.049	2.2243E-14	100
147	$2s^2 2p^5 7d^{13} p^o$	1	1090.951	1091.105	1.93798E-14	62.4+34.9(202)
148	$2s^2 2p^5 7d^{13} f^o$	3	1090.95	1091.115	2.21394E-14	53.4+39.7(185)
149	$2s^2 2p^5 7d^{13} d^o$	2	1090.986	1091.137	2.20198E-14	54.3+18.5(191)+18.2(192)
150	$2s^2 2p^5 7d^{13} f^o$	4	1091.488	1091.666	2.25708E-14	100
151	$2s^2 2p^5 7d^{13} d^o$	2	1091.52	1091.687	2.23373E-14	48.2+41.1(194)
152	$2s^2 2p^5 7d^{13} d^o$	3	1091.564	1091.729	2.22492E-14	70.9+27(185)
153	$2s^2 2p^5 7d^{13} p^o$	1	1091.684	1091.842	4.86779E-15	63.8+21(206)
154	$2s^2 2p^5 5s^{13} p^o$	0	1100.412	1092.106	1.67625E-14	100
155	$2s^2 2p^5 5s^{13} p^o$	1	1100.443	1092.13	1.43825E-14	66.6+33.4(71)
156	$2s^2 2p^5 5p^{13} d^e$	1	1102.702	1102.913	1.38953E-14	74+22.3(85)
157	$2s^2 2p^5 5p^{13} p^e$	0	1103.281	1103.469	1.4156E-14	66.1+33.8(87)
158	$2s^2 2p^5 5p^{13} s^e$	1	1108.935	1109.156	2.11005E-14	50.1+29.5(81)
159	$2s^2 2p^5 5p^{13} p^e$	2	1108.947	1109.169	2.08835E-14	50+33.4(79)+16.6(72)
160	$2s^2 2p^5 5d^{13} f^o$	2	1111.254	1111.465	1.03893E-14	74.6+20.1(35)
161	$2s^2 2p^5 5d^{13} d^o$	1	1111.574	1111.771	2.30698E-15	49.8+33.6(99)+16.5(102)
162	$2s^2 2p^5 5d^{13} p^o$	2	1112.822	1113.036	1.021E-14	47.9+35.6(97)
163	$2s^2 2p^5 5d^{13} f^o$	3	1112.858	1113.071	1.02483E-14	44.4+33.4(93)+22.3(103)
164	$2s^2 2p^5 5f^{13} g^e$	3	1114.116	1114.337	6.83421E-15	73.4+19.1(106)
165	$2s^2 2p^5 5f^{13} f^e$	2	1114.16	1114.38	6.69337E-15	44.5+33.3(48)+22.2(50)
166	$2s^2 2p^5 5f^{13} d^e$	3	1114.815	1115.035	6.99436E-15	54.3+29.8(104)
167	$2s^2 2p^5 5f^{13} g^e$	4	1114.814	1115.036	7.05689E-15	41.6+33.3(109)+25(112)
168	$2s^2 2p^5 5g^{13} h^o$	4	1114.995	1115.205	1.20581E-14	72.4+18.5(129)
169	$2s^2 2p^5 5g^{13} f^o$	3	1115.003	1115.214	1.20224E-14	41.7+33.3(135)+25(130)
170	$2s^2 2p^5 5g^{13} h^o$	5	1115.404	1115.614	1.22139E-14	39.9+33.3(57)+26.7(60)
171	$2s^2 2p^5 5g^{13} f^o$	4	1115.41	1115.621	1.21712E-14	57.6+26.6(127)
172	$2s^1 2p^6 5s^{13} s^e$	1	1137.113	1136.873	1.14169E-14	100
173	$2s^1 2p^6 5s^{13} s^e$	0	1137.514	1137.245	1.1377E-14	100
174	$2s^1 2p^6 5p^{13} p^o$	0	1139.491	1139.215	1.00681E-14	100
175	$2s^1 2p^6 5p^{13} p^o$	1	1139.503	1139.226	5.43028E-15	67.4+32.5(190)
176	$2s^1 2p^6 5p^{13} p^o$	2	1145.66	1145.399	1.3317E-14	100
177	$2s^1 2p^6 5p^{13} p^o$	1	1145.734	1145.469	4.61479E-15	67.4+32.5(195)
178	$2s^1 2p^6 5d^{13} d^e$	1	1147.977	1147.707	8.02283E-15	100
179	$2s^1 2p^6 5d^{13} d^e$	2	1148.047	1147.773	7.95701E-15	67.4+32.5(199)
180	$2s^1 2p^6 5d^{13} d^e$	3	1149.49	1149.227	7.95418E-15	100
181	$2s^1 2p^6 5d^{13} d^e$	2	1149.682	1149.407	7.86477E-15	67.4+32.5(207)
182	$2s^1 2p^6 5f^{13} f^o$	2	1150.76	1150.51	5.75814E-15	100
183	$2s^1 2p^6 5f^{13} f^o$	3	1150.759	1150.514	5.74263E-15	60.8+39.1(205)
184	$2s^1 2p^6 5f^{13} f^o$	4	1151.426	1151.178	5.89964E-15	100
185	$2s^1 2p^6 5f^{13} f^o$	3	1151.475	1151.228	5.93046E-15	60.8+39.1(205)
186	$2s^1 2p^6 5g^{13} g^e$	3	1151.617	1151.351	9.25868E-15	100
187	$2s^1 2p^6 5g^{13} g^e$	4	1151.604	1151.367	9.20854E-15	55.8+44.2(74)
188	$2s^1 2p^6 5g^{13} g^e$	5	1152.012	1151.759	9.29581E-15	100
189	$2s^1 2p^6 5g^{13} g^e$	4	1152.024	1151.775	9.35053E-15	55.8+44.2(67)
190	$2s^2 2p^5 6s^{13} p^o$	0	1160.21	1160.482	2.36377E-14	100
191	$2s^2 2p^5 6s^{13} p^o$	1	1160.226	1160.509	2.07965E-14	66.6+33.4(84)
192	$2s^2 2p^5 6p^{13} d^e$	1	1161.514	1161.798	1.97575E-14	74+22.3(113)
193	$2s^2 2p^5 6p^{13} p^e$	0	1161.817	1162.072	1.97973E-14	66.4+33.5(110)
194	$2s^2 2p^5 6p^{13} s^e$	1	1165.08	1165.383	2.88513E-14	50+29.6(108)
195	$2s^2 2p^5 6p^{13} d^e$	2	1165.084	1165.406	2.86028E-14	50+33.3(100)+16.6(96)
196	$2s^2 2p^5 6d^{13} f^o$	2	1166.387	1166.731	1.5421E-14	74.6+20(147)
197	$2s^2 2p^5 6d^{13} p^o$	1	1166.561	1166.903	4.09683E-15	49.8+33.5(153)+16.6(148)
198	$2s^2 2p^5 6d^{13} p^o$	2	1167.296	1167.649	1.5344E-14	47.9+35.6(144)
199	$2s^2 2p^5 6d^{13} f^o$	3	1167.315	1167.675	1.53799E-14	44.4+33.3(143)+22.3(145)
200	$2s^2 2p^5 7s^{13} p^o$	0	1195.609	1195.929	3.27248E-14	100
201	$2s^2 2p^5 7s^{13} p^o$	1	1195.618	1195.95	2.94384E-14	66.6+33.3(157)
202	$2s^2 2p^5 7p^{13} d^e$	1	1196.421	1196.608	2.74488E-14	74.1+22.3(165)
203	$2s^2 2p^5 7p^{13} p^e$	0	1196.606	1196.768	2.70753E-14	66.6+33.5(180)
204	$2s^2 2p^5 7p^{13} s^e$	1	1198.647	1196.807	3.84103E-14	50+29.6(168)
205	$2s^2 2p^5 7p^{13} d^e$	2	1198.65	1196.934	3.82344E-14	50+33.3(159)+16.6(161)
206	$2s^2 2p^5 7d^{13} f^o$	2	1199.458	1197.972	2.23397E-14	74.6+20(191)

207	$2s^2 2p^5 7d^{13} D^o$	1	1199.565	1197.985	6.58752E-15	50+33.4(204)+16.6(206)
208	$2s^2 2p^5 7d^{13} P^o$	2	1200.031	1199.002	2.24744E-14	48+35.6(196)
209	$2s^2 2p^5 7d^{13} F^o$	3	1200.042	1199.008	2.25037E-14	44.4+33.3(185)+22.3(187)

Table 5: Transition wavelength (in Å), transition probability in s^{-1} , oscillator strength (dimensionless), line strength (length form) for E1 transition using MCDF for Ne-like Hf

i	j	λ (in Å)	$A_{ji}(s^{-1})$	f_{ij}	$S_{ij}(au)$	Vel./len.
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3s \ ^1P_1$	1.58E+00	1.35E+14	1.52E-01	7.89E-04	9.90E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3d \ ^3P_1$	1.46E+00	6.37E+13	6.14E-02	2.96E-04	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3d \ ^1P_1$	1.44E+00	2.48E+15	2.32E+00	1.10E-02	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3s \ ^3P_1$	1.37E+00	3.32E+13	2.80E-02	1.26E-04	9.70E-01
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 3p \ ^3P_1$	1.28E+00	9.93E+14	7.34E-01	3.10E-03	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3d \ ^3D_1$	1.28E+00	8.85E+14	6.47E-01	2.72E-03	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 3p \ ^1P_1$	1.24E+00	4.00E+14	2.75E-01	1.12E-03	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 4s \ ^1P_1$	1.13E+00	4.77E+13	2.75E-02	1.02E-04	9.40E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 4d \ ^3P_1$	1.11E+00	2.60E+13	1.43E-02	5.22E-05	9.90E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 4d \ ^1P_1$	1.10E+00	8.98E+14	4.90E-01	1.78E-03	9.90E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 4s \ ^3P_1$	1.02E+00	1.73E+13	8.07E-03	2.71E-05	9.10E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 5s \ ^1P_1$	1.01E+00	3.02E+13	1.37E-02	4.54E-05	9.00E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 4d \ ^3D_1$	9.97E-01	4.51E+14	2.02E-01	6.61E-04	9.90E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 5d \ ^3P_1$	9.95E-01	9.74E+12	4.33E-03	1.42E-05	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 5d \ ^1P_1$	9.93E-01	5.46E+14	2.42E-01	7.91E-04	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 4p \ ^3P_1$	9.76E-01	1.26E+14	5.39E-02	1.73E-04	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 4p \ ^1P_1$	9.66E-01	2.12E+14	8.90E-02	2.83E-04	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 6s \ ^1P_1$	9.48E-01	1.32E+13	5.35E-03	1.67E-05	8.20E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 6d \ ^3P_1$	9.43E-01	7.74E+12	3.10E-03	9.61E-06	9.70E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 6d \ ^1P_1$	9.42E-01	2.35E+14	9.37E-02	2.91E-04	9.60E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 7s \ ^1P_1$	9.18E-01	7.09E+12	2.68E-03	8.11E-06	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 7d \ ^3P_1$	9.15E-01	9.34E+10	3.51E-05	1.06E-07	2.10E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 7d \ ^1P_1$	9.14E-01	1.24E+14	4.67E-02	1.41E-04	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 5s \ ^3P_1$	9.14E-01	1.87E+13	7.02E-03	2.11E-05	9.10E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 5d \ ^3D_1$	9.06E-01	2.84E+14	1.05E-01	3.12E-04	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 5p \ ^3P_1$	8.82E-01	6.94E+13	2.43E-02	7.05E-05	9.80E-01
$2s^2 2p^6 \ ^1S_0$	$2s 2p^6 5p \ ^1P_1$	8.78E-01	1.19E+14	4.12E-02	1.19E-04	9.60E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 6s \ ^3P_1$	8.67E-01	4.54E+12	1.54E-03	4.39E-06	7.40E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 6d \ ^3D_1$	8.63E-01	1.48E+14	4.96E-02	1.41E-04	9.60E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 7s \ ^3P_1$	8.42E-01	2.46E+12	7.85E-04	2.17E-06	9.30E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 7d \ ^3D_1$	8.39E-01	8.71E+13	2.76E-02	7.61E-05	1.00E+00

Table 6: Transition wavelength (in Å), transition probability in s^{-1} , oscillator strength (dimensionless), line strength (length form) for E1 transition using MCDF for Ne-like Ta

i	j	λ (in Å)	$A_{ji}(s^{-1})$	f_{ij}	$S_{ij}(au)$	Vel./len
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3s \ ^1P_1$	1.54E+00	1.44E+14	1.53E-01	7.74E-04	9.90E-01
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3d \ ^3P_1$	1.42E+00	7.22E+13	6.55E-02	3.06E-04	1.00E+00
$2s^2 2p^6 \ ^1S_0$	$2s^2 2p^5 3d \ ^1P_1$	1.40E+00	2.63E+15	2.32E+00	1.07E-02	1.00E+00

$2s^2 2p^6 1s_0$	$2s^2 2p^5 3s^3 P_1$	1.32E+00	3.61E+13	2.84E-02	1.24E-04	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3p^3 P_1$	1.24E+00	8.71E+14	6.03E-01	2.46E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3d^3 D_1$	1.23E+00	1.13E+15	7.70E-01	3.13E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3p^1 P_1$	1.20E+00	4.22E+14	2.72E-01	1.07E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4s^1 P_1$	1.10E+00	5.10E+13	2.77E-02	1.00E-04	9.40E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^3 P_1$	1.07E+00	2.91E+13	1.51E-02	5.33E-05	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^1 P_1$	1.07E+00	9.51E+14	4.89E-01	1.72E-03	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4s^3 P_1$	9.85E-01	1.84E+13	8.05E-03	2.61E-05	9.10E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5s^1 P_1$	9.75E-01	3.08E+13	1.32E-02	4.23E-05	9.00E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^3 P_1$	9.65E-01	4.15E+13	1.74E-02	5.51E-05	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^1 P_1$	9.64E-01	2.22E+14	9.27E-02	2.94E-04	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^3 D_1$	9.63E-01	8.08E+14	3.37E-01	1.07E-03	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4p^1 P_1$	9.45E-01	1.34E+14	5.40E-02	1.68E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4p^3 P_1$	9.34E-01	2.25E+14	8.82E-02	2.71E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6s^1 P_1$	9.20E-01	1.40E+13	5.33E-03	1.61E-05	8.30E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^3 P_1$	9.15E-01	8.54E+12	3.21E-03	9.67E-06	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^1 P_1$	9.14E-01	2.49E+14	9.33E-02	2.81E-04	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7s^1 P_1$	8.90E-01	7.57E+12	2.70E-03	7.90E-06	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^3 P_1$	8.87E-01	5.44E+12	1.93E-03	5.62E-06	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^1 P_1$	8.86E-01	1.41E+14	4.98E-02	1.45E-04	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5s^3 P_1$	8.84E-01	7.43E+12	2.61E-03	7.61E-06	8.20E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^3 D_1$	8.76E-01	3.00E+14	1.04E-01	2.99E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5p^3 P_1$	8.53E-01	7.41E+13	2.43E-02	6.82E-05	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5p^1 P_1$	8.49E-01	1.26E+14	4.07E-02	1.14E-04	9.60E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6s^3 P_1$	8.39E-01	4.83E+12	1.53E-03	4.22E-06	7.50E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^3 D_1$	8.34E-01	1.58E+14	4.94E-02	1.36E-04	9.60E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7s^3 P_1$	8.14E-01	2.62E+12	7.81E-04	2.09E-06	9.30E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^3 D_1$	8.11E-01	9.29E+13	2.75E-02	7.34E-05	1.00E+00

Table 7: Transition wavelength (in Å), transition probability in s^{-1} , oscillator strength (dimension less), line strength (length form) for E1 transition using MCDF for Ne-like W

i	j	λ (in Å)	$A_{ji}(s^{-1})$	f_{ij}	$S_{ij}(au)$	Vel./len.
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3s^1 P_1$	1.49E+00	1.54E+14	1.55E-01	7.60E-04	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3d^3 P_1$	1.38E+00	8.14E+13	6.96E-02	3.16E-04	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3d^1 P_1$	1.36E+00	2.79E+15	2.31E+00	1.04E-02	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3s^3 P_1$	1.28E+00	3.90E+13	2.88E-02	1.21E-04	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3p^3 P_1$	1.20E+00	7.99E+14	5.18E-01	2.05E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3d^3 D_1$	1.19E+00	1.33E+15	8.46E-01	3.32E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 3p^1 P_1$	1.16E+00	4.46E+14	2.68E-01	1.02E-03	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4s^1 P_1$	1.07E+00	5.44E+13	2.79E-02	9.78E-05	9.50E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^3 P_1$	1.04E+00	3.24E+13	1.58E-02	5.43E-05	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^1 P_1$	1.04E+00	1.01E+15	4.87E-01	1.66E-03	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4s^3 P_1$	9.53E-01	1.96E+13	8.01E-03	2.51E-05	9.10E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5s^1 P_1$	9.46E-01	3.21E+13	1.29E-02	4.03E-05	9.10E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^3 P_1$	9.36E-01	2.08E+13	8.21E-03	2.53E-05	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^1 P_1$	9.34E-01	2.29E+14	8.99E-02	2.77E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^3 D_1$	9.32E-01	8.88E+14	3.47E-01	1.07E-03	9.90E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4p^3 P_1$	9.14E-01	1.44E+14	5.40E-02	1.63E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4p^1 P_1$	9.04E-01	2.38E+14	8.74E-02	2.60E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6s^1 P_1$	8.93E-01	1.48E+13	5.30E-03	1.56E-05	8.40E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^3 P_1$	8.87E-01	9.38E+12	3.32E-03	9.71E-06	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^1 P_1$	8.86E-01	2.63E+14	9.29E-02	2.71E-04	9.70E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7s^1 P_1$	8.64E-01	8.04E+12	2.70E-03	7.67E-06	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^3 P_1$	8.61E-01	5.89E+12	1.96E-03	5.56E-06	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^1 P_1$	8.60E-01	1.50E+14	4.97E-02	1.41E-04	1.00E+00
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5s^3 P_1$	8.56E-01	8.84E+12	2.91E-03	8.20E-06	8.30E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^3 D_1$	8.47E-01	3.18E+14	1.03E-01	2.86E-04	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5p^3 P_1$	8.26E-01	7.89E+13	2.42E-02	6.59E-05	9.80E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5p^1 P_1$	8.22E-01	1.33E+14	4.03E-02	1.09E-04	9.60E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6s^3 P_1$	8.11E-01	5.13E+12	1.52E-03	4.06E-06	7.60E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 6d^3 D_1$	8.07E-01	1.68E+14	4.92E-02	1.31E-04	9.60E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7s^3 P_1$	7.87E-01	2.79E+12	7.78E-04	2.02E-06	9.30E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 7d^3 D_1$	7.85E-01	9.90E+13	2.74E-02	7.08E-05	1.00E+00

Table 8: Transition wavelength (in Å), transition probability in s^{-1} , oscillator strength (dimensionless), line strength (length form) for E1 transition using MCDF for Ne-like Re

i	j	λ (in Å)	$A_{ji}(s^{-1})$	f_{ij}	$S_{ij}(au)$	Vel./len.
$2s^2 2p^6 1S_0$	$2s^2 2p^5 3s^1 1P_1$	1.45E+00	1.65E+14	1.56E-01	7.47E-04	9.90E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 3d^1 3P_1$	1.34E+00	9.14E+13	7.37E-02	3.25E-04	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 3d^1 1P_1$	1.32E+00	2.95E+15	2.31E+00	1.00E-02	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 3s^1 3P_1$	1.24E+00	4.21E+13	2.91E-02	1.19E-04	9.70E-01
$2s^2 2p^6 1S_0$	$2s^1 2p^6 3p^1 3P_1$	1.16E+00	7.61E+14	4.62E-01	1.77E-03	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 3d^1 3D_1$	1.15E+00	1.50E+15	8.94E-01	3.39E-03	1.00E+00
$2s^2 2p^6 1S_0$	$2s^1 2p^6 3p^1 1P_1$	1.12E+00	4.70E+14	2.65E-01	9.76E-04	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 4s^1 1P_1$	1.04E+00	5.81E+13	2.80E-02	9.56E-05	9.50E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 4d^1 3P_1$	1.01E+00	3.60E+13	1.65E-02	5.51E-05	9.90E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 4d^1 1P_1$	1.01E+00	1.07E+15	4.86E-01	1.61E-03	9.90E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 4s^1 3P_1$	9.22E-01	2.06E+13	7.87E-03	2.39E-05	9.10E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 5s^1 1P_1$	9.19E-01	3.41E+13	1.29E-02	3.91E-05	9.10E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 5d^1 3P_1$	9.09E-01	2.09E+13	7.77E-03	2.32E-05	9.90E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 5d^1 1P_1$	9.07E-01	3.94E+14	1.46E-01	4.35E-04	9.80E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 4d^1 3D_1$	9.02E-01	7.93E+14	2.90E-01	8.62E-04	9.90E-01
$2s^2 2p^6 1S_0$	$2s^1 2p^6 4p^1 3P_1$	8.85E-01	1.53E+14	5.40E-02	1.57E-04	9.80E-01
$2s^2 2p^6 1S_0$	$2s^1 2p^6 4p^1 1P_1$	8.75E-01	2.52E+14	8.66E-02	2.49E-04	9.80E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 6s^1 1P_1$	8.66E-01	1.56E+13	5.26E-03	1.50E-05	8.40E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 6d^1 3P_1$	8.61E-01	1.03E+13	3.42E-03	9.71E-06	9.70E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 6d^1 1P_1$	8.60E-01	2.78E+14	9.26E-02	2.62E-04	9.70E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 7s^1 1P_1$	8.38E-01	8.54E+12	2.70E-03	7.45E-06	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 7d^1 3P_1$	8.35E-01	6.42E+12	2.01E-03	5.54E-06	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 7d^1 1P_1$	8.35E-01	1.59E+14	4.98E-02	1.37E-04	1.00E+00
$2s^2 2p^6 1S_0$	$2s^2 2p^5 5s^1 3P_1$	8.28E-01	9.68E+12	2.98E-03	8.14E-06	8.30E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 5d^1 3D_1$	8.20E-01	3.37E+14	1.02E-01	2.75E-04	9.80E-01
$2s^2 2p^6 1S_0$	$2s^1 2p^6 5p^1 3P_1$	8.00E-01	8.41E+13	2.42E-02	6.37E-05	9.80E-01
$2s^2 2p^6 1S_0$	$2s^1 2p^6 5p^1 1P_1$	7.95E-01	1.40E+14	3.98E-02	1.04E-04	9.60E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 6s^1 3P_1$	7.85E-01	5.44E+12	1.51E-03	3.90E-06	7.60E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 6d^1 3D_1$	7.81E-01	1.78E+14	4.89E-02	1.26E-04	9.70E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 7s^1 3P_1$	7.62E-01	2.97E+12	7.75E-04	1.94E-06	9.30E-01
$2s^2 2p^6 1S_0$	$2s^2 2p^5 7d^1 3D_1$	7.60E-01	1.05E+14	2.74E-02	6.84E-05	1.00E+00

Table 9: Transition wavelength (in Å), transition probability in s^{-1} , oscillator strength (dimensionless), line strength (length form) for E2, M1 and M2 transition using MCDF for Ne-like W

i	j	λ (in Å)	$A_{ji}(s^{-1})$	f_{ij}	$S_{ij}(au)$	Type
1	2	1.49E+00	4.32E+09	7.24E-06	1.08E-02	M2
1	4	1.47E+00	3.07E+10	2.97E-05	1.08E-02	M1
1	5	1.47E+00	9.28E+11	1.50E-03	2.82E-05	E2
1	6	1.41E+00	1.07E+10	9.46E-06	3.29E-03	M1
1	8	1.40E+00	9.18E+11	1.35E-03	2.23E-05	E2
1	13	1.38E+00	2.28E+08	3.24E-07	3.79E-04	M2
1	15	1.36E+00	1.21E+11	1.69E-04	1.92E-01	M2
1	20	1.26E+00	1.30E+09	9.30E-07	2.90E-04	M1
1	22	1.22E+00	2.25E+08	1.51E-07	4.55E-05	M1
1	24	1.21E+00	1.11E+12	1.23E-03	1.31E-05	E2
1	25	1.21E+00	2.80E+10	1.85E-05	5.55E-03	M1
1	28	1.19E+00	2.96E+09	3.17E-06	2.42E-03	M2
1	30	1.18E+00	3.42E+10	3.60E-05	2.67E-02	M2
1	32	1.16E+00	2.14E+10	2.15E-05	1.49E-02	M2
1	34	1.14E+00	5.64E+08	3.30E-07	9.30E-05	M1
1	35	1.14E+00	4.96E+12	4.83E-03	4.25E-05	E2
1	37	1.13E+00	1.20E+13	1.15E-02	9.86E-05	E2
1	38	1.07E+00	2.98E+09	2.55E-06	1.38E-03	M2
1	40	1.06E+00	1.73E+10	8.74E-06	2.29E-03	M1
1	41	1.06E+00	3.19E+11	2.70E-04	1.92E-06	E2
1	43	1.05E+00	8.16E+09	4.03E-06	1.04E-03	M1
1	44	1.05E+00	3.73E+11	3.06E-04	2.09E-06	E2
1	49	1.04E+00	7.19E+07	5.85E-08	2.95E-05	M2
1	51	1.04E+00	6.92E+10	5.59E-05	2.80E-02	M2
1	54	1.04E+00	1.38E+08	6.67E-08	1.71E-05	M1
1	56	1.04E+00	7.93E+11	6.37E-04	4.21E-06	E2
1	59	1.03E+00	7.60E+12	6.09E-03	4.01E-05	E2
1	64	9.49E-01	9.64E+08	3.90E-07	9.16E-05	M1
1	66	9.46E-01	2.10E+09	1.41E-06	5.35E-04	M2
1	68	9.44E-01	9.17E+09	3.67E-06	8.58E-04	M1
1	69	9.44E-01	1.87E+11	1.25E-04	6.27E-07	E2
1	70	9.38E-01	2.62E+09	1.04E-06	2.40E-04	M1

1	72	9.38E-01	2.46E+11	1.62E-04	7.98E-07	E2
1	74	9.37E-01	1.39E+10	5.49E-06	1.27E-03	M1
1	75	9.37E-01	5.39E+11	3.55E-04	1.74E-06	E2
1	79	9.36E-01	9.21E+07	6.05E-08	2.22E-05	M2
1	81	9.35E-01	4.13E+10	2.71E-05	9.89E-03	M2
1	84	9.34E-01	1.24E+08	4.87E-08	1.12E-05	M1
1	86	9.34E-01	5.65E+11	3.69E-04	1.79E-06	E2
1	89	9.33E-01	5.28E+12	3.45E-03	1.67E-05	E2
1	92	9.33E-01	3.75E+07	2.44E-08	8.87E-06	M2
1	100	9.33E-01	2.42E+09	1.58E-06	5.74E-04	M2
1	102	9.30E-01	1.74E+10	1.13E-05	4.05E-03	M2
1	105	9.28E-01	4.32E+12	2.78E-03	1.32E-05	E2
1	108	9.19E-01	4.17E+09	1.58E-06	3.59E-04	M1
1	112	9.04E-01	1.88E+10	1.15E-05	3.80E-03	M2
1	114	9.00E-01	3.16E+08	1.15E-07	2.56E-05	M1
1	115	9.00E-01	1.16E+12	7.03E-04	3.05E-06	E2
1	117	8.97E-01	2.71E+12	1.63E-03	7.02E-06	E2
1	118	8.95E-01	1.15E+06	6.91E-10	2.22E-07	M2
1	122	8.93E-01	1.09E+09	6.48E-07	2.06E-04	M2
1	124	8.91E-01	5.31E+09	1.90E-06	4.18E-04	M1
1	125	8.91E-01	1.29E+11	7.69E-05	3.24E-07	E2
1	126	8.89E-01	2.41E+09	8.56E-07	1.88E-04	M1
1	128	8.88E-01	1.70E+11	1.01E-04	4.20E-07	E2
1	133	8.87E-01	1.60E+07	9.43E-09	2.95E-06	M2
1	135	8.87E-01	2.37E+10	1.39E-05	4.35E-03	M2
1	138	8.64E-01	6.98E+08	3.90E-07	1.12E-04	M2
1	140	8.63E-01	3.30E+09	1.10E-06	2.36E-04	M1
1	141	8.63E-01	4.92E+10	2.75E-05	1.05E-07	E2
1	143	8.61E-01	1.20E+09	3.99E-07	8.50E-05	M1
1	144	8.61E-01	8.01E+10	4.45E-05	1.69E-07	E2
1	149	8.61E-01	1.09E+07	6.07E-09	1.73E-06	M2
1	151	8.60E-01	1.45E+10	8.07E-06	2.30E-03	M2
1	156	8.54E-01	6.83E+08	2.24E-07	4.73E-05	M1
1	158	8.49E-01	6.31E+09	2.05E-06	4.30E-04	M1
1	159	8.49E-01	3.07E+11	1.66E-04	6.05E-07	E2
1	160	8.47E-01	1.05E+09	5.65E-07	1.54E-04	M2
1	162	8.46E-01	1.11E+10	5.93E-06	1.61E-03	M2
1	165	8.45E-01	3.03E+12	1.62E-03	5.84E-06	E2
1	172	8.28E-01	2.08E+09	6.40E-07	1.31E-04	M1
1	176	8.22E-01	1.25E+10	6.32E-06	1.57E-03	M2
1	178	8.20E-01	1.66E+08	5.03E-08	1.02E-05	M1
1	179	8.20E-01	4.97E+11	2.51E-04	8.22E-07	E2
1	181	8.19E-01	1.26E+12	6.32E-04	2.07E-06	E2
1	182	8.18E-01	2.40E+06	1.20E-09	2.95E-07	M2
1	192	8.11E-01	4.44E+08	1.31E-07	2.63E-05	M1
1	194	8.08E-01	3.91E+09	1.15E-06	2.30E-04	M1
1	195	8.08E-01	2.44E+11	1.19E-04	3.76E-07	E2
1	196	8.07E-01	6.61E+08	3.23E-07	7.60E-05	M2
1	198	8.07E-01	6.55E+09	3.20E-06	7.51E-04	M2
1	202	7.87E-01	2.14E+08	5.95E-08	1.16E-05	M1
1	204	7.86E-01	2.54E+09	7.04E-07	1.37E-04	M1
1	205	7.86E-01	1.09E+11	5.06E-05	1.46E-07	E2
1	206	7.85E-01	4.14E+08	1.91E-07	4.13E-05	M2
1	208	7.85E-01	4.09E+09	1.89E-06	4.08E-04	M2

Table 10- comparison table of transition probability and oscillator strength for Z=74								
I	J	Transition probability			Oscillator strength		Vel/Length ratio	
		MRMP [Ref. 34]	GRASP [Ref. 24]	GRASP Our result	GRASP [Ref. 24]	GRASP Our result	GRASP [Ref. 24]	GRASP Our result
2s ² 2p ⁶ 1S ₀	2s ² 2p ⁵ 3s ¹ P ₁	1.206E+14	1.5309E+14	1.5424E+14	1.5354E-01	1.5468E-01	1.0E-00	9.9E-01
2s ² 2p ⁶ 1S ₀	2s ² 2p ⁵ 3d ¹ P ₁	6.551E+13	8.2270E+13	8.1400E+13	7.0330E-02	6.9574E-02	9.8E-01	1.0E+00
2s ² 2p ⁶ 1S ₀	2s ² 2p ⁵ 3d ¹ P ₁	2.613E+15	2.8077E+15	2.7869E+15	2.3320E+00	2.3142E+00	9.8E-01	1.0E+00
2s ² 2p ⁶ 1S ₀	2s ² 2p ⁵ 3s ¹ P ₁	2.694E+13	3.8180E+13	3.9031E+13	2.8152E-02	2.8777E-02	9.9E-01	9.7E-01
2s ² 2p ⁶ 1S ₀	2s2p ⁶ 3p ³ P ₁	6.243E+14	7.7623E+14	7.9945E+14	5.0372E-01	5.1842E-01	1.0E-00	1.0E+00
2s ² 2p ⁶ 1S ₀	2s ² 2p ⁵ 3d ¹ D ₁	1.227E+15	1.3590E+15	1.3258E+15	8.6763E-01	8.4636E-01	9.8E-01	1.0E+00
2s ² 2p ⁶ 1S ₀	2s2p ⁶ 3p ¹ P ₁	3.350E+14	4.4021E-14	4.4580E+14	2.6529E-01	2.6847E-01	1.0E-00	1.0E+00

$2s^2 2p^6 1s_0$	$2s^2 2p^5 4s^1 1p_1$	4.193E+13	5.3006E+13	5.4491E+13	2.7134E-02	2.7851E-02	9.6E-01	9.5E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^1 1p_1$	1.021E+15	1.0126E+15	1.0073E+15	4.8992E-01	4.8721E-01	9.7E-01	9.9E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 5d^1 1p_1$	2.365E+14	2.3392E+14	2.2900E+14	9.1872E-02	8.9924E-02	9.7E-01	9.8E-01
$2s^2 2p^6 1s_0$	$2s^2 2p^5 4d^1 3d_1$	8.690E+14	8.9169E+14	8.8822E+14	3.4857E-01	3.4717E-01	9.7E-01	9.9E-01
$2s^2 2p^6 1s_0$	$2s2p^6 4p^1 1p_1$	1.118E+14	1.3923E+14	1.4361E+14	5.2373E-02	5.3992E-02	9.9E-01	9.8E-01
$2s^2 2p^6 1s_0$	$2s2p^6 4p^1 1p_1$	1.850E+14	2.2983E+14	2.3789E+14	8.4470E-02	8.7389E-02	9.9E-01	9.8E-01
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 3p^1 1p_1$	2.917E+10	3.0224E+10	3.0225E+10	1.8434E-02	1.8391E-02	9.2E-01	1.2E+00
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 3p^1 1p_1$	2.395E+11	2.4114E+11	2.3979E+11	1.1881E-02	1.1799E-02	9.8E-01	1.1E+00
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 3p^1 3d_3$	1.669E+12	1.6814E+12	1.6674E+12	1.9361E-01	1.9177E-01	1.1E-00	1.1E+00
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 3p^1 3p_2$	9.092E+11	9.1611E+11	9.0791E+11	7.1771E-02	7.1016E-02	9.7E-01	1.0E+00
$2s^2 2p^5 3s^1 3p_2$	$2s2p^6 3s^1 3s_1$	1.580E+13	1.5536E+13	1.4716E+13	6.1622E-02	5.8201E-02	9.5E-01	8.6E-01
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 4p^1 1p_1$	4.805E+13	5.4832E+13	5.5384E+13	6.6094E-02	6.6730E-02	1.0E-00	1.0E+00
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 4p^1 3d_2$	2.845E+13	3.2448E+13	3.2797E+13	6.5169E-02	6.5840E-02	1.0E-00	1.0E+00
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 4p^1 3d_3$	3.484E+13	4.0782E+13	4.1553E+13	1.0485E-01	1.0679E-01	9.9E-01	9.9E-01
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 5p^1 1p_1$	2.616E+13	2.9775E+13	3.0477E+13	1.7587E-02	1.7996E-02	1.0E-00	9.8E-01
$2s^2 2p^5 3s^1 3p_2$	$2s^2 2p^5 5p^1 3d_3$	2.101E+13	2.4627E+13	2.5611E+13	3.2866E-02	3.4170E-02	9.8E-01	9.7E-01
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 3p^1 1p_1$	1.342E+12	1.3518E+12	1.3417E+12	1.1467E-01	1.1362E-01	1.0E-00	1.1E+00
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 3p^1 3p_2$	8.614E+11	8.6757E+11	8.6034E+11	1.1693E-01	1.1573E-01	1.0E-00	1.0E+00
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 3p^1 1s_0$	2.411E+12	2.4572E+12	2.4497E+12	5.3889E-02	5.3551E-02	9.5E-01	9.9E-01
$2s^2 2p^5 3s^1 1p_1$	$2s2p^6 3s^1 1s_0$	2.171E+13	2.1941E+13	2.1398E+13	4.6553E-02	4.5196E-02	9.5E-01	8.3E-01
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 4p^1 3d_2$	2.894E+13	3.2979E+13	3.3351E+13	1.1095E-01	1.1214E-01	9.9E-01	9.9E-01
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 4p^1 1p_1$	2.956E+13	3.4575E+13	3.5129E+13	6.3790E-02	6.4783E-02	9.9E-01	9.8E-01
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 4p^1 1s_0$	3.309E+13	3.8940E+13	3.9514E+13	2.3629E-02	2.3958E-02	1.0E-00	1.0E+00
$2s^2 2p^5 3s^1 1p_1$	$2s^2 2p^5 5p^1 1s_0$	2.062E+13	2.4239E+13	2.4802E+13	7.6916E-03	7.8668E-03	1.0E-00	1.0E+00

TABLE 11. Comparisons of lifetime in Ne-like W

	Label	J	Lifetime (GRASP)	Lifetime (MRMP) [Ref. 34]	Lifetimes Ref. [24]
1	$2s^2 2p^6 1s^e$	0	-----	-----	-----
2	$2s^2 2p^5 3s^1 3p^o$	2	2.326-10	2.667-10	2.31E-10
3	$2s^2 2p^5 3s^1 1p^o$	1	6.532-15	8.291-15	6.48E-15
4	$2s^2 2p^5 3p^1 3p^e$	1	1.534-11	2.038-11	1.53E-11
5	$2s^2 2p^5 3p^1 3d^e$	2	1.042-12	1.186-12	1.04E-12
6	$2s^2 2p^5 3p^1 1p^e$	1	6.236-13	6.313-13	6.28E-13
7	$2s^2 2p^5 3p^1 3d^e$	3	5.947-13	5.991-13	6.00E-13
8	$2s^2 2p^5 3p^1 3p^e$	2	3.707-13	3.875-13	3.72E-13
9	$2s^2 2p^5 3p^1 1s^e$	0	4.069-13	4.148-13	4.08E-13
10	$2s^2 2p^5 3d^1 3p^o$	0	8.081-13	8.091-13	8.19E-13
11	$2s^2 2p^5 3d^1 3p^o$	1	1.197-14	1.497-14	1.21E-14
12	$2s^2 2p^5 3d^1 3f^o$	3	7.670-13	7.686-13	7.79E-13
13	$2s^2 2p^5 3d^1 3d^o$	2	7.309-13	7.326-13	7.43E-13
14	$2s^2 2p^5 3d^1 3f^o$	4	6.324-12	6.310-12	6.41E-12
15	$2s^2 2p^5 3d^1 1d^o$	2	3.496-12	3.594-12	3.52E-12
16	$2s^2 2p^5 3d^1 3d^o$	3	5.761-12	5.760-12	5.85E-12
17	$2s^2 2p^5 3d^1 1p^o$	1	3.561-16	3.827-16	3.59E-16
18	$2s^2 2p^5 3s^1 3p^o$	0	3.057-11	3.036-11	3.16E-11
19	$2s^2 2p^5 3s^1 3p^o$	1	2.617-14	3.707-14	2.56E-14
20	$2s^2 2p^5 3p^1 3d^e$	1	1.504-11	1.482-11	1.52E-11
21	$2s^2 2p^5 3p^1 3p^e$	0	3.211-12	3.283-12	3.01E-12
22	$2s2p^6 3s^1 3s^e$	1	5.344-14	5.253-14	5.64E-14
23	$2s2p^6 3s^1 1s^e$	0	4.521-14	4.571-14	4.64E-14
24	$2s^2 2p^5 3p^1 1d^e$	2	3.538-13	3.717-13	3.55E-13
25	$2s^2 2p^5 3p^1 3s^e$	1	1.332-13	1.433-13	1.27E-13
26	$2s2p^6 3p^1 3p^o$	0	4.259-14	4.304-14	4.37E-14
27	$2s2p^6 3p^1 3p^o$	1	1.252-15	1.547-15	1.22E-15
28	$2s^2 2p^5 3d^1 3f^o$	2	7.336-13	7.346-13	7.44E-13
29	$2s^2 2p^5 3d^1 3d^o$	1	7.343-16	8.130-16	7.53E-16
30	$2s^2 2p^5 3d^1 3p^o$	2	3.275-12	3.251-12	3.36E-12
31	$2s^2 2p^5 3d^1 1f^o$	3	5.162-12	5.162-12	5.23E-12
32	$2s2p^6 3p^1 3p^o$	2	3.967-14	4.014-14	4.06E-14
33	$2s2p^6 3p^1 1p^o$	1	2.150-15	2.780-15	2.13E-15
34	$2s2p^6 3d^1 3d^e$	1	4.449-14	4.490-14	4.53E-14
35	$2s2p^6 3d^1 3d^e$	2	3.454-14	3.571-14	3.51E-14

36	$2s^2p^63d^3D^e$	3	4.388-14	4.434-14	4.49E-14
37	$2s^2p^63d^1D^e$	2	2.957-14	3.061-14	3.00E-14
38	$2s^22p^54s^3P^o$	2	1.484-14	1.673-14	1.45E-14
39	$2s^22p^54s^1P^o$	1	8.267-15	9.770-15	8.08E-15
40	$2s^22p^54p^3P^e$	1	1.220-14	1.384-14	1.20E-14
41	$2s^22p^54p^3D^e$	2	1.212-14	1.373-14	1.19E-14
42	$2s^22p^54p^3D^e$	3	1.931-14	2.257-14	1.89E-14
43	$2s^22p^54p^1P^e$	1	1.914-14	2.233-14	1.88E-14
44	$2s^22p^54p^3P^e$	2	1.939-14	2.265-14	1.90E-14
45	$2s^22p^54p^1S^e$	0	1.990-14	2.331-14	1.96E-14
46	$2s^22p^54d^3P^o$	0	8.226-15	9.049-15	8.15E-15
47	$2s^22p^54d^3P^o$	1	6.484-15	7.245-15	6.46E-15
48	$2s^22p^54d^3F^o$	3	3.259-15	9.084-15	8.18E-15
49	$2s^22p^54d^3D^o$	2	8.289-15	9.119-15	8.22E-15
50	$2s^22p^54d^3F^o$	4	7.933-15	8.479-15	7.88E-15
51	$2s^22p^54d^1D^o$	2	7.930-15	8.475-15	7.88E-15
52	$2s^22p^54d^3D^o$	3	7.977-15	8.526-15	7.93E-15
53	$2s^22p^54d^1P^o$	1	8.793-16	8.788-16	8.83E-16
54	$2s^22p^54f^3D^e$	1	3.739-15	3.870-15	3.75E-15
55	$2s^22p^54f^3G^e$	4	3.828-15	3.964-15	3.84E-15
56	$2s^22p^54f^3F^e$	3	3.823-15	3.958-15	3.84E-15
57	$2s^22p^54f^3G^e$	5	3.930-15	4.021-15	3.94E-15
58	$2s^22p^54f^1D^e$	2	3.813-15	3.907-15	3.83E-15
59	$2s^22p^54f^1F^e$	3	3.898-15	3.981-15	3.91E-15
60	$2s^22p^54f^3F^e$	4	3.939-15	4.022-15	3.95E-15
61	$2s^22p^54s^3P^o$	0	1.470-14	1.655-14	1.44E-14
62	$2s^22p^54s^3P^o$	1	1.151-14	1.349-14	1.12E-14
63	$2s^22p^54p^3D^e$	1	1.205-14	1.365-14	1.19E-14
64	$2s^22p^54p^3P^e$	0	1.244-14	1.413-14	1.23E-14
65	$2s^22p^55s^3P^o$	2	1.859-14	2.037-14	1.79E-14
66	$2s^22p^55s^1P^o$	1	1.179-14	1.384-14	1.13E-14
67	$2s^22p^55p^3P^e$	1	1.531-14	1.710-14	1.49E-14
68	$2s^22p^55p^3D^e$	2	1.529-14	1.708-14	1.49E-14
69	$2s^22p^55p^1P^e$	1	2.222-14	2.575-14	2.16E-14
70	$2s^22p^55p^3D^e$	3	2.310-14	2.672-14	2.22E-14
71	$2s^22p^55p^3P^e$	2	2.305-14	2.672-14	2.23E-14
72	$2s^22p^55p^1S^e$	0	2.296-14	2.675-14	2.28E-14
73	$2s^22p^54p^3S^e$	1	1.938-14	2.264-14	1.90E-14
74	$2s^22p^54p^3D^e$	2	1.111-14	1.185-14	1.86E-14
75	$2s^22p^55d^3P^o$	0	1.907-14	2.224-14	1.09E-14
76	$2s^22p^55d^3P^o$	1	9.016-15	9.738-15	8.91E-15
77	$2s^22p^55d^3F^o$	3	1.117-14	1.192-14	1.10E-14
78	$2s^22p^55d^3D^o$	2	1.117-14	1.192-14	1.10E-14
79	$2s^22p^55d^3F^o$	4	1.105-14	1.146-14	1.09E-14
80	$2s^22p^55d^1D^o$	2	1.097-14	1.139-14	1.08E-14
81	$2s^22p^55d^3D^o$	3	1.100-14	1.143-14	1.09E-14
82	$2s^22p^55d^1P^o$	1	3.051-15	3.063-15	3.10E-15
83	$2s^22p^55f^3D^e$	1	7.203-15	7.151-15	7.16E-15
84	$2s^22p^55f^3G^e$	4	7.299-15	7.252-15	7.29E-15
85	$2s^22p^55f^3F^e$	2	7.205-15	7.164-15	7.18E-15
86	$2s^22p^55f^3F^e$	3	7.257-15	7.214-15	7.24E-15
87	$2s^22p^55f^3G^e$	5	7.519-15	7.352-15	7.49E-15
88	$2s^22p^55f^1D^e$	2	7.250-15	7.132-15	7.28E-15
89	$2s^22p^55f^1F^e$	3	7.457-15	7.301-15	7.43E-15
90	$2s^22p^55f^3F^e$	4	7.492-15	7.340-15	7.48E-15
91	$2s^22p^55g^3F^o$	2	1.271-14		1.27E-14
92	$2s^22p^55g^3H^o$	5	1.283-14		1.28E-14
93	$2s^22p^55g^3G^o$	3	1.286-14		1.29E-14
94	$2s^22p^55g^3G^o$	4	1.284-14		1.28E-14
95	$2s^22p^55g^1F^o$	3	1.305-14		1.30E-14
96	$2s^22p^55g^3H^o$	6	1.298-14		1.30E-14
97	$2s^22p^55g^1G^o$	4	1.302-14		1.30E-14
98	$2s^22p^55g^3G^o$	5	1.299-14		1.30E-14

99	$2s^2 2p^5 4d \ ^3F^o$	2	8.343-15	9.096-15	8.26E-15
100	$2s^2 2p^5 4d \ ^3D^o$	1	9.888-16	1.022-15	9.92E-16
101	$2s^2 2p^5 4d \ ^3P^o$	2	7.913-15	8.447-15	7.87E-15
102	$2s^2 2p^5 4d \ ^1F^o$	3	7.955-15	3.505-15	7.91E-15
103	$2s^2 2p^5 4f \ ^3G^e$	3	3.822-15	3.959-15	3.84E-15
104	$2s^2 2p^5 4f \ ^3D^e$	2			3.78E-15
105	$2s^2 2p^5 4f \ ^3D^e$	3	3.907-15	3.992-15	3.92E-15
106	$2s^2 2p^5 4f \ ^1G^e$	4	3.935-15	4.021-15	3.95E-15
107	$2s 2p^6 4s \ ^3S^e$	1	1.096-14	1.198-14	1.09E-14
108	$2s 2p^6 4s \ ^1S^e$	0	1.102-14	1.206-14	1.09E-14
109	$2s 2p^6 4p \ ^3P^o$	0	9.513-15	1.051-15	9.45E-15
110	$2s 2p^6 4p \ ^3P^o$	1	4.084-15	4.824-15	4.00E-15
111	$2s 2p^6 4p \ ^3P^o$	2	1.337-14	1.491-14	1.32E-14
112	$2s 2p^6 4p \ ^1P^o$	1	3.276-15	3.957-15	3.19E-15
113	$2s 2p^6 4d \ ^3D^e$	1	6.918-15	7.505-15	6.89E-15
114	$2s 2p^6 4d \ ^3D^e$	2	6.880-15	7.454-15	6.85E-15
115	$2s 2p^6 4d \ ^3D^e$	3	6.692-15	7.087-15	6.67E-15
116	$2s 2p^6 4d \ ^1D^e$	2	6.616-15	6.987-15	6.60E-15
117	$2s 2p^6 4f \ ^3F^o$	2	3.513-15	3.648-15	3.51E-15
118	$2s 2p^6 4f \ ^3F^o$	3	3.519-15	3.640-15	3.52E-15
119	$2s 2p^6 4f \ ^3F^o$	4	3.602-15	3.681-15	3.60E-15
120	$2s 2p^6 4f \ ^1F^o$	3	3.617-15	3.707-15	3.61E-15