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COMPUTATION OF CHARACTERISTICS OF C IV TRANSITIONS[†]

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In this research, we computed transition probabilities, line strength, and oscillator strengths of more than 5000 transitions in C IV. Very few values of these spectroscopic characteristics were previously known and reported. The calculation method, based on a combination of the weakest bound electron model and numerical approximation, shows reliable values because the correlation between known and calculated values is high. The transition probabilities calculated in this work are compared with known values of the NIST database and those found in literature, and a reasonably good agreement has been observed. The lifetime of Rydberg levels ns, np, nd, nf, ng has been reported up to n = 25. A general sixth-degree polynomial was developed, generating C IV lifetimes with reasonable accuracy. Most of the results presented are new.
Keywords: *carbon atom; transition probability; oscillator strength; Rydberg atom; quantum defects*
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INTRODUCTION

The star's atmosphere or other astronomical objects like interstellar nebula have various chemical elements. The chemical composition varies from object to object; astronomers can identify it by recording and measuring the relative amount of electromagnetic radiation emitted by each. Understanding stellar evolution requires precise abundances of various elements, including carbon. The chemical abundance is also vital to understand the complex picture of stars. The study of Excited states of atoms is the foundation of quantum mechanics and has grabbed the focus of scientists for many decades. Many research papers and articles have been published with the application of the transition state of carbon atoms in molecular physics, nanochemistry, medicinal chemistry, environmental chemistry, and material science [1-7]. In 1970, Martinson measured the Mean lives of 16 excited levels in C II - C V with the beam-foil technique and found good agreement for the C III $2s3d\,^3D$ - $2s4f\,^3F^0$ (1923 Å) transition and the C IV $2s^2S$ - $2p^2p^0$ (1548 Å) transition [8]. In 1971, Poulizac also used the beam-foil excitation method to study the carbon spectra between 1100 Å and 7000 Å for C I, C II, C III, C IV, and C V energy ranging from 0.18 to 2.0 MeV [9]. In 1979, Ganas used a semiempirical approach with Optical oscillator strengths for excitations from the valence subshell of C (IV) and N (V) and obtained good agreement with experimental data [10]. In 1989, Baudinet-Robinet et al. applied the beam-foil-laser method to determine the lifetimes of two levels in multiply ionized carbon atoms and found the results for C Ill $2s3d^1$ D, 0.15±0.01 ns and C IV $3s^2$ S, 0.21±0.02 ns. These values are in good agreement with the theoretical predictions. They also determined these lifetimes using the classical (nonselective) beam-foil method and reported ≈ 20% longer than the beam-foil-laser values. These factors limit the accuracy of the lifetime determinations by the beam-foil-laser method [11]. In 1996, Gou used the multichannel saddle-point and saddle-point complex-rotation methods for Seven triply excited states of lithium-like beryllium and carbon, using first-order perturbation theory [12]. In 1997, Cheng improved the energy levels in neutral carbon using high-resolution infrared solar spectra. The main source is the ATMOS spectrum measured by the Fourier transform spectroscopy technique from 600 to 4800 cm^{-1}, supplemented by the MARK IV balloon data, covering 4700 to 5700 cm^{-1} [13]. P. Quinet, in 1998, by using the Ritz and the polarization methods, calculated the term energies up to $n = 30$ and $l \geq 3$ in C II, C III, and C IV. His article also reported the predicted wavelengths for these lines of high-*nl* term energies and the related oscillator strengths [14]. Nengwu Zheng et al., in 2001, by employing the WBEPM, computed transition probabilities of C I, C II, C III, and C IV. They calculated the required parameters for the calculation of transition probabilities through a proposed coupled equation which relates the energy and radial expectation value $\langle r \rangle_{nl}$ of the Weakest Bound Electron [15]. In 2004, Agarwal investigated Energy levels and radiative rates for transitions among the lowest 24 fine structure levels belonging to the $1s^2\,nl$ ($n \leq 5$) configurations of C IV using the fully relativistic GRASP code. Additionally, collision strengths for transitions among these levels have been computed over a wide energy range below 28 Ry using the Dirac Atomic R-matrix Code [16]. In 2002, Nengwu Zheng and Tao Wang computed the radiative lifetimes, transition probabilities, and oscillator strengths for individual lines of different transitions for atomic carbon and oxygen. In their article, WBEPM theory has been employed for calculations [17]. Zheng et al., in 2004, developed a unified WBEPM theory in which they presented the relativistic form of the theory and combined it with the non-relativistic form they proposed earlier. They have employed the newly proposed theory for calculating transition probabilities and F II oscillator strength, carbon atom energy levels, and Ionization potential for oxygen-like ions [18]. In 2018, Lischka introduced the progress in time-resolved spectroscopy to explain the characteristic features of excited states accurately. At the same time, the stable molecule's electronic ground state problems

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can efficiently solve with the implementation of quantum chemical methodology [19]. In 2020, Li et al. worked with the multiconfiguration Dirac-Hartree-Fock and Relativistic Configuration Interaction methods for the General-purpose Relativistic Atomic Structure Package GRASP2K to compute the Landé g-factors for states in C I−IV and other atoms. Further, they compared the accuracy of the wave functions for the states and the resulting Landé g-factors' accuracy with the computed excitation energies and energy separations with the National Institute of Standards and Technology (NIST) recommended data [20]. In 2022, Whang et al. employed a neural network machine learning method to simulate interatomic potentials for the structural properties of several carbon structures. First-principles Density Functional Theory (DFT) calculations are used to train the potential with a database of crystalline and liquid structures. The excellent accuracy and transferability of the NNP provide a promising tool for accurate atomistic simulations of various carbon materials with faster speed and much lower cost [21].

THEORY

Due to its complex nature, the Schrodinger equation for atoms and ions having many electrons is difficult to solve. However, an approximate solution for the hydrogen atom exists, with only one electron in its outermost shell. Like the hydrogen atom, some atoms have only one electron in the outermost shells; thus, the interaction terms are no longer required in the equation for the hydrogen-like atom. Hence Schrodinger equation for hydrogen atoms can be used for such atoms and ions with the approximation that all other electrons in the inner shells together with the nucleus form the core, like the hydrogen atom, e.g., hydrogen-like atoms and ions are Li I, Be II, B III, C IV, N V, and O VI. The theory used in this work is the same as in [22]. The Schrodinger equation for hydrogen-like atoms and ions is given by,

$$\left(\frac{d^2}{dr^2} - 2V(r) - \frac{l^*(l^*+1)}{r^2} + 2E\right)P(r) = o, \tag{1}$$

Here $P(r) = rR(r)$, and $R(r)$ is the radial wavefunction,

$$\frac{l^*(l^*+1)}{r^2} + V(r) = \frac{l(l+1)}{r^2} + \frac{B}{r^2} + \frac{A}{r} \tag{2}$$

The first term on the right side $\left(\frac{l(l+1)}{r^2}\right)$ is the same as for hydrogen atom, the second term $\left(\frac{B}{r^2} + \frac{A}{r}\right)$ is the total potential felt by the weakest bound electron. The energy of hydrogen-like atoms and ions is given by,

$$E = \frac{Z^{*2}}{2n^{*2}} \tag{3}$$

$n^* = n - \delta_n$ and $l^* = l - \delta_l$ are effective principal and orbital quantum numbers for hydrogen-like atoms and ions. δ is a quantum defect in principal and orbital quantum numbers (n, l). The quantum defect can be expressed as a polynomial in x, where x is $1/(n - \delta_o)$, the δ_o is the lowest value of quantum defect. The radial function can be defined as $R(r) = \frac{P(r)}{r}$, and can be expressed in terms of associated Laguerre polynomials.

The transition probability A_{fi} of a transition for spontaneous emission between levels (n_f, l_f) & (n_i, l_i) is given as,

$$A_{fi} = 2.0261 \times 10^{-6} \frac{(E_f - E_i)^3}{2l_i+1} S \tag{4}$$

$E_f > E_i$ and are energies of upper and lower levels, S is the electric dipole line strength; it is proportional to the dipole matrix element $P^{(1)}_{l_i l_f}$ which is given as,

$$P^{(1)}_{l_i l_f} = l_> < n_i, l_i|r|n_f, l_f > = l_> \int_0^\infty r^3 R_{n_i l_i} R_{n_f l_f} dr \tag{5}$$

The lifetime (τ) of Rydberg levels can be found by the following equation;

$$\tau_i = \frac{1}{\sum_f A_{fi}} \tag{6}$$

RESULT AND DISCUSSION

The Martin formula was used to calculate energies and quantum defects of the Rydberg lithium levels like C IV. These results calculated transition probabilities, oscillator strength, and line strength of five thousand two hundred and fifty transitions. The transition probability mainly depends on the energy difference of the levels involved in the transition and the line strength of the transition. Due to the unavailability of the wavefunction for the atoms and ions, it isn't easy to calculate line strength which depends on the dipole matrix element. However, the Weakest Bound Electron Potential Model (WBEPM) suggests hydrogen-like wavefunction for lithium-like atoms and ions. This wavefunction for C IV was used, and dipole integral was evaluated using the wavefunction of WBEPM; consequently, line strength was evaluated, which was further used in calculating transition probability. The energy levels of ns, np, nd, nf, and ng up to $n = 30$ have been calculated; using selection rules, more than 5250 transitions in C IV were studied. In Table I, the first column gives the configuration of the upper and lower levels of the transition (nlj). The first letter represents the principal quantum number, the second is the sub-orbital corresponding to the orbital quantum number, and the term in the bracket is the total angular momentum of the

level. The second column gives the transition probabilities determined in this work, NIST values, and Zheng's work. The third and fourth columns give oscillator strengths & line strengths determined in this work and NIST values.

Out of these 5250, only 225 transition probabilities are given on the NIST site, the comparison of these transition probabilities with those calculated in this work has a percentage error of less than 1% in most cases, and in a few cases, it is up to 7%. Similar is the case upon comparing the transition probabilities of Zheng's work and this study. However, there is one transition in each comparison with NIST data and Zheng's work, where a large deviation is seen from this work, as mentioned below.

The Transition $1s^2 8s - 1s^2 2p$

The transition probabilities for the transitions $1s^2 8s_{3/2} - 1s^2 2p_{1/2}$ and $1s^2 8s_{1/2} - 1s^2 2p_{3/2}$ determined in this work are 5.75×10^7 and 1.15×10^8, the corresponding values in the NIST data are 1.66×10^9, and 3.22×10^9, respectively. A difference of 99% between them can be seen. NIST data classifies these transitions in accuracy code B, which means it has 10% or fewer errors. As mentioned below, Zheng did not measure this transition where a large deviation is seen from this work.

The Transition $1s^2 3d$-$1s^2 2p$

The transition probabilities for the transitions $1s^2 3d_{3/2} - 1s^2 2p_{1/2}$ determined in this work are 1.52×10^{10}, and the corresponding value in Zheng's work is 1.47×10^6. A big difference is observed between the two, whereas the reported value in the NIST database is close to the value determined in this work (1.46×10^{10}). NIST data classifies it in accuracy code B, which means it has a 10% or less error. The maximum probability is found for the transition $1s^2 3d - 1s^2 2p$.

Fig. 1 compares transition probabilities calculated in this work and listed in the NIST database. An approximate straight-line graph among transition probabilities between this work and NIST values indicates a good agreement between both. The correlation coefficient between these probabilities is 0.999.

Since many transition probabilities are known, all possible transition probabilities from each level are known; hence equation (6) can be used to find the lifetime of the levels. The lifetimes of Rydberg levels $1s^2$ ns, $1s^2$ np, $1s^2$ nd, $1s^2$ nf, and $1s^2$ ng up to n = 25 have also been determined. Table II gives the values of the lifetime of the corresponding level.

Table I. List of transition calculated transition probabilities, oscillator strengths, and line strength compared with corresponding values in the NIST database.

Configurations	Transition Probability			Oscillator Strength		Line Strength	
Lower level - Upper level	This Work	NIST	Zheng ($\times10^8$)	This Work	NIST	NIST	This Work
$2p_{1/2} \rightarrow 3d_{3/2}$	1.516E+10	1.460E+10	0.0147	0.6690	0.6460	1.6913	1.6300
$3p_{1/2} \rightarrow 3d_{3/2}$	4.872E+05	4.890E+05	0.0049	0.0625	0.0629	8.5221	8.5700
$2p_{3/2} \rightarrow 3d_{3/2}$	3.030E+09	2.920E+09	29.3400	0.0669	0.0646	0.3385	0.3270
$3p_{3/2} \rightarrow 3d_{3/2}$	9.553E+04	9.580E+04	0.0010	0.0062	0.0062	1.7043	1.7100
$2p_{1/2} \rightarrow 4d_{3/2}$	5.045E+09	4.900E+09	49.7400	0.1262	0.1230	0.2402	0.2340
$3p_{1/2} \rightarrow 4d_{3/2}$	1.508E+09	1.470E+09	14.5600	0.5537	0.5410	4.0374	3.9400
$4p_{1/2} \rightarrow 4d_{3/2}$	1.527E+05	1.530E+05	0.0015	0.1115	0.1120	36.2447	36.4000
$2p_{3/2} \rightarrow 4d_{3/2}$	1.008E+09	9.780E+08	9.9400	0.0126	0.0123	0.0480	0.0467
$3p_{3/2} \rightarrow 4d_{3/2}$	3.016E+08	2.940E+08	2.9130	0.0554	0.0541	0.8084	0.7890
$4p_{3/2} \rightarrow 4d_{3/2}$	2.995E+04	3.000E+04	0.0003	0.0111	0.0111	7.2487	7.2700
$2p_{1/2} \rightarrow 5d_{3/2}$	2.340E+09	2.280E+09	23.2400	0.0471	0.0460	0.0805	0.0786
$3p_{1/2} \rightarrow 5d_{3/2}$	7.614E+08	7.430E+08	7.4390	0.1352	0.1320	0.6854	0.6700
$4p_{1/2} \rightarrow 5d_{3/2}$	3.026E+08	2.970E+08	2.9330	0.5239	0.5150	8.2970	8.1600
$5p_{1/2} \rightarrow 5d_{3/2}$	5.523E+04	5.520E+04	0.0006	0.1551	0.1550	98.9188	99.0000
$2p_{3/2} \rightarrow 5d_{3/2}$	4.676E+08	4.550E+08	4.6440	0.0047	0.0046	0.0161	0.0157
$3p_{3/2} \rightarrow 5d_{3/2}$	1.522E+08	1.480E+08	1.4880	0.0135	0.0132	0.1371	0.1340
$4p_{3/2} \rightarrow 5d_{3/2}$	6.054E+07	5.930E+07	0.5869	0.0524	0.0515	1.6616	1.6300
$5p_{3/2} \rightarrow 5d_{3/2}$	1.082E+04	1.080E+04	0.0001	0.0154	0.0154	19.7832	19.8000
$2p_{1/2} \rightarrow 6d_{3/2}$	1.287E+09	1.250E+09	12.8200	0.0233	0.0226	0.0376	0.0366
$3p_{1/2} \rightarrow 6d_{3/2}$	4.293E+08	4.190E+08	4.2150	0.0561	0.0549	0.2441	0.2390
$4p_{1/2} \rightarrow 6d_{3/2}$	1.842E+08	1.800E+08	1.8000	0.1386	0.1360	1.4475	1.4200
$5p_{1/2} \rightarrow 6d_{3/2}$	8.861E+07	8.720E+07	0.8621	0.5232	0.5160	15.3016	15.1000
$6p_{1/2} \rightarrow 6d_{3/2}$	2.325E+04	2.180E+04		0.1961	0.1840	216.7812	204.0000
$2p_{3/2} \rightarrow 6d_{3/2}$	2.571E+08	2.500E+08	2.5630	0.0023	0.0023	0.0075	0.0073
$3p_{3/2} \rightarrow 6d_{3/2}$	8.582E+07	8.380E+07	0.8428	0.0056	0.0055	0.0488	0.0478
$4p_{3/2} \rightarrow 6d_{3/2}$	3.684E+07	3.600E+07	0.3601	0.0139	0.0136	0.2897	0.2840
$5p_{3/2} \rightarrow 6d_{3/2}$	1.773E+07	1.740E+07		0.0524	0.0515	3.0652	3.0100
$6p_{3/2} \rightarrow 6d_{3/2}$	4.550E+03	4.280E+03		0.0195	0.0183	43.3555	40.9000
$2p_{3/2} \rightarrow 3d_{5/2}$	1.818E+10	1.750E+10	176.0300	0.6022	0.5810	3.0462	2.9400
$3p_{3/2} \rightarrow 3d_{5/2}$	5.770E+05	5.790E+05	0.0058	0.0560	0.0563	15.3405	15.4000
$2p_{3/2} \rightarrow 4d_{5/2}$	6.050E+09	5.870E+09		0.1136	0.1100	0.4324	0.4210
$3p_{3/2} \rightarrow 4d_{5/2}$	1.809E+09	1.760E+09	17.4700	0.4986	0.4860	7.2736	7.0900
$4p_{3/2} \rightarrow 4d_{5/2}$	1.808E+05	1.810E+05	0.0018	0.0999	0.1000	65.2427	65.4000
$2p_{3/2} \rightarrow 5d_{5/2}$	2.806E+09	2.730E+09	27.8700	0.0424	0.0414	0.1449	0.1410
$3p_{3/2} \rightarrow 5d_{5/2}$	9.135E+08	8.910E+08	8.9260	0.1217	0.1190	1.2343	1.2100

Configurations	Transition Probability			Oscillator Strength		Line Strength	
Lower level - Upper level	This Work	NIST	Zheng ($\times 10^8$)	This Work	NIST	NIST	This Work
$4p_{3/2} \rightarrow 5d_{5/2}$	3.632E+08	3.560E+08	3.5210	0.4719	0.4630	14.9503	14.7000
$5p_{3/2} \rightarrow 5d_{5/2}$	6.524E+04	6.520E+04	0.0007	0.1389	0.1390	178.0578	178.0000
$2p_{3/2} \rightarrow 6d_{5/2}$	1.543E+09	1.500E+09	15.3800	0.0209	0.0204	0.0677	0.0660
$3p_{3/2} \rightarrow 6d_{5/2}$	5.149E+08	5.030E+08	5.0570	0.0505	0.0494	0.4395	0.4300
$4p_{3/2} \rightarrow 6d_{5/2}$	2.210E+08	2.160E+08	2.1600	0.1248	0.1220	2.6069	2.5500
$5p_{3/2} \rightarrow 6d_{5/2}$	1.064E+08	1.050E+08	1.0350	0.4713	0.4660	27.5757	27.3000
$6p_{3/2} \rightarrow 6d_{5/2}$	2.747E+04	2.580E+04		0.1756	0.1650	390.2184	367.0000
$2s_{1/2} \rightarrow 2p_{1/2}$	2.726E+08	2.640E+08	2.6490	0.0981	0.0952	1.0017	0.9720
$2s_{1/2} \rightarrow 3p_{1/2}$	4.598E+09	4.630E+09	43.5200	0.0671	0.0678	0.1381	0.1390
$3s_{1/2} \rightarrow 3p_{1/2}$	3.186E+07	3.160E+07	0.3140	0.1612	0.1600	6.1694	6.1300
$3d_{3/2} \rightarrow 4p_{1/2}$	1.238E+08	1.280E+08		0.0266	0.0138	0.2100	0.2180
$2s_{1/2} \rightarrow 4p_{1/2}$	2.258E+09	2.270E+09	21.0900	0.0203	0.0204	0.0327	0.0329
$3s_{1/2} \rightarrow 4p_{1/2}$	5.054E+08	5.030E+08	4.9210	0.0680	0.0678	0.4245	0.4230
$4s_{1/2} \rightarrow 4p_{1/2}$	7.144E+06	7.110E+06	0.0709	0.2205	0.2200	20.8530	20.8000
$3d_{3/2} \rightarrow 5p_{1/2}$	5.230E+07	5.470E+07		0.0051	0.0027	0.0270	0.0283
$4d_{3/2} \rightarrow 5p_{1/2}$	6.511E+07	6.670E+07		0.0657	0.0337	1.1224	1.1500
$2s_{1/2} \rightarrow 5p_{1/2}$	1.207E+09	1.210E+09	11.2100	0.0090	0.0090	0.0131	0.0132
$3s_{1/2} \rightarrow 5p_{1/2}$	3.117E+08	3.110E+08	3.0070	0.0219	0.0219	0.0987	0.0986
$4s_{1/2} \rightarrow 5p_{1/2}$	1.083E+08	1.080E+08	1.0650	0.0718	0.0717	0.9954	0.9940
$5s_{1/2} \rightarrow 5p_{1/2}$	2.263E+06	2.260E+06	0.0225	0.2785	0.2790	52.5840	52.6000
$3d_{3/2} \rightarrow 6p_{1/2}$	2.722E+07	2.860E+07		0.0019	0.0010	0.0086	0.0091
$4d_{3/2} \rightarrow 6p_{1/2}$	3.191E+07	3.290E+07		0.0131	0.0068	0.1424	0.1470
$5d_{3/2} \rightarrow 6p_{1/2}$	3.251E+07	3.310E+07		0.1115	0.0569	3.5159	3.5900
$2s_{1/2} \rightarrow 6p_{1/2}$	7.113E+08	7.150E+08		0.0048	0.0048	0.0067	0.0068
$3s_{1/2} \rightarrow 6p_{1/2}$	1.914E+08	1.910E+08		0.0102	0.0102	0.0398	0.0398
$4s_{1/2} \rightarrow 6p_{1/2}$	7.601E+07	7.560E+07		0.0236	0.0235	0.2238	0.2230
$5s_{1/2} \rightarrow 6p_{1/2}$	3.319E+07	3.300E+07		0.0770	0.0766	1.9943	1.9900
$6s_{1/2} \rightarrow 6p_{1/2}$	8.893E+05	8.940E+05		0.3358	0.3380	111.0743	112.0000
$3d_{3/2} \rightarrow 7p_{1/2}$	1.609E+07	1.700E+07		0.0010	0.0005	0.0039	0.0042
$4d_{3/2} \rightarrow 7p_{1/2}$	1.817E+07	1.880E+07		0.0050	0.0026	0.0449	0.0465
$5d_{3/2} \rightarrow 7p_{1/2}$	1.763E+07	1.810E+07		0.0227	0.0117	0.4396	0.4520
$6d_{3/2} \rightarrow 7p_{1/2}$	1.707E+07	1.730E+07		0.1615	0.0820	8.4548	8.5800
$2s_{1/2} \rightarrow 7p_{1/2}$	4.521E+08	4.550E+08		0.0029	0.0029	0.0039	0.0040
$3s_{1/2} \rightarrow 7p_{1/2}$	1.239E+08	1.240E+08		0.0057	0.0057	0.0206	0.0206
$4s_{1/2} \rightarrow 7p_{1/2}$	5.102E+07	5.080E+07		0.0112	0.0112	0.0892	0.0890
$5s_{1/2} \rightarrow 7p_{1/2}$	2.529E+07	2.520E+07		0.0254	0.0254	0.4340	0.4330
$6s_{1/2} \rightarrow 7p_{1/2}$	1.271E+07	1.260E+07		0.0827	0.0821	3.5929	3.5700
$7s_{1/2} \rightarrow 7p_{1/2}$	4.049E+05	4.080E+05		0.3928	0.3960	208.2167	210.0000
$3d_{3/2} \rightarrow 8p_{1/2}$	1.034E+07	1.100E+07		0.0006	0.0003	0.0022	0.0023
$4d_{3/2} \rightarrow 8p_{1/2}$	1.142E+07	1.180E+07		0.0025	0.0013	0.0203	0.0210
$5d_{3/2} \rightarrow 8p_{1/2}$	1.072E+07	1.100E+07		0.0088	0.0046	0.1367	0.1410
$6d_{3/2} \rightarrow 8p_{1/2}$	9.956E+06	1.010E+07		0.0334	0.0170	1.0434	1.0600
$2s_{1/2} \rightarrow 8p_{1/2}$	3.044E+08	3.070E+08		0.0019	0.0019	0.0025	0.0025
$3s_{1/2} \rightarrow 8p_{1/2}$	8.427E+07	8.400E+07		0.0035	0.0035	0.0122	0.0122
$4s_{1/2} \rightarrow 8p_{1/2}$	3.524E+07	3.510E+07		0.0063	0.0063	0.0459	0.0458
$5s_{1/2} \rightarrow 8p_{1/2}$	1.805E+07	1.800E+07		0.0122	0.0122	0.1701	0.1700
$6s_{1/2} \rightarrow 8p_{1/2}$	1.025E+07	1.020E+07		0.0273	0.0272	0.7597	0.7570
$7s_{1/2} \rightarrow 8p_{1/2}$	5.673E+06	5.570E+06		0.0889	0.0875	5.9918	5.8900
$8s_{1/2} \rightarrow 8p_{1/2}$	2.052E+05	2.070E+05		0.4495	0.4540	358.0851	361.0000
$3d_{3/2} \rightarrow 9p_{1/2}$	7.064E+06	7.580E+06		0.0004	0.0002	0.0013	0.0014
$4d_{3/2} \rightarrow 9p_{1/2}$	7.680E+06	7.780E+06		0.0015	0.0008	0.0111	0.0113
$5d_{3/2} \rightarrow 9p_{1/2}$	7.060E+06	7.280E+06		0.0045	0.0023	0.0613	0.0633
$6d_{3/2} \rightarrow 9p_{1/2}$	6.365E+06	6.650E+06		0.0131	0.0069	0.3207	0.3360
$2s_{1/2} \rightarrow 9p_{1/2}$	2.145E+08	2.110E+08		0.0013	0.0013	0.0017	0.0017
$3s_{1/2} \rightarrow 9p_{1/2}$	5.973E+07	5.940E+07		0.0023	0.0023	0.0079	0.0079
$4s_{1/2} \rightarrow 9p_{1/2}$	2.518E+07	2.460E+07		0.0040	0.0039	0.0272	0.0266
$5s_{1/2} \rightarrow 9p_{1/2}$	1.307E+07	1.290E+07		0.0070	0.0069	0.0868	0.0858
$6s_{1/2} \rightarrow 9p_{1/2}$	7.656E+06	7.700E+06		0.0131	0.0132	0.2930	0.2950
$7s_{1/2} \rightarrow 9p_{1/2}$	4.770E+06	4.700E+06		0.0293	0.0289	1.2363	1.2200
$8s_{1/2} \rightarrow 9p_{1/2}$	2.828E+06	2.850E+06		0.0953	0.0962	9.4203	9.5100
$9s_{1/2} \rightarrow 9p_{1/2}$	1.128E+05	1.130E+05		0.5061	0.5070	576.9346	578.0000
$2s_{1/2} \rightarrow 2p_{3/2}$	2.741E+08	2.650E+08	2.6630	0.1966	0.1900	2.0040	1.9400
$2s_{1/2} \rightarrow 3p_{3/2}$	4.593E+09	4.630E+09	43.4500	0.1341	0.1360	0.2758	0.2790
$3s_{1/2} \rightarrow 3p_{3/2}$	3.205E+07	3.170E+07	0.3160	0.3230	0.3200	12.3406	12.2000
$3d_{3/2} \rightarrow 4p_{3/2}$	1.235E+07	1.280E+07		0.0053	0.0028	0.0419	0.0435
$3d_{5/2} \rightarrow 4p_{3/2}$	1.112E+08	1.150E+08		0.0319	0.0165	0.3774	0.3910
$2s_{1/2} \rightarrow 4p_{3/2}$	2.256E+09	2.270E+09	21.0700	0.0405	0.0408	0.0653	0.0658
$3s_{1/2} \rightarrow 4p_{3/2}$	5.047E+08	5.040E+08	4.9120	0.1358	0.1360	0.8474	0.8480
$4s_{1/2} \rightarrow 4p_{3/2}$	7.185E+06	7.150E+06	0.0713	0.4419	0.4410	41.7094	41.6000
$3d_{3/2} \rightarrow 5p_{3/2}$	5.220E+06	5.470E+06		0.0010	0.0005	0.0054	0.0057

Configurations	Transition Probability			Oscillator Strength		Line Strength	
Lower level - Upper level	This Work	NIST	Zheng ($\times 10^8$)	This Work	NIST	NIST	This Work
$4d_{3/2} \rightarrow 5p_{3/2}$	6.499E+06	6.680E+06		0.0131	0.0068	0.2240	0.2310
$3d_{5/2} \rightarrow 5p_{3/2}$	4.700E+07	4.920E+07		0.0061	0.0032	0.0486	0.0510
$4d_{5/2} \rightarrow 5p_{3/2}$	5.851E+07	6.010E+07		0.0787	0.0405	2.0170	2.0800
$2s_{1/2} \rightarrow 5p_{3/2}$	1.206E+09	1.210E+09	11.2000	0.0179	0.0180	0.0263	0.0264
$3s_{1/2} \rightarrow 5p_{3/2}$	3.114E+08	3.110E+08	3.0020	0.0437	0.0437	0.1971	0.1970
$4s_{1/2} \rightarrow 5p_{3/2}$	1.081E+08	1.080E+08	1.0630	0.1433	0.1430	1.9863	1.9900
$5s_{1/2} \rightarrow 5p_{3/2}$	2.277E+06	2.270E+06	0.0227	0.5582	0.5570	105.1729	105.0000
$3d_{3/2} \rightarrow 6p_{3/2}$	2.717E+06	2.860E+06		0.0004	0.0002	0.0017	0.0018
$4d_{3/2} \rightarrow 6p_{3/2}$	3.186E+06	3.290E+06		0.0026	0.0014	0.0284	0.0294
$5d_{3/2} \rightarrow 6p_{3/2}$	3.245E+06	3.310E+06		0.0223	0.0114	0.7015	0.7170
$3d_{5/2} \rightarrow 6p_{3/2}$	2.446E+07	2.580E+07		0.0023	0.0012	0.0155	0.0164
$4d_{5/2} \rightarrow 6p_{3/2}$	2.868E+07	2.960E+07		0.0157	0.0081	0.2560	0.2650
$5d_{5/2} \rightarrow 6p_{3/2}$	2.922E+07	2.980E+07		0.1336	0.0683	6.3171	6.4500
$2s_{1/2} \rightarrow 6p_{3/2}$	7.108E+08	7.150E+08		0.0096	0.0097	0.0134	0.0135
$3s_{1/2} \rightarrow 6p_{3/2}$	1.912E+08	1.910E+08		0.0203	0.0203	0.0796	0.0796
$4s_{1/2} \rightarrow 6p_{3/2}$	7.589E+07	7.560E+07		0.0471	0.0470	0.4468	0.4460
$5s_{1/2} \rightarrow 6p_{3/2}$	3.312E+07	3.300E+07		0.1535	0.1530	3.9781	3.9700
$6s_{1/2} \rightarrow 6p_{3/2}$	8.951E+05	9.000E+05		0.6731	0.6780	222.1530	224.0000
$3d_{3/2} \rightarrow 7p_{3/2}$	1.605E+06	1.700E+06		0.0002	0.0001	0.0008	0.0008
$4d_{3/2} \rightarrow 7p_{3/2}$	1.814E+06	1.880E+06		0.0010	0.0005	0.0090	0.0093
$5d_{3/2} \rightarrow 7p_{3/2}$	1.760E+06	1.810E+06		0.0045	0.0023	0.0877	0.0904
$6d_{3/2} \rightarrow 7p_{3/2}$	1.704E+06	1.730E+06		0.0322	0.0164	1.6868	1.7200
$3d_{5/2} \rightarrow 7p_{3/2}$	1.445E+07	1.530E+07		0.0011	0.0006	0.0071	0.0075
$4d_{5/2} \rightarrow 7p_{3/2}$	1.633E+07	1.690E+07		0.0060	0.0031	0.0807	0.0836
$5d_{5/2} \rightarrow 7p_{3/2}$	1.584E+07	1.620E+07		0.0272	0.0140	0.7901	0.8090
$6d_{5/2} \rightarrow 7p_{3/2}$	1.534E+07	1.560E+07		0.1935	0.0985	15.1918	15.5000
$2s_{1/2} \rightarrow 7p_{3/2}$	4.517E+08	4.550E+08		0.0058	0.0058	0.0078	0.0079
$3s_{1/2} \rightarrow 7p_{3/2}$	1.238E+08	1.240E+08		0.0113	0.0113	0.0411	0.0412
$4s_{1/2} \rightarrow 7p_{3/2}$	5.095E+07	5.080E+07		0.0223	0.0223	0.1781	0.1780
$5s_{1/2} \rightarrow 7p_{3/2}$	2.524E+07	2.520E+07		0.0508	0.0508	0.8662	0.8660
$6s_{1/2} \rightarrow 7p_{3/2}$	1.268E+07	1.260E+07		0.1650	0.1640	7.1649	7.1300
$7s_{1/2} \rightarrow 7p_{3/2}$	4.077E+05	4.100E+05		0.7874	0.7930	416.4325	420.0000
$3d_{3/2} \rightarrow 8p_{3/2}$	1.032E+06	1.100E+06		0.0001	0.0001	0.0004	0.0005
$4d_{3/2} \rightarrow 8p_{3/2}$	1.140E+06	1.180E+06		0.0005	0.0003	0.0041	0.0042
$5d_{3/2} \rightarrow 8p_{3/2}$	1.070E+06	1.100E+06		0.0018	0.0009	0.0273	0.0281
$6d_{3/2} \rightarrow 8p_{3/2}$	9.939E+05	1.010E+06		0.0067	0.0034	0.2083	0.2120
$3d_{5/2} \rightarrow 8p_{3/2}$	9.294E+06	9.870E+06		0.0007	0.0004	0.0039	0.0041
$4d_{5/2} \rightarrow 8p_{3/2}$	1.026E+07	1.070E+07		0.0030	0.0016	0.0365	0.0381
$5d_{5/2} \rightarrow 8p_{3/2}$	9.633E+06	9.910E+06		0.0106	0.0055	0.2457	0.2530
$6d_{5/2} \rightarrow 8p_{3/2}$	8.948E+06	9.130E+06		0.0401	0.0205	1.8754	1.9200
$2s_{1/2} \rightarrow 8p_{3/2}$	3.042E+08	3.070E+08		0.0038	0.0038	0.0050	0.0051
$3s_{1/2} \rightarrow 8p_{3/2}$	8.418E+07	8.400E+07		0.0070	0.0070	0.0243	0.0243
$4s_{1/2} \rightarrow 8p_{3/2}$	3.519E+07	3.510E+07		0.0127	0.0127	0.0916	0.0916
$5s_{1/2} \rightarrow 8p_{3/2}$	1.802E+07	1.800E+07		0.0243	0.0243	0.3397	0.3400
$6s_{1/2} \rightarrow 8p_{3/2}$	1.023E+07	1.020E+07		0.0546	0.0545	1.5162	1.5100
$7s_{1/2} \rightarrow 8p_{3/2}$	5.658E+06	5.570E+06		0.1773	0.1750	11.9461	11.8000
$8s_{1/2} \rightarrow 8p_{3/2}$	2.067E+05	2.080E+05		0.9012	0.9090	716.1562	722.0000
$3d_{3/2} \rightarrow 9p_{3/2}$	7.049E+05	7.580E+05		0.0001	0.0000	0.0003	0.0003
$4d_{3/2} \rightarrow 9p_{3/2}$	7.666E+05	7.780E+05		0.0003	0.0002	0.0022	0.0023
$5d_{3/2} \rightarrow 9p_{3/2}$	7.048E+05	7.280E+05		0.0009	0.0005	0.0122	0.0127
$6d_{3/2} \rightarrow 9p_{3/2}$	6.355E+05	6.650E+05		0.0026	0.0014	0.0640	0.0671
$3d_{5/2} \rightarrow 9p_{3/2}$	6.347E+06	6.820E+06		0.0004	0.0002	0.0024	0.0026
$4d_{5/2} \rightarrow 9p_{3/2}$	6.902E+06	7.010E+06		0.0018	0.0009	0.0200	0.0203
$5d_{5/2} \rightarrow 9p_{3/2}$	6.345E+06	6.550E+06		0.0054	0.0028	0.1101	0.1140
$6d_{5/2} \rightarrow 9p_{3/2}$	5.721E+06	5.980E+06		0.0157	0.0082	0.5765	0.6040
$2s_{1/2} \rightarrow 9p_{3/2}$	2.144E+08	2.110E+08		0.0026	0.0026	0.0034	0.0034
$3s_{1/2} \rightarrow 9p_{3/2}$	5.967E+07	5.940E+07		0.0047	0.0047	0.0157	0.0157
$4s_{1/2} \rightarrow 9p_{3/2}$	2.515E+07	2.460E+07		0.0080	0.0078	0.0543	0.0533
$5s_{1/2} \rightarrow 9p_{3/2}$	1.305E+07	1.290E+07		0.0139	0.0138	0.1733	0.1720
$6s_{1/2} \rightarrow 9p_{3/2}$	7.642E+06	7.700E+06		0.0262	0.0265	0.5848	0.5900
$7s_{1/2} \rightarrow 9p_{3/2}$	4.760E+06	4.700E+06		0.0585	0.0578	2.4668	2.4400
$8s_{1/2} \rightarrow 9p_{3/2}$	2.821E+06	2.850E+06		0.1901	0.1920	18.7786	19.0000
$9s_{1/2} \rightarrow 9p_{3/2}$	1.136E+05	1.130E+05		1.0146	1.0100	1153.8298	1150.0000
$2p_{1/2} \rightarrow 3s_{1/2}$	1.415E+09	1.420E+09		0.0372	0.0375	0.1029	0.1030
$2p_{3/2} \rightarrow 3s_{1/2}$	2.831E+09	2.850E+09		0.0373	0.0376	0.2061	0.2080
$2p_{1/2} \rightarrow 4s_{1/2}$	5.260E+08	5.320E+08		0.0069	0.0070	0.0136	0.0137
$3p_{1/2} \rightarrow 4s_{1/2}$	3.574E+08	3.590E+08		0.0809	0.0814	0.6554	0.6600
$2p_{3/2} \rightarrow 4s_{1/2}$	1.052E+09	1.060E+09		0.0069	0.0070	0.0271	0.0274
$3p_{3/2} \rightarrow 4s_{1/2}$	7.153E+08	7.180E+08		0.0810	0.0815	1.3131	1.3200
$2p_{1/2} \rightarrow 5s_{1/2}$	2.535E+08	2.570E+08		0.0026	0.0027	0.0045	0.0046

Configurations	Transition Probability			Oscillator Strength		Line Strength	
Lower level - Upper level	This Work	NIST	Zheng ($\times 10^8$)	This Work	NIST	NIST	This Work
$3p_{1/2} \rightarrow 5s_{1/2}$	1.623E+08	1.630E+08		0.0155	0.0156	0.0812	0.0818
$4p_{1/2} \rightarrow 5s_{1/2}$	1.165E+08	1.170E+08		0.1270	0.1280	2.2562	2.2700
$2p_{3/2} \rightarrow 5s_{1/2}$	5.072E+08	5.150E+08		0.0026	0.0027	0.0090	0.0092
$3p_{3/2} \rightarrow 5s_{1/2}$	3.247E+08	3.260E+08		0.0155	0.0156	0.1626	0.1640
$4p_{3/2} \rightarrow 5s_{1/2}$	2.332E+08	2.340E+08		0.1272	0.1280	4.5199	4.5400
$2p_{1/2} \rightarrow 6s_{1/2}$	1.416E+08	1.430E+08		0.0013	0.0013	0.0021	0.0021
$3p_{1/2} \rightarrow 6s_{1/2}$	8.824E+07	8.880E+07		0.0060	0.0060	0.0264	0.0266
$4p_{1/2} \rightarrow 6s_{1/2}$	5.977E+07	6.000E+07		0.0245	0.0246	0.2663	0.2680
$5p_{1/2} \rightarrow 6s_{1/2}$	4.621E+07	4.640E+07		0.1741	0.1750	5.7538	5.7900
$2p_{3/2} \rightarrow 6s_{1/2}$	2.834E+08	2.850E+08		0.0013	0.0013	0.0042	0.0043
$3p_{3/2} \rightarrow 6s_{1/2}$	1.765E+08	1.770E+08		0.0060	0.0060	0.0529	0.0531
$4p_{3/2} \rightarrow 6s_{1/2}$	1.196E+08	1.200E+08		0.0245	0.0246	0.5332	0.5360
$5p_{3/2} \rightarrow 6s_{1/2}$	9.249E+07	9.270E+07		0.1744	0.1750	11.5276	11.6000
$2p_{1/2} \rightarrow 7s_{1/2}$	8.720E+07	8.660E+07		0.0007	0.0007	0.0012	0.0012
$3p_{1/2} \rightarrow 7s_{1/2}$	5.351E+07	5.390E+07		0.0030	0.0031	0.0122	0.0124
$4p_{1/2} \rightarrow 7s_{1/2}$	3.527E+07	3.540E+07		0.0095	0.0096	0.0844	0.0849
$5p_{1/2} \rightarrow 7s_{1/2}$	2.575E+07	2.580E+07		0.0336	0.0338	0.6541	0.6570
$6p_{1/2} \rightarrow 7s_{1/2}$	2.111E+07	2.120E+07		0.2219	0.2230	12.2465	12.3000
$2p_{3/2} \rightarrow 7s_{1/2}$	1.745E+08	1.730E+08		0.0007	0.0007	0.0024	0.0023
$3p_{3/2} \rightarrow 7s_{1/2}$	1.071E+08	1.080E+08		0.0030	0.0031	0.0245	0.0248
$4p_{3/2} \rightarrow 7s_{1/2}$	7.057E+07	7.080E+07		0.0095	0.0096	0.1689	0.1700
$5p_{3/2} \rightarrow 7s_{1/2}$	5.152E+07	5.170E+07		0.0337	0.0338	1.3098	1.3200
$6p_{3/2} \rightarrow 7s_{1/2}$	4.224E+07	4.230E+07		0.2222	0.2230	24.5370	24.6000
$2p_{1/2} \rightarrow 8s_{1/2}$	5.751E+07	1.610E+09		0.0005	0.0132	0.0007	0.0204
$3p_{1/2} \rightarrow 8s_{1/2}$	3.497E+07	3.520E+07		0.0018	0.0018	0.0068	0.0069
$4p_{1/2} \rightarrow 8s_{1/2}$	2.269E+07	2.280E+07		0.0049	0.0049	0.0386	0.0389
$5p_{1/2} \rightarrow 8s_{1/2}$	1.612E+07	1.620E+07		0.0132	0.0133	0.2026	0.2040
$6p_{1/2} \rightarrow 8s_{1/2}$	1.248E+07	1.250E+07		0.0429	0.0430	1.3523	1.3600
$7p_{1/2} \rightarrow 8s_{1/2}$	1.070E+07	1.080E+07		0.2700	0.2730	23.0822	23.3000
$2p_{3/2} \rightarrow 8s_{1/2}$	1.151E+08	3.220E+09		0.0005	0.0132	0.0015	0.0408
$3p_{3/2} \rightarrow 8s_{1/2}$	6.996E+07	7.030E+07		0.0018	0.0018	0.0136	0.0137
$4p_{3/2} \rightarrow 8s_{1/2}$	4.539E+07	4.550E+07		0.0049	0.0049	0.0773	0.0776
$5p_{3/2} \rightarrow 8s_{1/2}$	3.225E+07	3.230E+07		0.0132	0.0132	0.4056	0.4070
$6p_{3/2} \rightarrow 8s_{1/2}$	2.498E+07	2.500E+07		0.0429	0.0430	2.7077	2.7100
$7p_{3/2} \rightarrow 8s_{1/2}$	2.142E+07	2.160E+07		0.2704	0.2730	46.2496	46.7000
$2p_{1/2} \rightarrow 9s_{1/2}$	3.993E+07	3.900E+07		0.0003	0.0003	0.0005	0.0005
$3p_{1/2} \rightarrow 9s_{1/2}$	2.413E+07	2.420E+07		0.0011	0.0012	0.0042	0.0043
$4p_{1/2} \rightarrow 9s_{1/2}$	1.550E+07	1.520E+07		0.0029	0.0029	0.0214	0.0210
$5p_{1/2} \rightarrow 9s_{1/2}$	1.084E+07	1.080E+07		0.0068	0.0068	0.0914	0.0913
$6p_{1/2} \rightarrow 9s_{1/2}$	8.170E+06	8.230E+06		0.0168	0.0170	0.4108	0.4140
$7p_{1/2} \rightarrow 9s_{1/2}$	6.625E+06	6.600E+06		0.0522	0.0520	2.4905	2.4900
$8p_{1/2} \rightarrow 9s_{1/2}$	5.884E+06	5.930E+06		0.3184	0.3210	39.8587	40.2000
$2p_{3/2} \rightarrow 9s_{1/2}$	7.989E+07	7.800E+07		0.0003	0.0003	0.0010	0.0009
$3p_{3/2} \rightarrow 9s_{1/2}$	4.828E+07	4.840E+07		0.0011	0.0012	0.0085	0.0085
$4p_{3/2} \rightarrow 9s_{1/2}$	3.101E+07	3.030E+07		0.0029	0.0028	0.0427	0.0418
$5p_{3/2} \rightarrow 9s_{1/2}$	2.168E+07	2.170E+07		0.0068	0.0068	0.1830	0.1830
$6p_{3/2} \rightarrow 9s_{1/2}$	1.635E+07	1.650E+07		0.0168	0.0170	0.8224	0.8310
$7p_{3/2} \rightarrow 9s_{1/2}$	1.326E+07	1.320E+07		0.0522	0.0521	4.9868	4.9700
$8p_{3/2} \rightarrow 9s_{1/2}$	1.178E+07	1.180E+07		0.3188	0.3200	79.8675	80.2000

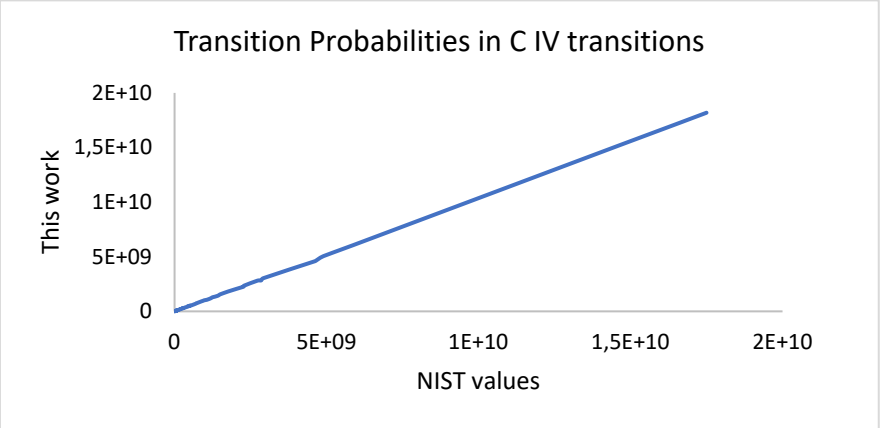

Figure 1. Plot of transition probabilities listed in the NIST database and corresponding calculated values

Table II. Lifetimes of Rydberg levels of C IV

State	Lifetime (ns)	State	Lifetime (ns)	State	Lifetime (ns)	State	Lifetime (ns)	State	Lifetime (ns)
3s	0.236	2p	3.658	4d	0.127	4f	0.281	5g	0.918
4s	0.377	3p	0.216	5d	0.244	5f	0.544	6g	1.571
5s	0.626	4p	0.346	6d	0.416	6f	0.932	7g	2.479
6s	0.992	5p	0.573	7d	0.655	7f	1.467	8g	3.681
7s	1.495	6p	0.906	8d	0.971	8f	2.175	9g	5.216
8s	2.157	7p	1.362	9d	1.374	9f	3.080	10g	7.126
9s	3.000	8p	1.961	10d	1.877	10f	4.206	11g	9.452
10s	4.046	9p	2.723	11d	2.489	11f	5.577	12g	12.235
11s	5.317	10p	3.665	12d	3.222	12f	7.218	13g	15.516
12s	6.837	11p	4.810	13d	4.086	13f	9.152	14g	19.337
13s	8.627	12p	6.176	14d	5.093	14f	11.404	15g	23.739
14s	10.711	13p	7.784	15d	6.253	15f	13.998	16g	28.763
15s	13.111	14p	9.653	16d	7.577	16f	16.960	17g	34.450
16s	15.849	15p	11.804	17d	9.077	17f	20.311	18g	40.841
17s	18.948	16p	14.256	18d	10.763	18f	24.079	19g	47.978
18s	22.432	17p	17.030	19d	12.646	19f	28.285	20g	55.902
19s	26.322	18p	20.145	20d	14.737	20f	32.956	21g	64.654
20s	30.641	19p	23.622	21d	17.046	21f	38.115	22g	74.275
21s	35.412	20p	27.481	22d	19.586	22f	43.786	23g	84.807
22s	40.658	21p	31.742	23d	22.366	23f	49.994	24g	96.292
23s	46.401	22p	36.424	24d	25.398	24f	56.764	25g	108.769
24s	52.665	23p	41.548	25d	28.692	25f	64.119		
25s	59.471	24p	47.134						
		25p	53.202						

A locally developed python program was used to fit a polynomial for each of the known values of lifetimes of Rydberg series. The lifetime for the series ns, np, nd, nf, and ng can be given a function of principal quantum number (n) in the form of a sixth-degree polynomial; the coefficients for the respective series are given in Table III

$$\tau_n = a_o + a_1 n + a_2 n^2 + a_3 n^3 + a_4 n^4 + a_5 n^5 + a_6 n^6$$

Table III. Coefficients of the sixth-degree polynomial for calculation of lifetimes of C IV series

Series	a_0	a_1	a_2	a_3	a_4	a_5	a_6	'n' value
ng	-8.26E-04	-8.90E-03	5.07E-03	6.63E-03	9.77E-06	-2.11E-07	1.93E-09	$5 \leq n$
nf	-7.74E-03	-2.88E-04	2.22E-03	3.97E-03	2.90E-06	-5.50E-08	4.56E-10	$4 \leq n$
nd	-1.73E-03	3.33E-04	8.48E-04	1.77E-03	1.91E-06	-4.40E-08	4.28E-10	$4 \leq n$
np	2.15E-01	-7.53E-02	1.98E-02	1.49E-03	9.59E-05	-2.56E-06	2.75E-08	$3 \leq n$
ns	2.30E-01	-7.87E-02	2.05E-02	1.75E-03	1.05E-04	-2.79E-06	2.99E-08	$3 \leq n$

CONCLUSION

An extended work has been carried out to determine the transition probabilities, oscillator strengths, and line strength for the transition in Rydberg levels of C IV. Total of 5250 transitions were studied. The calculated values were compared with the reported and NIST database values. The NIST database only contains 224 out of 5250 transitions (see Table I). That is, most of the values are reported for the first time. The maximum value of transition probabilities does not occur between the two lowest-lying levels, as is the case of the Li atom; instead, it occurs for the transition $1s^2 3d_{3/2} - 1s^2 2p_{1/2}$. Most transition probabilities are close to the reported values; a difference up to 7% has been observed in a few cases. A 99.9% correlation is found between calculated and known values of Transition probabilities (see Fig. 1). The comparison of calculated values of oscillator strengths and lines strengths with those listed in NIST shows a good agreement. Only 224 values of transition probabilities, oscillator strengths, and line strengths have been presented in this manuscript; a separate supplementary file contains all the 5250 values. The lifetimes of the first 25 levels of the Rydberg Series ns, np, nd, nf, and ng have also been calculated. A function of principal quantum number can calculate the lifetime; a sixth-degree polynomial gives this function for each Rydberg series for C IV.

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РОЗРАХУНОК ХАРАКТЕРИСТИК C IV ПЕРЕХОДІВ

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У цьому дослідженні ми обчислили ймовірності переходів, потужність лінії та потужність осцилятора понад 5000 переходів у C IV. Дуже небагато значень цих спектроскопічних характеристик були раніше відомі та повідомлені. На основі поєднання моделі найслабшого зв'язку електрона та чисельної апроксимації метод розрахунку показує надійні значення, оскільки кореляція між відомими та обчисленими значеннями висока. Імовірності переходу, розраховані в цій роботі, порівнюються з доступними значеннями бази даних NIST і тими, що містяться в літературі, і спостерігається досить хороша згода. Тривалість життя рівнів Рідберга ns, np, nd, nf, ng була повідомлена до n = 25. Було розроблено загальний поліном шостого ступеня, який генерує час життя C IV із достатньою точністю. Більшість представлених результатів є новими.

Ключові слова: *атом вуглецю; ймовірність переходу; сила осцилятора; атом Рідберга; квантові дефекти*