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ABSTRACT

Using the impact semiclassical perturbation approach, widths and shifts of the 4s-4p configuration of Fe V spectral line profiles due to collisions with electrons, H^+, He^+ and He^{2+} ions, have been calculated in the physical conditions of hot white dwarfs. Energy levels and oscillator strengths needed for the calculation have been obtained by using the Hartree–Fock method with relativistic corrections. The results may be of interest not only for spectroscopic diagnostics in astrophysics, but also for laboratory plasmas, and technological plasmas. The obtained results will enter the STARK-B database which is in free access and which is a node of the Virtual Atomic and Molecular Data Center - VAMDC.

Key words: atomic data – atomic processes – line: formation

1 INTRODUCTION

The variability of the fundamental constants, especially the variability of the fine structure constant (the so-called alpha) has been long a subject of a (major) large debate within the scientific community: in particular, a measurement of the space-time variation of alpha would be a test for string theory, for going beyond the Standard Model of particle physics. J.K. Webb and his coworkers have tried to obtain a probe of the space-time variability of the fine structure constant for many years: to cite only two among many publications, Webb, et al. (2001), Webb, et al. (2011). Recently Berengut, et al. (2013) proposed a new probe of dependence of the fine structure constant on the gravity. For that they proposed to make measurements of the shifts of certain spectral lines of the atmospheres of hot white-dwarfs, where the gravity is very high (about 10^4–10^5 that on Earth). They proposed to use spectral UV lines of Fe V and Ni V, and made measurements with the HST STIS. The interest of the method was presented in Bainbridge, et al. (2017). Then, Hu, et al. (2019) analyzed very accurate results of observations of the G291-B2B white dwarf obtained by the HST and its STIS (Space telescope imaging spectrograph), obtained in the 1150-1900 Å wavelength domain. Among the needed accurate atomic data, due to the high electron density of the atmosphere of these white dwarfs, the shifts and also widths of the line profiles due to collisions with electron and positive ions of the medium (the so-called 'Stark broadening") are needed. To our knowledge, no such data exist in the literature for Fe V lines. The Stark widths of the Kurucz database (http://kurucz.harvard.edu/atoms.html) are obtained by means of a fit by Peytremann (1972) to detailed calculations by Sahal-Bréchot & Segre (1971).

So, the object of the present paper is to calculate these missing data for Fe V lines. We will use the semiclassical impact perturbation theory (SCP) and the computer code of Sahal-Bréchot, Dimitrijević and coworkers. A summary of that theory and approximations can be found in Sahal-Bréchot, Dimitrijević & Ben Nessib (2014) and earlier papers cited in it. The numerical calculations are very fast. Thus the method is especially adapted for obtaining a great number of data in a same run. The SCP widths agree with the other theoretical methods (Alexiou, et al. 2014; Sahal-Bréchot, et al. 2018; Duan, et al. 2012, 2013), and with experimental results (Elabidi, Sahal-Bréchot & Ben Nessib 2009; Hamdi, et al. 2013, 2018) for instance. Comparing all these different results, the average accuracy can be estimated as 20-30% for the width. The SCP shifts are sometimes less accurate (Hamdi, et al. 2019). This is due to subtractions effects between the upper and the lower level of the studied line. To our knowledge, for ionized atomic lines, it has to be noted that the only quantum close coupling

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shifts calculations, are those of Barnes & Peach (1970) and of the GRASP/DARC method (Duan, et al. 2012, 2013), but the calculations are very long. In fact, most of the current results of calculations providing a great number of results are semi-classical. In fact, the SCP accuracy of the currently published data is most often sufficient for the needs of users, and a number of published data can be found in the STARK-B database (http://stark-b.obspm.fr), which is a node of the VAMDC (Virtual Atomic and Molecular Data Center, http://www.vamdc.org/).

Section 2 provides a brief summary of the impact semiclassical perturbation method and formulae used in the calculations. The necessary atomic structure data are obtained by means of the Cowan code (Cowan 1981). The set of atomic structure data used in the calculation of the Stark widths and shifts is specified.

In Section 3, these obtained atomic structure data are compared to those of Kramida (2014); Kramida et al. (2019) and presented in Table 1. Then the widths and shifts calculations have been made for the 4s - 4p spectral lines of Fe V, for collisions with electrons, protons, He^+ and He^{2+} ions within a temperature range from 50 000 to 600 000 K and a perturber density of 10^{17} cm^{-3}, 10^{18} cm^{-3} and 10^{19} cm^{-3}. The results for the widths are presented in Table 2, and for the shifts in Table 3. The chosen range of temperatures and densities includes the range of temperatures and densities which play a role in the G191-B2B white dwarf. Highest temperatures are useful for the white dwarfs with very hot atmospheres (Wesemael 1981).

2 THE IMPACT SEMICLASSICAL PERTURBATION METHOD

In this work, we combine the multiconfiguration pseudo-relativistic Hartree-Fock approach suite of codes and the semiclassical perturbation code (SCP) to calculate Stark widths and shifts for 4s-4p spectral lines of Fe V ion.

A detailed description of SCP formalism with all the innovations is given in Sahal-Bréchot (1969a,b, 1974, 1991); Fleurier, Sahal-Bréchot & Chapelle (1977); Dimitrijević, Sahal-Bréchot & Bommier (1991); Dimitrijević & Sahal-Bréchot (1996); Sahal-Bréchot, Dimitrijević & Ben Nessib (2014). First, the impact approximation is made, which means that the interactions between the radiating atom and the colliding perturbers are separated in time. In other words, this means that the mean duration of an interaction is much smaller than the mean interval between two collisions. Second, the method is restricted to "isolated lines", which means that neighbouring levels do not overlap. Consequently the profile is Lorentzian.

Previously, we applied an analogous method for the Pb IV ion (Hamdi, et al. 2013) and for Ar II ion (Hamdi, et al. 2018, 2019). The accuracy of our method was checked by comparing our calculated Stark broadening parameters with available experimental results. For most studied spectral lines, our results and experimental ones agree within their respective accuracy.

The SCP method need a sufficient set of energy levels and oscillator strengths. When the set of atomic data for an atom or ion is not sufficient, the SCP method cannot be applied. In this work, we use for atomic data calculations 16 configurations: $3d^4$; $3d^3$ nl (nl = 4s, 4d, 5s, 5d, 6s, 6d, 7s, 7d) (even parity) and $3d^3$ $n'l'$ ($n'l'$ = 4p, 4f, 5p, 5f, 6p, 6f, 7p) (odd parity). Energy levels and oscillator strengths are calculated using Cowan code ab initio procedure. Mean radius and mean square radius are calculated using hydrogenic approximation. In fact, the use of the mean radius and the mean square radius of the levels which enter the atomic data does not cause any significant difference in the results.

3 STARK BROADENING PARAMETERS

Since no experimental or other theoretical Stark broadening parameters are found in literature to compare, we compare only our calculated atomic data (used as input parameters for Stark broadening calculation) with the values taken from NIST database (Kramida et al. 2019). In Table 1, we compare our calculated wavelengths, oscillator strengths and transitions probabilities with the values taken from NIST database (Kramida et al. 2019). **In NIST database the wavelengths are given with very high accuracy (three and four decimal places), in Table 1, the wavelengths are presented with two decimal places.** The accuracies of the data taken from NIST database is B and C+ for 4s-4p transitions, C+ and C for 4p-4d transitions. Our calculated wavelengths agree with NIST ones within 1.2 % in average. Our oscillator strengths agree with NIST values within 10-20 %. In NIST database, the code letters used for the accuracies indicate the following:
B: uncertanties $\leq$ 10%
C+: uncertanties $\leq$ 18%
C: uncertanties $\leq$ 25%

In Table 2, we present our calculated Stark widths for some 4s - 4p transitions of Fe V ion of astrophysical interest. Stark widths are calculated for collisions with electrons, protons, singly and doubly charged helium ions using the impact semiclassical perturbation method (SCP). Calculations are made for a perturber density of 10^{17} cm^{-3} and a temperature range of 50 000 to 600 000 K. **The spectral lines presented in Table 2 were observed by Preval, et al. (2013) in the hot DA white dwarf G191-B2B**. Two sets of atomic data are used as input parameters of SCP calculation. The first set of energy levels and oscillator strengths is calculated using Hartree-Fock approach with relativistic corrections (Cowan 1981), the second set of energy levels and oscillator strengths is taken from NIST database. Since a small difference is found between observed and calculated wavelengths, we have corrected our widths obtained using HFR approach atomic data using Eq (8) of Hamdi, et al. (2013). For (^{2}D2) 4s ^{3}D$_1$ - (^{2}D2) 4p ^{3}P$^o_0$ (λ = 1331.19 Å) spectral line, the set of atomic data found in NIST database is not sufficiently complete to perform a suitable SCP calculation of Stark widths. For this reason Stark widths calculated using Cowan code atomic data are only given. As we can see from Table 2, the difference between results obtained using Cowan atomic data and results obtained using NIST atomic data is not large and does not exceed the limit of accuracy of SCP method. For example, for collisions with electrons, the average ratio between the two sets of results is 1.08 for the temperature 50 000 K. In Table 3 and Table 4, our Stark widths are presented for a perturber density of 10^{18} cm^{-3} and 10^{19} cm^{-3} respec-

tively. For all values given in Table 2, Table 3 and Table 4, the impact approximation is valid since the collision volume V multiplied by the perturber density N is much smaller than 1 (Sahal-Bréchot, Dimitrijević & Ben Nessib 2014). When the impact approximation reaches its limit of validity ($0.1<N\,V\leq 0.5$), the values are preceded by an asterisk.

Our Stark shifts are given in Table 5, Table 6 and Table 7 for a perturber density of 10^{17} cm^{-3}, 10^{18} cm^{-3} and 10^{19} cm^{-3} respectively for the same transitions presented in Table 2. **A positive shift is towards the red, a negative one is towards the blue.** Stark shifts are also calculated using both Cowan code and NIST atomic data. For Stark shifts, the difference between results obtained using the Cowan code atomic data and the NIST atomic data is larger than the difference found for the width. For collisions with electrons, the average ratio between the two sets of results is 1.6 for the temperature 50 000 K. The largest difference (280 %) is found for the transition (^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$ ($\lambda = 1321.49$ Å). The smallest difference (21%) is found for the transition (^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$.

4 LARGE SCALE CALCULATION

Our large-scale calculations of Stark widths and shifts for 4s-4p spectral lines of Fe V ion using the SCP approach and the preceding atomic structure data are presented in Table 8.The calculations have been made for a perturber density of 10^{17} cm^{-3} and a temperature range of 5 10^4 to 6 10^6K. All wavelengths given in Table 8 are taken from the National Institute of Standards and Technology (NIST). Our Stark broadening parameters for the electron densities 10^{18} cm^{-3} and 10^{19} cm^{-3} are presented in Table 9 and Table 10 respectively. We present here the results for two spectral lines only as a sample showing the content and the form of the additional data.

The complete results for 238 spectral lines of Fe V ion are given as additional data in electronic form in the online journal. Stark full widths and shifts at half intensity maximum (FWHM) are given for electron, proton, singly and doubly charged helium colliders. In this way we give results for most abundant colliders in hot white dwarf atmospheres. **The wavelengths of the transitions given in Table 8 are from 1111.83 Å to 1654.75 Å.**

In Table 8, we also specify a parameter C (Dimitrijević & Sahal-Bréchot 1984), which gives an estimate for the maximal perturber density for which the line may be treated as isolated when it is divided by the corresponding FWHM. For all values given in Table 8, the impact approximation is valid since the collision volume V multiplied by the perturber density N is much smaller than 1 (Sahal-Bréchot, Dimitrijević & Ben Nessib 2014). For $0.1<N\,V\leq 0.5$, the impact approximation reaches its limit of validity and the values are marked by an asterisk. It can be seen that for the chosen temperatures and density conditions, the impact approximation is always valid and that all the lines are isolated, except for He^{++} widths and shifts at 10^{19} cm^{-3}. This shows that the Stark shifts cannot be calculated within the quasistatic approximation (i.e. assuming a static field) in the case of G191-B2B (Hu, et al. 2019), since the impact approximation is valid (except the case of He^{++} at 10^{19} cm^{-3}).

All the data presented in Table 8, Table 9 and Table 10 will be implemented in the STARK-B database which is in free access (http://stark-b.obspm.fr/), and which contains widths and shifts of isolated lines of neutral and ionized elements, perturbed by electron and ion impacts. It is devoted to modelling and spectroscopic diagnostics of stellar atmospheres and envelopes, laboratory and fusion plasmas, laser equipment and technological plasmas. STARK-B is a node of the Virtual Atomic and Molecular Data Center (VAMDC Consortium: http://www.vamdc.eu/. STARK-B is also in free access via the VAMDC portal: https://portal.vamdc.eu).

5 CONCLUSIONS

Using the Hartree-Fock approach with relativistic corrections for the calculations of energy levels and oscillator strengths, and the semiclassical perturbation approach in impact approximation, we have determined Stark widths and shifts for spectral lines of Fe V ion. All studied lines belong to the 4s-4p transition array. Since Stark broadening and shifting is an important mechanism for spectroscopic diagnostics of the atmospheres with high surface gravity, we hope that these obtained results will be useful for the scientists who study the atmospheres of this kind of stars, and especially for those who search any possible variation of the fine structure constant in the presence of strong gravitational fields.

Table 1. Our calculated wavelengths, oscillator strengths and transition probabilities in s^{-1} for Fe V ion compared with the values taken from NIST database (Kramida et al. 2019).

Upper level (i)	Lower level (j)	λ (Å) This work	λ (Å) NIST	f_{ij} This work	f_{ij} NIST	A_{ji} This work	A_{ji} NIST	Acc.
(^2H) 4s $^3H_4$	(^2H) 4p $^3G^o_3$	1334.40	1320.41	1.72×10^{-1}	1.9×10^{-1}	8.29×10^{8}	9.2×10^{8}	C+
(^2H) 4s $^3H_5$	(^2H) 4p $^3G^o_4$	1330.74	1323.27	2.03×10^{-1}	1.8×10^{-1}	9.39×10^{8}	8.4×10^{8}	C+
(^2H) 4s $^3H_6$	(^2H) 4p $^3G^o_5$	1339.28	1330.41	2.27×10^{-1}	1.86×10^{-1}	1.00×10^{9}	8.3×10^{8}	B
(^2F) 4s $^1F_3$	(^2F) 4p $^1F^o_3$	1376.57	1354.84	3.08×10^{-1}	2.6×10^{-1}	1.08×10^{9}	9.4×10^{8}	C+
(^2F) 4s $^1F_3$	(^2F) 4p $^1G^o_4$	1391.87	1361.44	3.52×10^{-1}	2.9×10^{-1}	9.41×10^{8}	8.2×10^{8}	C+
$(^2D1)$ 4s $^1D_2$	$(^2D1)$ 4p $^1F^o_3$	1383.17	1361.69	4.39×10^{-1}	3.8×10^{-1}	1.09×10^{9}	9.7×10^{8}	C+
(^2F) 4s $^3F_4$	(^2F) 4p $^3G^o_5$	1384.06	1361.83	3.78×10^{-1}	3.2×10^{-1}	1.08×10^{9}	9.5×10^{8}	B
(^4F) 4s $^5F_4$	(^4F) 4p $^5F^o_4$	1385.27	1373.59	2.41×10^{-1}	2.0×10^{-1}	8.38×10^{8}	7.2×10^{8}	C+
(^2F) 4s $^3F_3$	(^2F) 4p $^3G^o_4$	1395.12	1374.12	3.87×10^{-1}	3.3×10^{-1}	1.03×10^{9}	9.0×10^{8}	B
$(^2D1)$ 4s $^3D_2$	$(^2D1)$ 4p $^3F^o_3$	1440.37	1374.79	2.82×10^{-1}	3.7×10^{-1}	6.48×10^{8}	9.2×10^{8}	C+
(^4F) 4s $^5F_5$	(^4F) 4p $^5F^o_5$	1387.23	1376.34	2.94×10^{-1}	2.22×10^{-1}	9.27×10^{8}	7.8×10^{8}	B
(^4P) 4s $^5P_3$	(^4P) 4p $^5D^o_4$	1392.63	1378.56	4.04×10^{-1}	3.5×10^{-1}	1.08×10^{9}	9.5×10^{8}	B
(^2H) 4s $^3H_6$	(^2H) 4p $^3I^o_7$	1405.62	1387.94	3.70×10^{-1}	3.2×10^{-1}	1.09×10^{9}	9.6×10^{8}	B
(^2H) 4s $^3H_5$	(^2H) 4p $^3I^o_6$	1418.04	1402.39	3.70×10^{-1}	3.2×10^{-1}	1.03×10^{9}	9.1×10^{8}	B
(^4F) 4s $^3F_4$	(^4F) 4p $^3F^o_4$	1417.53	1406.67	3.06×10^{-1}	2.52×10^{-1}	1.02×10^{9}	8.5×10^{8}	B
$(^2D2)$ 4s $^3D_3$	$(^2D2)$ 4p $^3F^o_4$	1429.17	1406.82	2.68×10^{-1}	3.0×10^{-1}	6.80×10^{8}	7.9×10^{8}	C+
(^2H) 4s $^1H_5$	(^2H) 4p $^1I^o_6$	1424.52	1407.25	3.74×10^{-1}	3.2×10^{-1}	1.04×10^{9}	9.0×10^{8}	B
(^4F) 4s $^5F_4$	(^4F) 4p $^5D^o_3$	1416.56	1409.22	2.23×10^{-1}	1.8×10^{-1}	9.54×10^{8}	7.7×10^{8}	C+
(^4F) 4s $^5F_5$	(^4F) 4p $^5D^o_4$	1418.06	1409.45	2.54×10^{-1}	2.13×10^{-1}	1.03×10^{9}	8.7×10^{8}	B
(^2H) 4s $^3H_4$	(^2H) 4p $^3I^o_5$	1430.08	1415.20	3.77×10^{-1}	3.3×10^{-1}	1.01×10^{9}	9.0×10^{8}	B
(^2G) 4s $^3G_5$	(^2G) 4p $^3G^o_5$	1433.15	1418.12	2.22×10^{-1}	1.8×10^{-1}	7.22×10^{8}	6.0×10^{8}	C+
(^4F) 4s $^5F_5$	(^4F) 4p $^5G^o_6$	1445.07	1430.57	3.76×10^{-1}	3.2×10^{-1}	1.01×10^{9}	8.8×10^{8}	B
$(^2D1)$ 4s $^3D_3$	$(^2D1)$ 4p $^3D^o_3$	1380.22	1439.05	1.71×10^{-1}	2.4×10^{-1}	6.00×10^{8}	7.8×10^{8}	C+
(^4F) 4s $^5F_4$	(^4F) 4p $^5G^o_5$	1452.48	1440.53	3.33×10^{-1}	2.73×10^{-1}	8.59×10^{8}	7.2×10^{8}	B
(^2G) 4s $^1G_4$	(^2G) 4p $^1H^o_5$	1460.41	1442.22	2.88×10^{-1}	2.5×10^{-1}	7.38×10^{8}	6.5×10^{8}	B
(^2P) 4s $^3P_2$	$(^2D2)$ 4p $^3P^o_2$	1457.95	1445.91	2.76×10^{-2}	2.8×10^{-2}	8.67×10^{7}	8.9×10^{7}	C+
(^2G) 4s $^3G_5$	(^2G) 4p $^3H^o_6$	1462.55	1446.62	2.70×10^{-1}	2.37×10^{-1}	7.12×10^{8}	6.4×10^{8}	B
(^2H) 4s $^1H_5$	(^2H) 4p $^1H^o_5$	1467.94	1453.62	2.40×10^{-1}	1.9×10^{-1}	7.44×10^{8}	6.1×10^{8}	C+
(^4F) 4s $^3F_2$	(^4F) 4p $^3G^o_3$	1468.26	1455.56	4.07×10^{-1}	3.3×10^{-1}	9.00×10^{8}	7.3×10^{8}	C+
(^2F) 4s $^3F_3$	(^2F) 4p $^3F^o_3$	1465.54	1459.26	2.60×10^{-1}	2.1×10^{-1}	7.95×10^{8}	6.5×10^{8}	C+
(^4F) 4s $^3F_3$	(^3F) 4p $^3G^o_4$	1472.36	1459.83	3.75×10^{-1}	3.0×10^{-1}	8.98×10^{8}	7.3×10^{8}	C+
(^2H) 4p $^1H^o_5$	(^2H) 4d $^1I_6$	853.61	891.87	5.62×10^{-1}	5.9×10^{-1}	4.35×10^{9}	4.2×10^{9}	C+
(^2H) 4p $^3H^o_5$	(^2H) 4d $^3H_5$	878.26	901.67	3.25×10^{-1}	3.9×10^{-1}	2.81×10^{9}	3.2×10^{9}	C
(^2H) 4p $^3H^o_4$	(^2H) 4d $^3H_4$	880.28	902.95	2.57×10^{-1}	3.1×10^{-1}	2.21×10^{9}	2.5×10^{9}	C
(^2H) 4p $^3H^o_6$	(^2H) 4d $^3H_6$	880.26	904.11	3.28×10^{-1}	4.0×10^{-1}	2.82×10^{9}	3.2×10^{9}	C+
(^2H) 4p $^1I^o_6$	(^2H) 4d $^1I_6$	869.02	910.27	2.38×10^{-1}	2.9×10^{-1}	2.09×10^{9}	2.3×10^{9}	C
(^2F) 4p $^1G^o_4$	(^2F) 4d $^1G_4$	904.38	923.14	2.47×10^{-1}	2.8×10^{-1}	2.02×10^{9}	2.2×10^{9}	C
(^4P) 4p $^5P^o_3$	(^4P) 4d $^5D_4$	905.28	936.52	4.69×10^{-1}	5.4×10^{-1}	2.97×10^{9}	3.2×10^{9}	C
(^2F) 4p $^3F^o_2$	(^2F) 4d $^3G_3$	945.68	955.74	3.91×10^{-1}	5.1×10^{-1}	2.09×10^{9}	2.6×10^{9}	C
(^2F) 4p $^3F^o_4$	(^2F) 4d $^3G_5$	947.61	960.14	3.43×10^{-1}	3.2×10^{-1}	2.09×10^{9}	1.9×10^{9}	C
(^2G) 4p $^3H^o_4$	(^2G) 4d $^3H_4$	986.00	967.23	2.20×10^{-1}	2.9×10^{-1}	1.48×10^{9}	2.0×10^{9}	C
(^2G) 4p $^3H^o_5$	(^2G) 4d $^3H_5$	989.02	969.89	1.85×10^{-1}	2.4×10^{-1}	1.27×10^{9}	1.7×10^{9}	C
(^4F) 4p $^5G^o_6$	(^4F) 4d $^5G_6$	995.46	978.84	2.47×10^{-1}	2.7×10^{-1}	1.66×10^{9}	1.9×10^{9}	C
(^2G) 4p $^3H^o_6$	(^2G) 4d $^3H_6$	996.65	979.57	2.68×10^{-1}	2.9×10^{-1}	1.80×10^{9}	2.0×10^{9}	C
(^2G) 4p $^3H^o_4$	(^2G) 4d $^3I_5$	1002.77	982.86	6.67×10^{-1}	7.2×10^{-1}	3.62×10^{9}	4.1×10^{9}	C+
(^4F) 4p $^5G^o_2$	(^4F) 4d $^5H_3$	1005.11	983.83	8.29×10^{-1}	9.1×10^{-1}	3.91×10^{9}	4.5×10^{9}	C+
(^4F) 4p $^3G^o_3$	(^4F) 4d $^5H_4$	1006.85	983.97	7.48×10^{-1}	8.2×10^{-1}	3.83×10^{9}	4.4×10^{9}	C+
(^2H) 4p $^3G^o_5$	(^2H) 4d $^3G_5$	966.10	984.18	1.34×10^{-1}	2.4×10^{-1}	9.55×10^{8}	1.6×10^{9}	C
(^2G) 4p $^3H^o_5$	(^2G) 4d $^3I_6$	1005.47	986.26	6.31×10^{-1}	6.6×10^{-1}	3.52×10^{9}	3.8×10^{9}	C+
(^4F) 4p $^5G^o_4$	(^4F) 4d $^5H_5$	1009.39	988.62	7.27×10^{-1}	7.9×10^{-1}	3.89×10^{9}	4.4×10^{9}	C+
(^4F) 4p $^3G^o_5$	(^4F) 4d $^3G_5$	1002.07	989.69	2.31×10^{-1}	2.6×10^{-1}	1.53×10^{9}	1.8×10^{9}	C
(^2G) 4p $^3G^o_3$	(^2G) 4d $^3H_4$	1008.94	989.87	2.80×10^{-1}	3.4×10^{-1}	1.45×10^{9}	1.8×10^{9}	C
(^2G) 4p $^3G^o_4$	(^2G) 4d $^3H_5$	1010.77	991.13	2.89×10^{-1}	3.4×10^{-1}	1.55×10^{9}	1.9×10^{9}	C
(^4F) 4p $^5G^o_5$	(^4F) 4d $^5H_6$	1012.68	992.52	7.32×10^{-1}	8.0×10^{-1}	4.03×10^{9}	4.6×10^{9}	C+
(^2G) 4p $^3G^o_5$	(^2G) 4d $^3H_6$	1010.76	993.08	3.37×10^{-1}	4.0×10^{-1}	1.86×10^{9}	2.3×10^{9}	C+
(^2G) 4p $^3H^o_6$	(^2G) 4d $^3I_7$	1011.82	993.84	6.66×10^{-1}	7.0×10^{-1}	3.70×10^{9}	4.1×10^{9}	C+
(^4P) 4p $^5D^o_3$	(^4P) 4d $^5F_4$	1012.79	994.94	6.84×10^{-1}	7.4×10^{-1}	3.46×10^{9}	3.9×10^{9}	C+
(^2H) 4p $^3H^o_5$	(^2H) 4d $^3I_6$	1014.80	995.74	4.43×10^{-1}	4.8×10^{-1}	2.43×10^{9}	2.8×10^{9}	C+
(^2H) 4p $^3H^o_6$	(^2H) 4d $^3I_7$	1017.28	997.47	4.54×10^{-1}	4.9×10^{-1}	2.53×10^{9}	2.9×10^{9}	C+
(^4F) 4p $^5G^o_6$	(^4F) 4d $^5H_7$	1016.79	997.65	7.59×10^{-1}	8.3×10^{-1}	4.25×10^{9}	4.8×10^{9}	C+
(^4P) 4p $^5D^o_4$	(^4P) 4d $^5F_5$	1018.16	1000.14	7.65×10^{-1}	8.2×10^{-1}	4.03×10^{9}	4.5×10^{9}	C+
(^4F) 4p $^5F^o_5$	(^4F) 4d $^5G_6$	1024.90	1005.96	4.82×10^{-1}	5.3×10^{-1}	2.59×10^{9}	3.0×10^{9}	C+

Table 2. Electron-, proton-, singly and doubly charged Helium-impact Stark widths for 4s - 4p spectral lines of Fe V calculated using semiclassical perturbation approach (Sahal-Bréchot 1969a,b; Sahal-Bréchot, Dimitrijević & Ben Nessib 2014) for a perturber density of 10^{17} cm^{-3} and temperature of 50 000 to 600 000 K. The needed atomic data are calculated using Cowan code (Cowan 1981) or taken from NIST database (Kramida et al. 2019). Wavelength of the transitions (in Å) and parameter C are also given. This parameter when divided with the corresponding Stark width gives an estimate for the maximal pertuber density for which the line may be treated as isolated. W_e: electron-impact full Stark width at half maximum, W_{H^+}: proton-impact full Stark width at half maximum, W_{He^+}: singly charged helium-impact full Stark width at half maximum, $W_{He^{++}}$: doubly charged helium-impact full Stark width at half maximum. All wavelengths are taken from NIST database

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	W_{H+} (Å) Cowan	W_{H+} (Å) NIST	W_{He+} (Å) Cowan	W_{He+} (Å) NIST	W_{He++} (Å) Cowan	W_{He++} (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	0.116E-01	0.110E-01	0.280E-03	0.277E-03	0.416E-03	0.413E-03	0.549E-03	0.543E-03
λ = 1280.47 Å	100.	0.836E-02	0.789E-02	0.508E-03	0.500E-03	0.632E-03	0.627E-03	0.101E-02	0.989E-03
C= 0.87E+20	200.	0.626E-02	0.588E-02	0.731E-03	0.717E-03	0.824E-03	0.815E-03	0.146E-02	0.142E-02
	300.	0.539E-02	0.506E-02	0.837E-03	0.815E-03	0.893E-03	0.880E-03	0.167E-02	0.163E-02
	400.	0.489E-02	0.459E-02	0.885E-03	0.859E-03	0.939E-03	0.924E-03	0.176E-02	0.171E-02
	600.	0.433E-02	0.406E-02	0.963E-03	0.928E-03	0.101E-02	0.987E-03	0.192E-02	0.185E-02
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	0.115E-01	0.101E-01	0.268E-03	0.265E-03	0.400E-03	0.398E-03	0.525E-03	0.521E-03
λ = 1288.17 Å	100.	0.828E-02	0.729E-02	0.491E-03	0.485E-03	0.613E-03	0.608E-03	0.971E-03	0.960E-03
C= 0.86E+20	200.	0.619E-02	0.701E-03	0.712E-03	0.701E-03	0.806E-03	0.798E-03	0.141E-02	0.139E-02
	300.	0.533E-02	0.465E-02	0.818E-03	0.803E-03	0.872E-03	0.862E-03	0.163E-02	0.160E-02
	400.	0.484E-02	0.420E-02	0.865E-03	0.847E-03	0.919E-03	0.907E-03	0.172E-02	0.169E-02
	600.	0.428E-02	0.369E-02	0.941E-03	0.918E-03	0.984E-03	0.969E-03	0.188E-02	0.183E-02
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	0.115E-01	0.107E-01	0.283E-03	0.278E-03	0.421E-03	0.416E-03	0.555E-03	0.546E-03
λ = 1293.38 Å	100.	0.831E-02	0.774E-02	0.515E-03	0.505E-03	0.641E-03	0.632E-03	0.102E-02	0.100E-02
C= 0.87E+20	200.	0.620E-02	0.576E-02	0.745E-03	0.727E-03	0.838E-03	0.825E-03	0.148E-02	0.144E-02
	300.	0.534E-02	0.495E-02	0.852E-03	0.829E-03	0.908E-03	0.891E-03	0.170E-02	0.165E-02
	400.	0.484E-02	0.448E-02	0.902E-03	0.875E-03	0.956E-03	0.937E-03	0.180E-02	0.174E-02
	600.	0.427E-02	0.395E-02	0.982E-03	0.947E-03	0.102E-02	0.100E-02	0.196E-02	0.189E-02
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	0.117E-01	0.105E-01	0.272E-03	0.270E-03	0.406E-03	0.404E-03	0.539E-03	0.530E-03
λ = 1297.54 Å	100.	0.842E-02	0.761E-02	0.499E-03	0.495E-03	0.622E-03	0.618E-03	0.997E-03	0.978E-03
C= 0.87E+20	200.	0.629E-02	0.566E-02	0.723E-03	0.715E-03	0.818E-03	0.812E-03	0.145E-02	0.142E-02
	300.	0.542E-02	0.486E-02	0.831E-03	0.821E-03	0.886E-03	0.879E-03	0.167E-02	0.164E-02
	400.	0.492E-02	0.440E-02	0.879E-03	0.867E-03	0.933E-03	0.924E-03	0.177E-02	0.173E-02
	600.	0.435E-02	0.387E-02	0.956E-03	0.942E-03	0.100E-02	0.991E-03	0.193E-02	0.188E-02
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	0.125E-01	0.111E-01	0.321E-03	0.319E-03	0.474E-03	0.472E-03	0.628E-03	0.626E-03
λ = 1311.82 Å	100.	0.901E-02	0.802E-02	0.574E-03	0.567E-03	0.714E-03	0.709E-03	0.113E-02	0.112E-02
C= 0.11E+21	200.	0.675E-02	0.599E-02	0.820E-03	0.807E-03	0.918E-03	0.909E-03	0.163E-02	0.160E-02
	300.	0.583E-02	0.515E-02	0.928E-03	0.911E-03	0.990E-03	0.983E-03	0.184E-02	0.182E-02
	400.	0.530E-02	0.467E-02	0.982E-03	0.961E-03	0.104E-02	0.103E-02	0.195E-02	0.192E-02
	600.	0.468E-02	0.412E-02	0.106E-02	0.104E-02	0.112E-02	0.110E-02	0.212E-02	0.207E-02
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	50.	0.121E-01	0.115E-01	0.305E-03	0.312E-03	0.453E-03	0.463E-03	0.598E-03	0.612E-03
λ = 1320.41 Å	100.	0.870E-02	0.831E-02	0.551E-03	0.559E-03	0.686E-03	0.698E-03	0.109E-02	0.111E-02
C= 0.11E+21	200.	0.649E-02	0.621E-02	0.791E-03	0.798E-03	0.891E-03	0.901E-03	0.157E-02	0.159E-02
	300.	0.558E-02	0.535E-02	0.902E-03	0.904E-03	0.964E-03	0.974E-03	0.180E-02	0.180E-02
	400.	0.507E-02	0.485E-02	0.954E-03	0.954E-03	0.102E-02	0.102E-02	0.190E-02	0.190E-02
	600.	0.447E-02	0.429E-02	0.104E-02	0.103E-02	0.109E-02	0.109E-02	0.207E-02	0.206E-02
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	0.128E-01	0.120E-01	0.282E-03	0.286E-03	0.421E-03	0.429E-03	0.554E-03	0.562E-03
λ = 1321.49 Å	100.	0.924E-02	0.866E-02	0.516E-03	0.519E-03	0.645E-03	0.652E-03	0.103E-02	0.103E-02
C= 0.99E+20	200.	0.691E-02	0.647E-02	0.748E-03	0.745E-03	0.847E-03	0.851E-03	0.149E-02	0.148E-02
	300.	0.597E-02	0.557E-02	0.859E-03	0.849E-03	0.918E-03	0.918E-03	0.172E-02	0.169E-02
	400.	0.542E-02	0.507E-02	0.909E-03	0.894E-03	0.970E-03	0.964E-03	0.181E-02	0.178E-02
	600.	0.481E-02	0.449E-02	0.989E-03	0.965E-03	0.104E-02	0.103E-02	0.198E-02	0.193E-02
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	0.121E-01	0.118E-01	0.308E-03	0.312E-03	0.456E-03	0.464E-03	0.610E-03	0.613E-03
1323.27 A	100.	0.874E-02	0.846E-02	0.555E-03	0.560E-03	0.691E-03	0.700E-03	0.111E-02	0.111E-02
C= 0.11E+21	200.	0.654E-02	0.630E-02	0.799E-03	0.799E-03	0.897E-03	0.903E-03	0.160E-02	0.159E-02
	300.	0.563E-02	0.542E-02	0.910E-03	0.905E-03	0.972E-03	0.976E-03	0.183E-02	0.181E-02
	400.	0.512E-02	0.492E-02	0.963E-03	0.955E-03	0.102E-02	0.102E-02	0.194E-02	0.190E-02
	600.	0.452E-02	0.434E-02	0.105E-02	0.103E-02	0.110E-02	0.109E-02	0.211E-02	0.206E-02
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	0.128E-01	0.122E-01	0.310E-03	0.316E-03	0.460E-03	0.469E-03	0.606E-03	0.620E-03
1330.41 A	100.	0.920E-02	0.881E-02	0.559E-03	0.566E-03	0.697E-03	0.707E-03	0.111E-02	0.112E-02
C= 0.85E+20	200.	0.686E-02	0.659E-02	0.802E-03	0.809E-03	0.904E-03	0.913E-03	0.159E-02	0.161E-02
	300.	0.591E-02	0.567E-02	0.913E-03	0.917E-03	0.978E-03	0.987E-03	0.182E-02	0.183E-02
	400.	0.538E-02	0.516E-02	0.964E-03	0.967E-03	0.103E-02	0.104E-02	0.191E-02	0.193E-02
	600.	0.476E-02	0.456E-02	0.105E-02	0.105E-02	0.110E-02	0.111E-02	0.208E-02	0.209E-02
(^{2}D$_2$) 4s ^{3}D$_1$ - (^{2}D$_2$) 4p ^{3}P$^o_0$	50.	0.125E-01		0.313E-03		0.465E-03		0.614E-03	
1331.19 Å	100.	0.912E-02		0.562E-03		0.702E-03		0.111E-02	
C= 0.11E+21	200.	0.685E-02		0.805E-03		0.907E-03		0.160E-02	

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DATA AVAILABILITY

The data underlying this article are available in the article and in its online supplementary material.

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Table 2. Continued

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	W_{H+} (Å) Cowan	W_{H+} (Å) NIST	W_{He+} (Å) Cowan	W_{He+} (Å) NIST	W_{He++} (Å) Cowan	W_{He++} (Å) NIST
	300.	0.592E-02		0.913E-03		0.980E-03		0.182E-02	
	400.	0.538E-02		0.964E-03		0.103E-02		0.192E-02	
	600.	0.477E-02		0.104E-02		0.110E-02		0.209E-02	
(^{2}D$_2$) 4s ^{1}D$_2$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	0.127E-01	0.116E-01	0.329E-03	0.329E-03	0.487E-03	0.487E-03	0.647E-03	0.646E-03
1331.64 Å	100.	0.920E-02	0.841E-02	0.588E-03	0.586E-03	0.732E-03	0.731E-03	0.116E-02	0.116E-02
C= 0.11E+21	200.	0.689E-02	0.629E-02	0.840E-03	0.834E-03	0.942E-03	0.938E-03	0.167E-02	0.166E-02
	300.	0.594E-02	0.541E-02	0.951E-03	0.942E-03	0.102E-02	0.101E-02	0.190E-02	0.188E-02
	400.	0.540E-02	0.491E-02	0.101E-02	0.995E-03	0.108E-02	0.107E-02	0.201E-02	0.198E-02
	600.	0.478E-02	0.433E-02	0.109E-02	0.107E-02	0.114E-02	0.114E-02	0.218E-02	0.214E-02

Table 3. Same as Table 2 but for a perturber density of 10^{18} cm^{-3} .

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	W_{H+} (Å) Cowan	W_{H+} (Å) NIST	W_{He+} (Å) Cowan	W_{He+} (Å) NIST	W_{He++} (Å) Cowan	W_{He++} (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	0.116	0.110	0.279E-02	0.276E-02	0.415E-02	0.411E-02	0.544E-02	0.537E-02
λ = 1280.47 Å	100.	0.836E-01	0.789E-01	0.508E-02	0.500E-02	0.632E-02	0.626E-02	0.100E-01	0.987E-02
C= 0.87E+22	200.	0.625E-01	0.588E-01	0.732E-02	0.717E-02	0.825E-02	0.815E-02	0.146E-01	0.142E-01
	300.	0.539E-01	0.506E-01	0.837E-02	0.815E-02	0.894E-02	0.880E-02	0.167E-01	0.163E-01
	400.	0.490E-01	0.459E-01	0.886E-02	0.859E-02	0.940E-02	0.924E-02	0.176E-01	0.171E-01
	600.	0.434E-01	0.406E-01	0.963E-02	0.928E-02	0.101E-01	0.987E-02	0.192E-01	0.185E-01
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	0.116	0.101	0.270E-02	0.265E-02	0.403E-02	0.396E-02	0.526E-02	0.516E-02
λ = 1288.17 Å	100.	0.836E-01	0.729E-01	0.496E-02	0.485E-02	0.618E-02	0.608E-02	0.980E-02	0.958E-02
C= 0.10E+22	200.	0.625E-01	0.542E-01	0.719E-02	0.701E-02	0.813E-02	0.798E-02	0.143E-01	0.139E-01
	300.	0.538E-01	0.465E-01	0.826E-02	0.803E-02	0.881E-02	0.862E-02	0.165E-01	0.160E-01
	400.	0.489E-01	0.420E-01	0.874E-02	0.847E-02	0.928E-02	0.907E-02	0.174E-01	0.169E-01
	600.	0.432E-01	0.369E-01	0.951E-02	0.918E-02	0.994E-02	0.969E-02	0.190E-01	0.183E-01
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	0.115	0.107	0.282E-02	0.278E-02	0.419E-02	0.414E-02	0.549E-02	0.541E-02
λ=1293.38Å	100.	0.830E-01	0.773E-01	0.515E-02	0.505E-02	0.640E-02	0.632E-02	0.102E-01	0.998E-02
C= 0.11E+22	200.	0.620E-01	0.576E-01	0.744E-02	0.727E-02	0.837E-02	0.825E-02	0.148E-01	0.144E-01
	300.	0.534E-01	0.495E-01	0.852E-02	0.829E-02	0.908E-02	0.891E-02	0.170E-01	0.165E-01
	400.	0.484E-01	0.448E-01	0.901E-02	0.875E-02	0.955E-02	0.937E-02	0.180E-01	0.174E-01
	600.	0.427E-01	0.395E-01	0.981E-02	0.947E-02	0.102E-01	0.100E-01	0.196E-01	0.189E-01
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	0.118	0.105	0.274E-02	0.269E-02	0.409E-02	0.403E-02	0.533E-02	0.525E-02
λ=1297.54 Å	100.	0.850E-01	0.761E-01	0.504E-02	0.494E-02	0.627E-02	0.618E-02	0.995E-02	0.976E-02
C= 0.11E+22	200.	0.635E-01	0.566E-01	0.730E-02	0.715E-02	0.825E-02	0.812E-02	0.145E-01	0.142E-01
	300.	0.547E-01	0.486E-01	0.839E-02	0.821E-02	0.895E-02	0.879E-02	0.167E-01	0.164E-01
	400.	0.497E-01	0.440E-01	0.888E-02	0.867E-02	0.942E-02	0.924E-02	0.177E-01	0.173E-01
	600.	0.439E-01	0.387E-01	0.966E-02	0.942E-02	0.101E-01	0.991E-02	0.193E-01	0.188E-01
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	500.	0.126	0.111	0.323E-02	0.318E-02	0.477E-02	0.470E-02	0.630E-02	0.619E-02
λ= 1311.82 Å	100.	0.910E-01	0.802E-01	0.579E-02	0.567E-02	0.721E-02	0.708E-02	0.115E-01	0.112E-01
C= 0.11E+22	200.	0.682E-01	0.599E-01	0.828E-02	0.807E-02	0.927E-02	0.909E-02	0.164E-01	0.160E-01
	300.	0.589E-01	0.515E-01	0.937E-02	0.911E-02	0.100E-01	0.983E-02	0.187E-01	0.182E-01
	400.	0.535E-01	0.467E-01	0.992E-02	0.961E-02	0.105E-01	0.103E-01	0.198E-01	0.192E-01
	600.	0.473E-01	0.412E-01	0.107E-01	0.104E-01	0.113E-01	0.110E-01	0.215E-01	0.207E-01
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	500.	0.120	0.115	0.303E-02	0.311E-02	0.450E-02	0.461E-02	0.591E-02	0.605E-02
λ= 1320.41 Å	100.	0.869E-01	0.831E-01	0.550E-02	0.558E-02	0.684E-02	0.698E-02	0.109E-01	0.110E-01
C= 0.10E+22	200.	0.648E-01	0.621E-01	0.790E-02	0.798E-02	0.890E-02	0.901E-02	0.157E-01	0.159E-01
	300.	0.557E-01	0.535E-01	0.901E-02	0.904E-02	0.963E-02	0.973E-02	0.180E-01	0.180E-01
	400.	0.506E-01	0.485E-01	0.953E-02	0.954E-02	0.102E-01	0.102E-01	0.190E-01	0.190E-01
	600.	0.446E-01	0.429E-01	0.104E-01	0.103E-01	0.109E-01	0.109E-01	0.207E-01	0.206E-01
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	0.128	0.120	0.281E-02	0.285E-02	0.420E-02	0.427E-02	0.548E-02	0.556E-02
λ = 1321.49 Å	100.	0.924E-01	0.866E-01	0.516E-02	0.519E-02	0.644E-02	0.652E-02	0.102E-01	0.102E-01
C= 0.12E+22	200.	0.691E-01	0.647E-01	0.748E-02	0.745E-02	0.847E-02	0.851E-02	0.149E-01	0.148E-01
	300.	0.597E-01	0.557E-01	0.859E-02	0.849E-02	0.918E-02	0.918E-02	0.172E-01	0.169E-01
	400.	0.542E-01	0.507E-01	0.909E-02	0.894E-02	0.970E-02	0.964E-02	0.181E-01	0.178E-01
	600.	0.481E-01	0.449E-01	0.989E-02	0.965E-02	0.104E-01	0.103E-01	0.198E-01	0.193E-01
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	0.121	0.118	0.306E-02	0.311E-02	0.453E-02	0.462E-02	0.596E-02	0.607E-02
λ = 1323.27 Å	100.	0.872E-01	0.846E-01	0.554E-02	0.559E-02	0.690E-02	0.699E-02	0.110E-01	0.111E-01
C= 0.11E+22	200.	0.653E-01	0.630E-01	0.797E-02	0.799E-02	0.895E-02	0.903E-02	0.158E-01	0.159E-01
	300.	0.562E-01	0.542E-01	0.908E-02	0.905E-02	0.970E-02	0.976E-02	0.181E-01	0.181E-01
	400.	0.511E-01	0.492E-01	0.961E-02	0.954E-02	0.102E-01	0.102E-01	0.192E-01	0.190E-01
	600.	0.452E-01	0.434E-01	0.105E-01	0.103E-01	0.110E-01	0.109E-01	0.208E-01	0.206E-01

Table 3. Continued

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	W_{H+} (Å) Cowan	W_{H+} (Å) NIST	W_{He+} (Å) Cowan	W_{He+} (Å) NIST	W_{He++} (Å) Cowan	W_{He++} (Å) NIST
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	0.127	0.122	0.308E-02	0.315E-02	0.457E-02	0.467E-02	0.600E-02	0.613E-02
λ = 1330.41 Å	100.	0.917E-01	0.881E-01	0.557E-02	0.566E-02	0.694E-02	0.707E-02	0.111E-01	0.112E-01
C= 0.11E+22	200.	0.684E-01	0.659E-01	0.799E-02	0.809E-02	0.901E-02	0.913E-02	0.159E-01	0.161E-01
	300.	0.589E-01	0.567E-01	0.910E-02	0.917E-02	0.975E-02	0.987E-02	0.182E-01	0.183E-01
	400.	0.536E-01	0.516E-01	0.961E-02	0.967E-02	0.103E-01	0.104E-01	0.191E-01	0.193E-01
	600.	0.475E-01	0.456E-01	0.105E-01	0.105E-01	0.110E-01	0.111E-01	0.208E-01	0.209E-01
(^{2}D$_2$) 4s ^{3}D$_1$ - (^{2}D$_2$) 4p ^{3}P$^o_0$	50.	0.126		0.312E-02		0.463E-02		0.607E-02	
λ = 1331.19 Å	100.	0.913E-01		0.562E-02		0.701E-02		0.111E-01	
C= 0.11E+22	200.	0.686E-01		0.805E-02		0.908E-02		0.160E-01	
	300.	0.593E-01		0.914E-02		0.981E-02		0.182E-01	
	400.	0.539E-01		0.965E-02		0.103E-01		0.192E-01	
	600.	0.478E-01		0.104E-01		0.110E-01		0.209E-01	
(^{2}D$_2$) 4s ^{1}D$_2$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	0.127	0.116	0.328E-02	0.328E-02	0.485E-02	0.485E-02	0.640E-02	0.639E-02
λ = 1331.64 Å	100.	0.919E-01	0.841E-01	0.588E-02	0.585E-02	0.732E-02	0.731E-02	0.116E-01	0.116E-01
C= 0.11E+22	200.	0.689E-01	0.629E-01	0.840E-02	0.834E-02	0.942E-02	0.938E-02	0.167E-01	0.166E-01
	300.	0.594E-01	0.541E-01	0.951E-02	0.942E-02	0.102E-01	0.101E-01	0.190E-01	0.188E-01
	400.	0.540E-01	0.491E-01	0.101E-01	0.995E-02	0.108E-01	0.107E-01	0.201E-01	0.198E-01
	600.	0.478E-01	0.433E-01	0.109E-01	0.107E-01	0.114E-01	0.114E-01	0.218E-01	0.214E-01

Table 4. Same as Table 2 but for a perturber density of 10^{19} cm^{-3}.

Transition	T (kK)	W$_e$ (Å) Cowan	W$_e$ (Å) NIST	W$_{H+}$ (Å) Cowan	W$_{H+}$ (Å) NIST	W$_{He+}$ (Å) Cowan	W$_{He+}$ (Å) NIST	W$_{He++}$ (Å) Cowan	W$_{He++}$ (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	1.16	1.10	0.273E-01	0.270E-01	0.403E-01	0.400E-01	0.496E-01	0.489E-01
λ = 1280.47 Å	100.	0.836	0.789	0.505E-01	0.497E-01	0.626E-01	0.621E-01	*0.985E-01	*0.968E-01
C= 0.11E+23	200.	0.625	0.588	0.732E-01	0.716E-01	0.823E-01	0.813E-01	0.145*	0.142*
	300.	0.539	0.506	0.836E-01	0.815E-01	0.893E-01	0.879E-01	0.167	0.162
	400.	0.490	0.459	0.886E-01	0.859E-01	0.939E-01	0.924E-01	0.176	0.171
	600.	0.434	0.406	0.963E-01	0.928E-01	0.101	0.987E-01	0.192	0.185
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	1.16	1.01	0.264E-01	0.259E-01	0.392E-01	0.385E-01	0.480E-01	0.470E-01
λ = 1288.17 Å	100.	0.836	0.729	0.493E-01	0.482E-01	0.613E-01	0.602E-01	0.962E-01	0.940E-01
C= 0.10E+23	200.	0.625	0.542	0.718E-01	0.700E-01	0.812E-01	0.796E-01	*0.142	*0.138
	300.	0.538	0.465	0.826E-01	0.803E-01	0.881E-01	0.862E-01	0.165	0.160
	400.	0.489	0.420	0.874E-01	0.847E-01	0.928E-01	0.906E-01	0.174	0.169
	600.	0.432	0.369	0.950E-01	0.918E-01	0.994E-01	0.969E-01	0.190	0.183
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	1.15	1.07	0.276E-01	0.271E-01	0.407E-01	0.402E-01	0.501E-01	0.493E-01
λ = 1293.38 Å	100.	0.830	0.773	0.512E-01	0.502E-01	0.634E-01	0.626E-01	*0.100	*0.978E-01
C= 0.11E+23	200.	0.620	0.576	0.743E-01	0.726E-01	0.836E-01	0.823E-01	*0.147	*0.144
	300.	0.534	0.495	0.852E-01	0.829E-01	0.906E-01	0.891E-01	0.170	0.165
	400.	0.484	0.448	0.901E-01	0.875E-01	0.955E-01	0.937E-01	0.180	0.174
	600.	0.427	0.395	0.981E-01	0.947E-01	0.102	0.100	0.196	0.189
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	1.18	1.05	0.268E-01	0.264E-01	0.397E-01	0.391E-01	0.487E-01	0.479E-01
λ= 1297.54 Å	100.	0.850	0.761	0.501E-01	0.492E-01	0.622E-01	0.613E-01	0.976E-01	0.958E-01
C= 0.11E+23	200.	0.635	0.566	0.729E-01	0.715E-01	0.824E-01	0.811E-01	*0.144	*0.141
	300.	0.547	0.486	0.839E-01	0.821E-01	0.894E-01	0.878E-01	0.167	0.163
	400.	0.497	0.440	0.888E-01	0.867E-01	0.941E-01	0.924E-01	0.177	0.173
	600.	0.439	0.387	0.966E-01	0.942E-01	0.101	0.990E-01	0.193	0.188
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	1.26	1.11	0.316E-01	0.311E-01	0.463E-01	0.456E-01	0.574E-01	0.563E-01
λ = 1311.82 Å	100.	0.910	0.802	0.576E-01	0.564E-01	0.714E-01	0.702E-01	*0.112	*0.110
C= 0.11E+23	200.	0.682	0.599	0.827E-01	0.806E-01	0.925E-01	0.908E-01	*0.164	*0.159
	300.	0.589	0.515	0.937E-01	0.911E-01	0.100	0.982E-01	*0.187	*0.181
	400.	0.535	0.467	0.992E-01	0.961E-01	0.105	0.103	0.198	0.191
	600.	0.473	0.412	0.107	0.104	0.113	0.110	0.214	0.207
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	50.	1.20	1.15	0.297E-01	0.304E-01	0.438E-01	0.447E-01	0.539E-01	0.551E-01
λ = 1320.41 Å	100.	0.869	0.831	0.547E-01	0.555E-01	0.678E-01	0.691E-01	*0.107	*0.108
C= 0.10E+23	200.	0.648	0.621	0.790E-01	0.797E-01	0.888E-01	0.899E-01	*0.157	*0.158
	300.	0.557	0.535	0.901E-01	0.904E-01	0.963E-01	0.973E-01	*0.179	*0.180
	400.	0.506	0.485	0.953E-01	0.954E-01	0.102	0.102	0.190	0.190
	600.	0.446	0.429	0.104	0.103	0.109	0.109	0.207	0.206
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	1.28	1.20	0.276E-01	0.279E-01	0.408E-01	0.415E-01	0.500E-01	0.506E-01
λ = 1321.49 Å	100.	0.924	0.866	0.514E-01	0.516E-01	0.638E-01	0.646E-01	0.100	0.100
C= 0.12E+23	200.	0.691	0.647	0.748E-01	0.744E-01	0.846E-01	0.849E-01	*0.148	*0.147
	300.	0.597	0.557	0.859E-01	0.849E-01	0.917E-01	0.918E-01	0.171	0.169
	400.	0.542	0.507	0.908E-01	0.894E-01	0.970E-01	0.963E-01	0.181	0.178
	600.	0.481	0.449	0.989E-01	0.965E-01	0.104	0.103	0.198	0.192
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	1.21	1.18	0.299E-01	0.305E-01	0.441E-01	0.449E-01	0.543E-01	0.552E-01
λ = 1323.27 Å	100.	0.872	0.846	0.551E-01	0.556E-01	0.684E-01	0.693E-01	*0.108	*0.108
C= 0.11E+23	200.	0.653	0.630	0.796E-01	0.798E-01	0.894E-01	0.901E-01	*0.157	*0.158
	300.	0.562	0.542	0.908E-01	0.905E-01	0.970E-01	0.975E-01	*0.181	*0.180
	400.	0.511	0.492	0.961E-01	0.954E-01	0.102	0.102	0.192	0.190
	600.	0.452	0.434	0.105	0.103	0.110	0.109	0.208	0.206
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	1.27	1.22	0.301E-01	0.308E-01	0.444E-01	0.453E-01	0.547E-01	0.558E-01
λ = 1330.41 Å	100.	0.917	0.881	0.554E-01	0.563E-01	0.688E-01	0.700E-01	*0.108	*0.110
C= 0.11E+23	200.	0.684	0.659	0.798E-01	0.808E-01	0.900E-01	0.911E-01	*0.158	*0.160
	300.	0.589	0.567	0.909E-01	0.916E-01	0.975E-01	0.986E-01	*0.181	*0.182
	400.	0.536	0.516	0.961E-01	0.967E-01	0.103	0.104	0.191	0.193
	600.	0.475	0.456	0.105	0.105	0.110	0.111	0.208	0.209

Table 4. Continued

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	W_{H+} (Å) Cowan	W_{H+} (Å) NIST	W_{He+} (Å) Cowan	W_{He+} (Å) NIST	W_{He++} (Å) Cowan	W_{He++} (Å) NIST
($^2D_2$) 4s $^3D_1$ - ($^2D_2$) 4p $^3P^o_0$	50.	1.26		0.305E-01		0.449E-01		0.553E-01	
λ = 1331.19 Å	100.	0.913		0.559E-01		0.696E-01		*0.109	
C= 0.11E+23	200.	0.686		0.804E-01		0.906E-01		*0.159	
	300.	0.593		0.913E-01		0.981E-01		*0.181	
	400.	0.539		0.965E-01		0.103		0.192	
	600.	0.478		0.104		0.110		0.208	
($^2D_2$) 4s $^1D_2$ - ($^2D_2$) 4p $^1D^o_2$	50.	1.27	1.16	0.322E-01	0.321E-01	0.470E-01	0.470E-01	0.583E-01	0.581E-01
λ =1331.64 Å	100.	0.919	0.841	0.585E-01	0.582E-01	0.726E-01	0.724E-01	*0.114	*0.113
C= 0.11E+23	200.	0.689	0.629	0.839E-01	0.833E-01	0.940E-01	0.937E-01	*0.166	*0.165
	300.	0.594	0.541	0.950E-01	0.942E-01	0.102	0.101	*0.189	*0.188
	400.	0.540	0.491	0.101	0.995E-01	0.108	0.107	0.201	0.198
	600.	0.478	0.433	0.109	0.107	0.114	0.114	0.218	0.214

Table 5. Same as Table 2 but for Stark shifts for a perturber density of 10^{17} cm^{-3}. d_e: electron-impact Stark shift, d_{H^+}: proton-impact Stark shift, d_{He^+}: singly charged helium-impact Stark shift, $d_{He^{++}}$: doubly charged helium-impact Stark shift . All wavelengths are taken from NIST database

Transition	T (kK)	d_e (Å) Cowan	d_e (Å) NIST	d_{H^+} (Å) Cowan	d_{H^+} (Å) NIST	d_{He^+} (Å) Cowan	d_{He^+} (Å) NIST	$d_{He^{++}}$ (Å) Cowan	$d_{He^{++}}$ (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	-0.188E-03	-0.909E-04	-0.983E-04	-0.591E-04	-0.956E-04	-0.582E-04	-0.192E-03	-0.115E-03
λ = 1280.47 Å	100.	-0.248E-03	-0.127E-03	-0.177E-03	-0.111E-03	-0.164E-03	-0.103E-03	-0.353E-03	-0.221E-03
C= 0.87E+20	200.	-0.274E-03	-0.146E-03	-0.267E-03	-0.179E-03	-0.234E-03	-0.154E-03	-0.538E-03	-0.359E-03
	300.	-0.300E-03	-0.158E-03	-0.325E-03	-0.216E-03	-0.278E-03	-0.188E-03	-0.654E-03	-0.434E-03
	400.	-0.271E-03	-0.130E-03	-0.366E-03	-0.248E-03	-0.298E-03	-0.208E-03	-0.736E-03	-0.499E-03
	600.	-0.269E-03	-0.131E-03	-0.406E-03	-0.281E-03	-0.334E-03	-0.232E-03	-0.816E-03	-0.566E-03
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.192E-03	-0.153E-03	-0.977E-04	-0.753E-04	-0.952E-04	-0.738E-04	-0.190E-03	-0.147E-03
λ = 1288.17 Å	100.	-0.252E-03	-0.203E-03	-0.176E-03	-0.139E-03	-0.163E-03	-0.129E-03	-0.351E-03	-0.277E-03
C= 0.86E+20	200.	-0.279E-03	-0.219E-03	-0.267E-03	-0.218E-03	-0.234E-03	-0.188E-03	-0.536E-03	-0.438E-03
	300.	-0.304E-03	-0.241E-03	-0.325E-03	-0.264E-03	-0.278E-03	-0.227E-03	-0.652E-03	-0.531E-03
	400.	-0.279E-03	-0.226E-03	-0.365E-03	-0.299E-03	-0.298E-03	-0.248E-03	-0.735E-03	-0.602E-03
	600.	-0.277E-03	-0.222E-03	-0.405E-03	-0.334E-03	-0.335E-03	-0.276E-03	-0.814E-03	-0.672E-03
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	-0.218E-03	-0.137E-03	-0.107E-03	-0.744E-04	-0.104E-03	-0.730E-04	-0.208E-03	-0.145E-03
λ = 1293.38 Å	100.	-0.283E-03	-0.185E-03	-0.192E-03	-0.138E-03	-0.177E-03	-0.127E-03	-0.380E-03	-0.274E-03
C= 0.87E+20	200.	-0.309E-03	-0.204E-03	-0.286E-03	-0.216E-03	-0.252E-03	-0.186E-03	-0.576E-03	-0.434E-03
	300.	-0.339E-03	-0.223E-03	-0.349E-03	-0.262E-03	-0.298E-03	-0.226E-03	-0.701E-03	-0.527E-03
	400.	-0.313E-03	-0.201E-03	-0.391E-03	-0.297E-03	-0.318E-03	-0.247E-03	-0.786E-03	-0.597E-03
	600.	-0.308E-03	-0.199E-03	-0.435E-03	-0.332E-03	-0.357E-03	-0.274E-03	-0.873E-03	-0.669E-03
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.197E-03	-0.183E-03	-0.100E-03	-0.874E-04	-0.976E-04	-0.854E-04	-0.197E-03	-0.170E-03
λ = 1297.54 Å	100.	-0.258E-03	-0.240E-03	-0.181E-03	-0.160E-03	-0.167E-03	-0.148E-03	-0.363E-03	-0.318E-03
C= 0.87E+20	200.	-0.286E-03	-0.258E-03	-0.273E-03	-0.245E-03	-0.240E-03	-0.214E-03	-0.555E-03	-0.493E-03
	300.	-0.312E-03	-0.284E-03	-0.333E-03	-0.298E-03	-0.284E-03	-0.256E-03	-0.674E-03	-0.599E-03
	400.	-0.286E-03	-0.267E-03	-0.373E-03	-0.337E-03	-0.304E-03	-0.276E-03	-0.760E-03	-0.679E-03
	600.	-0.284E-03	-0.262E-03	-0.415E-03	-0.374E-03	-0.342E-03	-0.308E-03	-0.842E-03	-0.753E-03
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.200E-03	-0.135E-03	-0.101E-03	-0.693E-04	-0.981E-04	-0.681E-04	-0.195E-03	-0.135E-03
λ = 1311.82 Å	100.	-0.255E-03	-0.176E-03	-0.182E-03	-0.129E-03	-0.168E-03	-0.120E-03	-0.361E-03	-0.257E-03
C= 0.11E+21	200.	-0.286E-03	-0.194E-03	-0.275E-03	-0.205E-03	-0.242E-03	-0.176E-03	-0.551E-03	-0.412E-03
	300.	-0.304E-03	-0.207E-03	-0.335E-03	-0.249E-03	-0.287E-03	-0.215E-03	-0.670E-03	-0.500E-03
	400.	-0.284E-03	-0.194E-03	-0.377E-03	-0.283E-03	-0.308E-03	-0.237E-03	-0.756E-03	-0.570E-03
	600.	-0.281E-03	-0.192E-03	-0.418E-03	-0.318E-03	-0.345E-03	-0.263E-03	-0.838E-03	-0.642E-03
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	50.	-0.203E-03	-0.141E-03	-0.101E-03	-0.766E-04	-0.990E-04	-0.752E-04	-0.197E-03	-0.149E-03
λ = 1320.41 Å	100.	-0.264E-03	-0.187E-03	-0.183E-03	-0.142E-03	-0.170E-03	-0.131E-03	-0.363E-03	-0.283E-03
C= 0.11E+21	200.	-0.287E-03	-0.207E-03	-0.277E-03	-0.223E-03	-0.243E-03	-0.192E-03	-0.557E-03	-0.449E-03
	300.	-0.313E-03	-0.224E-03	-0.337E-03	-0.271E-03	-0.289E-03	-0.233E-03	-0.676E-03	-0.544E-03
	400.	-0.291E-03	-0.203E-03	-0.379E-03	-0.307E-03	-0.310E-03	-0.255E-03	-0.764E-03	-0.617E-03
	600.	-0.285E-03	-0.202E-03	-0.420E-03	-0.343E-03	-0.347E-03	-0.283E-03	-0.847E-03	-0.691E-03
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	-0.184E-03	-0.659E-04	-0.998E-04	-0.521E-04	-0.979E-04	-0.515E-04	-0.195E-03	-0.102E-03
λ = 1321.49 Å	100.	-0.240E-03	-0.922E-04	-0.181E-03	-0.992E-04	-0.168E-03	-0.931E-04	-0.361E-03	-0.197E-03
C= 0.99E+20	200.	-0.271E-03	-0.114E-03	-0.275E-03	-0.163E-03	-0.241E-03	-0.141E-03	-0.553E-03	-0.327E-03
	300.	-0.294E-03	-0.118E-03	-0.334E-03	-0.197E-03	-0.287E-03	-0.172E-03	-0.672E-03	-0.395E-03
	400.	-0.262E-03	-0.843E-04	-0.376E-03	-0.226E-03	-0.307E-03	-0.193E-03	-0.758E-03	-0.455E-03
	600.	-0.258E-03	-0.895E-04	-0.418E-03	-0.263E-03	-0.344E-03	-0.214E-03	-0.842E-03	-0.529E-03
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	-0.214E-03	-0.123E-03	-0.106E-03	-0.711E-04	-0.103E-03	-0.699E-04	-0.209E-03	-0.139E-03
λ = 1323.27 Å	100.	-0.279E-03	-0.168E-03	-0.191E-03	-0.133E-03	-0.177E-03	-0.123E-03	-0.384E-03	-0.264E-03
C= 0.11E+21	200.	-0.304E-03	-0.187E-03	-0.288E-03	-0.210E-03	-0.252E-03	-0.181E-03	-0.585E-03	-0.423E-03
	300.	-0.332E-03	-0.201E-03	-0.350E-03	-0.255E-03	-0.300E-03	-0.220E-03	-0.712E-03	-0.512E-03
	400.	-0.309E-03	-0.179E-03	-0.394E-03	-0.290E-03	-0.321E-03	-0.242E-03	-0.801E-03	-0.584E-03
	600.	-0.302E-03	-0.178E-03	-0.438E-03	-0.326E-03	-0.360E-03	-0.270E-03	-0.889E-03	-0.657E-03
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	-0.168E-03	-0.139E-03	-0.935E-04	-0.782E-04	-0.913E-04	-0.768E-04	-0.182E-03	-0.152E-03
λ = 1330.41 A	100.	-0.225E-03	-0.188E-03	-0.170E-03	-0.145E-03	-0.157E-03	-0.134E-03	-0.339E-03	-0.289E-03
C= 0.85E+20	200.	-0.250E-03	-0.208E-03	-0.261E-03	-0.227E-03	-0.228E-03	-0.196E-03	-0.524E-03	-0.457E-03
	300.	-0.271E-03	-0.225E-03	-0.318E-03	-0.276E-03	-0.273E-03	-0.238E-03	-0.637E-03	-0.555E-03
	400.	-0.245E-03	-0.202E-03	-0.359E-03	-0.313E-03	-0.294E-03	-0.260E-03	-0.721E-03	-0.629E-03
	600.	-0.241E-03	-0.200E-03	-0.398E-03	-0.349E-03	-0.329E-03	-0.289E-03	-0.800E-03	-0.705E-03
(^{2}D$_2$) 4s ^{3}D$_1$ - (^{2}D$_2$) 4p ^{3}P$^o_0$	50.	-0.151E-03		-0.838E-04		-0.820E-04		-0.164E-03	
λ = 1331.19 Å	100.	-0.200E-03		-0.155E-03		-0.142E-03		-0.308E-03	
C= 0.11E+21	200.	-0.224E-03		-0.240E-03		-0.208E-03		-0.483E-03	
	300.	-0.241E-03		-0.292E-03		-0.251E-03		-0.587E-03	
	400.	-0.215E-03		-0.330E-03		-0.272E-03		-0.664E-03	
	600.	-0.215E-03		-0.367E-03		-0.304E-03		-0.741E-03	
(^{2}D$_2$) 4s ^{1}D$_2$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.200E-03	-0.156E-03	-0.101E-03	-0.794E-04	-0.979E-04	-0.779E-04	-0.196E-03	-0.155E-03
λ = 1331.64 Å	100.	-0.254E-03	-0.203E-03	-0.181E-03	-0.147E-03	-0.168E-03	-0.136E-03	-0.362E-03	-0.293E-03

Table 5. Continued

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	d_{H+} (Å) Cowan	d_{H+} (Å) NIST	d_{He+} (Å) Cowan	d_{He+} (Å) NIST	d_{He++} (Å) Cowan	d_{He++} (Å) NIST
C= 0.11E+21	200.	-0.284E-03	-0.225E-03	-0.276E-03	-0.230E-03	-0.242E-03	-0.198E-03	-0.556E-03	-0.463E-03
	300.	-0.304E-03	-0.242E-03	-0.336E-03	-0.280E-03	-0.288E-03	-0.240E-03	-0.675E-03	-0.562E-03
	400.	-0.282E-03	-0.225E-03	-0.378E-03	-0.316E-03	-0.309E-03	-0.263E-03	-0.763E-03	-0.637E-03
	600.	-0.279E-03	-0.222E-03	-0.420E-03	-0.354E-03	-0.346E-03	-0.292E-03	-0.847E-03	-0.712E-03

Table 6. Same as Table 5 but for a perturber density of 10^{18} cm^{-3}.

Transition	T (kK)	d_e (Å) Cowan	d_e (Å) NIST	d_{H+} (Å) Cowan	d_{H+} (Å) NIST	d_{He+} (Å) Cowan	d_{He+} (Å) NIST	d_{He++} (Å) Cowan	d_{He++} (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	-0.194E-02	-0.923E-03	-0.929E-03	-0.558E-03	-0.903E-03	-0.549E-03	-0.173E-02	-0.104E-02
λ =1280.47 Å	100.	-0.248E-02	-0.127E-02	-0.175E-02	-0.110E-02	-0.162E-02	-0.102E-02	-0.339E-02	-0.214E-02
C= 0.87E+22	200.	-0.270E-02	-0.143E-02	-0.268E-02	-0.178E-02	-0.235E-02	-0.153E-02	-0.531E-02	-0.355E-02
	300.	-0.300E-02	-0.158E-02	-0.325E-02	-0.216E-02	-0.278E-02	-0.188E-02	-0.653E-02	-0.433E-02
	400.	-0.272E-02	-0.129E-02	-0.365E-02	-0.248E-02	-0.297E-02	-0.208E-02	-0.735E-02	-0.498E-02
	600.	-0.269E-02	-0.131E-02	-0.406E-02	-0.281E-02	-0.334E-02	-0.232E-02	-0.815E-02	-0.566E-02
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.200E-02	-0.158E-02	-0.932E-03	-0.711E-03	-0.906E-03	-0.696E-03	-0.174E-02	-0.133E-02
λ = 1288.17 Å	100.	-0.255E-02	-0.202E-02	-0.176E-02	-0.138E-02	-0.163E-02	-0.127E-02	-0.342E-02	-0.267E-02
C= 0.10E+22	200.	-0.277E-02	-0.215E-02	-0.269E-02	-0.217E-02	-0.236E-02	-0.187E-02	-0.536E-02	-0.433E-02
	300.	-0.307E-02	-0.241E-02	-0.327E-02	-0.264E-02	-0.280E-02	-0.227E-02	-0.658E-02	-0.531E-02
	400.	-0.281E-02	-0.225E-02	-0.369E-02	-0.299E-02	-0.300E-02	-0.248E-02	-0.741E-02	-0.601E-02
	600.	-0.279E-02	-0.221E-02	-0.409E-02	-0.334E-02	-0.338E-02	-0.276E-02	-0.822E-02	-0.672E-02
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	-0.224E-02	-0.141E-02	-0.101E-02	-0.702E-03	-0.978E-03	-0.688E-03	-0.188E-02	-0.131E-02
λ = 1293.38 Å	100.	-0.283E-02	-0.185E-02	-0.189E-02	-0.136E-02	-0.174E-02	-0.126E-02	-0.367E-02	-0.265E-02
C= 0.11E+22	200.	-0.304E-02	-0.200E-02	-0.286E-02	-0.216E-02	-0.252E-02	-0.186E-02	-0.569E-02	-0.429E-02
	300.	-0.339E-02	-0.223E-02	-0.349E-02	-0.262E-02	-0.296E-02	-0.225E-02	-0.700E-02	-0.526E-02
	400.	-0.312E-02	-0.200E-02	-0.391E-02	-0.297E-02	-0.318E-02	-0.246E-02	-0.785E-02	-0.596E-02
	600.	-0.308E-02	-0.199E-02	-0.434E-02	-0.332E-02	-0.356E-02	-0.274E-02	-0.872E-02	-0.668E-02
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.205E-02	-0.188E-02	-0.956E-03	-0.825E-03	-0.930E-03	-0.806E-03	-0.178E-02	-0.154E-02
λ = 1297.54 Å	100.	-0.262E-02	-0.240E-02	-0.180E-02	-0.158E-02	-0.167E-02	-0.146E-02	-0.350E-02	-0.306E-02
C= 0.11E+22	200.	-0.284E-02	-0.253E-02	-0.276E-02	-0.245E-02	-0.242E-02	-0.213E-02	-0.548E-02	-0.487E-02
	300.	-0.315E-02	-0.284E-02	-0.335E-02	-0.298E-02	-0.287E-02	-0.256E-02	-0.673E-02	-0.598E-02
	400.	-0.288E-02	-0.267E-02	-0.377E-02	-0.337E-02	-0.307E-02	-0.276E-02	-0.759E-02	-0.678E-02
	600.	-0.287E-02	-0.262E-02	-0.419E-02	-0.374E-02	-0.345E-02	-0.308E-02	-0.841E-02	-0.752E-02
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.213E-02	-0.143E-02	-0.960E-03	-0.654E-03	-0.934E-03	-0.643E-03	-0.179E-02	-0.122E-02
λ = 1311.82 Å	100.	-0.257E-02	-0.175E-02	-0.181E-02	-0.128E-02	-0.168E-02	-0.118E-02	-0.352E-02	-0.248E-02
C= 0.11E+22	200.	-0.284E-02	-0.191E-02	-0.278E-02	-0.205E-02	-0.244E-02	-0.176E-02	-0.553E-02	-0.408E-02
	300.	-0.307E-02	-0.206E-02	-0.338E-02	-0.249E-02	-0.289E-02	-0.215E-02	-0.679E-02	-0.499E-02
	400.	-0.285E-02	-0.193E-02	-0.380E-02	-0.283E-02	-0.310E-02	-0.236E-02	-0.766E-02	-0.569E-02
	600.	-0.284E-02	-0.192E-02	-0.422E-02	-0.318E-02	-0.348E-02	-0.263E-02	-0.849E-02	-0.641E-02
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	50.	-0.209E-02	-0.145E-02	-0.955E-03	-0.723E-03	-0.929E-03	-0.709E-03	-0.178E-02	-0.135E-02
λ = 1320.41 Å	100.	-0.262E-02	-0.187E-02	-0.180E-02	-0.140E-02	-0.166E-02	-0.129E-02	-0.350E-02	-0.273E-02
C= 0.10E+22	200.	-0.282E-02	-0.204E-02	-0.277E-02	-0.223E-02	-0.243E-02	-0.192E-02	-0.550E-02	-0.444E-02
	300.	-0.312E-02	-0.224E-02	-0.336E-02	-0.271E-02	-0.288E-02	-0.233E-02	-0.676E-02	-0.543E-02
	400.	-0.290E-02	-0.202E-02	-0.379E-02	-0.306E-02	-0.309E-02	-0.255E-02	-0.762E-02	-0.616E-02
	600.	-0.285E-02	-0.201E-02	-0.420E-02	-0.343E-02	-0.347E-02	-0.283E-02	-0.846E-02	-0.690E-02
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	-0.192E-02	-0.679E-03	-0.946E-03	-0.492E-03	-0.920E-03	-0.486E-03	-0.177E-02	-0.918E-03
λ = 1321.49 Å	100.	-0.240E-02	-0.922E-03	-0.179E-02	-0.980E-03	-0.165E-02	-0.919E-03	-0.348E-02	-0.190E-02
C= 0.12E+22	200.	-0.266E-02	-0.111E-02	-0.275E-02	-0.163E-02	-0.241E-02	-0.141E-02	-0.546E-02	-0.324E-02
	300.	-0.294E-02	-0.118E-02	-0.334E-02	-0.196E-02	-0.286E-02	-0.172E-02	-0.671E-02	-0.394E-02
	400.	-0.260E-02	-0.833E-03	-0.376E-02	-0.226E-02	-0.307E-02	-0.193E-02	-0.757E-02	-0.455E-02
	600.	-0.258E-02	-0.894E-03	-0.418E-02	-0.263E-02	-0.344E-02	-0.214E-02	-0.841E-02	-0.529E-02
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	-0.219E-02	-0.125E-02	-0.998E-03	-0.671E-03	-0.972E-03	-0.659E-03	-0.187E-02	-0.125E-02
λ = 1323.27 Å	100.	-0.278E-02	-0.167E-02	-0.189E-02	-0.131E-02	-0.174E-02	-0.121E-02	-0.366E-02	-0.255E-02
C= 0.11E+22	200.	-0.297E-02	-0.183E-02	-0.288E-02	-0.210E-02	-0.252E-02	-0.180E-02	-0.571E-02	-0.418E-02
	300.	-0.330E-02	-0.201E-02	-0.350E-02	-0.255E-02	-0.298E-02	-0.220E-02	-0.701E-02	-0.511E-02
	400.	-0.307E-02	-0.178E-02	-0.392E-02	-0.290E-02	-0.320E-02	-0.242E-02	-0.790E-02	-0.583E-02
	600.	-0.301E-02	-0.178E-02	-0.437E-02	-0.326E-02	-0.360E-02	-0.270E-02	-0.877E-02	-0.656E-02
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	-0.173E-02	-0.142E-02	-0.879E-03	-0.739E-03	-0.859E-03	-0.724E-03	-0.164E-02	-0.138E-02
λ = 1330.41 Å	100.	-0.224E-02	-0.188E-02	-0.168E-02	-0.143E-02	-0.155E-02	-0.132E-02	-0.326E-02	-0.278E-02
C= 0.11E+22	200.	-0.246E-02	-0.204E-02	-0.261E-02	-0.227E-02	-0.227E-02	-0.196E-02	-0.517E-02	-0.452E-02
	300.	-0.270E-02	-0.225E-02	-0.316E-02	-0.276E-02	-0.271E-02	-0.237E-02	-0.636E-02	-0.554E-02
	400.	-0.243E-02	-0.201E-02	-0.358E-02	-0.312E-02	-0.293E-02	-0.260E-02	-0.720E-02	-0.628E-02
	600.	-0.240E-02	-0.200E-02	-0.397E-02	-0.349E-02	-0.328E-02	-0.289E-02	-0.799E-02	-0.704E-02
(^{2}D$_2$) 4s ^{3}D$_1$ - (^{2}D$_2$) 4p ^{3}P$^o_0$	50.	-0.157E-02		-0.792E-03		-0.775E-03		-0.147E-02	
λ = 1331.19 Å	100.	-0.200E-02		-0.153E-02		-0.140E-02		-0.296E-02	
C= 0.11E+22	200.	-0.221E-02		-0.240E-02		-0.208E-02		-0.478E-02	
	300.	-0.240E-02		-0.291E-02		-0.250E-02		-0.586E-02	
	400.	-0.213E-02		-0.330E-02		-0.273E-02		-0.663E-02	
	600.	-0.215E-02		-0.368E-02		-0.304E-02		-0.741E-02	

Table 6. Continued

Transition	T (kK)	W_e (Å) Cowan	W_e (Å) NIST	d_{H+} (Å) Cowan	d_{H+} (Å) NIST	d_{He+} (Å) Cowan	d_{He+} (Å) NIST	d_{He++} (Å) Cowan	d_{He++} (Å) NIST
(^{2}D$_2$) 4s ^{1}D$_2$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.210E-02	-0.165E-02	-0.948E-03	-0.750E-03	-0.923E-03	-0.735E-03	-0.177E-02	-0.140E-02
λ = 1331.64 Å	100.	-0.254E-02	-0.203E-02	-0.180E-02	-0.145E-02	-0.166E-02	-0.134E-02	-0.348E-02	-0.282E-02
C= 0.11E+22	200.	-0.279E-02	-0.221E-02	-0.276E-02	-0.230E-02	-0.242E-02	-0.198E-02	-0.549E-02	-0.458E-02
	300.	-0.303E-02	-0.241E-02	-0.335E-02	-0.279E-02	-0.288E-02	-0.240E-02	-0.674E-02	-0.561E-02
	400.	-0.280E-02	-0.223E-02	-0.378E-02	-0.316E-02	-0.309E-02	-0.262E-02	-0.761E-02	-0.636E-02
	600.	-0.278E-02	-0.222E-02	-0.420E-02	-0.354E-02	-0.346E-02	-0.292E-02	-0.846E-02	-0.712E-02

Table 7. Same as Table 5 but for a perturber density of 10^{19} cm^{-3}.

Transition	T (kK)	d_e (Å) Cowan	d_e (Å) NIST	d_{H+} (Å) Cowan	d_{H+} (Å) NIST	d_{He+} (Å) Cowan	d_{He+} (Å) NIST	d_{He++} (Å) Cowan	d_{He++} (Å) NIST
(^{2}G) 4s ^{3}G$_5$ - (^{2}D$_2$) 4p ^{3}F$^o_4$	50.	-0.174E-01	-0.829E-02	-0.797E-02	-0.480E-02	-0.771E-02	-0.471E-02	-0.125E-01	-0.756E-02
λ =1280.47 Å	100.	-0.237E-01	-0.121E-01	-0.163E-01	-0.103E-01	-0.150E-01	-0.948E-02	*-0.298E-01	*-0.189E-01
C= 0.11E+23	200.	-0.264E-01	-0.140E-01	-0.262E-01	-0.175E-01	-0.230E-01	-0.150E-01	*-0.496E-01	*-0.334E-01
	300.	-0.292E-01	-0.153E-01	-0.321E-01	-0.213E-01	-0.274E-01	-0.185E-01	*-0.624E-01	*-0.417E-01
	400.	-0.266E-01	-0.127E-01	-0.365E-01	-0.247E-01	-0.297E-01	-0.208E-01	-0.721E-01	-0.489E-01
	600.	-0.265E-01	-0.129E-01	-0.406E-01	-0.280E-01	-0.334E-01	-0.231E-01	-0.813E-01	-0.564E-01
(^{4}P) 4s ^{5}P$_2$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.180E-01	-0.143E-01	-0.800E-02	-0.611E-02	-0.775E-02	-0.596E-02	-0.126E-01	-0.962E-02
λ =1288.17 Å	100.	-0.244E-01	-0.194E-01	-0.164E-01	-0.128E-01	-0.150E-01	-0.118E-01	-0.300E-01	-0.236E-01
C= 0.10E+23	200.	-0.271E-01	-0.210E-01	-0.264E-01	-0.214E-01	-0.231E-01	-0.184E-01	*-0.500E-01	*-0.406E-01
	300.	-0.299E-01	-0.234E-01	-0.323E-01	-0.261E-01	-0.276E-01	-0.224E-01	-0.629E-01	-0.509E-01
	400.	-0.276E-01	-0.221E-01	-0.368E-01	-0.298E-01	-0.300E-01	-0.247E-01	-0.727E-01	-0.590E-01
	600.	-0.276E-01	-0.219E-01	-0.408E-01	-0.334E-01	-0.337E-01	-0.275E-01	-0.820E-01	-0.670E-01
(^{2}G) 4s ^{3}G$_3$ - (^{2}D$_2$) 4p ^{3}F$^o_2$	50.	-0.203E-01	-0.127E-01	-0.865E-02	-0.603E-02	-0.835E-02	-0.589E-02	-0.136E-01	-0.950E-02
λ = 1293.38 Å	100.	-0.270E-01	-0.177E-01	-0.175E-01	-0.127E-01	-0.162E-01	-0.116E-01	*-0.321E-01	*-0.233E-01
C= 0.11E+23	200.	-0.296E-01	-0.196E-01	-0.281E-01	-0.212E-01	-0.246E-01	-0.182E-01	*-0.530E-01	*-0.403E-01
	300.	-0.329E-01	-0.217E-01	-0.344E-01	-0.259E-01	-0.292E-01	-0.222E-01	-0.670E-01	-0.505E-01
	400.	-0.307E-01	-0.197E-01	-0.390E-01	-0.296E-01	-0.317E-01	-0.246E-01	-0.769E-01	-0.585E-01
	600.	-0.305E-01	-0.197E-01	-0.433E-01	-0.331E-01	-0.355E-01	-0.273E-01	-0.870E-01	-0.666E-01
(^{4}P) 4s ^{5}P$_3$ - (^{2}P) 4p ^{1}D$^o_2$	50.	-0.185E-01	-0.171E-01	-0.821E-02	-0.709E-02	-0.794E-02	-0.689E-02	-0.129E-01	-0.112E-01
λ = 1297.54 Å	100.	-0.250E-01	-0.230E-01	-0.168E-01	-0.147E-01	-0.154E-01	-0.135E-01	-0.307E-01	-0.270E-01
C= 0.11E+23	200.	-0.278E-01	-0.248E-01	-0.270E-01	-0.240E-01	-0.236E-01	-0.209E-01	*-0.512E-01	*-0.456E-01
	300.	-0.307E-01	-0.277E-01	-0.331E-01	-0.294E-01	-0.282E-01	-0.252E-01	-0.644E-01	-0.573E-01
	400.	-0.283E-01	-0.262E-01	-0.376E-01	-0.336E-01	-0.306E-01	-0.276E-01	-0.743E-01	-0.665E-01
	600.	-0.283E-01	-0.259E-01	-0.418E-01	-0.373E-01	-0.344E-01	-0.307E-01	-0.839E-01	-0.750E-01
(^{2}P) 4s ^{1}P$_1$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.189E-01	-0.127E-01	-0.824E-02	-0.562E-02	-0.798E-02	-0.551E-02	-0.130E-01	-0.886E-02
λ = 1311.82 Å	100.	-0.246E-01	-0.168E-01	-0.169E-01	-0.119E-01	-0.155E-01	-0.110E-01	*-0.309E-01	*-0.219E-01
C= 0.11E+23	200.	-0.278E-01	-0.187E-01	-0.273E-01	-0.202E-01	-0.238E-01	-0.172E-01	*-0.516E-01	*-0.383E-01
	300.	-0.299E-01	-0.201E-01	-0.333E-01	-0.246E-01	-0.285E-01	-0.212E-01	*-0.649E-01	*-0.479E-01
	400.	-0.281E-01	-0.189E-01	-0.380E-01	-0.282E-01	-0.310E-01	-0.236E-01	-0.750E-01	-0.559E-01
	600.	-0.280E-01	-0.190E-01	-0.421E-01	-0.318E-01	-0.347E-01	-0.263E-01	-0.847E-01	-0.640E-01
(^{2}H) 4s ^{3}H$_4$ - (^{2}H) 4p ^{3}G$^o_3$	500.	-0.190E-01	-0.131E-01	-0.819E-02	-0.622E-02	-0.794E-02	-0.608E-02	-0.129E-01	-0.979E-02
λ = 1320.41 Å	1000.	-0.252E-01	-0.179E-01	-0.167E-01	-0.131E-01	-0.154E-01	-0.120E-01	*-0.307E-01	*-0.241E-01
C= 0.10E+23	200.	-0.276E-01	-0.199E-01	-0.271E-01	-0.219E-01	-0.237E-01	-0.188E-01	*-0.514E-01	*-0.416E-01
	300.	-0.303E-01	-0.217E-01	-0.332E-01	-0.267E-01	-0.284E-01	-0.230E-01	*-0.646E-01	*-0.521E-01
	400.	-0.285E-01	-0.198E-01	-0.378E-01	-0.306E-01	-0.308E-01	-0.254E-01	-0.747E-01	-0.605E-01
	600.	-0.282E-01	-0.199E-01	-0.419E-01	-0.342E-01	-0.346E-01	-0.283E-01	-0.844E-01	-0.689E-01
(^{2}G) 4s ^{3}G$_5$ - (^{2}H) 4p ^{3}H$^o_6$	50.	-0.172E-01	-0.592E-02	-0.812E-02	-0.423E-02	-0.786E-02	-0.417E-02	-0.128E-01	-0.668E-02
λ = 1321.49 Å	100.	-0.228E-01	-0.869E-02	-0.166E-01	-0.916E-02	-0.153E-01	-0.856E-02	-0.305E-01	-0.169E-01
C= 0.12E+23	200.	-0.260E-01	-0.109E-01	-0.270E-01	-0.160E-01	-0.235E-01	-0.138E-01	*-0.511E-01	*-0.305E-01
	300.	-0.286E-01	-0.115E-01	-0.329E-01	-0.194E-01	-0.282E-01	-0.169E-01	-0.641E-01	-0.380E-01
	400.	-0.256E-01	-0.811E-02	-0.375E-01	-0.226E-01	-0.306E-01	-0.193E-01	-0.742E-01	-0.447E-01
	600.	-0.255E-01	-0.872E-02	-0.417E-01	-0.262E-01	-0.343E-01	-0.214E-01	-0.839E-01	-0.527E-01
(^{2}H) 4s ^{3}H$_5$ - (^{2}H) 4p ^{3}G$^o_4$	50.	-0.200E-01	-0.113E-01	-0.859E-02	-0.577E-02	-0.830E-02	-0.565E-02	-0.135E-01	-0.909E-02
λ = 1323.27 Å	100.	-0.267E-01	-0.160E-01	-0.175E-01	-0.122E-01	-0.161E-01	-0.112E-01	*-0.321E-01	*-0.225E-01
C= 0.11E+23	200.	-0.291E-01	-0.179E-01	-0.282E-01	-0.207E-01	-0.246E-01	-0.177E-01	*-0.534E-01	*-0.393E-01
	300.	-0.321E-01	-0.195E-01	-0.345E-01	-0.252E-01	-0.294E-01	-0.217E-01	*-0.672E-01	*-0.491E-01
	400.	-0.302E-01	-0.175E-01	-0.392E-01	-0.289E-01	-0.319E-01	-0.242E-01	-0.775E-01	-0.573E-01
	600.	-0.298E-01	-0.175E-01	-0.436E-01	-0.325E-01	-0.359E-01	-0.269E-01	-0.874E-01	-0.655E-01
(^{2}H) 4s ^{3}H$_6$ - (^{2}H) 4p ^{3}G$^o_5$	50.	-0.156E-01	-0.129E-01	-0.756E-02	-0.635E-02	-0.734E-02	-0.620E-02	-0.118E-01	-0.100E-01
λ =1330.41 Å	100.	-0.213E-01	-0.179E-01	-0.156E-01	-0.134E-01	-0.143E-01	-0.122E-01	*-0.287E-01	*-0.246E-01
C= 0.11E+23	200.	-0.240E-01	-0.199E-01	-0.256E-01	-0.223E-01	-0.222E-01	-0.192E-01	*-0.485E-01	*-0.424E-01
	300.	-0.263E-01	-0.218E-01	-0.312E-01	-0.272E-01	-0.268E-01	-0.234E-01	*-0.609E-01	*-0.532E-01
	400.	-0.239E-01	-0.198E-01	-0.357E-01	-0.312E-01	-0.292E-01	-0.259E-01	-0.706E-01	-0.617E-01
	600.	-0.237E-01	-0.197E-01	-0.397E-01	-0.349E-01	-0.327E-01	-0.288E-01	-0.797E-01	-0.702E-01
(^{2}D$_2$) 4s ^{3}D$_1$ - (^{2}D$_2$) 4p ^{3}P$^o_0$	50.	-0.140E-01		-0.681E-02		-0.663E-02		-0.107E-01	
λ = 1331.19 Å	100.	-0.190E-01		-0.142E-01		-0.130E-01		*-0.262E-01	
C= 0.11E+23	200.	-0.216E-01		-0.235E-01		-0.203E-01		*-0.447E-01	
	300.	-0.234E-01		-0.288E-01		-0.247E-01		*-0.562E-01	
	400.	-0.210E-01		-0.330E-01		-0.272E-01		-0.651E-01	
	600.	-0.212E-01		-0.367E-01		-0.303E-01		-0.739E-01	
(^{2}D$_2$) 4s ^{1}D$_2$ - (^{2}D$_2$) 4p ^{1}D$^o_2$	50.	-0.187E-01	-0.147E-01	-0.814E-02	-0.644E-02	-0.788E-02	-0.629E-02	-0.128E-01	-0.101E-01
λ =1331.64 Å	100.	-0.243E-01	-0.194E-01	-0.167E-01	-0.135E-01	-0.154E-01	-0.124E-01	*-0.306E-01	*-0.249E-01
C= 0.11E+23	200.	-0.274E-01	-0.216E-01	-0.271E-01	-0.226E-01	-0.236E-01	-0.194E-01	*-0.513E-01	*-0.429E-01
	300.	-0.296E-01	-0.235E-01	-0.331E-01	-0.276E-01	-0.283E-01	-0.237E-01	*-0.645E-01	*-0.538E-01
	400.	-0.276E-01	-0.220E-01	-0.377E-01	-0.316E-01	-0.308E-01	-0.262E-01	-0.747E-01	-0.624E-01
	600.	-0.276E-01	-0.220E-01	-0.420E-01	-0.353E-01	-0.345E-01	-0.291E-01	-0.843E-01	-0.710E-01

Table 8. Electron-, proton- singly and doubly charged helium-impact Stark broadening parameters for 4s - 4p spectral lines of Fe V calculated using semiclassical perturbation approach (Sahal-Bréchot 1969a,b; Sahal-Bréchot, Dimitrijević & Ben Nessib 2014) for a perturber density of 10^{17} cm^{-3} and temperature of 50 000 to 600 000 K. The needed atomic data are calculated using Cowan code (Cowan 1981). W_e: electron-impact full Stark width at half maximum, d_e: electron-impact Stark shift, W_{H^+}: proton-impact full Stark width at half maximum, d_{H^+}: proton-impact Stark shift, W_{He^+}: singly charged helium-impact full Stark width at half maximum, d_{He^+}: singly charged helium-impact Stark shift. $W_{He^{++}}$: doubly charged helium-impact full Stark width at half maximum, $d_{He^{++}}$: doubly charged helium-impact Stark shift. All wavelengths are taken from NIST database (Kramida et al. 2019). This table is available in its entirety for 238 spectral lines in machine-readable form in the online journal as additional data. A portion is shown here to illustrate its form and content.

Transition	T (kK)	W_e (Å)	d_e (Å)	W_{H+} (Å)	d_{H+} (Å)	W_{He+} (Å)	d_{He+} (Å)	W_{He++} (Å)	d_{He++} (Å)
(^{4}F) 4s ^{5}F$_3$ - (^{4}F) 4p ^{5}F$^o_4$	50.	0.134E-01	-0.178E-03	0.230E-03	-0.994E-04	0.352E-03	-0.971E-04	0.452E-03	-0.194E-03
1363.08 A	100.	0.960E-02	-0.242E-03	0.440E-03	-0.181E-03	0.559E-03	-0.167E-03	0.869E-03	-0.360E-03
C= 0.13E+21	200.	0.716E-02	-0.270E-03	0.655E-03	-0.277E-03	0.759E-03	-0.242E-03	0.130E-02	-0.557E-03
	300.	0.617E-02	-0.297E-03	0.773E-03	-0.337E-03	0.823E-03	-0.289E-03	0.154E-02	-0.677E-03
	400.	0.561E-02	-0.261E-03	0.822E-03	-0.381E-03	0.869E-03	-0.312E-03	0.164E-02	-0.767E-03
	600.	0.495E-02	-0.260E-03	0.898E-03	-0.422E-03	0.937E-03	-0.347E-03	0.179E-02	-0.850E-03
(^{2}F) 4s ^{3}F$_3$ - (^{2}F) 4p ^{3}G$^o_4$	50.	0.141E-01	-0.167E-03	0.397E-03	-0.954E-04	0.581E-03	-0.933E-04	0.780E-03	-0.186E-03
1374.12 A	100.	0.101E-01	-0.223E-03	0.692E-03	-0.175E-03	0.863E-03	-0.161E-03	0.137E-02	-0.348E-03
C= 0.84E+20	200.	0.758E-02	-0.252E-03	0.980E-03	-0.269E-03	0.109E-02	-0.234E-03	0.194E-02	-0.541E-03
	300.	0.655E-02	-0.274E-03	0.109E-02	-0.327E-03	0.117E-02	-0.281E-03	0.217E-02	-0.658E-03
	400.	0.596E-02	-0.239E-03	0.115E-02	-0.371E-03	0.123E-02	-0.305E-03	0.230E-02	-0.746E-03
	600.	0.529E-02	-0.239E-03	0.124E-02	-0.410E-03	0.131E-02	-0.339E-03	0.248E-02	-0.826E-03

Table 9. Same as Table 8 but for perturber density 10^{18} cm^{-3}

Transition	T (kK)	W_e (Å)	d_e (Å)	W_{H+} (Å)	d_{H+} (Å)	W_{He+} (Å)	d_{He+} (Å)	W_{He++} (Å)	d_{He++} (Å)
(^{4}F) 4s ^{5}F$_3$ - (^{4}F) 4p ^{5}F$^o_4$	50.	0.134	-0.183E-02	0.229E-02	-0.939E-03	0.351E-02	-0.916E-03	0.447E-02	-0.175E-02
1363.08 Å	100.	0.960E-01	-0.242E-02	0.440E-02	-0.179E-02	0.559E-02	-0.165E-02	0.867E-02	-0.347E-02
0.13E+21	200.	0.716E-01	-0.265E-02	0.655E-02	-0.277E-02	0.759E-02	-0.241E-02	0.130E-01	-0.550E-02
	300.	0.617E-01	-0.296E-02	0.773E-02	-0.337E-02	0.823E-02	-0.289E-02	0.154E-01	-0.676E-02
	400.	0.561E-01	-0.260E-02	0.822E-02	-0.381E-02	0.869E-02	-0.311E-02	0.164E-01	-0.766E-02
	600.	0.495E-01	-0.260E-02	0.898E-02	-0.422E-02	0.937E-02	-0.347E-02	0.179E-01	-0.849E-02
(^{2}F) 4s ^{3}F$_3$ - (^{2}F) 4p ^{3}G$^o_4$	50.	0.141	-0.170E-02	0.396E-02	-0.901E-03	0.579E-02	-0.880E-03	0.771E-02	-0.168E-02
1374.12 Å	100.	0.101	-0.223E-02	0.692E-02	-0.173E-02	0.862E-02	-0.159E-02	0.137E-01	-0.336E-02
C= 0.84E+20	200.	0.758E-01	-0.247E-02	0.980E-02	-0.269E-02	0.109E-01	-0.234E-02	0.194E-01	-0.535E-02
	300.	0.655E-01	-0.274E-02	0.109E-01	-0.327E-02	0.117E-01	-0.281E-02	0.217E-01	-0.657E-02
	400.	0.596E-01	-0.238E-02	0.115E-01	-0.371E-02	0.123E-01	-0.304E-02	0.230E-01	-0.744E-02
	600.	0.529E-01	-0.239E-02	0.124E-01	-0.410E-02	0.131E-01	-0.339E-02	0.248E-01	-0.825E-02

Table 10. Same as Table 8 but for perturber density 10^{19} cm^{-3}

Transition	T (kK)	W_e (Å)	d_e (Å)	W_{H+} (Å)	d_{H+} (Å)	W_{He+} (Å)	d_{He+} (Å)	W_{He++} (Å)	d_{He++} (Å)
(^{4}F) 4s ^{5}F$_3$ - (^{4}F) 4p ^{5}F$^o_4$	50.	1.34	-0.164E-01	0.224E-01	-0.807E-02	0.341E-01	-0.783E-02	0.409E-01	-0.127E-01
1363.08 Å	100.	0.960	-0.231E-01	0.438E-01	-0.166E-01	0.554E-01	-0.153E-01	0.852E-01	-0.306E-01
0.13E+21	200.	0.716	-0.259E-01	0.654E-01	-0.272E-01	0.758E-01	-0.236E-01	0.130	-0.515E-01
	300.	0.617	-0.288E-01	0.773E-01	-0.332E-01	0.822E-01	-0.285E-01	0.154	-0.647E-01
	400.	0.561	-0.255E-01	0.822E-01	-0.380E-01	0.869E-01	-0.311E-01	0.164	-0.751E-01
	600.	0.495	-0.256E-01	0.897E-01	-0.421E-01	0.937E-01	-0.346E-01	0.179	-0.847E-01
(^{2}F) 4s ^{3}F$_3$ - (^{2}F) 4p ^{3}G$^o_4$	50.	1.41	-0.153E-01	0.387E-01	-0.774E-02	0.562E-01	-0.753E-02	0.700E-01	-0.122E-01
1374.12 A	100.	1.01	-0.213E-01	0.688E-01	-0.161E-01	0.855E-01	-0.147E-01	*0.134	*-0.295E-01
C= 0.84E+20	200.	0.758	-0.242E-01	0.980E-01	-0.264E-01	0.109	-0.229E-01	*0.193	*-0.501E-01
	300.	0.655	-0.266E-01	0.109	-0.323E-01	0.117	-0.276E-01	*0.217	*-0.629E-01
	400.	0.596	-0.233E-01	0.115	-0.370E-01	0.123	-0.304E-01	*0.230	*-0.730E-01
	600.	0.529	-0.236E-01	0.124	-0.410E-01	0.131	-0.338E-01	0.248	-0.824E-01