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Ab initio calculations of Ca III Stark broadening parameters, transition probabilities and radiative lifetimes

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ABSTRACT

We have determined matrix elements for all experimental configurations of Ca III, including the $3s3p^63d$ configuration. These values have been obtained using intermediate coupling (IC). For these IC calculations, we have used the standard method of least-squares fitting from the experimental energy levels, using the computer code developed by Robert Cowan. In this paper, using these matrix elements, we report the calculated values of the Ca III Stark widths and shifts for 148 spectral lines, of 56 Ca III spectral line transition probabilities and of eight radiative lifetimes of Ca III levels. The Stark widths and shifts, calculated using the Griem semi-empirical approach, correspond to the spectral lines of Ca III and are presented for an electron density of 10^{17} cm^{-3} and temperatures $T = 1.0$–10.0 ($\times 10^4$ K). The theoretical trends of the Stark broadening parameter versus the temperature are presented for transitions that are of astrophysical interest. There is good agreement between our calculations, for transition probabilities and radiative lifetimes, and the experimental values presented in the literature. We have not been able to find any values for the Stark parameters in the references.

Key words: atomic data – atomic processes.

1 INTRODUCTION

Data on the Stark broadening parameters of spectral lines are relevant not only for research on atomic structure, but also for astrophysics and analytical techniques in plasma diagnosis. The Stark broadening mechanism plays an important role in the analysis and modelling of B-type and A-type stellar atmospheres. Calcium is an important element in astrophysics. Calcium abundance is an indicator of the history of the stellar object (Gabriel, Fawcett & Jordan 1966). Calcium lines are detected in the atmospheres of white dwarfs (WDs) at high temperatures (above 25 000 K; Zuckerman et al. 2003). Recently, Ca V lines have been introduced in the atmospheric model used by Rauch et al. (2007), and calcium in a higher ionization stage (Ca X) has been observed by Werner, Rauch & Kruk (2008) in the photosphere of the hot WD, KPD 0005+5106. Our aim in this paper is to provide calculations of the Stark broadening parameters of Ca III, in order to help fill the gaps in the Stark broadening data for different species of calcium.

Borgström (1971) and Hansen, Persson & Borgström (1975) have carried out exhaustive investigations into the energy levels of Ca III, isoelectronic with Ar I. Borgström (1971) measured 222 spectral lines of Ca III, ranging between 2290 and 9649 Å, which allowed them to provide the exact values of the energy levels of various configurations: $3p^54s$, 5s, 4p, 3d, 4d, 4f, 5f and 5g, and different levels of 5p, 5d, 6d, 6f and 7f. With the inclusion of the $3s3p^63d$ configuration, Hansen et al. (1975) were able to solve the small differences observed in the level allocation of the 5f configuration.

The theoretical transition probabilities and oscillator strengths in Ca III have been the subject of several works carried out by different authors. Baluja (1986) has presented the theoretical oscillator strengths for the resonant lines of Ca III of 403.7 and 357.9 Å. Using a compilation of experimental levels, Verner et al. (1994) have presented theoretical values for the transition probabilities of the resonant lines of Ca III of wavelengths 403.7, 357.9 and 296.9 Å. Later, using several methods, such as non-orthogonal spline configuration interaction (CI), multiconfiguration Hartree–Fock and multiconfiguration Dirac–Hartree–Fock, Froese Fischer, Tachiev & Irimia (2006) have presented the transition probabilities for lines of Ca III arising from $3p^54s$ and $3p^54p$.

The lifetimes of the Ca III levels were first calculated in 1973 and 1974, and then measured in 1975. Aymar & Schweighofer (1973) predicted the theoretical lifetimes of the $3p^54p$, $3p^55s$ and $3p^54d$ levels of Ca III. Gruzdew & Loginov (1974) and Loginov & Gruzdew (1986) calculated the lifetimes of the Ca III levels with the $3p^5ns$ ($n = 4$–7), $3p^5np$ ($n = 4$–6), $3p^5nd$ ($n = 3$–5) and $3p^54f$ configurations. Using the beam-foil technique, both Emmoth et al. (1975) and Andersen, Petkov & Sørensen (1975) carried out the experimental determinations of lifetimes for a number of levels of doubled ionized calcium.

Our aim in this paper is to provide values for missing Stark broadening parameters. We have calculated semi-empirical values of the Stark broadening parameters for 148 lines of Ca III arising from the $3s^23p^5ns$ (n = 4, 5), $3s^23p^54p$ and $3s^23p^5nd$ (n = 3, 4)

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Table 1. Transition probabilities of several spectral lines arising from $3p^54s$, $3p^54p$ and $3p^5nd$ (n = 3, 4) configurations of Ca III. We also show the radiative lifetimes of the levels of these configurations.

Transition levels		λ (Å)[a]	Transition probabilities (10^8 s^{-1})		Lifetimes (ns)		
Upper	Lower		This work	Other authors	This work	Other authors	
$3p^54s\ ^1P_1$	$3p^6\ ^1S_0$	403.7	88.3	96.8[b] 95.5[c] 66.3[d]	0.11	0.15[d]	
$3p^54p\ ^3P_2$	$3p^53d\ ^3P_1$	1281.1	0.15	0.19[d]	1.31	1.45[d]	1.60±0.15[e]
	$3p^53d\ ^3P_2$	1298.0	0.93	0.99[d]			1.55±0.20[f]
	$3p^54s\ ^3F_3$	1459.8	0.39				
	$3p^54s\ ^3F_2$	1480.4	0.051				
	$3p^53d\ ^1D_2$	1783.9	0.22	0.20[d]			
	$3p^53d\ ^3D_3$	1800.2	0.93				
	$3p^53d\ ^3D_2$	1835.1	0.018				
	$3p^53d\ ^1F_3$	1870.3	1.60	1.56[d]			
	$3p^54s\ ^3P_2$	2541.5	0.98	0.74[d]			
	$3p^54s\ ^3P_1$	2634.1	0.82	0.75[d]			
	$3p^54s\ ^1P_1$	2924.4	1.52	1.40[d]			
$3p^54p\ ^1D_2$	$3p^53d\ ^3P_1$	1317.7	0.24	0.27[d]	1.47	1.60[d]	1.65±0.15[e]
	$3p^53d\ ^3P_2$	1335.1	0.42	0.58[d]			1.9±0.3[f]
	$3p^54s\ ^3F_3$	1506.9	0.33	0.24[d]			
	$3p^54s\ ^3F_2$	1528.9	0.044	0.032[d]			
	$3p^53d\ ^1D_2$	1854.7	0.14	0.09[d]			
	$3p^53d\ ^3D_3$	1872.4	1.44	1.42[d]			
	$3p^53d\ ^3D_2$	1910.1	0.43	0.36[d]			
	$3p^53d\ ^3D_1$	1911.7	0.025	0.022[d]			
	$3p^53d\ ^1F_3$	1948.3	0.76	0.54[d]			
	$3p^54s\ ^3P_2$	2687.8	1.54	1.44[d]			
	$3p^54s\ ^3P_1$	2791.6	0.35	0.36[d]			
	$3p^54s\ ^1P_1$	3119.7	1.09	0.88[d]			
$3p^54p\ ^3D_1$	$3p^53d\ ^3P_0$	1328.9	0.19	0.18[d]	1.35	1.47[d]	1.65±0.15[e]
	$3p^53d\ ^3P_1$	1337.5	0.007				1.7±0.2[f]
	$3p^53d\ ^3P_2$	1355.4	0.047	0.067[d]			
	$3p^53d\ ^3F_2$	1555.5	3.51	3.34[d]			
	$3p^53d\ ^1D_2$	1894.1	0.23	0.19[d]			
	$3p^53d\ ^3D_2$	1951.9	0.022	0.017[d]			
	$3p^53d\ ^3D_1$	1953.5	0.54	0.45[d]			
	$3p^54s\ ^3P_2$	2771.3	0.32	0.29[d]			
	$3p^54s\ ^3P_1$	2881.8	1.90	1.70[d]			
	$3p^54s\ ^3P_0$	3028.6	0.63	0.54[d]			
	$3p^54s\ ^1P_1$	3232.7	0.0032				
$3p^54p\ ^3D_3$	$3p^53d\ ^3P_2$	1385.4	0.14	0.10[d]	1.29	1.39[d]	1.55±0.15[e]
	$3p^53d\ ^3F_4$	1545.3	3.93	3.81[d]			1.8±0.2[f]
	$3p^53d\ ^3F_3$	1571.3	0.39	0.37[d]			
	$3p^53d\ ^3F_3$	1595.2	0.012				
	$3p^53d\ ^1D_2$	1953.3	0.0043				
	$3p^53d\ ^3D_3$	1972.8	0.31	0.26[d]			
	$3p^53d\ ^3D_3$	2014.7	0.035				
	$3p^54s\ ^1F_3$	2057.3	0.034				
	$3p^54s\ ^3P_2$	2899.8	2.87	2.57[d]			
$3p^54p\ ^3S_1$	$3p^53d\ ^3P_0$	1453.3	0.77	0.75[d]	1.34	1.43[d]	1.70±0.15[e]
	$3p^53d\ ^3P_1$	1463.3	2.07	1.99[d]			2.0±0.2[f]
	$3p^53d\ ^3P_2$	1484.8	2.75	2.57[d]			
	$3p^53d\ ^1D_2$	2099.4	0.0006				
	$3p^53d\ ^3D_2$	2232.2	0.010				
	$3p^53d\ ^3D_1$	2231.0	0.0029				
	$3p^54s\ ^3P_2$	3373.6	1.30	1.16[d]			
	$3p^54s\ ^3P_1$	3538.8	0.41	0.37[d]			
	$3p^54s\ ^3P_0$	3762.6	0.10	0.089[d]			
	$3p^54s\ ^1P_1$	4083.0	0.027	0.019[d]			
$3p^53d\ ^1P_1$	$3p^6\ ^1S_0$	357.9	783.3	640.2[b] 665.0[c]	0.013	0.016[d]	
$3p^54d\ ^1P_1$	$3p^6\ ^1S_0$	296.9	244.5	295.0[c]	0.040		

[a]Borgström (1971).
[b]Baluja (1986).
[c]Verner et al. (1994).
[d]Froese Fischer et al. (2006).
[e]Andersen et al. (1975).
[f]Emmoth et al. (1975).

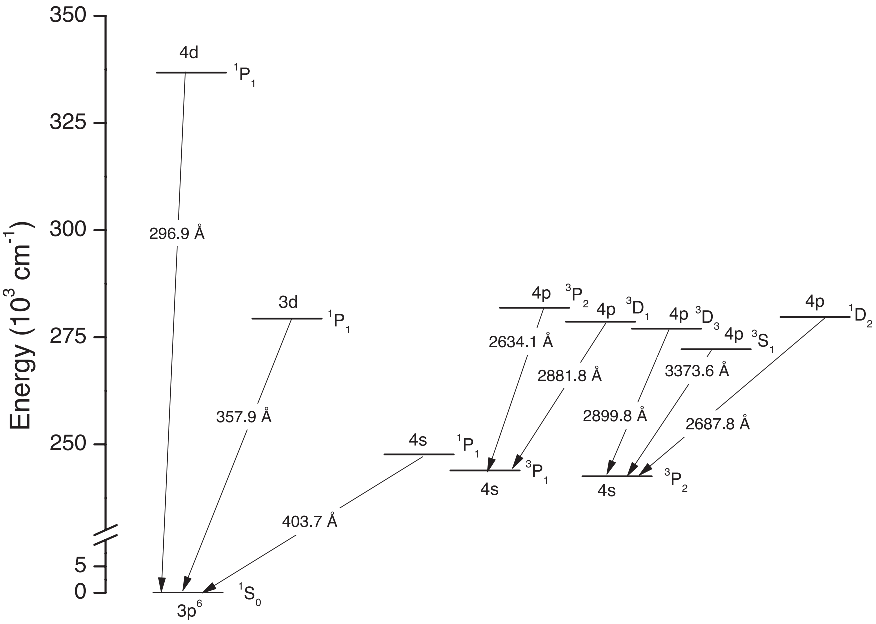

Figure 1. Schematic diagram of the Ca III energy levels corresponding to some spectral lines that have been calculated in this paper.

configurations. For these calculations, we have used the well-known semiclassical approximation of Griem (1968), using the matrix elements of all known experimental4 transitions, calculated in the framework of the Relativistic Hartree–Fock (HFR) method, using the computer code of Cowan (1981). Moreover, these matrix elements have been used to calculate the transition probabilities and lifetimes for the spectral lines and energy levels considered.

In this paper, we present only some transition probabilities and lifetimes (i.e. those for which there are experimental or theoretical values in the literature that we could use to test the accuracy of our calculations). Stark widths and shifts are presented for an electron density of 10^{17} cm^{-3} and temperatures $T = 0.5$–10.0 ($\times$ 10^4 K).

2 METHOD OF CALCULATION

In this paper, we have used a similar procedure to that described by Alonso-Medina et al. (2010) and Colón, Alonso-Medina & Porcher (2011). The experimental energy levels used in the intermediate coupling (IC) calculations have been taken from Borgström (1971) and Hansen et al. (1975). The IC calculations have been carried out with the standard method of least-squares fitting of the experimental energy levels using the computer code of Cowan (1981). In this approach, each configuration is treated individually and their orbitals are calculated and optimized by the HFR procedure in each individual configuration.

The basis set used in this paper consists of nine configurations of even parity, $3s^23p^6$, $3s^23p^5np$ (n = 4–6), $3s^23p^5nf$ (n = 4, 5) and $3s3p^63d$, and 10 configurations of odd parity, $3s^23p^5ns$ (n = 4–6), $3s^23p^5nd$ (n = 3–6) and $3s^23p^5ng$ (n = 5–7). As can be seen, we have taken into account the suggestion of Hansen et al. (1975) to introduce the $3s3p^63d$ configuration in order to obtain accurate values of the 5f levels.

Because of the high number of parameters to adjust (which exceeds of the number of experimental levels), we have excluded from the adjustment process a certain number of parameters. For all the F^k, G^k and R^k integrals with no adjustments in the fitting procedure, we take the HFR *ab initio* values scaled down by a factor of 0.85 (as suggested by Cowan 1981). For the spin-orbit integrals $\zeta_{\rm nl}$, characterized by small numerical values and no adjustment in the fitting procedures, we have used the HFR *ab initio* values without scaling. Our results are not essentially different from those published by Borgström (1971) and Hansen et al. (1975). Therefore, we do not present the details here, but these can be obtained from the authors on request.

The matrix elements obtained using this procedure were later used in the semi-empirical formulae of Griem (1968) to calculate the Stark broadening parameters; Griem (1968) presented a simple semi-empirical impact approximation. This approach was based on the original formulation of Baranger (1958), and the use of an effective Gaunt factor, proposed by Seaton (1962) and Van Regemorter (1962). It is well known that the results of this approach depend on the Gaunt factor precision. In this work, we have used the Gaunt factor suggested by Niemann et al. (2003), because these factors give us theoretical values closer to the experimental values.

The Stark linewidth and Stark line shifts can be calculated from the following semi-expressions:

$$\omega_{\rm se} \approx 8\left(\frac{\pi}{3}\right)^{3/2} \frac{\hbar}{ma_0} N_{\rm e} \left(\frac{E_{\rm H}}{kT}\right)^{1/2} \left[\sum_{i'} \left|\langle i'\,|\boldsymbol{r}|\,i\rangle\right|^2 g_{\rm se} \times \left(\frac{E}{\Delta E_{i'i}}\right) + \sum_{f'} \left|\langle f'\,|\boldsymbol{r}|\,f\rangle\right|^2 g_{\rm se} \left(\frac{E}{\Delta E_{f'f}}\right)\right]; \quad (1)$$

$$d \approx -8\left(\frac{\pi}{3}\right)^{3/2} \frac{\hbar}{ma_0} N_{\rm e} \left(\frac{E_{\rm H}}{kT}\right)^{1/2} \left[\sum_{i'} \left(\frac{\Delta E_{i'i}}{|\Delta E_{i'i}|}\right) \times \left|\langle i'\,|\boldsymbol{r}|\,i\rangle\right|^2 g_{\rm sh} \left(\frac{E}{\Delta E_{i'i}}\right) - \sum_{f'} \left(\frac{\Delta E_{f'f}}{|\Delta E_{f'f}|}\right) \times \left|\langle f'\,|\boldsymbol{r}|\,f\rangle\right|^2 g_{\rm sh} \left(\frac{E}{\Delta E_{f'f}}\right)\right]. \quad (2)$$

Table 2. The Ca III $3s^23p^6$–$3s^23p^5ns$ (n = 4, 5) and $3s^23p^54p$–$3s^23p^5ns$ (n = 4, 5) linewidths (FWHM), ω (pm) and shifts, d (pm), normalized to $N_e = 10^{17}$ cm^{-3}. Note that a positive shift is red.

Wavelength λ (Å)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
409.9	$3s^23p^6$–$3s^23p^54s$	^1S–^3P	0–1	1.0	0.41	−0.41
				2.0	0.26	−0.26
				3.3	0.19	−0.19
				10.0	0.10	−0.10
403.7	$3s^23p^6$–$3s^23p^54s$	^1S–^1P	0–1	1.0	0.41	−0.39
				2.0	0.26	−0.24
				3.3	0.19	−0.18
				10.0	0.10	−0.09
1794.2	$3s^23p^54p$–$3s^23p^55s$	^3S–^3P	1–2	1.0	39.63	−28.49
				2.0	25.87	−18.85
				3.3	19.38	−14.28
				10.0	10.79	−8.11
1964.6	$3s^23p^54p$–$3s^23p^55s$	^3D–^3P	1–2	1.0	60.38	−39.27
				2.0	39.10	−25.81
				3.3	29.11	−19.44
				10.0	16.01	−10.93
1978.6	$3s^23p^54p$–$3s^23p^55s$	^3D–^3P	2–2	1.0	54.99	−37.43
				2.0	35.73	−24.68
				3.3	26.68	−18.64
				10.0	14.75	−10.53
2075.6	$3s^23p^54p$–$3s^23p^55s$	^1D–^3P	2–2	1.0	60.79	−41.28
				2.0	39.50	−27.22
				3.3	29.49	−20.56
				10.0	16.31	−11.62
2172.1	$3s^23p^54p$–$3s^23p^55s$	^3P–^3P	2–2	1.0	66.64	−45.51
				2.0	43.30	−30.01
				3.3	32.33	−22.67
				10.0	17.87	−12.82
2205.1	$3s^23p^54p$–$3s^23p^55s$	^3P–^3P	1–2	1.0	60.44	−43.81
				2.0	39.44	−29.00
				3.3	29.55	−21.97
				10.0	16.45	−12.49
304.3	$3s^23p^6$–$3s^23p^55s$	^1S–^1P	0–1	1.0	0.62	−0.50
				2.0	0.41	−0.33
				3.3	0.30	−0.25
				10.0	0.17	−0.14
1773.2	$3s^23p^54p$–$3s^23p^55s$	^3S–^1P	1–1	1.0	26.19	−17.42
				2.0	17.01	−11.48
				3.3	12.70	−8.67
				10.0	7.02	−4.89
1953.0	$3s^23p^54p$–$3s^23p^55s$	^3D–^1P	2–1	1.0	38.40	−23.85
				2.0	24.80	−15.63
				3.3	18.43	−11.75
				10.0	10.10	−6.59
2001.4	$3s^23p^54p$–$3s^23p^55s$	^3D–^1P	1–1	1.0	33.71	−22.63
				2.0	21.89	−14.92
				3.3	16.34	−11.26
				10.0	9.02	−6.37
2047.4	$3s^23p^54p$–$3s^23p^55s$	^1D–^1P	2–1	1.0	42.46	−26.29
				2.0	27.43	−17.24
				3.3	20.38	−12.97
				10.0	11.17	−7.27
2107.7	$3s^23p^54p$–$3s^23p^55s$	^1P–^1P	1–1	1.0	37.06	−24.98
				2.0	24.07	−16.47
				3.3	17.97	−12.44
				10.0	9.93	−7.05
2141.2	$3s^23p^54p$–$3s^23p^55s$	^3P–^1P	2–1	1.0	46.51	−29.05
				2.0	30.04	−19.05
				3.3	22.32	−14.33
				10.0	12.23	−8.04

Table 2 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J*–*J*	*T* (10^4 K)	*ω* (pm)	*d* (pm)
2150.1	$3s^23p^54p–3s^23p^55s$	$^3P–^1P$	0–1	1.0	31.63	−23.47
				2.0	20.69	−15.58
				3.3	15.54	−11.83
				10.0	8.69	−6.75
2173.3	$3s^23p^54p–3s^23p^55s$	$^3P–^1P$	1–1	1.0	39.92	−26.93
				2.0	25.92	−17.75
				3.3	19.34	−13.41
				10.0	10.69	−7.58
2655.4	$3s^23p^54p–3s^23p^55s$	$^1S–^1P$	0–1	1.0	49.31	−34.82
				2.0	32.29	−23.10
				3.3	24.25	−17.53
				10.0	13.57	−10.01
1699.0	$3s^23p^54p–3s^23p^55s$	$^3S–^3P$	1–0	1.0	12.54	−7.02
				2.0	8.04	−4.57
				3.3	5.95	−3.41
				10.0	3.23	−1.88
1907.4	$3s^23p^54p–3s^23p^55s$	$^3D–^3P$	1–0	1.0	16.09	−9.24
				2.0	10.33	−6.02
				3.3	7.64	−4.50
				10.0	4.15	−2.49
2003.7	$3s^23p^54p–3s^23p^55s$	$^1P–^3P$	1–0	1.0	17.47	−10.10
				2.0	11.22	−6.57
				3.3	8.30	−4.92
				10.0	4.51	−2.72
2062.9	$3s^23p^54p–3s^23p^55s$	$^3P–^3P$	1–0	1.0	18.98	−11.04
				2.0	12.19	−7.19
				3.3	9.01	−5.38
				10.0	4.89	−2.98
301.7	$3s^23p^6–3s^23p^55s$	$^1S–^3P$	0–1	1.0	0.62	−0.50
				2.0	0.40	−0.33
				3.3	0.30	−0.25
				10.0	0.17	−0.14
1688.8	$3s^23p^54p–3s^23p^55s$	$^3S–^3P$	1–1	1.0	24.00	−16.02
				2.0	15.60	−10.56
				3.3	11.64	−7.97
				7.5	7.46	−5.20
				10.0	6.44	−4.50
1851.1	$3s^23p^54p–3s^23p^55s$	$^3D–^3P$	2–1	1.0	34.79	−21.68
				2.0	22.48	−14.22
				2.3	20.66	−13.11
				10.0	9.16	−5.99
1894.6	$3s^23p^54p–3s^23p^55s$	$^3D–^3P$	1–1	1.0	30.52	−20.55
				2.0	19.82	−13.55
				3.3	14.80	−10.24
				10.0	8.18	−5.79
1935.7	$3s^23p^54p–3s^23p^55s$	$^1D–^3P$	2–1	1.0	38.28	−23.79
				2.0	24.73	−15.60
				3.3	18.38	−11.74
				10.0	10.08	−6.58
1989.6	$3s^23p^54p–3s^23p^55s$	$^1P–^3P$	1–1	1.0	33.37	−22.56
				2.0	21.68	−14.88
				3.3	16.19	−11.24
				10.0	8.95	−6.36
2019.4	$3s^23p^54p–3s^23p^55s$	$^3P–^3P$	2–1	1.0	41.72	−26.15
				2.0	26.96	−17.16
				3.3	20.03	−12.91
				10.0	10.98	−7.24
2027.3	$3s^23p^54p–3s^23p^55s$	$^3P–^3P$	0–1	1.0	28.47	−21.18
				2.0	18.63	−14.06
				3.3	13.99	−10.67
				10.0	7.82	−6.10
2047.9	$3s^23p^54p–3s^23p^55s$	$^3P–^3P$	1–1	1.0	35.81	−24.23
				2.0	23.26	−15.98

Table 2 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J*–*J*	*T* (10^4 K)	ω (pm)	*d* (pm)
				3.3	17.36	−11.07
				10.0	9.59	−6.83
2464.5	$3s^23p^54p$–$3s^23p^55s$	^1S–^3P	0–1	1.0	43.01	−30.46
				2.0	28.16	−20.21
				3.3	21.16	−15.34
				10.0	11.84	−8.76

[a]Borgström (1971).

Table 3. The Ca III $3s^23p^53d$–$3s^23p^54p$ and $3s^23p^54s$–$3s^23p^54p$ linewidths (FWHM), ω (pm), and shifts, *d* (pm), normalized to $N_e = 10^{17}$ cm^{-3}. Note that a positive shift is red.

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J*–*J*	*T* (10^4 K)	ω (pm)	*d* (pm)
1453.3	$3s^23p^53d$–$3s^23p^54p$	^3P–^3S	0–1	1.0	5.16	−1.93
				3.3	2.35	−0.85
				10.0	1.22	−0.42
1463.3	$3s^23p^53d$–$3s^23p^54p$	^3P–^3S	1–1	1.0	5.74	−2.47
				3.3	2.60	−1.08
				10.0	1.34	−0.54
1484.8	$3s^23p^53d$–$3s^23p^54p$	^3P–^3S	2–1	1.0	6.44	−3.08
				3.3	2.91	−1.34
				10.0	1.50	−0.66
2099.4	$3s^23p^53d$–$3s^23p^54p$	^1D–^3S	2–1	1.0	13.58	−6.86
				3.3	6.13	−3.01
				10.0	3.15	−1.49
2232.2	$3s^23p^53d$–$3s^23p^54p$	^3D–^3S	2–1	1.0	15.35	−7.75
				3.3	6.93	−3.40
				10.0	3.57	−1.68
2231.0*	$3s^23p^53d$–$3s^23p^54p$	^3D–^3S	1–1	1.0	13.83	−6.23
				3.3	6.26	−2.73
				10.0	3.24	−1.36
3373.6	$3s^23p^54s$–$3s^23p^54p$	^3P–^3S	2–1	1.0	59.34	−41.97
				3.3	27.32	−19.25
				10.0	14.42	−10.12
3538.8	$3s^23p^54s$–$3s^23p^54p$	^3P–^3S	1–1	1.0	51.08	−31.60
				3.3	23.46	−14.42
				10.0	12.35	−7.54
3762.6	$3s^23p^54s$–$3s^23p^54p$	^3P–^3S	0–1	1.0	41.05	−19.45
				3.3	18.78	−8.75
				10.0	9.84	−4.49
4083.0	$3s^23p^54s$–$3s^23p^54p$	^1P–^3S	1–1	1.0	69.37	−41.55
				2.0	31.84	−19.00
				10.0	16.73	−9.96
1385.4	$3s^23p^53d$–$3s^23p^54p$	^3P–^3D	2–3	1.0	12.01	−5.22
				3.3	5.45	−2.32
				10.0	2.83	−1.18
1545.3	$3s^23p^53d$–$3s^23p^54p$	^3F–^3D	4–3	1.0	16.27	−7.82
				2.0	7.36	−3.47
				10.0	3.80	−1.75
1571.3	$3s^23p^53d$–$3s^23p^54p$	^3F–^3D	3–3	1.0	16.19	−7.46
				3.3	7.34	−3.32
				10.0	3.80	−1.67
1595.2	$3s^23p^53d$–$3s^23p^54p$	^3F–^3D	2–3	1.0	16.03	−7.03
				3.3	7.28	−3.13
				10.0	3.77	−1.59
1953.3	$3s^23p^53d$–$3s^23p^54p$	^1D–^3D	2–3	1.0	24.48	−10.99
				3.3	11.11	−4.90
				10.0	5.76	−2.48

Table 3 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J*–*J*	*T* (10^4 K)	ω (pm)	*d* (pm)
1972.8	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	3–3	1.0	26.19	−12.42
				3.3	11.86	−5.53
				10.0	3.14	−2.79
2014.7	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	2–3	1.0	26.04	−11.68
				3.3	11.82	−5.21
				10.0	6.13	−2.64
2899.8	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	2–3	1.0	71.88	−42.14
				3.3	32.97	−19.28
				10.0	17.33	−10.10
1360.0	$3s^23p^53d–3s^23p^54p$	$^3P–^3D$	1–2	1.0	8.17	−3.45
				3.3	3.71	−1.54
				10.0	1.93	−0.78
1378.6	$3s^23p^53d–3s^23p^54p$	$^3P–^3D$	2–2	1.0	8.85	−4.00
				3.3	4.01	−1.78
				10.0	2.08	−0.89
1562.5	$3s^23p^53d–3s^23p^54p$	$^3F–^3D$	3–2	1.0	12.11	−5.88
				3.3	5.48	−2.61
				10.0	2.83	−1.31
1586.1	$3s^23p^53d–3s^23p^54p$	$^3F–^3D$	2–2	1.0	11.83	−5.41
				3.3	5.36	−2.40
				10.0	2.78	−1.21
1939.7	$3s^23p^53d–3s^23p^54p$	$^1D–^3D$	2–2	1.0	18.13	−8.53
				3.3	8.22	−3.79
				10.0	4.25	−1.91
1958.9	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	3–2	1.0	19.69	−9.89
				3.3	8.91	−4.39
				10.0	4.60	−2.21
2000.3	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	2–2	1.0	19.28	−9.07
				3.3	8.74	−4.03
				10.0	4.52	−2.03
2002.0	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	1–2	1.0	18.10	−7.86
				3.3	8.22	−3.50
				10.0	4.27	−1.77
2042.2	$3s^23p^53d–3s^23p^54p$	$^1F–^3D$	3–2	1.0	21.54	−10.89
				3.3	9.74	−4.83
				10.0	5.03	−2.43
2869.9	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	2–2	1.0	57.26	−36.23
				3.3	26.31	−16.61
				10.0	13.85	−8.72
2988.6	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	1–2	1.0	51.96	−28.88
				3.3	23.82	−13.19
				10.0	12.51	−6.90
3367.8	$3s^23p^54s–3s^23p^54p$	$^1P–^3D$	1–2	1.0	66.91	−36.33
				3.3	30.66	−16.61
				10.0	16.09	−8.70
1328.9	$3s^23p^53d–3s^23p^54p$	$^3P–^3D$	0–1	1.0	4.46	−1.81
				3.3	2.03	−0.81
				10.0	1.06	−0.41
1337.5	$3s^23p^53d–3s^23p^54p$	$^3P–^3D$	1–1	1.0	4.95	−2.26
				3.3	2.24	−1.00
				10.0	1.16	−0.51
1355.4	$3s^23p^53d–3s^23p^54p$	$^3P–^3D$	2–1	1.0	5.52	−2.76
				3.3	2.49	−1.22
				10.0	1.28	−0.61
1555.5	$3s^23p^53d–3s^23p^54p$	$^3F–^3D$	2–1	1.0	7.38	−3.74
				3.3	3.33	−1.66
				10.0	1.72	0.83
1894.1	$3s^23p^53d–3s^23p^54p$	$^1D–^3D$	2–1	1.0	11.36	−5.97
				3.3	5.13	−2.65
				10.0	2.64	−1.33
1951.9	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	2–1	1.0	12.07	−6.33
				3.3	5.45	−2.81
				10.0	2.81	−1.41

Table 3 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J*–*J*	*T* (10^4 K)	*ω* (pm)	*d* (pm)
1953.5	$3s^23p^53d–3s^23p^54p$	$^3D–^3D$	1–1	1.0	10.93	−5.19
				3.3	4.95	−2.31
				10.0	2.56	−1.16
2771.3	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	2–1	1.0	40.70	−29.15
				3.3	18.74	−13.42
				10.0	9.89	−7.08
2881.8	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	1–1	1.0	34.58	−21.84
				3.3	15.88	−10.02
				10.0	8.36	−5.27
3028.6	$3s^23p^54s–3s^23p^54p$	$^3P–^3D$	0–1	1.0	27.38	−13.59
				3.3	12.53	−6.17
				10.0	6.57	−3.21
3232.7	$3s^23p^54s–3s^23p^54p$	$^1P–^3D$	1–1	1.0	19.23	−17.74
				3.3	8.90	−8.26
				10.0	4.72	−4.42
1317.7	$3s^23p^53d–3s^23p^54p$	$^3P–^1D$	1–2	1.0	7.78	−3.28
				3.3	3.54	−1.46
				10.0	1.84	−0.74
1335.1	$3s^23p^53d–3s^23p^54p$	$^3P–^1D$	2–2	1.0	8.42	−3.79
				3.3	3.82	−1.69
				10.0	1.98	−0.85
1506.9	$3s^23p^53d–3s^23p^54p$	$^3F–^1D$	3–2	1.0	11.41	−5.51
				3.3	5.17	−2.45
				10.0	2.67	−1.23
1528.9	$3s^23p^53d–3s^23p^54p$	$^3F–^1D$	2–2	1.0	11.14	−5.07
				3.3	5.06	−2.26
				10.0	2.62	−1.14
1854.7	$3s^23p^53d–3s^23p^54p$	$^1D–^1D$	2–2	1.0	16.8	−7.87
				3.3	7.62	−3.50
				10.0	3.95	−1.77
1872.4	$3s^23p^53d–3s^23p^54p$	$^3D–^1D$	3–2	1.0	18.21	−9.11
				3.3	8.24	−4.05
				10.0	4.26	−2.04
1910.1	$3s^23p^53d–3s^23p^54p$	$^3D–^1D$	2–2	1.0	17.81	−8.34
				3.3	8.08	−3.72
				10.0	4.19	−1.88
1911.7	$3s^23p^53d–3s^23p^54p$	$^3D–^1D$	1–2	1.0	16.73	−7.25
				3.3	7.61	−3.24
				10.0	3.96	−1.64
1948.3	$3s^23p^53d–3s^23p^54p$	$^1F–^1D$	3–2	1.0	19.84	−9.99
				3.3	8.98	−4.44
				10.0	4.64	−2.24
2687.8	$3s^23p^54s–3s^23p^54p$	$^3P–^1D$	2–2	1.0	50.68	−31.92
				3.3	23.29	−14.65
				10.0	12.27	−7.71
2791.6	$3s^23p^54s–3s^23p^54p$	$^3P–^1D$	1–2	1.0	45.82	−25.36
				3.3	21.02	−11.60
				10.0	11.05	−6.07
3119.7	$3s^23p^54s–3s^23p^54p$	$^1P–^1D$	1–2	1.0	58.02	−31.37
				3.3	26.60	−14.37
				10.0	13.97	−7.54
1285.9	$3s^23p^53d–3s^23p^54p$	$^3P–^1P$	0–1	1.0	4.06	−1.65
				3.3	1.85	−0.74
				10.0	0.96	−0.37
1293.9	$3s^23p^53d–3s^23p^54p$	$^3P–^1P$	1–1	1.0	4.51	−2.07
				3.3	2.58	−1.17
				10.0	1.06	−0.46
1310.7	$3s^23p^53d–3s^23p^54p$	$^3P–^1P$	2–1	1.0	5.04	−2.54
				3.3	2.28	−1.12
				10.0	1.17	−0.56
1496.9	$3s^23p^53d–3s^23p^54p$	$^3F–^1P$	2–1	1.0	6.67	−3.41
				3.3	3.01	−1.51
				10.0	1.55	−0.76

Table 3 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	*J–J*	*T* (10^4 K)	ω (pm)	*d* (pm)
1807.9	$3s^23p^53d–3s^23p^54p$	$^1D–^1P$	2–1	1.0	10.12	−5.35
				3.3	4.57	−2.37
				10.0	2.25	−1.19
1860.4	$3s^23p^53d–3s^23p^54p$	$^3D–^1P$	2–1	1.0	10.71	−5.66
				3.3	4.84	−2.51
				10.0	2.49	−1.26
2590.4	$3s^23p^54s–3s^23p^54p$	$^3P–^1P$	2–1	1.0	35.08	−25.29
				3.3	16.15	−11.64
				10.0	8.53	−6.14
2686.7	$3s^23p^54s–3s^23p^54p$	$^3P–^1P$	1–1	1.0	29.54	−18.80
				3.3	13.57	−8.63
				10.0	7.14	−4.54
2813.9	$3s^23p^54s–3s^23p^54p$	$^3P–^1P$	0–1	1.0	23.07	−11.52
				3.3	10.56	−5.23
				10.0	5.53	−2.72
2989.3	$3s^23p^54s–3s^23p^54p$	$^1P–^1P$	1–1	1.0	37.31	−23.00
				3.3	17.12	−10.57
				10.0	9.00	−5.57
1281.5	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	1–2	1.0	7.38	−3.20
				3.3	3.36	−1.44
				10.0	1.75	−0.73
1298.0	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	2–2	1.0	7.98	−3.69
				3.3	3.62	−1.65
				10.0	1.88	−0.84
1459.8	$3s^23p^54s–3s^23p^54p$	$^3F–^3P$	3–2	1.0	10.74	−5.31
				3.3	4.86	−2.37
				10.0	2.51	−1.20
1480.4	$3s^23p^54s–3s^23p^54p$	$^3F–^3P$	2–2	1.0	10.48	−4.90
				3.3	4.75	−2.19
				10.0	2.46	−1.11
1783.9	$3s^23p^53d–3s^23p^54p$	$^1D–^3P$	2–2	1.0	15.59	−7.48
				3.3	7.07	−3.34
				10.0	3.66	−1.70
1800.2	$3s^23p^53d–3s^23p^54p$	$^3D–^3P$	3–2	1.0	16.88	−8.63
				3.3	7.64	−3.85
				10.0	3.95	−1.95
1835.1	$3s^23p^53d–3s^23p^54p$	$^3D–^3P$	2–2	1.0	16.49	−7.92
				3.3	7.48	−3.54
				10.0	3.87	−1.80
1870.3	$3s^23p^53d–3s^23p^54p$	$^1F–^3P$	3–2	1.0	18.34	−9.43
				3.3	8.30	−4.21
				10.0	4.29	−2.13
2541.5	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	2–2	1.0	45.41	−28.96
				3.3	20.87	−13.31
				10.0	10.99	−7.01
2634.1	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	1–2	1.0	40.90	−23.03
				3.3	18.76	−10.55
				10.0	9.86	−5.54
2924.3	$3s^23p^54s–3s^23p^54p$	$^1P–^3P$	1–2	1.0	51.11	−28.12
				3.3	23.43	−12.90
				10.0	12.30	−6.79
1278.4	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	1–0	1.0	1.95	−1.13
				3.3	0.88	−0.50
				10.0	0.45	−0.25
1830.0	$3s^23p^53d–3s^23p^54p$	$^3D–^3P$	1–0	1.0	4.32	−2.64
				3.3	1.94	−1.17
				10.0	1.00	−0.59
2620.8	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	1–0	1.0	17.80	−14.14
				3.3	8.21	−6.54
				10.0	4.35	−3.47

Table 3 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
2907.9	$3s^23p^54s–3s^23p^54p$	$^1P–^3P$	1–0	1.0	22.60	17.15
				3.3	10.41	−7.95
				10.0	5.50	−4.24
1262.6	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	0–1	1.0	4.09	−1.71
				3.3	1.86	−0.77
				10.0	0.97	−0.40
1270.3	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	1–1	1.0	4.52	−2.12
				3.3	2.05	−0.95
				10.0	1.06	−0.48
1286.5	$3s^23p^53d–3s^23p^54p$	$^3P–^3P$	2–1	1.0	5.04	−2.57
				3.3	2.28	−1.15
				10.0	1.17	−0.58
1465.5	$3s^23p^53d–3s^23p^54p$	$^3F–^3P$	2–1	1.0	6.63	−3.43
				3.3	3.00	−1.53
				10.0	1.55	−0.77
1762.3	$3s^23p^53d–3s^23p^54p$	$^1D–^3P$	2–1	1.0	9.95	−5.33
				3.3	4.50	−2.37
				10.0	2.32	−1.20
1812.1	$3s^23p^53d–3s^23p^54p$	$^3D–^3P$	2–1	1.0	10.52	−5.63
				3.3	4.75	−2.51
				10.0	2.45	−1.27
1813.6	$3s^23p^53d–3s^23p^54p$	$^3D–^3P$	1–1	1.0	9.54	−4.64
				3.3	4.32	−2.08
				10.0	2.24	−1.06
2497.7	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	2–1	1.0	33.29	−24.01
				3.3	15.33	−11.07
				10.0	8.10	−5.85
2587.1	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	1–1	1.0	28.12	−17.96
				3.3	12.92	−8.26
				10.0	6.80	−4.36
2704.9	$3s^23p^54s–3s^23p^54p$	$^3P–^3P$	0–1	1.0	22.11	−11.22
				3.3	10.12	−5.12
				10.0	5.31	−2.68
2866.5	$3s^23p^54s–3s^23p^54p$	$^1P–^3P$	1–1	1.0	35.19	−21.80
				3.3	16.16	−10.04
				10.0	8.50	−5.31
1148.4	$3s^23p^53d–3s^23p^54p$	$^3P–^1S$	1–0	1.0	1.77	−0.73
				2.0	0.81	−0.31
				10.0	0.42	−0.15
2129.2	$3s^23p^54s–3s^23p^54p$	$^3P–^1S$	1–0	1.0	12.41	−8.71
				3.3	5.78	−3.99
				10.0	3.08	−2.11
2312.1	$3s^23p^54s–3s^23p^54p$	$^1P–^1S$	1–0	1.0	15.11	−10.10
				3.3	7.01	−4.65
				10.0	3.72	−2.46

[a]Borgström (1971).

Here, ω_{se} and d are the Stark linewidth and shifts, respectively, in angular frequency units, N_e is the free electron perturber density, T is the electron temperature, $E = (3/2)kT$ is the mean energy of the perturbing electron, E_H is the hydrogen ionization energy and g_{se} and g_{sh} are the effective Gaunt factors. These factors are slowly varying functions of $x_{i'i} = E/\Delta E_{i'i}$, where $\Delta E_{i'i}$ is the energy difference between a perturbing level i' and the perturbed level i. The indices i and f denote the initial (upper) and final (lower) levels of the transitions, respectively. ω_{se} is the half width at half-maximum (HWHM) of the Lorentz profile in frequency units. ω_{se} is proportional to the full width at half-maximum (FWHM) line ω in wavelength units, through the expression $\omega = \omega_{se}\lambda^2/(\pi c)$.

3 RESULTS AND DISCUSSION

Table 1 shows the theoretical transition probabilities and oscillator strengths of some spectral lines and radiative lifetimes of some levels of Ca III. We present only those values that can be compared with the data found in the literature, which can be used to test our matrix elements.

Fig. 1 displays a schematic diagram of the Ca III energy levels corresponding to some spectral lines that have been calculated in this work.

We also present the Stark broadening parameters for 148 spectral lines of Ca III. These values are reported in the literature for the first time. The Stark linewidths (FWHM) and line shifts are displayed in Tables 2– 4. The data are presented at an electron density of

Table 4. The Ca III $3s^23p6$–$3s^23p^53d$ and $3s^23p^54p$–$3s^23p^54d$ linewidths (FWHM), ω (pm) and shifts, d (pm), normalized to $N_e = 10^{17}$ cm^{-3}. Note that a positive shift is red.

Wavelength λ (Å)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
490.5	$3s^23p^6$–$3s^23p^53d$	^1S–^3P	0–1	1.0	0.25	−0.25
				3.3	0.11	−0.11
				10.0	0.05	−0.05
439.7	$3s^23p^6$–$3s^23p^53d$	^1S–^3D	0–1	1.0	0.22	−0.22
				3.3	0.10	−0.10
				10.0	−0.05	−0.05
357.9	$3s^23p^6$–$3s^23p^53d$	^1S–^1P	0–1	1.0	0.31	−0.20
				3.3	0.14	−0.09
				10.0	0.07	−0.04
1981.2	$3s^23p^54p$–$3s^23p^54d$	^3S–^3P	1–0	1.0	14.43	−6.18
				3.3	6.67	−2.86
				10.0	3.54	−1.52
2493.5	$3s^23p^54p$–$3s^23p^54d$	^3P–^3P	1–0	1.0	23.61	−10.79
				3.3	10.92	−5.05
				10.0	5.79	−2.71
1967.9	$3s^23p^54p$–$3s^23p^54d$	^3S–^3P	1–1	1.0	24.76	−12.18
				3.3	11.57	−5.79
				10.0	6.20	−3.15
1943.0	$3s^23p^54p$–$3s^23p^54d$	^3S–^3P	1–2	1.0	34.5	−17.9
				3.3	16.20	−8.59
				10.0	8.73	−4.73
2276.5	$3s^23p^54p$–$3s^23p^54d$	^1D–^3P	1–2	1.0	56.69	−28.37
				3.3	26.51	−13.54
				10.0	14.22	−7.41
2123.0	$3s^23p^54p$–$3s^23p^54d$	^3D–^3F	3–4	1.0	81.33	−42.42
				3.3	38.17	−20.38
				10.0	20.54	−11.22
2098.5	$3s^23p^54p$–$3s^23p^54d$	^3D–^3F	3–3	1.0	67.59	−34.58
				3.3	31.67	−16.57
				10.0	17.01	−9.10
2114.4	$3s^23p^54p$–$3s^23p^54d$	^3D–^3F	2–3	1.0	61.48	−32.37
				3.3	28.90	−15.59
				10.0	15.58	−8.60
2078.9	$3s^23p^54p$–$3s^23p^54d$	^3D–^3F	2–2	1.0	47.67	−24.44
				3.3	22.36	−11.72
				10.0	12.02	−6.43
2133.9	$3s^23p^54p$–$3s^23p^54d$	^3D–^3F	1–2	1.0	42.71	−23.00
				3.3	20.12	−11.12
				10.0	10.87	−6.15
2033.4	$3s^23p^54p$–$3s^23p^54d$	^3D–^1F	3–3	1.0	64.53	−33.73
				3.3	30.33	−16.24
				10.0	16.34	−8.95
2152.4	$3s^23p^54p$–$3s^23p^54d$	^1D–^1F	2–3	1.0	65.20	−35.05
				3.3	30.76	−13.97
				10.0	16.63	−9.41
304.8	$3s^23p^6$–$3s^23p^54d$	^1S–^3D	0–1	1.0	0.47	−0.32
				3.3	0.22	−0.15
				10.0	0.12	−0.08
1977.0	$3s^23p^54p$–$3s^23p^54d$	^3D–^3D	2–1	1.0	33.10	−16.62
				3.3	15.50	−7.94
				10.0	8.32	−4.34
2026.7	$3s^23p^54p$–$3s^23p^54d$	^3D–^3D	1–1	1.0	28.00	−14.98
				3.3	13.20	−7.24
				10.0	7.12	−4.00
2179.3	$3s^23p^54p$–$3s^23p^54d$	^3P–^3D	0–1	1.0	24.90	−14.61
				3.3	11.85	−7.16
				10.0	6.46	−4.01
2129.2	$3s^23p^54p$–$3s^23p^54d$	^1P–^1D	1–2	1.0	42.74	−23.41
				3.3	20.18	−11.35
				10.0	10.92	−6.30

Table 4 – *continued*

Wavelength λ (Å)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
2141.0	$3s^23p^54p$–$3s^23p^54d$	^3P–^3D	2–3	1.0	64.4	−34.77
				3.3	30.36	−16.82
				10.0	16.41	−9.32
2046.4	$3s^23p^54p$–$3s^23p^54d$	^1D–^3D	2–2	1.0	47.40	−24.98
				3.3	22.31	−12.05
				10.0	12.03	−6.65
2172.3	$3s^23p^54p$–$3s^23p^54d$	^3P-^3D	1–2	1.0	45.49	−25.46
				3.3	21.52	−12.38
				10.0	11.67	−6.89
296.95	$3s^23p^6$–$3s^23p^54d$	^1S–^1S	0–1	1.0	0.58	−0.46
				3.3	0.28	−0.23
				10.0	0.15	−0.13

[a]Borgström (1971).

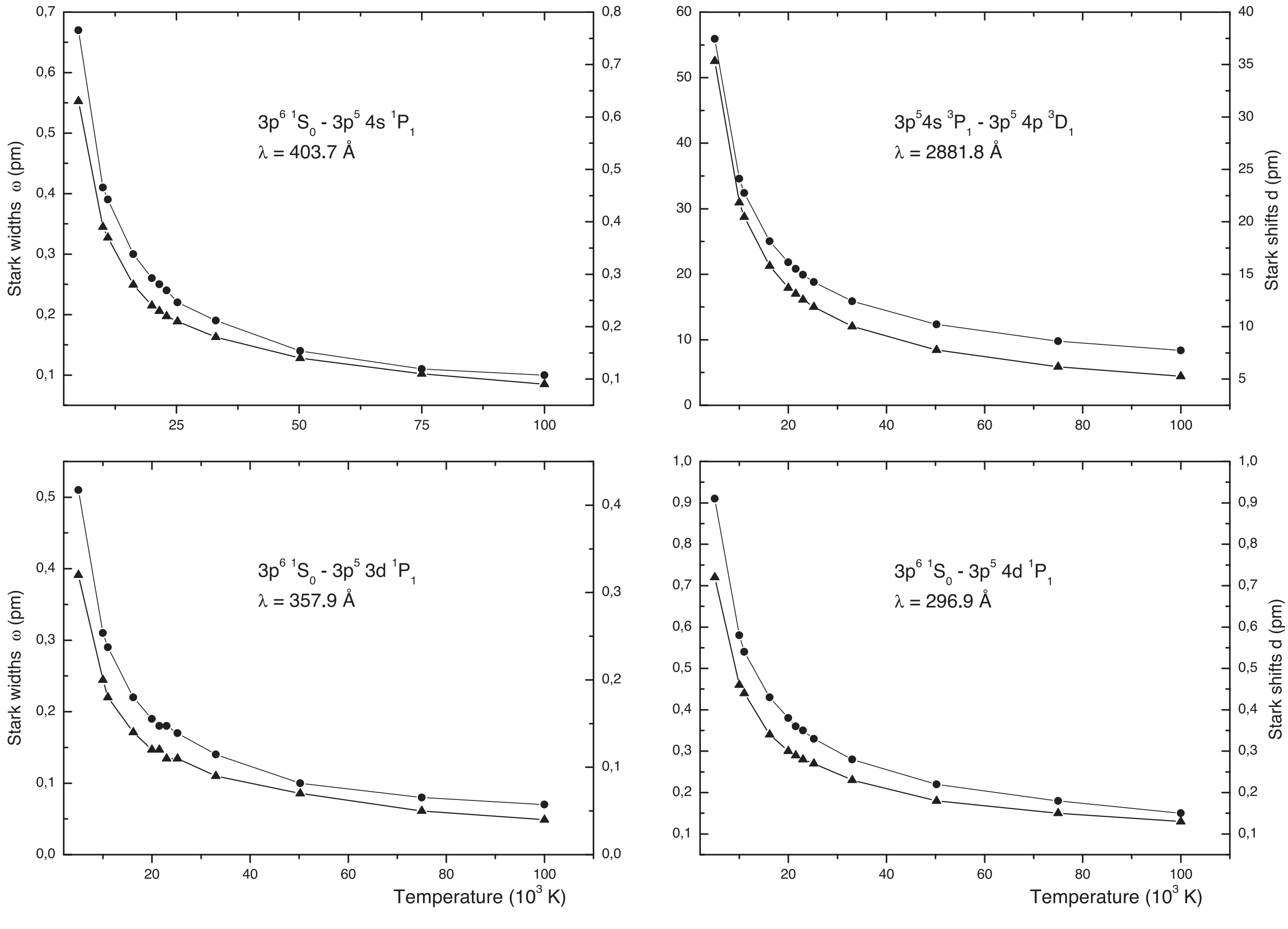

Figure 2. Calculated Stark widths FWHM (ω, Å) and shifts versus temperature for 296.5-, 357.9-, 403.7-, 2168.7- and 2881.8-Å Ca III lines at an electron density of 10^{17} cm^{-3}.

10^{17} cm^{-3} and at several temperatures $T = 1.0$–10.0 ($\times 10^4$ K). The first column gives the wavelengths (in Å; Borgström 1971). The following three columns give the transition level for each transition, following the allocation made by Borgström (1971) and Hansen et al. (1975). Temperatures are shown in the fifth column and the Stark broadening linewidths (in pm) are displayed in column 6. The final column displays the theoretical Stark line shift (a positive shift is to red). As is well known, both positive and negative contributions of the perturber level can be present in the calculations of Stark line shifts (Griem 1968). Sometimes a near cancellation occurs, resulting in very small shifts for lines that have large widths. In these cases, the experimental shift values can be smaller than the uncertainty of any semiclassical calculation. Discrepancies can be expected with experimental values where relatively large configuration mixings are present. Perhaps this lack of precision is the reason for the absence of redshifts in our calculations.

In order to display the theoretical trends of Stark parameters, in Fig. 2 we present our calculated Stark widths and shifts versus temperature for the relevant 295.9-, 357.9-, 403.7- and 2881.8-Å spectral lines of Ca III.

In conclusion, using the computer code of Cowan (1981) and the approach of Griem (1968), we have obtained the Stark broadening parameters of Ca III spectral lines. To the best of our knowledge, we are the first to present these data, which are useful in the modelling of astrophysical atmospheres. Clear trends in the Stark widths are seen in our results.

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REFERENCES

Alonso-Medina A., Colón C., Montero J. L., Nation L., 2010, MNRAS, 401, 1080
Andersen T., Petkov A. P., Sørensen G., 1975, Phys. Scr., 12, 283
Aymar M., Schweighofer M. G., 1973, Physica, 67, 585
Baluja K. L., 1986, J. Phys. B: Atom. Mol. Opt. Phys., 19, L551
Baranger M., 1958, Phys. Rev., 112, 855
Borgström A., 1971, Phys. Scr., 3, 157
Colón C., Alonso-Medina A., Porcher P., 2011, At. Data Nucl. Data Tables, 97, 36
Cowan R. D., 1981, The Theory of Atomic Structure and Spectra. University of California Press, Berkeley, CA
Emmoth B., Braun M., Bromander J., Martinson I., 1975, Phys. Scr., 12, 75
Froese Fischer C., Tachiev G., Irimia A., 2006, At. Data Nucl. Data Tables, 92, 607
Gabriel A. H., Fawcett B. C., Jordan C., 1966, Proc. Phys. Soc., 87, 825
Griem H. R., 1968, Phys. Rev., 165, 258
Gruzdew P. F., Loginov A. V., 1974, Opt. Spectrosc., 36, 719
Hansen J. E., Persson W., Borgström A., 1975, Phys. Scr., 11, 31
Loginov A. V., Gruzdew P. F., 1986, Opt. Spectrosc., 61, 417
Niemann C. et al., 2003, J. Phys. D: Appl. Phys., 36, 2102
Rauch T., Ziegler M., Werner K., Kruk J. W., Oliveira C. M., Vande Putte D., Mignani R. P., Kerber F., 2007, A&A, 470, 317
Seaton M. J., 1962, in Bates D. R., ed., Atomic and Molecular Processes. Academic, New York
Van Regemorter H., 1962, ApJ, 136, 906
Verner D. A., Barthel P. D., Tytler D., 1994, A&AS, 108, 287
Werner K., Rauch T., Kruk J. W., 2008, A&A, 492, L43
Zuckerman B., Koester D., Reid I. N., Hünsch M., 2003, ApJ, 596, 477

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