On the Stark broadening of some Cr II spectral lines in a plasma

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- Introduction: Atomic structure of the Cr II ion
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    - Line profile-width and shift of a spectral line
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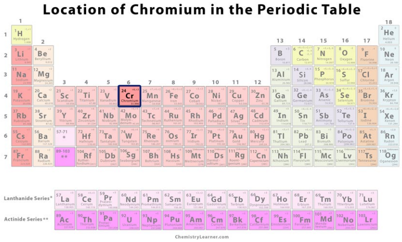
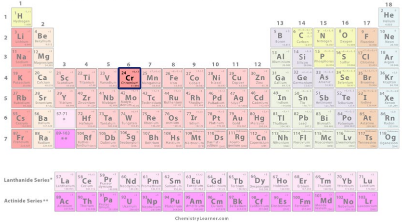


Fundamental configuration of Cr II

$[Ar]\ 3d^5$

Introduction: Atomic structure of the Cr II ion

Location of Chromium in the Periodic Table



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Singly ionized chromium Cr II Singly ionized chromium is important for technology applications.
It is also important for investigation in plasma physics, fusion research and plasma technologies.

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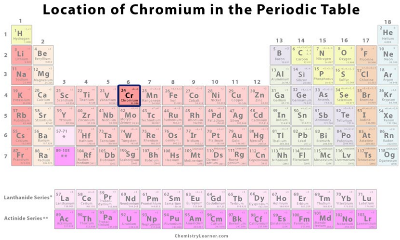

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$3d^4 4p \quad {}^2F_{5/2} \quad E = 74436.10 \text{cm}^{-1}$

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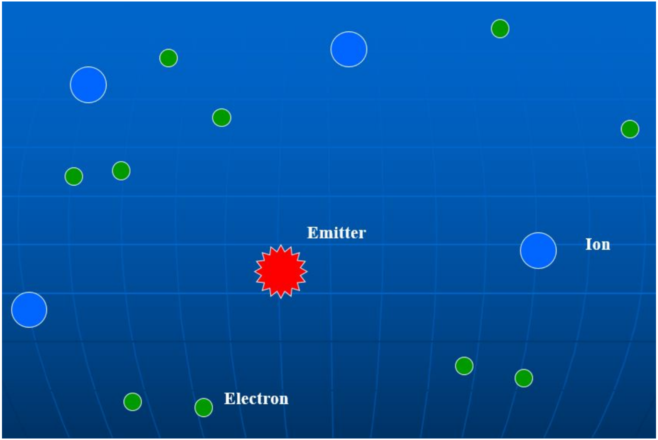
$3d^4 4p \quad x\,^2F_{5/2} \qquad E = 74436.10\text{cm}^{-1}$

$3d^4 4p \quad y\,^2F_{5/2} \qquad E = 70584.39\text{cm}^{-1}$

$3d^4 4p \quad z\,^2F_{5/2} \qquad E = 68583.31\text{cm}^{-1}$

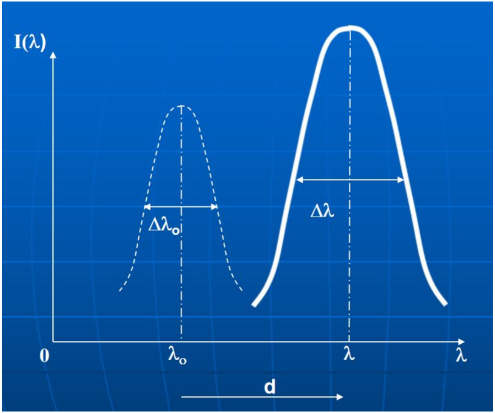
Seniority number



Emitter
Ion
Electron

Stark broadening of spectral lines in plasma:

Line profile-width and shift of a spectral line



Spectral Line Broadening in Plasma

- Natural width
- Doppler width
- Collisional width

$$L(x) = \frac{1}{\pi \gamma_L} \frac{\gamma_L^2}{\left(x^2 + \gamma_L^2\right)}$$

$$j_{A,R}(x) = \frac{1}{\pi} \int_0^{\infty} \frac{W_R(\beta)}{1 + \left(x - A^{4/3}\beta^2\right)^2} d\beta$$

$$G(x) = \sqrt{\frac{\ln(2)}{\pi}} \frac{\exp\left[-\ln(2)\left(\frac{x}{\gamma_G}\right)^2\right]}{\gamma_G}$$

According to the impact approximation (Baranger, 1958), the full half-width (FWHM) of an isolated ion line is given by:

$$W = N \left\{ v \left[\sum_{i'} \sigma_{i'i} + \sum_{f'} \sigma_{f'f} \right] \right\}_{av} + W_{el}$$

where N is the electron density, $\sigma_{j'j}$ the inelastic cross sections for collisional transitions, $\{.\}_{av}$ is the average over the electron velocity v distribution and W_{el} is the line width induced by elastic collisions.

Baranger, Michel. "General impact theory of pressure broadening." Physical Review 112.3 (1958): 855.

Stark broadening of spectral lines in plasma:

SCP approach

According to the semiclassical perturbation approach (SSB 1969 and SSB et al. 2014):

$$W = N \int v f(v) \left(\sum_{i' \neq i} \sigma_{i'i}(v) + \sum_{f' \neq f} \sigma_{f'f}(v) + \sigma_{el} \right)$$

where $f(v)$ is the Maxwellian velocity distribution function for electrons,

$$\sum_{j' \neq j} \sigma_{j'j}(v) = \frac{1}{2} R_1^2 + \int_{R_1}^{R_D} 2\pi \rho d\rho \sum_{j'j} P_{jj'}(\rho, v)$$

is the inelastic cross section and the elastic cross section is given by:

$$\sigma_{el} = 2\pi R_2^2 + \int_{R_2}^{R_D} 2\pi \rho d\rho \sin^2 \delta + \sigma_r$$

Sahal-Bréchot, S. "Impact theory of the broadening and shift of spectral lines due to electrons and ions in a plasma." Astronomy and Astrophysics 1 (1969): 91 and 2 (1969): 322.

Sahal-Bréchot, S., Dimitrijević, M. and Ben Nessib, N. "Widths and shifts of isolated lines of neutral and ionized atoms perturbed by collisions with electrons and ions." Atoms 2.2 (2014): 225-252.

According to the semiempirical approach (Griem, 1968), the full half-width (FWHM) of an isolated ion line is given by:

$$W = N\frac{8\pi}{3}\frac{\hbar^2}{m^2}\left(\frac{2m}{\pi kT}\right)^{1/2}\frac{\pi}{\sqrt{3}}\left[\sum_{i'} R^2_{i'i}\, g\left(\frac{E}{\Delta E_{i'i}}\right) + \sum_{f'} R^2_{f'f}\, g\left(\frac{E}{\Delta E_{f'f}}\right)\right]$$

where $E = 3kT/2$ is the energy of the perturbing electron, $\Delta E_{j'j} = \left|E_{j'} - E_j\right|$ is the energy difference between levels j' and j, $R^2_{j'j}$ is the square of the coordinate operator matrix element and $g(x)$ the Gaunt factor function for width.

Griem, Hans R. "Semiempirical formulas for the electron-impact widths and shifts of isolated ion lines in plasmas." Physical Review 165.1 (1968): 258.

Stark broadening of spectral lines in plasma:

MSE approach

According to the modified semiempirical approach (Dimitrijević and Konjević, 1980), the full half-width (FWHM) of an isolated ion line is given by:

$$W = N\frac{8\pi}{3}\frac{\hbar^2}{m^2}\left(\frac{2m}{\pi kT}\right)^{1/2}\frac{\pi}{\sqrt{3}}\left[R^2_{l_i,l_i+1}\tilde{g}\left(\frac{E}{\Delta E_{l_i,l_i+1}}\right)\right.$$
$$+R^2_{l_i,l_i-1}\tilde{g}\left(\frac{E}{\Delta E_{l_i,l_i-1}}\right)$$
$$+R^2_{l_f,l_f+1}\tilde{g}\left(\frac{E}{\Delta E_{l_f,l_f+1}}\right)+R^2_{l_f,l_f-1}\tilde{g}\left(\frac{E}{\Delta E_{l_f,l_f-1}}\right)$$
$$\left.+\sum_{i'}\left(R^2_{ii'}\right)_{\Delta n\neq 0}g\left(\frac{3kTn_i^3}{4Z^2E_H}\right)+\sum_{f'}\left(R^2_{ff'}\right)_{\Delta n\neq 0}g\left(\frac{3kTn_f^3}{4Z^2E_H}\right)\right]$$

$E = 3kT/2$ is the energy of the perturbing electron, $\Delta E_{j'j} = |E_{j'} - E_j|$ is the energy difference between levels j' and j, $R^2_{j'j}$ is the square of the coordinate operator matrix element, $\tilde{g}(x) = 7 - \frac{1.1}{Z} + g(x)$ and $g(x)$ are the Gaunt factor functions for width.

Dimitrijević, M. S., and Konjević, N. "Stark widths of doubly-and triply-ionized atom lines." Journal of Quantitative Spectroscopy and Radiative Transfer 24 (1980): 451-459.

Stark broadening of Cr II spectral lines:

Precedent calculations (Dimitrijević et al. 2007 & Simić et al. 2013)

Stark broadening parameters for Cr II 4s – 4p multiplets.

Perturbers are:		Electrons		Protons		Helium ions	
Transition	T(K)	$FWHM$(Å)	Shift(Å)	$FWHM$(Å)	Shift(Å)	$FWHM$(Å)	Shift(Å)
	5000	0.413E-03	–0.108E-03	0.484E-05	–0.433E-05	0.687E-05	–0.404E-05
CrII	10 000	0.306E-03	–0.945E-04	0.896E-05	–0.700E-05	0.106E-04	–0.604E-05
${}^4D–{}^6P^o$	20 000	0.224E-03	–0.804E-04	0.134E-04	–0.973E-05	0.139E-04	–0.823E-05
3483.7 Å	30 000	0.182E-03	–0.786E-04	0.154E-04	–0.111E-04	0.154E-04	–0.915E-05
C = 0.36E+18	50 000	0.152E-03	–0.669E-04	0.178E-04	–0.127E-04	0.172E-04	–0.104E-04
	100 000	0.133E-03	–0.583E-04	0.212E-04	–0.151E-04	0.195E-04	–0.123E-04
	5000	0.396E-03	–0.105E-03	0.462E-05	–0.378E-05	0.659E-05	–0.354E-05
CrII	10 000	0.285E-03	–0.847E-04	0.845E-05	–0.616E-05	0.101E-04	–0.534E-05
${}^4D–{}^6D^o$	20 000	0.199E-03	–0.742E-04	0.126E-04	–0.856E-05	0.131E-04	–0.728E-05
3355.5 Å	30 000	0.160E-03	–0.676E-04	0.143E-04	–0.985E-05	0.144E-04	–0.810E-05
C = 0.33E+18	50 000	0.132E-03	–0.568E-04	0.165E-04	–0.113E-04	0.161E-04	–0.927E-05
	100 000	0.113E-03	–0.488E-04	0.196E-04	–0.135E-04	0.184E-04	–0.110E-04
	5000	0.330E-03	–0.822E-04	0.437E-05	–0.389E-05	0.609E-05	–0.359E-05
CrII	10 000	0.249E-03	–0.749E-04	0.768E-05	–0.607E-05	0.913E-05	–0.524E-05
${}^4D–{}^4D^o$	20 000	0.185E-03	–0.641E-04	0.115E-04	–0.834E-05	0.116E-04	–0.692E-05
2872.3 Å	30 000	0.156E-03	–0.652E-04	0.129E-04	–0.932E-05	0.128E-04	–0.770E-05
C = 0.18E+18	50 000	0.133E-03	–0.567E-04	0.149E-04	–0.107E-04	0.144E-04	–0.882E-05
	100 000	0.120E-03	–0.479E-04	0.177E-04	–0.127E-04	0.159E-04	–0.102E-04
	5000	0.413E-03	–0.105E-03	0.485E-05	–0.527E-05	0.671E-05	–0.488E-05
CrII	10 000	0.310E-03	–0.957E-04	0.884E-05	–0.808E-05	0.103E-04	–0.705E-05
${}^4D–{}^4F^o$	20 000	0.230E-03	–0.829E-04	0.136E-04	–0.111E-04	0.134E-04	–0.910E-05
3128.8 Å	30 000	0.193E-03	–0.840E-04	0.155E-04	–0.123E-04	0.150E-04	–0.102E-04
C = 0.19E+18	50 000	0.164E-03	–0.735E-04	0.180E-04	–0.142E-04	0.168E-04	–0.116E-04
	100 000	0.147E-03	–0.621E-04	0.217E-04	–0.169E-04	0.194E-04	–0.136E-04
	5000	0.443E-03	–0.115E-03	0.497E-05	–0.514E-05	0.695E-05	–0.474E-05
CrII	10 000	0.331E-03	–0.101E-03	0.922E-05	–0.809E-05	0.108E-04	–0.695E-05
${}^4D–{}^4P^o$	20 000	0.246E-03	–0.866E-04	0.140E-04	–0.111E-04	0.142E-04	–0.926E-05
3391.5 Å	30 000	0.201E-03	–0.857E-04	0.161E-04	–0.124E-04	0.157E-04	–0.103E-04
C = 0.28E+18	50 000	0.172E-03	–0.736E-04	0.188E-04	–0.143E-04	0.177E-04	–0.117E-04
	100 000	0.155E-03	–0.620E-04	0.226E-04	–0.172E-04	0.204E-04	–0.137E-04
	5000	0.147E-03	–0.135E-04	0.272E-05	–0.445E-06	0.404E-05	–0.440E-06
CrII	10 000	0.111E-03	–0.101E-04	0.485E-05	–0.840E-06	0.608E-05	–0.790E-06
${}^6D–{}^6P^o$	20 000	0.846E-04	–0.802E-05	0.691E-05	–0.138E-05	0.782E-05	–0.120E-05
2758.2 Å	30 000	0.732E-04	–0.686E-05	0.780E-05	–0.167E-05	0.844E-05	–0.146E-05
C = 0.26E+18	50 000	0.636E-04	–0.597E-05	0.858E-05	–0.212E-05	0.918E-05	–0.174E-05
	100 000	0.568E-04	–0.510E-05	0.961E-05	–0.254E-05	0.999E-05	–0.209E-05
	5000	0.159E-03	–0.340E-06	0.268E-05	–0.127E-06	0.397E-05	–0.127E-06
CrII	10 000	0.115E-03	–0.736E-06	0.474E-05	–0.251E-06	0.594E-05	–0.245E-06
${}^6D–{}^6D^o$	20 000	0.837E-04	–0.740E-06	0.671E-05	–0.455E-06	0.758E-05	–0.421E-06
2677.2 Å	30 000	0.706E-04	–0.630E-06	0.754E-05	–0.606E-06	0.818E-05	–0.534E-06
C = 0.24E+18	50 000	0.592E-04	–0.828E-06	0.827E-05	–0.777E-06	0.888E-05	–0.678E-06
	100 000	0.503E-04	–0.807E-06	0.922E-05	–0.103E-05	0.965E-05	–0.846E-06

Electron-, proton- and He II-impact broadening parameters for Cr II, $3d^5–3d^44p$ spectral lines, for a perturber density of 10^{17} cm^{-3} and temperatures from 5 000 to 100 000 K. The calculated wavelength of the transitions (in Å) and parameter C are also given. This parameter when divided by the corresponding Stark width gives an estimate for the maximal perturber density for which the line may be treated as isolated. WIDTH is FWHM. We note that for the first four lines, electron- and proton-impact broadening parameters are previously communicated on a conference and published in the corresponding proceedings (Simić et al. 2009a).

Perturber density is 1.E+17 cm^{-3}

Perturbers are:		Electrons		Protons		Helium ions	
Transition	T (K)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
	5000	0.514E−01	−0.334E−03	0.148E−02	−0.542E−04	0.219E−02	−0.541E−04
Cr II	10 000	0.382E−01	−0.379E−03	0.268E−02	−0.120E−03	0.335E−02	−0.118E−03
${}^6S–{}^6P^o$	20 000	0.282E−01	−0.438E−03	0.382E−02	−0.232E−03	0.433E−02	−0.214E−03
2060.4 Å	30 000	0.238E−01	−0.425E−03	0.431E−02	−0.311E−03	0.468E−02	−0.278E−03
C = 0.15E+21	50 000	0.196E−01	−0.460E−03	0.473E−02	−0.405E−03	0.508E−02	−0.355E−03
	100 000	0.157E−01	−0.515E−03	0.528E−02	−0.547E−03	0.553E−02	−0.446E−03
	5000	0.382	0.718E−01	0.102E−01	0.117E−02	0.147E−01	0.115E−02
Cr II	10 000	0.284	0.491E−01	0.175E−01	0.244E−02	0.218E−01	0.227E−02
${}^4F–{}^4D^o$	20 000	0.212	0.378E−01	0.244E−01	0.416E−02	0.269E−01	0.359E−02
4588.2 Å	30 000	0.182	0.319E−01	0.268E−01	0.505E−02	0.290E−01	0.439E−02
C = 0.40E+21	50 000	0.155	0.265E−01	0.295E−01	0.639E−02	0.315E−01	0.522E−02
	100 000	0.133	0.219E−01	0.329E−01	0.770E−02	0.339E−01	0.630E−02
	5000	0.480	0.743E−01	0.120E−01	0.874E−03	0.174E−01	0.868E−03
Cr II	10 000	0.358	0.514E−01	0.209E−01	0.188E−02	0.261E−01	0.180E−02
${}^4F–{}^4F^o$	20 000	0.268	0.399E−01	0.293E−01	0.337E−02	0.326E−01	0.304E−02
5279.6 Å	30 000	0.229	0.338E−01	0.325E−01	0.425E−02	0.352E-01	0.370E−02
C = 0.53E+21	50 000	0.194	0.274E−01	0.357E−01	0.546E−02	0.383E−01	0.464E−02
	100 000	0.165	0.229E−01	0.398E−01	0.679E−02	0.414E−01	0.556E−02
	5000	0.793	0.264	0.144E−01	0.411E−02	0.210E−01	0.397E−02
Cr II	10 000	0.577	0.197	0.258E−01	0.806E−02	0.320E−01	0.742E−02
${}^4F–{}^4P^o$	20 000	0.425	0.155	0.368E−01	0.127E−01	0.408E−01	0.111E−01
6073.4 Å	30 000	0.357	0.134	0.414E−01	0.156E−01	0.442E−01	0.132E−01
C = 0.70E+21	50 000	0.294	0.110	0.459E−01	0.184E−01	0.483E−01	0.152E−01
	100 000	0.255	0.920E−01	0.521E−01	0.221E−01	0.528E−01	0.182E−01
	5000	0.159	0.646E−02	0.543E−02	0.322E−03	0.781E−02	0.320E−03
Cr II	10 000	0.120	0.399E−02	0.929E−02	0.695E−03	0.116E−01	0.669E−03
${}^4D–{}^4D^o$	20 000	0.903E−01	0.383E−02	0.130E−01	0.125E−02	0.143E−01	0.114E−02
3378.0 Å	30 000	0.774E−01	0.355E−02	0.142E−01	0.161E−02	0.154E−01	0.138E−02
C = 0.25E+21	50 000	0.654E−01	0.352E−02	0.156E−01	0.205E−02	0.168E−01	0.176E−02
	100 000	0.547E−01	0.356E−02	0.174E−01	0.257E−02	0.181E−01	0.212E−02
	5000	0.218	0.344E−01	0.585E−02	0.431E−03	0.851E−02	0.429E−03
Cr II	10 000	0.168	0.240E−01	0.103E−01	0.929E−03	0.128E−01	0.891E−03
${}^4D–{}^4F^o$	20 000	0.129	0.183E−01	0.144E−01	0.167E−02	0.161E−01	0.151E−02
3738.4 Å	30 000	0.111	0.155E−01	0.160E−01	0.211E−02	0.174E−01	0.183E−02
C = 0.26E+21	50 000	0.951E−01	0.126E−01	0.176E−01	0.270E−02	0.189E−01	0.230E−02
	100 000	0.822E−01	0.106E−01	0.196E−01	0.336E−02	0.204E−01	0.276E−02
	5000	0.309	0.916E−01	0.514E−02	0.245E−02	0.742E−02	0.233E−02
Cr II	10 000	0.229	0.799E−01	0.932E−02	0.463E−02	0.114E−01	0.411E−02
${}^4P–{}^4P^o$	20 000	0.168	0.730E−01	0.136E−01	0.701E−02	0.147E−01	0.603E−02
3637.7 Å	30 000	0.141	0.654E−01	0.154E−01	0.836E−02	0.161E−01	0.683E−02
C = 0.32E+21	50 000	0.115	0.592E−01	0.174E−01	0.972E−02	0.177E−01	0.794E−02
	100 000	0.994E−01	0.498E−01	0.201E−01	0.116E−01	0.197E−01	0.945E−02
	5000	0.152	0.363E−01	0.440E−02	0.669E−03	0.633E−02	0.655E−03
Cr II	10 000	0.114	0.253E−01	0.756E−02	0.137E−02	0.942E−02	0.126E−02
${}^4P–{}^4D^o$	20 000	0.854E−01	0.195E−01	0.106E−01	0.227E−02	0.116E−01	0.195E−02
3046.9 Å	30 000	0.731E−01	0.164E−01	0.116E−01	0.277E−02	0.126E−01	0.238E−02
C = 0.20E+21	50 000	0.625E−01	0.138E−01	0.128E−01	0.341E−02	0.137E−01	0.278E−02
	100 000	0.539E−01	0.114E−01	0.144E−01	0.409E−02	0.147E−01	0.334E−02
	5000	0.160	0.315E−01	0.424E−02	0.444E−03	0.618E−02	0.439E−03
Cr II	10 000	0.120	0.216E−01	0.745E−02	0.939E−03	0.930E−02	0.886E−03
${}^4G–{}^4F^o$	20 000	0.904E−01	0.168E−01	0.105E−01	0.165E−02	0.117E−01	0.144E−02
3197.6 Å	30 000	0.775E−01	0.143E−01	0.117E−01	0.200E−02	0.126E−01	0.176E−02
C = 0.19E+21	50 000	0.657E−01	0.116E−01	0.128E−01	0.258E−02	0.137E−01	0.214E−02
	100 000	0.563E−01	0.968E−02	0.143E−01	0.313E−02	0.149E−01	0.257E−02

Dimitrijević, M. S., et al. "The influence of Stark broadening on Cr II spectral line shapes in stellar atmospheres." *Astronomy & Astrophysics* 469.2 (2007): 681-686.

Simić, Z., M. S. Dimitrijević, and S. Sahal-Bréchot. "Stark broadening of resonant Cr II 3d5–3d44p spectral lines in hot stellar atmospheres." *Monthly Notices of the Royal Astronomical Society* 432.3 (2013): 2247-2251.

Stark broadening of Cr II spectral lines:

Recent experimental work (Aguilera et al. 2014)

Table 1. Stark widths (FWHM) w (pm) and shifts d (pm) at electron density 10^{17} cm^{-3} of Cr II spectral lines, compared to experimental and theoretical values reported in the literature. The temperature range is 12 000–16 300 K. The relative error of w is 15 per cent. The relative error of d is 11 per cent, with a minimum absolute error of 0.1 pm.

				Experimental				Theoretical			
No.	Transition	Multiplet	λ (Å)	w	d	w^a	d^a	w^b	w^c	d^b	d^c
1	3d^5–3d^4(^{5}D)4p	$a\,^6$S–$z\,^6$P*	2055.596	3.7	1.4				3.42		−0.0402
			2061.575	3.4	1.4				3.42		−0.0402
2	3d^4(^{5}D)4s–3d^4(^{5}D)4p	$a\,^6$D–$z\,^6$F*	2835.629	5.0	0.1						
			2843.249	5.1	0.0						
			2849.837	5.1	− 0.1						
			2855.670	5.0							
			2860.934	5.0	− 0.2						
			2862.571	4.7							
3		$a\,^6$D–$z\,^6$P*	2766.531	4.4	− 0.1			10.0		− 0.927	
			2762.589	4.5				10.0		− 0.927	
			2757.720	4.7	− 0.1			10.0		− 0.927	
			2751.864	4.8	− 0.1			10.0		− 0.927	
			2750.727	5.1	− 0.1			10.0		− 0.927	
			2748.980	5.0				10.0		− 0.927	
			2743.641	5.1				10.0		− 0.927	
4		$a\,^6$D–$z\,^4$P*	2672.826	5.4	− 0.2						
			2712.303	5.9	− 0.2						
			2653.578	5.3	− 0.1						
5		$a\,^6$D–$z\,^6$D*	2691.040	4.3	0.3			10.2		− 0.0738	
			2671.803	4.6	0.2			10.2		− 0.0738	
			2668.707	4.6	0.1			10.2		− 0.0738	
			2666.020	4.8	0.3			10.2		− 0.0738	
			2678.789	5.0				10.2		− 0.0738	
6		$a\,^6$D–$z\,^4$F*	2534.333	5.3							

Stark broadening of Cr II spectral lines:

Recent experimental work (Aguilera et al. 2014)

7		$a^4D–z^4P^*$	3368.041	9.1	−0.2			29.7		−9.52	
			3422.732	8.5				29.7		−9.52	
			3342.576	8.7	−0.2			29.7		−9.52	
			3421.202	8.9				29.7		−9.52	
8		$a^4D–z^4F^*$	3132.053	7.2	−0.1	34	−10	27.8		−9.06	
			3124.973	7.4	−0.1	26	−12	27.8		−9.06	
			3120.359	7.5	−0.2	22.6	−11	27.8		−9.06	
			3118.646	7.6	−0.2			27.8		−9.06	
			3147.220	7.5	−0.2			27.8		−9.06	
			3128.692	7.1	−0.2			27.8		−9.06	
9		$a^4D–z^4D^*$	2870.432	6.5	0.4			22.3		−7.06	
			2880.863	6.9	0.3			22.3		−7.06	
10	$3d^4(^5D)4s–3d^4(^3F)4p$	$a^4D–y^4F^*$	2107.944	4.1							
11	$3d^5–3d^4(^5D)4p$	$a^4G–z^4F^*$	3180.693	10.7					10.8		1.97
			3209.176	10.9					10.8		1.97
12	$3d^5–3d^4(^3H)4p$	$a^4G–z^4H^*$	2297.169	4.7	1.6						
			2314.721	5.0	1.5						
13	$3d^5–3d^4(^5D)4p$	$b^4D–z^4D^*$	3360.291	12.1					10.8		0.392
14	$3d^5–3d^4(a\ ^3P)4p$	$b^4D–y^4P^*$	2397.748	5.9	1.6						
15	$3d^4(^3P)4s–3d^4(a\ ^3P)4p$	$b^4P–y^4D^*$	2935.132	6.6							
			2930.847	6.6	−0.1						
			2976.709	6.0	−0.1						
			2961.721	6.2	−0.2						
16	$3d^5–3d^4(^1I)4p$	$a^2I–w^2H^*$	2121.257	4.7							
17	$3d^4(^3H)4s–3d^4(^3H)4p$	$a^4H–z^4H^*$	2971.899	7.1							
			2979.736	7.0	−0.4						
			2989.190	6.8							
18		$a^4H–z^4I^*$	2840.013	5.4	0.1						
			2851.354	5.6							
19		$a^4H–y^4G^*$	2693.528	4.9	0.2						
20	$3d^4(^3H)4s–3d^4(^3G)4p$	$a^4H–y^4H^*$	2584.107	4.0							
21	$3d^4(^3F)4s–3d^4(a\ ^3P)4p$	$a^4F–y^4D^*$	2966.038	5.5	0.2						
			3003.911	6.2							
22	$3d^4(^3F)4s–3d^4(a^3F)4p$	$a^4F–z^4G^*$	2936.933	7.2	0.0						
23		$a^4F–x^4D^*$	2727.254	5.5							
24	$3d^4(^3G)4s–3d^4(^3H)4p$	$b^4G–z^4H^*$	3295.423	7.9	−0.4						

Stark broadening of Cr II spectral lines:

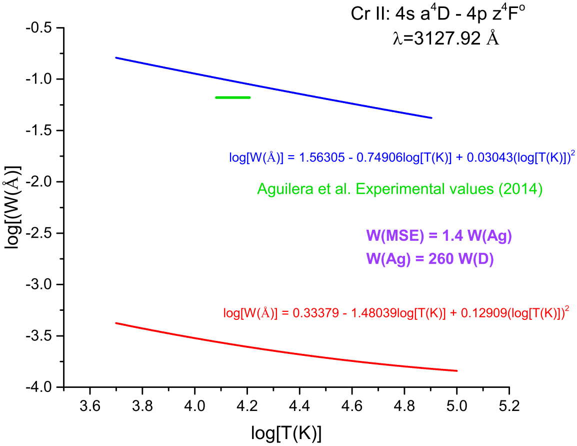
Recent experimental work (Aguilera et al. 2014)

				Experimental				Theoretical			
No.	Transition	Multiplet	λ (Å)	w	d	w^a	d^a	w^b	w^c	d^b	d^c
25	$3d^4(^3G)4s–3d^4(a\,^3F)4p$	$b\,^4G–z\,^4G^\star$	3122.596	6.3	0.1						
26	$3d^4(^3G)4s–3d^4(^3G)4p$	$b\,^4G–y\,^4H^\star$	2800.758	6.4							
27		$b\,^4G–^4F^\star$	2792.151	5.4	0.0						
			2785.692	5.7							
28	$3d^4(^3H)4s–3d^4(^3H)4p$	$a\,^2H–z\,^2I^\star$	3050.130	7.5	1.0						
			3040.924	8.0							
29	$3d^4(^3H)4s–3d^4(a\,^3F)4p$	$a\,^2H–y\,^2G^\star$	2832.452	6.2	0.9						
30	$3d^4(^3P)4s–3d^4(a\,^3P)4p$	$a\,^2P–z\,^2S^\star$	3291.763	9.2							
31		$a\,^2P–z\,^2P^\star$	3172.070	7.8	−0.1						
32	$3d^4(^3P)4s–3d^4(a\,^3F)4p$	$a\,^2P–y\,^4F^\star$	3152.213	7.2	−0.2						
33	$3d^4(^3F)4s–3d^4(a\,^3F)4p$	$b\,^2F–y\,^4F^\star$	3183.326	8.5							
34		$b\,^2F–z\,^2F^\star$	3028.124	7.7							
35	$3d^5–3d^4(^3H)4p$	$b\,^2H–z\,^2H^\star$	3041.720	9.2							
36	$3d^5–3d^4(^1I)4p$	$b\,^2H–^2I^\star$	2575.788	5.7							
37	$3d^5–3d^4(a\,^1G)4p$	$b\,^2H–x\,^2H^\star$	2573.532	7.8							
38	$3d^5–3d^4(^1I)4p$	$b\,^2H–w\,^2H^\star$	2416.393	6.2							
39	$3d^5–3d^4(a\,^1D)4p$	$a\,^2G–v\,^2F^\star$	2215.065	5.3							
40	$3d^4(^3D)4s–3d^4(^3D)4p$	$c\,^4D–w\,^4D^\star$	2838.778	5.5	0.2						
41	$3d^4(^3G)4s–3d^4(^3G)4p$	$b\,^2G–x\,^4G^\star$	3107.563	7.9							
42		$b\,^2G–x\,^2G^\star$	2927.083	6.9							
43	$3d^4(a\,^1G)4s–3d^4(a\,^1G)4p$	$c\,^2G–w\,^2G^\star$	2774.430	6.3	1.3						
44	$3d^5–3d^4(a\,^3F)4p$	$c\,^2F–y\,^2G^\star$	3306.955	7.8	0.0						
45	$3d^4(^3D)4s–3d^4(^3D)4p$	$b\,^2D–w\,^2F^\star$	2941.957	6.6	0.7						

[a] Rathore et al. (1984). Temperature 13 700 K.
[b] Dimitrijević et al. (2007). Data interpolated to a temperature of 14 000 K.
[c] Simić et al. (2013). Data interpolated to a temperature of 14 000 K.

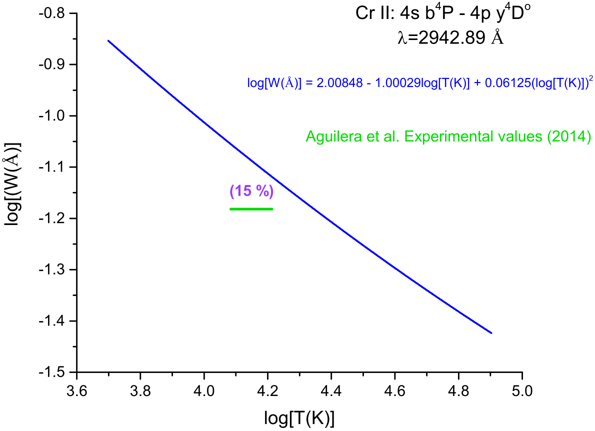
Stark broadening of Cr II spectral lines:

Present calculations



Stark broadening of Cr II spectral lines:

Present calculations



Conclusion

In this work, we calculate the spectral line widths of some Cr II lines at an electron density of 10^{17} cm^{-3} and electron temperatures from 5000 K to 80000K using the modified semi-empirical (MSE) approach. The needed atomic data are taken from NIST database.
The obtained widths are compared to Dimitrijević et al. (2007), Simić et al. (2013) and Aguilera et al. (2014) values.

Thank you for your attention

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