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On the Stark broadening of N II spectral lines

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Abstract. Stark broadening parameters, widths and shifts, for spectral lines within 45 N II multiplets, have been calculated for collisions with He III, B II; B III and B IV ions, by using the semiclassica perturbation method. The obtained data are of particular interest for proton-boron fusion experiments where boron nitride (BN) targets are used.

Key words: Stark broadening – N II – spectral lines – line profiles – proton-boron fusion

1. Introduction

Stark broadening is successfully implemented for spectroscopy diagnostics of astrophysical and laboratory plasma, as well as for laser, industrial, technological and fusion plasma. Recently, many experimental and theoretical efforts are oriented to the new direction of nuclear fusion, proton-boron fusion. Proton-boron fusion reaction is potentially promising for production of energy with several considerable advantages (Belloni, 2022). There are no radioactive species and neutrons in the reaction. Regarding the reactants, they are stable, cheap and abundant in nature. The fact that the production of neutrons is very low during the fusion process means that there is no induced activation of the environment surrounding the fuel. Clean fusion energy is a very important advantage. The proton-boron fusion produces three alpha particles and releases about 8.7 MeV. Three papers (Yoon et al., 2014; Giuffrida et al., 2016; Cirrone et al., 2018) report that α-particle generation during proton-boron fusion could be a valuable source for medical and industrial applications. According to the measurements and results presented by Schollmeier et al. (2022), boron-nitride (BN) nanotube targets are more efficient than regular foils and previously published nanostructured targets, so that in some experiments BN targets are used. Hegelich et al.

(2023) underline that in order to optimize the fusion yield, a plasma diagnostic is needed. Consequently, Stark broadening data for N II may be useful for determination of conditions in fusion plasma.

Our aim here is to calculate Stark broadening parameters for 45 multiplets of singly charged nitrogen (N II), for collisions with He III (alpha particles), B II, B III and B IV ions, in order to provide the data needed for proton-boron fusion experiments with BN targets.

2. Theory

In order to calculate Stark broadening parameters for spectral lines within the considered multiplets of singly charged nitrogen, the semiclassical perturbation theory (Sahal-Bréchot, 1969a,b; Sahal-Bréchot, Dimitrijević, & Ben Nessib, 2014) has been used. Since it has been described in detail in above mentioned references, only basic formulas will be given here, in order to understand the method of calculations. The full width at half maximum (FWHM - W) and shift (d) of an isolated spectral line of a non-hydrogenic ion is given as:

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

$$d = N \int v f(v) dv \int_{R_3}^{R_D} 2\pi \rho d\rho \sin(2\varphi_p). \tag{1}$$

where i and f denote the initial and final level of the corresponding transition; i' and f' are perturbing levels; N perturber density; v perturber velocity, and $f(v)$ is the Maxwellian distribution of electron velocities. The inelastic cross sections $\sigma_{kk'}(v)$, $k = i, f$ are presented here by an integration of the transition probability $P_{kk'}(\rho, v)$, over the impact parameter ρ as:

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

The cross section for elastic collisions is given as:

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

$$\delta = (\varphi_p^2 + \varphi_q^2)^{\frac{1}{2}}. \tag{3}$$

Here, δ denotes the phase shift with components φ_p (r^{-4}) and φ_q (r^{-3}), describing contributions due to polarization and quadrupole potentials, respectively. The method of symmetrization and calculation of cut-off parameters R_1, R_2, R_3, and the Debye cut-off R_D is explained in Sahal-Bréchot (1969b). The calculation of the contribution of Feshbach resonances (σ_r), is explained in detail in Fleurier et al. (1977) and Sahal-Bréchot (2021).

3. Results and discussion

We calculated Stark broadening parameters, full width at half intensity maximum (FWHM - W) and shift (d) by empoying the semiclassical perturbation theory (Sahal-Bréchot, 1969a,b; Sahal-Bréchot, Dimitrijević, & Ben Nessib, 2014). The electron density is 10^{16} cm^{-3} and temperatures 5 000 K, 10 000 K, 30 000 K, 50 000 K, 100 000 K, and 200 000 K. Atomic energy levels needed for present calculations have been taken from Moore (1993) and Kramida et al. (2021).

The results, for Stark Full Width at Half intensity Maximum (FWHM) and shift for 45 N II multiplets broadened by collisions with He III and B II ions are presented in Table 1, and broadened by collisions with B III and B IV in Table 2.

Since the wavelengths are calculated from atomic energy levels, they are not identical with wavelengths in NIST databases (Kramida et al., 2021).

From the quantity C (Dimitrijević & Sahal-Bréchot, 1984), presented in Tables 1 and 2, one can obtain the maximal perturber density for which the line may be considered as isolated, if it is divided by the corresponding width (W). Namely, a line is isolated if nondegenerate energy levels, broadened by collisions, do not overlap. This is satisfied if the width of a line is smaller or equal to the energy distance to the nearest perturbing level, represented by the quantity C. So the density limit is density where the values of C and the corresponding width are equal.

Additionally, we checked the validity of impact approximation calculating the value of NV, where V is the collision volume and N the perturber density. If $NV < 0.1$, the impact approximation is valid. We excluded from tables the cases when $NV > 0.5$, since than the impact approximation is not valid. In the case when the violation of impact approximation is more or less tolerable, for $0.1 < NV \leq 0.5$ we put an asterisk before the corresponding Stark broadening parameter in order to draw attention that this value is on the limit of validity of impact approximation

In order to obtain the line profile $F(\omega)$ (where ω is angular frequency) from the values given in Tables 1 and 2, we can use the expression:

$$F(\omega) = \frac{W/(2\pi)}{(\omega - \omega_{if} - d)^2 + (W/2)^2}. \tag{4}$$

Here

$$\omega_{if} = \frac{E_i - E_f}{\hbar}$$

where E_i, E_f are the energies of initial and final atomic energy level, respectively.

4. Conclusions

The Stark broadening parameters, FWHM and shifts, determining Lorentzian profile of a spectral line, have been calculated for 45 multiplets of singly charged nitrogen ion (N II), with the help of the impact semiclassical perturbation theory (Sahal-Bréchot, 1969a,b; Sahal-Bréchot, Dimitrijević, & Ben Nessib, 2014). The calculations have been performed for broadening by collisions of N II ion with He III, B II, B III and B IV ions. Such results are of interest for investigation of proton-boron fusion, since in some experimental devices boron nitride (BN) targets are used, so that broadening of N II by collisions with different boron ions is of interest for diagnostic purposes and for optimization, modeling and investigation of created plasma. The presented Stark broadening parameters will also be implemented in STARK-B database (http://stark-b.obspm.fr/ - Sahal-Bréchot et al. (2015)), which is also a part of Virtual Atomic and Molecular Data Center (VAMDC) (http://www.vamdc.org/ - Dubernet et al. (2010, 2016); Albert et al. (2020)).

Table 1. This table gives He III-, and B II-impact broadening parameters for N II multiplets, Stark FWHM W and shift d, expressed in Å. Calculated 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. Results are for perturber density of 10^{16} cm^{-3} and temperatures are from 5 000 K to 200 000 K. A positive shift is towards the red part of the spectrum. An asterisk before a value indicates that this value is on the limit of validity of impact approximation.

		He III		B II	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3s^1P^o$-$3p^1P$	5000.	0.452E-02	-0.145E-02	0.379E-02	-0.717E-03
6483.8 Å	10000.	0.776E-02	-0.269E-02	0.532E-02	-0.118E-02
C=0.65 10^{20}	30000.	0.121E-01	-0.493E-02	0.667E-02	-0.184E-02
	50000.	0.135E-01	-0.570E-02	0.722E-02	-0.211E-02
	100000.	0.153E-01	-0.682E-02	0.765E-02	-0.252E-02
	200000.	0.164E-01	-0.806E-02	0.802E-02	-0.289E-02
N II $3s^1P^o$-$3p^1D$	5000.	0.274E-02	0.363E-03	0.214E-02	0.183E-03
3996.1 Å	10000.	0.432E-02	0.702E-03	0.288E-02	0.316E-03
C=0.21 10^{20}	30000.	0.626E-02	0.134E-02	0.350E-02	0.518E-03
	50000.	0.686E-02	0.160E-02	0.374E-02	0.592E-03
	100000.	0.758E-02	0.192E-02	0.388E-02	0.708E-03
	200000.	0.793E-02	0.230E-02	0.405E-02	0.813E-03
N II $3s^1P^o$-$3p^1S$	5000.	0.324E-02	0.281E-02	0.213E-02	0.120E-02
3438.1 Å	10000.	0.519E-02	0.429E-02	0.286E-02	0.174E-02
C=0.14 10^{20}	30000.	0.800E-02	0.640E-02	0.373E-02	0.236E-02
	50000.	0.915E-02	0.729E-02	0.416E-02	0.270E-02
	100000.	0.112E-01	0.858E-02	0.442E-02	0.301E-02
	200000.	0.119E-01	0.939E-02	0.498E-02	0.348E-02
N II $3s^1P^o$-$4p^1P$	5000.	0.333E-02	0.587E-04	0.217E-02	0.300E-04
1887.4 Å	10000.	0.438E-02	0.117E-03	0.248E-02	0.532E-04
C=0.15 10^{19}	30000.	0.530E-02	0.232E-03	0.283E-02	0.916E-04
	50000.	0.561E-02	0.285E-03	0.291E-02	0.105E-03
	100000.	0.583E-02	0.341E-03	0.300E-02	0.126E-03
	200000.	0.600E-02	0.409E-03	0.302E-02	0.149E-03
N II $3s^1P^o$-$4p^1D$	5000.	0.400E-02	0.142E-02	0.242E-02	0.616E-03
1780.6 Å	10000.	0.508E-02	0.215E-02	0.278E-02	0.825E-03
C=0.15 10^{19}	30000.	0.635E-02	0.304E-02	0.315E-02	0.113E-02
	50000.	0.679E-02	0.343E-02	0.330E-02	0.122E-02
	100000.	0.751E-02	0.405E-02	0.339E-02	0.141E-02
	200000.	0.751E-02	0.434E-02	0.374E-02	0.171E-02
N II $3s^1P^o$-$4p^1S$	5000.	*0.640E-02	*0.457E-02	*0.315E-02	*0.183E-02
1732.4 Å	10000.	*0.827E-02	*0.631E-02	0.377E-02	0.248E-02
C=0.13 10^{19}	30000.	*0.113E-01	*0.915E-02	0.469E-02	0.328E-02
	50000.	0.123E-01	0.102E-01	0.485E-02	0.359E-02
	100000.	0.145E-01	0.112E-01	0.533E-02	0.427E-02
	200000.	0.164E-01	0.124E-01	0.687E-02	0.472E-02

Table 1. Continued.

TRANSITION	T[K]	He III W[Å]	d[Å]	B II W[Å]	d[Å]
N II $2p^{21}D$-$3s^{1}P^{o}$	5000.	0.663E-05	0.291E-04	0.534E-05	0.140E-04
747.0 Å	10000.	0.243E-04	0.526E-04	0.138E-04	0.218E-04
C=0.86 10^{18}	30000.	0.741E-04	0.907E-04	0.305E-04	0.335E-04
	50000.	0.971E-04	0.104E-03	0.374E-04	0.386E-04
	100000.	0.122E-03	0.124E-03	0.493E-04	0.453E-04
	200000.	0.160E-03	0.145E-03	0.559E-04	0.511E-04
N II $2p^{21}S$-$3s^{1}P^{o}$	5000.	0.899E-05	0.384E-04	0.729E-05	0.185E-04
858.4 Å	10000.	0.325E-04	0.695E-04	0.185E-04	0.288E-04
C=0.11 10^{19}	30000.	0.984E-04	0.120E-03	0.406E-04	0.442E-04
	50000.	0.129E-03	0.137E-03	0.498E-04	0.510E-04
	100000.	0.162E-03	0.164E-03	0.655E-04	0.598E-04
	200000.	0.212E-03	0.192E-03	0.741E-04	0.675E-04
N II $2p^{21}D$-$3d^{1}D^{o}$	5000.	0.528E-04	-0.130E-04	0.418E-04	-0.641E-05
582.2 Å	10000.	0.850E-04	-0.241E-04	0.570E-04	-0.104E-04
C=0.30 10^{18}	30000.	0.126E-03	-0.435E-04	0.695E-04	-0.161E-04
	50000.	0.139E-03	-0.500E-04	0.750E-04	-0.185E-04
	100000.	0.155E-03	-0.605E-04	0.788E-04	-0.217E-04
	200000.	0.164E-03	-0.702E-04	0.802E-04	-0.251E-04
N II $2p^{21}D$-$3d^{1}F^{o}$	5000.	0.611E-04	0.773E-05	0.474E-04	0.390E-05
574.7 Å	10000.	0.955E-04	0.149E-04	0.631E-04	0.670E-05
C=0.50 10^{18}	30000.	0.137E-03	0.284E-04	0.765E-04	0.110E-04
	50000.	0.150E-03	0.338E-04	0.815E-04	0.125E-04
	100000.	0.164E-03	0.407E-04	0.852E-04	0.148E-04
	200000.	0.173E-03	0.488E-04	0.877E-04	0.171E-04
N II $2p^{21}D$-$3d^{1}P^{o}$	5000.	0.655E-04	0.198E-04	0.498E-04	0.942E-05
572.1 Å	10000.	0.102E-03	0.352E-04	0.661E-04	0.145E-04
C=0.39 10^{18}	30000.	0.148E-03	0.594E-04	0.805E-04	0.219E-04
	50000.	0.163E-03	0.679E-04	0.859E-04	0.250E-04
	100000.	0.181E-03	0.812E-04	0.891E-04	0.295E-04
	200000.	0.191E-03	0.934E-04	0.957E-04	0.337E-04
N II $2p^{21}S$-$3d^{1}P^{o}$	5000.	0.811E-04	0.244E-04	0.616E-04	0.116E-04
635.2 Å	10000.	0.126E-03	0.435E-04	0.817E-04	0.179E-04
C=0.48 10^{18}	30000.	0.183E-03	0.733E-04	0.994E-04	0.271E-04
	50000.	0.202E-03	0.837E-04	0.106E-03	0.309E-04
	100000.	0.224E-03	0.100E-03	0.110E-03	0.364E-04
	200000.	0.236E-03	0.115E-03	0.118E-03	0.416E-04
N II $3p^{1}P$-$3d^{1}P^{o}$	5000.	0.443E-02	0.663E-03	0.326E-02	0.323E-03
3920.1 Å	10000.	0.659E-02	0.122E-02	0.406E-02	0.516E-03
C=0.18 10^{20}	30000.	0.885E-02	0.216E-02	0.489E-02	0.795E-03
	50000.	0.963E-02	0.249E-02	0.515E-02	0.910E-03
	100000.	0.105E-01	0.295E-02	0.530E-02	0.108E-02
	200000.	0.109E-01	0.347E-02	0.563E-02	0.126E-02

Table 1. Continued.

TRANSITION	T[K]	He III W[Å]	d[Å]	B II W[Å]	d[Å]
N II $3p^1P$-$3d^1D^o$	5000.	0.494E-02	-0.111E-02	0.367E-02	-0.530E-03
4448.3 Å	10000.	0.747E-02	-0.199E-02	0.469E-02	-0.822E-03
C=0.17 10^{20}	30000.	0.104E-01	-0.340E-02	0.569E-02	-0.126E-02
	50000.	0.113E-01	-0.387E-02	0.599E-02	-0.143E-02
	100000.	0.123E-01	-0.468E-02	0.618E-02	-0.168E-02
	200000.	0.130E-01	-0.524E-02	0.660E-02	-0.193E-02
N II $3p^1D$-$3d^1D^o$	5000.	0.189E-01	-0.615E-02	0.136E-01	-0.288E-02
7764.4 Å	10000.	0.281E-01	-0.102E-01	0.168E-01	-0.425E-02
C=0.53 10^{20}	30000.	0.380E-01	-0.164E-01	0.205E-01	-0.611E-02
	50000.	0.418E-01	-0.188E-01	0.215E-01	-0.696E-02
	100000.	0.454E-01	-0.221E-01	0.224E-01	-0.799E-02
	200000.	0.498E-01	-0.256E-01	0.227E-01	-0.901E-02
N II $3p^1D$-$3d^1F^o$	5000.	0.146E-01	-0.225E-02	0.106E-01	-0.108E-02
6612.4 Å	10000.	0.214E-01	-0.408E-02	0.129E-01	-0.169E-02
C=0.56 10^{20}	30000.	0.281E-01	-0.704E-02	0.155E-01	-0.259E-02
	50000.	0.307E-01	-0.805E-02	0.162E-01	-0.299E-02
	100000.	0.329E-01	-0.961E-02	0.170E-01	-0.354E-02
	200000.	0.341E-01	-0.113E-01	0.171E-01	-0.394E-02
N II $3p^1D$-$3d^1P^o$	5000.	0.136E-01	-0.531E-03	0.983E-02	-0.274E-03
6286.1 Å	10000.	0.198E-01	-0.107E-02	0.119E-01	-0.491E-03
C=0.47 10^{20}	30000.	0.257E-01	-0.217E-02	0.143E-01	-0.870E-03
	50000.	0.279E-01	-0.272E-02	0.149E-01	-0.101E-02
	100000.	0.299E-01	-0.326E-02	0.154E-01	-0.121E-02
	200000.	0.307E-01	-0.393E-02	0.159E-01	-0.139E-02
N II $3p^1S$-$3d^1P^o$	5000.	0.272E-01	-0.390E-02	0.194E-01	-0.187E-02
8441.1 Å	10000.	0.393E-01	-0.702E-02	0.233E-01	-0.290E-02
C=0.84 10^{20}	30000.	0.507E-01	-0.120E-01	0.279E-01	-0.446E-02
	50000.	0.549E-01	-0.137E-01	0.290E-01	-0.508E-02
	100000.	0.591E-01	-0.165E-01	0.304E-01	-0.593E-02
	200000.	0.621E-01	-0.187E-01	0.305E-01	-0.683E-02
N II $3d^1D^o$-$4p^1P$	5000.	0.456E-01	0.437E-02	0.292E-01	0.205E-02
6631.6 Å	10000.	0.588E-01	0.728E-02	0.333E-01	0.303E-02
C=0.19 10^{20}	30000.	0.713E-01	0.117E-01	0.379E-01	0.434E-02
	50000.	0.750E-01	0.134E-01	0.391E-01	0.496E-02
	100000.	0.785E-01	0.157E-01	0.397E-01	0.579E-02
	200000.	0.801E-01	0.182E-01	0.405E-01	0.636E-02
N II $3d^1D^o$-$4p^1D$	5000.	0.409E-01	0.148E-01	0.244E-01	0.638E-02
5476.8 Å	10000.	0.514E-01	0.222E-01	0.281E-01	0.856E-02
C=0.14 10^{20}	30000.	0.647E-01	0.320E-01	0.321E-01	0.115E-01
	50000.	0.699E-01	0.365E-01	0.337E-01	0.130E-01
	100000.	0.735E-01	0.408E-01	0.361E-01	0.148E-01
	200000.	0.784E-01	0.471E-01	0.374E-01	0.170E-01

Table 1. Continued.

TRANSITION	T[K]	He III W[Å]	He III d[Å]	B II W[Å]	B II d[Å]
N II $3d^1F^o$-$4p^1D$	5000.	0.536E-01	0.180E-01	0.320E-01	0.783E-02
6244.1 Å	10000.	0.670E-01	0.273E-01	0.368E-01	0.105E-01
C=0.18 10^{20}	30000.	0.837E-01	0.387E-01	0.416E-01	0.144E-01
	50000.	0.897E-01	0.443E-01	0.437E-01	0.157E-01
	100000.	0.965E-01	0.513E-01	0.451E-01	0.179E-01
	200000.	0.101	0.567E-01	0.485E-01	0.213E-01
N II $3d^1P^o$-$4p^1P$	5000.	0.731E-01	0.407E-02	0.466E-01	0.194E-02
8298.5 Å	10000.	0.939E-01	0.726E-02	0.532E-01	0.299E-02
C=0.30 10^{20}	30000.	0.114	0.123E-01	0.604E-01	0.453E-02
	50000.	0.120	0.140E-01	0.623E-01	0.518E-02
	100000.	0.124	0.168E-01	0.629E-01	0.611E-02
	200000.	0.127	0.191E-01	0.644E-01	0.704E-02
N II $3d^1P^o$-$4p^1D$	5000.	0.596E-01	0.204E-01	0.355E-01	0.883E-02
6566.0 Å	10000.	0.746E-01	0.308E-01	0.409E-01	0.119E-01
C=0.20 10^{20}	30000.	0.937E-01	0.439E-01	0.466E-01	0.162E-01
	50000.	0.999E-01	0.503E-01	0.489E-01	0.178E-01
	100000.	0.105	0.576E-01	0.506E-01	0.203E-01
	200000.	0.113	0.647E-01	0.535E-01	0.240E-01
N II $3d^1P^o$-$4p^1S$	5000.	*0.786E-01	*0.545E-01	*0.391E-01	*0.219E-01
5955.9 Å	10000.	*0.102	*0.756E-01	0.464E-01	0.295E-01
C=0.16 10^{20}	30000.	*0.137	*0.109	0.574E-01	0.391E-01
	50000.	0.149	0.121	0.596E-01	0.432E-01
	100000.	0.173	0.135	0.650E-01	0.511E-01
	200000.	0.194	0.145	0.820E-01	0.556E-01
N II $3s^3P^o$-$3p^3D$	5000.	0.379E-02	-0.910E-03	0.315E-02	-0.455E-03
5680.9 Å	10000.	0.639E-02	-0.172E-02	0.438E-02	-0.765E-03
C=0.57 10^{20}	30000.	0.977E-02	-0.324E-02	0.544E-02	-0.122E-02
	50000.	0.108E-01	-0.377E-02	0.589E-02	-0.140E-02
	100000.	0.121E-01	-0.456E-02	0.617E-02	-0.168E-02
	200000.	0.131E-01	-0.533E-02	0.639E-02	-0.197E-02
N II $3s^3P^o$-$3p^3S$	5000.	0.332E-02	-0.502E-03	0.270E-02	-0.255E-03
5030.2 Å	10000.	0.546E-02	-0.985E-03	0.373E-02	-0.446E-03
C=0.45 10^{20}	30000.	0.817E-02	-0.191E-02	0.458E-02	-0.746E-03
	50000.	0.901E-02	-0.231E-02	0.494E-02	-0.852E-03
	100000.	0.100E-01	-0.277E-02	0.522E-02	-0.102E-02
	200000.	0.107E-01	-0.325E-02	0.535E-02	-0.119E-02
N II $3s^3P^o$-$3p^3P$	5000.	0.304E-02	-0.143E-03	0.246E-02	-0.750E-04
4624.5 Å	10000.	0.494E-02	-0.300E-03	0.337E-02	-0.143E-03
C=0.36 10^{20}	30000.	0.729E-02	-0.678E-03	0.411E-02	-0.274E-03
	50000.	0.799E-02	-0.861E-03	0.440E-02	-0.332E-03
	100000.	0.884E-02	-0.108E-02	0.462E-02	-0.398E-03
	200000.	0.927E-02	-0.129E-02	0.479E-02	-0.472E-03

Table 1. Continued.

		He III		B II	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3s^3P^o$-$4p^3D$	5000.	0.344E-02	0.797E-03	0.221E-02	0.343E-03
1859.2 Å	10000.	0.450E-02	0.122E-02	0.252E-02	0.497E-03
C=0.21 10^{19}	30000.	0.550E-02	0.183E-02	0.290E-02	0.677E-03
	50000.	0.591E-02	0.206E-02	0.296E-02	0.773E-03
	100000.	0.613E-02	0.246E-02	0.312E-02	0.867E-03
	200000.	0.633E-02	0.265E-02	0.318E-02	0.994E-03
N II $3s^3P^o$-$4p^3P$	5000.	0.351E-02	0.842E-03	0.224E-02	0.359E-03
1844.6 Å	10000.	0.455E-02	0.128E-02	0.255E-02	0.520E-03
C=0.22 10^{19}	30000.	0.559E-02	0.192E-02	0.291E-02	0.700E-03
	50000.	0.593E-02	0.218E-02	0.298E-02	0.785E-03
	100000.	0.619E-02	0.253E-02	0.319E-02	0.900E-03
	200000.	0.642E-02	0.284E-02	0.320E-02	0.103E-02
N II $3s^3P^o$-$4p^3S$	5000.	0.359E-02	0.109E-02	0.226E-02	0.466E-03
1834.0 Å	10000.	0.466E-02	0.165E-02	0.259E-02	0.646E-03
C=0.21 10^{19}	30000.	0.576E-02	0.239E-02	0.296E-02	0.884E-03
	50000.	0.617E-02	0.273E-02	0.311E-02	0.987E-03
	100000.	0.661E-02	0.323E-02	0.317E-02	0.115E-02
	200000.	0.720E-02	0.376E-02	0.316E-02	0.129E-02
N II $2p^{23}P$-$4s^3P^o$	5000.	0.926E-04	0.129E-03	0.427E-04	0.560E-04
508.7 Å	10000.	0.168E-03	0.195E-03	0.696E-04	0.749E-04
C=0.16 10^{18}	30000.	0.277E-03	0.279E-03	0.105E-03	0.100E-03
	50000.	0.327E-03	0.318E-03	0.120E-03	0.113E-03
	100000.	0.396E-03	0.357E-03	0.133E-03	0.131E-03
	200000.	0.453E-03	0.408E-03	0.164E-03	0.150E-03
N II $2p^{23}P$-$3d^3D^o$	5000.	0.454E-04	0.722E-05	0.359E-04	0.363E-05
533.7 Å	10000.	0.725E-04	0.138E-04	0.487E-04	0.618E-05
C=0.44 10^{18}	30000.	0.106E-03	0.261E-04	0.592E-04	0.100E-04
	50000.	0.116E-03	0.308E-04	0.634E-04	0.114E-04
	100000.	0.129E-03	0.370E-04	0.660E-04	0.136E-04
	200000.	0.136E-03	0.446E-04	0.686E-04	0.157E-04
N II $2p^{23}P$-$3d^3P^o$	5000.	0.506E-04	0.139E-04	0.391E-04	0.671E-05
529.7 Å	10000.	0.797E-04	0.253E-04	0.524E-04	0.105E-04
C=0.39 10^{18}	30000.	0.117E-03	0.438E-04	0.638E-04	0.161E-04
	50000.	0.128E-03	0.501E-04	0.680E-04	0.184E-04
	100000.	0.144E-03	0.593E-04	0.720E-04	0.222E-04
	200000.	0.153E-03	0.706E-04	0.739E-04	0.249E-04
N II $3p^3D$-$3d^3F^o$	5000.	0.629E-02	-0.280E-03	0.470E-02	-0.145E-03
5005.9 Å	10000.	0.946E-02	-0.573E-03	0.598E-02	-0.264E-03
C=0.41 10^{20}	30000.	0.129E-01	-0.118E-02	0.720E-02	-0.479E-03
	50000.	0.140E-01	-0.151E-02	0.762E-02	-0.556E-03
	100000.	0.152E-01	-0.181E-02	0.793E-02	-0.670E-03
	200000.	0.158E-01	-0.217E-02	0.801E-02	-0.789E-03

Table 1. Continued.

		He III		B II	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3p^3D$-$3d^3D^o$	5000.	0.602E-02	-0.886E-03	0.447E-02	-0.435E-03
4794.8 Å	10000.	0.904E-02	-0.164E-02	0.566E-02	-0.704E-03
C=0.35 10^{20}	30000.	0.123E-01	-0.296E-02	0.683E-02	-0.109E-02
	50000.	0.134E-01	-0.340E-02	0.718E-02	-0.126E-02
	100000.	0.145E-01	-0.411E-02	0.749E-02	-0.147E-02
	200000.	0.155E-01	-0.477E-02	0.767E-02	-0.170E-02
N II $3p^3D$-$3d^3P^o$	5000.	0.562E-02	0.715E-04	0.416E-02	0.377E-04
4490.7 Å	10000.	0.836E-02	0.153E-03	0.520E-02	0.749E-04
C=0.28 10^{20}	30000.	0.112E-01	0.381E-03	0.626E-02	0.154E-03
	50000.	0.122E-01	0.489E-03	0.658E-02	0.197E-03
	100000.	0.132E-01	0.649E-03	0.682E-02	0.240E-03
	200000.	0.137E-01	0.777E-03	0.692E-02	0.287E-03
N II $3p^3S$-$3d^3P^o$	5000.	0.730E-02	0.723E-03	0.536E-02	0.362E-03
5002.2 Å	10000.	0.108E-01	0.137E-02	0.666E-02	0.606E-03
C=0.35 10^{20}	30000.	0.145E-01	0.256E-02	0.803E-02	0.961E-03
	50000.	0.157E-01	0.296E-02	0.840E-02	0.111E-02
	100000.	0.170E-01	0.358E-02	0.876E-02	0.132E-02
	200000.	0.178E-01	0.423E-02	0.893E-02	0.154E-02
N II $3p^3P$-$3d^3D^o$	5000.	0.101E-01	-0.144E-02	0.740E-02	-0.704E-03
5940.2 Å	10000.	0.150E-01	-0.265E-02	0.923E-02	-0.113E-02
C=0.54 10^{20}	30000.	0.201E-01	-0.474E-02	0.111E-01	-0.175E-02
	50000.	0.219E-01	-0.544E-02	0.117E-01	-0.202E-02
	100000.	0.238E-01	-0.651E-02	0.121E-01	-0.236E-02
	200000.	0.250E-01	-0.754E-02	0.127E-01	-0.274E-02
N II $3p^3P$-$3d^3P^o$	5000.	0.906E-02	-0.477E-03	0.664E-02	-0.244E-03
5480.3 Å	10000.	0.134E-01	-0.955E-03	0.820E-02	-0.434E-03
C=0.42 10^{20}	30000.	0.177E-01	-0.190E-02	0.987E-02	-0.751E-03
	50000.	0.193E-01	-0.234E-02	0.103E-01	-0.866E-03
	100000.	0.208E-01	-0.281E-02	0.108E-01	-0.103E-02
	200000.	0.214E-01	-0.334E-02	0.109E-01	-0.120E-02
N II $3d^3F^o$-$4p^3D$	5000.	0.416E-01	0.965E-02	0.262E-01	0.411E-02
6169.8 Å	10000.	0.534E-01	0.147E-01	0.299E-01	0.593E-02
C=0.23 10^{20}	30000.	0.653E-01	0.218E-01	0.340E-01	0.802E-02
	50000.	0.691E-01	0.250E-01	0.348E-01	0.902E-02
	100000.	0.725E-01	0.283E-01	0.369E-01	0.104E-01
	200000.	0.737E-01	0.327E-01	0.370E-01	0.118E-01
N II $3d^3D^o$-$4p^3D$	5000.	0.467E-01	0.108E-01	0.294E-01	0.460E-02
6523.6 Å	10000.	0.600E-01	0.164E-01	0.336E-01	0.664E-02
C=0.26 10^{20}	30000.	0.734E-01	0.243E-01	0.382E-01	0.898E-02
	50000.	0.776E-01	0.280E-01	0.391E-01	0.101E-01
	100000.	0.815E-01	0.316E-01	0.414E-01	0.116E-01
	200000.	0.827E-01	0.366E-01	0.416E-01	0.132E-01

Table 1. Continued.

TRANSITION	T[K]	He III W[Å]	He III d[Å]	B II W[Å]	B II d[Å]
N II $3d^3D^o$-$4p^3P$	5000.	0.456E-01	0.109E-01	0.285E-01	0.462E-02
6347.6 Å	10000.	0.583E-01	0.165E-01	0.327E-01	0.661E-02
C=0.26 10^{20}	30000.	0.719E-01	0.242E-01	0.372E-01	0.893E-02
	50000.	0.759E-01	0.277E-01	0.385E-01	0.101E-01
	100000.	0.796E-01	0.317E-01	0.397E-01	0.117E-01
	200000.	0.826E-01	0.363E-01	0.398E-01	0.130E-01
N II $3d^3P^o$-$4p^3D$	5000.	0.572E-01	0.126E-01	0.360E-01	0.537E-02
7185.8 Å	10000.	0.733E-01	0.192E-01	0.411E-01	0.778E-02
C=0.32 10^{20}	30000.	0.896E-01	0.287E-01	0.467E-01	0.105E-01
	50000.	0.945E-01	0.327E-01	0.478E-01	0.118E-01
	100000.	0.983E-01	0.382E-01	0.509E-01	0.135E-01
	200000.	0.102	0.421E-01	0.508E-01	0.154E-01
N II $3d^3P^o$-$4p^3P$	5000.	0.555E-01	0.126E-01	0.347E-01	0.538E-02
6972.8 Å	10000.	0.708E-01	0.192E-01	0.397E-01	0.774E-02
C=0.32 10^{20}	30000.	0.870E-01	0.285E-01	0.450E-01	0.105E-01
	50000.	0.916E-01	0.326E-01	0.465E-01	0.118E-01
	100000.	0.963E-01	0.365E-01	0.485E-01	0.134E-01
	200000.	0.982E-01	0.426E-01	0.483E-01	0.155E-01
N II $3d^3P^o$-$4p^3S$	5000.	0.550E-01	0.156E-01	0.340E-01	0.666E-02
6824.0 Å	10000.	0.700E-01	0.236E-01	0.389E-01	0.922E-02
C=0.29 10^{20}	30000.	0.863E-01	0.340E-01	0.443E-01	0.125E-01
	50000.	0.918E-01	0.388E-01	0.466E-01	0.140E-01
	100000.	0.978E-01	0.454E-01	0.463E-01	0.165E-01
	200000.	0.106	0.530E-01	0.464E-01	0.178E-01

Table 2. Same as in Table 1 but for B III-, and B IV-impact broadening of N II spectral lines.

		B III		B IV	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3s^1P^o$-$3p^1P$	5000.	0.452E-02	-0.145E-02	0.379E-02	-0.717E-03
6483.8 Å	10000.	0.776E-02	-0.269E-02	0.532E-02	-0.118E-02
C=0.65 10^{20}	30000.	0.121E-01	-0.493E-02	0.667E-02	-0.184E-02
	50000.	0.135E-01	-0.570E-02	0.722E-02	-0.211E-02
	100000.	0.153E-01	-0.682E-02	0.765E-02	-0.252E-02
	200000.	0.164E-01	-0.806E-02	0.802E-02	-0.289E-02
N II $3s^1P^o$-$3p^1D$	5000.	0.274E-02	0.363E-03	0.214E-02	0.183E-03
3996.1 Å	10000.	0.432E-02	0.702E-03	0.288E-02	0.316E-03
C=0.21 10^{20}	30000.	0.626E-02	0.134E-02	0.350E-02	0.518E-03
	50000.	0.686E-02	0.160E-02	0.374E-02	0.592E-03
	100000.	0.758E-02	0.192E-02	0.388E-02	0.708E-03
	200000.	0.793E-02	0.230E-02	0.405E-02	0.813E-03
N II $3s^1P^o$-$3p^1S$	5000.	0.324E-02	0.281E-02	0.213E-02	0.120E-02
3438.1 Å	10000.	0.519E-02	0.429E-02	0.286E-02	0.174E-02
C=0.14 10^{20}	30000.	0.800E-02	0.640E-02	0.373E-02	0.236E-02
	50000.	0.915E-02	0.729E-02	0.416E-02	0.270E-02
	100000.	0.112E-01	0.858E-02	0.442E-02	0.301E-02
	200000.	0.119E-01	0.939E-02	0.498E-02	0.348E-02
N II $3s^1P^o$-$4p^1P$	5000.	0.333E-02	0.587E-04	0.217E-02	0.300E-04
1887.4 Å	10000.	0.438E-02	0.117E-03	0.248E-02	0.532E-04
C=0.15 10^{19}	30000.	0.530E-02	0.232E-03	0.283E-02	0.916E-04
	50000.	0.561E-02	0.285E-03	0.291E-02	0.105E-03
	100000.	0.583E-02	0.341E-03	0.300E-02	0.126E-03
	200000.	0.600E-02	0.409E-03	0.302E-02	0.149E-03
N II $3s^1P^o$-$4p^1D$	5000.	0.400E-02	0.142E-02	0.242E-02	0.616E-03
1780.6 Å	10000.	0.508E-02	0.215E-02	0.278E-02	0.825E-03
C=0.15 10^{19}	30000.	0.635E-02	0.304E-02	0.315E-02	0.113E-02
	50000.	0.679E-02	0.343E-02	0.330E-02	0.122E-02
	100000.	0.751E-02	0.405E-02	0.339E-02	0.141E-02
	200000.	0.751E-02	0.434E-02	0.374E-02	0.171E-02
N II $3s^1P^o$-$4p^1S$	5000.	*0.640E-02	*0.457E-02	*0.315E-02	*0.183E-02
1732.4 Å	10000.	*0.827E-02	*0.631E-02	0.377E-02	0.248E-02
C=0.13 10^{19}	30000.	*0.113E-01	*0.915E-02	0.469E-02	0.328E-02
	50000.	0.123E-01	0.102E-01	0.485E-02	0.359E-02
	100000.	0.145E-01	0.112E-01	0.533E-02	0.427E-02
	200000.	0.164E-01	0.124E-01	0.687E-02	0.472E-02
N II $2p^{21}D$-$3s^1P^o$	5000.	0.663E-05	0.291E-04	0.534E-05	0.140E-04
747.0 Å	10000.	0.243E-04	0.526E-04	0.138E-04	0.218E-04
C=0.86 10^{18}	30000.	0.741E-04	0.907E-04	0.305E-04	0.335E-04
	50000.	0.971E-04	0.104E-03	0.374E-04	0.386E-04
	100000.	0.122E-03	0.124E-03	0.493E-04	0.453E-04
	200000.	0.160E-03	0.145E-03	0.559E-04	0.511E-04

Table 2. Continued.

		B III		B IV	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $2p^{21}S$-$3s^{1}P^{o}$	5000.	0.899E-05	0.384E-04	0.729E-05	0.185E-04
858.4 Å	10000.	0.325E-04	0.695E-04	0.185E-04	0.288E-04
C=0.11 10^{19}	30000.	0.984E-04	0.120E-03	0.406E-04	0.442E-04
	50000.	0.129E-03	0.137E-03	0.498E-04	0.510E-04
	100000.	0.162E-03	0.164E-03	0.655E-04	0.598E-04
	200000.	0.212E-03	0.192E-03	0.741E-04	0.675E-04
N II $2p^{21}D$-$3d^{1}D^{o}$	5000.	0.528E-04	-0.130E-04	0.418E-04	-0.641E-05
582.2 Å	10000.	0.850E-04	-0.241E-04	0.570E-04	-0.104E-04
C=0.30 10^{18}	30000.	0.126E-03	-0.435E-04	0.695E-04	-0.161E-04
	50000.	0.139E-03	-0.500E-04	0.750E-04	-0.185E-04
	100000.	0.155E-03	-0.605E-04	0.788E-04	-0.217E-04
	200000.	0.164E-03	-0.702E-04	0.802E-04	-0.251E-04
N II $2p^{21}D$-$3d^{1}F^{o}$	5000.	0.611E-04	0.773E-05	0.474E-04	0.390E-05
574.7 Å	10000.	0.955E-04	0.149E-04	0.631E-04	0.670E-05
C=0.50 10^{18}	30000.	0.137E-03	0.284E-04	0.765E-04	0.110E-04
	50000.	0.150E-03	0.338E-04	0.815E-04	0.125E-04
	100000.	0.164E-03	0.407E-04	0.852E-04	0.148E-04
	200000.	0.173E-03	0.488E-04	0.877E-04	0.171E-04
N II $2p^{21}D$-$3d^{1}P^{o}$	5000.	0.655E-04	0.198E-04	0.498E-04	0.942E-05
572.1 Å	10000.	0.102E-03	0.352E-04	0.661E-04	0.145E-04
C=0.39 10^{18}	30000.	0.148E-03	0.594E-04	0.805E-04	0.219E-04
	50000.	0.163E-03	0.679E-04	0.859E-04	0.250E-04
	100000.	0.181E-03	0.812E-04	0.891E-04	0.295E-04
	200000.	0.191E-03	0.934E-04	0.957E-04	0.337E-04
N II $2p^{21}S$-$3d^{1}P^{o}$	5000.	0.811E-04	0.244E-04	0.616E-04	0.116E-04
635.2 Å	10000.	0.126E-03	0.435E-04	0.817E-04	0.179E-04
C=0.48 10^{18}	30000.	0.183E-03	0.733E-04	0.994E-04	0.271E-04
	50000.	0.202E-03	0.837E-04	0.106E-03	0.309E-04
	100000.	0.224E-03	0.100E-03	0.110E-03	0.364E-04
	200000.	0.236E-03	0.115E-03	0.118E-03	0.416E-04
N II $3p^{1}P$-$3d^{1}P^{o}$	5000.	0.443E-02	0.663E-03	0.326E-02	0.323E-03
3920.1 Å	10000.	0.659E-02	0.122E-02	0.406E-02	0.516E-03
C=0.18 10^{20}	30000.	0.885E-02	0.216E-02	0.489E-02	0.795E-03
	50000.	0.963E-02	0.249E-02	0.515E-02	0.910E-03
	100000.	0.105E-01	0.295E-02	0.530E-02	0.108E-02
	200000.	0.109E-01	0.347E-02	0.563E-02	0.126E-02
N II $3p^{1}P$-$3d^{1}D^{o}$	5000.	0.494E-02	-0.111E-02	0.367E-02	-0.530E-03
4448.3 Å	10000.	0.747E-02	-0.199E-02	0.469E-02	-0.822E-03
C=0.17 10^{20}	30000.	0.104E-01	-0.340E-02	0.569E-02	-0.126E-02
	50000.	0.113E-01	-0.387E-02	0.599E-02	-0.143E-02
	100000.	0.123E-01	-0.468E-02	0.618E-02	-0.168E-02
	200000.	0.130E-01	-0.524E-02	0.660E-02	-0.193E-02

Table 2. Continued.

		B III		B IV	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3p^1D$-$3d^1D^o$	5000.	0.189E-01	-0.615E-02	0.136E-01	-0.288E-02
7764.4 Å	10000.	0.281E-01	-0.102E-01	0.168E-01	-0.425E-02
C=0.53 10^{20}	30000.	0.380E-01	-0.164E-01	0.205E-01	-0.611E-02
	50000.	0.418E-01	-0.188E-01	0.215E-01	-0.696E-02
	100000.	0.454E-01	-0.221E-01	0.224E-01	-0.799E-02
	200000.	0.498E-01	-0.256E-01	0.227E-01	-0.901E-02
N II $3p^1D$-$3d^1F^o$	5000.	0.146E-01	-0.225E-02	0.106E-01	-0.108E-02
6612.4 Å	10000.	0.214E-01	-0.408E-02	0.129E-01	-0.169E-02
C=0.56 10^{20}	30000.	0.281E-01	-0.704E-02	0.155E-01	-0.259E-02
	50000.	0.307E-01	-0.805E-02	0.162E-01	-0.299E-02
	100000.	0.329E-01	-0.961E-02	0.170E-01	-0.354E-02
	200000.	0.341E-01	-0.113E-01	0.171E-01	-0.394E-02
N II $3p^1D$-$3d^1P^o$	5000.	0.136E-01	-0.531E-03	0.983E-02	-0.274E-03
6286.1 Å	10000.	0.198E-01	-0.107E-02	0.119E-01	-0.491E-03
C=0.47 10^{20}	30000.	0.257E-01	-0.217E-02	0.143E-01	-0.870E-03
	50000.	0.279E-01	-0.272E-02	0.149E-01	-0.101E-02
	100000.	0.299E-01	-0.326E-02	0.154E-01	-0.121E-02
	200000.	0.307E-01	-0.393E-02	0.159E-01	-0.139E-02
N II $3p^1S$-$3d^1P^o$	5000.	0.272E-01	-0.390E-02	0.194E-01	-0.187E-02
8441.1 Å	10000.	0.393E-01	-0.702E-02	0.233E-01	-0.290E-02
C=0.84 10^{20}	30000.	0.507E-01	-0.120E-01	0.279E-01	-0.446E-02
	50000.	0.549E-01	-0.137E-01	0.290E-01	-0.508E-02
	100000.	0.591E-01	-0.165E-01	0.304E-01	-0.593E-02
	200000.	0.621E-01	-0.187E-01	0.305E-01	-0.683E-02
N II $3d^1D^o$-$4p^1P$	5000.	0.456E-01	0.437E-02	0.292E-01	0.205E-02
6631.6 Å	10000.	0.588E-01	0.728E-02	0.333E-01	0.303E-02
C=0.19 10^{20}	30000.	0.713E-01	0.117E-01	0.379E-01	0.434E-02
	50000.	0.750E-01	0.134E-01	0.391E-01	0.496E-02
	100000.	0.785E-01	0.157E-01	0.397E-01	0.579E-02
	200000.	0.801E-01	0.182E-01	0.405E-01	0.636E-02
N II $3d^1D^o$-$4p^1D$	5000.	0.409E-01	0.148E-01	0.244E-01	0.638E-02
5476.8 Å	10000.	0.514E-01	0.222E-01	0.281E-01	0.856E-02
C=0.14 10^{20}	30000.	0.647E-01	0.320E-01	0.321E-01	0.115E-01
	50000.	0.699E-01	0.365E-01	0.337E-01	0.130E-01
	100000.	0.735E-01	0.408E-01	0.361E-01	0.148E-01
	200000.	0.784E-01	0.471E-01	0.374E-01	0.170E-01
N II $3d^1F^o$-$4p^1D$	5000.	0.536E-01	0.180E-01	0.320E-01	0.783E-02
6244.1 Å	10000.	0.670E-01	0.273E-01	0.368E-01	0.105E-01
C=0.18 10^{20}	30000.	0.837E-01	0.387E-01	0.416E-01	0.144E-01
	50000.	0.897E-01	0.443E-01	0.437E-01	0.157E-01
	100000.	0.965E-01	0.513E-01	0.451E-01	0.179E-01
	200000.	0.101	0.567E-01	0.485E-01	0.213E-01

Table 2. Continued.

TRANSITION	T[K]	B III W[Å]	d[Å]	B IV W[Å]	d[Å]
N II $3d^1P^o$-$4p^1P$	5000.	0.731E-01	0.407E-02	0.466E-01	0.194E-02
8298.5 Å	10000.	0.939E-01	0.726E-02	0.532E-01	0.299E-02
C=0.30 10^{20}	30000.	0.114	0.123E-01	0.604E-01	0.453E-02
	50000.	0.120	0.140E-01	0.623E-01	0.518E-02
	100000.	0.124	0.168E-01	0.629E-01	0.611E-02
	200000.	0.127	0.191E-01	0.644E-01	0.704E-02
N II $3d^1P^o$-$4p^1D$	5000.	0.596E-01	0.204E-01	0.355E-01	0.883E-02
6566.0 Å	10000.	0.746E-01	0.308E-01	0.409E-01	0.119E-01
C=0.20 10^{20}	30000.	0.937E-01	0.439E-01	0.466E-01	0.162E-01
	50000.	0.999E-01	0.503E-01	0.489E-01	0.178E-01
	100000.	0.105	0.576E-01	0.506E-01	0.203E-01
	200000.	0.113	0.647E-01	0.535E-01	0.240E-01
N II $3d^1P^o$-$4p^1S$	5000.	*0.786E-01	*0.545E-01	*0.391E-01	*0.219E-01
5955.9 Å	10000.	*0.102	*0.756E-01	0.464E-01	0.295E-01
C=0.16 10^{20}	30000.	*0.137	*0.109	0.574E-01	0.391E-01
	50000.	0.149	0.121	0.596E-01	0.432E-01
	100000.	0.173	0.135	0.650E-01	0.511E-01
	200000.	0.194	0.145	0.820E-01	0.556E-01
N II $3s^3P^o$-$3p^3D$	5000.	0.379E-02	-0.910E-03	0.315E-02	-0.455E-03
5680.9 Å	10000.	0.639E-02	-0.172E-02	0.438E-02	-0.765E-03
C=0.57 10^{20}	30000.	0.977E-02	-0.324E-02	0.544E-02	-0.122E-02
	50000.	0.108E-01	-0.377E-02	0.589E-02	-0.140E-02
	100000.	0.121E-01	-0.456E-02	0.617E-02	-0.168E-02
	200000.	0.131E-01	-0.533E-02	0.639E-02	-0.197E-02
N II $3s^3P^o$-$3p^3S$	5000.	0.332E-02	-0.502E-03	0.270E-02	-0.255E-03
5030.2 Å	10000.	0.546E-02	-0.985E-03	0.373E-02	-0.446E-03
C=0.45 10^{20}	30000.	0.817E-02	-0.191E-02	0.458E-02	-0.746E-03
	50000.	0.901E-02	-0.231E-02	0.494E-02	-0.852E-03
	100000.	0.100E-01	-0.277E-02	0.522E-02	-0.102E-02
	200000.	0.107E-01	-0.325E-02	0.535E-02	-0.119E-02
N II $3s^3P^o$-$3p^3P$	5000.	0.304E-02	-0.143E-03	0.246E-02	-0.750E-04
4624.5 Å	10000.	0.494E-02	-0.300E-03	0.337E-02	-0.143E-03
C=0.36 10^{20}	30000.	0.729E-02	-0.678E-03	0.411E-02	-0.274E-03
	50000.	0.799E-02	-0.861E-03	0.440E-02	-0.332E-03
	100000.	0.884E-02	-0.108E-02	0.462E-02	-0.398E-03
	200000.	0.927E-02	-0.129E-02	0.479E-02	-0.472E-03
N II $3s^3P^o$-$4p^3D$	5000.	0.344E-02	0.797E-03	0.221E-02	0.343E-03
1859.2 Å	10000.	0.450E-02	0.122E-02	0.252E-02	0.497E-03
C=0.21 10^{19}	30000.	0.550E-02	0.183E-02	0.290E-02	0.677E-03
	50000.	0.591E-02	0.206E-02	0.296E-02	0.773E-03
	100000.	0.613E-02	0.246E-02	0.312E-02	0.867E-03
	200000.	0.633E-02	0.265E-02	0.318E-02	0.994E-03

Table 2. Continued.

		B III		B IV	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3s^3P^o$-$4p^3P$	5000.	0.351E-02	0.842E-03	0.224E-02	0.359E-03
1844.6 Å	10000.	0.455E-02	0.128E-02	0.255E-02	0.520E-03
C=0.22 10^{19}	30000.	0.559E-02	0.192E-02	0.291E-02	0.700E-03
	50000.	0.593E-02	0.218E-02	0.298E-02	0.785E-03
	100000.	0.619E-02	0.253E-02	0.319E-02	0.900E-03
	200000.	0.642E-02	0.284E-02	0.320E-02	0.103E-02
N II $3s^3P^o$-$4p^3S$	5000.	0.359E-02	0.109E-02	0.226E-02	0.466E-03
1834.0 Å	10000.	0.466E-02	0.165E-02	0.259E-02	0.646E-03
C=0.21 10^{19}	30000.	0.576E-02	0.239E-02	0.296E-02	0.884E-03
	50000.	0.617E-02	0.273E-02	0.311E-02	0.987E-03
	100000.	0.661E-02	0.323E-02	0.317E-02	0.115E-02
	200000.	0.720E-02	0.376E-02	0.316E-02	0.129E-02
N II $2p^{23}P$-$4s^3P^o$	5000.	0.926E-04	0.129E-03	0.427E-04	0.560E-04
508.7 Å	10000.	0.168E-03	0.195E-03	0.696E-04	0.749E-04
C=0.16 10^{18}	30000.	0.277E-03	0.279E-03	0.105E-03	0.100E-03
	50000.	0.327E-03	0.318E-03	0.120E-03	0.113E-03
	100000.	0.396E-03	0.357E-03	0.133E-03	0.131E-03
	200000.	0.453E-03	0.408E-03	0.164E-03	0.150E-03
N II $2p^{23}P$-$3d^3D^o$	5000.	0.454E-04	0.722E-05	0.359E-04	0.363E-05
533.7 Å	10000.	0.725E-04	0.138E-04	0.487E-04	0.618E-05
C=0.44 10^{18}	30000.	0.106E-03	0.261E-04	0.592E-04	0.100E-04
	50000.	0.116E-03	0.308E-04	0.634E-04	0.114E-04
	100000.	0.129E-03	0.370E-04	0.660E-04	0.136E-04
	200000.	0.136E-03	0.446E-04	0.686E-04	0.157E-04
N II $2p^{23}P$-$3d^3P^o$	5000.	0.506E-04	0.139E-04	0.391E-04	0.671E-05
529.7 Å	10000.	0.797E-04	0.253E-04	0.524E-04	0.105E-04
C=0.39 10^{18}	30000.	0.117E-03	0.438E-04	0.638E-04	0.161E-04
	50000.	0.128E-03	0.501E-04	0.680E-04	0.184E-04
	100000.	0.144E-03	0.593E-04	0.720E-04	0.222E-04
	200000.	0.153E-03	0.706E-04	0.739E-04	0.249E-04
N II $3p^3D$-$3d^3F^o$	5000.	0.629E-02	-0.280E-03	0.470E-02	-0.145E-03
5005.9 Å	10000.	0.946E-02	-0.573E-03	0.598E-02	-0.264E-03
C=0.41 10^{20}	30000.	0.129E-01	-0.118E-02	0.720E-02	-0.479E-03
	50000.	0.140E-01	-0.151E-02	0.762E-02	-0.556E-03
	100000.	0.152E-01	-0.181E-02	0.793E-02	-0.670E-03
	200000.	0.158E-01	-0.217E-02	0.801E-02	-0.789E-03
N II $3p^3D$-$3d^3D^o$	5000.	0.602E-02	-0.886E-03	0.447E-02	-0.435E-03
4794.8 Å	10000.	0.904E-02	-0.164E-02	0.566E-02	-0.704E-03
C=0.35 10^{20}	30000.	0.123E-01	-0.296E-02	0.683E-02	-0.109E-02
	50000.	0.134E-01	-0.340E-02	0.718E-02	-0.126E-02
	100000.	0.145E-01	-0.411E-02	0.749E-02	-0.147E-02
	200000.	0.155E-01	-0.477E-02	0.767E-02	-0.170E-02

Table 2. Continued.

		B III		B IV	
TRANSITION	T[K]	W[Å]	d[Å]	W[Å]	d[Å]
N II $3p^3D$-$3d^3P^o$	5000.	0.562E-02	0.715E-04	0.416E-02	0.377E-04
4490.7 Å	10000.	0.836E-02	0.153E-03	0.520E-02	0.749E-04
C=0.28 10^{20}	30000.	0.112E-01	0.381E-03	0.626E-02	0.154E-03
	50000.	0.122E-01	0.489E-03	0.658E-02	0.197E-03
	100000.	0.132E-01	0.649E-03	0.682E-02	0.240E-03
	200000.	0.137E-01	0.777E-03	0.692E-02	0.287E-03
N II $3p^3S$-$3d^3P^o$	5000.	0.730E-02	0.723E-03	0.536E-02	0.362E-03
5002.2 Å	10000.	0.108E-01	0.137E-02	0.666E-02	0.606E-03
C=0.35 10^{20}	30000.	0.145E-01	0.256E-02	0.803E-02	0.961E-03
	50000.	0.157E-01	0.296E-02	0.840E-02	0.111E-02
	100000.	0.170E-01	0.358E-02	0.876E-02	0.132E-02
	200000.	0.178E-01	0.423E-02	0.893E-02	0.154E-02
N II $3p^3P$-$3d^3D^o$	5000.	0.101E-01	-0.144E-02	0.740E-02	-0.704E-03
5940.2 Å	10000.	0.150E-01	-0.265E-02	0.923E-02	-0.113E-02
C=0.54 10^{20}	30000.	0.201E-01	-0.474E-02	0.111E-01	-0.175E-02
	50000.	0.219E-01	-0.544E-02	0.117E-01	-0.202E-02
	100000.	0.238E-01	-0.651E-02	0.121E-01	-0.236E-02
	200000.	0.250E-01	-0.754E-02	0.127E-01	-0.274E-02
N II $3p^3P$-$3d^3P^o$	5000.	0.906E-02	-0.477E-03	0.664E-02	-0.244E-03
5480.3 Å	10000.	0.134E-01	-0.955E-03	0.820E-02	-0.434E-03
C=0.42 10^{20}	30000.	0.177E-01	-0.190E-02	0.987E-02	-0.751E-03
	50000.	0.193E-01	-0.234E-02	0.103E-01	-0.866E-03
	100000.	0.208E-01	-0.281E-02	0.108E-01	-0.103E-02
	200000.	0.214E-01	-0.334E-02	0.109E-01	-0.120E-02
N II $3d^3F^o$-$4p^3D$	5000.	0.416E-01	0.965E-02	0.262E-01	0.411E-02
6169.8 Å	10000.	0.534E-01	0.147E-01	0.299E-01	0.593E-02
C=0.23 10^{20}	30000.	0.653E-01	0.218E-01	0.340E-01	0.802E-02
	50000.	0.691E-01	0.250E-01	0.348E-01	0.902E-02
	100000.	0.725E-01	0.283E-01	0.369E-01	0.104E-01
	200000.	0.737E-01	0.327E-01	0.370E-01	0.118E-01
N II $3d^3D^o$-$4p^3D$	5000.	0.467E-01	0.108E-01	0.294E-01	0.460E-02
6523.6 Å	10000.	0.600E-01	0.164E-01	0.336E-01	0.664E-02
C=0.26 10^{20}	30000.	0.734E-01	0.243E-01	0.382E-01	0.898E-02
	50000.	0.776E-01	0.280E-01	0.391E-01	0.101E-01
	100000.	0.815E-01	0.316E-01	0.414E-01	0.116E-01
	200000.	0.827E-01	0.366E-01	0.416E-01	0.132E-01
N II $3d^3D^o$-$4p^3P$	5000.	0.456E-01	0.109E-01	0.285E-01	0.462E-02
6347.6 Å	10000.	0.583E-01	0.165E-01	0.327E-01	0.661E-02
C=0.26 10^{20}	30000.	0.719E-01	0.242E-01	0.372E-01	0.893E-02
	50000.	0.759E-01	0.277E-01	0.385E-01	0.101E-01
	100000.	0.796E-01	0.317E-01	0.397E-01	0.117E-01
	200000.	0.826E-01	0.363E-01	0.398E-01	0.130E-01

Table 2. Continued.

TRANSITION	T[K]	B III W[Å]	d[Å]	B IV W[Å]	d[Å]
N II $3d^3P^o$-$4p^3D$	5000.	0.572E-01	0.126E-01	0.360E-01	0.537E-02
7185.8 Å	10000.	0.733E-01	0.192E-01	0.411E-01	0.778E-02
C=0.32 10^{20}	30000.	0.896E-01	0.287E-01	0.467E-01	0.105E-01
	50000.	0.945E-01	0.327E-01	0.478E-01	0.118E-01
	100000.	0.983E-01	0.382E-01	0.509E-01	0.135E-01
	200000.	0.102	0.421E-01	0.508E-01	0.154E-01
N II $3d^3P^o$-$4p^3P$	5000.	0.555E-01	0.126E-01	0.347E-01	0.538E-02
6972.8 Å	10000.	0.708E-01	0.192E-01	0.397E-01	0.774E-02
C=0.32 10^{20}	30000.	0.870E-01	0.285E-01	0.450E-01	0.105E-01
	50000.	0.916E-01	0.326E-01	0.465E-01	0.118E-01
	100000.	0.963E-01	0.365E-01	0.485E-01	0.134E-01
	200000.	0.982E-01	0.426E-01	0.483E-01	0.155E-01
N II $3d^3P^o$-$4p^3S$	5000.	0.550E-01	0.156E-01	0.340E-01	0.666E-02
6824.0 Å	10000.	0.700E-01	0.236E-01	0.389E-01	0.922E-02
C=0.29 10^{20}	30000.	0.863E-01	0.340E-01	0.443E-01	0.125E-01
	50000.	0.918E-01	0.388E-01	0.466E-01	0.140E-01
	100000.	0.978E-01	0.454E-01	0.463E-01	0.165E-01
	200000.	0.106	0.530E-01	0.464E-01	0.178E-01

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