

STARK BROADENING PARAMETER TABLES FOR NEUTRAL ZINC  
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**SUMMARY:** Using a semiclassical approach, we have calculated electron-, proton- and He II-impact line widths and shifts for 32 Zn I multiplets as a function of temperature and perturber density

## 1. INTRODUCTION

The neutral zinc spectral lines Stark broadening parameters are of interest for stellar (see *e.g.* Sneden *et al.* 1991) and solar (see *e.g.* Biémont and Godefroid 1980, Grevesse 1984) abundances determination, as well as for plasma analysis modeling and diagnostics. For laboratory plasma diagnostics, modelling and investigation, such data are of interest as well (see Grechikhin 1969, Kusch and Obershelp 1967, Salakhov 1975, Fishman *et al.* 1979, Dimitrijević and Konjević 1983, Lakićević 1983, Rathore *et al.* 1985, Rao *et al.* 1989). Within the semiclassical-perturbation formalism (Sahal–Bréchet 1969ab, see also Sahal - Bréchet 1974, Dimitrijević and Sahal - Bréchet 1984), we have calculated electron-, proton-, and ionized helium-impact line widths and shifts for 32 neutral zinc multiplets, as the continuation of our project to create a large Stark broadening data set for astrophysical and laboratory plasma research purposes.

## 2. RESULTS AND DISCUSSION

The semiclassical perturbation formalism has been reviewed briefly in Dimitrijević and Sahal - Bréchet (1984). All additional details concerning the calculation procedure will be published in Dimitrijević and Sahal–Bréchet (1999).

Atomic energy levels needed for calculations have been taken from Sugar and Musgrove (1995). In table 1, electron-, proton-, and He II-impact broadening parameters for Zn I for perturber densities of  $10^{13}\text{cm}^{-3}$  -  $10^{19}\text{cm}^{-3}$  and temperatures from 2,500 up to 50,000 K, are shown. For perturber density of  $10^{13}\text{cm}^{-3}$ , only data for three multiplets are shown, since other data are linear with density for densities lower than  $10^{14}\text{cm}^{-3}$ . For perturber densities lower than  $10^{13}\text{cm}^{-3}$ , Stark broadening parameters for all tabulated multiplets are linear with perturber density. We also specify a parameter C (Dimitrijević and Sahal–Bréchet 1984), which gives an estimate

**Table 1.** This table shows electron-, proton-, and He II-impact broadening parameters for Zn I for perturber densities of  $10^{13}\text{cm}^{-3}$  -  $10^{19}\text{cm}^{-3}$  and temperatures from 2,500 up to 50,000 K. For perturber density of  $10^{13}\text{cm}^{-3}$ , only data for three multiplets are shown, since other data are linear with density for densities lower than  $10^{14}\text{cm}^{-3}$ . Transitions and averaged wavelengths for the multiplet (in Å) are also given in the table. By dividing C by the corresponding full width at half maximum (Dimitrijević and Sahal–Bréchet 1984), we obtain an estimate for the maximum perturber density for which the line may be treated as isolated and tabulated data may be used. The asterisk identifies cases for which the collision volume multiplied by the perturber density (the condition for validity of the impact approximation) lies between 0.1 and 0.5.

PERTURBER DENSITY = $1.E+13\text{ cm}^{-3}$							
PERTURBERS ARE:	ELECTRONS			PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4F - 5D	2500.	6.72	2.75	1.24	0.987	1.07	0.787
396196.5 Å	5000.	7.91	2.09	1.36	1.11	1.15	0.889
C = 0.40E+19	10000.	9.02	1.60	1.50	1.25	1.25	1.00
	20000.	9.63	0.979	1.67	1.41	1.36	1.13
	30000.	9.87	0.726	1.79	1.51	1.43	1.21
	50000.	9.97	0.360	1.98	1.64	1.54	1.31
4F - 5G	2500.	0.182	-0.294E-01	0.406E-01	-0.359E-01	0.326E-01	-0.286E-01
39372.2 Å	5000.	0.180	-0.112E-01	0.460E-01	-0.408E-01	0.363E-01	-0.325E-01
C = 0.59E+16	10000.	0.172	0.312E-02	0.528E-01	-0.460E-01	0.404E-01	-0.368E-01
	20000.	0.161	0.779E-02	0.622E-01	-0.518E-01	0.452E-01	-0.414E-01
	30000.	0.156	0.114E-01	0.695E-01	-0.557E-01	0.484E-01	-0.444E-01
	50000.	0.149	0.107E-01	0.813E-01	-0.613E-01	0.529E-01	-0.484E-01
5G - 6H	2500.	1.57	-0.823E-01	0.269	-0.231	0.214	-0.184
73670.3 Å	5000.	1.52	-0.420E-02	0.309	-0.263	0.238	-0.210
C = 0.11E+17	10000.	1.42	0.340E-01	0.364	-0.287	0.265	-0.238
	20000.	1.32	0.572E-01	0.447	-0.337	0.297	-0.269
	30000.	1.26	0.547E-01	0.512	-0.365	0.319	-0.288
	50000.	1.20	0.435E-01	0.610	-0.410	0.351	-0.315
PERTURBER DENSITY = $1.E+14\text{ cm}^{-3}$							
4S - 4P	2500.	0.255E-04	0.201E-04	0.120E-04	0.566E-05	0.115E-04	0.452E-05
2139.2 Å	5000.	0.303E-04	0.235E-04	0.123E-04	0.636E-05	0.117E-04	0.509E-05
C = 0.41E+17	10000.	0.350E-04	0.278E-04	0.127E-04	0.715E-05	0.120E-04	0.572E-05
	20000.	0.390E-04	0.290E-04	0.132E-04	0.803E-05	0.123E-04	0.643E-05
	30000.	0.420E-04	0.294E-04	0.136E-04	0.859E-05	0.126E-04	0.688E-05
	50000.	0.467E-04	0.256E-04	0.141E-04	0.936E-05	0.129E-04	0.749E-05
4S - 5P	2500.	0.232E-03	-0.924E-04	0.536E-04	-0.386E-04	0.475E-04	-0.307E-04
1589.6 Å	5000.	0.260E-03	-0.542E-04	0.577E-04	-0.437E-04	0.504E-04	-0.349E-04
C = 0.11E+16	10000.	0.280E-03	-0.278E-04	0.627E-04	-0.493E-04	0.538E-04	-0.394E-04
	20000.	0.286E-03	-0.221E-05	0.688E-04	-0.554E-04	0.578E-04	-0.443E-04
	30000.	0.289E-03	0.944E-05	0.732E-04	-0.594E-04	0.605E-04	-0.475E-04
	50000.	0.295E-03	0.116E-04	0.798E-04	-0.647E-04	0.643E-04	-0.518E-04
4S - 6P	2500.	0.708E-03	-0.387E-03	0.169E-03	-0.126E-03	0.147E-03	-0.100E-03
1457.6 Å	5000.	0.772E-03	-0.260E-03	0.184E-03	-0.144E-03	0.158E-03	-0.115E-03
C = 0.57E+15	10000.	0.866E-03	-0.174E-03	0.201E-03	-0.164E-03	0.170E-03	-0.130E-03
	20000.	0.908E-03	-0.100E-03	0.222E-03	-0.185E-03	0.184E-03	-0.148E-03
	30000.	0.935E-03	-0.623E-04	0.236E-03	-0.198E-03	0.194E-03	-0.158E-03
	50000.	0.964E-03	-0.304E-04	0.258E-03	-0.216E-03	0.207E-03	-0.173E-03
4S - 7P	2500.	0.179E-02	-0.106E-02	0.431E-03	-0.323E-03	0.370E-03	-0.254E-03
1404.1 Å	5000.	0.187E-02	-0.852E-03	0.470E-03	-0.373E-03	0.399E-03	-0.295E-03
C = 0.33E+15	10000.	0.209E-02	-0.548E-03	0.517E-03	-0.425E-03	0.433E-03	-0.338E-03
	20000.	0.220E-02	-0.424E-03	0.572E-03	-0.483E-03	0.472E-03	-0.385E-03
	30000.	0.224E-02	-0.291E-03	0.610E-03	-0.520E-03	0.498E-03	-0.414E-03
	50000.	0.226E-02	-0.185E-03	0.667E-03	-0.567E-03	0.533E-03	-0.454E-03
5S - 5P	2500.	0.190E-01	-0.824E-02	0.430E-02	-0.315E-02	0.379E-02	-0.251E-02
14042.5 Å	5000.	0.205E-01	-0.529E-02	0.464E-02	-0.357E-02	0.403E-02	-0.285E-02
C = 0.89E+17	10000.	0.223E-01	-0.402E-02	0.505E-02	-0.402E-02	0.431E-02	-0.322E-02
	20000.	0.234E-01	-0.245E-02	0.556E-02	-0.453E-02	0.465E-02	-0.362E-02
	30000.	0.244E-01	-0.188E-02	0.591E-02	-0.485E-02	0.487E-02	-0.388E-02
	50000.	0.259E-01	-0.119E-02	0.645E-02	-0.529E-02	0.519E-02	-0.423E-02

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
5S - 6P 7801.5 Å C = 0.16E+17	2500.	0.206E-01	-0.110E-01	0.487E-02	-0.364E-02	0.424E-02	-0.289E-02
	5000.	0.223E-01	-0.751E-02	0.529E-02	-0.416E-02	0.454E-02	-0.330E-02
	10000.	0.250E-01	-0.530E-02	0.579E-02	-0.472E-02	0.489E-02	-0.376E-02
	20000.	0.265E-01	-0.324E-02	0.639E-02	-0.533E-02	0.531E-02	-0.426E-02
	30000.	0.274E-01	-0.231E-02	0.680E-02	-0.571E-02	0.558E-02	-0.457E-02
	50000.	0.286E-01	-0.105E-02	0.742E-02	-0.623E-02	0.596E-02	-0.498E-02
5S - 7P 6481.0 Å C = 0.71E+16	2500.	0.383E-01	-0.227E-01	0.918E-02	-0.689E-02	0.789E-02	-0.541E-02
	5000.	0.401E-01	-0.174E-01	0.100E-01	-0.795E-02	0.851E-02	-0.629E-02
	10000.	0.449E-01	-0.130E-01	0.110E-01	-0.908E-02	0.923E-02	-0.721E-02
	20000.	0.473E-01	-0.853E-02	0.122E-01	-0.103E-01	0.101E-01	-0.821E-02
	30000.	0.481E-01	-0.589E-02	0.130E-01	-0.111E-01	0.106E-01	-0.883E-02
	50000.	0.487E-01	-0.323E-02	0.142E-01	-0.121E-01	0.114E-01	-0.968E-02
6S - 6P 38916.9 Å C = 0.41E+18	2500.	0.543	-0.323	0.125	-0.948E-01	0.108	-0.750E-01
	5000.	0.575	-0.257	0.136	-0.108	0.116	-0.860E-01
	10000.	0.659	-0.197	0.149	-0.123	0.126	-0.978E-01
	20000.	0.732	-0.144	0.165	-0.139	0.137	-0.111
	30000.	0.775	-0.107	0.176	-0.149	0.144	-0.119
	50000.	0.825	-0.687E-01	0.192	-0.162	0.154	-0.130
6S - 7P 19300.0 Å C = 0.63E+17	2500.	0.346	-0.204	0.820E-01	-0.617E-01	0.704E-01	-0.484E-01
	5000.	0.363	-0.167	0.896E-01	-0.712E-01	0.760E-01	-0.563E-01
	10000.	0.408	-0.122	0.985E-01	-0.813E-01	0.825E-01	-0.646E-01
	20000.	0.438	-0.773E-01	0.109	-0.922E-01	0.900E-01	-0.735E-01
	30000.	0.449	-0.534E-01	0.116	-0.992E-01	0.949E-01	-0.791E-01
	50000.	0.460	-0.242E-01	0.127	-0.108	0.102	-0.866E-01
7S - 7P 82284.9 Å C = 0.11E+19	2500.	6.82	-4.29	1.53	-1.16	1.31	-0.913
	5000.	7.32	-3.68	1.68	-1.34	1.42	-1.06
	10000.	8.25	-2.61	1.85	-1.53	1.54	-1.22
	20000.	9.17	-1.81	2.05	-1.74	1.68	-1.39
	30000.	9.58	-1.33	2.19	-1.87	1.78	-1.49
	50000.	9.99	-0.888	2.39	-2.04	1.91	-1.64
4P - 5S 11057.3 Å C = 0.87E+18	2500.	0.264E-02	0.171E-02	0.577E-03	0.482E-03	0.489E-03	0.385E-03
	5000.	0.301E-02	0.197E-02	0.634E-03	0.543E-03	0.532E-03	0.434E-03
	10000.	0.344E-02	0.232E-02	0.699E-03	0.611E-03	0.581E-03	0.489E-03
	20000.	0.388E-02	0.261E-02	0.773E-03	0.687E-03	0.638E-03	0.550E-03
	30000.	0.420E-02	0.260E-02	0.821E-03	0.735E-03	0.676E-03	0.588E-03
	50000.	0.471E-02	0.251E-02	0.887E-03	0.801E-03	0.727E-03	0.641E-03
4P - 6S 5183.4 Å C = 0.69E+17	2500.	0.245E-02	0.172E-02	0.514E-03	0.473E-03	0.413E-03	0.376E-03
	5000.	0.290E-02	0.203E-02	0.576E-03	0.536E-03	0.463E-03	0.427E-03
	10000.	0.334E-02	0.237E-02	0.646E-03	0.604E-03	0.518E-03	0.483E-03
	20000.	0.375E-02	0.246E-02	0.725E-03	0.680E-03	0.581E-03	0.544E-03
	30000.	0.410E-02	0.244E-02	0.775E-03	0.729E-03	0.621E-03	0.583E-03
	50000.	0.454E-02	0.213E-02	0.844E-03	0.795E-03	0.676E-03	0.636E-03
4P - 7S 4299.5 Å C = 0.22E+17	2500.	0.484E-02	0.333E-02	0.975E-03	0.888E-03	0.781E-03	0.704E-03
	5000.	0.581E-02	0.393E-02	0.109E-02	0.101E-02	0.876E-03	0.805E-03
	10000.	0.676E-02	0.441E-02	0.123E-02	0.115E-02	0.984E-03	0.914E-03
	20000.	0.790E-02	0.437E-02	0.138E-02	0.129E-02	0.110E-02	0.103E-02
	30000.	0.880E-02	0.403E-02	0.148E-02	0.139E-02	0.118E-02	0.111E-02
	50000.	0.101E-01	0.348E-02	0.161E-02	0.151E-02	0.129E-02	0.121E-02
4P - 8S 3966.6 Å C = 0.11E+17	2500.	0.951E-02	0.625E-02	0.181E-02	0.162E-02	0.145E-02	0.128E-02
	5000.	0.115E-01	0.739E-02	0.203E-02	0.185E-02	0.162E-02	0.147E-02
	10000.	0.137E-01	0.770E-02	0.228E-02	0.211E-02	0.182E-02	0.168E-02
	20000.	0.168E-01	0.722E-02	0.256E-02	0.239E-02	0.205E-02	0.191E-02
	30000.	0.190E-01	0.630E-02	0.274E-02	0.257E-02	0.219E-02	0.205E-02
	50000.	0.223E-01	0.519E-02	0.298E-02	0.280E-02	0.238E-02	0.224E-02
4P - 9S 3800.1 Å C = 0.59E+16	2500.	0.174E-01	0.108E-01	0.307E-02	0.269E-02	0.246E-02	0.211E-02
	5000.	0.214E-01	0.122E-01	0.345E-02	0.311E-02	0.276E-02	0.246E-02
	10000.	0.264E-01	0.124E-01	0.387E-02	0.356E-02	0.310E-02	0.283E-02
	20000.	0.338E-01	0.107E-01	0.435E-02	0.404E-02	0.348E-02	0.322E-02
	30000.	0.388E-01	0.904E-02	0.466E-02	0.435E-02	0.373E-02	0.347E-02
	50000.	0.453E-01	0.706E-02	0.507E-02	0.476E-02	0.406E-02	0.380E-02

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
5P - 6S 31977.2 Å C = 0.46E+18	2500.	0.178	0.100	0.327E-01	0.274E-01	0.273E-01	0.218E-01
	5000.	0.197	0.109	0.361E-01	0.311E-01	0.299E-01	0.248E-01
	10000.	0.215	0.115	0.400E-01	0.352E-01	0.329E-01	0.281E-01
	20000.	0.233	0.111	0.446E-01	0.396E-01	0.363E-01	0.316E-01
	30000.	0.247	0.104	0.477E-01	0.424E-01	0.385E-01	0.339E-01
	50000.	0.268	0.888E-01	0.522E-01	0.463E-01	0.415E-01	0.370E-01
5P - 7S 14097.9 Å C = 0.90E+17	2500.	0.683E-01	0.409E-01	0.121E-01	0.108E-01	0.982E-02	0.853E-02
	5000.	0.801E-01	0.478E-01	0.136E-01	0.123E-01	0.109E-01	0.976E-02
	10000.	0.907E-01	0.521E-01	0.152E-01	0.139E-01	0.122E-01	0.111E-01
	20000.	0.104	0.517E-01	0.170E-01	0.157E-01	0.137E-01	0.126E-01
	30000.	0.113	0.469E-01	0.182E-01	0.168E-01	0.146E-01	0.135E-01
	50000.	0.128	0.402E-01	0.199E-01	0.184E-01	0.158E-01	0.147E-01
5P - 8S 11054.9 Å C = 0.55E+17	2500.	0.839E-01	0.511E-01	0.148E-01	0.131E-01	0.119E-01	0.104E-01
	5000.	0.101	0.597E-01	0.166E-01	0.151E-01	0.133E-01	0.120E-01
	10000.	0.118	0.635E-01	0.186E-01	0.172E-01	0.149E-01	0.137E-01
	20000.	0.143	0.587E-01	0.209E-01	0.194E-01	0.167E-01	0.155E-01
	30000.	0.160	0.523E-01	0.224E-01	0.209E-01	0.179E-01	0.167E-01
	50000.	0.185	0.419E-01	0.244E-01	0.228E-01	0.195E-01	0.182E-01
5P - 9S 9852.0 Å C = 0.40E+17	2500.	0.125	0.738E-01	0.212E-01	0.185E-01	0.170E-01	0.145E-01
	5000.	0.153	0.848E-01	0.238E-01	0.215E-01	0.191E-01	0.170E-01
	10000.	0.188	0.844E-01	0.268E-01	0.245E-01	0.214E-01	0.195E-01
	20000.	0.237	0.739E-01	0.301E-01	0.279E-01	0.240E-01	0.222E-01
	30000.	0.271	0.624E-01	0.322E-01	0.300E-01	0.257E-01	0.239E-01
	50000.	0.315	0.479E-01	0.351E-01	0.328E-01	0.280E-01	0.262E-01
6P - 7S 71609.1 Å C = 0.14E+19	2500.	2.92	1.69	0.547	0.447	0.459	0.353
	5000.	3.29	1.81	0.604	0.511	0.502	0.406
	10000.	3.66	1.80	0.670	0.581	0.551	0.463
	20000.	4.11	1.60	0.746	0.658	0.607	0.525
	30000.	4.41	1.40	0.797	0.705	0.644	0.564
	50000.	4.86	1.13	0.871	0.770	0.694	0.615
6P - 8S 29860.1 Å C = 0.24E+18	2500.	0.811	0.464	0.139	0.118	0.113	0.927E-01
	5000.	0.955	0.523	0.154	0.135	0.126	0.107
	10000.	1.10	0.527	0.172	0.154	0.140	0.123
	20000.	1.29	0.482	0.193	0.175	0.155	0.139
	30000.	1.43	0.418	0.207	0.188	0.166	0.150
	50000.	1.63	0.338	0.226	0.205	0.179	0.164
6P - 9S 22454.8 Å C = 0.14E+18	2500.	0.760	0.431	0.123	0.106	0.995E-01	0.827E-01
	5000.	0.925	0.491	0.138	0.122	0.111	0.967E-01
	10000.	1.12	0.471	0.155	0.140	0.124	0.111
	20000.	1.38	0.408	0.174	0.159	0.139	0.127
	30000.	1.56	0.333	0.186	0.171	0.149	0.136
	50000.	1.79	0.262	0.203	0.187	0.161	0.150
7P - 8S 135650.2 Å C = 0.31E+19	2500.	22.6	13.6	4.48	*3.47	*3.80	2.72
	5000.	25.2	12.6	4.93	4.01	4.13	3.17
	10000.	28.6	10.5	5.44	4.59	4.51	3.64
	20000.	32.9	7.36	6.05	5.21	4.95	4.15
	30000.	35.3	5.74	6.46	5.61	5.24	4.47
	50000.	37.5	4.13	7.06	6.13	5.63	4.90
7P - 9S 54299.7 Å C = 0.50E+18	2500.	4.81	2.71	0.828	0.658	*0.692	*0.515
	5000.	5.58	2.67	0.915	0.763	0.758	0.603
	10000.	6.57	2.28	1.02	0.874	0.834	0.694
	20000.	7.84	1.58	1.13	0.994	0.920	0.791
	30000.	8.59	1.29	1.21	1.07	0.977	0.852
	50000.	9.28	0.897	1.32	1.17	1.05	0.935
4P - 5S 4767.4 Å C = 0.17E+18	2500.	0.272E-03	0.220E-03	0.684E-04	0.619E-04	0.559E-04	0.495E-04
	5000.	0.321E-03	0.255E-03	0.762E-04	0.697E-04	0.620E-04	0.558E-04
	10000.	0.371E-03	0.301E-03	0.851E-04	0.784E-04	0.690E-04	0.627E-04
	20000.	0.408E-03	0.339E-03	0.950E-04	0.882E-04	0.769E-04	0.705E-04
	30000.	0.425E-03	0.331E-03	0.101E-03	0.943E-04	0.819E-04	0.755E-04
	50000.	0.454E-03	0.324E-03	0.110E-03	0.103E-03	0.889E-04	0.822E-04

PERTURBERS ARE: TRANSITION		ELECTRONS		PROTONS		IONIZED HELIUM	
	T(K)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4P - 6S 3054.7 Å C = 0.25E+17	2500.	0.582E-03	0.423E-03	0.125E-03	0.116E-03	0.100E-03	0.926E-04
	5000.	0.676E-03	0.497E-03	0.141E-03	0.132E-03	0.113E-03	0.105E-03
	10000.	0.752E-03	0.590E-03	0.158E-03	0.148E-03	0.126E-03	0.118E-03
	20000.	0.809E-03	0.575E-03	0.177E-03	0.167E-03	0.142E-03	0.133E-03
	30000.	0.857E-03	0.565E-03	0.190E-03	0.179E-03	0.152E-03	0.143E-03
	50000.	0.920E-03	0.488E-03	0.206E-03	0.195E-03	0.165E-03	0.156E-03
4P - 4D 3324.8 Å C = 0.16E+17	2500.	0.398E-03	-0.159E-03	0.103E-03	-0.511E-04	0.985E-04	-0.408E-04
	5000.	0.424E-03	-0.120E-03	0.106E-03	-0.575E-04	0.100E-03	-0.460E-04
	10000.	0.488E-03	-0.515E-04	0.110E-03	-0.647E-04	0.103E-03	-0.518E-04
	20000.	0.543E-03	-0.301E-05	0.116E-03	-0.728E-04	0.106E-03	-0.582E-04
	30000.	0.567E-03	0.234E-04	0.120E-03	-0.779E-04	0.109E-03	-0.623E-04
	50000.	0.595E-03	0.375E-04	0.125E-03	-0.848E-04	0.112E-03	-0.679E-04
4P - 5D 2786.7 Å C = 0.20E+16	2500.	0.190E-02	0.763E-03	0.412E-03	0.301E-03	0.362E-03	0.239E-03
	5000.	0.244E-02	0.727E-03	0.446E-03	0.343E-03	0.386E-03	0.273E-03
	10000.	0.285E-02	0.643E-03	0.487E-03	0.388E-03	0.414E-03	0.310E-03
	20000.	0.314E-02	0.546E-03	0.538E-03	0.438E-03	0.446E-03	0.350E-03
	30000.	0.322E-02	0.479E-03	0.574E-03	0.469E-03	0.468E-03	0.375E-03
	50000.	0.325E-02	0.373E-03	0.631E-03	0.511E-03	0.499E-03	0.409E-03
4D - 4F 16501.0 Å C = 0.69E+17	2500.	0.640E-01	-0.219E-01	0.132E-01	-0.103E-01	0.114E-01	-0.814E-02
	5000.	0.727E-01	-0.135E-01	0.144E-01	-0.117E-01	0.122E-01	-0.928E-02
	10000.	0.765E-01	-0.629E-02	0.159E-01	-0.132E-01	0.133E-01	-0.105E-01
	20000.	0.779E-01	0.507E-03	0.177E-01	-0.149E-01	0.144E-01	-0.119E-01
	30000.	0.780E-01	0.212E-02	0.190E-01	-0.159E-01	0.152E-01	-0.127E-01
	50000.	0.784E-01	0.313E-02	0.209E-01	-0.174E-01	0.163E-01	-0.139E-01
4F - 5G 39372.2 Å C = 0.59E+17	2500.	1.82	-0.276	0.406	-0.339	*0.325	-0.265
	5000.	1.80	-0.104	0.459	-0.393	0.362	-0.310
	10000.	1.72	0.324E-01	0.528	-0.450	0.404	-0.357
	20000.	1.61	0.779E-01	0.622	-0.511	0.452	-0.407
	30000.	1.56	0.114	0.696	-0.551	0.484	-0.438
	50000.	1.49	0.107	0.813	-0.610	0.529	-0.480
5G - 6H 73670.3 Å C = 0.11E+18	2500.	15.7	-0.704	*2.69	-2.13	*2.14	-1.65
	5000.	15.2	-0.254E-01	*3.09	-2.50	*2.38	-1.97
	10000.	14.2	0.351	3.64	-2.79	*2.65	-2.29
	20000.	13.1	0.572	4.47	-3.31	*2.97	-2.62
	30000.	12.6	0.547	5.12	-3.60	3.19	-2.83
	50000.	12.0	0.435	6.10	-4.06	3.51	-3.11
PERTURBER DENSITY = 1.E+15 cm <sup>-3</sup>							
4S - 4P 2139.2 Å C = 0.41E+18	2500.	0.255E-03	0.200E-03	0.120E-03	0.559E-04	0.115E-03	0.445E-04
	5000.	0.303E-03	0.234E-03	0.123E-03	0.633E-04	0.117E-03	0.505E-04
	10000.	0.350E-03	0.277E-03	0.127E-03	0.712E-04	0.120E-03	0.569E-04
	20000.	0.390E-03	0.290E-03	0.132E-03	0.801E-04	0.123E-03	0.641E-04
	30000.	0.420E-03	0.294E-03	0.136E-03	0.858E-04	0.126E-03	0.686E-04
	50000.	0.467E-03	0.256E-03	0.141E-03	0.935E-04	0.129E-03	0.748E-04
4S - 5P 1589.6 Å C = 0.11E+17	2500.	0.232E-02	-0.909E-03	0.535E-03	-0.368E-03	0.474E-03	-0.289E-03
	5000.	0.260E-02	-0.534E-03	0.577E-03	-0.424E-03	0.503E-03	-0.336E-03
	10000.	0.280E-02	-0.273E-03	0.627E-03	-0.483E-03	0.537E-03	-0.384E-03
	20000.	0.286E-02	-0.209E-04	0.688E-03	-0.549E-03	0.578E-03	-0.437E-03
	30000.	0.289E-02	0.947E-04	0.732E-03	-0.590E-03	0.605E-03	-0.470E-03
	50000.	0.295E-02	0.116E-03	0.798E-03	-0.643E-03	0.643E-03	-0.514E-03
4S - 6P 1457.6 Å C = 0.57E+16	2500.	0.708E-02	-0.375E-02	0.169E-02	-0.115E-02	*0.146E-02	-0.882E-03
	5000.	0.772E-02	-0.252E-02	0.184E-02	-0.136E-02	*0.157E-02	-0.106E-02
	10000.	0.866E-02	-0.171E-02	0.201E-02	-0.158E-02	0.170E-02	-0.124E-02
	20000.	0.908E-02	-0.990E-03	0.222E-02	-0.180E-02	0.184E-02	-0.143E-02
	30000.	0.935E-02	-0.620E-03	0.236E-02	-0.195E-02	0.194E-02	-0.155E-02
	50000.	0.964E-02	-0.304E-03	0.258E-02	-0.214E-02	0.207E-02	-0.170E-02
4S - 7P 1404.1 Å C = 0.33E+16	2500.	0.179E-01	-0.101E-01	*0.427E-02	-0.270E-02		
	5000.	0.187E-01	-0.817E-02	*0.469E-02	-0.335E-02		
	10000.	0.209E-01	-0.544E-02	*0.516E-02	-0.399E-02	*0.432E-02	-0.312E-02
	20000.	0.220E-01	-0.417E-02	*0.572E-02	-0.464E-02	*0.472E-02	-0.366E-02
	30000.	0.224E-01	-0.290E-02	*0.610E-02	-0.503E-02	*0.498E-02	-0.398E-02
	50000.	0.226E-01	-0.184E-02	0.666E-02	-0.555E-02	*0.533E-02	-0.441E-02

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
5S - 5P 14042.5 Å C = 0.89E+18	2500.	0.190	-0.810E-01	0.429E-01	-0.300E-01	0.378E-01	-0.236E-01
	5000.	0.205	-0.528E-01	0.464E-01	-0.346E-01	0.403E-01	-0.274E-01
	10000.	0.223	-0.399E-01	0.505E-01	-0.395E-01	0.431E-01	-0.314E-01
	20000.	0.234	-0.245E-01	0.556E-01	-0.448E-01	0.465E-01	-0.357E-01
	30000.	0.244	-0.188E-01	0.591E-01	-0.482E-01	0.487E-01	-0.384E-01
	50000.	0.259	-0.119E-01	0.645E-01	-0.526E-01	0.519E-01	-0.420E-01
5S - 6P 7801.5 Å C = 0.16E+18	2500.	0.206	-0.106	0.485E-01	-0.330E-01	*0.421E-01	-0.254E-01
	5000.	0.223	-0.735E-01	0.528E-01	-0.391E-01	*0.453E-01	-0.306E-01
	10000.	0.250	-0.527E-01	0.578E-01	-0.454E-01	0.489E-01	-0.358E-01
	20000.	0.265	-0.324E-01	0.639E-01	-0.520E-01	0.530E-01	-0.413E-01
	30000.	0.274	-0.230E-01	0.680E-01	-0.561E-01	0.558E-01	-0.446E-01
	50000.	0.286	-0.105E-01	0.742E-01	-0.616E-01	0.596E-01	-0.490E-01
5S - 7P 6481.0 Å C = 0.71E+17	2500.	0.383	-0.215	*0.910E-01	-0.576E-01		
	5000.	0.401	-0.173	*0.100E+00	-0.715E-01		
	10000.	0.449	-0.127	*0.110	-0.851E-01	*0.921E-01	-0.665E-01
	20000.	0.473	-0.848E-01	*0.122	-0.990E-01	*0.101	-0.781E-01
	30000.	0.481	-0.585E-01	*0.130	-0.107	*0.106	-0.850E-01
	50000.	0.487	-0.321E-01	0.142	-0.118	*0.114	-0.940E-01
6S - 6P 38916.9 Å C = 0.41E+19	2500.	5.43	-3.14	1.25	-0.856	*1.07	-0.659
	5000.	5.75	-2.52	1.36	-1.02	*1.16	-0.795
	10000.	6.59	-1.96	1.49	-1.18	1.25	-0.932
	20000.	7.32	-1.44	1.65	-1.35	1.36	-1.07
	30000.	7.75	-1.07	1.76	-1.46	1.44	-1.16
	50000.	8.25	-0.687	1.92	-1.60	1.54	-1.28
6S - 7P 19300.0 Å C = 0.63E+18	2500.	3.46	-1.95	*0.813	-0.515		
	5000.	3.63	-1.64	*0.893	-0.640		
	10000.	4.08	-1.22	*0.984	-0.762	*0.823	-0.595
	20000.	4.38	-0.773	*1.09	-0.886	*0.899	-0.699
	30000.	4.49	-0.534	*1.16	-0.961	*0.948	-0.761
	50000.	4.60	-0.242	1.27	-1.06	*1.02	-0.842
4P - 5S 11057.3 Å C = 0.87E+19	2500.	0.264E-01	0.170E-01	0.577E-02	0.471E-02	0.489E-02	0.374E-02
	5000.	0.301E-01	0.197E-01	0.634E-02	0.535E-02	0.532E-02	0.426E-02
	10000.	0.344E-01	0.232E-01	0.699E-02	0.607E-02	0.581E-02	0.483E-02
	20000.	0.388E-01	0.261E-01	0.773E-02	0.683E-02	0.638E-02	0.546E-02
	30000.	0.420E-01	0.260E-01	0.821E-02	0.732E-02	0.676E-02	0.585E-02
	50000.	0.471E-01	0.251E-01	0.887E-02	0.799E-02	0.727E-02	0.639E-02
4P - 6S 5183.4 Å C = 0.69E+18	2500.	0.245E-01	0.169E-01	0.514E-02	0.449E-02	0.413E-02	0.353E-02
	5000.	0.290E-01	0.201E-01	0.576E-02	0.519E-02	0.462E-02	0.410E-02
	10000.	0.334E-01	0.237E-01	0.646E-02	0.592E-02	0.518E-02	0.471E-02
	20000.	0.375E-01	0.246E-01	0.725E-02	0.672E-02	0.581E-02	0.535E-02
	30000.	0.410E-01	0.244E-01	0.775E-02	0.723E-02	0.621E-02	0.576E-02
	50000.	0.454E-01	0.213E-01	0.844E-02	0.789E-02	0.676E-02	0.631E-02
4P - 7S 4299.5 Å C = 0.22E+18	2500.	0.483E-01	0.325E-01	0.975E-02	0.814E-02	0.781E-02	0.630E-02
	5000.	0.581E-01	0.389E-01	0.109E-01	0.959E-02	0.876E-02	0.752E-02
	10000.	0.676E-01	0.439E-01	0.123E-01	0.111E-01	0.983E-02	0.876E-02
	20000.	0.790E-01	0.437E-01	0.138E-01	0.127E-01	0.110E-01	0.101E-01
	30000.	0.880E-01	0.403E-01	0.148E-01	0.136E-01	0.118E-01	0.109E-01
	50000.	0.101	0.348E-01	0.161E-01	0.150E-01	0.129E-01	0.119E-01
4P - 8S 3966.6 Å C = 0.11E+18	2500.	0.951E-01	0.605E-01	*0.181E-01	*0.141E-01	*0.145E-01	*0.107E-01
	5000.	0.115	0.731E-01	*0.203E-01	*0.171E-01	*0.162E-01	*0.133E-01
	10000.	0.137	0.765E-01	0.228E-01	0.201E-01	*0.182E-01	*0.158E-01
	20000.	0.168	0.721E-01	0.256E-01	0.232E-01	*0.205E-01	*0.183E-01
	30000.	0.190	0.629E-01	0.274E-01	0.250E-01	0.219E-01	0.199E-01
	50000.	0.223	0.518E-01	0.298E-01	0.275E-01	0.238E-01	0.219E-01
4P - 9S 3800.1 Å C = 0.59E+17	2500.	0.174	0.104	*0.307E-01	*0.222E-01		
	5000.	0.214	0.119	*0.345E-01	*0.278E-01		
	10000.	0.264	0.124	*0.387E-01	*0.332E-01	*0.310E-01	*0.259E-01
	20000.	0.338	0.107	*0.435E-01	*0.387E-01	*0.348E-01	*0.305E-01
	30000.	0.388	0.902E-01	*0.465E-01	*0.421E-01	*0.372E-01	*0.333E-01
	50000.	0.453	0.706E-01	0.507E-01	0.464E-01	*0.406E-01	*0.369E-01

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
5P - 6S 31977.2 Å C = 0.46E+19	2500.	1.78	0.986	0.326	0.257	0.273	0.201
	5000.	1.97	1.08	0.361	0.299	0.299	0.236
	10000.	2.15	1.14	0.400	0.343	0.329	0.272
	20000.	2.33	1.10	0.446	0.390	0.362	0.310
	30000.	2.47	1.03	0.477	0.420	0.385	0.334
	50000.	2.68	0.888	0.522	0.460	0.415	0.367
5P - 7S 14097.9 Å C = 0.90E+18	2500.	0.683	0.400	0.121	0.980E-01	*0.981E-01	*0.757E-01
	5000.	0.801	0.474	0.136	0.116	0.109	0.908E-01
	10000.	0.907	0.519	0.152	0.134	0.122	0.106
	20000.	1.04	0.517	0.170	0.154	0.136	0.122
	30000.	1.13	0.469	0.182	0.166	0.146	0.132
	50000.	1.28	0.402	0.199	0.182	0.158	0.145
5P - 8S 11054.9 Å C = 0.55E+18	2500.	0.838	0.497	*0.148	*0.114	*0.119	*0.866E-01
	5000.	1.01	0.590	*0.166	*0.139	*0.133	*0.108
	10000.	1.18	0.634	0.186	0.163	*0.149	*0.128
	20000.	1.43	0.586	0.209	0.188	*0.167	*0.149
	30000.	1.60	0.522	0.224	0.204	0.179	0.161
	50000.	1.85	0.419	0.244	0.224	0.195	0.178
5P - 9S 9852.0 Å C = 0.40E+18	2500.	1.25	0.705	*0.212	*0.152		
	5000.	1.53	0.837	*0.238	*0.191		
	10000.	1.88	0.836	*0.267	*0.229	*0.214	*0.178
	20000.	2.37	0.738	*0.300	*0.267	*0.240	*0.210
	30000.	2.71	0.624	*0.322	*0.290	*0.257	*0.229
	50000.	3.15	0.478	0.351	0.320	*0.280	*0.254
6P - 8S 29860.1 Å C = 0.24E+19	2500.	8.11	4.55	*1.38	*1.01		
	5000.	9.55	5.16	*1.54	*1.23	*1.25	*0.953
	10000.	11.0	5.26	*1.72	*1.46	*1.39	*1.14
	20000.	12.9	4.81	1.93	1.69	*1.55	*1.33
	30000.	14.3	4.18	2.07	1.83	*1.65	*1.45
	50000.	16.3	3.38	2.26	2.01	*1.79	*1.60
6P - 9S 22454.8 Å C = 0.14E+19	2500.	7.60	4.20	*1.23	*0.858		
	5000.	9.25	4.89	*1.38	*1.08		
	10000.	11.2	4.66	*1.55	*1.30	*1.24	*1.01
	20000.	13.8	4.07	*1.74	*1.52	*1.39	*1.20
	30000.	15.6	3.33	*1.86	*1.65	*1.48	*1.31
	50000.	17.9	2.62	*2.03	*1.83	*1.61	*1.45
4P - 5S 4767.4 Å C = 0.17E+19	2500.	0.272E-02	0.219E-02	0.684E-03	0.607E-03	0.558E-03	0.483E-03
	5000.	0.321E-02	0.254E-02	0.763E-03	0.689E-03	0.620E-03	0.549E-03
	10000.	0.371E-02	0.301E-02	0.851E-03	0.779E-03	0.690E-03	0.622E-03
	20000.	0.408E-02	0.339E-02	0.950E-03	0.877E-03	0.769E-03	0.701E-03
	30000.	0.425E-02	0.331E-02	0.101E-02	0.940E-03	0.819E-03	0.752E-03
	50000.	0.454E-02	0.324E-02	0.110E-02	0.103E-02	0.889E-03	0.820E-03
4P - 6S 3054.7 Å C = 0.25E+18	2500.	0.582E-02	0.419E-02	0.125E-02	0.111E-02	0.100E-02	0.878E-03
	5000.	0.676E-02	0.494E-02	0.141E-02	0.128E-02	0.113E-02	0.101E-02
	10000.	0.752E-02	0.590E-02	0.158E-02	0.146E-02	0.126E-02	0.116E-02
	20000.	0.809E-02	0.574E-02	0.177E-02	0.165E-02	0.142E-02	0.132E-02
	30000.	0.857E-02	0.565E-02	0.190E-02	0.177E-02	0.152E-02	0.142E-02
	50000.	0.920E-02	0.488E-02	0.206E-02	0.194E-02	0.165E-02	0.155E-02
4P - 4D 3324.8 Å C = 0.16E+18	2500.	0.398E-02	-0.158E-02	0.103E-02	-0.497E-03	0.984E-03	-0.394E-03
	5000.	0.424E-02	-0.119E-02	0.106E-02	-0.566E-03	0.100E-02	-0.450E-03
	10000.	0.488E-02	-0.513E-03	0.110E-02	-0.642E-03	0.103E-02	-0.511E-03
	20000.	0.543E-02	-0.301E-04	0.116E-02	-0.723E-03	0.106E-02	-0.578E-03
	30000.	0.567E-02	0.234E-03	0.120E-02	-0.775E-03	0.109E-02	-0.620E-03
	50000.	0.595E-02	0.375E-03	0.125E-02	-0.846E-03	0.112E-02	-0.676E-03
4P - 5D 2786.7 Å C = 0.20E+17	2500.	0.190E-01	0.741E-02	0.411E-02	0.279E-02	*0.360E-02	*0.217E-02
	5000.	0.244E-01	0.712E-02	0.445E-02	0.327E-02	0.385E-02	0.257E-02
	10000.	0.285E-01	0.641E-02	0.487E-02	0.376E-02	0.413E-02	0.298E-02
	20000.	0.314E-01	0.543E-02	0.538E-02	0.429E-02	0.446E-02	0.341E-02
	30000.	0.322E-01	0.478E-02	0.574E-02	0.462E-02	0.468E-02	0.368E-02
	50000.	0.325E-01	0.373E-02	0.631E-02	0.507E-02	0.499E-02	0.404E-02

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4D - 4F 16501.0 Å C = 0.69E+18	2500.	0.640	-0.214	0.132	-0.950E-01	0.113	-0.738E-01
	5000.	0.727	-0.130	0.144	-0.111	0.122	-0.874E-01
	10000.	0.765	-0.610E-01	0.159	-0.128	0.132	-0.101
	20000.	0.779	0.540E-02	0.177	-0.146	0.144	-0.116
	30000.	0.780	0.215E-01	0.190	-0.157	0.152	-0.125
	50000.	0.784	0.314E-01	0.209	-0.172	0.163	-0.137
4F - 5D 396196.5 Å C = 0.40E+21	2500.	672.	271.	124.	86.6	*106.	*66.6
	5000.	791.	206.	136.	103.	*115.	*80.3
	10000.	902.	160.	150.	119.	125.	94.1
	20000.	963.	97.7	167.	137.	136.	108.
	30000.	987.	72.6	179.	147.	143.	117.
	50000.	997.	36.0	199.	162.	154.	129.
4F - 5G 39372.2 Å C = 0.59E+18	2500.	18.1	-2.06				
	5000.	17.9	-0.668	*4.59	-3.47		
	10000.	17.1	0.424	*5.27	-4.17		
	20000.	16.0	0.779	*6.22	-4.88	*4.52	-3.84
	30000.	15.5	1.17	*6.95	-5.32	*4.84	-4.19
	50000.	14.9	1.07	*8.12	-5.94	*5.29	-4.65
PERTURBER DENSITY = 1.E+16 cm <sup>-3</sup>							
4S - 4P 2139.2 Å C = 0.41E+19	2500.	0.255E-02	0.198E-02	0.119E-02	0.536E-03	0.115E-02	0.422E-03
	5000.	0.303E-02	0.233E-02	0.123E-02	0.615E-03	0.117E-02	0.488E-03
	10000.	0.350E-02	0.277E-02	0.127E-02	0.700E-03	0.120E-02	0.557E-03
	20000.	0.390E-02	0.289E-02	0.132E-02	0.794E-03	0.123E-02	0.633E-03
	30000.	0.420E-02	0.294E-02	0.136E-02	0.852E-03	0.126E-02	0.681E-03
	50000.	0.467E-02	0.256E-02	0.141E-02	0.930E-03	0.129E-02	0.744E-03
4S - 5P 1589.6 Å C = 0.11E+18	2500.	0.232E-01	-0.853E-02	*0.529E-02	-0.312E-02	*0.462E-02	-0.233E-02
	5000.	0.260E-01	-0.499E-02	0.574E-02	-0.384E-02	*0.499E-02	-0.296E-02
	10000.	0.280E-01	-0.247E-02	0.626E-02	-0.455E-02	*0.536E-02	-0.356E-02
	20000.	0.286E-01	-0.101E-03	0.688E-02	-0.528E-02	0.577E-02	-0.417E-02
	30000.	0.289E-01	0.968E-03	0.732E-02	-0.572E-02	0.604E-02	-0.454E-02
	50000.	0.295E-01	0.117E-02	0.798E-02	-0.631E-02	0.642E-02	-0.501E-02
4S - 6P 1457.6 Å C = 0.57E+17	2500.	0.708E-01	-0.332E-01				
	5000.	0.772E-01	-0.226E-01				
	10000.	0.866E-01	-0.157E-01	*0.200E-01	-0.139E-01		
	20000.	0.908E-01	-0.921E-02	*0.222E-01	-0.167E-01		
	30000.	0.935E-01	-0.605E-02	*0.236E-01	-0.184E-01	*0.194E-01	-0.144E-01
	50000.	0.964E-01	-0.304E-02	*0.258E-01	-0.205E-01	*0.207E-01	-0.162E-01
4S - 7P 1404.1 Å C = 0.33E+17	2500.	*0.178	-0.831E-01				
	5000.	0.187	-0.692E-01				
	10000.	0.209	-0.511E-01				
	20000.	0.220	-0.386E-01				
	30000.	0.223	-0.283E-01				
	50000.	0.225	-0.179E-01				
5S - 5P 14042.5 Å C = 0.89E+19	2500.	1.90	-0.763	*0.425	-0.253	*0.369	-0.189
	5000.	2.05	-0.496	0.462	-0.313	*0.399	-0.241
	10000.	2.23	-0.381	0.504	-0.371	*0.430	-0.290
	20000.	2.34	-0.239	0.555	-0.431	0.464	-0.340
	30000.	2.44	-0.188	0.591	-0.467	0.487	-0.370
	50000.	2.59	-0.118	0.645	-0.515	0.518	-0.409
5S - 6P 7801.5 Å C = 0.16E+19	2500.	2.06	-0.954				
	5000.	2.23	-0.656				
	10000.	2.50	-0.480	*0.576	-0.400		
	20000.	2.65	-0.312	*0.638	-0.482		
	30000.	2.74	-0.222	*0.680	-0.530	*0.557	-0.415
	50000.	2.86	-0.102	*0.742	-0.591	*0.596	-0.466
5S - 7P 6481.0 Å C = 0.71E+18	2500.	*3.81	-1.77				
	5000.	4.00	-1.46				
	10000.	4.47	-1.11				
	20000.	4.72	-0.800				
	30000.	4.81	-0.571				
	50000.	4.87	-0.311				

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4P - 5S 11057.3 Å C = 0.87E+20	2500.	0.264	0.166	0.576E-01	0.436E-01	0.487E-01	0.338E-01
	5000.	0.301	0.194	0.633E-01	0.510E-01	0.531E-01	0.401E-01
	10000.	0.344	0.230	0.698E-01	0.588E-01	0.581E-01	0.465E-01
	20000.	0.388	0.260	0.773E-01	0.671E-01	0.638E-01	0.533E-01
	30000.	0.420	0.260	0.821E-01	0.722E-01	0.675E-01	0.575E-01
	50000.	0.471	0.251	0.887E-01	0.792E-01	0.727E-01	0.631E-01
4P - 6S 5183.4 Å C = 0.69E+19	2500.	0.245	0.162	*0.513E-01	*0.375E-01	*0.411E-01	*0.279E-01
	5000.	0.290	0.197	0.576E-01	0.466E-01	*0.462E-01	*0.358E-01
	10000.	0.334	0.235	0.646E-01	0.555E-01	*0.518E-01	*0.434E-01
	20000.	0.375	0.246	0.724E-01	0.646E-01	0.581E-01	0.509E-01
	30000.	0.410	0.244	0.775E-01	0.701E-01	0.621E-01	0.554E-01
	50000.	0.454	0.213	0.843E-01	0.773E-01	0.676E-01	0.614E-01
4P - 7S 4299.5 Å C = 0.22E+19	2500.	0.483	0.301	*0.968E-01	*0.578E-01		
	5000.	0.581	0.373	*0.109	*0.792E-01		
	10000.	0.676	0.431	*0.123	*0.990E-01	*0.983E-01	*0.758E-01
	20000.	0.790	0.436	*0.138	*0.118	*0.110	*0.923E-01
	30000.	0.880	0.402	*0.147	*0.130	*0.118	*0.102
	50000.	1.01	0.347	*0.161	*0.144	*0.129	*0.114
4P - 8S 3966.6 Å C = 0.11E+19	2500.	0.951	0.540				
	5000.	1.15	0.687				
	10000.	1.37	0.738				
	20000.	1.68	0.715				
	30000.	1.90	0.626	*0.274	*0.232		
	50000.	2.23	0.516	*0.298	*0.261		
4P - 9S 3800.1 Å C = 0.59E+18	2500.	*1.73	*0.886				
	5000.	*2.14	*1.08				
	10000.	*2.64	*1.18				
	20000.	*3.38	*1.05				
	30000.	*3.88	*0.897				
	50000.	4.53	0.706				
5P - 7S 14097.9 Å C = 0.90E+19	2500.	6.83	3.71				
	5000.	8.01	4.63	*1.35	*0.944		
	10000.	9.07	5.11	*1.52	*1.19		
	20000.	10.4	5.17	*1.70	*1.43	*1.36	*1.11
	30000.	11.3	4.68	*1.82	*1.57	*1.46	*1.23
	50000.	12.8	4.01	*1.99	*1.75	*1.58	*1.38
5P - 8S 11054.9 Å C = 0.55E+19	2500.	8.38	4.42				
	5000.	10.1	5.55				
	10000.	11.8	6.19				
	20000.	14.3	5.84				
	30000.	16.0	5.20				
	50000.	18.5	4.19	*2.44	*2.12		
5P - 9S 9852.0 Å C = 0.40E+19	2500.	*12.5	*6.00				
	5000.	*15.3	*7.65				
	10000.	*18.8	*7.95				
	20000.	*23.7	*7.25				
	30000.	*27.1	*6.24				
	50000.	31.5	4.75				
4P - 5S 4767.4 Å C = 0.17E+20	2500.	0.272E-01	0.215E-01	0.684E-02	0.570E-02	0.558E-02	0.445E-02
	5000.	0.321E-01	0.252E-01	0.762E-02	0.663E-02	0.620E-02	0.523E-02
	10000.	0.371E-01	0.300E-01	0.850E-02	0.760E-02	0.689E-02	0.603E-02
	20000.	0.408E-01	0.339E-01	0.950E-02	0.864E-02	0.768E-02	0.688E-02
	30000.	0.425E-01	0.330E-01	0.101E-01	0.930E-02	0.819E-02	0.741E-02
	50000.	0.454E-01	0.324E-01	0.110E-01	0.102E-01	0.889E-02	0.813E-02
4P - 6S 3054.7 Å C = 0.25E+19	2500.	0.582E-01	0.403E-01	0.125E-01	0.962E-02	*0.100E-01	*0.725E-02
	5000.	0.676E-01	0.483E-01	0.141E-01	0.117E-01	0.113E-01	0.907E-02
	10000.	0.752E-01	0.589E-01	0.158E-01	0.138E-01	0.126E-01	0.108E-01
	20000.	0.809E-01	0.571E-01	0.177E-01	0.160E-01	0.142E-01	0.126E-01
	30000.	0.857E-01	0.564E-01	0.189E-01	0.173E-01	0.152E-01	0.137E-01
	50000.	0.920E-01	0.488E-01	0.206E-01	0.190E-01	0.165E-01	0.151E-01

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4P - 4D 3324.8 Å C = 0.16E+19	2500.	0.398E-01	-0.153E-01	0.102E-01	-0.457E-02	0.968E-02	-0.354E-02
	5000.	0.424E-01	-0.116E-01	0.106E-01	-0.537E-02	0.998E-02	-0.422E-02
	10000.	0.488E-01	-0.502E-02	0.110E-01	-0.621E-02	0.103E-01	-0.491E-02
	20000.	0.543E-01	-0.226E-03	0.116E-01	-0.709E-02	0.106E-01	-0.563E-02
	30000.	0.567E-01	0.235E-02	0.119E-01	-0.764E-02	0.108E-01	-0.608E-02
	50000.	0.595E-01	0.376E-02	0.125E-01	-0.838E-02	0.112E-01	-0.668E-02
4P - 5D 2786.7 Å C = 0.20E+18	2500.	0.189	0.666E-01	*0.399E-01	*0.207E-01		
	5000.	0.244	0.660E-01	*0.441E-01	*0.276E-01		
	10000.	0.285	0.636E-01	*0.485E-01	*0.341E-01	*0.411E-01	*0.262E-01
	20000.	0.314	0.530E-01	*0.537E-01	*0.404E-01	*0.445E-01	*0.316E-01
	30000.	0.322	0.476E-01	*0.574E-01	*0.442E-01	*0.468E-01	*0.348E-01
	50000.	0.325	0.373E-01	*0.631E-01	*0.490E-01	*0.499E-01	*0.388E-01
4D - 4F 16501.0 Å C = 0.69E+19	2500.	6.39	-1.88	*1.29	-0.710		
	5000.	7.27	-1.13	*1.43	-0.943		
	10000.	7.65	-0.503	*1.58	-1.16	*1.32	-0.894
	20000.	7.78	0.858E-01	*1.77	-1.38	*1.44	-1.08
	30000.	7.80	0.233	*1.89	-1.50	*1.52	-1.18
	50000.	7.84	0.321	2.09	-1.67	*1.63	-1.32
PERTURBER DENSITY = 1.E+17 cm <sup>-3</sup>							
4S - 4P 2139.2 Å C = 0.41E+20	2500.	0.255E-01	0.191E-01	0.117E-01	0.463E-02	*0.109E-01	*0.349E-02
	5000.	0.303E-01	0.228E-01	0.122E-01	0.564E-02	0.115E-01	0.436E-02
	10000.	0.350E-01	0.273E-01	0.127E-01	0.664E-02	0.119E-01	0.521E-02
	20000.	0.390E-01	0.287E-01	0.132E-01	0.767E-02	0.123E-01	0.607E-02
	30000.	0.420E-01	0.292E-01	0.136E-01	0.830E-02	0.125E-01	0.659E-02
	50000.	0.467E-01	0.256E-01	0.141E-01	0.914E-02	0.129E-01	0.727E-02
4S - 5P 1589.6 Å C = 0.11E+19	2500.	0.229	-0.658E-01				
	5000.	0.259	-0.361E-01				
	10000.	0.278	-0.150E-01				
	20000.	0.285	0.584E-02	*0.685E-01	-0.465E-01		
	30000.	0.289	0.147E-01	*0.730E-01	-0.521E-01		
	50000.	0.294	0.135E-01	*0.797E-01	-0.591E-01	*0.641E-01	-0.462E-01
4S - 6P 1457.6 Å C = 0.57E+18	2500.	*0.641	-0.196				
	5000.	*0.732	-0.131				
	10000.	*0.839	-0.893E-01				
	20000.	0.890	-0.442E-01				
	30000.	0.920	-0.256E-01				
	50000.	0.953	-0.121E-01				
4S - 7P 1404.1 Å C = 0.33E+18	2500.						
	5000.						
	10000.	*1.87	-0.226				
	20000.	*2.05	-0.191				
	30000.	*2.11	-0.143				
	50000.	*2.16	-0.120				
4P - 5S 11057.3 Å C = 0.87E+21	2500.	2.64	1.55	*0.567	*0.324	*0.468	*0.227
	5000.	3.01	1.86	0.630	0.432	*0.525	*0.323
	10000.	3.44	2.25	0.697	0.532	*0.579	*0.410
	20000.	3.88	2.57	0.772	0.631	0.637	0.494
	30000.	4.20	2.58	0.820	0.690	0.675	0.543
	50000.	4.71	2.50	0.886	0.766	0.726	0.606
4P - 6S 5183.4 Å C = 0.69E+20	2500.	2.45	1.38				
	5000.	2.90	1.80				
	10000.	3.34	2.23				
	20000.	3.75	2.42	*0.724	*0.563		
	30000.	4.10	2.41	*0.775	*0.633		
	50000.	4.54	2.12	*0.843	*0.720	*0.676	*0.561
4P - 7S 4299.5 Å C = 0.22E+20	2500.	*4.82	*2.26				
	5000.	*5.81	*3.19				
	10000.	*6.76	*3.93				
	20000.	7.90	4.13				
	30000.	8.80	3.91				
	50000.	10.1	3.41				

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
4P - 8S 3966.6 Å C = 0.11E+20	2500. 5000. 10000. 20000. 30000. 50000.	*13.7 *16.8 *19.0 *22.2	*6.31 *6.51 *5.95 *4.96				
4P - 5S 4767.4 Å C = 0.17E+21	2500. 5000. 10000. 20000. 30000. 50000.	0.272 0.320 0.371 0.408 0.425 0.454	0.203 0.243 0.295 0.336 0.328 0.324	0.680E-01 0.761E-01 0.850E-01 0.950E-01 0.101 0.110	0.452E-01 0.579E-01 0.701E-01 0.822E-01 0.895E-01 0.991E-01	*0.551E-01 0.618E-01 0.689E-01 0.768E-01 0.819E-01 0.888E-01	*0.327E-01 0.439E-01 0.543E-01 0.646E-01 0.707E-01 0.785E-01
4P - 6S 3054.7 Å C = 0.25E+20	2500. 5000. 10000. 20000. 30000. 50000.	0.581 0.676 0.752 0.809 0.857 0.920	0.355 0.449 0.565 0.562 0.563 0.488	*0.140 *0.158 *0.177 *0.189 *0.206	*0.831E-01 *0.114 *0.143 *0.159 *0.179	*0.142 *0.152 *0.165	*0.109 *0.123 *0.141
4P - 4D 3324.8 Å C = 0.16E+20	2500. 5000. 10000. 20000. 30000. 50000.	0.398 0.423 0.488 0.543 0.567 0.595	-0.141 -0.107 -0.469E-01 0.714E-04 0.240E-01 0.380E-01	*0.933E-01 *0.103 *0.109 0.115 0.119 0.125	-0.330E-01 -0.447E-01 -0.557E-01 -0.664E-01 -0.727E-01 -0.808E-01	*0.101 *0.105 *0.108 *0.112	-0.427E-01 -0.518E-01 -0.571E-01 -0.639E-01
4P - 5D 2786.7 Å C = 0.20E+19	2500. 5000. 10000. 20000. 30000. 50000.	*1.74 *2.33 *2.77 3.08 3.18 3.22	*0.414 *0.481 *0.509 0.458 0.467 0.373				
PERTURBER DENSITY = 1.E+18 cm <sup>-3</sup>							
4S - 4P 2139.2 Å C = 0.41E+21	2500. 5000. 10000. 20000. 30000. 50000.	0.254 0.303 0.350 0.390 0.420 0.467	0.168 0.211 0.261 0.278 0.285 0.251	*0.878E-01 *0.112 *0.123 *0.131 *0.135 0.141	*0.235E-01 *0.402E-01 *0.549E-01 *0.686E-01 *0.764E-01 0.863E-01	*0.112 *0.121 *0.124 *0.128	*0.406E-01 *0.526E-01 *0.592E-01 *0.675E-01
4S - 5P 1589.6 Å C = 0.11E+20	2500. 5000. 10000. 20000. 30000. 50000.	*1.41 *2.07 *2.45 *2.63 2.71 2.80	-0.115 *0.260E-01 *0.124 *0.252 0.305 0.267				
4P - 5S 4767.4 Å C = 0.17E+22	2500. 5000. 10000. 20000. 30000. 50000.	2.71 3.20 3.71 4.08 4.25 4.54	1.65 2.17 2.75 3.30 3.23 3.23	*0.536 *0.729 *0.843 *0.948 *1.01 *1.10	*0.991E-01 *0.315 *0.513 *0.690 *0.787 *0.907	*0.765 *0.818 *0.888	*0.514 *0.599 *0.701
4P - 6S 3054.7 Å C = 0.25E+21	2500. 5000. 10000. 20000. 30000. 50000.	*5.66 *6.73 *7.51 8.09 8.57 9.19	*1.98 *3.38 *4.86 5.02 5.18 4.68				
4P - 4D 3324.8 Å C = 0.16E+21	2500. 5000. 10000. 20000. 30000. 50000.	3.67 4.15 4.84 5.41 5.65 5.93	-0.955 -0.755 -0.213 0.145 0.312 0.433				

PERTURBERS ARE: TRANSITION	T(K)	ELECTRONS		PROTONS		IONIZED HELIUM	
		WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)	WIDTH (Å)	SHIFT (Å)
PERTURBER DENSITY = 1.E+19 cm <sup>-3</sup>							
4S - 4P	2500.	2.41	0.943				
2139.2 Å	5000.	3.00	1.59				
C = 0.41E+22	10000.	3.49	2.25				
	20000.	3.89	2.52				
	30000.	4.20	2.64				
	50000.	4.67	2.34				

for the maximum perturber density for which the line may be treated as isolated when it is divided by the corresponding full width at half maximum. For each value given in Table 1, the collision volume (V) multiplied by the perturber density (N) is much less than one and the impact approximation is valid (Sahal–Bréchet, 1969ab). Values for  $NV > 0.5$  are not given and values for  $0.1 < NV \leq 0.5$  are denoted by an asterisk. Stark broadening parameters for densities lower than tabulated, are linear with perturber density. When the impact approximation is not valid, the ion broadening contribution may be estimated by using quasistatic approach (Sahal–Bréchet 1991 or Griem 1974). In the region between where neither of these two approximations is valid, a unified type theory should be used. For example in Barnard *et al.* (1974), a simple analytical formulas for such a case are given. The accuracy of the results obtained decreases when broadening by ion interactions becomes important. The discussion of obtained results, and the comparison with available experimental (Kusch and Obershelp 1967, Fishman *et al.* 1979, Rathore *et al.* 1985) and theoretical (Dimitrijević and Konjević 1983, Lakićević 1983) data, will be published in Dimitrijević and Sahal–Bréchet (1999).

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ТАБЕЛЕ ПАРАМЕТАРА ШТАРКОВОГ ШИРЕЊА СПЕКТРАЛНИХ ЛИНИЈА  
НЕУТРАЛНОГ ЦИНКАМ. С. Димитријевић<sup>1</sup> и S. Sahal–Bréchet<sup>2</sup><sup>1</sup> *Астрономска опсерваторија, Волгина 7, 11160 Београд-74, Југославија*<sup>2</sup> *Laboratoire "Astrophysique, Atomes et Molécules"  
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*Претходно саопштење*

Користећи семикласичан прилаз, израчунате су ширине и помераји спектралних линија, проузроковани сударима са електронима,

протонима и јонима хелијума за 32 мултиплета Zn I. Резултати су приказани у функцији температуре и густине пертурбера.