

## STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES OF ASTROPHYSICAL IMPORTANCE

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**SUMMARY:** Using a semiclassical approach, we have calculated electron–, proton–, and He III–impact line widths and shifts for 5 O IV and 19 O V multiplets as a function of temperature and perturber density.

### 1. INTRODUCTION

Due to its high cosmical abundance oxygen lines are of particular interest for the analysis of stellar spectra. In order to provide to astrophysicists the needed Stark broadening data, we have calculated within the semiclassical-perturbation formalism (Sahal–Bréchet, 1969ab) electron-, proton-, and He III-, -impact line widths and shifts for 5 O IV and 19 O V multiplets, in order to continue our effort to provide to astrophysicists the needed Stark broadening data.

### 2. RESULTS AND DISCUSSION

Analysis of obtained results and all details of calculations as well as the comparison with available experimental data will be published elsewhere (Dimitrijević and Sahal–Bréchet, 1994). Here, we present tables of Stark broadening parameters for solar and laboratory plasma diagnostic purposes. Our results for 5 O IV and 19 O V multiplets are shown in Table 1, for perturber densities  $10^{17} - 10^{22} \text{ cm}^{-3}$  and temperatures  $T = 20,000 - 1,000,000 \text{ K}$ . We also specify a parameter  $c$  (Dimitrijević and Sahal–Bréchet

**Table 1.** This table shows electron-, proton-, and He III- impact broadening parameters for O IV and O V, for perturber densities of  $10^{17}$  -  $10^{22}$   $\text{cm}^{-3}$  and temperatures from 200,000 to 2,000,000 K. Transitions and averaged wavelengths for the multiplet (in Å) are also given. By using  $c$  [see Eq. (5) in Dimitrijević et al, 1991], 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. Table 1 is also available in electronic form: see the editorial in *Astron.Astrophys.* 1992, Vol. 266, No 2, page E1 or in *Astron.Astrophys. Suppl. Series* 1992, Vol. 96, No3, and Dimitrijević and Sahal-Brechot, 1994.

Transition	T(K)	Perturbers					
		Electrons		Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
Perturber density = $1 \times 10^{17}$ $\text{cm}^{-3}$							
O IV 2P 3S 279.9 Å C= 0.26E+19	20000.	0.609E-03	0.158E-04	0.995E-06	0.858E-05	0.186E-05	0.161E-04
	50000.	0.362E-03	0.330E-04	0.736E-05	0.192E-04	0.146E-04	0.378E-04
	100000.	0.266E-03	0.358E-04	0.176E-04	0.282E-04	0.356E-04	0.568E-04
	200000.	0.205E-03	0.383E-04	0.323E-04	0.373E-04	0.655E-04	0.764E-04
O IV 2P 3D 238.5 Å C= 0.17E+19	20000.	0.477E-03	-0.138E-04	0.345E-05	-0.124E-05	0.637E-05	-0.233E-05
	50000.	0.303E-03	-0.198E-05	0.997E-05	-0.317E-05	0.190E-04	-0.624E-05
	100000.	0.221E-03	0.814E-06	0.163E-04	-0.547E-05	0.319E-04	-0.110E-04
	200000.	0.167E-03	0.343E-06	0.227E-04	-0.792E-05	0.447E-04	-0.161E-04
O IV 3S 3P 3066.4 Å C= 0.28E+21	20000.	0.155	-0.141E-02	0.110E-02	-0.613E-03	0.203E-02	-0.115E-02
	50000.	0.991E-01	-0.237E-02	0.289E-02	-0.145E-02	0.554E-02	-0.286E-02
	100000.	0.741E-01	-0.233E-02	0.444E-02	-0.224E-02	0.865E-02	-0.453E-02
	200000.	0.578E-01	-0.270E-02	0.584E-02	-0.308E-02	0.116E-01	-0.628E-02
O IV 3P 3D 3410.9 Å C= 0.34E+21	20000.	0.162	-0.244E-02	0.964E-03	-0.780E-03	0.178E-02	-0.146E-02
	50000.	0.106	-0.205E-02	0.274E-02	-0.184E-02	0.525E-02	-0.363E-02
	100000.	0.784E-01	-0.211E-02	0.441E-02	-0.283E-02	0.864E-02	-0.572E-02
	200000.	0.607E-01	-0.220E-02	0.617E-02	-0.389E-02	0.123E-01	-0.794E-02
O IV 3D 4F 1067.8 Å C= 0.30E+19	20000.	0.306E-01	-0.666E-03	0.745E-03	-0.123E-02	0.144E-02	-0.229E-02
	50000.	0.208E-01	-0.539E-03	0.177E-02	-0.209E-02	0.350E-02	-0.409E-02
	100000.	0.160E-01	-0.572E-03	0.269E-02	-0.261E-02	0.530E-02	-0.526E-02
	200000.	0.129E-01	-0.336E-03	0.350E-02	-0.313E-02	0.680E-02	-0.638E-02
Perturber density = $1 \times 10^{18}$ $\text{cm}^{-3}$							
O IV 2P 3S 279.9 Å C= 0.26E+20	20000.	0.609E-02	0.435E-04	0.988E-05	0.744E-04	0.184E-04	0.119E-03
	50000.	0.363E-02	0.333E-03	0.738E-04	0.184E-03	0.145E-03	0.345E-03
	100000.	0.266E-02	0.354E-03	0.176E-03	0.278E-03	0.356E-03	0.544E-03
	200000.	0.205E-02	0.378E-03	0.323E-03	0.372E-03	0.654E-03	0.752E-03
O IV 2P 3D 238.5 Å C= 0.17E+20	20000.	0.476E-02	-0.215E-03	0.339E-04	-0.108E-04	0.597E-04	-0.174E-04
	50000.	0.302E-02	-0.129E-04	0.995E-04	-0.306E-04	0.189E-03	-0.576E-04
	100000.	0.221E-02	0.734E-05	0.163E-03	-0.541E-04	0.318E-03	-0.106E-03
	200000.	0.167E-02	0.289E-05	0.227E-03	-0.791E-04	0.447E-03	-0.159E-03

## STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES

Transition	T(K)	Electrons		Perturbers Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O IV 3S 3P 3066.4 Å C= 0.28E+22	20000.	1.55	-0.875E-02	0.108E-01	-0.532E-02	0.190E-01	-0.855E-02
	50000.	0.991	-0.236E-01	0.288E-01	-0.139E-01	0.549E-01	-0.262E-01
	100000.	0.741	-0.231E-01	0.444E-01	-0.221E-01	0.863E-01	-0.437E-01
	200000.	0.578	-0.267E-01	0.584E-01	-0.308E-01	0.116	-0.620E-01
O IV 3P 3D 3410.9 Å C= 0.34E+22	20000.	1.62	-0.261E-01	0.948E-02	-0.677E-02	0.167E-01	-0.109E-01
	50000.	1.06	-0.199E-01	0.273E-01	-0.177E-01	0.520E-01	-0.333E-01
	100000.	0.784	-0.209E-01	0.441E-01	-0.279E-01	0.862E-01	-0.552E-01
	200000.	0.607	-0.217E-01	0.617E-01	-0.388E-01	0.123	-0.783E-01
O IV 3D 4F 1067.8 Å C= 0.30E+20	20000.	0.306	-0.447E-02	0.738E-02	-0.103E-01	*0.138E-01	-0.156E-01
	50000.	0.208	-0.377E-02	0.178E-01	-0.195E-01	*0.348E-01	-0.350E-01
	100000.	0.160	-0.449E-02	0.269E-01	-0.254E-01	*0.530E-01	-0.484E-01
	200000.	0.129	-0.247E-02	0.350E-01	-0.312E-01	0.680E-01	-0.618E-01
Perturber density = $1 \times 10^{+19} \text{ cm}^{-3}$							
O IV 2P 3S 279.9 Å C= 0.26E+21	20000.	0.618E-01	-0.207E-03	0.961E-04	0.454E-03	0.159E-03	0.428E-03
	50000.	0.362E-01	0.305E-02	0.736E-03	0.159E-02	0.145E-02	0.260E-02
	100000.	0.266E-01	0.335E-02	0.176E-02	0.257E-02	0.356E-02	0.470E-02
	200000.	0.205E-01	0.364E-02	0.323E-02	0.363E-02	0.654E-02	0.702E-02
O IV 2P 3D 238.5 Å C= 0.17E+21	20000.	0.477E-01	-0.218E-02	0.283E-03	-0.667E-04	0.352E-03	-0.645E-04
	50000.	0.302E-01	-0.104E-03	0.980E-03	-0.270E-03	0.179E-02	-0.455E-03
	100000.	0.221E-01	0.938E-04	0.163E-02	-0.511E-03	0.313E-02	-0.957E-03
	200000.	0.167E-01	0.473E-04	0.227E-02	-0.779E-03	0.445E-02	-0.152E-02
O IV 3S 3P 3066.4 Å C= 0.28E+23	20000.	15.4	-0.453E-01	0.894E-01	-0.327E-01	*0.110	-0.313E-01
	50000.	9.91	-0.216	0.283	-0.122	*0.517	-0.203
	100000.	7.41	-0.218	0.441	-0.206	*0.847	-0.385
	200000.	5.78	-0.257	0.583	-0.301	*1.16	-0.584
O IV 3P 3D 3410.9 Å C= 0.34E+23	20000.	16.2	-0.218	0.792E-01	-0.416E-01	*0.995E-01	-0.398E-01
	50000.	10.6	-0.177	0.269	-0.154	*0.494	-0.257
	100000.	7.84	-0.192	0.439	-0.260	*0.848	-0.485
	200000.	6.07	-0.205	0.616	-0.380	*1.22	-0.738
O IV 3D 4F 1067.8 Å C= 0.30E+21	20000.	*3.01	*0.517E-01	*0.647E-01	-0.522E-01		
	50000.	2.05	0.161E-01	*0.175	-0.151		
	100000.	1.59	-0.823E-02	*0.267	-0.218		
	200000.	1.28	0.235E-02	*0.350	-0.296		
Perturber density = $1 \times 10^{+20} \text{ cm}^{-3}$							
O IV 2P 3S 279.9 Å C= 0.26E+22	20000.	*0.613	-0.218E-01	*0.663E-03	*0.938E-03		
	50000.	0.363	0.207E-01	*0.716E-02	*0.954E-02		
	100000.	0.266	0.271E-01	*0.175E-01	*0.205E-01		
	200000.	0.205	0.321E-01	*0.322E-01	*0.316E-01		

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Transition	T(K)	Electrons		Perturbers Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O IV 2P 3D 238.5 Å C=0.17E+22	20000.	*0.477	-0.177E-01	*0.109E-02	-0.152E-03		
	50000.	0.302	0.421E-03	*0.828E-02	-0.179E-02		
	100000.	0.221	0.188E-02	*0.158E-01	-0.437E-02		
	200000.	0.167	0.114E-02	*0.224E-01	-0.711E-02		
Perturber density = $1 \times 10^{21} \text{ cm}^{-3}$							
O IV 2P 3S 279.9 Å C= 0.26E+23	20000.						
	50000.	*3.45	-0.224				
	100000.	*2.61	*0.289E-01				
	200000.	2.02	0.165				
O IV 2P 3D 238.5 Å C= 0.17E+23	20000.						
	50000.						
	100000.	*2.18	*0.561E-01				
	200000.	1.66	0.354E-01				
Perturber density = $1 \times 10^{17} \text{ cm}^{-3}$							
O V 2S-2P 629.7 Å C= 0.63E+20	40000.	0.810E-03	0.189E-04	0.123E-05	-0.199E-05	0.226E-05	-0.385E-05
	100000.	0.516E-03	-0.999E-05	0.477E-05	-0.506E-05	0.888E-05	-0.101E-04
	200000.	0.369E-03	-0.987E-05	0.113E-04	-0.947E-05	0.215E-04	-0.190E-04
	500000.	0.245E-03	-0.129E-04	0.230E-04	-0.168E-04	0.451E-04	-0.343E-04
O V 2P 3S 248.5 Å C= 0.12E+19	40000.	0.375E-03	0.152E-04	0.327E-05	0.138E-04	0.627E-05	0.267E-04
	100000.	0.250E-03	0.260E-04	0.153E-04	0.258E-04	0.306E-04	0.522E-04
	200000.	0.191E-03	0.263E-04	0.275E-04	0.356E-04	0.549E-04	0.725E-04
	500000.	0.138E-03	0.250E-04	0.447E-04	0.455E-04	0.893E-04	0.928E-04
O V 2P 4S 174.6 Å C= 0.19E+18	40000.	0.631E-03	0.645E-04	0.349E-04	0.557E-04	0.703E-04	0.108E-03
	100000.	0.445E-03	0.723E-04	0.738E-04	0.832E-04	0.150E-03	0.168E-03
	200000.	0.352E-03	0.699E-04	0.986E-04	0.100E-03	0.199E-03	0.205E-03
	500000.	0.264E-03	0.614E-04	0.135E-03	0.124E-03	0.269E-03	0.256E-03
O V 2P 3D 220.4 Å C= 0.15E+19	40000.	0.257E-03	-0.932E-05	0.224E-05	-0.147E-05	0.417E-05	-0.283E-05
	100000.	0.166E-03	-0.775E-06	0.637E-05	-0.347E-05	0.122E-04	-0.694E-05
	200000.	0.122E-03	-0.170E-05	0.103E-04	-0.555E-05	0.202E-04	-0.113E-04
	500000.	0.864E-04	-0.198E-07	0.152E-04	-0.834E-05	0.301E-04	-0.170E-04
O V 2P 4D 170.2 Å C= 0.10E+18	40000.	0.657E-03	0.105E-04	0.224E-04	0.234E-04	0.432E-04	0.454E-04
	100000.	0.463E-03	0.120E-04	0.431E-04	0.379E-04	0.846E-04	0.762E-04
	200000.	0.366E-03	0.127E-04	0.581E-04	0.464E-04	0.113E-03	0.951E-04
	500000.	0.276E-03	0.989E-05	0.814E-04	0.586E-04	0.147E-03	0.119E-03
O V 3D 4F 728.7 Å C= 0.19E+19	40000.	0.810E-02	-0.165E-03	0.271E-03	-0.446E-03	0.521E-03	-0.863E-03
	100000.	0.555E-02	-0.152E-03	0.623E-03	-0.717E-03	0.123E-02	-0.144E-02
	200000.	0.433E-02	-0.974E-04	0.929E-03	-0.875E-03	0.180E-02	-0.179E-02
	500000.	0.327E-02	-0.535E-04	0.134E-02	-0.110E-02	0.244E-02	-0.226E-02

STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES

Transition	T(K)	Electrons		Perturbers Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3D 5F 509.4 Å C= 0.14E+18	40000.	0.160E-01	-0.119E-02	0.363E-02	-0.358E-02		
	100000.	0.119E-01	-0.114E-02	0.528E-02	-0.489E-02	*0.102E-01	-0.967E-02
	200000.	0.959E-02	-0.889E-03	0.701E-02	-0.566E-02	*0.129E-01	-0.116E-01
	500000.	0.722E-02	-0.656E-03	0.939E-02	-0.670E-02	*0.160E-01	-0.137E-01
O V 2P 3S 215.2 Å C= 0.17E+19	40000.	0.222E-03	0.690E-05	0.935E-06	0.564E-05	0.177E-05	0.109E-04
	100000.	0.144E-03	0.130E-04	0.552E-05	0.116E-04	0.107E-04	0.234E-04
	200000.	0.108E-03	0.163E-04	0.112E-04	0.162E-04	0.225E-04	0.331E-04
	500000.	0.779E-04	0.151E-04	0.205E-04	0.216E-04	0.416E-04	0.444E-04
O V 2P 4S 156.2 Å C= 0.33E+18	40000.	0.370E-03	0.346E-04	0.110E-04	0.231E-04	0.213E-04	0.449E-04
	100000.	0.253E-03	0.445E-04	0.275E-04	0.367E-04	0.553E-04	0.738E-04
	200000.	0.199E-03	0.416E-04	0.417E-04	0.443E-04	0.849E-04	0.910E-04
	500000.	0.149E-03	0.387E-04	0.585E-04	0.557E-04	0.117E-03	0.116E-03
O V 3P 4S 716.3 Å C= 0.69E+19	40000.	0.107E-01	0.679E-03	0.237E-03	0.456E-03	0.458E-03	0.883E-03
	100000.	0.736E-02	0.849E-03	0.574E-03	0.728E-03	0.115E-02	0.147E-02
	200000.	0.577E-02	0.803E-03	0.855E-03	0.885E-03	0.175E-02	0.182E-02
	500000.	0.433E-02	0.742E-03	0.119E-02	0.113E-02	0.237E-02	0.228E-02
O V 3S 3P 2784.8 Å C= 0.14E+21	40000.	0.852E-01	-0.101E-02	0.812E-03	-0.259E-03	0.152E-02	-0.501E-03
	100000.	0.567E-01	-0.100E-02	0.198E-02	-0.609E-03	0.380E-02	-0.122E-02
	200000.	0.431E-01	-0.170E-02	0.291E-02	-0.963E-03	0.566E-02	-0.196E-02
	500000.	0.315E-01	-0.148E-02	0.388E-02	-0.143E-02	0.750E-02	-0.293E-02
O V 2P 3D 192.9 Å C= 0.67E+18	40000.	0.187E-03	-0.824E-05	0.158E-05	-0.230E-05	0.294E-05	-0.445E-05
	100000.	0.121E-03	-0.214E-05	0.493E-05	-0.507E-05	0.948E-05	-0.102E-04
	200000.	0.897E-04	-0.191E-05	0.847E-05	-0.747E-05	0.166E-04	-0.152E-04
	500000.	0.634E-04	-0.933E-06	0.137E-04	-0.106E-04	0.267E-04	-0.217E-04
O V 2P 4D 151.5 Å C= 0.12E+18	40000.	0.497E-03	0.150E-05	0.126E-04	0.451E-05	0.240E-04	0.873E-05
	100000.	0.348E-03	0.498E-05	0.227E-04	0.865E-05	0.439E-04	0.175E-04
	200000.	0.273E-03	0.521E-05	0.292E-04	0.119E-04	0.564E-04	0.243E-04
	500000.	0.206E-03	0.506E-05	0.378E-04	0.153E-04	0.684E-04	0.313E-04
O V 3P 3D 5591.4 Å C= 0.56E+21	40000.	0.282	-0.697E-02	0.278E-02	-0.464E-02	0.523E-02	-0.899E-02
	100000.	0.189	-0.644E-02	0.829E-02	-0.930E-02	0.162E-01	-0.187E-01
	200000.	0.143	-0.566E-02	0.135E-01	-0.129E-01	0.265E-01	-0.263E-01
	500000.	0.105	-0.499E-02	0.204E-01	-0.169E-01	0.396E-01	-0.346E-01
O V 3P 4D 627.5 Å C= 0.21E+19	40000.	0.955E-02	0.185E-04	0.169E-03	0.443E-04	0.321E-03	0.859E-04
	100000.	0.669E-02	0.258E-04	0.312E-03	0.924E-04	0.602E-03	0.185E-03
	200000.	0.527E-02	0.377E-04	0.417E-03	0.130E-03	0.800E-03	0.264E-03
	500000.	0.397E-02	0.337E-04	0.548E-03	0.174E-03	0.959E-03	0.356E-03

Transition	T(K)	Electrons		Perturbers		He III	
		Width (Å)	Shift (Å)	Protons Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3D 4F 681.3 Å C= 0.25E+19	40000.	0.671E-02	-0.904E-04	0.159E-03	-0.242E-03	0.306E-03	-0.469E-03
	100000.	0.458E-02	-0.832E-04	0.373E-03	-0.412E-03	0.737E-03	-0.829E-03
	200000.	0.355E-02	-0.510E-04	0.563E-03	-0.519E-03	0.111E-02	-0.106E-02
	500000.	0.268E-02	-0.289E-04	0.811E-03	-0.663E-03	0.153E-02	-0.136E-02
O V 3D 5F 481.1 Å C= 0.52E+17	40000.	0.134E-01	-0.887E-03	*0.393E-02	-0.360E-02		
	100000.	0.996E-02	-0.825E-03	*0.599E-02	-0.487E-02		
	200000.	0.803E-02	-0.729E-03	0.803E-02	-0.567E-02	*0.130E-01	-0.116E-01
	500000.	0.608E-02	-0.529E-03	0.115E-01	-0.680E-02	*0.165E-01	-0.141E-01
O V 4D 4F 18849.4 Å C= 0.19E+22	40000.	9.26	-0.166	0.156	-0.256	0.300	-0.495
	100000.	6.55	-0.161	0.364	-0.419	0.713	-0.841
	200000.	5.21	-0.138	0.551	-0.517	1.07	-1.06
	500000.	3.98	-0.109	0.830	-0.651	1.46	-1.35
O V 4D 5F 1506.7 Å C= 0.51E+18	40000.	0.153	-0.935E-02	*0.385E-01	-0.354E-01		
	100000.	0.113	-0.873E-02	*0.586E-01	-0.479E-01		
	200000.	0.917E-01	-0.778E-02	0.788E-01	-0.560E-01	*0.127	*-0.114
	500000.	0.695E-01	-0.575E-02	0.114	-0.669E-01	*0.163	*-0.139
Perturber density = $1 \times 10^{+18} \text{ cm}^{-3}$							
O V 2S-2P 629.7 Å C= 0.63E+21	40000.	0.812E-02	0.154E-03	0.122E-04	-0.186E-04	0.223E-04	-0.338E-04
	100000.	0.516E-02	-0.107E-03	0.477E-04	-0.501E-04	0.887E-04	-0.974E-04
	200000.	0.369E-02	-0.101E-03	0.113E-03	-0.946E-04	0.215E-03	-0.189E-03
	500000.	0.245E-02	-0.129E-03	0.230E-03	-0.168E-03	0.451E-03	-0.343E-03
O V 2P 3S 248.5 Å C= 0.12E+20	40000.	0.377E-02	0.157E-03	0.327E-04	0.128E-03	0.626E-04	0.232E-03
	100000.	0.250E-02	0.255E-03	0.153E-03	0.254E-03	0.306E-03	0.497E-03
	200000.	0.191E-02	0.259E-03	0.275E-03	0.355E-03	0.549E-03	0.712E-03
	500000.	0.138E-02	0.250E-03	0.447E-03	0.454E-03	0.893E-03	0.925E-03
O V 2P 4S 174.6 Å C= 0.19E+19	40000.	0.633E-02	0.592E-03	0.349E-03	0.498E-03	*0.701E-03	*0.874E-03
	100000.	0.445E-02	0.685E-03	0.738E-03	0.807E-03	*0.150E-02	*0.153E-02
	200000.	0.352E-02	0.674E-03	0.986E-03	0.100E-02	*0.199E-02	*0.198E-02
	500000.	0.264E-02	0.612E-03	0.135E-02	0.124E-02	*0.269E-02	*0.254E-02
O V 2P 3D 220.4 Å C= 0.15E+20	40000.	0.256E-02	-0.813E-04	0.223E-04	-0.136E-04	0.411E-04	-0.248E-04
	100000.	0.166E-02	-0.391E-05	0.637E-04	-0.343E-04	0.122E-03	-0.670E-04
	200000.	0.122E-02	-0.162E-04	0.103E-03	-0.555E-04	0.202E-03	-0.111E-03
	500000.	0.864E-03	-0.162E-06	0.152E-03	-0.833E-04	0.301E-03	-0.170E-03
O V 2P 4D 170.2 Å C= 0.10E+19	40000.	0.657E-02	0.919E-04	0.223E-03	0.214E-03	0.425E-03	0.384E-03
	100000.	0.463E-02	0.107E-03	0.430E-03	0.370E-03	0.845E-03	0.714E-03
	200000.	0.366E-02	0.118E-03	0.581E-03	0.463E-03	0.113E-02	0.927E-03
	500000.	0.276E-02	0.982E-04	0.814E-03	0.585E-03	0.147E-02	0.119E-02

STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES

Transition	T(K)	Electrons		Perturbers Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3D 4F 728.7 Å C= 0.19E+20	40000.	0.810E-01	-0.123E-02	0.270E-02	-0.407E-02	0.517E-02	-0.729E-02
	100000.	0.555E-01	-0.123E-02	0.622E-02	-0.700E-02	0.123E-01	-0.135E-01
	200000.	0.433E-01	-0.830E-03	0.929E-02	-0.873E-02	0.180E-01	-0.175E-01
	500000.	0.327E-01	-0.522E-03	0.134E-01	-0.110E-01	0.244E-01	-0.225E-01
O V 3D 5F 509.4 Å C= 0.14E+19	40000.	0.154	-0.356E-02				
	100000.	0.116	-0.599E-02				
	200000.	0.934E-01	-0.514E-02				
	500000.	0.706E-01	-0.627E-02				
O V 2P 3S 215.2 Å C= 0.17E+20	40000.	0.223E-02	0.758E-04	0.938E-05	0.523E-04	0.177E-04	0.953E-04
	100000.	0.144E-02	0.130E-03	0.552E-04	0.115E-03	0.108E-03	0.224E-03
	200000.	0.108E-02	0.161E-03	0.112E-03	0.162E-03	0.225E-03	0.326E-03
	500000.	0.779E-03	0.151E-03	0.205E-03	0.215E-03	0.416E-03	0.443E-03
O V 2P 4S 156.2 Å C= 0.33E+19	40000.	0.372E-02	0.331E-03	0.109E-03	0.211E-03	0.213E-03	0.378E-03
	100000.	0.253E-02	0.432E-03	0.275E-03	0.359E-03	0.553E-03	0.689E-03
	200000.	0.199E-02	0.407E-03	0.417E-03	0.442E-03	0.849E-03	0.885E-03
	500000.	0.149E-02	0.386E-03	0.585E-03	0.556E-03	0.117E-02	0.116E-02
O V 3P 4S 716.3 Å C= 0.69E+20	40000.	0.107	0.646E-02	0.236E-02	0.415E-02	0.457E-02	0.745E-02
	100000.	0.736E-01	0.821E-02	0.573E-02	0.711E-02	0.115E-01	0.137E-01
	200000.	0.577E-01	0.784E-02	0.855E-02	0.883E-02	0.175E-01	0.177E-01
	500000.	0.433E-01	0.741E-02	0.119E-01	0.113E-01	0.237E-01	0.227E-01
O V 3S 3P 2784.8 Å C= 0.14E+22	40000.	0.852	-0.104E-01	0.808E-02	-0.241E-02	0.150E-01	-0.439E-02
	100000.	0.567	-0.100E-01	0.198E-01	-0.601E-02	0.379E-01	-0.117E-01
	200000.	0.431	-0.170E-01	0.291E-01	-0.962E-02	0.566E-01	-0.193E-01
	500000.	0.315	-0.148E-01	0.388E-01	-0.143E-01	0.750E-01	-0.293E-01
O V 2P 3D 192.9 Å C= 0.67E+19	40000.	0.187E-02	-0.720E-04	0.157E-04	-0.214E-04	0.290E-04	-0.390E-04
	100000.	0.121E-02	-0.182E-04	0.493E-04	-0.500E-04	0.948E-04	-0.978E-04
	200000.	0.897E-03	-0.181E-04	0.847E-04	-0.746E-04	0.166E-03	-0.150E-03
	500000.	0.634E-03	-0.927E-05	0.137E-03	-0.106E-03	0.267E-03	-0.216E-03
O V 2P 4D 151.5 Å C= 0.12E+19	40000.	0.497E-02	0.180E-04	0.125E-03	0.417E-04	0.235E-03	0.759E-04
	100000.	0.348E-02	0.492E-04	0.227E-03	0.851E-04	0.437E-03	0.167E-03
	200000.	0.273E-02	0.500E-04	0.291E-03	0.119E-03	0.564E-03	0.239E-03
	500000.	0.206E-02	0.505E-04	0.378E-03	0.153E-03	0.684E-03	0.312E-03
O V 3P 3D 5591.4 Å C= 0.56E+22	40000.	2.82	-0.648E-01	0.277E-01	-0.430E-01	0.517E-01	-0.784E-01
	100000.	1.89	-0.617E-01	0.829E-01	-0.916E-01	0.162	-0.179
	200000.	1.43	-0.549E-01	0.135	-0.129	0.265	-0.259
	500000.	1.05	-0.498E-01	0.204	-0.169	0.396	-0.345

Transition	T(K)	Perturbers					
		Electrons		Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3P 4D 627.5 Å C= 0.21E+20	40000.	0.955E-01	0.196E-03	0.168E-02	0.412E-03	0.315E-02	0.750E-03
	100000.	0.669E-01	0.248E-03	0.311E-02	0.910E-03	0.600E-02	0.178E-02
	200000.	0.527E-01	0.352E-03	0.417E-02	0.130E-02	0.800E-02	0.261E-02
	500000.	0.397E-01	0.336E-03	0.548E-02	0.174E-02	0.959E-02	0.356E-02
O V 3D 4F 681.3 Å C= 0.25E+20	40000.	0.672E-01	-0.676E-03	0.158E-02	-0.222E-02	0.304E-02	-0.401E-02
	100000.	0.458E-01	-0.675E-03	0.373E-02	-0.404E-02	0.736E-02	-0.782E-02
	200000.	0.355E-01	-0.450E-03	0.563E-02	-0.517E-02	0.111E-01	-0.104E-01
	500000.	0.268E-01	-0.282E-03	0.811E-02	-0.662E-02	0.153E-01	-0.135E-01
O V 3D 5F 481.1 Å C= 0.52E+18	40000.	0.126	-0.329E-02				
	100000.	0.944E-01	-0.445E-02				
	200000.	0.767E-01	-0.444E-02				
	500000.	0.585E-01	-0.496E-02				
O V 4D 4F 18849.4 Å C= 0.19E+23	40000.	92.6	-1.44	1.55	-2.34	2.98	-4.19
	100000.	65.5	-1.45	3.63	-4.10	7.13	-7.89
	200000.	52.1	-1.29	5.51	-5.16	10.7	-10.3
	500000.	39.8	-1.09	8.30	-6.50	14.6	-13.5
O V 4D 5F 1506.7 Å C= 0.51E+19	40000.	1.44	-0.384E-01				
	100000.	1.08	-0.498E-01				
	200000.	0.881	-0.496E-01				
	500000.	0.673	-0.542E-01				
Perturber density = $1 \times 10^{19} \text{ cm}^{-3}$							
O V 2S-2P 629.7 Å C= 0.63E+22	100000.	0.516E-01	-0.102E-02	0.475E-03	-0.470E-03	0.878E-03	-0.869E-03
	200000.	0.369E-01	-0.997E-03	0.113E-02	-0.933E-03	0.215E-02	-0.180E-02
	500000.	0.245E-01	-0.129E-02	0.230E-02	-0.168E-02	0.452E-02	-0.340E-02
	800000.	0.203E-01	-0.119E-02	0.303E-02	-0.211E-02	0.601E-02	-0.429E-02
O V 2P 3S 248.5 Å C= 0.12E+21	100000.	0.250E-01	0.234E-02	0.153E-02	0.231E-02	0.306E-02	0.420E-02
	200000.	0.191E-01	0.244E-02	0.275E-02	0.345E-02	0.547E-02	0.648E-02
	500000.	0.138E-01	0.240E-02	0.447E-02	0.453E-02	0.894E-02	0.902E-02
	800000.	0.119E-01	0.234E-02	0.527E-02	0.507E-02	0.105E-01	0.104E-01
O V 2P 4S 174.6 Å C= 0.19E+20	100000.	0.445E-01	0.560E-02	*0.739E-02	*0.673E-02		
	200000.	0.351E-01	0.580E-02	*0.986E-02	*0.944E-02		
	500000.	0.264E-01	0.549E-02	*0.135E-01	*0.123E-01		
	800000.	0.228E-01	0.503E-02	*0.154E-01	*0.137E-01		
O V 2P 3D 220.4 Å C= 0.15E+21	100000.	0.166E-01	-0.272E-04	0.634E-03	-0.320E-03	0.120E-02	-0.592E-03
	200000.	0.122E-01	-0.148E-03	0.103E-02	-0.545E-03	0.201E-02	-0.105E-02
	500000.	0.864E-02	0.103E-04	0.152E-02	-0.832E-03	0.301E-02	-0.168E-02
	800000.	0.742E-02	-0.203E-04	0.172E-02	-0.942E-03	0.337E-02	-0.193E-02



STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES

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Transition	T(K)	Electrons		Perturbers		He III	
		Width (Å)	Shift (Å)	Protons Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 2P 4D 170.2 Å C= 0.10E+20	100000.	0.462E-01	0.614E-03	*0.426E-02	*0.324E-02		
	200000.	0.365E-01	0.844E-03	*0.580E-02	*0.444E-02		
	500000.	0.275E-01	0.754E-03	*0.814E-02	*0.583E-02		
	800000.	0.240E-01	0.780E-03	*0.965E-02	*0.639E-02		
O V 3D 4F 728.7 Å C= 0.19E+21	100000.	0.554	-0.374E-02	0.618E-01	-0.612E-01		
	200000.	0.432	-0.180E-02	0.929E-01	-0.836E-01		
	500000.	0.326	-0.916E-03	0.134	-0.110		
	800000.	0.286	0.433E-03	0.163	-0.120		
O V 3D 5F 509.4 Å C= 0.14E+20	100000.	0.975	0.142E-01				
	200000.	0.811	0.698E-02				
	500000.	0.629	-0.726E-02				
	800000.	0.551	-0.172E-01				
O V 2P 3S 215.2 Å C= 0.17E+21	100000.	0.144E-01	0.121E-02	0.553E-03	0.106E-02	0.107E-02	0.193E-02
	200000.	0.108E-01	0.156E-02	0.112E-02	0.158E-02	0.226E-02	0.300E-02
	500000.	0.779E-02	0.147E-02	0.205E-02	0.215E-02	0.415E-02	0.433E-02
	800000.	0.670E-02	0.143E-02	0.243E-02	0.245E-02	0.492E-02	0.498E-02
O V 2P 4S 156.2 Å C= 0.33E+20	100000.	0.253E-01	0.389E-02	0.274E-02	0.312E-02		
	200000.	0.199E-01	0.376E-02	0.417E-02	0.423E-02		
	500000.	0.149E-01	0.365E-02	0.585E-02	0.554E-02		
	800000.	0.130E-01	0.338E-02	0.673E-02	0.622E-02		
O V 3P 4S 716.3 Å C= 0.69E+21	100000.	0.736	0.739E-01	0.574E-01	0.622E-01		
	200000.	0.577	0.723E-01	0.855E-01	0.845E-01		
	500000.	0.433	0.700E-01	0.119	0.112		
	800000.	0.377	0.647E-01	0.137	0.122		
O V 3S 3P 2784.8 Å C= 0.14E+23	100000.	5.67	-0.967E-01	0.197	-0.561E-01	0.373	-0.104
	200000.	4.31	-0.168	0.291	-0.945E-01	0.563	-0.182
	500000.	3.15	-0.146	0.388	-0.143	0.749	-0.288
	800000.	2.73	-0.144	0.437	-0.161	0.819	-0.331
O V 2P 3D 192.9 Å C= 0.67E+20	100000.	0.121E-01	-0.157E-03	0.491E-03	-0.464E-03	0.937E-03	-0.855E-03
	200000.	0.897E-02	-0.157E-03	0.847E-03	-0.731E-03	0.166E-02	-0.140E-02
	500000.	0.634E-02	-0.761E-04	0.137E-02	-0.105E-02	0.267E-02	-0.212E-02
	800000.	0.543E-02	-0.846E-04	0.162E-02	-0.120E-02	0.309E-02	-0.245E-02
O V 2P 4D 151.5 Å C= 0.12E+20	100000.	0.347E-01	0.414E-03	0.224E-02	0.777E-03	*0.424E-02	*0.142E-02
	200000.	0.273E-01	0.451E-03	0.291E-02	0.116E-02	*0.559E-02	*0.218E-02
	500000.	0.206E-01	0.470E-03	0.378E-02	0.152E-02	*0.684E-02	*0.304E-02
	800000.	0.179E-01	0.462E-03	0.436E-02	0.171E-02	*0.746E-02	*0.353E-02

Transition	T(K)	Perturbers					
		Electrons		Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3P 4D 627.5 Å C= 0.21E+21	100000.	0.668	0.172E-02	0.309E-01	0.840E-02	*0.583E-01	*0.154E-01
	200000.	0.526	0.305E-02	0.416E-01	0.127E-01	*0.792E-01	*0.240E-01
	500000.	0.396	0.300E-02	0.548E-01	0.173E-01	*0.958E-01	*0.348E-01
	800000.	0.346	0.310E-02	0.647E-01	0.196E-01	*0.104	*0.401E-01
O V 3D 4F 681.3 Å C= 0.25E+21	100000.	0.457	-0.249E-02	0.371E-01	-0.359E-01	*0.726E-01	-0.632E-01
	200000.	0.355	-0.125E-02	0.563E-01	-0.499E-01	*0.111	-0.913E-01
	500000.	0.268	-0.695E-03	0.811E-01	-0.660E-01	*0.153	-0.131
	800000.	0.235	0.762E-03	0.989E-01	-0.740E-01	*0.173	-0.150
O V 3D 5F 481.1 Å C= 0.52E+19	100000.	0.829	-0.379E-02				
	200000.	0.687	-0.104E-01				
	500000.	0.534	-0.130E-01				
	800000.	0.469	-0.187E-01				
O V 4D 5F 1506.7 Å C= 0.51E+20	100000.	9.68	-0.894E-01				
	200000.	8.02	-0.157				
	500000.	6.23	-0.179				
	800000.	5.46	-0.234				
Perturber density = $1 \times 10^{+20} \text{ cm}^{-3}$							
O V 2S-2P 629.7 Å C= 0.63E+23	100000.	0.516	-0.925E-02	0.465E-02	-0.397E-02	0.797E-02	-0.604E-02
	200000.	0.369	-0.927E-02	0.112E-01	-0.864E-02	0.212E-01	-0.158E-01
	500000.	0.245	-0.125E-01	0.230E-01	-0.166E-01	0.451E-01	-0.325E-01
	800000.	0.203	-0.116E-01	0.303E-01	-0.211E-01	0.601E-01	-0.421E-01
O V 2P 3S 248.5 Å C= 0.12E+22	100000.	0.250	0.161E-01	*0.152E-01	*0.177E-01		
	200000.	0.191	0.195E-01	*0.274E-01	*0.295E-01		
	500000.	0.138	0.208E-01	*0.447E-01	*0.434E-01		
	800000.	0.119	0.211E-01	*0.527E-01	*0.504E-01		
O V 2P 4S 174.6 Å C= 0.19E+21	100000.	*0.420	*0.130E-01				
	200000.	0.336	0.291E-01				
	500000.	0.254	0.361E-01				
	800000.	0.221	0.360E-01				
O V 2P 3D 220.4 Å C= 0.15E+22	100000.	0.166	0.409E-03	0.615E-02	-0.266E-02	*0.104E-01	-0.396E-02
	200000.	0.122	-0.996E-03	0.102E-01	-0.495E-02	*0.195E-01	-0.890E-02
	500000.	0.864E-01	0.434E-03	0.152E-01	-0.813E-02	*0.299E-01	-0.157E-01
	800000.	0.742E-01	0.241E-05	0.172E-01	-0.939E-02	*0.336E-01	-0.186E-01
O V 2P 4D 170.2 Å C= 0.10E+21	100000.	*0.434	*-0.299E-02				
	200000.	0.347	0.216E-02				
	500000.	0.264	0.314E-02				
	800000.	0.231	0.392E-02				

STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES

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Transition	T(K)	Electrons		Perturbers Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3D 4F 728.7 Å C= 0.19E+22	100000.	5.21	0.178				
	200000.	4.12	0.128				
	500000.	3.14	0.897E-01				
	800000.	2.77	0.860E-01				
O V 3D 5F 509.4 Å C= 0.14E+21	100000.	*6.85	*0.414				
	200000.	*6.05	*0.311				
	500000.	5.01	0.169				
	800000.	4.50	0.107				
O V 2P 3S 215.2 Å C= 0.17E+22	100000.	0.144	0.941E-02	0.551E-02	0.842E-02		
	200000.	0.108	0.136E-01	0.112E-01	0.138E-01		
	500000.	0.779E-01	0.134E-01	0.204E-01	0.207E-01		
	800000.	0.670E-01	0.134E-01	0.243E-01	0.244E-01		
O V 2P 4S 156.2 Å C= 0.33E+21	100000.	0.251	0.239E-01				
	200000.	0.198	0.275E-01				
	500000.	0.148	0.299E-01				
	800000.	0.129	0.291E-01				
O V 3P 4S 716.3 Å C= 0.69E+22	100000.	*7.32	*0.448				
	200000.	5.75	0.527				
	500000.	4.31	0.572				
	800000.	3.76	0.555				
O V 2P 3D 192.9 Å C= 0.67E+21	100000.	0.121	-0.424E-03	0.479E-02	-0.379E-02	*0.832E-02	-0.545E-02
	200000.	0.897E-01	-0.801E-03	0.840E-02	-0.650E-02	*0.162E-01	-0.114E-01
	500000.	0.633E-01	-0.250E-03	0.137E-01	-0.102E-01	*0.266E-01	-0.195E-01
	800000.	0.543E-01	-0.494E-03	0.162E-01	-0.120E-01	*0.308E-01	-0.235E-01
O V 2P 4D 151.5 Å C= 0.12E+21	100000.	*0.332	*0.232E-02				
	200000.	0.263	0.333E-02				
	500000.	0.200	0.387E-02	*0.377E-01	*0.146E-01		
	800000.	0.175	0.390E-02	*0.436E-01	*0.170E-01		
O V 3P 4D 627.5 Å C= 0.21E+22	100000.	*6.41	*0.426E-02	*0.289	*0.672E-01		
	200000.	5.09	0.223E-01	*0.406	*0.111		
	500000.	3.86	0.234E-01	*0.546	*0.167		
	800000.	3.38	0.243E-01	*0.646	*0.195		
O V 3D 4F 681.3 Å C= 0.25E+22	100000.	4.44	0.112				
	200000.	3.46	0.785E-01				
	500000.	2.63	0.530E-01				
	800000.	2.31	0.553E-01				

Transition	T(K)	Electrons		Perturbers		He III	
		Width (Å)	Shift (Å)	Protons Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 3D 5F 481.1 Å C= 0.52E+20	100000.	*6.33	*0.327				
	200000.	*5.50	*0.186				
	500000.	4.48	0.959E-01				
	800000.	4.01	0.537E-01				
Perturber density = $1 \times 10^{21} \text{ cm}^{-3}$							
O V 2S-2P 629.7 Å C= 0.63E+24	100000.	5.16	-0.605E-01	0.378E-01	-0.226E-01	*0.380E-01	-0.176E-01
	200000.	3.69	-0.717E-01	0.109	-0.704E-01	*0.181	*-0.998E-01
	500000.	2.45	-0.112	0.229	-0.152	*0.442	*-0.277
	800000.	2.03	-0.105	0.302	-0.200	*0.597	*-0.377
O V 2P 3S 248.5 Å C= 0.12E+23	100000.	*2.31	*-0.989E-01				
	200000.	1.81	0.295E-01				
	500000.	1.33	0.112				
	800000.	1.15	0.130				
O V 2P 4S 174.6 Å C= 0.19E+22	100000.						
	200000.	*2.32	*-0.147				
	500000.	*1.95	*0.714E-01				
	800000.	1.74	0.108				
O V 2P 3D 220.4 Å C= 0.15E+23	100000.	*1.64	*0.337E-01	*0.447E-01	-0.141E-01		
	200000.	1.22	0.791E-02	*0.953E-01	-0.376E-01		
	500000.	0.860	0.148E-01	*0.150	-0.710E-01		
	800000.	0.739	0.871E-02	*0.170	-0.861E-01		
O V 2P 4D 170.2 Å C= 0.10E+22	100000.						
	200000.						
	500000.	*2.20	*0.304E-01				
	800000.	*1.97	*0.318E-01				
O V 2P 3S 215.2 Å G= 0.17E+23	100000.	*1.42	*-0.139E-01				
	200000.	1.07	0.699E-01				
	500000.	0.773	0.948E-01				
	800000.	0.665	0.101				
O V 2P 4S 156.2 Å C= 0.33E+22	100000.						
	200000.	*1.69	-0.188E-01				
	500000.	*1.32	*0.125				
	800000.	1.17	0.143				
O V 2P 3D 192.9 Å C= 0.67E+22	100000.	*1.17	*0.364E-01				
	200000.	0.874	0.179E-01				
	500000.	0.621	0.124E-01				
	800000.	0.533	0.780E-02	*0.163	*-0.107		

**STARK BROADENING PARAMETER TABLES FOR O IV AND O V LINES**

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Transition	T(K)	Perturbers					
		Electrons		Protons		He III	
		Width (Å)	Shift (Å)	Width (Å)	Shift (Å)	Width (Å)	Shift (Å)
O V 2P 4D 151.5 Å C= 0.12E+22	100000.						
	200000.	*2.06	*0.252E-01				
	500000.	*1.67	*0.331E-01				
	800000.	*1.49	*0.336E-01				
Perturber density = $1 \times 10^{22} \text{ cm}^{-3}$							
O V 2P 3S 248.5 Å C= 0.12E+24	100000.						
	200000.	*11.6	*-1.94				
	500000.	*9.85	-0.432				
	800000.	*8.89	*0.642E-01				
O V 2P 3D 220.4 Å C= 0.15E+24	100000.						
	200000.						
	500000.	*8.03	*0.331				
	800000.	*6.97	*0.235				
O V 2P 3S 215.2 Å C= 0.17E+24	100000.						
	200000.	*8.06	*-1.03				
	500000.	*6.52	-0.785E-01				
	800000.	*5.75	*0.220				
O V 2P 3D 192.9 Å C= 0.67E+23	100000.						
	200000.	*7.44	*0.333				
	500000.	*5.52	*0.277				
	800000.	*4.81	*0.204				

1984), which gives an estimate 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  $0.1 < NV < 0.5$  are denoted by an asterisk. When the impact approximation is not valid, the ion broadening contribution may be estimated by using quasistatic approach (Sahal-Bréchet 1991 and Griem 1974). The accuracy of the results obtained decreases when broadening by ion interactions becomes important.

The analysis of present results and comparison with available experimental and theoretical data will be published elsewhere (Dimitrijević and Sahal-Bréchet, 1994).

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ТАБЕЛЕ ПАРАМЕТАРА ШТАРКОВОГ ШИРЕЊА АСТРОФИЗИЧКИ  
 ЗНАЧАЈНИХ ЛИНИЈА О IV И О V

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Користећи семикласичан прилаз, израчуна-  
 те су ширине и помераји спектралних линија, про-  
 узроковани сударима са електронима, протонима

и He III, за 5 мултиплета О IV и 19 мултиплета  
 О V. Резултати су дати у функцији температуре и  
 концентрације пертурбера.