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LINE BROADENING DATA: STARK BROADENING OF Ca II Sc III AND Ti IV LINES

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ABSTRACT Electron- and proton-impact line widths and shifts for important Ca II, Sc III and Ti IV lines, have been calculated using the semiclassical-perturbation formalism. The obtained results were used to investigate the behaviour of Stark broadening parameters within the K I isoelectronic sequence.

INTRODUCTION

Stark broadening of spectral lines has been taking a new interest in astrophysics (Seaton, 1987), owing to the recent development of researches on the physics of stellar interiors: in subphotospheric layers, the modellisation of energy transport needs the knowledge of radiative opacities and thus, certain atomic processes must be known with accuracy.In order to provide a method for quick interpolation of new data along an isoelectronic sequence it is of interest to investigate if a sufficiently regular behaviour of Stark broadening parameters along such a sequence exists. Consequently, one of aims of this paper is to provide Stark broadening data for a number of transitions within several members of an isoelectronic sequence.

The present paper concerns Ca II, Sc III and Ti IV lines from the kalium isoelectronic sequence. Beyond the interest for the stellar atmospheres investigation and the modellisation of stellar interiors, the knowledge of Ca II, Sc III and Ti broadening parameters is important for a number of problems in astrophysics and plasma physics. Particularly is important Ca II which is among the most abundant elements in stellar plasma after hydrogen and helium.

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RESULTS AND DISCUSSION

In order to provide reliable data for the mentioned lines broadened by collisions with all important charged perturbers in stellar plasmas, we have calculated electron-, proton-, and ionized helium-impact line widths and shifts for 28 Ca II (Dimitrijević et al, 1992ab), 10 Sc III and 10 Ti IV

TABLE I This table shows electron- and proton-impact broadening parameters for Ca II, Sc III and Ti IV lines, for perturber density of 10^{17} cm^{-3} as a function of temperature. Transitions and averaged wavelengths for the multiplet (in Å) are also given. By deviding c with electron-impact WIDTH 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 = 0.1D+18(cm-3)

		ELECTRONS		PROTONS	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
CA II 3D-4P	5000.	1.34	0.595E-01	0.397E-01	-0.642E-02
8581.1 A	10000.	1.05	0.308E-01	0.666E-01	-0.129E-01
C= 0.86E+21	20000.	0.856	0.228E-01	0.927E-01	-0.209E-01
	30000.	0.776	0.913E-02	0.101	-0.255E-01
	50000.	0.707	0.736E-02	0.112	-0.309E-01
	100000.	0.643	0.792E-02	0.125	-0.374E-01
CA II 3D-5P	5000.	0.303	-0.363E-01	0.238E-01	-0.737E-02
2132.3 A	10000.	0.241	-0.220E-01	0.308E-01	-0.115E-01
C= 0.17E+20	20000.	0.207	-0.224E-01	0.359E-01	-0.152E-01
	30000.	0.196	-0.182E-01	0.391E-01	-0.170E-01
	50000.	0.189	-0.146E-01	0.410E-01	-0.198E-01
	100000.	0.183	-0.132E-01	0.431E-01	-0.225E-01
CA II 3D-6P	5000.	0.413	-0.129		
1644.1 A	10000.	0.358	-0.988E-01		
C= 0.48E+19	20000.	0.333	-0.783E-01	*0.730E-01	-0.374E-01
	30000.	0.328	-0.634E-01	*0.762E-01	-0.415E-01
	50000.	0.332	-0.552E-01	*0.806E-01	-0.477E-01
	100000.	0.334	-0.436E-01	*0.885E-01	-0.558E-01
SCIII 3D-4P	20000.	0.278E-01	0.836E-03	0.105E-02	0.153E-03
1605.1 A	50000.	0.183E-01	0.894E-03	0.184E-02	0.331E-03
C= 0.95E+20	100000.	0.140E-01	0.785E-03	0.227E-02	0.477E-03
	200000.	0.113E-01	0.869E-03	0.257E-02	0.613E-03

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TIIV 3D-4P	20000.	0.596E-02	0.758E-04	0.787E-04	0.128E-04
777.8 A	50000.	0.384E-02	0.913E-04	0.198E-03	0.326E-04
C= 0.29E+20	100000.	0.281E-02	0.912E-04	0.295E-03	0.563E-04
	200000.	0.215E-02	0.109E-03	0.373E-03	0.816E-04
TIIV 3D-5P	20000.	0.473E-02	0.553E-04	0.236E-03	0.127E-04
433.7 A	50000.	0.335E-02	0.891E-04	0.394E-03	0.298E-04
C= 0.35E+19	100000.	0.270E-02	0.891E-04	0.467E-03	0.457E-04
	200000.	0.227E-02	0.984E-04	0.525E-03	0.627E-04

multiplets (Dimitrijević and Sahal-Bréchot, 1992c), using the semiclassical-perturbation formalism (Sahal-Bréchot, 1969ab). This is a part of an effort to provide reliable Stark broadening data for stellar plasma research (see the review on up to now performed calculations for He I, Na I, K I, F I, Be II, Mg II, Ca II, Sr II, Ba II, Si II, Ar II, Ga II, Ga III and several lines of other light elements, in Dimitrijevic and Sahal-Bréchot, 1991).

As an example, in Table I are presented results for some important Ca II, Sc III and Ti IV lines. The obtained results were used also to investigate the behaviour of Stark broadening parameters within the isoelectronic sequence in order to examine the use of such behaviour for the interpolation of new data of interest for the stellar plasma investigations. Our analysis shows that a regular behaviour exist but the mutual relation of the corresponding Stark broadening parameters depends on temperature. Additional experimental and theoretical work for the investigated case is needed as well as the extension to the other members of K isoelectronic sequence.

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