Groupe de Recherche en Physique Atomique et Astrophysique

Ab initio Stark broadening calculations for Ca V spectral lines

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•Ca V belongs to the sulfure-like sequense, its ground state configuration is $[Ne]3s^2 3p^4$ with the term ^3P.

•Calcium lines are detected in the atmospheres of white dwarfs (Zuckerman et al. 2003 for example). Recently, calcium in higher ionization stage (Ca X) is observed in photosphere of the hot white dwarf KPD 0005+5106 (Werner et al. 2008). Ca V lines are introduced in atmospheric model used by Rauch et al. (2007) to study white dwarf central star of Sh 2-216.

•The aim of this work is to provide ab initio calculations of Stark broadening parameters due to electron, proton, and ionized helium impact of Ca V lines.

The method

- The energy levels and oscillator strengths were carried out with the general purpose atomic structure program SUPERSTRUCTURE (Eissner et al. 1974), as modified by Nussbaumer & Storey (1978).

- The adopted atomic model for Ca V includes 12 configurations $3s^2 3p^4$, $3s3p^5$, $3s^2 3p^3 3d$, $3s^2 3p^3 4\ell$, $3s^2 3p^3 5\ell$ ($\ell \leq n-1$).

- Relativistic corrections are introduced by means of Breit-Pauli approximation $H = H_{nr} + H_{BP}$.

- Stark broadening parameter calculations have been performed within the semiclassical perturbation method (Sahal-Bréchot 1969a, 1969b).

- SUPERSTRUCURE + semiclassical perturbation method → ab initio calculation of Stark broadening parameters.

Results

N=10^{17}cm^{-3}

transition	T(K)	w_e	d_e	w_{H+}	d_{H+}	w_{He+}	d_{He+}
$3s^2 3p^4\ {}^3P$-$3s3p^5\ {}^3P^\circ$	50000.	0.191E-02	-0.275E-03	0.762E-05	-0.949E-05	0.137E-04	-0.943E-05
694.6 Å	100000.	0.135E-02	-0.173E-03	0.196E-04	-0.184E-04	0.295E-04	-0.177E-04
C= 0.69E+20	150000.	0.110E-02	-0.143E-03	0.303E-04	-0.256E-04	0.415E-04	-0.237E-04
	200000.	0.949E-03	-0.138E-03	0.398E-04	-0.314E-04	0.485E-04	-0.282E-04
	300000.	0.776E-03	-0.123E-03	0.514E-04	-0.392E-04	0.609E-04	-0.342E-04
	500000.	0.616E-03	-0.109E-03	0.698E-04	-0.501E-04	0.723E-04	-0.423E-04
$3s^2 3p^4\ {}^1D$-$3s3p^5\ {}^1P^\circ$	50000.	0.192E-02	-0.383E-03	0.783E-05	-0.143E-04	0.135E-04	-0.140E-04
591.6 Å	100000.	0.136E-02	-0.246E-03	0.208E-04	-0.267E-04	0.290E-04	-0.247E-04
C= 0.59E+20	150000.	0.112E-02	-0.214E-03	0.323E-04	-0.356E-04	0.400E-04	-0.320E-04
	200000.	0.974E-03	-0.193E-03	0.418E-04	-0.422E-04	0.473E-04	-0.362E-04
	300000.	0.811E-03	-0.169E-03	0.544E-04	-0.512E-04	0.598E-04	-0.442E-04
	500000.	0.664E-03	-0.151E-03	0.731E-04	-0.628E-04	0.705E-04	-0.511E-04
$3s^2 3p^4\ {}^1D$-$3p^3({}^2D)3d\ {}^1D^\circ$	50000.	0.990E-03	-0.156E-03	0.198E-05	-0.690E-05	0.351E-05	-0.680E-05
433.7 Å	100000.	0.699E-03	-0.102E-03	0.642E-05	-0.130E-04	0.890E-05	-0.121E-04
C= 0.30E+20	150000.	0.571E-03	-0.898E-04	0.108E-04	-0.174E-04	0.138E-04	-0.157E-04
	200000.	0.498E-03	-0.826E-04	0.154E-04	-0.208E-04	0.167E-04	-0.179E-04
	300000.	0.414E-03	-0.734E-04	0.207E-04	-0.252E-04	0.225E-04	-0.219E-04
	500000.	0.339E-03	-0.666E-04	0.305E-04	-0.313E-04	0.285E-04	-0.255E-04

New Stark broadening parameters calculations and measurements for this ion will be interesting to check the validity of our results.

Thank you for your attention