SIMPLE EXPRESSION FOR THE LINEAR STARK BROADENING CONSTANT OF HYDROGEN LINES

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ABSTRACT. A simple analytic expression is presented allowing to take into account the Stark broadening constant of hydrogen lines.

Key words: Line profiles, Stark broadening

The main line broadening factor of hydrogen lines in stellar photospheres is the Stark broadening. But in stellar chromospheres the sufficient micro– and macro turbulent velocities are presented. Therefore if we use chromosphere models for the hydrogen line profile calculations the Doppler broadening to be under consideration. The simultaneous treating of Stark and Doppler broadening is the serious computation problem. In this paper the simple expression for the linear Stark broadening constant of hydrogen lines is presented. With the aid of our above mentioned expression the simultaneous consideration of Stark and Doppler line profile broadening becomes a very easy process.

In the classical Weisskopf theory all pressure dumping parameters γ_n are expressed by common formulae:

$$\gamma_n = 2\pi\rho_0^2 Nv \tag{1}$$

(Mihalas 1978). The linear Stark parameter γ_2 from these theory is equal:

$$\gamma_2 = 2\pi\left(\frac{C_2}{v}\pi\right)^2 Nv \tag{2}$$

(Mihalas 1978). Let's try to estimate the mean value of relationship constant $\bar{C}_2$ for all Stark components:

$$\bar{C}_2 = \frac{3h\bar{n_k}}{4\pi m} = 1.738\bar{n_k}, \tag{3}$$

where $\bar{n_k} = n(n-1)/2$ if $n >> 1$.

So, from Eq.(1) and Eq.(2) we have:

$$\gamma_2 = \frac{2\pi^3}{4}(1.738^2 \cdot n^2(n-1)^2)N/v \tag{4}$$

Taking in the consideration the linear Stark effect depending on N_e and N_p we then may rewrite our Eq. (4) in the following manner:

$$\gamma_2 = 4.683 \cdot 10^1(n^2(n-1)^2)\times \times (N_e/v_e + N_p/v_p) \tag{5}$$

where

$$v_e = \left[\frac{8kT}{\pi}\left(\frac{1}{m_H}+\frac{1}{m_e}\right)\right]^{1/2} \approx \left[\frac{8kT}{\pi m_e}\right]^{1/2} = 6.212 \cdot 10^5\sqrt{T} \tag{6}$$

and

$$v_p = \left[\frac{16kT}{\pi}\left(\frac{1}{m_H}\right)\right]^{1/2} = 2.050 \cdot 10^4\sqrt{T} \tag{7}$$

In the conclusion we can write down the simple expression for the linear Stark parameter:

$$\gamma_2 = 46.83(n^2(n-1)^2)\times \times (N_e 16.212 \cdot 10^5 + N_p 12.050 \cdot 10^4)/\sqrt{T} \tag{8}$$

References

Mihalas D.: 1978, *Stellar atmospheres.*