Substituting equation (5) into equation (4) gives

$$\delta E_n = \frac{\pi r_n n^3}{3\alpha Ry} kT \sqrt[3]{N}, \tag{6}$$

for the width of the level n. Now using in equation (6) $r_n = a_0 n^2/Z$ the radius of the orbit of the electron, the most probable distance, for the quantum state n, for a hydrogenic atom, where a_0 is the Bohr radius and Z is the atomic number of the atom, to finally obtain

$$\delta E_n = \frac{2\pi a_0}{3\alpha Z}\ kT \sqrt[3]{N} n^2, \tag{7}$$

that represents the width of the level of principal quantum number n in ergs. For a line between two levels n_1 and n_2 by convolution of two Gaussians the FWHM of the line is (Mihalas 1978)

$$w = \frac{2\pi a_0}{3\alpha Z} kT \sqrt[3]{N}(n_1^2 + n_2^2). \tag{8}$$

This is the FWHM of the lines for Hydrogenic atoms in ergs. The convolution of the Gaussian distribution of the fluctuations with the Lorentzian of the natural broadening produces a Voigt profile, α is composed of some numerical factors to obtain the FWHM and is defined by $\alpha = \pi\sqrt{\pi}(2\sqrt{2\ln 2}\ )^2$.

3.2. *Non Hydrogenic Atoms*

For non hydrogenic atoms the effective charge and the effective quantum numbers of the levels are used. The effective charge is $Z_{\rm eff} = J + 1$, J is the ionization state of the chemical element. The effective quantum numbers $n_{\rm eff}$ are obtained from (NIST 2010; TOP 2010). Then instead of equation (8) one has

$$w = \frac{2\pi a_0}{3\alpha Z_{\rm eff}}\ kT\ \sqrt[3]{N}\ (n_{\rm eff1}^2\ +\ n_{\rm eff2}^2), \tag{9}$$

for the FWHM in ergs.

4. COMPARISON WITH EXPERIMENTAL RESULTS

The experimental line widths are given for temperature and electron densities and the proportion of the constituents is not given. Therefore the calculations are made for pure elements. Figure 1 shows the FWHM of Hα for electron number densities for different temperatures and experimental FWHM with argon (Wiese et al. 1972; Vitel 1987), and helium plasmas (Büscher et al. 2002), and theoretical values (Gigosos & Cardenosos 1996). There is good agreement between the FWHM.

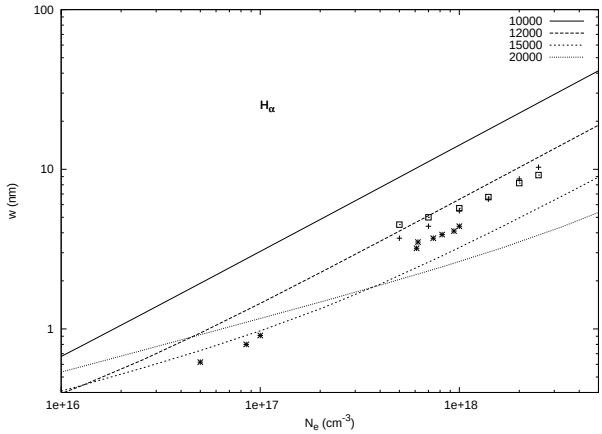

Fig. 1. Shows the width of Hα in Å for several temperatures, compared with experimental and theoretical FWHM in argon and helium.

5. CONCLUSIONS

The results agree well with the experimental results, The widths of the lines would be greater than those calculated with other methods and could help eliminate the so-called "microturbulence" in stellar atmospheres.

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