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HW 04: LINE BROADENING

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1. NATURAL BROADENING

The equation used to generate the Lorentz profile is provided in equation 1. The profile is shown in figure 1 (left), with a green line to indicate the half maximum intensity. Based on the figure, the full width at half maximum is approximately 2.5×10^{-4} $\mathring{A}$, which agrees with $\Gamma/2\pi$.

$$\phi_\nu = \frac{\Gamma/4\pi^2}{(\nu - \nu_0)^2 + (\Gamma/4\pi)^2} \tag{1}$$

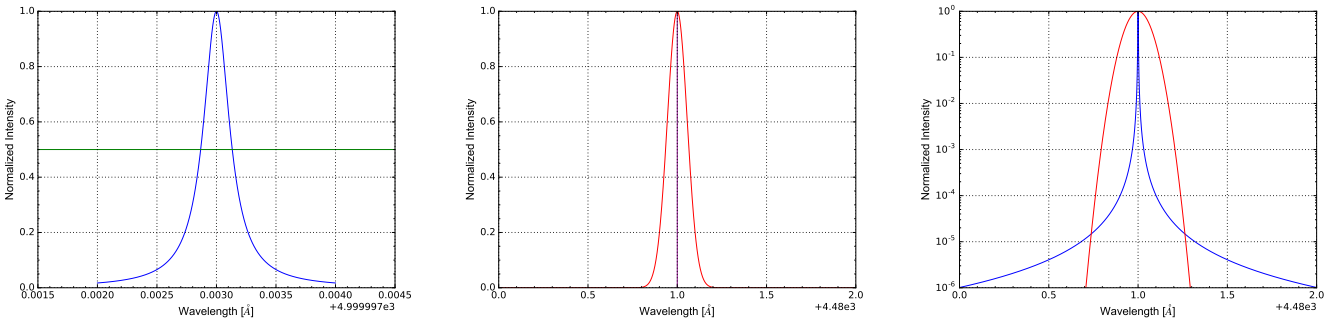

Figure 1. Profiles for Lorentz (left), Doppler (middle), and a combination of the two (right).

2. DOPPLER BROADENING

The equation used to generate the Doppler broadening is provided in equation 2. The profile is shown in figure 1 (middle). The V_{th} and the $\Delta\lambda_D^2$ found for the Mg II line at 4481 Åwere 2.6322 km/s and 0.0787 Å, respectively. The normalized intensity when inputting $\lambda = \lambda_0 + \Delta\lambda_D^2$ in equation 2, was 0.3679. When both the Lorentz and Doppler profiles are compared, figure 1 (right), the wavelength at which the Lorentz profile is greater than the Doppler is at approximately 4481.27 Å.

$$exp(-\frac{(\lambda - \lambda_0)^2}{\Delta\lambda_D^2}) \tag{2}$$

3. ROTATION

The stellar parameters in table 1, used for this section were found at the Caltech "Encyclopedia of Astronomy and Astrophysics" (http://www.astro.caltech.edu/~george/ay20/eaa-stellarmasses.pdf). The highest escape velocities were from spectral class O, and in general, the higher spectral classes. Rotational velocities of the main sequence objects were found in the "Allen-Astrophysical Quantities" reference, and consisted of the vsin(i) parameters. The maximum rotational broadening were found using the vsin(i) parameters against the speed of light. For a B-type star, the maximum rotational broadening is approximately 6004 Å

It cannot be an H-line because of pressure broadening (Stark). The Stark broadening in particular is not sensitive to rotational broadening, therefore it must be a metal line or else Stark broadening dominates the profile.

Table 1. Stellar Parameters.

Spectral Class	Mass [$M_\odot$]	Radius [$R_\odot$]	Escape Velocity [km/s]	$v_e$sin(i) [km/s]	Max Rotational Broadening [Å]
O4 V	60	10	1513.187402	140	4669.897333
B5 V	5	2.7	840.6596678	180	6004.153714
A2 III	2.5	3.8	501.0664191	160	5337.025523
F5 V	1.25	1.2	630.4947509	60	2001.384571
G8 V	1	1.2	563.931649	20	667.1281904

NOTE—Stellar parameters found from derivations and catalogs.