HW 6, #4

By comparing the wavelengths of a feature in the two spectra, one can compute redshift. The strongest emission line has

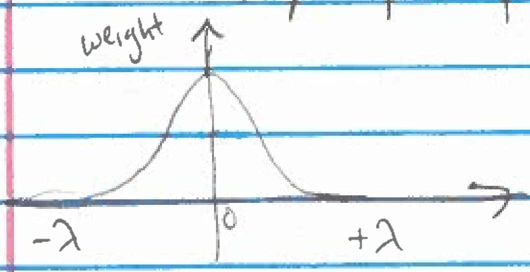
star: central $\lambda_s = 4307$ Å
galaxy: $\lambda_g = 4383$ Å

$$(1+z)\lambda_s = \lambda_g$$

$$\rightarrow z = \frac{\lambda_g}{\lambda_s} - 1 = \frac{4383}{4307} - 1 = \boxed{0.018}$$

In order to find the velocity dispersion of stars in the galaxy, one method is to work forward: start with the stellar spectrum, and convolve it with gaussians of different widths until the result matches the galaxy's spectrum.

One tricky aspect: performing the convolution is not so simple.



gaussian $g(\lambda) = e^{-\lambda^2/2\sigma_\lambda^2}$

It's easy to compute a gaussian for some given choice of σ_λ.

And one can calculate the width of the gaussian σ_λ for any choice of velocity dispersion in the galaxy σ_v (in km/s)

$$\frac{\sigma_\lambda}{\lambda_0} = \frac{\sigma_v}{c}$$

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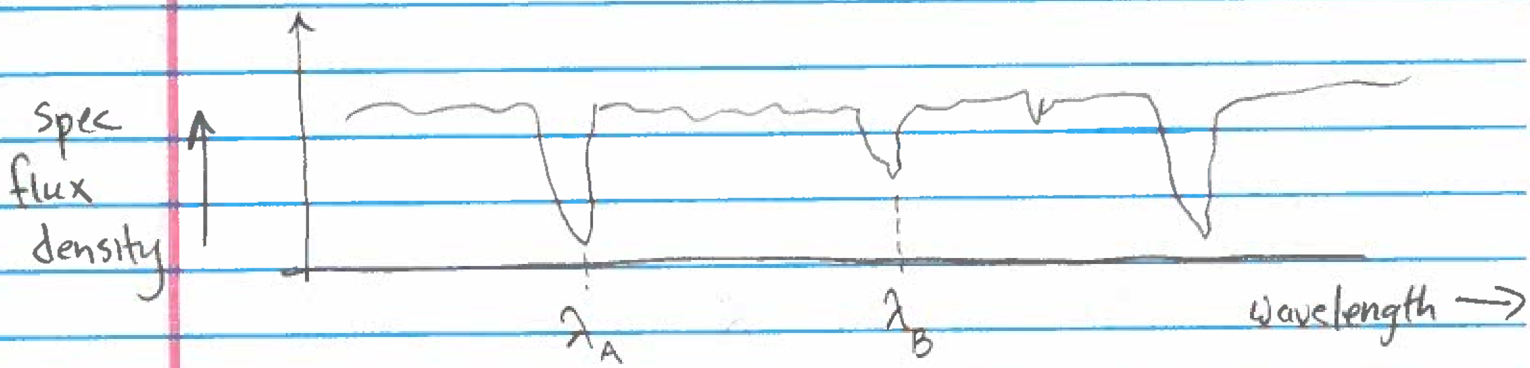
The tricky part is the value λ_0 in this equation.



If one is convolving an extended spectrum, where wavelength changes appreciably, then one cannot use the same gaussian function for the entire calculation.

When convolving values near absorption line A, one must use a gaussian with width in wavelength

$$\frac{\sigma_\lambda}{\lambda_A} = \frac{\sigma_v}{c} \rightarrow \sigma_\lambda = \lambda_A \cdot \frac{\sigma_v}{c}$$

But when convolving the data near the absorption line B, at a longer wavelength, the gaussian must be correspondingly wider:

$$\frac{\sigma_\lambda}{\lambda_B} = \frac{\sigma_v}{c} \rightarrow \sigma_\lambda = \lambda_B \cdot \frac{\sigma_v}{c}$$

You should find that convolving with $\sigma_v \approx 580$ km/s will cause the stellar spectrum to match the galaxy's spectrum very well.