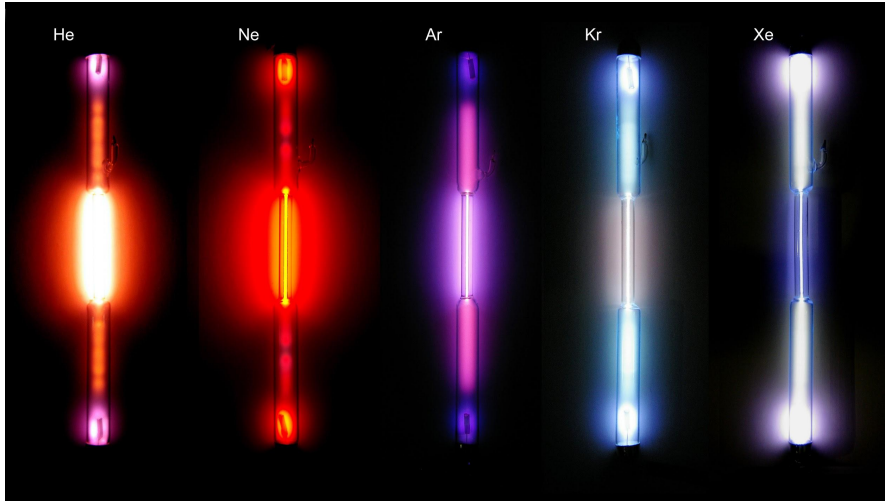
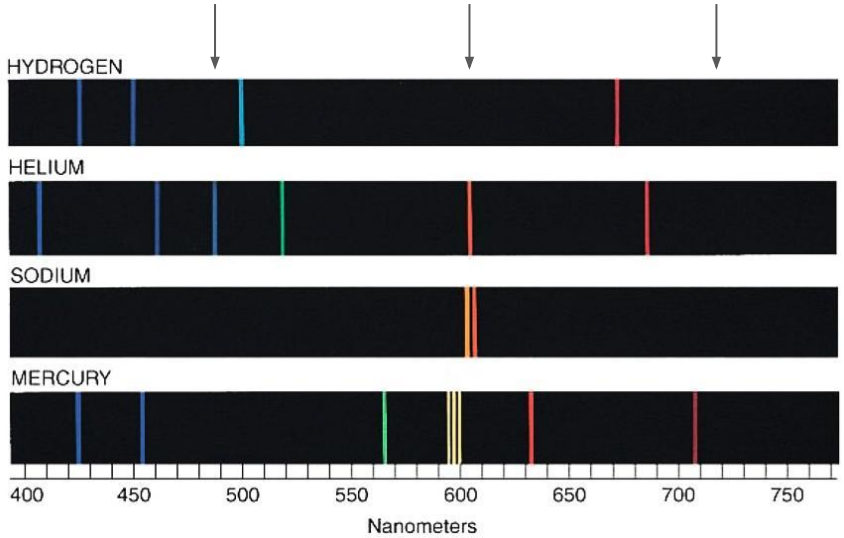
Centroids and Centroiding

Theoretical Background

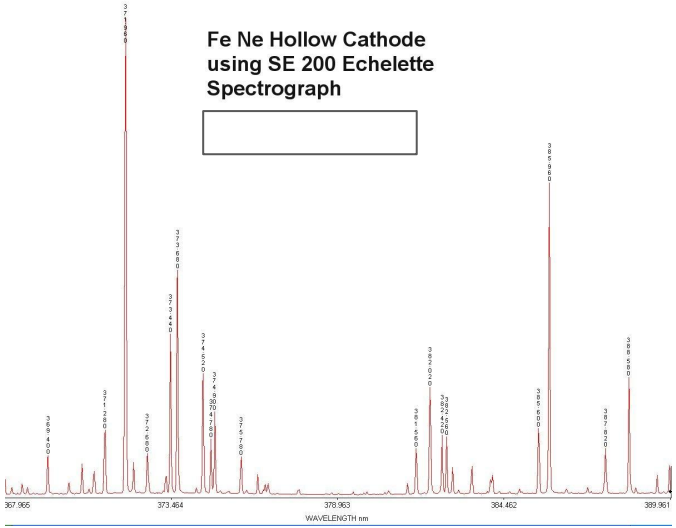
- From physics, we know that different elements produce different spectral lines
- These lines are caused by electrons absorbing energy (thermal or photons) and then emitting photons at specific wavelengths linked to the ΔE between electron energy levels.

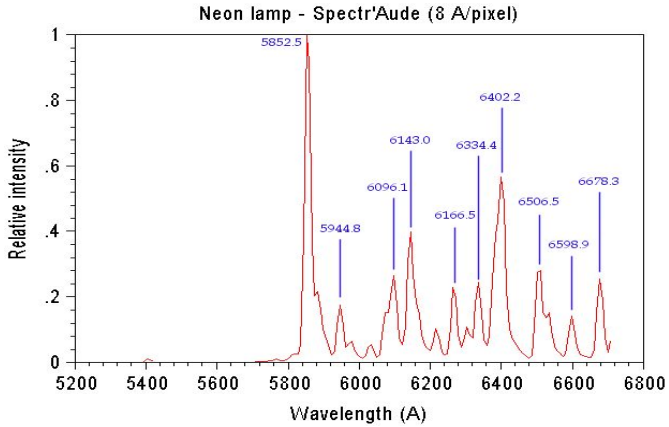




Line Broadening

- Classically, these lines should be quantized at exact wavelengths/energies.
- Quantum physics tells us they can never be exactly unique.
- Doppler broadening is caused by atoms moving in different directions, such that individual photons are slightly red- or blueshifted.
- Other effects? What causes the difference in linewidth for neon between the two examples here?





Center of Light (Centroid)

- To calibrate our spectrometer, we need to obtain single values to use as our best estimate of the location of each line in our spectrum.
- There are multiple ways to do this. One method is called centroiding.
- Centroiding is the process of calculating the “Center of mass” using light.

Formula:

$$x_{cm} = \frac{\sum x_i I_i}{\sum I_i}.$$

Where x_i = is your pixel array and I_i is your signal/intensity array

Plotting some centroids (i.e. the final output) and some further things to consider:

- Consider: Is the centroid of a line within a single spectrum the most accurate estimate of that line location? How can we get our best guess?
- Consider: How do we estimate the uncertainty in our centroid measurement for an empirical case like this?