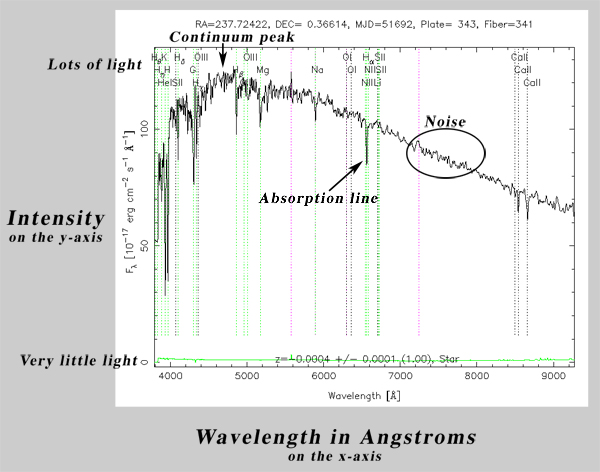
**Types of Stars**

**Purpose:** To acquire a better understanding of the classification of stars by absorption line strength and temperature

**Items:** [SDSS DR15 Navigate Tool](http://skyserver.sdss.org/dr15/en/tools/chart/navi.aspx)

**Introduction:**

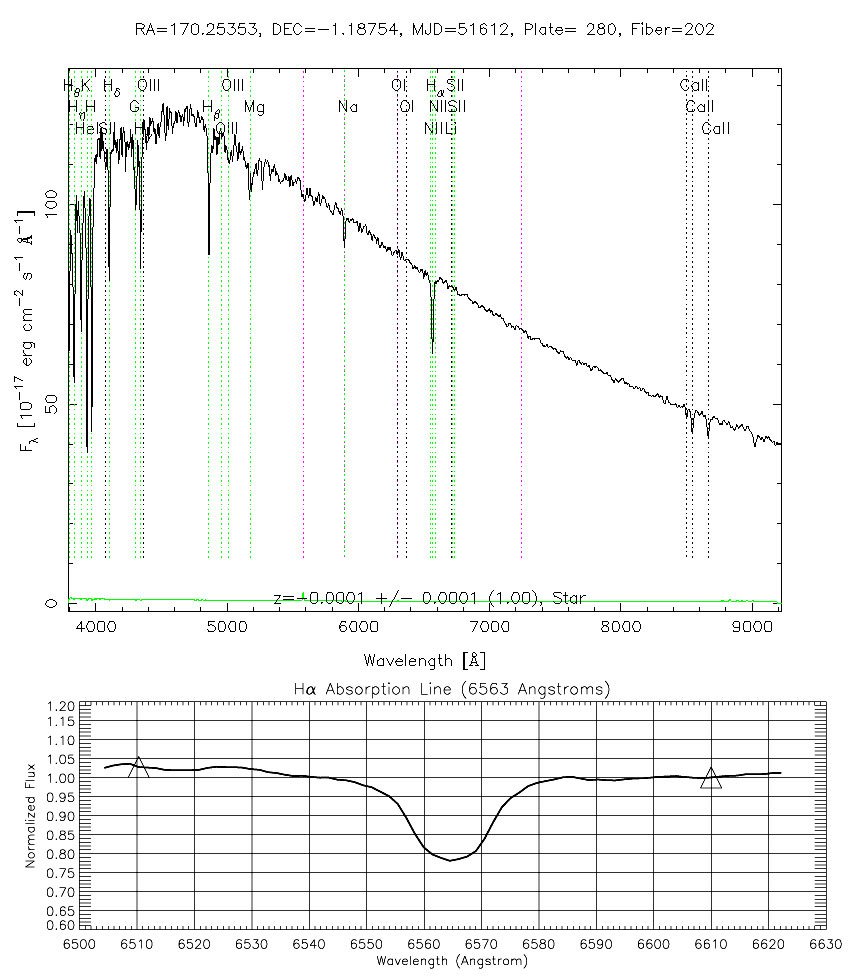
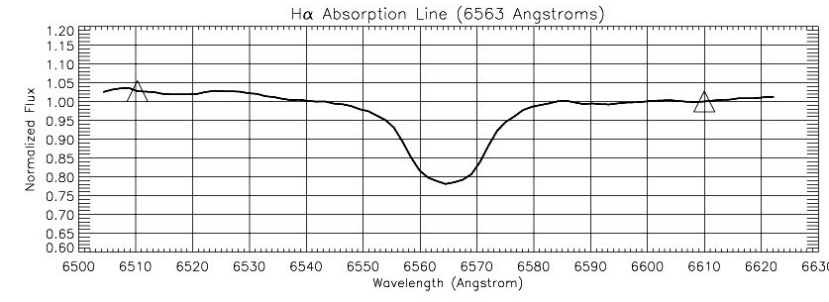
The Sloan Digital Sky Survey (SDSS) measures wavelength in units of Ångstroms (symbol Å), 1 Ångstrom = 10-10 meters. The wavelengths of SDSS spectra go from around 4000 Å (just into ultraviolet light) to 9000 Å (just into infrared light). The scale for the amount of light is complicated, but higher numbers are brighter. The image below shows a typical SDSS spectrum with some labels to point out several features. Some features of the spectrum are:

* ***Continuum peak*** - the top of the broad "hill" in the spectrum
* ***Absorption line*** - one of the narrow "valleys" in the spectrum
* ***Noise*** - some small random fluctuation in the spectrum; noise is usually much smaller than the absorption lines

The spectrum of a star is composed mainly of ***thermal radiation*** that produces a continuous spectrum. The object give off light at many different wavelength, but has a continuum peak wavelength at which they emit more light than at any other wavelength. In addition to the continuous spectrum, a star's spectrum includes a number of dark lines (*absorption lines*). Absorption lines are produced by atoms whose electrons absorb light at a specific wavelength, causing the electrons to move from a lower energy level to a higher one. This process removes some of the continuum being produced by the star and results in dark features in the spectrum.

**Procedure:**

**Part I: Classifying by Line Strength**

The spectrum above is with a zoom-in of the spectrum's Hα line. Notice that the Hα absorption line dips down vertically, but it is not a straight drop; the line has some width. The two triangles in the zoom-in mark two spots on the continuum spectrum. If you drew a line between the centers of the two triangles, you would see approximately how much light would A zoom-in of the spectrum's Hα line with text line strength about 7.5 squareshave been emitted by the star if it had no hydrogen.

1. Look at the spectra of [these seven stars](http://skyserver.sdss.org/dr15/en/proj/basic/spectraltypes/spectra.aspx), count the number of grid squares in the area under the line connecting the triangle centers, record the number in the column of Line strength in the table below. **(only look at star #1, 3, 5, 6)**
2. Originally, astronomers classified those stars with the strongest hydrogen lines as 'A' stars, stars with the next strongest lines as 'B' stars, the next strongest 'C' and so on. The letter assigned to a star is called its ***spectral class***. The spectral classes for the following stars are: A,F, K and M. In the “Spectral Class” of the table, write one of these spectral class letters for each star in the table, in that order (the strongest line is A, etc.). There is only one star of each class in this data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stars | ra | dec | Line strength | Spectral Class |
| Star #1 | 237.61973 | 0.63370 |  |  |
| Star #3 | 170.25353 | -1.18754 |  |  |
| Star #5 | 179.18272 | -1.14384 |  |  |
| Star #6 | 237.17385 | -0.00098 |  |  |

1. Rank the stars by line strength from the strongest line (greatest area) to weakest line (least line area) using star numbers. Record the rank below.

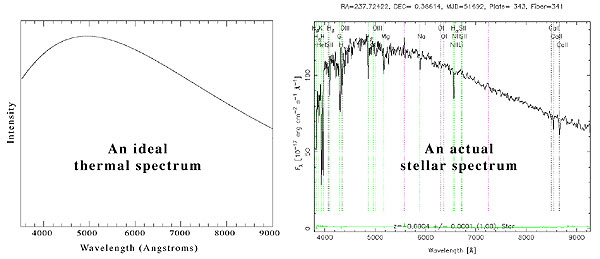
**Part II: Classifying by Temperature**

According to Wien’s law, the temperature (measured in kelvin) of the object is inversely proportional to the continuum peak wavelength (measured in Å) and can be calculated as:

Temperature = 29,000,000 Å / continuum peak wavelength

Å is the unit angstrom which is equal to 0.1 nanometer or 10-10 meters

A spectrum that was only due to temperature is shown on the left of the image below; the spectrum of a real star is shown on the right. The overall shape of the spectrum for the real star peaks at about 4500 Å, so its continuum peak wavelength is 4500 Å



1. Look at the spectra of the same [seven stars](http://skyserver.sdss.org/dr15/en/proj/basic/spectraltypes/spectra.aspx). For this exercise, you can ignore the zoom-in beneath each panel. For each spectrum, trace the underlying continuum shape - this is what the spectrum would look like if it had no emission or absorption lines. Find the continuum peak wavelength for each star. Record in the table below. For example the peak wavelength of star #1 is about 5800 Å. **(only look at star #1, 3, 5, 6)**
2. Use the equation of the Wien’s law described above to calculate the surface temperature of each star. Round the temperature value to a whole number and record it in the table.
3. Click and open [SDSS DR15 Navigate Tool](http://skyserver.sdss.org/dr15/en/tools/chart/navi.aspx). In the Parameter panel on the upper left side of Navigation tool window, enter the coordinates of star showed in the table below to get its images. For example, for star #1 enter ra = 237.61973 and dec=0.63370 and then click search button. The image of the star will show at the center of view. On the right side of the Navigation tool window, you will see the enlarged image of the star (middle)
4. According to the enlarged image of the star, record the color for each star in the table. Please choose from the following available colors: **white, blue, yellow and orange**. Note, you need to look at the center of the star to determine its color. For example, the color for star #1 is yellow.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stars | ra | dec | Peak wavelength (Å) | Temperature (K) | Color |
| Star #1 | 237.61973 | 0.63370 |  |  |  |
| Star #3 | 170.25353 | -1.18754 |  |  |  |
| Star #5 | 179.18272 | -1.14384 |  |  |  |
| Star #6 | 237.17385 | -0.00098 |  |  |  |

1. Rank the stars by temperature from the hottest to coolest using star numbers. Record the rank below.
2. Which star has highest surface temperature? What is the color of the star?
3. Which star has the lowest surface temperature? What is the color of the star?
4. Rank the stars by temperature from the hottest to coolest using their colors. Record the rank below.