Lab 10 -Processing SGS Spectra

Purpose

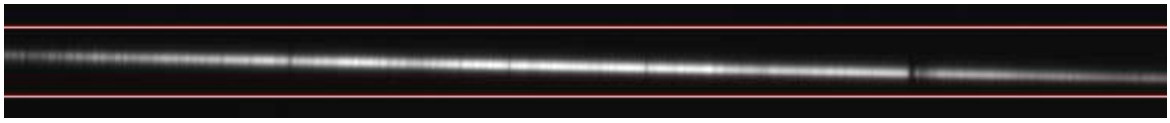
In this experiment we process and graph our astronomical spectra taken with the SGS spectrograph, using Vspec (Visual Spec) software, available to students for free PC download. http://www.astrosurf.com/vdesnoux/ Vspec contains many operations for advanced use, and Vspec basics will be covered in this exercise. These procedures become familiar with use.

Two images taken with the SGS will be used to measure and graph our data, one containing stellar spectra only, and one including neon calibration spectra. We can then identify absorption lines (stellar "fingerprints") http://en.wikipedia.org/wiki/Spectral_line in the star's spectra. We'll also identify Doppler shift, and measure radial velocity. http://en.wikipedia.org/wiki/Doppler_effect#Astronomy

Procedure

Open Vspec. Go to File_open image, navigate to your folder, and open both the star spectra and calibration spectra (i.e. A3, A3cal) .fits files. Choose the star image first. (without vertical neon lines) Reverse the image using mirror X. (SGS creates reversed spectra.) Crop the spectra using the Display reference binning zone tool:

Left-click drag the orange box to surround/crop the spectra: With the mouse, set the bottom line first. Allow space (1 slit tall) between the spectra and the cropping box, then set the top line, allowing the same space between the spectra and crop line, like this:



Cropping bars surrounding the spectra. Vspec.

Hit object binning and an un-calibrated graph of the spectra appears. Now choose the calibration spectra image (loaded in the beginning), reverse the image with Mirror X, and choose Reference binning. This lays the calibration spectra on top of the stellar spectra! Choose Calibration 2 lines to temporarily show only the neon calibration spectra, for line identification.

Next, we identify 2 neon emission lines using the chart provided. These precise identifiers in angstroms, will allow wavelength identification of specific features in our spectra.

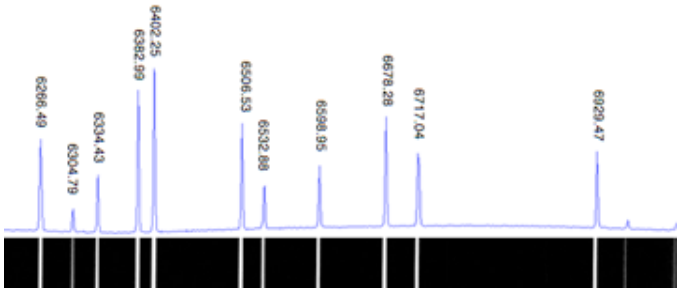


Chart showing neon emission lines.

In Vspec, we are now looking at neon emission lines on the screen. With the cursor in the image window, a hand appears on a vertical red line. Using the neon chart, choose a strong calibration feature, left of center, and *mark both sides of the line*:

Use the mouse/arrow keys to position vertical lines around your calibration feature, for identification: Position the line on the left side of your feature. Then left-click-hold, and use the computer arrow keys ◄ ► to extend the line to the right side. With the feature centered between the 2 vertical markers, release the mouse.

Calibration spectra. Vspec

Type in the *correct identifier* (from the neon chart), and hit the Enter key. Repeat this procedure with a second emission line located right of center, (i.e. 6717.04) and hit Enter. The calibrated star spectrum will now reappear. Hit the Graduations button in the spectra window to show wavelength in angstroms on X axis and intensity on Y axis.

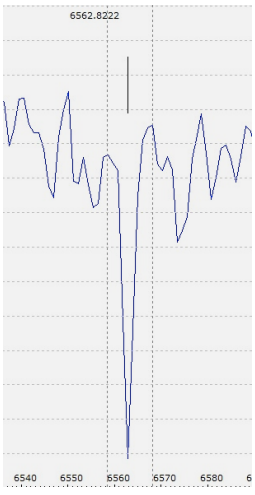
Crop the data vertically as needed: Choose Axis Y to open the "Graphic" window and adjust Hi / Lo thresholds to position your data. Also check the Display gridlines box to show horizontal markers in the graph, and hit Apply.

Create a title box. In Graphic window, go to General tab and click Header to display the UT date/time of your data. In the Graphic Title window type the star name and spectral type. (i.e. Zavijavi F8) In the Comment box type the wavelength range of your data (i.e. 6160-6970Ang). Wavelength range is found in Vspec's "L" window at top, by moving the vertical red line to the extreme left and right of your spectrum. Hit Apply. Finally, return to the Axis X tab, click Display Title and Apply. The title box appears in the graph. Left-click-drag to reposition as needed.

Identify H-alpha and Doppler in your data. The standard wavelength of H-alpha is 6562Å. http://en.wikipedia.org/wiki/Wavelength We will now find the Hα line in our data, to determine the red shift or blue shift (Doppler) of the target star.

In your spectra, visually locate the distinct Hα absorption feature close to 6562Å in your graph. Place the vertical red line on the left side of the feature, left-click-hold, scroll to the right side of the feature, and let go.

Now place the cursor between the lines, right-click and choose Label to display the wavelength of this feature, in angstroms. If your result is higher (+) than the standard wavelength, the star is red shifted, moving away from us. If the result is lower (-) than 6562 Å, the star is blue shifted, and moving toward us.



H-alpha line. Vspec.

Next, we will measure radial velocity of the star, using our Doppler measurement and the simple formula:

(observed wavelength - standard wavelength) / standard wavelength * *c*

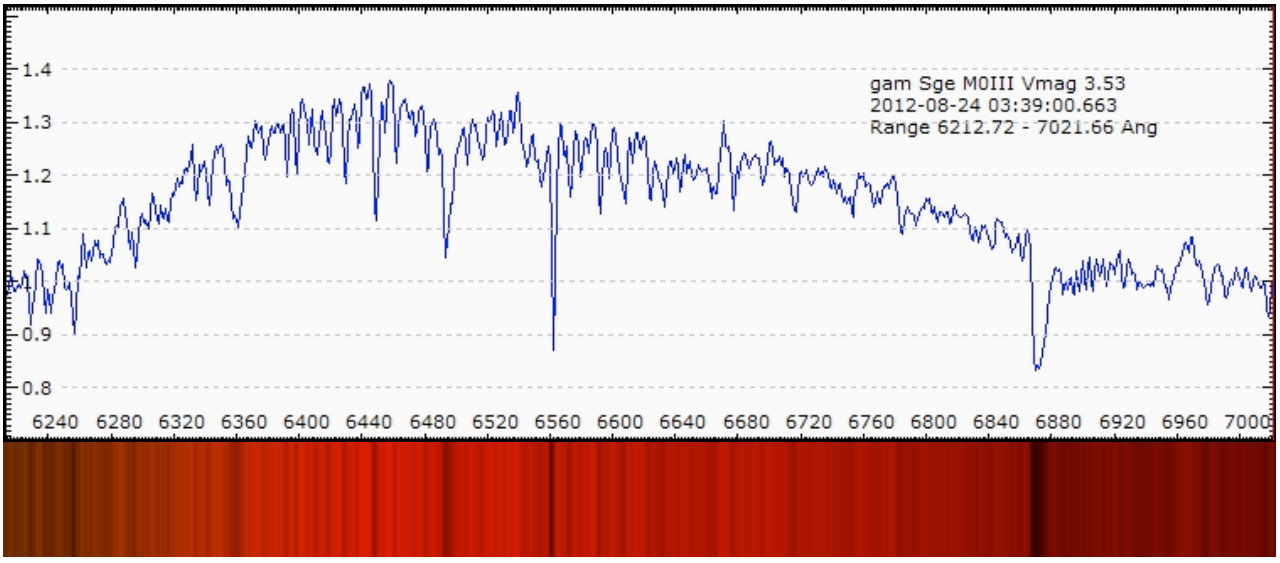
For example, if we measure our star's H-alpha line at 6563 Å and *c* (the speed of light) is 300,000 km/s, we have: (6563 – 6562) / 6562 * 300,000 = radial velocity of +45.7 km/s

Save 2 files. Move the vertical red line out of view to the right. Go to file_Export bmp to save the graph as a bmp image file. Next, under Tools click Synthesis to display a gradient image of your spectrum. Right click in the gradient and choose Colorer to produce a synthesized color spectrum. Move the vertical red line out of view. Right click in the color image and hit Exporter to save a bmp image file of the color bar. Vspec adds "-s" to the file name, identifying this as the synthesized color image.

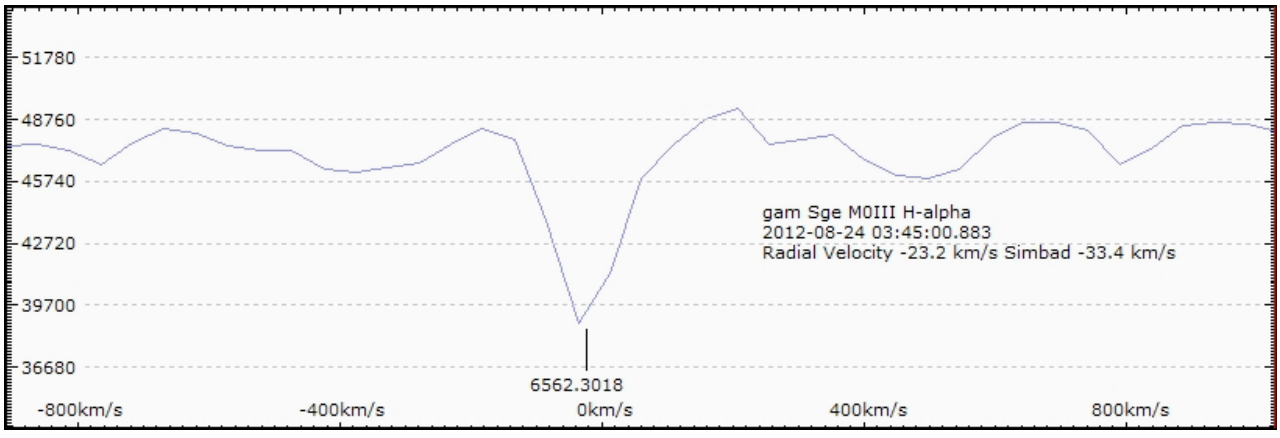
Additional Resources:

Visual Spec Software http://www.astrosurf.com/vdesnoux/
Vspec tutorial http://www.astrosurf.com/vdesnoux/tutorial.html
Simbad Astronomicl Database http://simbad.u-strasbg.fr/simbad/
Balmer Lines http://en.wikipedia.org/wiki/Balmer_series
Absorption Lines http://en.wikipedia.org/wiki/Absorption_line

Observatory SGS spectra processed in VSpec



Gamma Sge SGS data and spectrum -Student Peter Roomian



Gamma Sge radial velocity -Student Peter Roomian