

Group Members:

Stellar Spectroscopy

This lab makes use of software from CLEA (Contemporary Laboratory Exercises in Astronomy) which is being developed by Gettysburg College in PA. The purpose is to illustrate how astronomers classify stars according to characteristics in their spectra.

Part 1: Learning how to collect the spectrum of a star

The software simulates both the taking of spectra and the analysis of spectra. You will look at both parts. Begin with taking data. You will find the program by going to **Start**, then **Programs**, then **Astronomy Programs**, then **Classification of Stellar Spectra**. Choose **login** and enter your names. You are now in the main menu. Select **Run** from the menu. This provides two choices. Choose **Take Spectra**. The program simulates taking data using a telescope. You will need to begin by opening the dome. Once it is open you will need to turn the tracking on. This is to compensate for the rotation of the earth. Because of the earth's rotation the stars will appear to drift westward as time goes on. The telescope must move with them in order to keep them in the field of view.

Changing the direction in which the telescope is pointing is called slewing. You have controls to slew the telescope north, south, east, or west. (Move the mouse so that your cursor points at one of these directions then hold down the mouse button.) You also can set the slew rate. Experiment with it a little and then choose a fairly bright star to make a spectrum of. Center it in the box and then choose **Change View**. This will change to a magnified view. Again center the star--this time between the lines. You are now ready to choose **Take Reading**.

The data taking will begin when you choose **Take Reading** then **Start**. You will be able to watch the spectrum take shape as the data builds up. Initially the features are hard to see because there are so few counts the data is lost in the noise. But as additional data comes in the statistics get better and you will see the spectral features develop. The readout gives the signal to noise ratio. A signal to noise ratio of 100 is adequate to be able to classify spectra. You can stop the integration when it is appropriate by clicking on **Stop**. As you will be analyzing the spectrum you just too click on **Save** and enter the **Object** number for the **Number/ID of Star**. The program will give you the name of the file your spectrum was saved under. Record the file name below

Bright Star File Name: _____

Now, go back (Click on **Return** and then **Change View**) and choose a second star, a dim one this time, and make a spectrum for it. Describe the differences in working with the bright star and with the dim star. Save the spectrum as before and record the file name

Dim Star File Name: _____

Part 2: Learning how to classify the spectrum of a star

Now go back to the **Run** menu and choose **Classify Spectra**. Click on **Load** then **Unknown Spectrum** then **Program List** then on the first star on the list (e.g. HD124320—that is the 124,320 star in the Henry Draper catalog). Also load the Atlas of Stellar Spectra-Main Sequence. This will allow you to determine the approximate spectral type of your star by making comparisons with reference. One way of proceeding is to minimize the Main Sequence and then move **Up** or **Down** through the standards until your unknown matches the standard. You can also make comparisons by choosing **Difference** to get a plot of the difference between a standard and the unknown. It is still possible to move up and down through the standards.

Once you have identified the spectral class of the star, go to **Table 1: Prominent Spectral Features of Stars** on the next page. From this table determine the expected spectral features for your star and record them in the data table.

Now you are ready to measure the wavelength of several spectral lines for your star. To do this, move the cursor so that it is directly on the spectral line, then double click with the left mouse button. This will mark the spectral line with a red line and tell you the corresponding wavelength. You may want to **Zoom In** to get as accurate a reading as possible. Measure and record the wavelengths of several spectral lines in your data table. Then **Load** the **Spectral Line Table** and use it to identify these spectral lines from their wavelengths. Are these lines consistent with the expected spectral features for your star? Are there any missing or extra lines? Note these in your data table.

Repeat these measurements for one other star from the list of unknowns and the two stars you measured in the first part of the lab. The data tables at the end of this activity can be used to record your data on each star.

Table 1: Prominent Spectral Features of Stars in Different Spectral Classes

Spectral Class	Prominent Spectral Features
O	Lines of ionized Helium (e.g. He II) Lines of multiply ionized elements such as O III, N III, C III, Si IV Balmer lines of Hydrogen (H_{α} , H_{β} , H_{γ} , H_{δ} , H_{ϵ}) rather weak
B	Lines of neutral helium (He I) Lines of ionized elements such as O II, N II, C III, Fe III Balmer lines of Hydrogen (H_{α} , H_{β} , H_{γ} , H_{δ} , H_{ϵ}) moderately strong
A	Balmer lines of Hydrogen (H_{α} , H_{β} , H_{γ} , H_{δ} , H_{ϵ}) very strong Other features very weak or absent
F	Balmer lines of Hydrogen (H_{α} , H_{β} , H_{γ} , H_{δ} , H_{ϵ}) moderately strong Lines of some ionized elements such as Ca II, Ti II, Fe II. (Ca II is about as strong as H_{γ})
G	Balmer lines of Hydrogen (H_{α} , H_{β} , H_{γ} , H_{δ} , H_{ϵ}) present but weaker than in hotter stars Lines of neutral elements strong (e.g. Fe I, Ti I, Mg I) Lines of easily ionized elements (e.g. Ca II) are strong
K	Lines of neutral elements strongest. Ca II still present but weaker
M	Spectrum dominated by molecular features (e.g. TiO, C_2 , CH) Balmer lines weak Many lines of neutral elements

Data Tables

Star #1

Star name:	HD 124320	
Spectral type:		
	Measured wavelength	Name of line
Spectral line #1		
Spectral line #2		
Spectral line #3		
Expected Spectral Lines		
Observed Spectral Lines		
Missing/Extra Lines		

Star #2 (from Program List of Unknown Spectrum)

Star name:		
Spectral type:		
	Measured wavelength	Name of line
Spectral line #1		
Spectral line #2		
Spectral line #3		
Expected Spectral Lines		
Observed Spectral Lines		
Missing/Extra Lines		

Star #3: Your Bright Star

Star name:		
Spectral type:		
	Measured wavelength	Name of line
Spectral line #1		
Spectral line #2		
Spectral line #3		
Expected Spectral Lines		
Observed Spectral Lines		
Missing/Extra Lines		

Star #4: Your Dim Star

Star name:		
Spectral type:		
	Measured wavelength	Name of line
Spectral line #1		
Spectral line #2		
Spectral line #3		
Expected Spectral Lines		
Observed Spectral Lines		
Missing/Extra Lines		